

SYSTEM DRIVES

ACS6000

User manual



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1. About this manual

1.1. Equipment covered by this manual

This manual covers standard drive and provides generic information on the drive. The manual does not claim to cover all variations and details of the drive, nor to consider all eventualities that may arise during installation, commissioning, operation and maintenance of the drive.

If the drive is adapted to specific customer needs or applications, and handling, installation, and operation of the drive are affected by these modifications, information on these modifications is provided in the appropriate documentation (such as layout drawings, wiring diagrams, project-specific data, engineering notes).

If information is required beyond the instructions in this manual, refer the matter to ABB.

1.2. Structure of the user documentation

The documentation for a standard drive consists of this document and the following project-specific appendices.

NOTE – These appendices are NOT included in this document.

- **Appendix A - Additional manuals** provides manuals about additional equipment delivered with the drive (such as project-specific options such as pulse encoder or fieldbus interfaces), or information on modifications of the standard drive.
- **Appendix B - Technical data** contains the technical data sheets of the drive.
- **Appendix C - Mechanical drawings** provides the outline drawings of the drive. The drawings are generated according to the customer-specific project.
- **Appendix D - Wiring diagrams** contains the circuit diagrams with information on device identification, cross-reference and device identification conventions. The diagrams are generated according to the customer-specific project.

NOTE – “Setting of protective devices” is generated according to the customer-specific project.

- **Appendix E - Parts list** is produced for each project and contains all information to identify a component.
- **Appendix F - Test reports and certificates** provides the test reports of the drive. Quality certificates, and codes and standards the drive complies with are added if necessary for the project.
- **Appendix G - Signal and parameter table** includes descriptions of actual signals, control and status words, and control parameters and their default settings.

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ACS6000	User manual	3BHS212794 E01	Q	en	19/272

1.3. Terms and abbreviations

The following table lists terms and abbreviations you should be familiar with when using this user manual. Some of the terms and abbreviations used in this user manual are unique to ABB and might differ from the normal usage.

Table 1–1 Terms and abbreviations

Term	Definition
AC	Alternating current
ACDA	Auxiliary Control Device Adapter
ACS6000	ACS6000 medium voltage AC drive
ACU	Air Cooling Unit
AF100	Advant Fieldbus 100 Communications interface between the I/O stations and the Advant Controllers
AI	Analog input
AMC	The application and motor controller (AMC) is a digital signal processor and the heart of the drive control system.
AMCOS	Application and Motor Controller Operating System
ANSI	American National Standards Institute
AO	Analog Output
APU	Auxiliary Pump Unit
ARU	Active Rectifier Unit The ARU rectifies the voltage of the supply network to the DC voltage and maintains the DC-link voltage at a constant level irrespective of changes in the supply network. The unit is designed as a self-commutated, 3-level voltage source inverter consisting of three identical phase modules. The unit allows regenerative braking.
ASE	Anti Saturation Equipment
Azipod®	ABB's electric propulsion system for ships
BCU	Braking Chopper Unit
BOD	Break Over Diode. Bods protect semiconductors such as thyristors and diodes against transient voltages.
CBU	Capacitor Bank Unit
CCB	Converter Control Board
CDP Control panel	Serves as the basic user interface for operating and monitoring the drive when the local operating mode has been selected, also known as assistant control panel.
CHU	Charging Unit
CIT	Conductivity Transmitter
CIU	Customer Interface Unit

Table 1–1 Terms and abbreviations (continued)

Term	Definition
CIW	Customer interface unit integrated into the water cooling unit (WCU)
$C_N P_N$	C_N stands for the cluster number of an S800 I/O device. P_N stands for the position of an S800 I/O device within the cluster.
Converter	Short form for ACS6000 frequency converter
COU	Control Unit The COU consists of a control compartment and a customer interface compartment. The control compartment incorporates the hardware for control, monitoring and protection functions of the drive and the communication interface to the door-mounted control panel.
CW1	Control water system 1
CW2	Control water system 2
CVMI	Current and Voltage Measuring Interface
DBC	Drive Backup Control
DC	Direct Current
DC_NP	DC Neutral Point. Neutral point of the DC link of the drive
DCS	Acronym for the AC-to-DC converter or the three-phase AC power controller of an excitation unit
DDCS	Distributed drive control system. DDCS is an acronym for a serial communications protocol designed for data transfer via optical fibers.
DI	Digital Input
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DIU	Discharging Unit
DO	Digital Output
Drive	Synonym for ACS6000 frequency converter
Drive system	The drive system includes all equipment for converting electrical into mechanical power to give motion to the machine.
Drivebus	Communication link dedicated for ABB drives
DriveDebug	DriveDebug is part of ABB's DriveWare® software tools for devices using the DDCS communications protocol. DriveDebug runs on computers with Windows® operating systems. DriveDebug is a specialist tool used to diagnose, tune and troubleshoot frequency converters.
DriveWindow	DriveWindow is a DriveWare® product. DriveWindow is a 32 bit Windows® application for commissioning and maintaining ABB drives equipped with fiber-optic communication.
DTC	Direct Torque Control
DTL	Direct-to-line
EAF	Earth Fault monitoring device
ECB	Excitation Circuit Breaker

Table 1–1 Terms and abbreviations (continued)

Term	Definition
EIC	Excitation Input Contactor
EMC	Electromagnetic Compatibility
EOB	Excitation Output Breaker
EPLD	Erasable Programmable Logic Device
Equipment	Frequency converter and related equipment
ESP	Electric Submersible Pump
EXU	Excitation Unit The EXU supplies excitation power to a synchronous motor.
FBA	Fieldbus Adapter
FCB	Function Chart Builder
FCI	Fieldbus Communication Interface
FFU	Fin Fan Unit
FIR filter	Fast Impulse Response filter
FIS	Flow meter
FT	Firing Through Synonym for protective firing. Meaning: simultaneous gating of the power semiconductors of the inverter unit to effectively protect the semiconductors against overvoltage and overcurrent.
FSCD	Fast Short-Circuit Detection
Ground (noun)	Earth
ground (verb)	The conducting path (eg, conductor) between the electric equipment (eg, frequency converter) and the earth. The electric equipment is connected to the earth, eg, by a grounding set or a grounding switch.
GCT	Gate-Commutated Thyristor
GDR	Gate Driver Board
GRAY	Gray-coded interface for determining the absolute position of a rotor.
GTO	Gate Turn-Off thyristor
HVD	High Voltage Divider
I/O	Input / Output
ID	Induced Draft fan
IEC	International Electrotechnical Commission
IFU	Input Filter Unit
IGBT	Insulated-Gate Bipolar Transistor
IGCT	Integrated Gate-Commutated Thyristor
ISU	Isolation Unit
IM	Induction Motor

Table 1–1 Terms and abbreviations (continued)

Term	Definition
INT	Interface circuit board
INU	Inverter Unit The INU converts the three DC voltages to the required AC motor voltage. The unit is designed as a self-commutated, 3-level voltage source inverter consisting of three identical power modules.
I/O device	Term of ABB's S800 I/O system. An I/O device consists of a module termination unit (MTU) and one I/O module.
I/O module	Term of ABB's S800 I/O system. The I/O module is an active input or output device for digital or analog signals.
I/O station	Term of ABB's S800 I/O system. The I/O station typically consists of a bus modem and several input and output devices.
IOI	Inverter Output Isolator The IOI is a switching device that disconnects the inverter from the motor.
IP	Ingress Protection The IP code specifies the degree of protection provided by an enclosure.
IPS	Isolated Power Supply
Line voltage	RMS voltage of the main power supply of the drive
LSU	Line Supply Unit The LSU rectifies the AC line voltage and supplies the electrical energy to the DC link capacitors.
MCB	Main Circuit Breaker The MCB is a major protection device of the drive and the main connection and disconnection point between the main power supply and the drive.
MSM	Main State Machine
MVD	Medium Voltage Drive
NBIO	Fast I/O module
NDBU-95	DDCS branching unit
NETA-21	Monitoring and diagnostics tool that allows access to the drive from any location in the world via a secure Internet connection.
NP	Neutral Point The term refers to the neutral point of the DC link
NTAC	Pulse encoder interface module
PAI	Pulse Amplifier Interface board
PCB	Printed Circuit Board
PE	Protective Earth Ground bus for the connection of the ground cable
PFF	Power Feed Forward
PF	Power Failure

Table 1–1 Terms and abbreviations (continued)

Term	Definition
PG	Power Ground Ground bus for the connection of cable shields
Phase module	The phase module is a compact assembly of wired components including the power semiconductors that serves as a standardized building block for the ARU, LSU and INU of the drive.
PINT	Pulse Interface Circuit Board
POM	Power Operation Mode
PPCC	Power Plate Communication Circuit
PPCS	Power plate communication system PPCS is an acronym for a serial communication protocol designed for data transfer via optical fibers between AMC circuit board and INterface circuit boards
PUB	PPCS unit for branching software running on an INT circuit board that is used for data branching
PUPA	Pulse pattern
PWM	Pulse width modulation
RAL	German color standard
RBU	Resistor Braking Unit
RDC	Redundant Drive Control
RDI	Redundant Drive Interface
RDR	Receive Data Register
RMD	Rolling Mill Drive
RPM	Revolutions Per Minute
S800 I/O	The S800 I/O is a distributed process input output system that can be connected to various process controllers from ABB and other companies.
SC	Short-Circuit
SM	Synchronous Motor
SRD	Semi-Redundant Drive
SSI	Synchronous Serial Interface The SSI is a point-to-point, serial communication interface for digital data transmission between a master (eg, drive) and a slave (eg, sensor).
TCSM	Torque Controller State Machine
TEU	Terminal Unit The TEU provides the terminals for the transformer and motor cables, the ground frame for the cable screens and the ground cable, and the grounding accessories.
THD	Total Harmonic Distortion
TT	Temperature Transmitter

Table 1–1 Terms and abbreviations (continued)

Term	Definition
UPS	Uninterruptible Power Supply
USB	Universal Serial Bus
VLSCD	Voltage Limiting Short Circuit Detection
VLU	Voltage Limiter Unit
VSD	Variable Speed Drive
VSI	Voltage Source Inverter
WCU	Water Cooling Unit The WCU dissipates the heat from the power electronics components of the drive.
Zero speed threshold	Used in the manual to indicate that the drive has reached the value “zero speed” that is set in a parameter. The value can be set in the range of 0 and maximum speed (the unit for the speed is rpm).

1.4. Related documents

The following documents are available for supplementary information:

Table 1–2 Maintenance

Title	ABB ID
ACS6000 preventive maintenance schedule	3BHS855273 E01

Table 1–3 Technical data

Title	ABB ID
Technical data from drive smart (configuration software for medium voltage drives)	
Air-cooled excitation units, brush brushless excitation technical data	3BHS299399 E01

Table 1–4 Schematics

Title	ABB ID
Layout drawing	Project-specific

Table 1–5 Specifications and guidelines

Title	ABB ID
Main circuit breaker specification	3BHS125149 E60
ARU - main transformer specification	3BHS356582 E01
ABB MVD ACS Transformer Specification	3BHS356582 E01
ABB MVD ACS Motor Specification	3BHS824803 E01
Technical project Specification Motor	3BHS824804 E01
ABB MVD ACS High Performance Motor Specification	3BHS824805 E01
ABB MVD ACS High Speed Motor Specification	3BHS824806 E01
Power cable specification	3BHS125090 E01
Power cables engineering guideline	3BHS542290 E01
Auxiliary power and control cables guideline	3BHS813742 E01
Voltage transformer requirement specification	3BHS125393 E01
Emergency-off and stop modes and prevention of operation	3BHS196243 E01
Recycling instructions	3BHS122085 E01
Environmental information, material declaration	3BHS360175 E01
Roxtec CF16EMC installation instructions	3BHS820829 E01
ACS6000/ACS6080 label placement	3BHS544773 E01
Painting specification for ACS1000, ACS2000, ACS5000 and ACS6000/ACS6080	3BHS104301 E01

Table 1–6 Service

Title	ABB ID
Service equipment	3BHS264536 E01
ACS6000 Service manual	3BHS202077 E01

Table 1–7 Communication interfaces

Title	ABB ID
AF 100 fieldbus - NAFA-01 installation and start-up guide	3BFE58919837
DCS800 drives firmware manual	3ADW000193R0801
Emergency off/stop modes and prevention of operation & safe torque off	3BHS196243
Modbus TCP - NETA-21 remote monitoring tool user manual	3AUA0000096939
Modbus RTU - NMBA-01 installation and startup guide	3AFY58919772
Profibus - NPBA-12 installation and startup guide	3BFE64341588
S800 I/O Getting started	3BSE020923
S800 I/O Modules and termination units	3BSE020924

Table 1–8 User manuals related to drive units

Title	ABB ID
ACS5000, ACS6000 and ACS6080 water cooling unit WCU800 user manual	3BHS821937 E01
ACS5000, ACS6000 and ACS6080 water cooling unit WCU1400 user manual	3BHS835714 E01

1.5. Target groups and required qualification

The drive presented in this manual is part of an industrial environment where voltages are present that contain a potential hazard of electric shock and / or burn. For this reason, only personnel who have a thorough knowledge of the drive and the industrial environment and have obtained the required qualification should handle, install, operate, or maintain the drive.

The manual addresses personnel who are responsible for unpacking, transportation, installation, operation and maintenance of the drive. The personnel must carry out the below listed tasks in a manner that does not cause physical harm or danger, and ensures the safe and reliable functioning of the drive.

IMPORTANT! Commissioning of the drive must only be performed by qualified and certified ABB personnel.

1.5.1. Handling

Personnel must be skilled and experienced in unpacking and transporting heavy equipment.

1.5.2. Mechanical installation

The personnel must be qualified to prepare the installation site according to the site and equipment requirements and to perform the installation accordingly.

1.5.3. Electrical installation

Personnel must have a sound knowledge of the relevant electrical codes and specifications covering low and medium voltage equipment, be experienced with electrical wiring principles and know the electrical symbols typically used in wiring diagrams.

1.5.4. Operation

The personnel include all persons who operate the drive from the local operator panel of the drive. The personnel must know the functions of the operator panel, be adequately trained for the drive, and know the driven process. Special knowledge of frequency converter technology is not required.

1.5.5. Maintenance

The personnel include all persons who

- Are qualified to carry out preventive and corrective maintenance on drive as described in this manual
- Are thoroughly familiar with the drive
- Have a sound knowledge of the relevant electrical codes and specifications covering low and medium voltage equipment
- Are able to assess the hazards associated with the energy sources of the drive and act correspondingly
- Know the safe shutdown and grounding procedures for the drive system

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1.6. User's responsibilities

It is the responsibility of those in charge of the drive to ensure that each person involved in the installation, operation or maintenance of the drive has received the appropriate training and has thoroughly read and clearly understood the instructions in this manual and the relevant safety instructions.

1.7. Intended use of equipment

Those in charge of the drive must ensure that the drive is only used as specified in the contractual documents, operated under the conditions stipulated in the technical specifications and on the rating plate of the drive, and serviced in the intervals specified by ABB.

Use of the drive outside the scope of the specifications is not permitted.

Intended equipment use also implies that only spare parts recommended and approved by ABB must be used.

Unauthorized modifications and constructional changes of the drive are not permitted.

1.8. Quality certificates and applicable standards

The following certificates and conformity declarations are available with ABB:

- ISO 9001 and ISO 14001 certificates stating that ABB Switzerland Ltd has implemented and maintains a management system which fulfills the requirements of the normative standards
- EC declaration of conformity
- List of standards the drive complies with (see “Appendix F - Test reports and certificates”)

Table 1–9 Standards that are referred to in this document

Standard	Title
ANSI Z535.6	'American national standard for product safety information in product manuals, instructions, and other collateral materials'
ISO 3864-2	2004 (E) - 'Graphical symbols - Safety colors and safety signs - Part 2: Design principles for product safety labels'
ISO 7010	2011 (E) - Graphical symbols - Safety colours and safety signs - Registered safety sign
EN 50110	'European standard code for electrical work safety'
ISO 13849-1	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design, section 6.2.6 Category 3
IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
IEC 60721-3-1	Classification of environmental conditions: Classification of groups of environmental parameters and their severities; Storage

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Table 1–9 Standards that are referred to in this document (continued)

Standard	Title
IEC 60721-3-2	Classification of environmental conditions: Classification of groups of environmental parameters and their severities; Transportation
IEC 60721-3-3	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 3: Stationary use at weather-protected locations
ISO 3506-1	Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and stud
IEC 81346-1	Industrial systems, installations and equipment and industrial products - Structuring principles and reference designations - Part 1: Basic rules
IEC 62477-2	Safety requirements for power electronic converter systems and equipment Part 2: Power electronic converters from 1000 V AC or 1500 V DC up to 36 kV AC or 54 kV DC

1.9. Identifying the delivery

The drive and accessories are identified by the type code printed on the rating label.

The rating label is located on the back of the control compartment door.

The label provides information on the type of drive, the rated voltage, the frequency and the current of the main and the auxiliary power supply.

1.10. Tools

ABB offers various tool sets containing all necessary tools and equipment for installation, commissioning and maintenance of the drive. The content of the tool sets is described in the Service Equipment manual.

2. Important safety information



Read this material carefully before working on or around the equipment. Failure to do so can result in serious Injury or DEATH! Keep for future reference.

2.1. Safety standards

The following industry standards are observed:

- ANSI Z535.6
- ISO 3864-2
- ISO 7010
- EN 50110

2.2. Safety messages

The following safety messages are provided to help prevent personal injury and damage to the equipment. The indicated hazard level is based on the ANSI Z535.6 standard.



This is the safety alert symbol. It is used to alert you to potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.



DANGER Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.



NOTICE Is used to address practices not related to physical injury, but which can result in equipment damage.

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2.3. Product safety labels

Safety labels are affixed to the drive components to alert personnel of potential hazards when working on the equipment. For more information, see the label placement document for the drive. The instructions on the safety labels must always be followed and the labels must be kept in a perfectly legible condition.

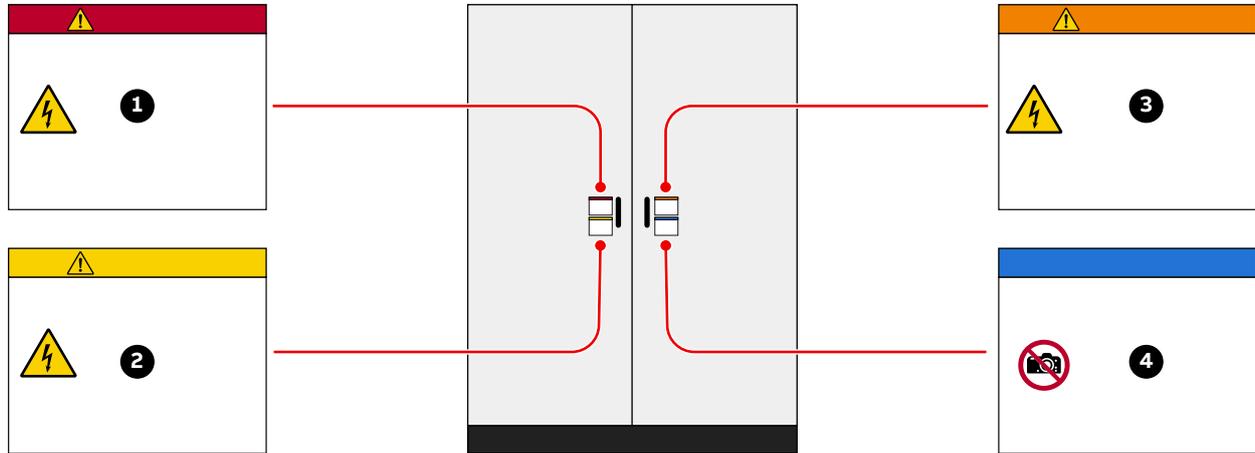


Figure 2–1 Product warning label examples (label placement depends on the drive)

- | | |
|------------------|------------------|
| 1) Danger label | 3) Caution label |
| 2) Warning label | 4) Notice label |

Additional safety labels, including the following, might also be provided:



Electricity warning

This sign can also have additional text below it, eg, “High voltage”.



Hot surface



Crushing of hands



No access for people with active implanted cardiac device

The magnetic field of the drive can influence the functioning of pacemakers. The pacemaker sign should be installed at the entrance to the drive room or at a minimum distance of 6 m from the drive to stop personnel with pacemakers approaching the drive.

2.4. General safety instructions



1) Minimize hazards



2) Before energizing the drive:

- Remove all foreign objects from the drive
- Fasten all internal and external covers securely
- Close, lock, and/or bolt all doors
- Move the release dial of the door safety switches into the locked position



3) Before working on the drive:

- Turn off, lock out, and tag out the main and auxiliary power supplies to the drive
- De-energize the drive
- Ensure that the safety ground connections are in place
- Ensure that the appropriate personal protective equipment (PPE) is available and used when required
- Inform the involved personnel about the potential safety hazards
- Wear hearing protection when a drive is running.



4) While working on the drive:

- Do not step on the roof
- Do not install foreign objects on the roof



5) Before working on a water cooling unit (WCU):

In addition to the safety instructions for working on a drive, always read the WCU safety data sheet for relevant safety information, eg, the type of ion exchange resin and glycol.



6) Before working simultaneously on the drive and on other drive system equipment:

- Observe the relevant safety codes and standards
- Turn off all energy sources for the equipment
- Ensure that all lockout and tagout devices are in place
- Install barriers around and use appropriate covers on the equipment that is still energized
- Inform the involved personnel about the potential safety hazards



7) In case of fire in the drive room:

- Observe the established rules and regulations for fire safety
- Only allow firefighters with the appropriate PPE to enter the drive room

2.5. The 7 steps that save lives

ABB's 7 steps that save lives concept is a series of actions that must take place prior to commencing work on or near electrical installations.



1) Prepare for the work: do an on-site risk assessment or job hazard analysis that considers the limits of approach for shock and arc-flash.

- Be in possession of a clear work order to execute the work.
- When required, the access or work permit is to be obtained by a person who is authorized for the specific electrical system.
- Engage the person responsible for electrical equipment or system to review single-line diagrams, schematics, switching plans, etc.
- Ensure the competence of workers.
- Check for proper tools for the job.
- Determine and select the proper arc-rated Personal Protective Equipment (PPE).
- Decide of the appropriate work methods and initiate the Permit To Work (PTW) process.



2) Clearly identify the work location and equipment.

- Use your senses (sight, hearing and smell) to identify problem areas.
- Define the work area via barriers and barricading and label equipment.
- Avoid distractions such as talking or texting on the phone.



3) Disconnect all sources of supply and secure against reconnection by applying Lockout/Tagout.

- If ABB is responsible for switching and it cannot be done remotely, then the person performing the switching must be properly trained and wearing the proper PPE identified in step 1.
- The Person in Charge of Work (PICW) must ensure that switching is performed in the proper manner by witnessing it from a safe distance if present on site or by engaging the person responsible for switching to identify all isolation points.
- Apply Lockout/Tagout (LOTO) to the energy isolation device and if multiple energy isolation devices are involved, then Group LOTO must be implemented with the PICW serving as the Group LOTO Leader.

**4) Verify the absence of operating voltage: always test before you touch!**

Only use properly rated and inspected voltage detection devices and wear proper PPE identified in step 1:

- Test voltage detection device
- Test for voltage
- Test voltage detection device

It is highly important that the voltage detection device is tested on a known voltage source such as a Proving Unit or by performing an internal self-test, according to the manufacturer's instructions, before and after testing for the absence of operating voltage.

**5) Carry out earthing and short-circuiting.**

- Close and lock the earthing switch if the electrical equipment is designed for this purpose or apply portable equipment for earthing and short-circuiting.

If this is carried out by the customer, then the PICW must ensure that this equipment is properly earthed as a part of the integration/verification and during step 7 when the PICW walks the PTW.

**6) Protect against adjacent live parts and take special precautions when close to bare conductors.**

- Determine minimum approach distances, apply screening or shrouding, and when applicable, padlock both cable and busbar shutters.
- If working within the restricted approach boundary or vicinity zone where inadvertent movement could cause contact with live parts, special precautions must be employed, such as the use of the properly rated insulated gloves and tools.

**7) Complete the permit to work and "Walk the Permit".**

- Check isolation points
- Verify that all circuits are isolated and secured
- Ensure all parties are integrated with the Lockout/Tagout
- Check the earths are properly applied
- Answer specific questions from the working group
- Ensure the work can proceed without danger
- Complete and verify the "Permit to Work"

2.6. Possible residual risks

Residual risks must be considered by the drive system integrator and/or plant owner when assessing the hazards of the equipment to personnel. The following risks can pose a hazard to drive system personnel:

**1) Electric power equipment generates electro-magnetic fields which can cause a hazard to people with metal implants and / or a pacemaker.**

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2) Drive system components can move unintentionally when being commissioned, operated, or serviced due to:

- Operation of the equipment outside the scope of the specifications
- Incorrectly assembled or installed equipment
- Incorrectly connected cables
- External influence on, or damage of the equipment
- Incorrect parameter settings
- Software errors
- Faulty hardware



3) Hazardous touch voltages can be present on drive system components, which can be caused by:

- Operation of the equipment outside the scope of the specifications
- External influence on, or damage of the equipment
- Induced voltages by external equipment
- Condensation on equipment components, or pollution
- Faulty hardware



4) High temperatures, noise, particles, or gases can be emitted from drive system components caused by:

- Operation of the equipment outside the scope of the specifications
- External influence on or damage of the equipment
- Incorrect parameter settings
- Software errors
- Faulty hardware



5) Hazardous substances can be emitted from drive system components, eg, due to incorrect disposal of components

2.7. Important note - main circuit breaker

The main circuit breaker (MCB) is a major protection device of the drive. If a serious fault occurs in the drive, the MCB must disconnect the main power supply to the drive immediately. The main power supply must be disconnected without delay on an open or trip command from the drive to prevent hazard to the personnel and further damage to the equipment. The MCB is located on the primary side of the converter transformer.

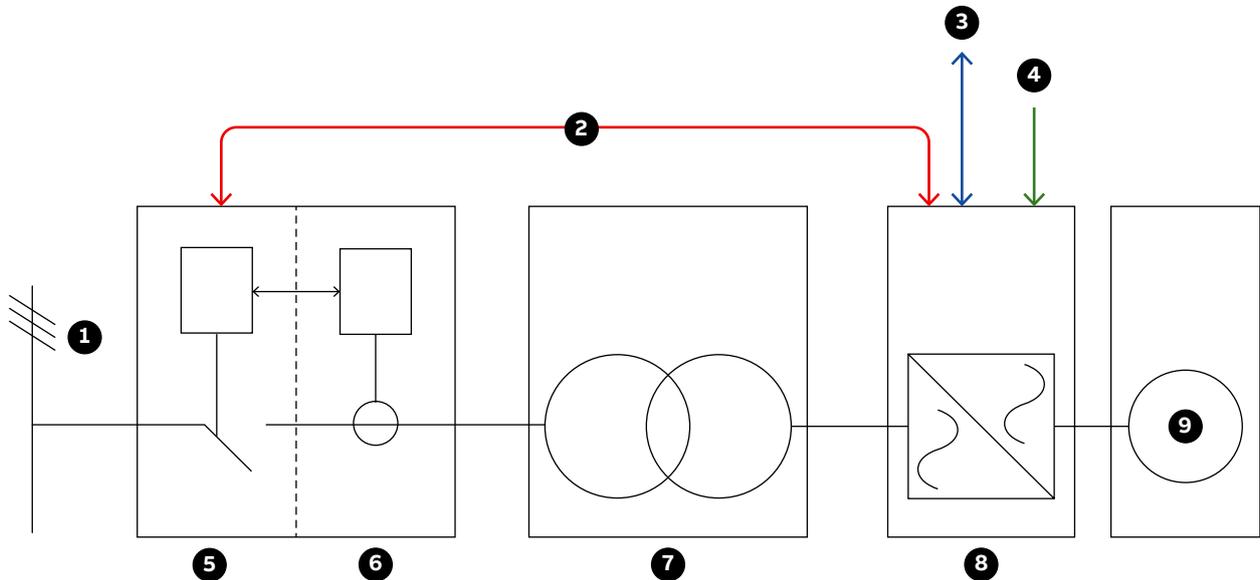


Figure 2-2 Drive system overview

- | | |
|--------------------------------|--------------------------|
| 1) Main power supply | 6) Protection relay |
| 2) MCB control interface | 7) Converter transformer |
| 3) Higher-level control system | 8) Drive |
| 4) Local MCB control | 9) Motor |
| 5) MCB | |

NOTE – MCBs and protection relays are not included in the drive supply.

Typical MCBs devices

- Vacuum circuit breakers
- SF6 circuit breakers
- Fused contactors or motor control centers

Dedicated protection relay

- Transformer or drive primary cable protection (DTL)
- Transformer protection (if applicable)
- Transformer secondary cable protection (if applicable)
- Backing up the drive protection

2.7.1. Safety and protection requirements

The system integrator must ensure that the following minimum safety and protection requirements for the drive are met:

- ISO 13849-1
- IEC 60204-1

2.7.2. Safety and protection requirements for the MCB

The following safety requirements are also in the MCB specifications for the drive:

- **MCB open and/or trip command:** must be wired directly from the drive to the MCB. If you want to wire the command through a PLC or DCS system, the system must be certified to meet SIL three-level requirements and to fulfill the maximum MCB opening timing requirements. The drive must also be able to open the MCB at any time. It is not permitted to interrupt the open and/or trip command, eg, with a local-remote switch in the MCB.
- **Closing control of the MCB:** when the MCB is in service position, the drive must have exclusive control over closing the MCB, ie, local closing of the MCB is not permitted.
- **MCB maximum opening time:** cannot exceed the maximum time that is defined in the product or project-specific MCB specifications.

Typical maximum values for the drive are defined as follows:

- **Maximum protection trip time:** 75 ms
The maximum protection trip time is the maximum allowed breaking time (open and arcing) of the breaking device after the open command has been initiated to prevent further damage to the drive, such as diode failures.
- **Maximum safety trip time:** 500 ms
The maximum safety trip time is the maximum allowed time to ensure safe disconnection of the main power supply to prevent any hazard to personnel.

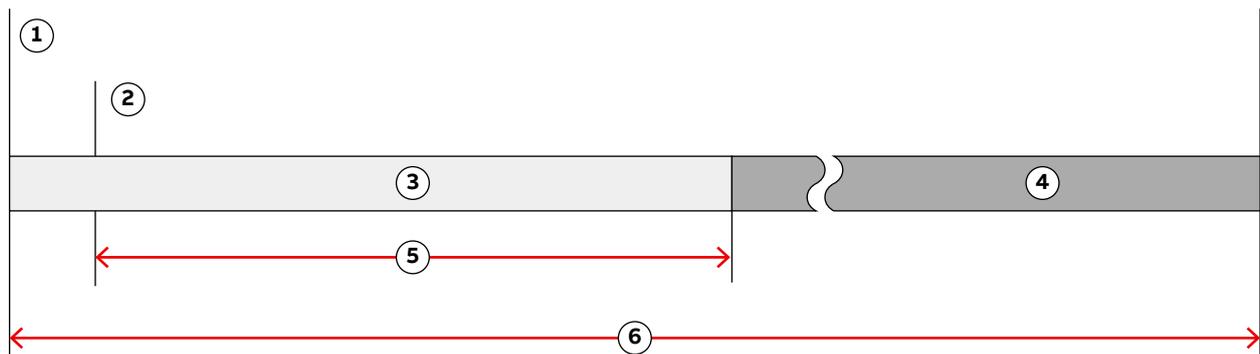


Figure 2-3 MCB opening timing diagram

- 1) Short-circuit occurs
- 2) Open and or trip command is set at the drive control output
- 3) No further damage to the drive
- 4) No hazard to personnel
- 5) Maximum protection trip time
- 6) Maximum safety trip time

In order to meet the stipulated safety requirements, ABB recommends one of the following:

- MCB is equipped with 2 independent opening coils
- MCB is equipped with an opening coil and an undervoltage coil for monitoring of the control voltage
- Upstream protection coordination scheme is provided which uses the “breaker failure” (ANSI 50BF) signal to automatically trip the upstream breaker, in case the MCB does not open.

IMPORTANT! The upstream breaker must open within the maximum safety trip time after a failure has occurred.

2.8. Maintenance recommendation

The MCB trip circuits should be checked annually.

3. Power electronics and cabinet features

3.1. Drive system topology

The ACS6000 drive system consists of the following components:

- **Main circuit breaker:** For more information, see section 2.8, **Maintenance recommendation**, page 39.
- **Input transformer:** Required if the line voltage must be adapted to the motor voltage. For more information, see the “Main transformer specification”.
- **Drive**
- **Motor**

3.1.1. Drive

The ACS6000 is a voltage source frequency converter for high-power induction and synchronous motors. The drive features a common DC bus permitting the configuration of single-motor or multi-motor solutions.

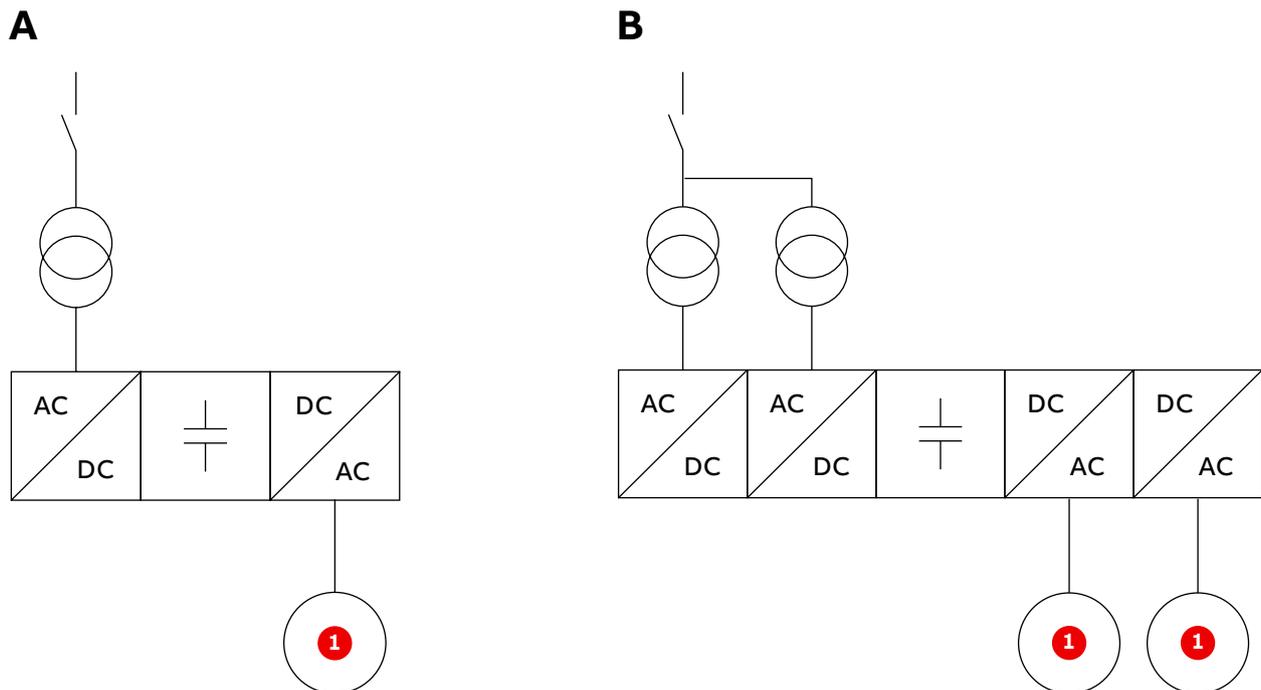


Figure 3-1 Common DC-bus principle for single motor drive (A) and multi-motor drive (B)

1) Motor

The drive has a flexible modular design with standard and optional cabinet units. Each cabinet unit is dedicated to a specific function.

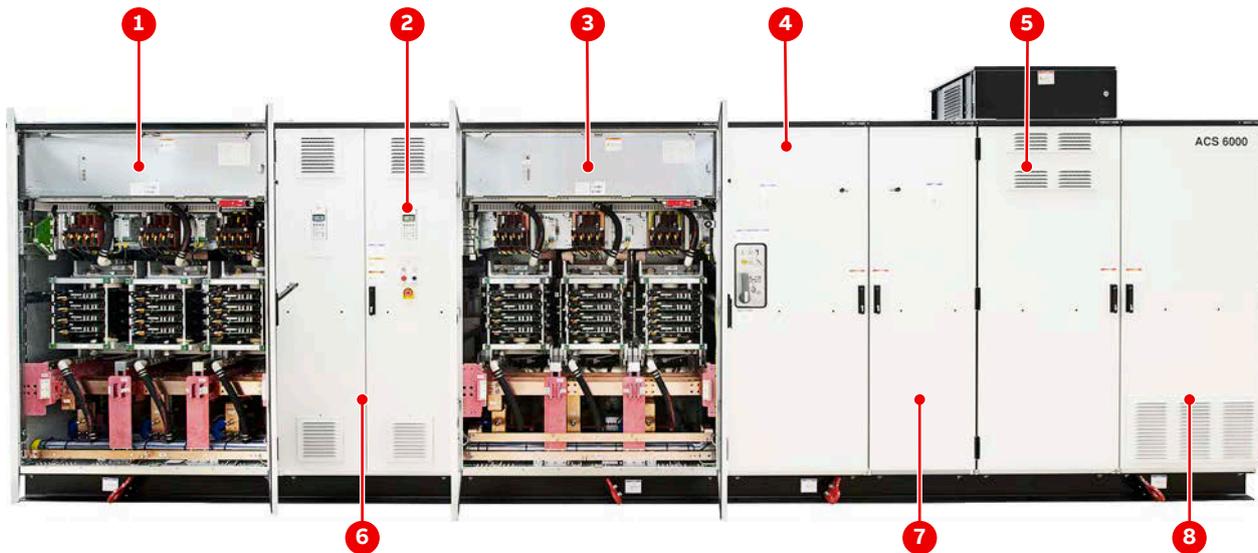


Figure 3–2 ACS6000 drive example

- | | |
|--|--|
| <p>1) Active rectifier unit (ARU):
Self-commutated, 6-pulse, 3-level voltage source inverter with IGCT technology</p> <p>2) Drive control panel for local operation:
Keypad with multi-language display, main supply on/off push buttons, and emergency-off push button</p> <p>3) Inverter unit (INU):
Self-commutated, 6-pulse, 3-level voltage source inverter with IGCT technology</p> <p>4) Capacitor bank unit (CBU):
DC capacitors for smoothing the intermediate DC voltage</p> | <p>5) Water cooling unit (WCU):
Supplies deionized water for cooling the main power components</p> <p>6) Terminal unit (TEU) and control unit (COU):
Contains the power terminals and the control swing frame</p> <p>7) Braking chopper unit (BCU), resistor braking unit (RBU) or voltage limiter unit (VLU):
Optional cabinet units</p> <p>8) Excitation unit (EXU):
Optional cabinet unit that supplies a synchronous motor with excitation</p> |
|--|--|

The drive is assembled from standard and optional cabinet units. Each unit is dedicated to a specific function.

For more information on the cabinet units in your drive, see the layout drawing in “Appendix C - Mechanical drawings”.

3.1.1.1. ACS6000 cabinet units

Standard cabinet units	Optional cabinet units
– Active rectifier unit (ARU)	– Input reactor unit (IRU)
– Inverter unit (INU)	– Input filter unit (IFU)
– Line supply unit (LSU)	– Voltage limiter unit (VLU)
– Capacitor bank unit (CBU)	– Braking units:
– Terminal unit (TEU)	• Resistor braking unit (RBU)
– Control unit (COU)	• Braking chopper unit (BCU)
– Water cooling unit (WCU)	– Excitation unit (EXU)
	– Customer interface unit (CIU)

3.1.1.2. Final drive configuration

The final drive configuration depends on the following factors:

- Required output power
- Configuration of the main power supply (input transformer or direct-to-line connection)
- Ability to recover energy (active or diode front end)
- Motor type (synchronous or asynchronous)
- Single or multi-motor application.

3.1.2. Motor

See the “Motor specification”.

3.2. Standard cabinet units

The following sections describe the ARU, INU, LSU, CBU, TEU, COU and WCU cabinets.

3.2.1. Active rectifier unit (ARU)/inverter unit (INU)

An ARU and INU have the same mechanical and electrical designs.

- **ARU:** 6-pulse self-commutated voltage source inverter that rectifies the line voltage of the supply network and maintains the DC-link voltage at a constant level irrespective of changes in the supply network.

The active 6-pulse rectifier allows for regenerative braking.

- **INU:** controls the 3-phase motor voltage and converts the DC-link voltage to the required AC motor voltage and frequency.

The INU is a self-commutated voltage source inverter in 6-pulse, 3-level topology. To increase the drive power, 4 units can be operated in parallel on 1 motor.

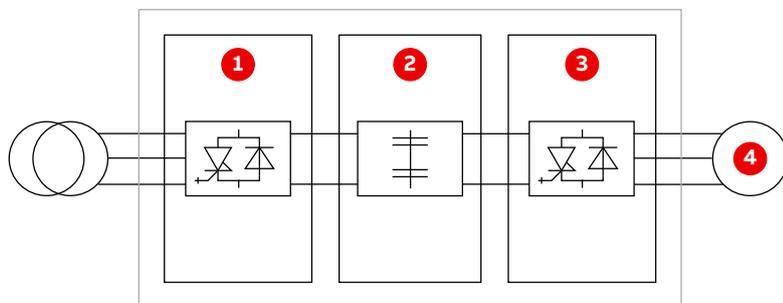


Figure 3-3 ARU/INU block diagram

- | | |
|------------|----------|
| 1) ARU | 3) INU |
| 2) DC-link | 4) Motor |

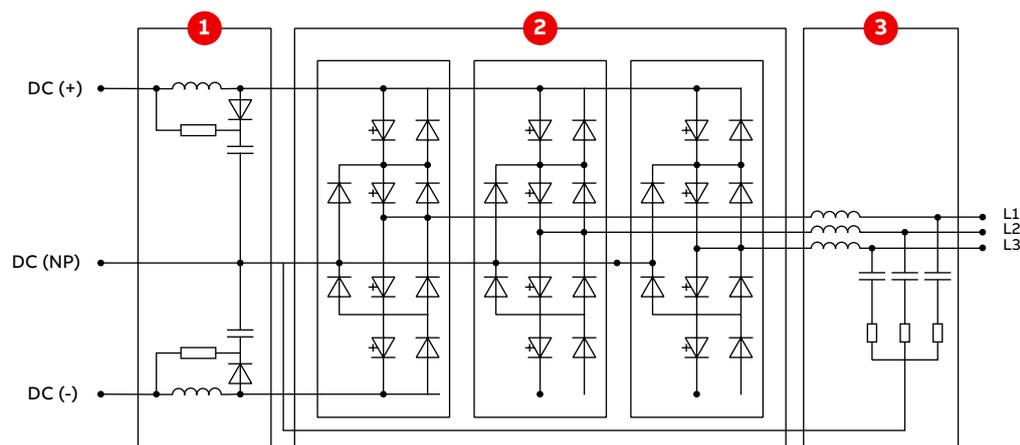
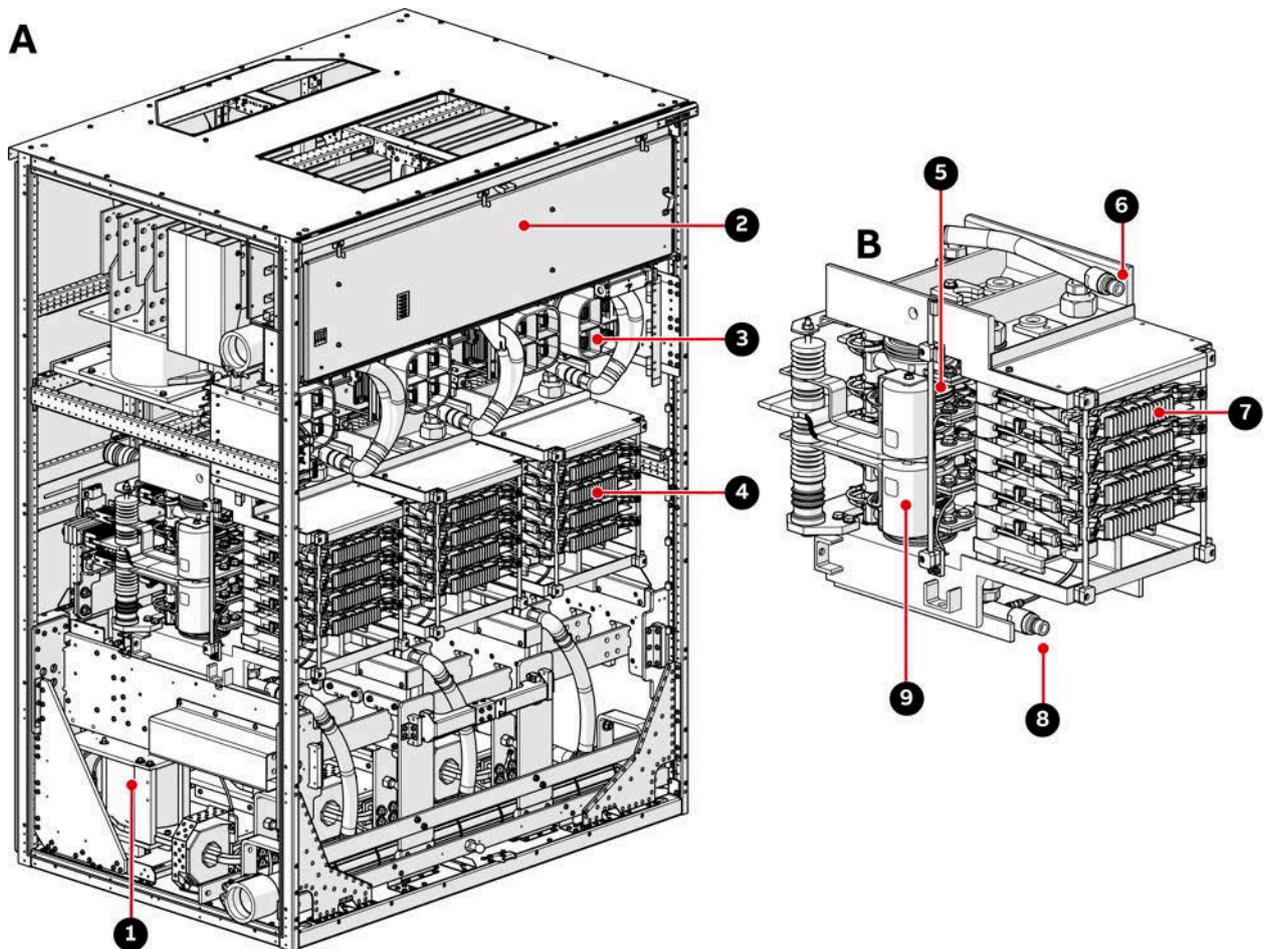


Figure 3-4 ARU/INU circuit diagram

- | | |
|---------------------|---------------|
| 1) Clamping circuit | 3) EMC filter |
| 2) Phase modules | |

Table 3–1 Main components in an ARU/INU cabinet

Component	Description
Phase module	Consists of integrated gate-commutated thyristors (IGCTs), diodes and clamp capacitors. The phase modules are identical in construction for all power ratings. However, the types of semiconductors vary depending on the power rating. For this reason, it is not possible to mix phase modules for different power ratings in one unit.
Clamping circuit	Protects the circuit from excessive rises in current with di/dt reactors and freewheeling diodes.
Electromagnetic compatibility (EMC) filter	Protects the transformer from excessive voltage slopes

**Figure 3–5 ARU/INU (A) and phase modules with IGCTs (B)**

- | | |
|----------------------|--------------------|
| 1) EMC filter | 6) Coolant outlet |
| 2) Control interface | 7) IGCT |
| 3) IPS | 8) Coolant inlet |
| 4) Phase module | 9) Clamp capacitor |
| 5) Diode | |

3.2.2. Line supply unit (LSU)

The LSU is a 12-pulse rectifier that rectifies the AC line voltage and supplies the DC link with electrical energy. An LSU is used with input transformers and is available in various power ratings.

The LSU allows two-quadrant operation and maintains the power factor at 0.95 in the whole operating range.

To achieve 24-pulse rectification or to increase the drive power, units with the same power rating can be operated in parallel.

Two different types of LSUs exist.

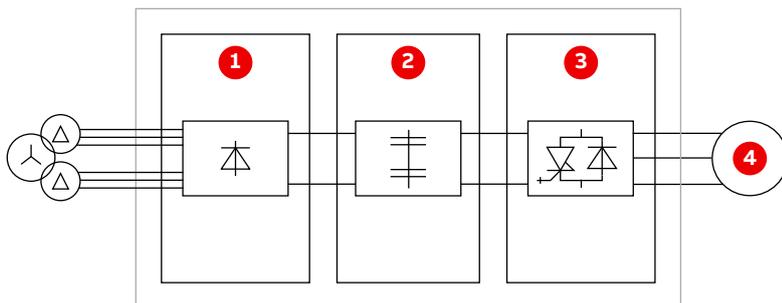


Figure 3-6 LSU block diagram

- | | |
|------------|----------|
| 1) LSU | 3) INU |
| 2) DC-link | 4) Motor |

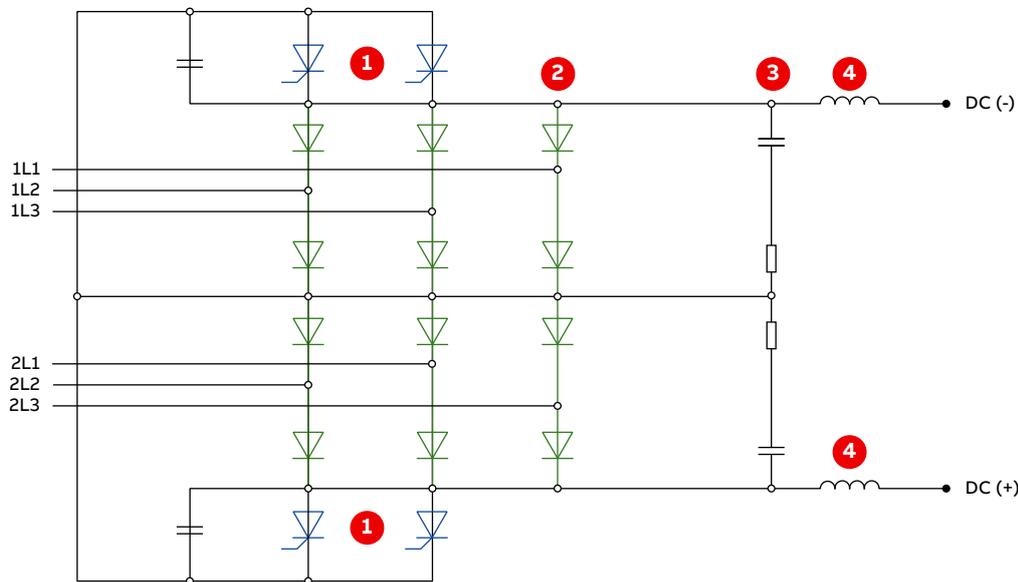


Figure 3-7 LSU (12-pulse) circuit diagram

- | | |
|----------------------|--------------------|
| 1) Thyristor crowbar | 3) Snubber circuit |
| 2) Diode rectifier | 4) di/dt choke |

Table 3–2 Main components in a 12-pulse LSU cabinet

Component	Description
12-pulse diode rectifier	
Snubber circuit	Limits the rate of the voltage rise (dv/dt) across the diodes and the crowbar thyristors.
di/dt limiting reactors	Define the current rise in the thyristor crowbar.
Thyristor crowbar	Protection circuit that activates when a short-circuit occurs. By applying protection firing, the thyristor crowbar short-circuits the rectifier to prevent further damage of the drive.

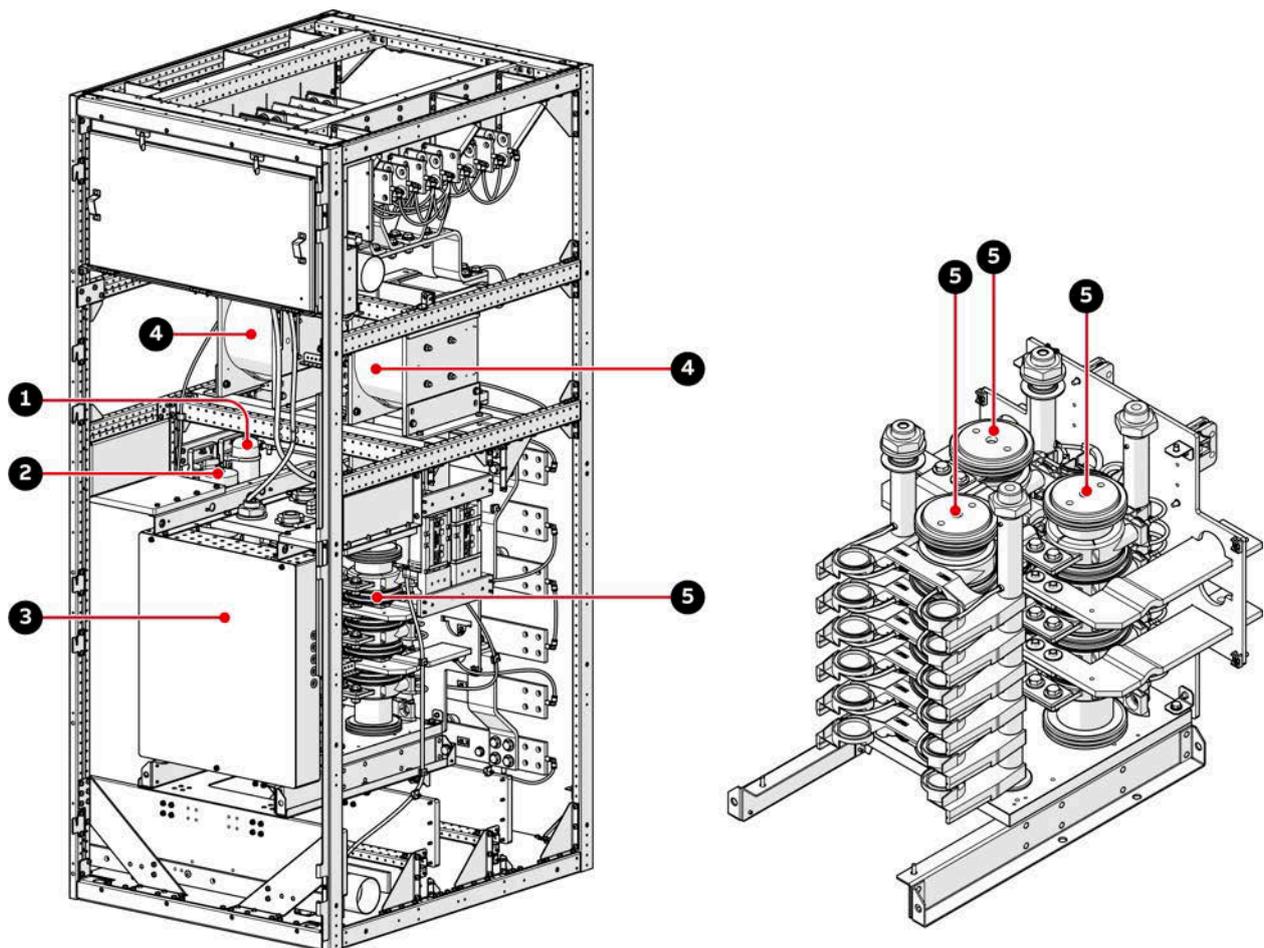


Figure 3–8 LSU (12-pulse)

- | | |
|------------------------------|----------------------------|
| 1) Snubber resistor | 4) di/dt limiting reactors |
| 2) Snubber capacitor | 5) Diode stacks |
| 3) Rectifier monitoring unit | |

3.2.3. Capacitor bank unit (CBU)

The capacitor bank unit (CBU) smooths the DC-link voltage and decouples the rectifier from the inverter. A CBU consists of DC-link capacitors, a charging unit and a grounding switch. The CBU is based on a modular design and the amount of DC-link capacitors in the CBU depends on the converter power rating.

The width of the unit (800 mm or 1000 mm) depends of the number of capacitors that are required.

Table 3–3 Main components in a CBU cabinet

Component	Description
Liquid-cooled DC-link capacitors	
Charging unit	To avoid excessive inrush currents after the main circuit breaker has been closed, the capacitors are charged before the drive is connected to the main power source.
Discharging unit	This optional unit discharges the DC-link capacitors if the drive is not equipped with a voltage limiter unit, resistor braking unit or braking chopper unit.
Grounding switch	The grounding switch is a safety switch to ground the DC bus of the drive. These can only be closed if the DC-link capacitors have been discharged. For more information, see section 8.5, EXU control panel , page 174.

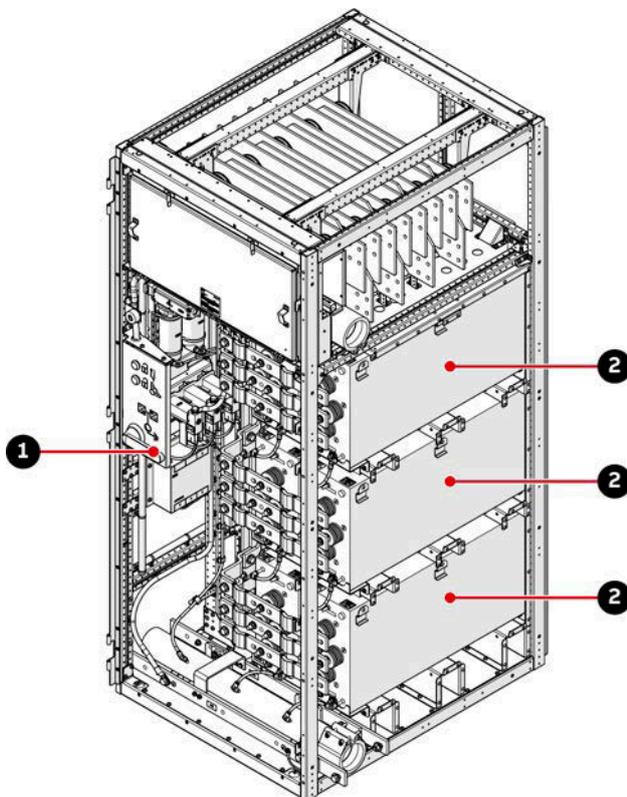


Figure 3–9 CBU

1) Grounding switch

2) DC-link capacitor

3.2.4. Terminal unit (TEU)

Mains and motor cables of the drive are connected to terminal busbars of TEUs. These units are designed for top or bottom cable entry.

The terminal units are available either as individual units or are integrated into a master COU or ARU.

The width of the unit (600 mm or 1000 mm) depends of the number of line supply units or active rectifier units and/or the motors supplied via one terminal unit.

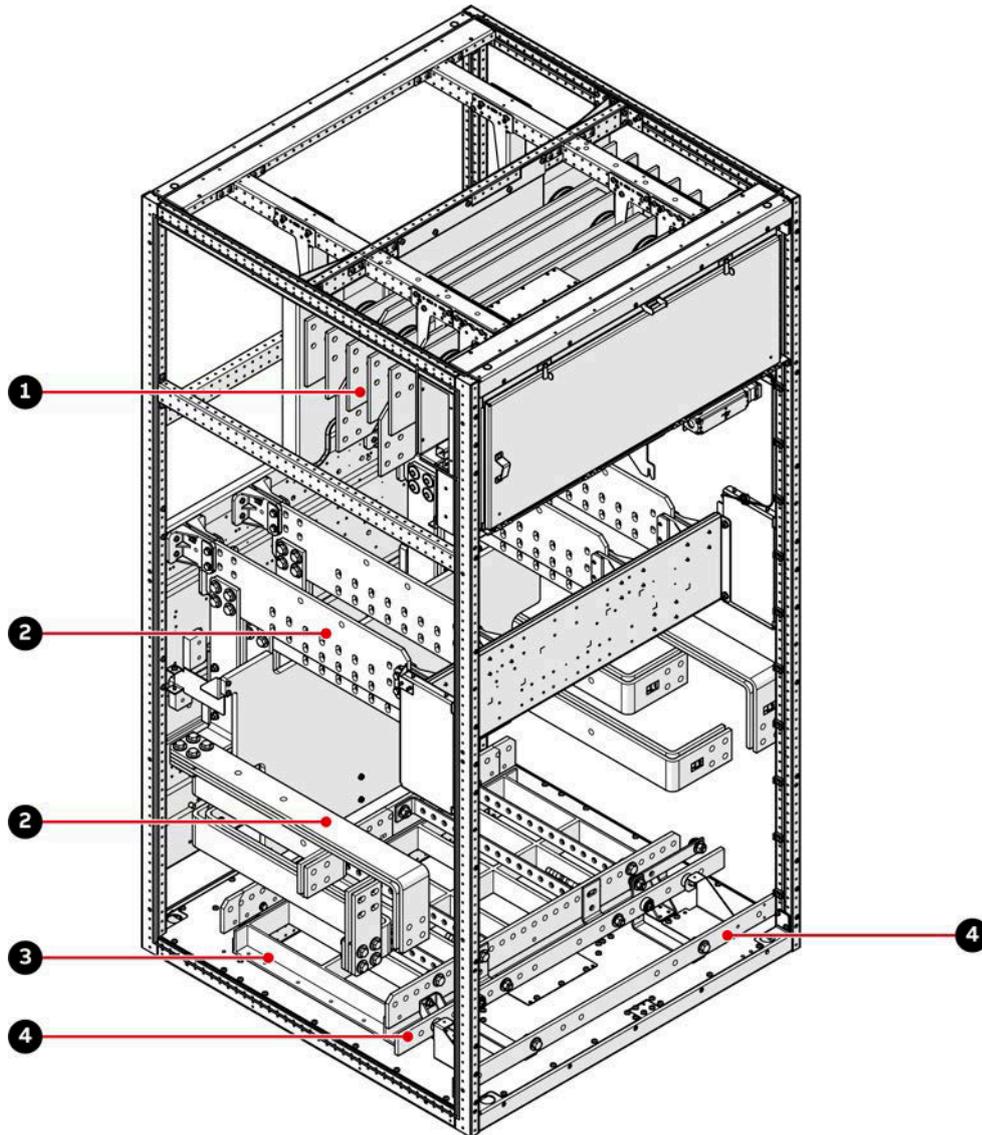


Figure 3–10 TEU (1000 mm)

- | | |
|---------------|----------------------|
| 1) DC busbars | 3) Cable entry frame |
| 2) AC busbars | 4) PE ground busbars |

3.2.5. Control unit (COU)

The COU incorporates the hardware for the control, monitoring and protection functions of the drive, and the communication interfaces to the local control panel and to the remote control hardware.

3.2.5.1. COU versions

The number of COUs in the drive depends on the configuration and application of the drive:

- Typically, an ARU in combination with an inverter unit (INU) shares the control unit of the first INU.

Depending on the selected options and the configuration of the drive, a separate control unit is used for the ARU.

If an LSU is part of the drive, all rectifier- and line-related functions are implemented in the control unit of the INU.

- A separate control unit is assigned to each INU that supplies a single motor.
- If several INUs supply one motor, they share one control unit.

For information on the number of control units and their location in the drive, see “Appendix C - Mechanical drawings”.

The hardware components of a COU are fitted on a swing frame. The size of the swing frame and the mounting position of the components depend on the cabinet version where the swing frame is installed in Fig. 3–11.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
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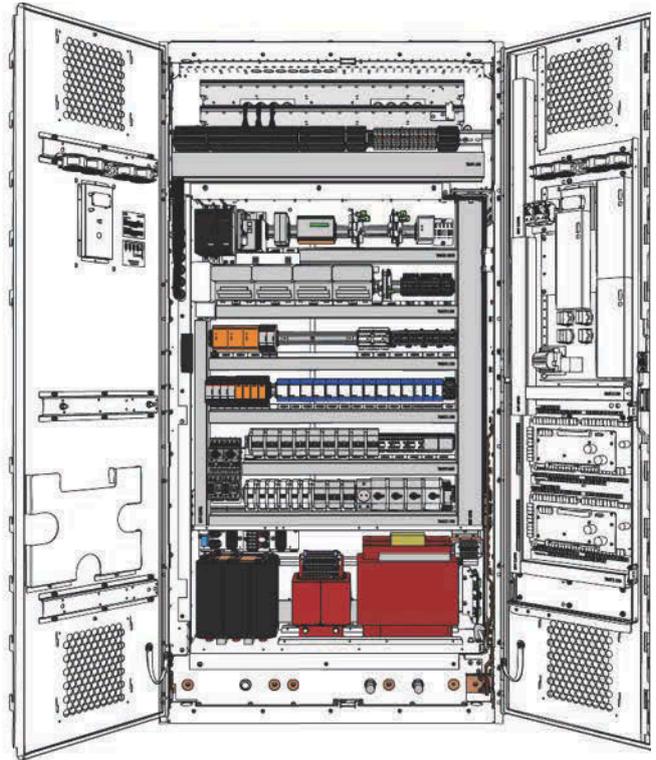
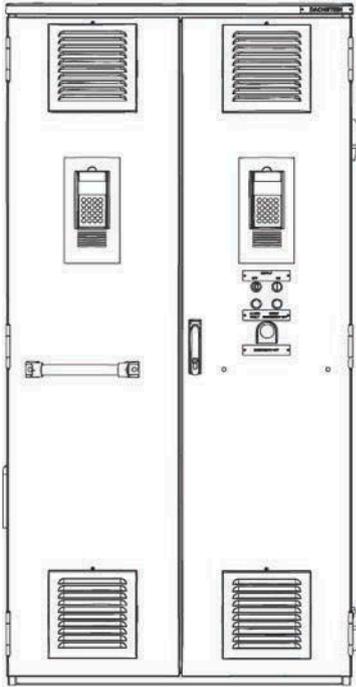
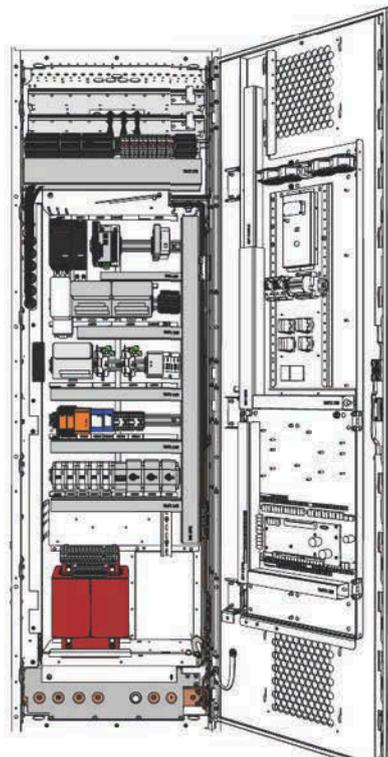
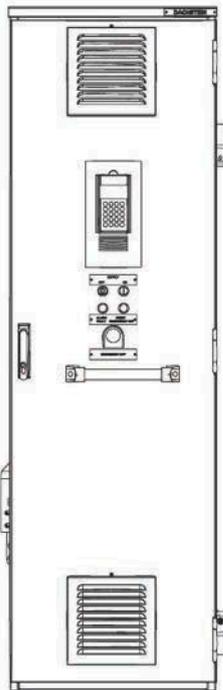
A**B**

Figure 3–11 Control units: 1000 mm COU (A) and 600 mm COU (B)

3.2.5.2. Control system configuration

The control system of the drive has a decentralized structure to support the modular design of the drive and to ensure fast and reliable data and signal transfer between the individual drive units. Identical hardware is used for control, monitoring, measurement and protection on both throughout the drive. However, circuit boards of the same type can be equipped with different software depending on the function the circuit board fulfills.

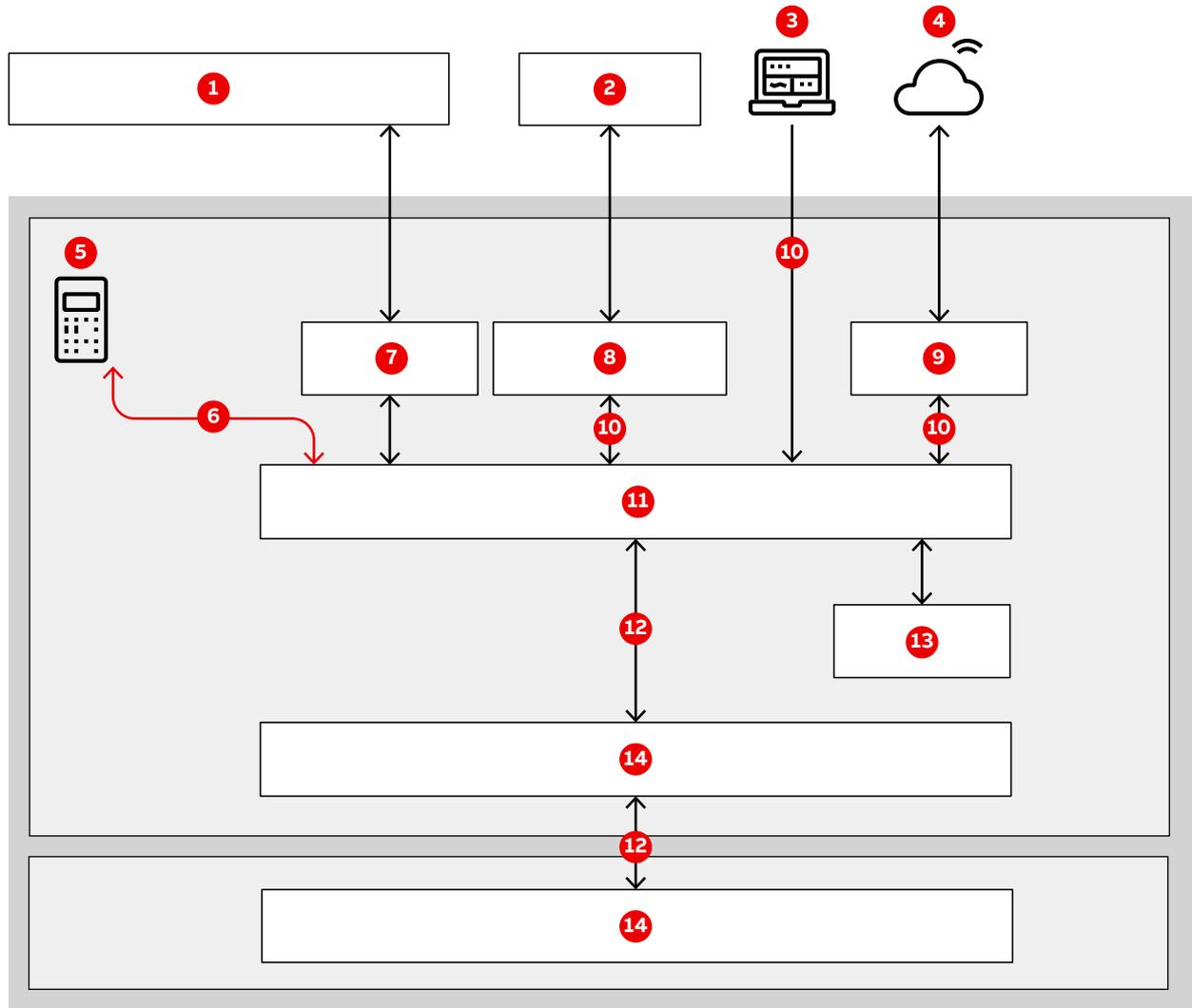


Figure 3–12 Block diagram of control system

- | | |
|--------------------------------|----------------------------|
| 1) Higher-level control system | 8) S800 I/O devices |
| 2) External devices | 9) NETA-21 |
| 3) DriveWare | 10) DDCCS |
| 4) Cloud connectivity | 11) AMC circuit board |
| 5) CDP control panel | 12) PPCS |
| 6) RS485 | 13) Pulse encoder (option) |
| 7) Fieldbus adapter | 14) INT circuit board |

The control system is configured, customized and tuned with a set of application parameters. The application parameters are organized in functional groups and have factory-set default values. The default parameter values are set during commissioning to the specific application of the drive. The settings activate the specific control, monitoring and protection functions for the driven process, and define the signals and data transferred between drive and external equipment.

For more information on the parameters, see the “Appendix G - Signal and parameter table”.

3.2.5.3. AMC circuit board

The AMC circuit board is the major component of the control system and performs general drive, motor control, and closed loop functions. The main internal control hardware and the peripheral input and output interfaces to the customer communicate with the AMC circuit board via optical fibers.

The circuit board is fitted with a Motorola DSP processor and features two PPCS and eight DDCS communication channels. The communication channels are used for high-speed data transfer to the INT circuit boards inside the ARU and INU (Fig. 3–12).

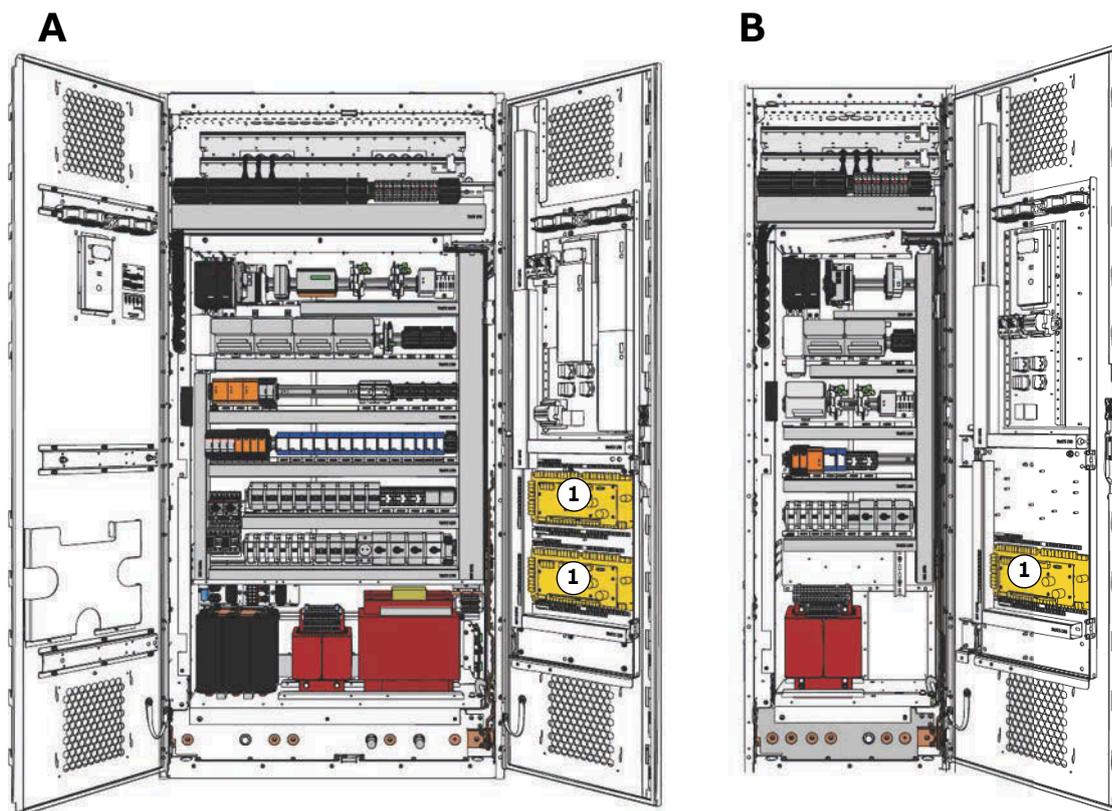


Figure 3–13 Examples of AMC circuit boards in 1000 mm COU (A) and 600 mm COU (B)

1) AMC circuit board

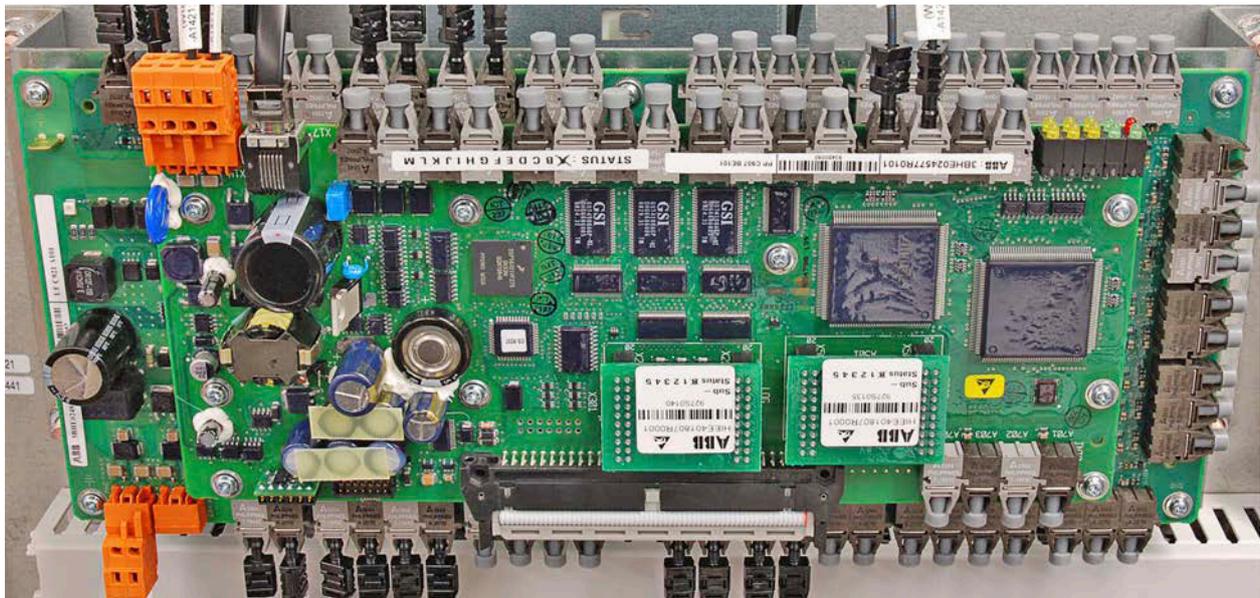


Figure 3-14 AMC circuit board example

The AMC circuit board has specific control and closed-loop tasks assigned to it. The tasks include processing drive and status information, controlling the speed and torque, and monitoring the operation of the drive.

The AMC circuit board continuously monitors all relevant drive variables (eg, speed, torque, current, voltage). Pre-programmed protection functions ensure that these variables remain within certain limits in order to maintain safe operation of the drive. These internal functions are not programmable by the user.

Optionally, the drive offers monitoring of signals from external equipment. These can be activated and set with parameters.

Other general control, protection and monitoring tasks regarding the whole drive include control and monitoring of:

- Main circuit breaker
- Grounding switch
- Door locking system
- Cooling system

For more information on control, protection and monitoring functions, see the “Appendix G - Signal and parameter table”.

3.2.5.4. Main circuit breaker

The main circuit breaker (MCB) is an important switching and protection device of the drive system. Therefore it must only be controlled and monitored by the drive.

For more information, see:

- “Main circuit breaker specification”, 3BHS125149 E60
- **Important note - main circuit breaker**, page 37.

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3.2.5.6. Peripheral I/O devices

The peripheral input and output devices connected to the AMC circuit board include:

- Local control panels
- S800 I/O system for parallel signal transfer to external devices
- Optional fieldbus adapters for serial data transfer to a higher-level control system
- **DriveWare® software tools:** includes software tools such as the commissioning and maintenance tools DriveWindow and DriveDebug, and DriveOPC for data transfer between ABB drives and Windows®-based applications.
- **NETA-21:** monitoring and diagnostics tool that allows access to the drive from any location in the world via a secure Internet connection.

3.2.5.7. Local control panels

Each control unit (COU) is equipped with a local control panel. The control panel serves as the basic user interface for monitoring, control and operation of the drive and setting of parameters.

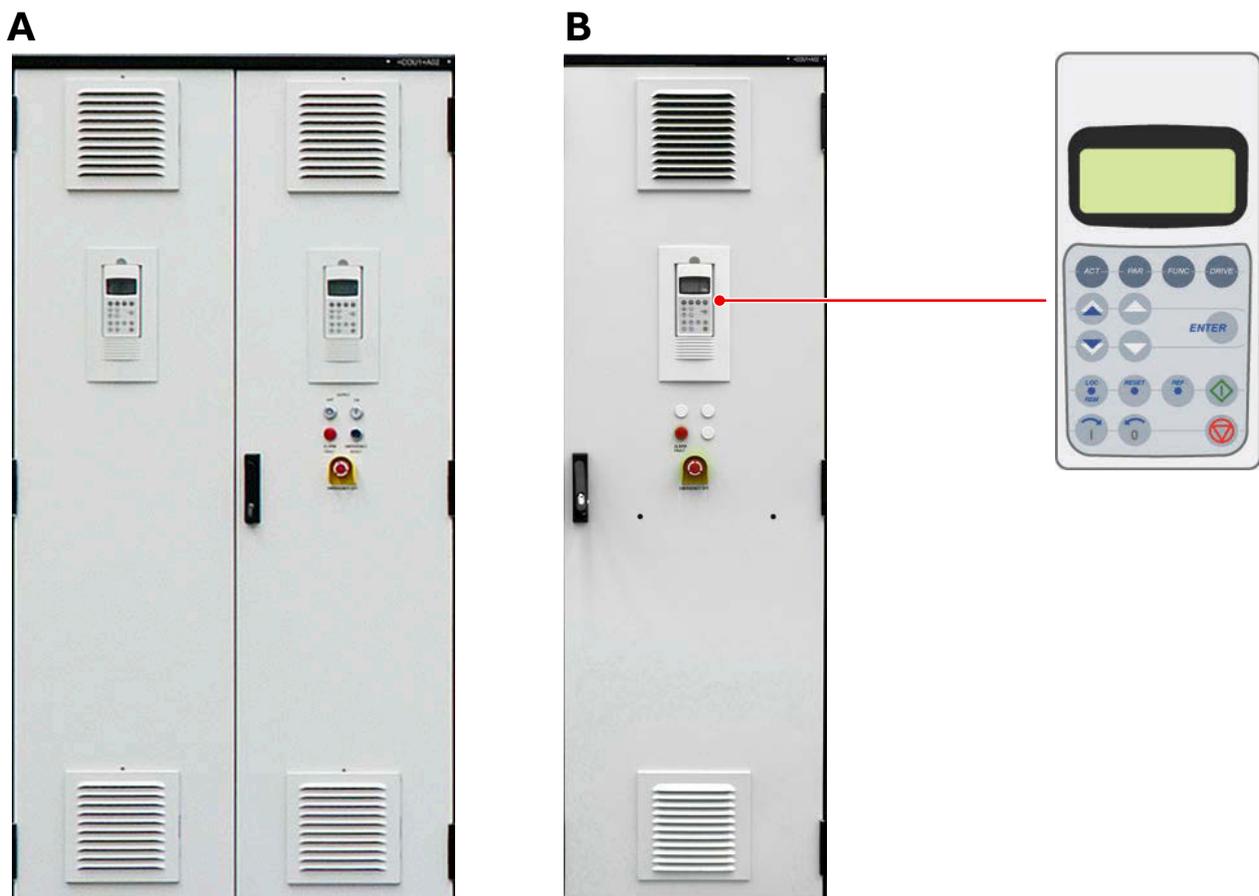


Figure 3–16 Local control panels on 1000 mm COU (A) and 600 mm COU (B)

For more information, see chapter 8, **Operation**, page 169 and section 9, **CDP control panel**, page 191.

3.2.5.8. S800 I/O system

Standard S800 I/O modules connect the internal and external I/O signals to the control system. External I/O signals connect to the terminals inside the water cooling unit (WCU) and are wired internally to their I/O modules.

An S800 I/O station consists of up to 12 I/O modules and a TB 820 bus modem that serves as an interface to the AMC circuit boards. Each I/O module is plugged into a module termination unit that contains the S800 I/O module bus. The module bus transmits the data between the bus modem and the I/O modules. The number of S800 I/O stations per drive depends on the drive configuration.

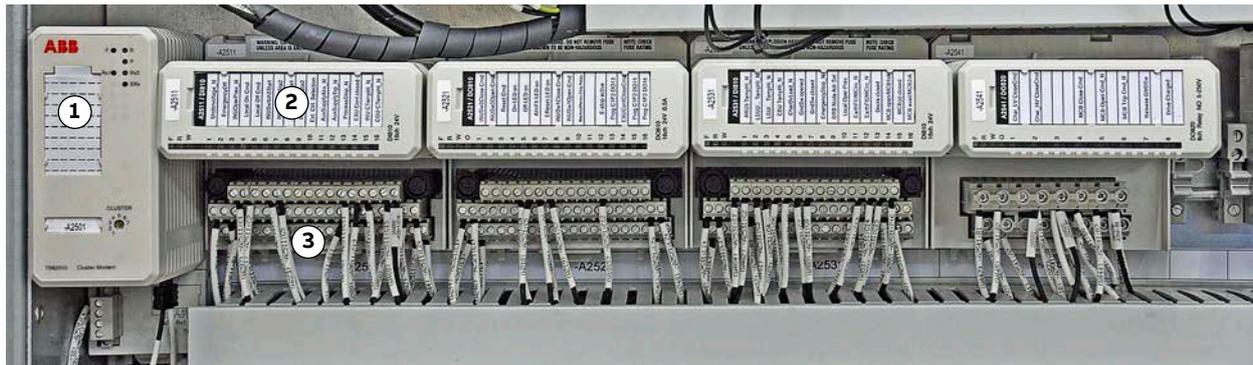


Figure 3-17 Typical S800 I/O station

- | | |
|---------------------|----------------------------|
| 1) TB 820 bus modem | 3) Module termination unit |
| 2) I/O modules | |

For more information, see:

- “S800 I/O Getting started” , 3BSE020923
- “S800 I/O Modules and termination units” , 3BSE020924

3.2.6. Water cooling unit (WCU)

The closed-loop water-cooling system transfers the heat losses of the main power electronics components of the drive (eg, rectifier bridges, inverter phase modules, DC-link capacitors) to the exterior.

Redundant pumps circulate the coolant through the feeding pipes to the power electronics components and transfer the heat losses through the return pipes and the water-to-water heat exchanger.

The water cooling units are accessible for maintenance even when the drive is in operation.

For more information, see:

- “ACS5000, ACS6000 and ACS6080 water cooling unit WCU800 user manual”, 3BHS821937 E01
- “ACS5000, ACS6000 and ACS6080 water cooling unit WCU1400 user manual”, 3BHS835714 E01.

Table 3–4 Main components in a WCU cabinet

Component	Description
Swing frame	Contains the auxiliary power supply switch, the pump motor starters and digital and analog I/O modules for controlling and monitoring the water-cooling circuit.
Control and monitoring devices	Measure the temperature, pressure and conductivity of the coolant. A solution based on a double-sensor configuration is available as an option, to guarantee full operation in case of single sensor failure.
Water pump	Circulates the coolant through the internal cooling circuit. The standard solution is based on redundant pumps (one of the two pumps is always on standby and starts automatically if the running pump fails). An alternative solution based on one pump is also available.
Water-to-water heat exchanger	Transfers the heat from the internal cooling circuit to the external cooling circuit.
Expansion vessel	Used for pressure compensations
Ion exchange vessel	The ion exchange vessel in the water treatment circuit deionizes the coolant of the internal cooling circuit and maintains the conductivity.
3-way valve	The three-way valve controls the flow of the external cooling liquid through the water-to-water heat exchanger.

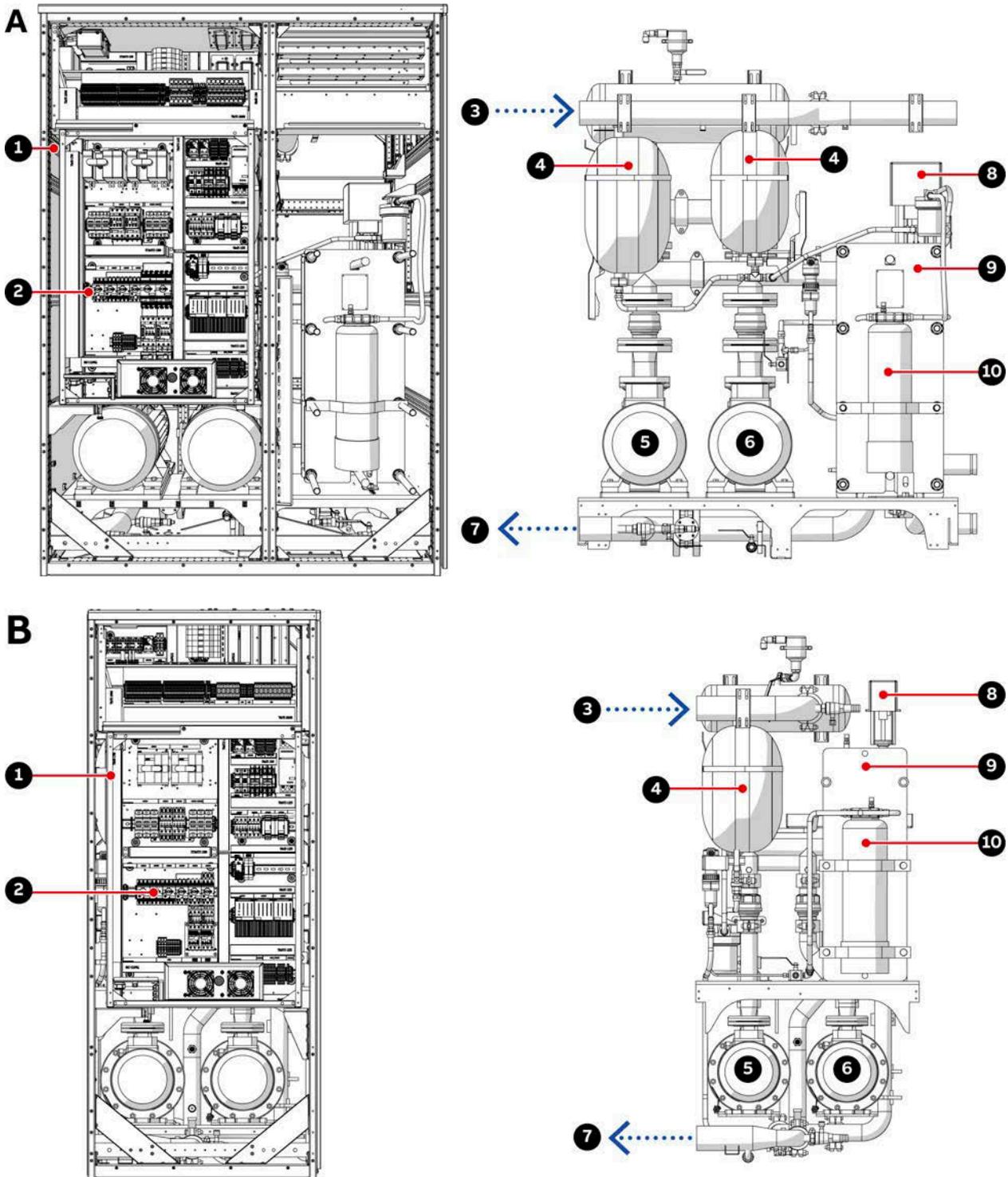


Figure 3-18 WCU1400 (A) and WCU800 (B) cabinet and system components

- | | |
|---|----------------------------------|
| 1) Control equipment mounted on a swing frame | 6) Pump 2 |
| 2) Pump circuit breakers | 7) Cool water |
| 3) Warm water | 8) Motor for 3-way valve |
| 4) Expansion vessel | 9) Water-to-water heat exchanger |
| 5) Pump 1 | 10) Deionizer |

3.2.6.1. Cooling circuit

The water cooling system distinguishes two circuits for dissipating heat losses (Fig. 3–19):

- **Internal cooling circuit:** circulates coolant (distilled/deionized cooling liquid) and transfers the heat losses of the main power components to the exterior. The internal cooling circuit also includes - among the other components - the water treatment circuit, which continuously deionizes the cooling liquid to keep conductivity at a low level.
- **External cooling circuit:** transfers the heat losses from the water-to-water heat exchanger to the exterior.

The water cooling units are pressurized and not open to atmospheric pressure.

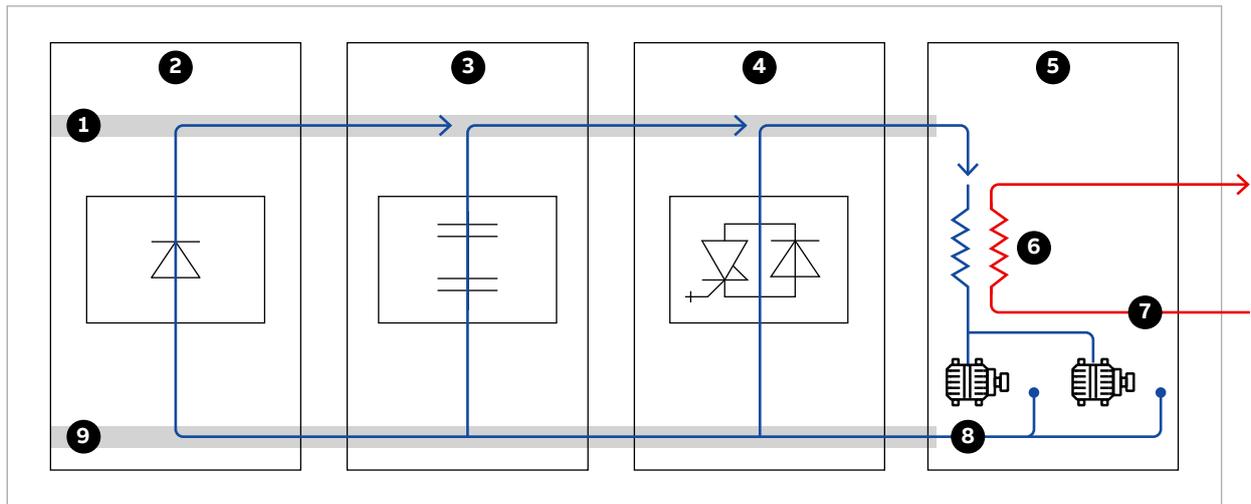


Figure 3–19 Cooling circuit in an ACS6000 drive

- | | |
|-----------------|-----------------------------|
| 1) Return pipes | 6) Heat exchanger |
| 2) LSU | 7) External cooling circuit |
| 3) CBU | 8) Internal cooling circuit |
| 4) INU | 9) Feeding pipes |
| 5) WCU | |

3.2.6.2. External cooling connection

Two flanges connect the WCU to the external cooling circuit water supply and return pipes. The location of the flanges, i.e., top, bottom, side, or back of the WCU, depend on your drive configuration.

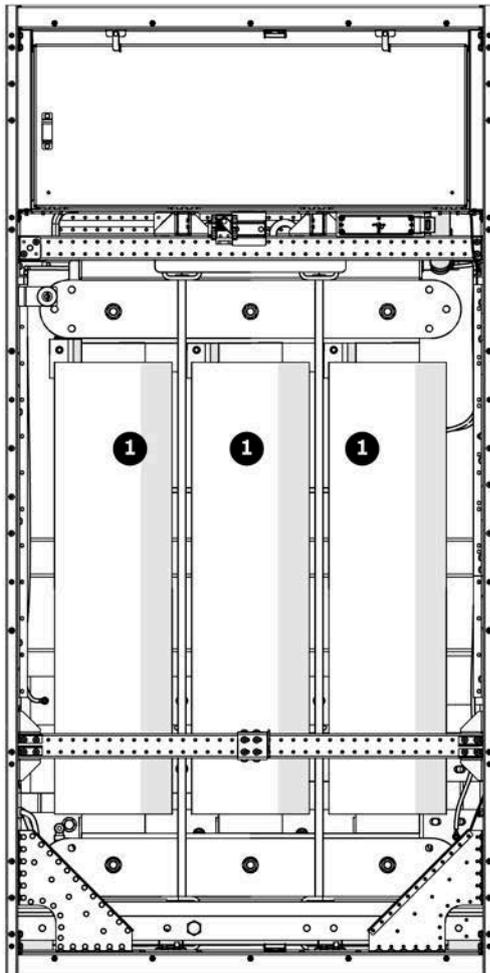
3.3. Optional cabinet units

The following sections describe the IRU, IFU, VLU, BCU, RBU and EXU optional cabinet units.

3.3.1. Input reactor unit (IRU)

The IRU is used with the 6-pulse LSU for applications without an input transformer. The IRU limits the input current and improves the total harmonic distortion (THD) of the supply voltage.

A



B

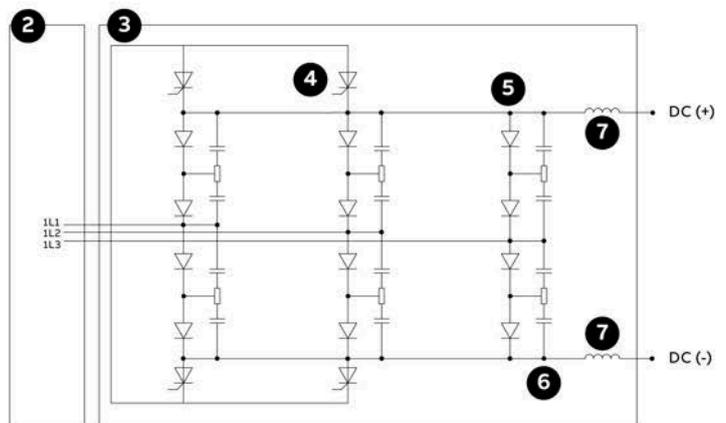


Figure 3–20 IRU cabinet (A) and circuit diagram (B)

- | | |
|------------------------|--------------------|
| 1) Three-phase reactor | 5) Diode rectifier |
| 2) IRU | 6) Snubber circuit |
| 3) LSU | 7) di/dt choke |
| 4) Thyristor crowbar | |

3.3.2. Input filter unit (IFU)

The IFU is used in combination with 6-pulse active rectifier units connected to a weak supply network. The tuned filter is located between the input transformer and the ARU and reduces harmonic voltages injected to the supply network.

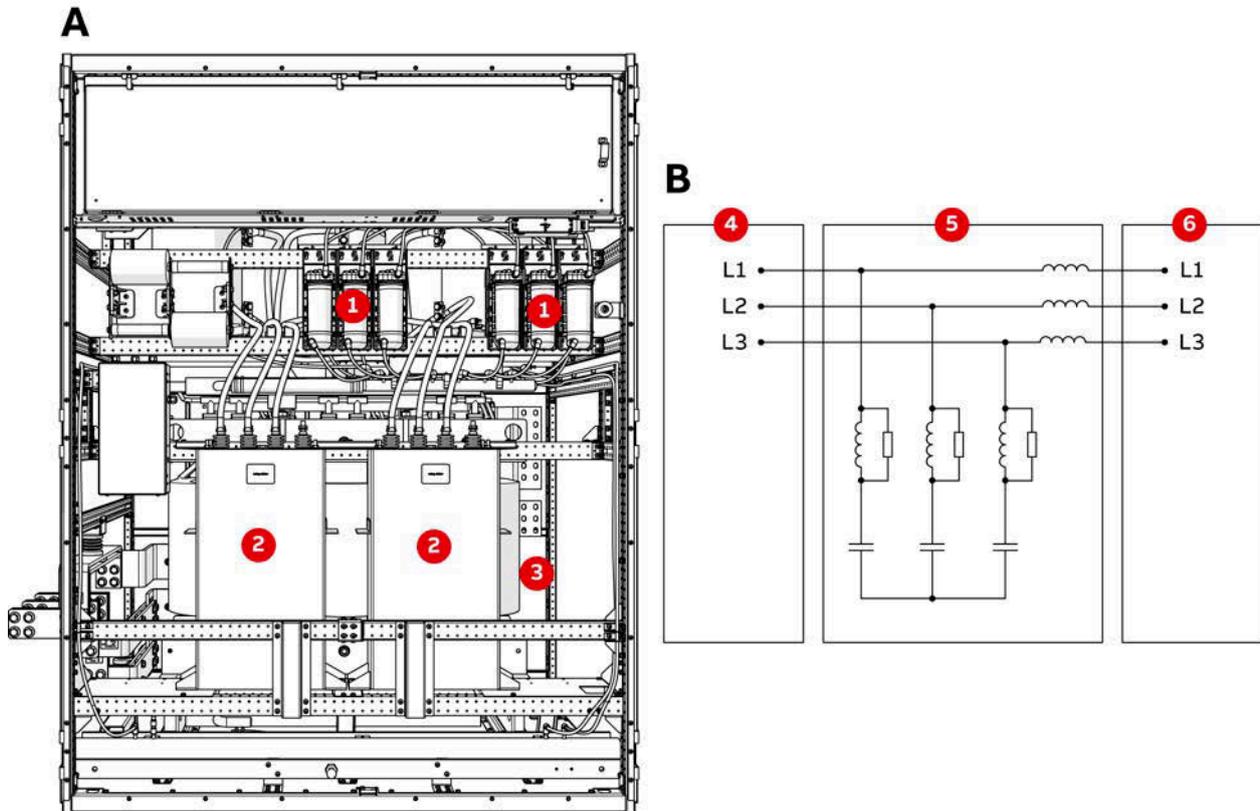


Figure 3-21 IFU cabinet (A) and circuit diagram (B)

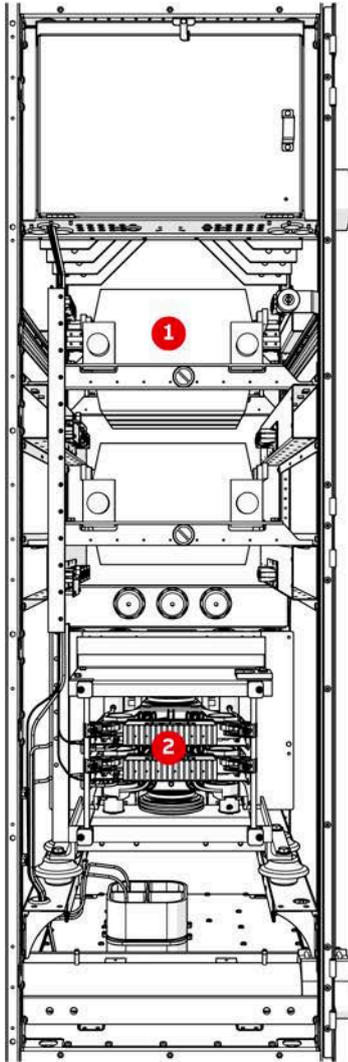
- | | |
|--------------|--------|
| 1) Resistor | 4) TEU |
| 2) Capacitor | 5) IFU |
| 3) Reactor | 6) ARU |

3.3.3. Voltage limiter unit (VLU)

The VLU is used for applications that require dynamic changes between driving and braking mode.

During braking, the energy is dissipated in liquid-cooled resistors. The resistors are controlled by IGCT semiconductors and protected against overload.

A



B

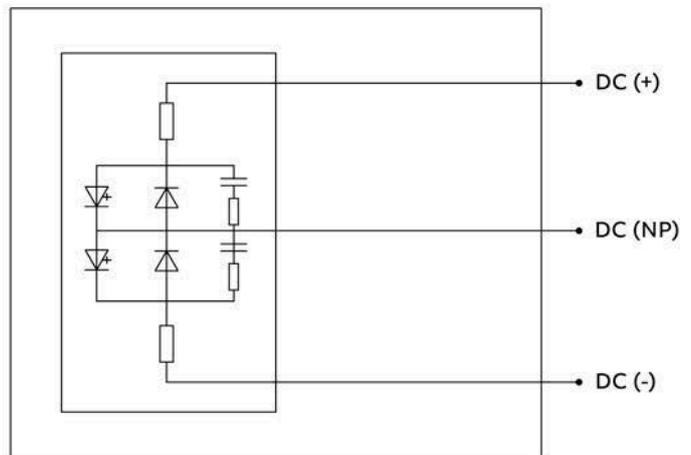


Figure 3–22 VLU cabinet (A) and circuit diagram (B)

1) Air-cooled resistors

2) IGCT

3.3.4. Braking units

A braking chopper unit (BCU) and a resistor braking unit (RBU) are available for the ACS6000.

Table 3–5 BCU braking power

Braking resistor (ohm)	Single braking power (kW)	Double braking power (kW)
RBU	800	1600
10	1100	2200
8	1400	2800
7	1600	2800
6	1900	3200
5	2200	3700
4	2800	4500
3.6	3100	5600

Table 3–6 RBU braking power

Single braking power (kW)	Double braking power (kW)
800	1600

These braking units are used for applications that require fast braking where regenerative braking is not allowed, eg, marine applications; therefore these units are typically part of a drive that contains an LSU. The BCU and RBU enable such drives to perform effective motor braking.

However, BCUs and RBUs can also be used in combination with ARUs, eg, mine hoists and other special applications that require emergency braking in the event of a power outage.

During braking, the BCU limits the DC-link voltage and converts the braking energy into heat that is dissipated in resistors. IGCT semiconductors switch the braking energy to the resistors.

3.3.4.1. Braking chopper unit

A BCU is used when the braking scenario requires consistent energy dissipation. The energy generated during braking is dissipated in external water-cooled resistors, which are not part of the drive.

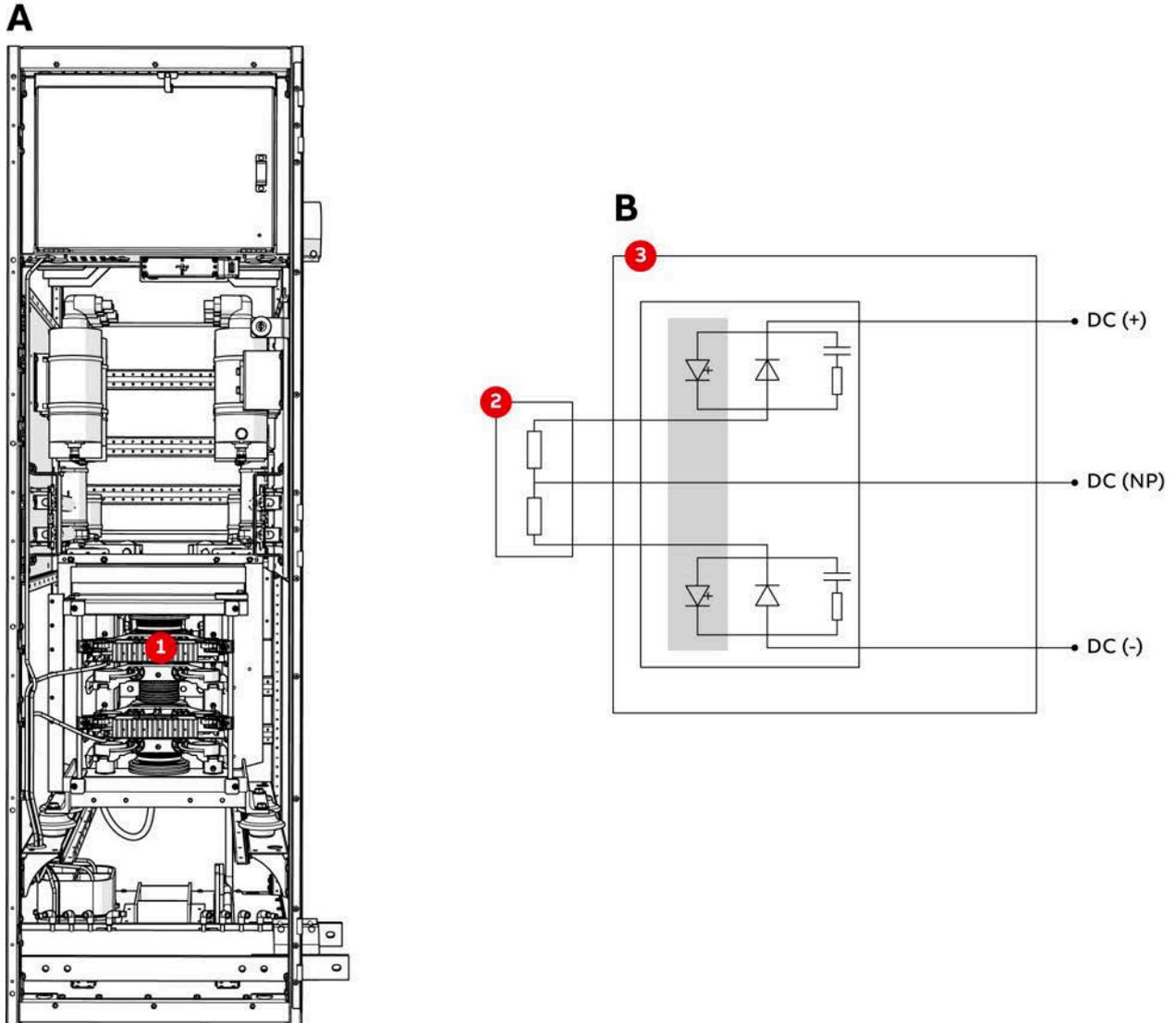


Figure 3–23 BCU cabinet (A) and circuit diagram (B)

- | | |
|------------------------|--------|
| 1) IGCT | 3) BCU |
| 2) Resistor (external) | |

3.3.4.2. Resistor braking unit

An RBU, with integrated resistors, is used for smaller braking capabilities.

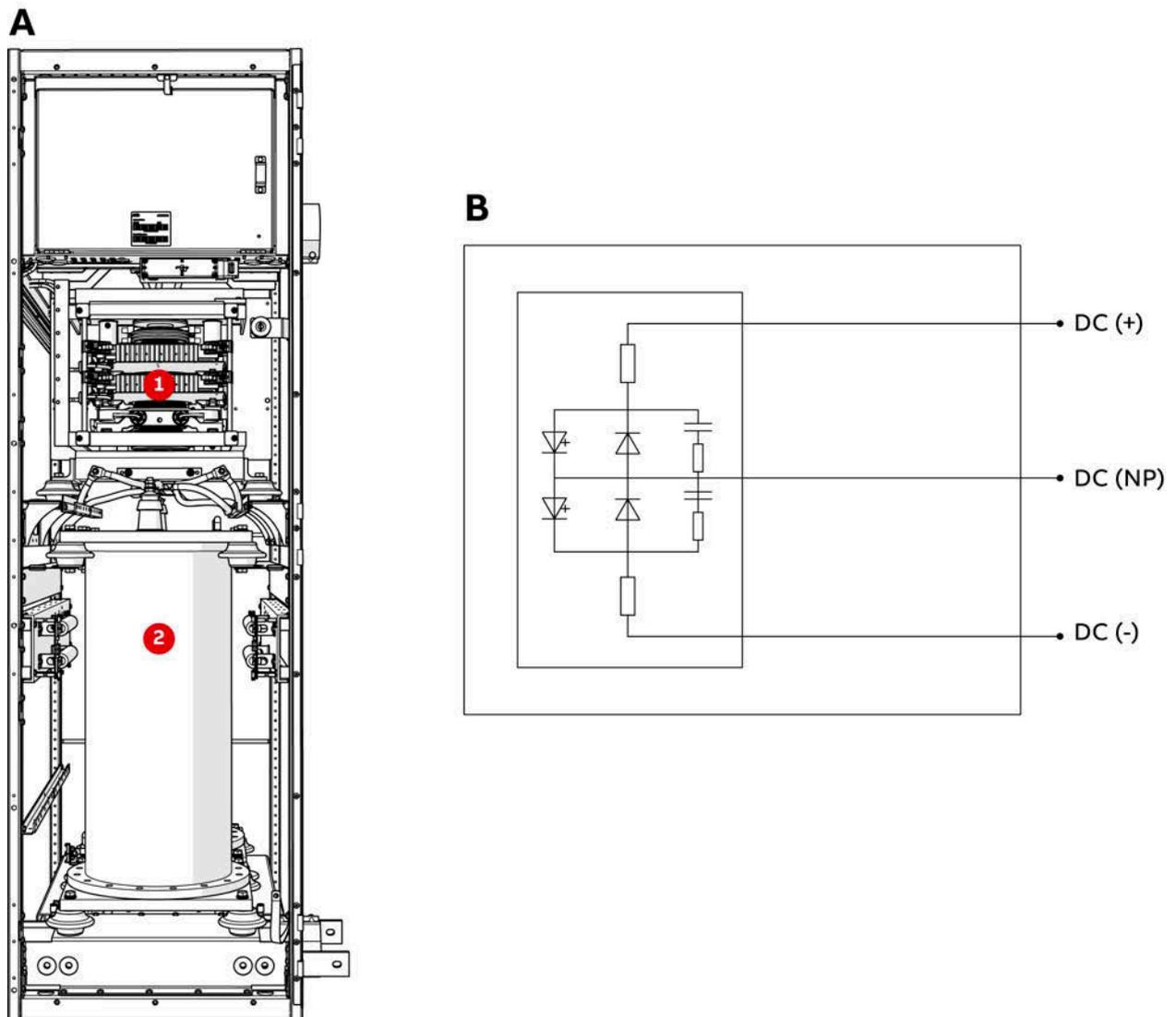


Figure 3–24 RBU cabinet (A) and circuit diagram (B)

1) IGCT

2) Water-cooled resistor

3.3.5. Excitation unit (EXU)

The EXU supplies a synchronous motor with excitation power. The EXU is available for the following excitation methods:

- **Brush excitation (DC excitation):** Uses a DCS800 AC-to-DC converter which is supplied by the mains. The converter controls the direct current for generating the magnetic field. Brushes and slip-rings feed the DC current to the rotor.
- **Brushless excitation (AC excitation):** Uses a three-phase DCS800 AC-power controller. The power controller feeds an exciter which is mounted on the shaft of the main motor. The rotating armature of the exciter supplies a rectifier which generates the DC current for producing the magnetic field in the synchronous motor.

For more information, see “Air-cooled excitation units, brush brushless excitation technical data” , 3BHS299399 E01.

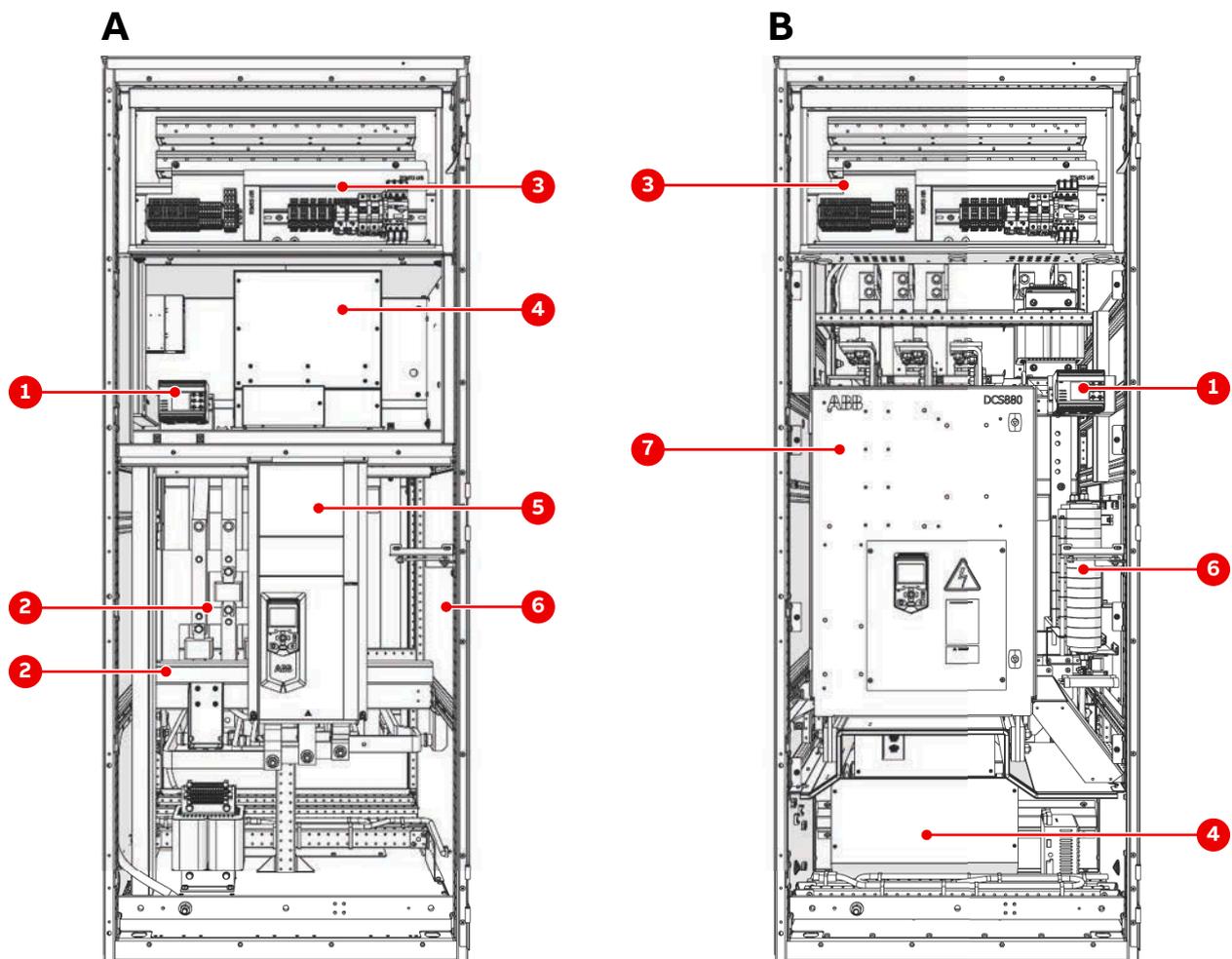


Figure 3–25 EXU D4 frame cabinet (A) and EXU D5 frame cabinet (B)

- | | |
|---|--|
| 1) Ground fault detection device (optional) | 5) DCS800 D4 unit |
| 2) Fuses | 6) Overvoltage protection (not shown in A) |
| 3) Control compartment | 7) DCS800 D5 unit |
| 4) Fan units | |

3.3.5.1. DCS800 control panel

The control panel of the DCS800 unit enables the user to control, read the status messages and set the parameters of the DCS800 unit. The panel can also be used to copy parameters from one DCS800 unit to another DCS800.

For more information, see section 8.5, **EXU control panel**, page 174.

3.3.5.2. Reversing switch

The EXU for brushless excitation is equipped with a reversing switch for changing the sense of rotation. The switch is actuated by the drive.

The switch changes the sense of rotation via the optical communication link. When the drive is in state ReadyOn or NotReadyOn, the switch is opened.

3.3.5.3. Output disconnecter

The optional output disconnecter is used to disconnect the EXU from the motor for maintenance purposes.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	68/272

3.3.6. Customer interface unit (CIU)

The optional customer interface unit (CIU) provides I/O modules to monitor the transformer and motors (Fig. 3–23). The following units are available:

- CIU provides predefined I/O modules for controlling and monitoring the auxiliaries of motors and the transformers.
The I/O module modules are connected to the drive controller.
- CIUe provides engineered project-specific interfaces and an application controller with customer-specific software.

As an option for single-motor drives, it is possible to integrate the predefined I/O modules (maximum 4 modules in the rooftop extension box (REB) of the water cooling unit). For more I/O modules, a CIU is required.

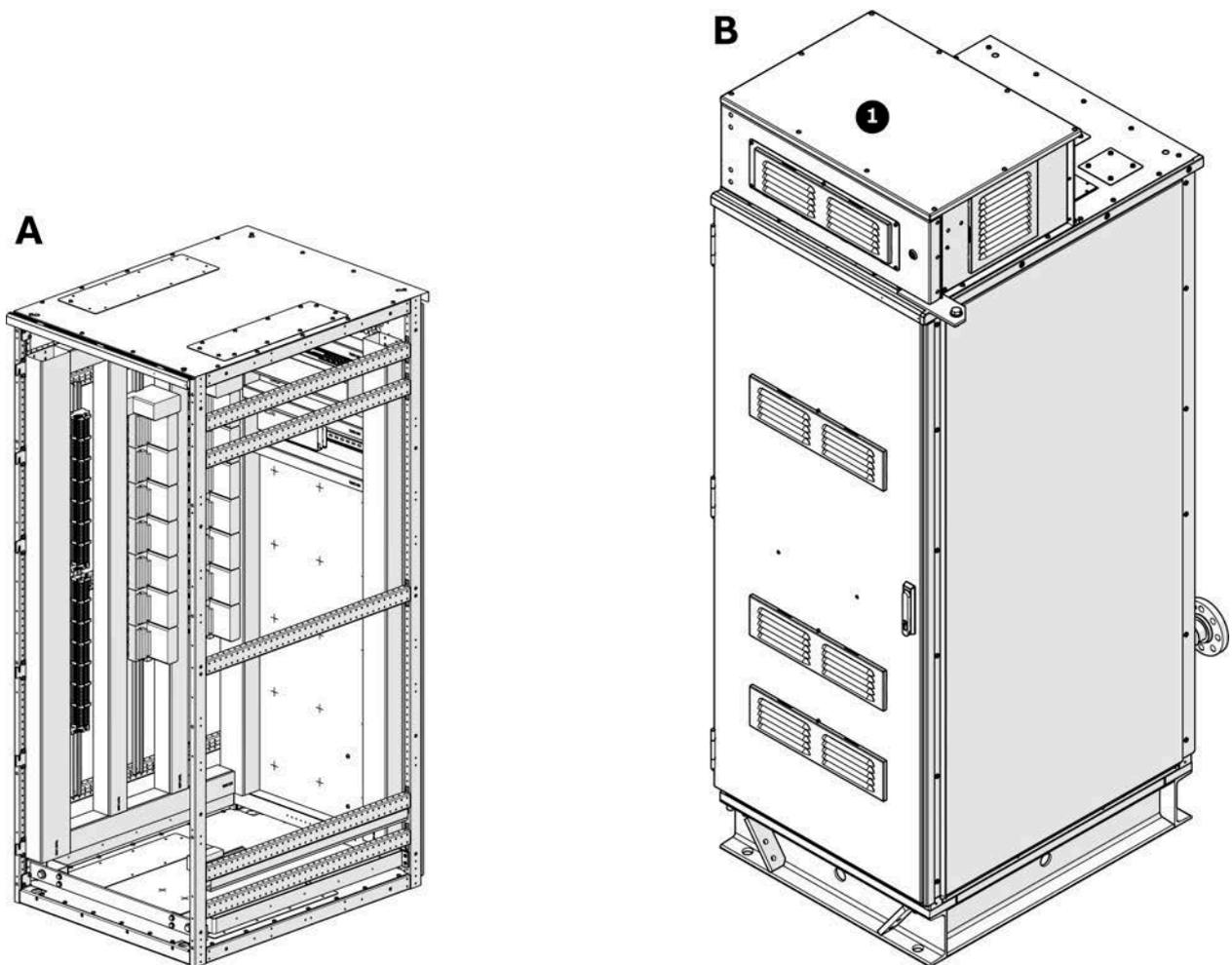


Figure 3–26 CIU cabinet (A) and WCU800 cabinet (B)

1) Roof extension box (REB)

3.3.6.1. Arc detection with Arc Guard (optional)

If the drive is equipped with an Arc Guard System for fast arc fault detection in the terminal sections, the arc monitor and the related HMI panel are mounted in the roof extension box (REB).

For more information, see section 8.11, **Arc detection with the Arc Guard System™ (optional)**, page 189.

3.4. Air cooling

Air-to-air heat exchangers and auxiliary fan units can also be used for non-water-cooled components in the drive.

3.4.1. Air-to-air heat exchangers

Drives for high-power applications are equipped with air-to-air heat exchangers. They ensure a constant air flow through the medium voltage units and transfer the heat losses of non-water-cooled components to the exterior. The fans of the air-to-air heat exchangers are controlled by the drive.

The auxiliary power for the heat exchangers is supplied by an additional transformer.

For information on number and location of heat exchangers and transformer, see “Appendix C - Mechanical drawings”.

The number of installed air-to-air heat exchangers and transformers depends on the configuration of the drive.



Figure 3–27 ACS6000 example drive with air-to-air heat exchanger

- 1) Air-to-air heat exchanger 2) Additional transformer

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	70/272

3.4.2. Auxiliary fan units

Thermostat-controlled fan units circulate the air in the control unit cabinet(s) and in the WCU cabinet. If installed, additional fan units are available in the optional WCU roof box.

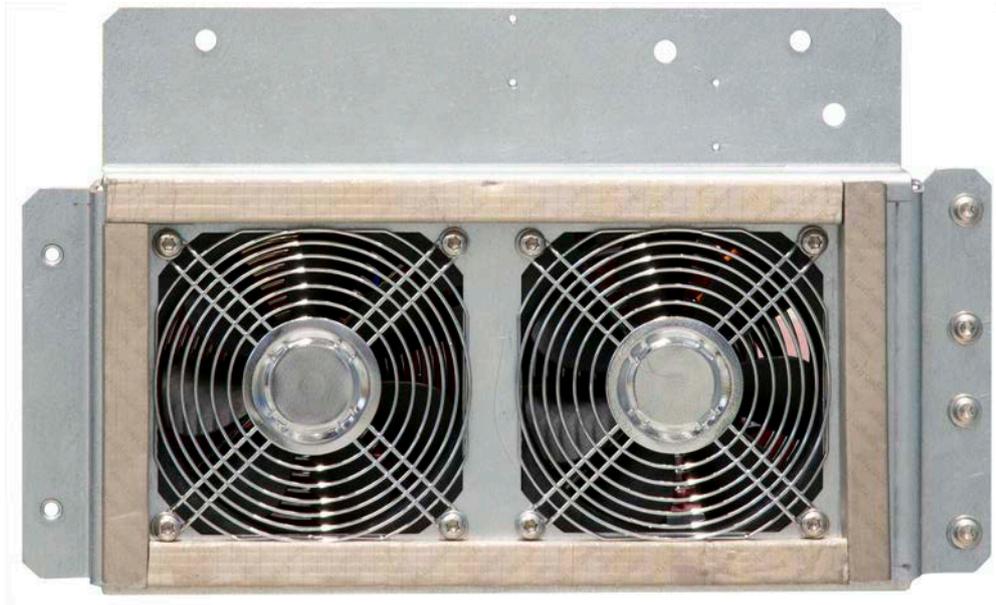


Figure 3-28 Auxiliary fan unit

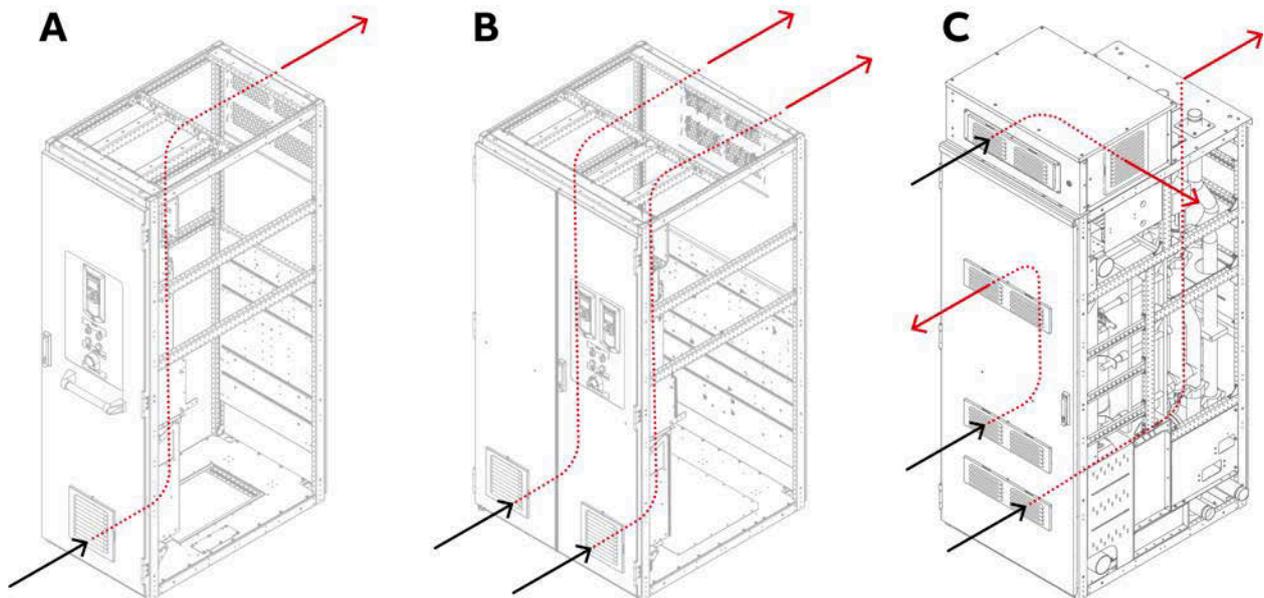


Figure 3-29 Air circulation through ventilation grids in 600 mm COU (A), 1000 mm COU (B) and WCU800 (C)

NOTE – The number of fans varies depending on the cabinet.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	71/272

3.5. Cabinet design

The cabinet has been designed using the modular cabinet system of ABB and fulfills the requirements of international standards.

The design consists of a skeletal frame made of galvanized steel where the outer panels made of 1.5 mm thick painted galvanized steel are bolted to. Corrosion resistant materials are used to ensure durability of the cabinets.

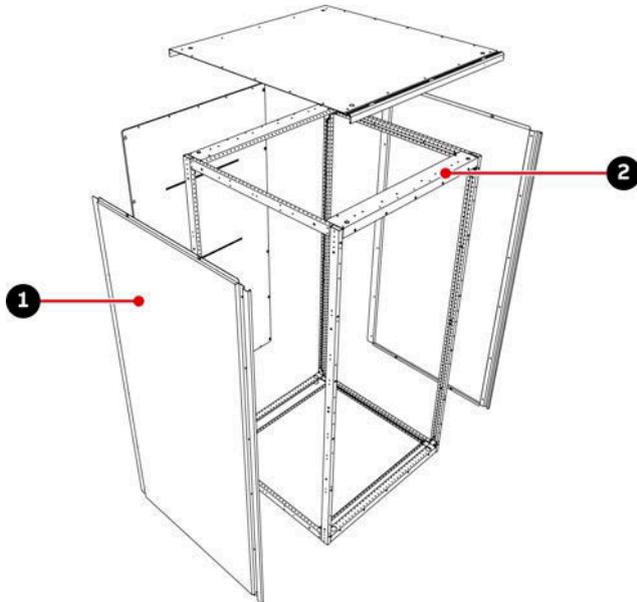


Figure 3–30 Basic cabinet design

- | | |
|---|---------------------------|
| 1) Outer panel made with 1.5 mm powder painted (standard color - RAL 7035) galvanized steel | 2) Galvanized steel frame |
|---|---------------------------|

Electromagnetic compatibility (EMC)

Electromagnetic compatibility (EMC) has been achieved by applying an EMC sealing around the doors and on the rear and side panels. The inside panels of the compartments are not painted, because paint tends to reduce the effectiveness of metallic bonding, which is paramount to successful EMC.

The joining surfaces of two transport units are equipped with EMC sealing strips. The cabinet doors and the internal cable ducts are also equipped with EMC sealing.

Degree of protection

The standard cabinets are rated for IP 32. Ratings for IP 42 and IP 54 are available as an option. The sound pressure level is < 75 dB (A).

Painting

The standard color for the cabinets is RAL 7035 (light gray), which is applied as a powder coat paint. Other colors are available on request. For more information, see the “Painting specification for ACS1000, ACS2000, ACS5000 and ACS6000/ACS6080”, 3BHS104301 E01.

PRODUCT ACS6000	DOCUMENT KIND User manual	DOCUMENT ID. 3BHS212794 E01	REV. Q	LANG. en	PAGE 72/272
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Transportation

Small drives are shipped as one unit. Larger drives are shipped in separate transport units. All transport units are fitted with lifting lugs for a crane that must be used to position the units.

Safety labels

Safety labels are attached to the drive doors to alert personnel of potential hazards when working on the drive.

The standard language of the labels is English; however, other languages can be ordered. The label design is based on the relevant ANSI and ISO standards.

For more information, see section 2.3, **Product safety labels**, page 32.

3.6. Door locking system

For more information on the door locking system, including grounding switches, locking bars, and safety switches, see section 8.5, **EXU control panel**, page 174.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	73/272

3.7. Arc resistant design

The optional “Arc Resistant Design” provides the drive with arc fault protection (see Table 3–7) in accordance with IEC 62477-2.

Table 3–7 ABB arc resistant classes

ABB class	Description
Class I	Protection based on arc prevention (NOT certified according to IEC 62477-2)
Class II	Protection based on arc resistant cabinet structure ⁽¹⁾
Class III	Protection based on external arc fault limitation and elimination. HV fuses are applied externally to limit the arc fault current ⁽¹⁾
Class IV	Fast arc detection and elimination ⁽¹⁾

⁽¹⁾ IAC certified by 3rd body according to IEC 62477-2

3.7.1. Internal arc classification

The arc fault rating, which is based on arc fault tests, is on the label underneath the drive rating plate.

Internal Arc Classification (IAC) ABB Class II									
IAC	F	L	R	T	B	I _A	t _A	APR	SC
IEC 62477-2	2b	2b	2b	1	1	20 kA	0.5 s	Yes	No
Distance [m]	0.3	0.3	0.3	-	-				

3BHB049908R6220

Figure 3–31 IAC label example

IMPORTANT! The Main Circuit Breaker (MCB) for the drive fulfills the APR (Associated Protection Requirement) without the need for additional devices. The MCB requirements are described in section 2.7, **Important note - main circuit breaker**, page 37.

Based on the ACS6000 IAC rating, the minimum approach distance is 0.3 m. Local rules may require additional distance. The user is responsible to determine the correct approach distance considering local rules.

3.8. Busbars and grounding

The drive contains busbars for various types of connections.

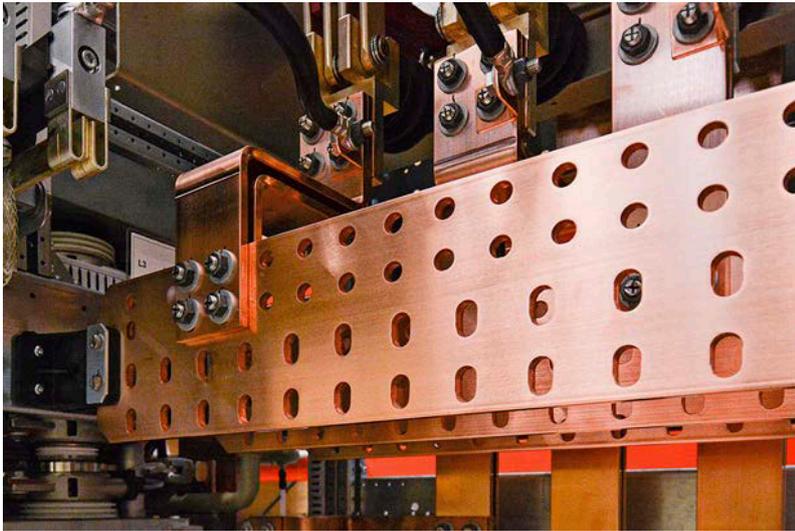


Figure 3–32 Busbars

3.8.1. AC busbars

The incoming feeder and motor cables are connected to their corresponding busbars inside a TEU. In multi-motor drives, several TEUs are part of the drive lineup.

Depending on drive configuration, the incoming busbars are interconnected with the ARU or the LSU. The outgoing busbars are interconnected with the inverter unit(s). Phase designations help identifying the busbars.

3.8.2. DC busbars

The DC busbars connect the ARU or the LSU with INU(s) and CBU. A multi-motor configuration, can have up to four DC busbar arrangements. The busbars are mounted in the upper part of the drive and are marked with DC (+), DC (-) and DC (neutral point).

3.8.3. PE busbar

To maintain safety and to ensure smooth functioning of the equipment, it is important to ground the drive properly. For this reason, the ground cable of the drive is connected to the grounding system of the installation site.

The drive is equipped with a continuous PE ground busbar that stretches across the bottom part of the entire cabinet.

3.8.4. PG busbar

To ensure proper operation, cable shields are connected to the PG ground busbar. The PE and PG busbar connect inside the capacitor bank unit, which has the grounding switch on the front door. The connection is made in the factory.

PRODUCT ACS6000	DOCUMENT KIND User manual	DOCUMENT ID. 3BHS212794 E01	REV. Q	LANG. en	PAGE 76/272
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4. Transportation, storage and disposal

4.1. Safety



The drive must only be handled by personnel who are skilled and experienced in unpacking and transporting heavy equipment.

4.2. Transport conditions

The transport conditions for the drive are based on IEC 60721-3-2.

– **Classification:** 2K12 / 2B1 / 2C2 / 2S5 / 2M4⁽¹⁾

⁽¹⁾ Special conditions apply to marine drives

4.3. Unpacking and inspection

1. Remove all packaging material carefully.
2. Check the drive and accompanying equipment for damages.
3. Compare the complete delivery with the purchase order and the packing list.
4. If parts are missing or damaged, immediately inform the shipping company and the ABB service organization.

It is recommended to photograph the damages and send the photographs to ABB.

4.4. Identifying transport units

A delivery can consist of transport units for several drives. To identify the transport units and assign them to a particular drive, see the following accompanying papers for information:

- Packing list that is attached to the packaging of each transport unit
- Packing label on the back wall of each drive unit (PCU, COU, WCU). The packing label is only visible after the packaging has been removed.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	77/272

4.4.1. Packing list

The “Commodity description” column of the packing list states the number of the drive that the transport unit belongs to.

ABB item Customer item	Qty.	Unit.	Identnumber	Commodity description
001201	1	PC		Converter 1 ⁽¹⁾ : Transport Unit 1
ABB Switzerland Ltd				
Drives				
Mailing address: CH-5401 Baden/Switzerland	Phone: +41 58 589 27 95	Telex: 755749 abb ch	Facsimile: +41 58 580 20 84	Bank Credit Suisse CH-8070 Zurich/Switzerland

(1) All of the transport units for a drive have the same converter number, in this case, “Converter **1**”.

The item number in the “ABB Item / Customer item” column of the packing list provides information about separately delivered crates with accessories such as tools and installation material.

ABB item Customer item	Qty.	Unit.	Identnumber	Commodity description
00 1 221 ⁽¹⁾	1	PC		cross wiring
00 1 222	1	PC		WCU accessory
00 1 223	1	PC		crank for isolator
00 1 500	1	PC	3BHB013202R0001	ACS6000 Max-SL LOOSE PARTS config.
ABB Switzerland Ltd				
Drives				
Mailing address: CH-5401 Baden/Switzerland	Phone: +41 58 589 27 95	Telex: 755749 abb ch	Facsimile: +41 58 580 20 84	Bank Credit Suisse CH-8070 Zurich/Switzerland

(1) The third digit from the right identifies the drive that the accessories belong to, ie, drive **1**.

4.4.2. Packing label

The packing labels on the back wall of transport units can also be used for identification.

ABB	Packing Label	0000
Material no	3BHB009964R1500	1 ST
Material	Cabinet ARU/INU LSU config.	
Order no/positions	11027727 00 1 241 ⁽¹⁾	Project CBA
Material Document	 004902892300012004	

(1) The fourth digit from the right identifies the drive that the transport unit belongs to, ie, drive **1**.

4.5. Lifting and transportation



WARNING Risk of serious injury!

Incorrect securing and lifting of loads can cause serious injury and damage the equipment.

- ▶ Lift operations **MUST** be performed by qualified personnel in accordance with local lifting laws!
- ▶ **DO NOT** use a forklift for transport units or drives; for a stand-alone EXU, you can use a manual forklift
- ▶ Use suitable lifting gear for the load weight, eg, web slings, chain slings, round slings, safety hooks, and shackles
- ▶ Use a lift frame or spreader frame for large loads, eg transport unit or drive on a base frame.
- ▶ Only use the original lifting attachments with the original mounting bolts (and washers where applicable) to transport the equipment
- ▶ Before use, always check the lifting attachments for damage, eg, corrosion and cracks. **DO NOT** attempt to lift equipment with a damaged lifting attachment; contact ABB for a replacement before you proceed
- ▶ Always transport the load in an upright position
- ▶ Always observe the center of gravity
- ▶ **DO NOT** lift more than one load at a time



Refer to “Appendix C - Mechanical drawings” for the relevant dimensions and weight.

NOTICE Risk of component damage.

Dirt and metallic dust can cause failure when the drive is energized.

- ▶ Keep cabinet doors closed during operation

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	79/272

4.5.1. Lifting attachment types



Only use the lifting attachments that are included with the delivery, either factory-installed or in the loose parts box for the drive. These lifting attachments are intended exclusively for use with ACS6000 equipment. Any use beyond this is strictly prohibited.



Figure 4-1 Lifting attachment types

- | | |
|---|---|
| 1) M24 rotating eyebolt for 220 mm base frame | 3) M16 rotating eyebolt for top-lifting (EXU cabinet) |
| 2) Lifting plate with M16 × 40 (A2-70) bolts for 160 mm base frame with | 4) M8 rotating eyebolt for top-lifting (air-to-air heat exchangers) |

4.5.2. Lifting with lifting plates

Lifting plates are factory-installed on the base frame of transport units.



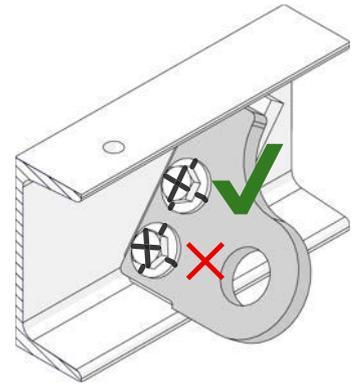
CAUTION Risk of tipping!

The following procedure requires a crane with a lift frame or a spreader frame. If you do not have this equipment:

- ▶ Ensure that the slope angle of the slings DOES NOT exceed 15° (Fig. 4–3)

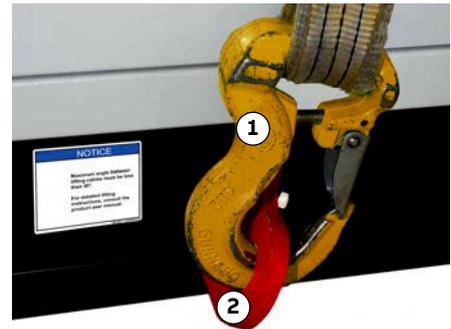
1. Verify that the factory torque marks on the mounting bolts and washers of the lifting plates are aligned.

If the marks are not aligned or are not visible, tighten the mounting bolt to the torque that is specified in Table 4–1.



2. Attach slings to the lifting plates (1) with load-appropriate safety hooks (2) or shackles.

CAUTION! DO NOT run a sling through the hole of a lifting plate!



Referring to Fig. 4–3, page 84:

3. Wrap a sling horizontally around the upper $\frac{1}{3}$ of the load height and secure in place with vertical slings.
4. Protect the edges and other protrusions on the load from direct contact with the lifting gear, eg slings.
5. Lift the load slowly and steadily, with no abrupt stops, in an upright position to the required clearance height.

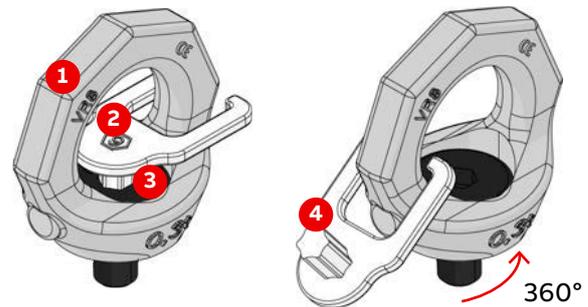
CAUTION! Keep an eye on the horizontal position of the load and reposition the slings when necessary.

4.5.3. Lifting with rotating eyebolts

Rotating eyebolts are either installed in the factory, or are in the loose parts box for the drive. The following procedure requires a crane with a lift frame or a spreader frame.

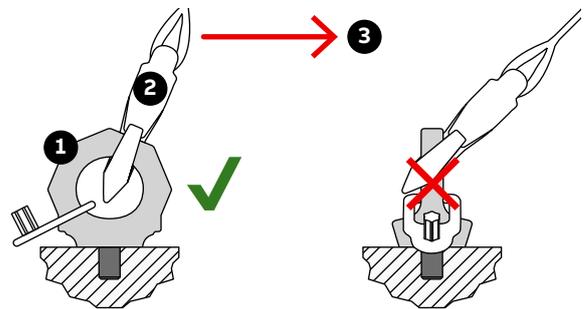
1. For rotating eyebolts (1) from the loose parts box, use the attached star key (2) to hand-tighten and properly seat the mounting bolt (3).

CAUTION! DO NOT use an extension with the star key tool. Remove the star key (4) before you attach the lifting gear. The eyebolt must be able to rotate 360° when mounted.



2. Rotate the eyebolts (1) in the pull direction (3), ie, sling direction, and then attach slings to the eyebolts with safety hooks or shackles (2).

CAUTION! DO NOT run slings through the eyebolts!



Referring to Fig. 4–3, page 84:

3. For a large load, eg, transport unit, wrap a sling horizontally around the upper $\frac{1}{3}$ of the load height and secure in place with vertical slings.
4. Protect the edges and other protrusions on the load from direct contact with the lifting gear, eg slings.
5. Lift the load slowly and steadily, with no abrupt stops, in an upright position to the required clearance height.

CAUTION! Keep an eye on the horizontal position of the load and reposition the slings when necessary.
6. At the end of the lifting operation, remove the hand-tightened eyebolts that you installed in step 1.

NOTE – For a permanent installation, tighten the eyebolts to the correct torque (see section 4.5.3.1, **Reinstalling lifting attachments**, page 83) with a suitable torque wrench socket (not included in the scope of delivery).

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	82/272

4.5.3.1. Reinstalling lifting attachments

If you need to reinstall factory-mounted lifting attachments, eg, when the drive is at end of life, tighten the mounting bolts to the torque that is specified in Table 4–1.

NOTE – The torque wrench sockets for the rotating eyebolts are not included in the scope of delivery.

Table 4–1 Lifting attachment specifications

Type	Mounting bolt	Torque (Nm)	ABB ID
Lifting plate	2 × M16 × 40 (A2-70)	204	3BHB039841R0001
M24 rotating eyebolt	M24	190	3BHE015753P0024
M16 rotating eyebolt	M16	60	3BHE015753P0016
M8 rotating eyebolt	M8	10	3BHE015753P0008



Figure 4–2 Torque wrench socket for rotating eyebolt (not included in delivery)

4.5.4. Sling configurations for lift frames and spreader frames

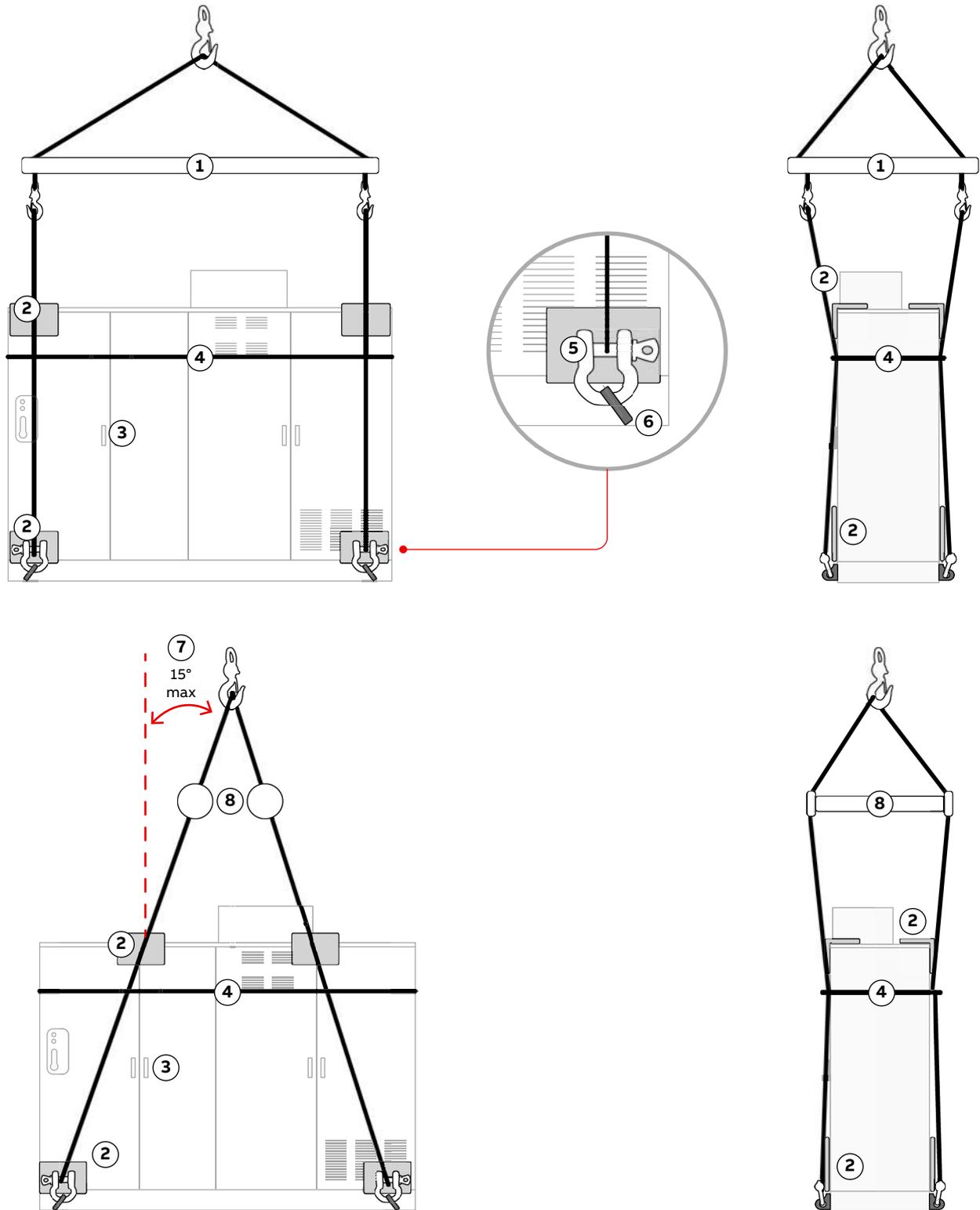


Figure 4–3 Lift frame (A) and lift spreader (B)

- | | |
|--|------------------------------|
| 1) Safety hook | 5) Safety hook or shackle |
| 2) Protect the edges | 6) Lifting plate |
| 3) Protect the door handles and levers | 7) Slope angle (maximum 15°) |
| 4) Extra sling | 8) Spreader frame |

4.6. Storage

The drive can be stored for up to one year in the original packaging as long as it is not damaged or opened.

For information on longer storage periods, contact the ABB service organization.

4.6.1. Storage conditions

The minimum requirements for storage are based on IEC 60721-3-1.

– **Classification:** 1K22 / 1B1 / 1C2 / 1S11 / 1M11⁽¹⁾

⁽¹⁾ Special conditions apply to marine drives

4.6.2. Storing the drive

If the drive is taken out of service for a longer time proceed as follows:

1. Drain the cooling circuit completely or add the appropriate amount of glycol for frost proofing if the drive is to be stored in ambient temperatures below 0 °C.

For information about draining and frost proofing, see the manual of the water cooling unit in “Appendix A - Additional manuals”.

2. Cover all cable inlets and ventilation slots with an impermeable plastic or aluminum foil and a wooden panel.

3. Add a desiccant of the appropriate quality:

- 1 unit desiccant (30 g) absorbs 6 g water vapor

IMPORTANT! If you use polyethylene foil to cover the cabinets, use 10 units of desiccant/m² foil.

4. Close and lock the doors of the drive.

5. Use polyethylene or equivalent for packaging:

- 0.3 g/m² /24 h water vapor diffusion

6. Attach humidity indicators to the packaging.

NOTICE The storage conditions and the packaging should be checked regularly. Any damages which occur during the storage period must be repaired immediately.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	85/272

4.6.3. Storing and handling of spare parts



NOTICE Risk of component damage!

Electronic devices (eg, circuit boards, semiconductors) are sensitive to electrostatic discharge (ESD).

- ▶ Apply ESD handling precautions before handling these devices.

4.6.3.1. Warranty information

IMPORTANT! Check the spare parts immediately after receipt for damages and report any damage to the shipping company and the ABB service organization.

Observe the following to maintain spare parts in good condition and to keep the warranty valid during the warranty period:

- Keep spare parts in their original packaging.
- Store printed circuit boards in antistatic bags or boxes.
- Storage temperature range: -5 °C to +55 °C
- Storage place requirements:
 - Free of vibration and shock
 - Protected against dust, sand, vermin and insects
 - Free of corrosive gases, salt or other impurities that could damage electronic equipment
 - Dry, no condensation
 - Relative humidity: 5 – 85%
- DO NOT touch a circuit board without wearing a wrist grounding strap.
- Put the component on a grounded working surface protected against electrostatic discharges.
- Hold the component only by the edge.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	86/272

4.7. Disposing package materials and components

Dispose of the packaging materials and components at the end of the life time of the drive according to local regulations.

For more information on the disposal of packaging materials and drive components, see the recycling instructions.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	87/272

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	88/272

5. Mechanical installation

5.1. Safety



All installation work must be carried out by qualified personnel according to the site and equipment requirements and in compliance with local regulations.

5.2. Overview

The installation includes the following work:

- All drives
 - **Floor preparation**, page 91
 - **Floor fixation**, page 91
 - **Raw water circuit**, page 91
- Only drives with separately delivered units
 - **Aligning transport units**, page 92
 - **Joining transport units**, page 94
 - **Joining water pipes**, page 95
 - **Joining busbars**, page 97
 - **Installing the roof joints and the roof attachments**, page 120
- Only for optional components
 - **Installing and removing air-to-air heat exchangers**, page 106
 - **Installing the pressure relief vents**, page 117
 - **Attaching the sealing tapes**, page 119

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ACS6000	User manual	3BHS212794 E01	Q	en	89/272

5.3. General notes on installation

NOTICE Risk of component damage!

Observe the following during installation:

- ▶ Ensure that no dirt enters the drive. Always close the doors when work is discontinued and completely cover openings. Metallic dust in particular could cause failures when the drive is powered up and cause damage.
- ▶ When joining two transport units, **DO NOT** damage or dislocate the EMC sealing strip that is glued onto the outer joining surfaces of the cabinet frame.
- ▶ If the transport units are joined but not yet on the base frame, do not lift and move them with a crane. Instead, use appropriate transport means, such as heavy load hydraulics rollers or air cushions.

5.3.1. Dimensions and clearances

For information on dimensions, location and size of fixing holes and clearances, see “Appendix C - Mechanical drawings”.

5.3.2. Access to the cabinets

Joining transport units and fitting the DC- busbar joints require rear and top access.

5.3.3. Cabinet roof

NOTICE Risk of damage.

The cabinet roof is not designed as a base for foreign devices or cable ducts.

- ▶ **DO NOT** install any foreign objects on the roof and **DO NOT** step on roof.

5.3.4. Fire protection

To prevent fire from spreading into the drive, apply suitable fire protection measures.

5.3.5. Cable duct material

NOTICE Risk of component damage!

- ▶ Use cable ducts of non-flammable material with non-abrasive surface.
- ▶ To prevent dust, humidity and animals from entering the drive, protect all cable entries and exits of cable ducts.

5.3.6. Installation material

Installation material is supplied with the drive in a separate box.

5.3.7. Tools

See section 1.10, **Tools**, page 30.

5.3.8. Floor preparation

See “Appendix C - Mechanical drawings”.

5.3.9. Floor fixation

The cabinet can be bolted or welded to the floor. For more information, see “Appendix C - Mechanical drawings”.



CAUTION Hazardous voltage!

- ▶ If you want to weld a cabinet to the floor, connect the earth clamp of the welder to the PE ground busbar of the drive.

5.3.10. Raw water circuit

The incoming and outgoing raw water pipes are connected to the flanges of the WCU. Installation material such as counter-flanges, bolts, nuts and seals are supplied. For information on dimensions of the raw water entry and the flanges, see “Appendix C - Mechanical drawings”.

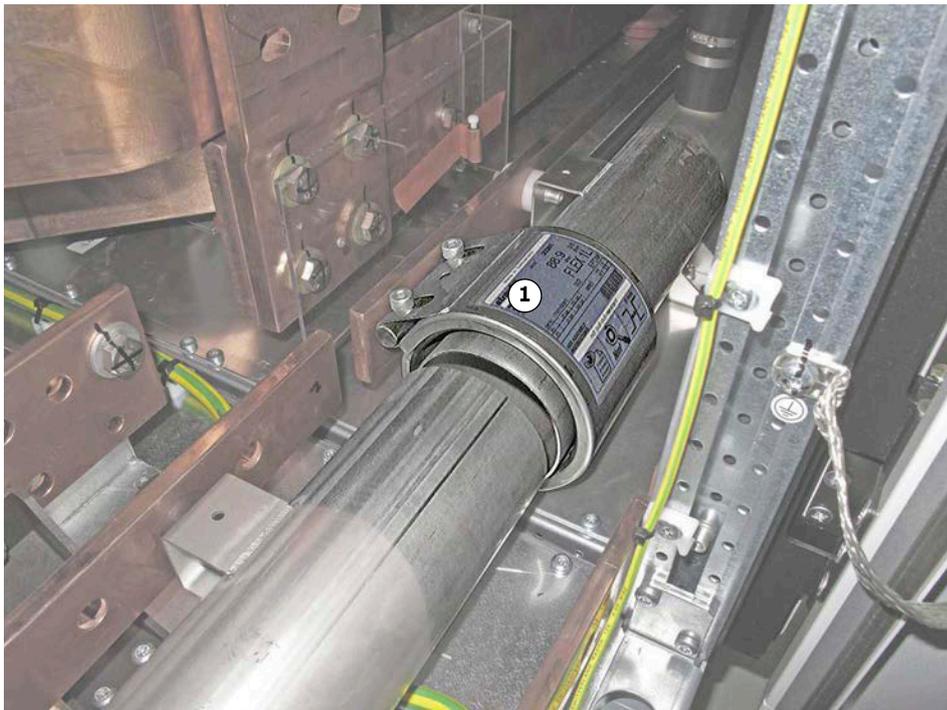
5.4. Aligning transport units

This section applies to drives that are delivered in several transport units.

1. If a transport unit has water pipes, remove the protective covers from the water pipe ends on both sides.



2. Check that a pipe joint (1) has been slid on one pipe end of two adjoining water pipes.



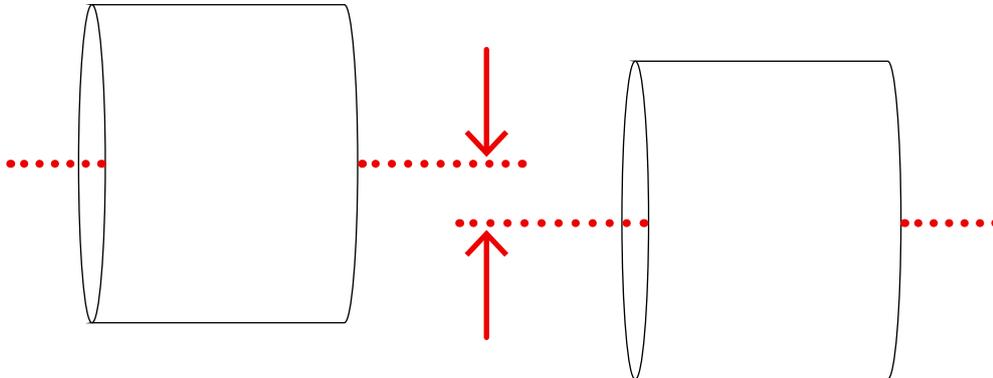
3. Line-up the transport units as shown in “Appendix C - Mechanical drawings”.

NOTE – The units can be lined-up either beginning from the left or the right.

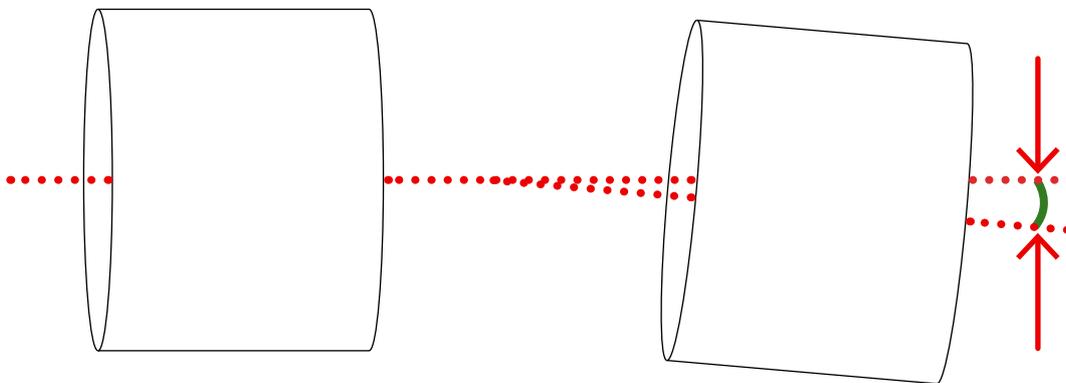
PRODUCT ACS6000	DOCUMENT KIND User manual	DOCUMENT ID. 3BHS212794 E01	REV. Q	LANG. en	PAGE 92/272
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4. Align the transport units and verify the following:

- Maximum values for the axial misalignment and the angular deflection of two adjoining water pipes are not exceeded.
 - Axial misalignment: ± 3 mm:



- Axial deflection: 5° :



- Bolt holes are aligned where transport units are joined (see the connection points on Fig. 5-1)
- Cabinet doors are not misaligned and that there are no gaps between cabinet walls and cabinet frame
- Adjoining surfaces of transport units meet perfectly all around

5.5. Joining transport units

This section applies to drives that are delivered in multiple transport units.

NOTICE Risk of component damage!

- DO NOT move joined transport units with a crane!
- Use transport means, such as heavy load hydraulics rollers or air cushions instead.

Procedure

1. Join the transport units at the connection points that are indicated in Fig. 5–1.

NOTE – Some of the connection points might not be accessible in certain configurations. In such cases, you only need to join the connection points that you can access.

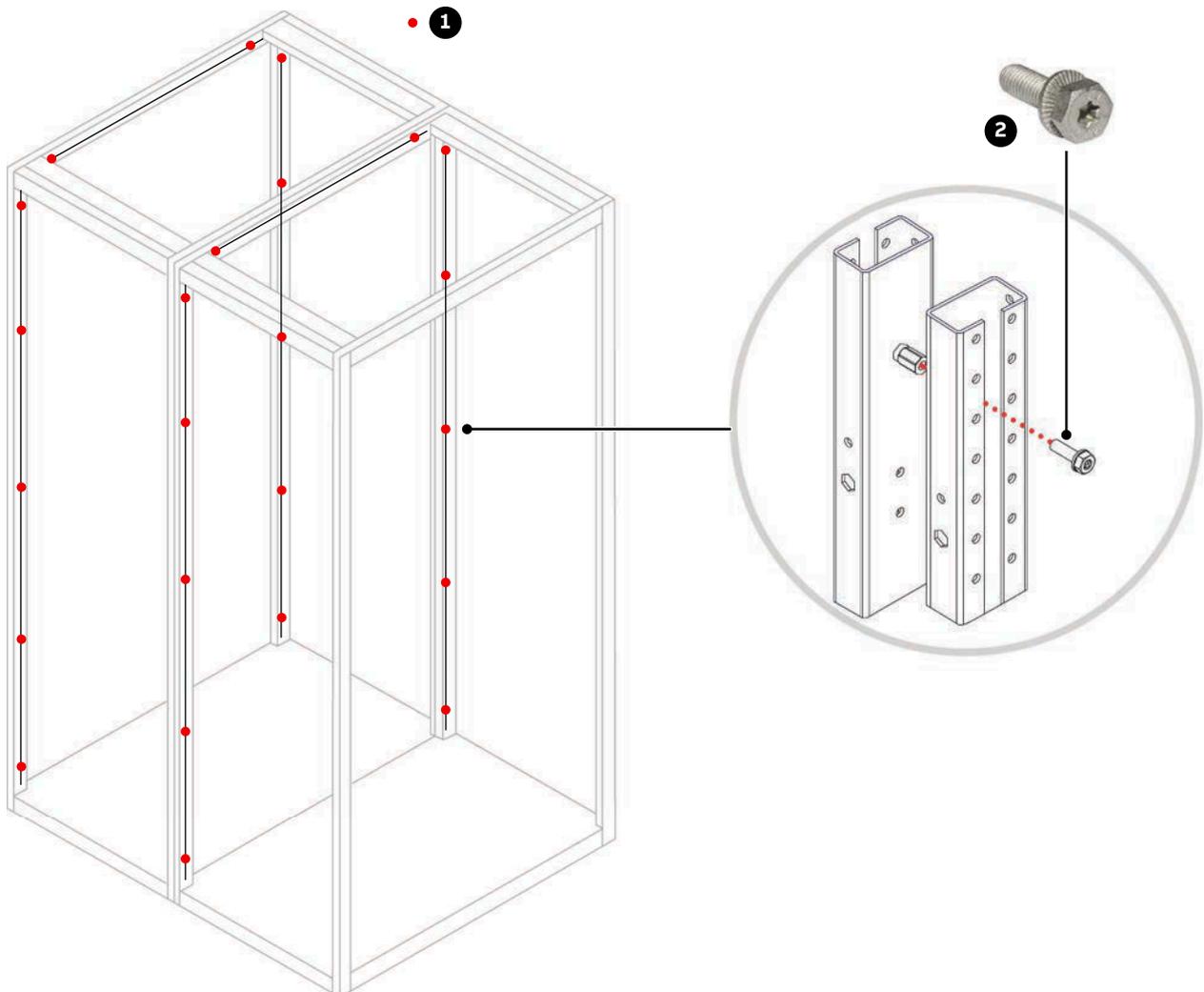


Figure 5–1 Connection point locations on transport units

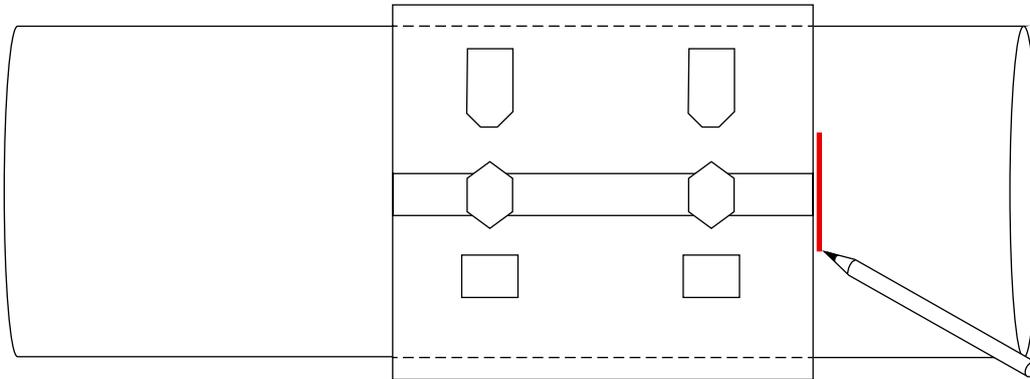
1) Connection point locations

2) M6 × 16 (9ABA450093R0259
SCR-CBS-M6X16-8_8-FLZNNC)

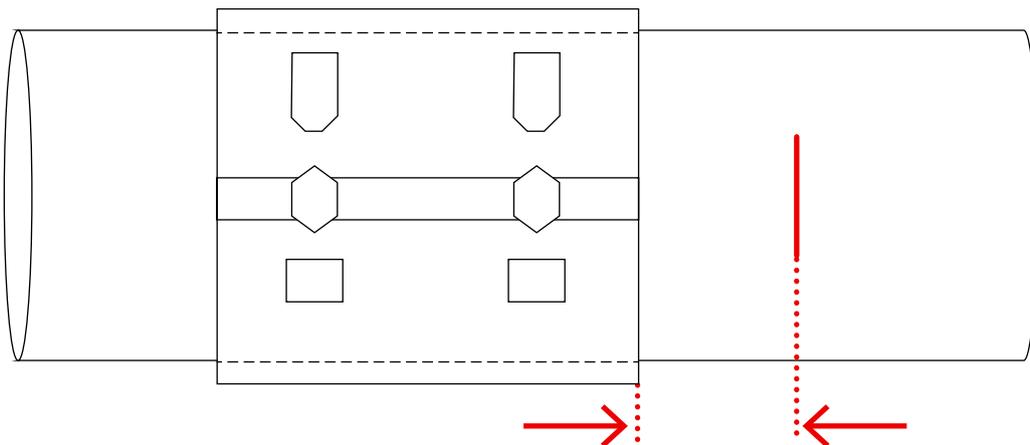
5.6. Joining water pipes

The pipe joints of two adjoining transport units have been slid onto the water pipes in the factory. The locking bolts show into the direction where they can be reached best with a wrench.

1. Mark the length of a pipe joint on one end of a water pipe as a fitting guide.



2. Slide the pipe joint over the two adjoining pipe ends.
3. Center the pipe joint.



4. Orientate the locking bolts of the pipe joint for the return water pipes (Fig. 5-2).

WARNING! Flashover hazard! The locking bolts maintain the required minimum distances between pipe joint and busbars to prevent flashover when the drive is energized.

5.7. Joining busbars



CAUTION Flashover hazard!

Incorrect orientation of the busbar bolts can cause flashover when the drive is energized.

- ▶ Orientate the bolts and the nuts of each connection as shown in this section to maintain the required minimal distances between busbars of different polarity.



NOTICE Risk of component damage!

Tightening torque for M12 bolts:

- ▶ 40 Nm if two busbars are joined
- ▶ 60 Nm if three and more busbars are joined

Joining the busbars of two adjoining transport units

- Busbar joints within a transport unit have been installed in the factory.
- Use only the supplied installation material.
- Orientate the parts of a joint (plates, bolts, and nuts) as shown.
- Use a conical spring washer on the bolt side of the connection.

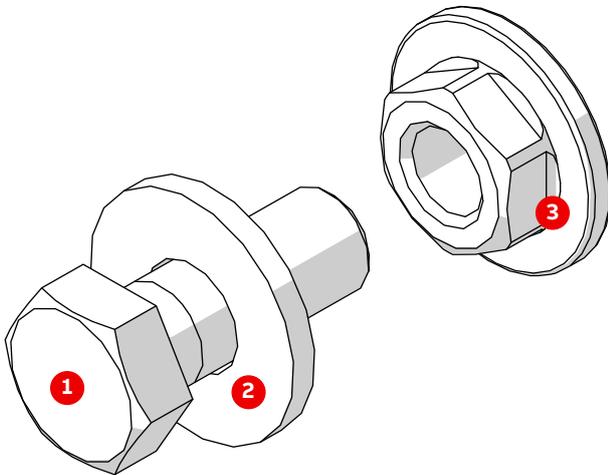


Figure 5–3 Bolted busbar connection

- | | |
|--------------------------|---------------|
| 1) Hex-head bolt | 3) Flange nut |
| 2) Conical spring washer | |

5.7.1. DC busbars

The DC busbars can be accessed from the back and the top of the cabinet. If necessary, you can remove the top plates and the rear walls.

NOTE – If you need to remove the air-to-air heat exchangers to access the top plates, see section 5.8.2, **Removing air-to-air heat exchangers**, page 111.

The following DC busbar configurations depend on the configuration of the drive:

- DC busbar configuration 1 (Fig. 5–4)
- DC busbar configuration 2 (A in Fig. 5–5)
- DC busbar configuration 3 (B in Fig. 5–5)
- DC busbar configuration 4 (C in Fig. 5–5)

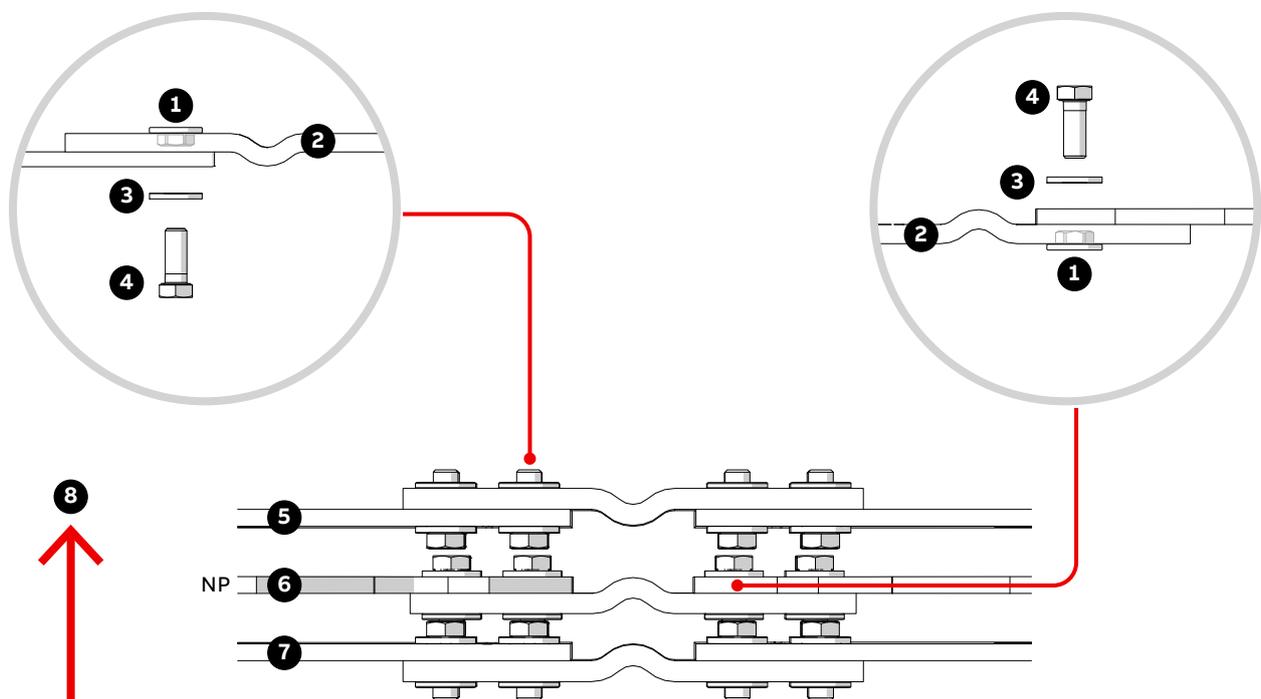


Figure 5–4 Top view of DC busbar configuration 1

Item	Quantity	Technical parameters	Identification
1) Captive flange nut	N/A	M12-A2-70, coated	3BHB038117R0001
2) Connecting plate	3	Flex	3BHB050592R0001/R0051
3) Conical spring washer	24	13 × 29 × 3	HAQN400344P0111
4) Hex-head bolt	24	M12 × 30-A2	NB 312350P8117
5) Busbar with positive potential			
6) Busbar with neutral potential			
7) Busbar with negative potential			
8) Front of cabinet			

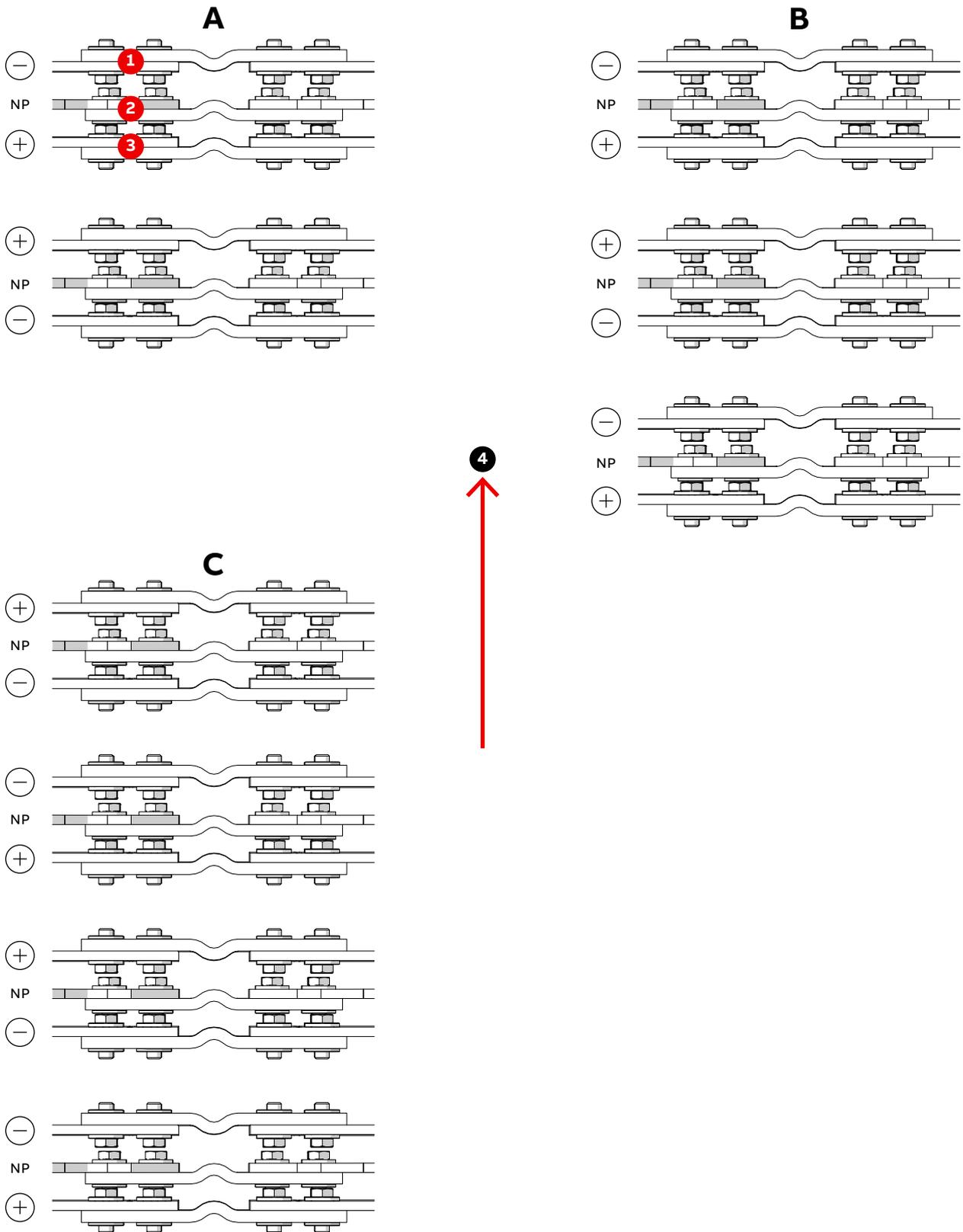


Figure 5-5 Top view DC busbar configurations 2 (A), 3 (B) and 4 (C)

- | | |
|-----------------------------------|-----------------------------------|
| 1) Busbar with negative potential | 3) Busbar with positive potential |
| 2) Busbar with neutral potential | 4) Front of cabinet |

5.7.2. Ground busbars

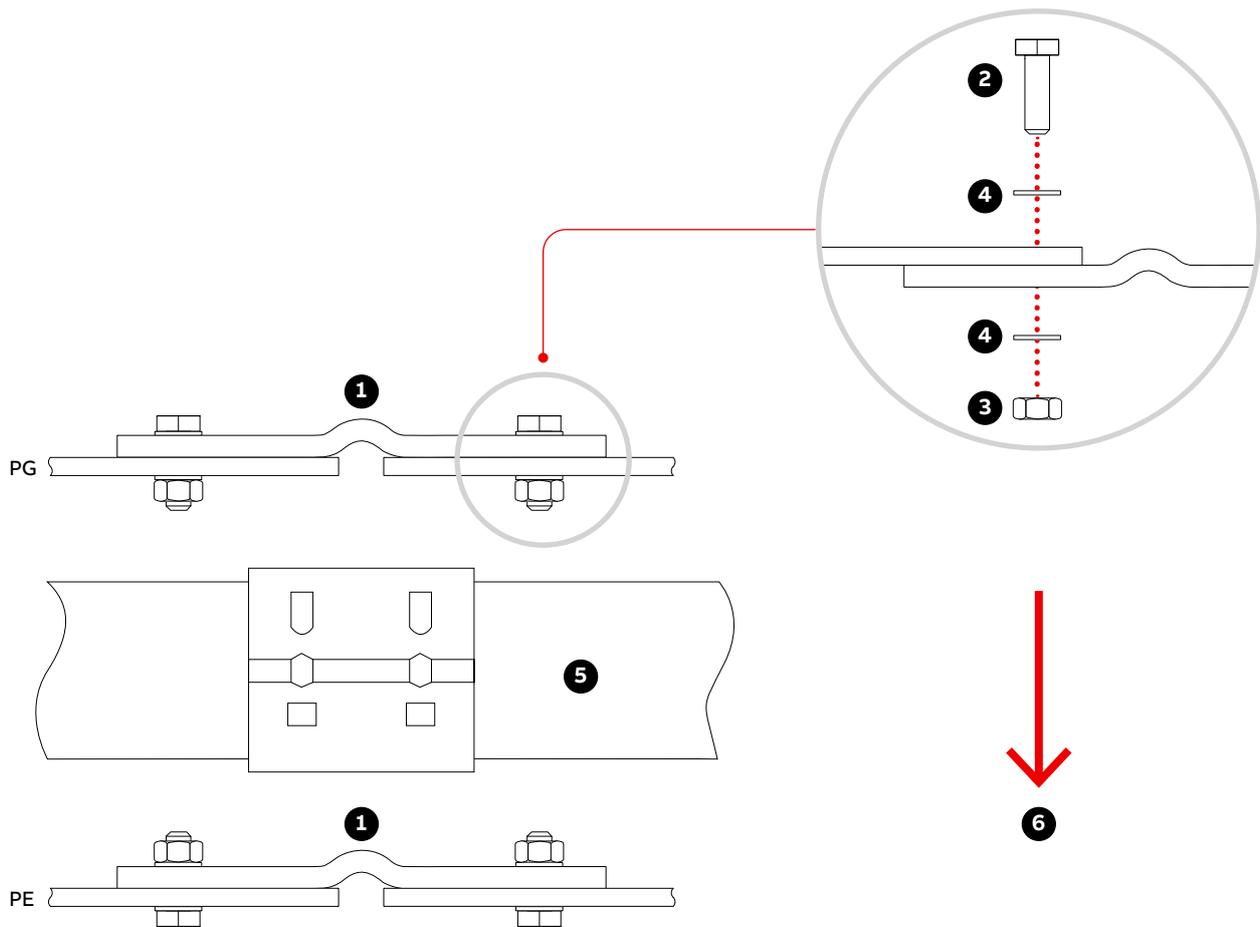


Figure 5–6 Ground busbar joints

Item	Quantity	Technical parameters	Identification
1) Connecting plate	2	Flex	3BHB010246R0001/R0051
2) Hex-head bolt	4	M12 × 40-A2	NB 312350P8119
3) Hex-head nut	4	M12-A2-70, coated	HZN 452198P1022
4) Conical spring washer	8	13 × 29 × 3	HAQN400344P0111
5) Water pipe			
6) Cabinet front			

5.7.3. AC busbars between COU/TEU and LSU (5/7/9 MVA)

The busbar configuration shown in Fig. 5–7 is for a TEU (A) connected to the left side of an LSU (B). For a TEU connected to the right side of an LSU, the busbar configuration is the mirror image of this figure.

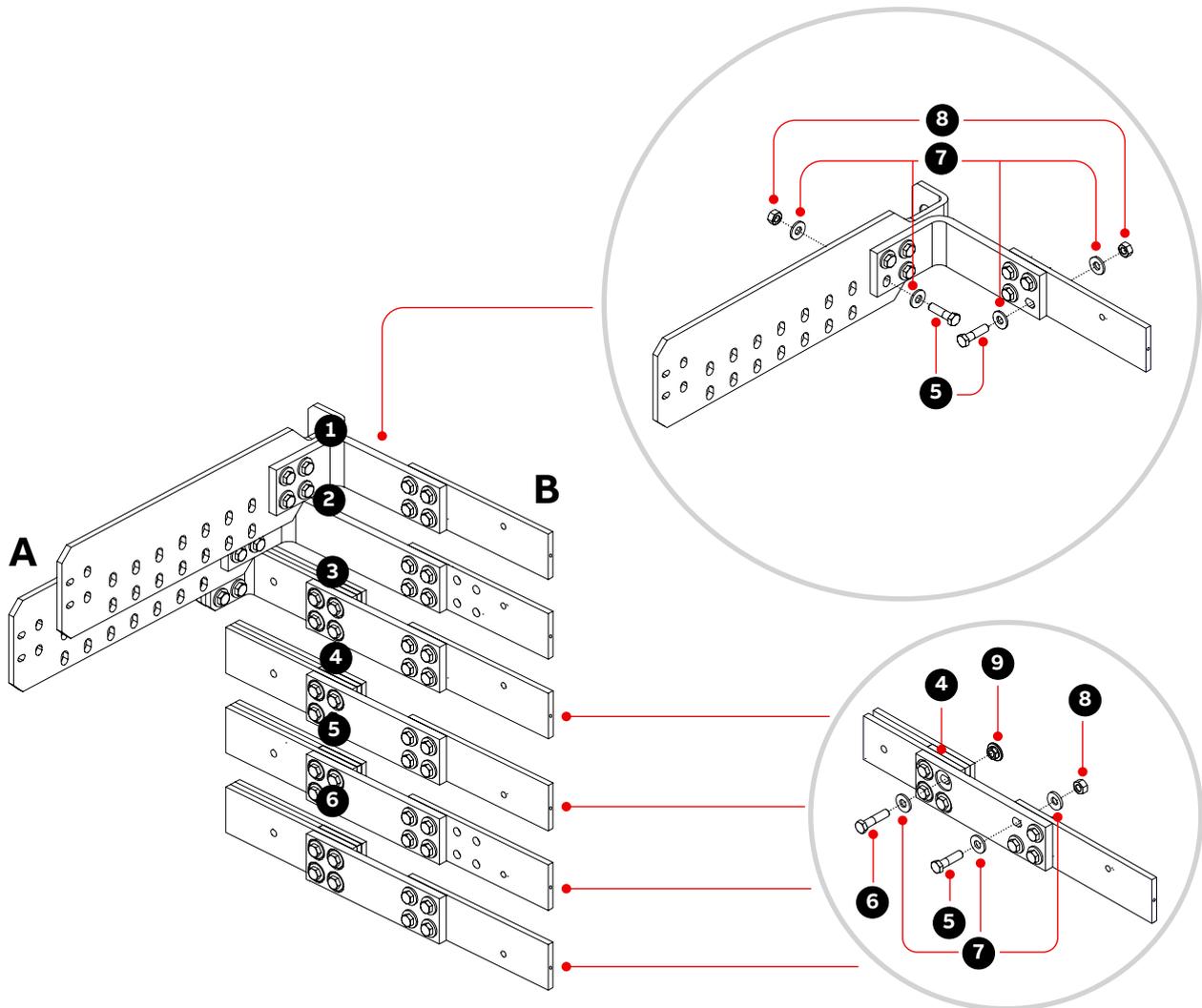


Figure 5–7 AC busbar joints between the COU/TEU and LSU (5/7/9 MVA).

Item	Quantity	Technical parameters	Identification
1) Connection bus bar	1	LSU-TEU 1b	3BHB045554R0001
2) Connection bus bar	1	LSU-TEU 2b	3BHB045556R0001
3) Connection bus bar	4	LSU-TEU 3b	3BHB045558R0001
4) Bus bar spacer	4	80 mm spacer 10 mm	3BHB031095R0001
5) Hex-head bolt	32	M12 × 45-A2-70	NB 312450P8120
6) Hex-head bolt	16	M12 × 50-A2-70	NB 312450P8121
7) Conical spring washer	80	DIN6796-13 × 29 × 3	HAQN400344P0111
8) Hex-head nut	32	M12-A2-70	HZN 452198P1022
9) Flange nut	16	M12-A2	3BHB038117R0001

5.7.4. AC busbars between COU/TEU and LSU (14 MVA)

The busbar configuration shown in Fig. 5–8 is for a TEU (A) connected to the left side of an LSU (B). For a TEU connected to the right side of an LSU, the busbar configuration is the mirror image of this figure.

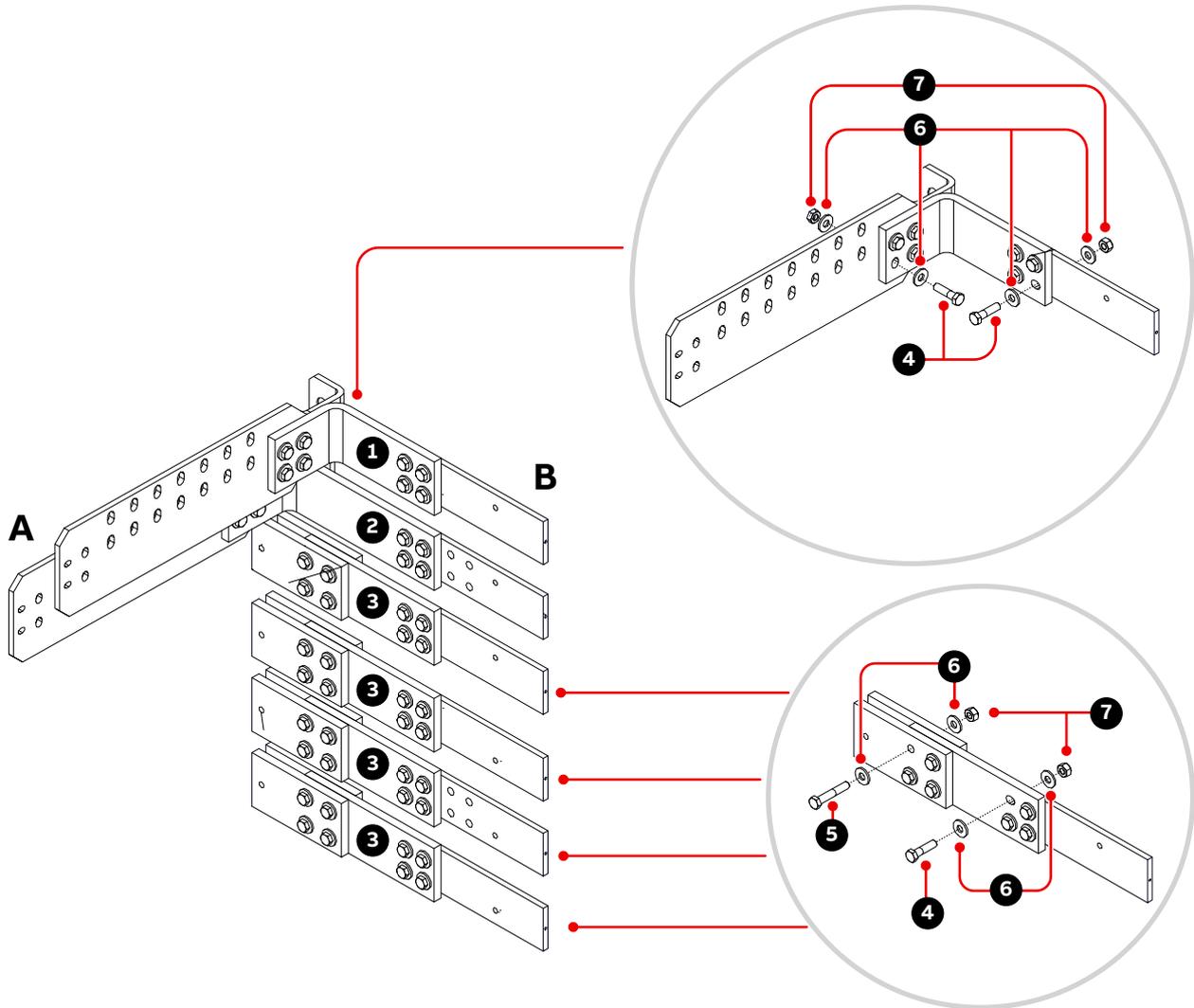


Figure 5–8 AC busbar joints between the COU/TEU and LSU (14 MVA).

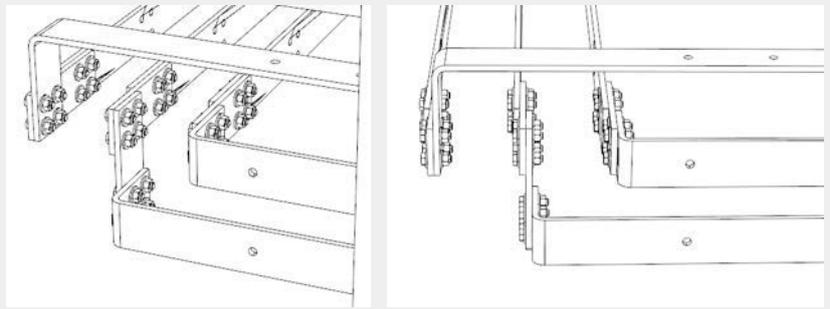
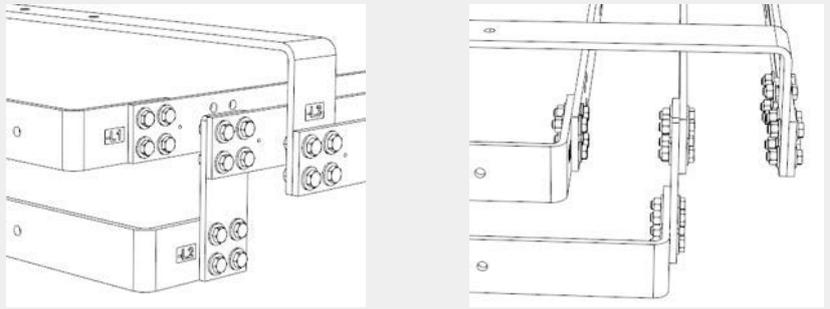
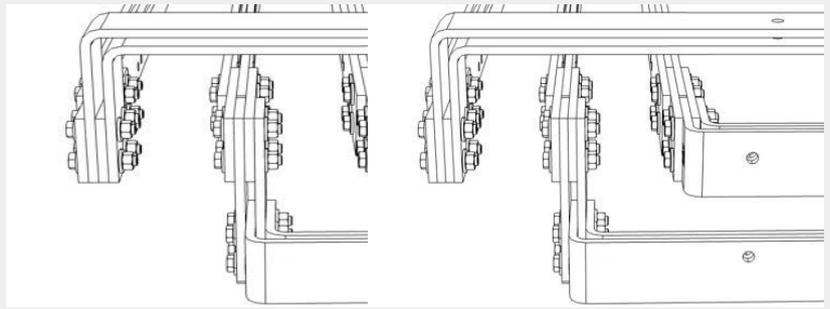
Item	Quantity	Technical parameters	Identification
1) Connection bus bar	1	LSU-TEU 1a	3BHB045554R0001
2) Connection bus bar	1	LSU-TEU 2a	3BHB045556R0001
3) Connection bus bar	4	LSU-TEU 3a	3BHB045558R0001
4) Hex-head bolt	32	M12 × 45-A2-70	NB 312450P8120
5) Hex-head bolt	16	M12 × 65-A2-70	NB 312450P8124
6) Conical spring washer	9	DIN6796-13×29×3	HAQN400344P0111
7) Hex-head nut	4	DIN934-M12-A2-70	HZN 452198P1022

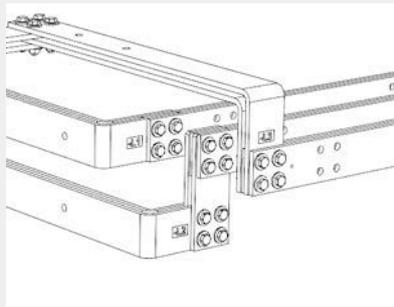
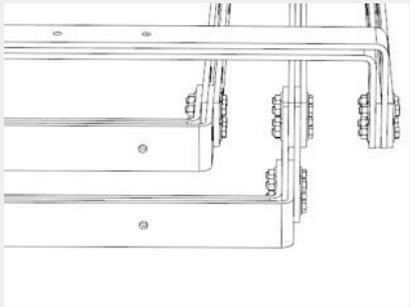
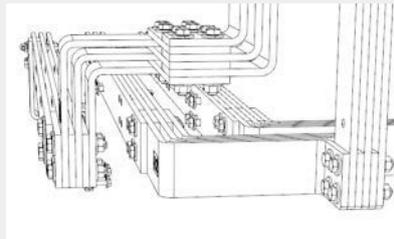
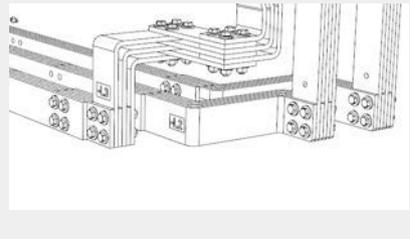
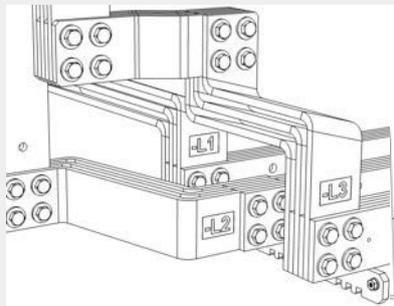
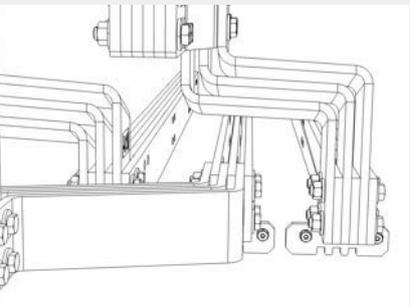
5.7.5. AC busbars between COU/TEU and ARU/INU

Table 5–1 Installation material for AC busbars (COU/TEU – ARU/INU)

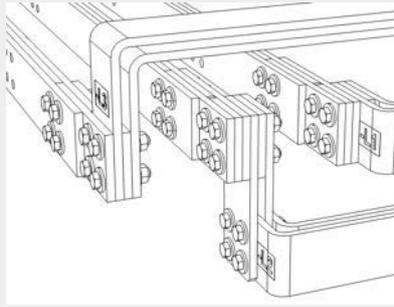
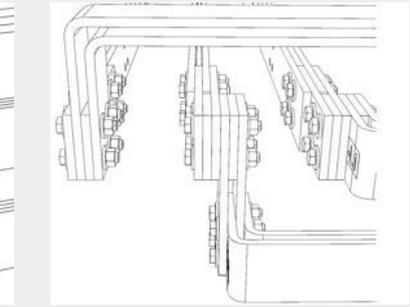
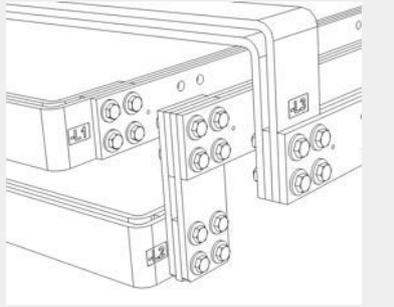
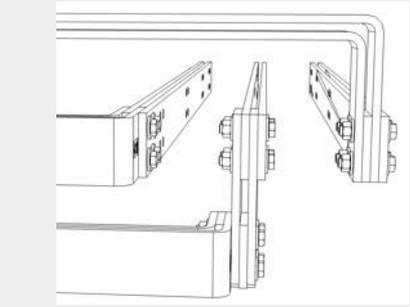
Item	Technical parameter	Identification	Usage
Hex-head bolt	M12 × 40-A2-70	NB 312350P8119	Single busbar
Hex-head bolt	M12 × 60-A2-70	NB 312450P8123	Double busbars
Hex-head bolt	M12 × 80-A2-70	NB 312450P8127	Triple busbars
Conical spring washer	13 × 29 × 3	HAQN400344P0111	
Hex-head nut	M12-A2-70, coated	HZN 452198P1022	

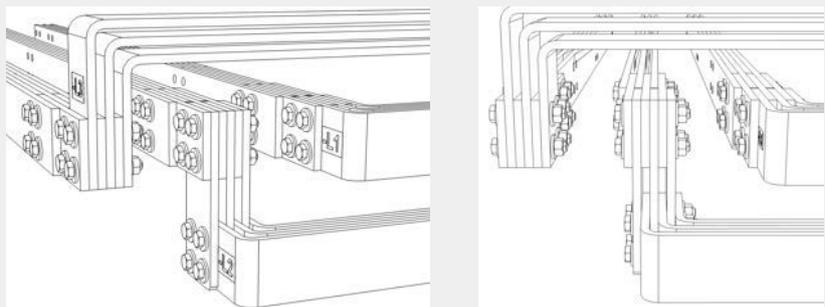
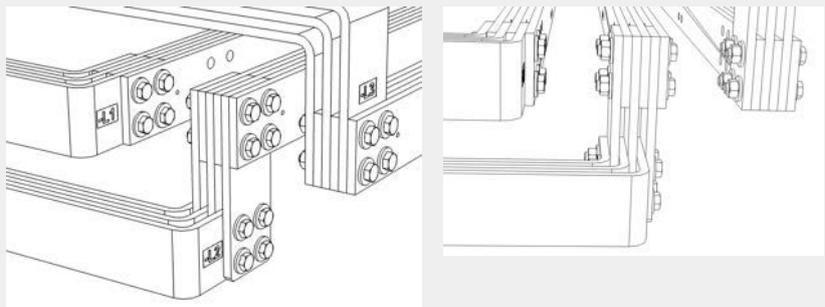
5.7.6. AC busbar joints - without disconnecter

Modules	Busbar joints
<ul style="list-style-type: none"> • ARU/INU - COU/TEU • ARU/INU: 5 MVA (without MOI) • COU/TEU: <ul style="list-style-type: none"> - 600 mm - 1000 mm 	
<ul style="list-style-type: none"> • COU/TEU - ARU/INU • ARU/INU: 5 MVA (without MOI) • COU/TEU: <ul style="list-style-type: none"> - 600 mm - 1000 mm 	
<ul style="list-style-type: none"> • ARU/INU - COU/TEU • ARU/INU: <ul style="list-style-type: none"> - 7, 9, 13 peak MVA - 5 MVA (with MOI) • COU/TEU: <ul style="list-style-type: none"> - 600 mm - 1000 mm 	

Modules	Busbar joints
<ul style="list-style-type: none"> • COU/TEU - ARU/INU • ARU/INU: <ul style="list-style-type: none"> - 7, 9, 13 peak MVA - 5 MVA (with MOI) • COU/TEU: <ul style="list-style-type: none"> - 600 mm - 1000 mm 	 
<ul style="list-style-type: none"> • ARU/INU - COU/TEU • ARU/INU: <ul style="list-style-type: none"> - 12 MVA • COU/TEU: <ul style="list-style-type: none"> - 1000 mm 	 
<ul style="list-style-type: none"> • COU/TEU - ARU/INU • ARU/INU: <ul style="list-style-type: none"> - 12 MVA • COU/TEU: <ul style="list-style-type: none"> - 1000 mm 	 

5.7.7. AC busbar joints - with motorized disconnecter

Module	Busbar joints
<ul style="list-style-type: none"> • ARU/INU - COU/TEU • ARU/INU: <ul style="list-style-type: none"> - 5, 7, 9, 13 peak MVA • COU/TEU: <ul style="list-style-type: none"> - 1000 mm 	 
<ul style="list-style-type: none"> • COU/TEU - ARU/INU • ARU/INU: <ul style="list-style-type: none"> - 5, 7, 9, 13 peak MVA • COU/TEU: <ul style="list-style-type: none"> - 1000 mm 	 

Module	Busbar joints
<ul style="list-style-type: none">• ARU/INU - COU/TEU• ARU/INU:<ul style="list-style-type: none">- 12 MVA• COU/TEU:<ul style="list-style-type: none">- 1000 mm	 The image contains two technical line drawings. The left drawing shows a perspective view of a busbar joint where a horizontal busbar is connected to a vertical busbar. The right drawing shows a perspective view of a busbar joint where two horizontal busbars are connected to a vertical busbar.
<ul style="list-style-type: none">• COU/TEU - ARU/INU• ARU/INU:<ul style="list-style-type: none">- 12 MVA• COU/TEU:<ul style="list-style-type: none">- 1000 mm	 The image contains two technical line drawings. The left drawing shows a perspective view of a busbar joint where a horizontal busbar is connected to a vertical busbar. The right drawing shows a perspective view of a busbar joint where two horizontal busbars are connected to a vertical busbar.

5.8. Installing and removing air-to-air heat exchangers

This section describes how to install and remove the optional air-to-air heat exchangers.

5.8.1. Installing air-to-air heat exchangers

For information on the number of air-to-air heat exchangers to be installed and their fitting position, see “Appendix C - Mechanical drawings”.



Figure 5-9 Air-to-air heat exchanger (type LT-5-5165-UL)

- Weight: ~65 kg
- Length: 1025 mm
- Width: 750 mm
- Height: 316 mm



Figure 5-10 Tools for installing an air-to-air heat exchanger

- | | |
|-------------------|-----------------------|
| 1) Cordless drill | 4) M6 × 12 Torx screw |
| 2) Wire cutter | 5) Cable tie |
| 3) Torx drill bit | |

5.8.1.1. Installation



CAUTION Risk of falling object

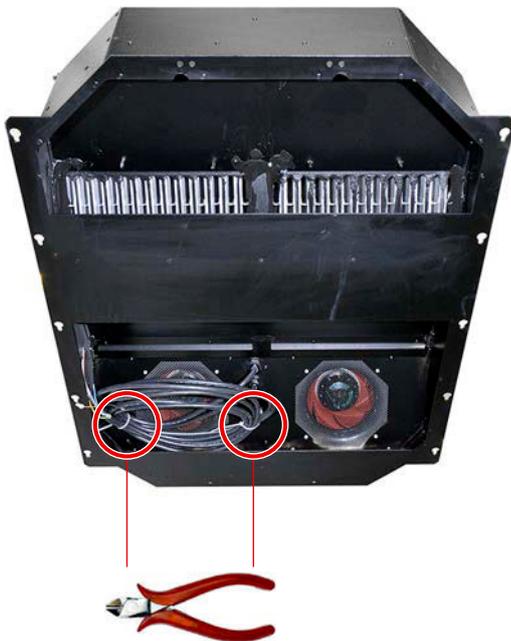
An improperly secured load can shift and fall.

- ▶ Always lift an air-to-air heat exchanger with a the rotating eyebolts (Fig. 4–1) that were delivered with the drive

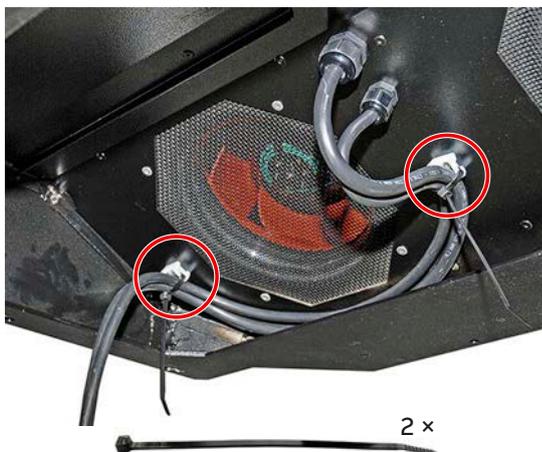
NOTICE Risk of damage!

Incorrectly installed heat exchanger cables can cause ground faults, unexpected shutdown of the drive, and damage to the heat exchanger.

1. Before lifting the heat exchanger onto the roof, cut off the cable ties.



2. Loop the cables as illustrated and fasten them to the cable tie mounts (circles).



3. Loop a length of the cables and fasten them to the cable tie mount (circle).

CAUTION! Hazardous voltage! Make sure that the heat exchanger cables DO NOT touch the high-voltage carrying DC busbars (2 in Fig. 5–11).

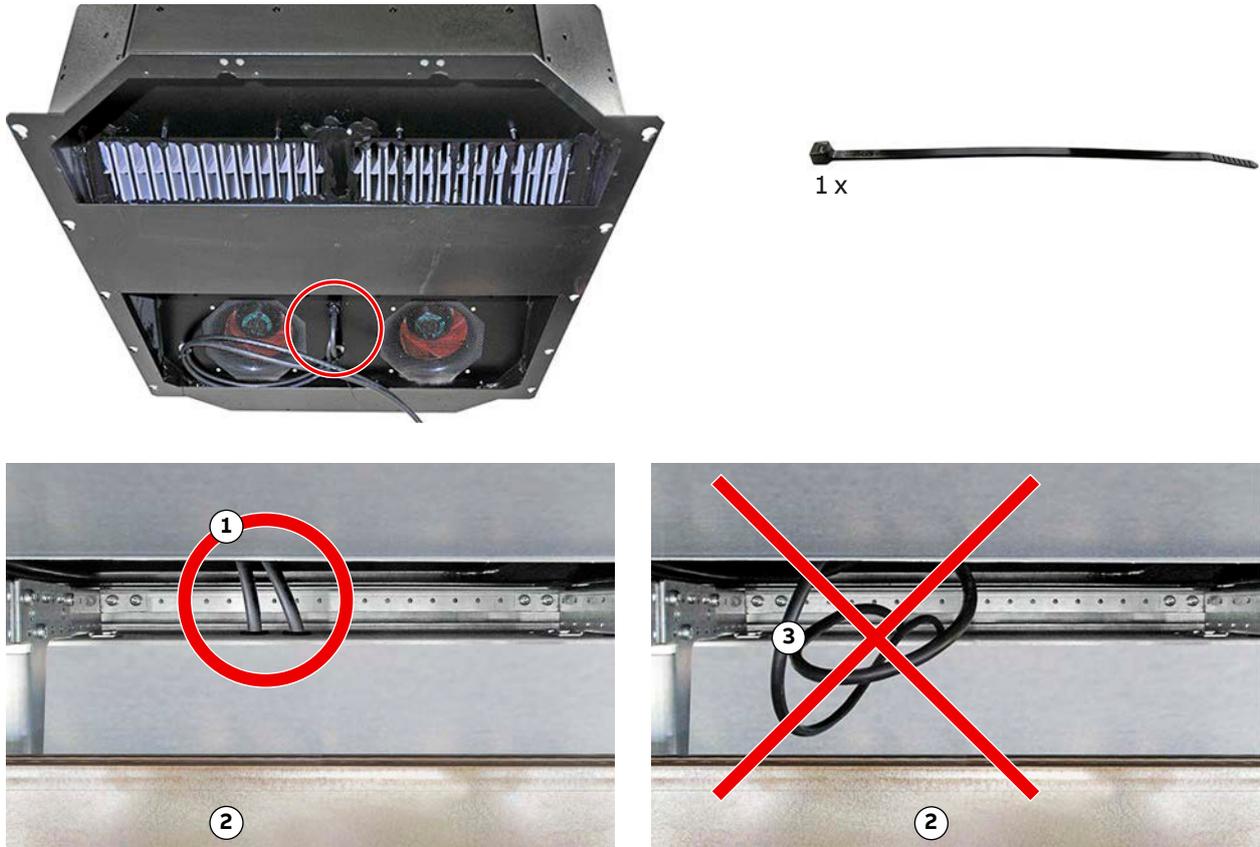


Figure 5–11 Correct and incorrect cable installation

1) Correct cable installation
2) DC busbar

3) Incorrect cable installation

4. Remove the cover on the roof where the heat exchanger is installed.

5. Install rotating eyebolts (1) in the top corners of the heat exchanger.

CAUTION! For a single lifting operation, tighten the eyebolts (1) firmly with the star key (2). DO NOT leave the star key in the bolt head. The eyebolt must be able to rotate 360° freely. For a permanent installation, tighten the eyebolts to the nominal torque that is specified in section 4.5.1, **Lifting attachment types**, page 80.



Figure 5–12 M8 rotating eyebolt and heat exchanger with mounted rotating eyebolts

6. Orient the rotating eyebolts in the direction of force.

CAUTION! Rotation during transportation must be avoided.

7. Lift the heat exchanger above the opening in the roof and orientate the heat exchanger with the LEDs (circle in Fig. 5-12) pointing to the front of the cabinet.

8. Route the cables through the designated openings (circle) at the front of the cabinet.



9. While lowering the heat exchanger onto the roof, pull the cables through the openings.

10. From the openings (1), route the cables to the terminals (2) as illustrated in the examples for ARU / INU / IFU 9 MVA and LSU.

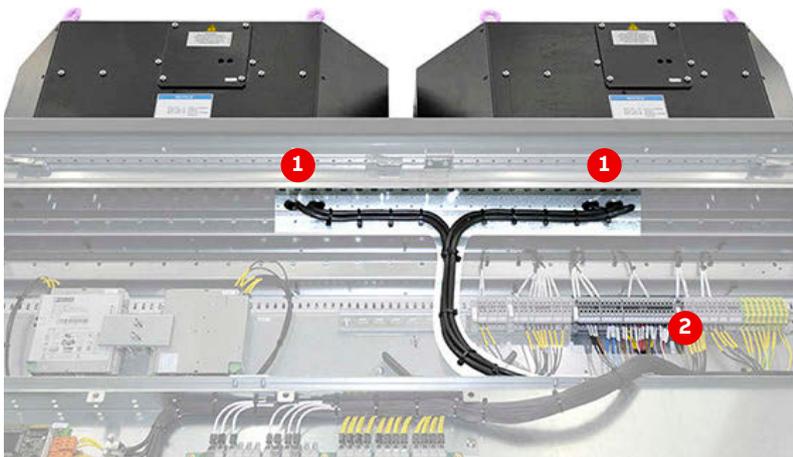


Figure 5-13 ARU/INU/IFU cable routing

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	109/272

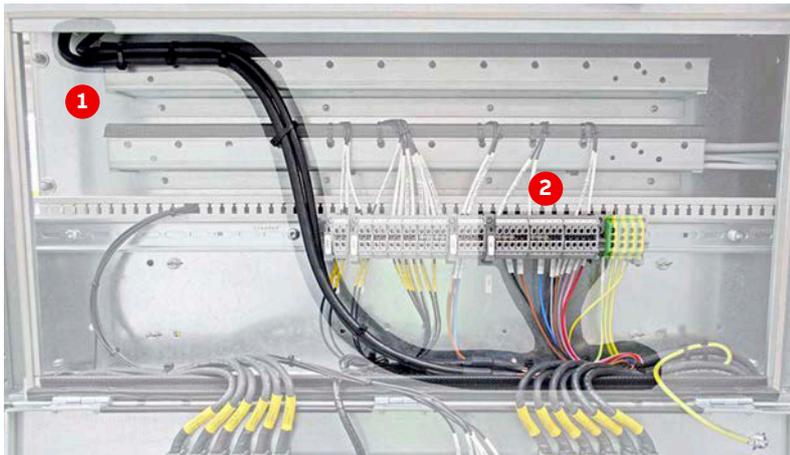
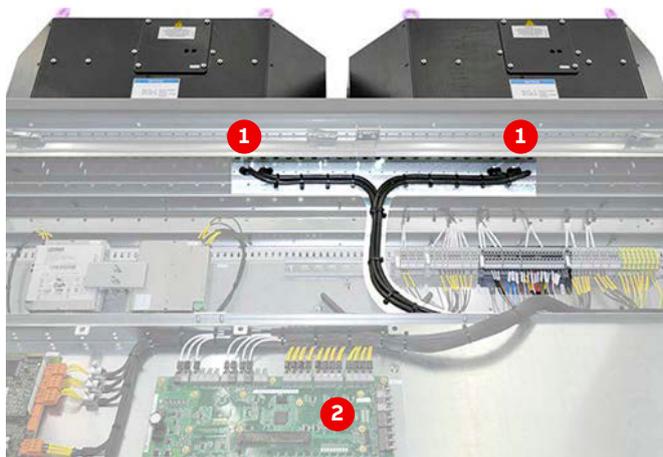


Figure 5-14 LSU cable routing

- 11.** Connect each wire to terminal block -X1 according to the terminal numbers printed on the marker sleeves (white).



- 12.** In the upper part of the cable duct (1), fasten the cables to the cabinet frame.



15 × 

- 13.** In the lower part (2), tie the cables together at regular distances.

- 14.** Check that the cables do not touch the DC busbars.

15. Fasten the heat exchanger to the roof with 14 self-tapping M6x12 screws (HAQN401205P0257).



16. Remove the rotating eyebolts that you installed in step 5.

5.8.2. Removing air-to-air heat exchangers

This section applies to drives that are delivered in several transport units.

⚠ CAUTION Heavy object!

An air-air heat exchanger weighs approximately **65 kg**.

- ▶ Observe the installation height of the heat exchanger as well as the dimensions and weight of the heat exchanger.
- ▶ Take appropriate measures for removing and installing the heat exchanger safely.



Figure 5–15 Air-to-air heat exchangers (type LT-5-5165-UL)

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	111/272

Air-to-air heat exchangers must be removed and refitted where two transport units are joined.

Depending on the drive configuration, at least one heat exchanger must be removed for joining the DC busbars of two adjacent transport units.



Figure 5-16 Tools for removing an air-to-air heat exchanger

- | | |
|-------------------|-------------------|
| 1) Cordless drill | 3) Torx drill bit |
| 2) Wire cutter | 4) Cable tie |

5.8.2.1. Removing an air-to-air heat exchanger

1. Loosen the 4 self-tapping M6×12 screws (HAQN401205P0257) that fasten the heat exchanger to the roof.



2. Remove the cable ties.



3. Lift the heat exchanger by crane and move it approximately 20 cm to the back and place it on pieces of square timber.

4. Pull out the cables, but leave them connected.



5. Put two pieces of square timber on the adjacent heat exchanger and place the removed heat exchanger on the timber.



6. Join the DC busbars with the supplied installation material.

5.8.2.2. Reinstalling an air-to-air heat exchanger

1. Move the heat exchanger to its original position.
2. Pull the cables down towards the terminal box.
3. Move the heat exchanger to its exact position.
4. Fix the cables with cable ties at regular distances of approximately 20 cm.
5. Tighten all screws of the heat exchanger.
6. Fix the cables inside the terminal box with cable ties.

5.8.3. Installing the transformers of air-to-air heat exchangers

This section applies to drives with separately delivered air-to-air heat exchangers.

For information on the number of transformers to be installed and their fitting position, see “Appendix C - Mechanical drawings”.

1. Install the transformer and hood as illustrated.

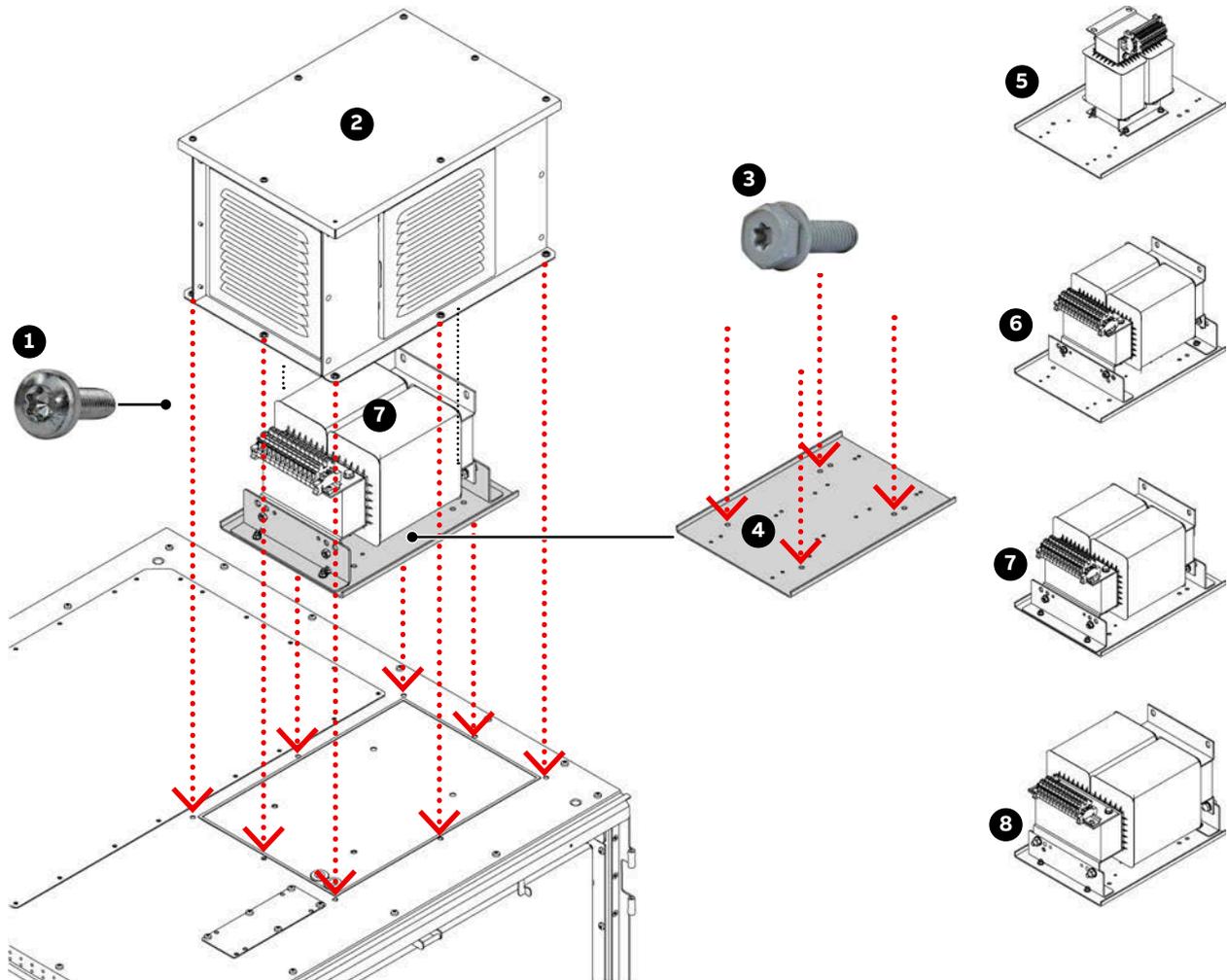


Figure 5–17 Installation example of transformers in an air-to-air heat exchanger

- | | |
|---------------------------------|--------------------------------|
| 1) 8 × M6x12 (HAQN401205P0257) | 5) 1.5 kVA transformer: ~17 kg |
| 2) Transformer hood | 6) 2.8 kVA transformer: ~49 kg |
| 3) 4 × M8x20 (9ABA450093R0310) | 7) 3.5 kVA transformer: ~49 kg |
| 4) Transformer connection plate | 8) 6 kVA transformer: ~66 kg |

2. Connect each wire to the terminal block according to the terminal numbers printed on the marker sleeves.

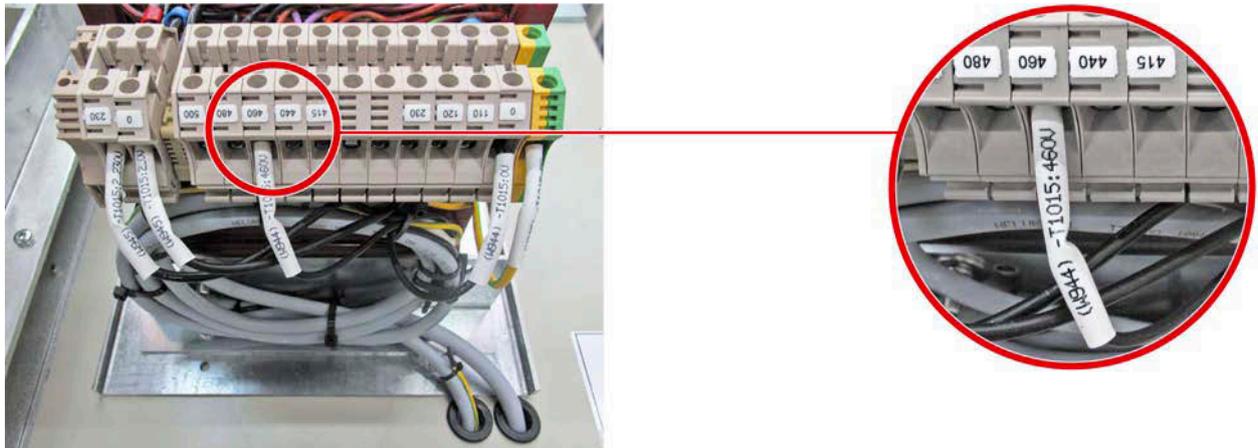


Figure 5-18 Connect wires to terminal block

5.9. Installing the pressure relief vents

This section applies to drives with separately delivered pressure relief vents.

Pressure relief vents are installed on the roofs of TEUs and COUs.



Figure 5–19 Pressure relief vents

- Weight: ~26 kg
- Length: 840 mm
- Width: 520 mm
- Height: 210 mm



Figure 5–20 Tools required to fasten the pressure relief vent to the roof

- | | |
|--|---|
| <ol style="list-style-type: none"> 1) Cordless drill 2) Torx bit | <ol style="list-style-type: none"> 3) 24 × M6x20 Self-tapping
(HAQN40105P0260) |
|--|---|

Procedure

1. Orientate the pressure relief vents with the baffle blades (arrows) pointing to the center of the drive.

NOTE – The orientation of the baffle blades can be seen through the grill on the underside.

2. Fasten the pressure relief vent to the roof with the supplied screws (Fig. 5–21).

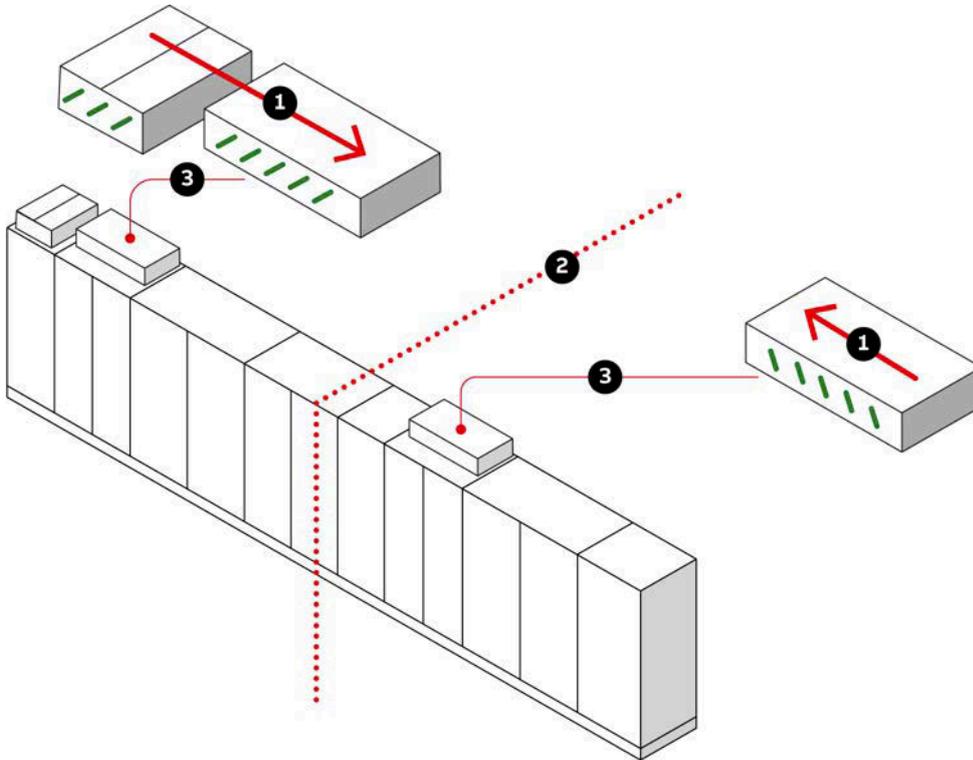


Figure 5–21 Installation example of pressure relief vents

- | | |
|---------------------------------|--------------------------|
| 1) Orientation of baffle blades | 3) Pressure relief vents |
| 2) Center of drive | |

5.10. Attaching the sealing tapes

This section applies to transport units with degree of protection IP 54.

The self-adhesive sealing tape (3BHB012376R0001) supplied with the drive (1 m per transport unit) prevents water entering the gap between two adjoining roof plates. The tape is installed where two transport units have been joined. Gaps within a transport unit have been sealed with a tape in the factory.

Procedure

1. Remove the roof plates of two adjoining transport units.
2. Cut the sealing tape to the required length.
3. Attach the tape on the whole length of the joining crossbars (1).

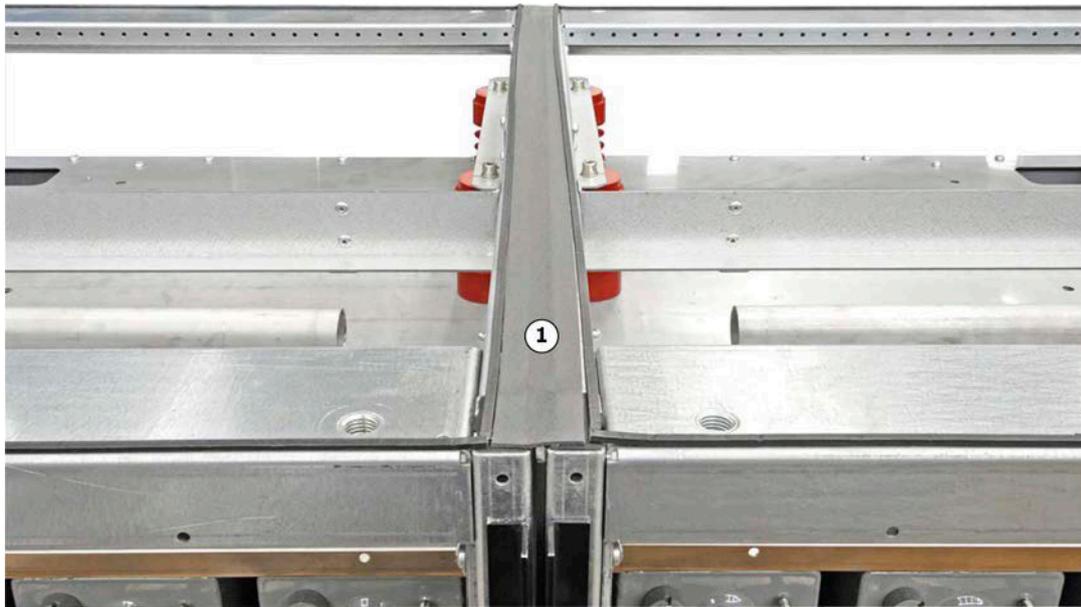


Figure 5-22 Attach sealing tape to the joining crossbar (1)

4. Reinstall the roof plates.

5.11. Installing the roof joints and the roof attachments

This section applies to drives that are delivered in several transport units.

5.11.1. Installing roof joints

For information on the fitting position, see “Appendix C - Mechanical drawings”.

Table 5–2 Installation material for roof joints

Item	Technical parameter	Identification
Connecting plate	8 × 80 × 220 mm	3BHB011552R0001
Hex-head bolt	M16 × 40-A2	NB 312350P0464
Washer	17 × 30 × 3	9ABA450078P0008

- Install the joints at the front and the back of the roof of two adjoining transport units using the supplied installation material.

NOTE – The joints (1) within a transport unit are factory-installed.

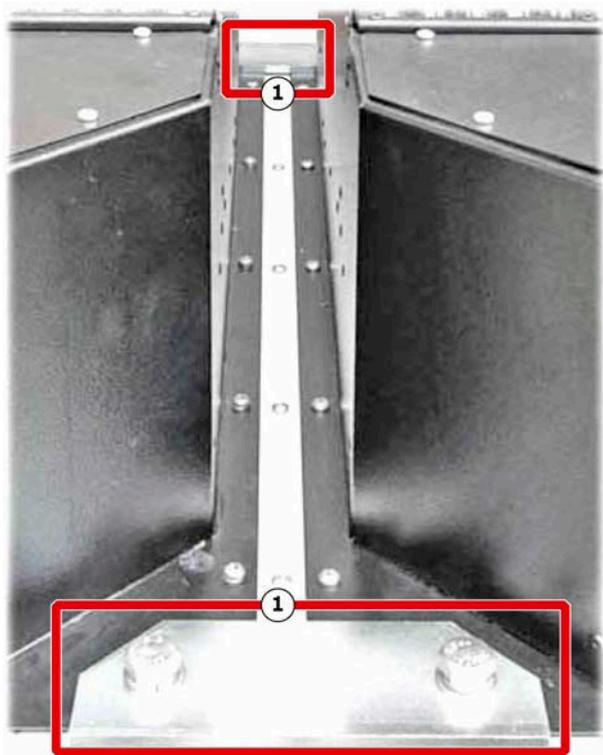


Figure 5–23 Roof joints (1)

5.11.2. Installing roof attachments

This section applies to marine drives.

The roof attachments prevent tilting of the cabinets and dampen vibrations. Struts for attaching the cabinets to the wall of the drive room are not supplied.

For information on the fitting location, see “Appendix C - Mechanical drawings”.

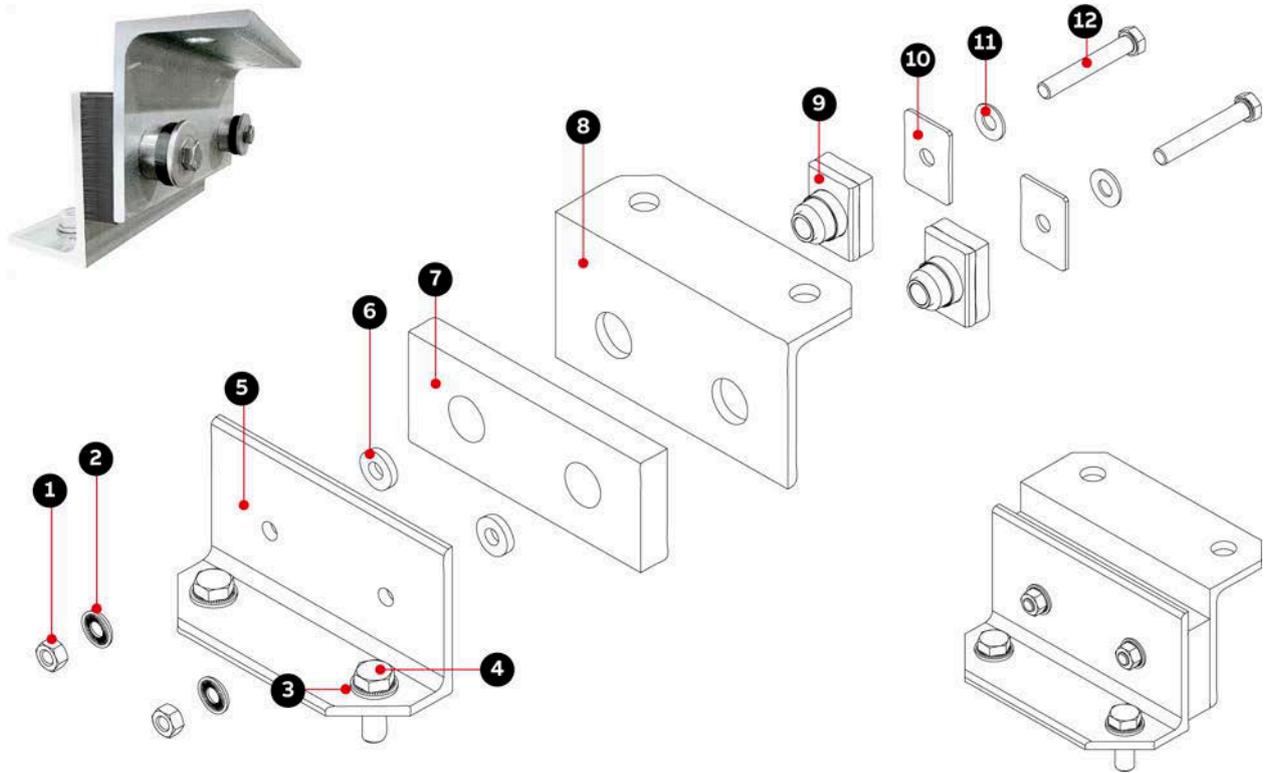


Figure 5–24 Roof attachment parts

Item	Details	ID number
1) 2 × nuts	M12	HZN 452198P1022
2) 2 × washers	13 / 29 ST / ZN	9ABA450078P0007
3) 2 × washers	17 × 30 × 3	9ABA450078P0008
4) 2 × hex-head bolts	M16 × 40	NB 312350P0464
5) 1 × bracket		3BHB035997R0002
6) 2 × spacers		3BHB032466R0001
7) 1 × damping pad		3BHB035998R0001
8) 1 × bracket		3BHB035997R0001
9) 2 × damping connectors		3BHB033405R0001
10) 2 × plates		3BHB035999R0001
11) 2 × washers	13 / 29 ST / ZN	9ABA450078P0007
12) 2 × hex-head bolts	M12 × 80	NB 312450P8127

Procedure:

1. Assemble the roof attachment.
2. Tighten the bolts firmly.
3. To fix the drive to the ceiling or the back wall, use two suitable struts per roof attachment.

WARNING! DO NOT install the struts at a 90° angle to the cabinet roof (Fig. 5–25).

NOTE – The struts are not supplied.

4. If you fix the drive to the ceiling, use two struts per roof attachment (1 in Fig. 5–25).
5. If you fix the drive to the back wall, install one strut in a 90° angle to the drive (2 in Fig. 5–25).

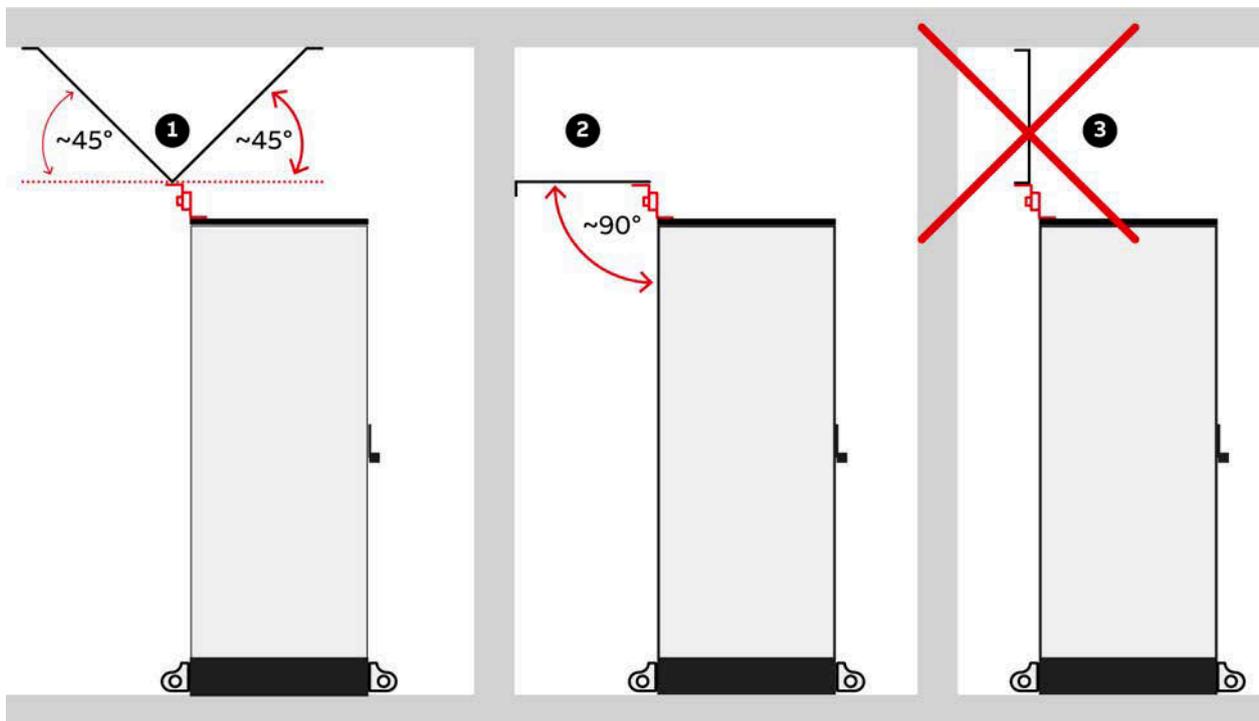


Figure 5–25 Recommended ceiling and wall fixings

- | | |
|---------------------------------|---|
| 1) Two struts at 45° to ceiling | 3) DO NOT install the struts at a 90° angle to the cabinet roof |
| 2) One strut at 90° to wall | |

6. Electrical installation

6.1. Safety



⚠ DANGER Hazardous voltage!

Improper work can result in life-threatening injury or DEATH!

- ▶ Only qualified personnel who are familiar with the site requirements, equipment requirements and the relevant electrical codes can perform the installation.
- ▶ DO NOT switch on the main and auxiliary power supplies during the installation.
- ▶ After the installation, obtain permission from the ABB commissioning personnel BEFORE switching on the main and auxiliary power supplies.

Overview

The installation includes the following items:

- **Grounding the drive system**, page 125
- **Internal wiring**, page 127
- **Cable entry systems**, page 131
- **Auxiliary power, control and serial communication cables**, page 146
- **Heating cable**, page 162



Figure 6–1 Phase module on lift table

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	123/272

6.2. Cable requirements

Power, auxiliary and control cables have different requirements.

6.2.1. Power cables

For information on the requirements for power cables, ground cable and equipotential bonding conductor, see:

- “Power cable specification” , 3BHS125090 E01
- “Power cables engineering guideline” , 3BHS542290 E01

6.2.2. Auxiliary and control cables

NOTICE Risk of false signals!

- ▶ DO NOT lay control cables parallel to the power supply cables.
If this cannot be avoided, maintain a minimum distance of **30 cm** between the control and power supply cables.
- ▶ Cross control and power supply cables at an angle of 90°

For information on the requirements for the auxiliary power cable and the control cables, see “Auxiliary power and control cables guideline”, 3BHS813742 E01.

6.2.3. Synchronization cables

Synchronization cables are used in drives with an ARU. A shielded, 3-phase cable without neutral wire is required for the supply voltage of the synchronization transformer.

6.3. Grounding the drive system

To identify the ground buses, see “Appendix C - Mechanical drawings”.

6.3.1. Grounding diagrams

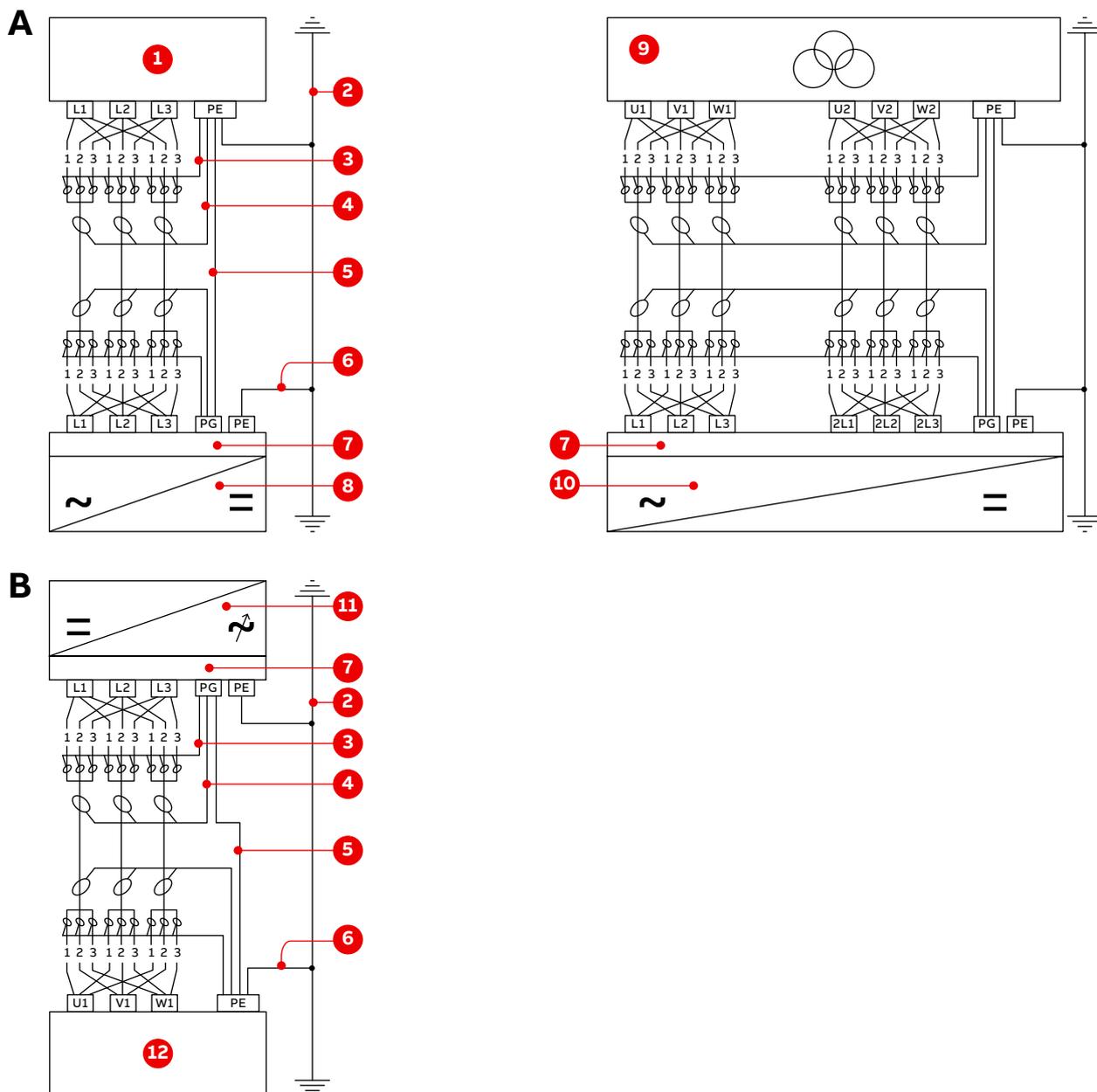


Figure 6–2 Grounding the input side (A) and output side (B) of the drive system

- | | |
|------------------------------------|----------------|
| 1) Transformer or busbar | 7) TEU |
| 2) System ground | 8) ARU |
| 3) Cable shield | 9) Transformer |
| 4) Cable armor | 10) LSU |
| 5) Equipotential bonding conductor | 11) INU |
| 6) Ground cable | 12) Motor |

6.3.2. Ground cable connection

The ground cable is connected to the PE ground busbar of the drive at only one point, ie, at the ground busbar inside the TEU part of the master COU.

In cabinets with top cable entry, the PE ground busbar is fitted below the roof.

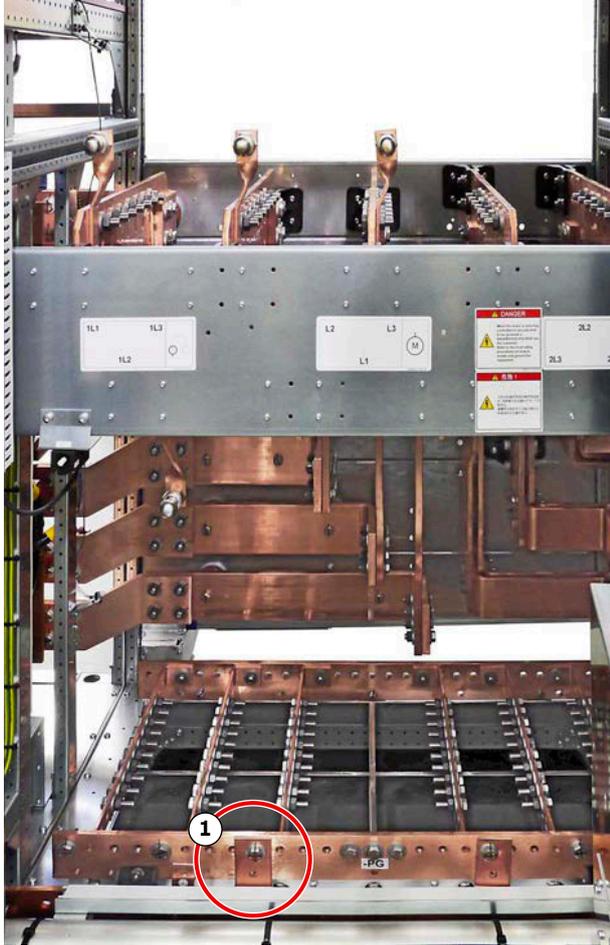


Figure 6–3 System ground connection (1) in a 600 mm TEU

For project-specific information, see “Appendix D - Wiring diagrams”. For information on busbar thickness and fastening hole diameter, see “Appendix C - Mechanical drawings”.

6.3.3. Cable shield ground connection

Cable shields are connected to the separate PG ground busbar. The connection between the PE and PG ground busbars inside the CBU is made in the factory. The CBU has a grounding switch on the door.

PRODUCT ACS6000	DOCUMENT KIND User manual	DOCUMENT ID. 3BHS212794 E01	REV. Q	LANG. en	PAGE 126/272
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6.3.4. EXU cabinet ground connections

It is important that the EXU is properly grounded to maintain safety and to ensure smooth functioning of the equipment.

- Connect the ground to the ground system of the installation site and to the ground busbar inside the EXU.
- Cross-section of the ground cable and the ground connection must be in compliance with local regulations.
- Ground the outer cable screen at both ends of a cable.
- At the EXU, ground the cable screen via the conductive sleeve of the entry plate.

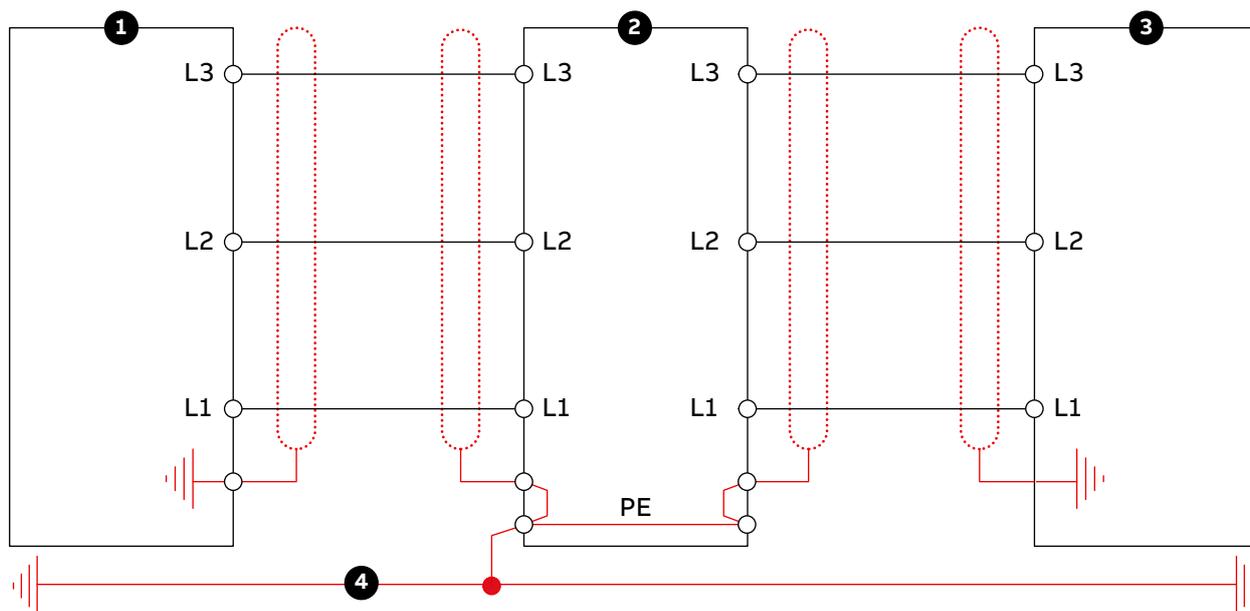


Figure 6-4 Grounding the EXU

- | | |
|----------------|-----------------|
| 1) Transformer | 3) Motor |
| 2) EXU | 4) Ground cable |

6.4. Internal wiring

This section applies to a drive that is delivered as multiple transport units.

Cables for internal wiring are delivered separately. The pre-assembled cables are fitted with terminal identifications at each end.

All necessary data for each individual connection are specified on the “Converter hardware diagram” and the Wiring list in “Appendix D - Wiring diagrams”.

The data provide information on:

- Cable identification
- Cable type
- Cross-sectional area
- Location of terminals

6.4.1. Optical fiber cables



NOTICE Risk of equipment failure!

Handle optical fibers with care. A damaged or incorrectly installed optical fiber cable can degrade data transmission and cause equipment failure.

- ▶ Only use the designated encoder cable conduit that passes through the drive to the EXU.
The conduit extends 10 – 20 mm from the entry plate of the drive.
- ▶ Cover the cable end with a cap BEFORE you pull the cable through the conduit.
- ▶ DO NOT exceed the maximum tensile load of 1.0 N and the minimum bend radius of 25 mm.
- ▶ When you tighten the cable ties DO NOT deform the optical fibers and DO NOT use a cable tie gun.
- ▶ Hold the connector when you connect or disconnect an optical fiber.

6.4.1.1. Installing the standard optical fibers

1. Pull all cables through the cable duct (3) at the top of the cabinets.

NOTE – Cut-outs in the ducts provide entry into the cabinets.

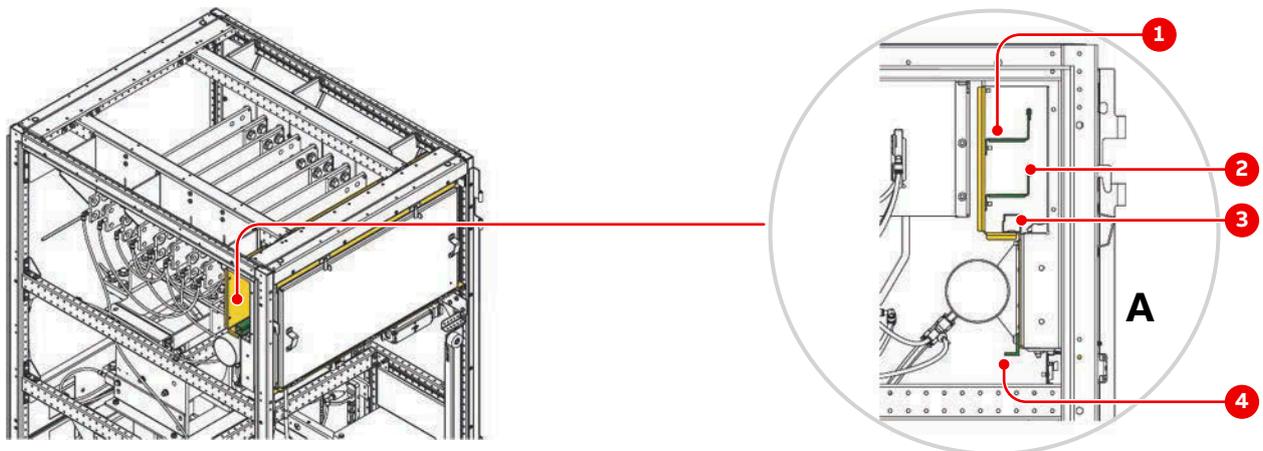


Figure 6–5 Cable tray and cable ducts in an LSU (A = front)

- | | |
|--|--|
| 1) Cable tray for auxiliary power supply cable | 4) Rail for IGCT power supply cables of RBU, BCU and VLU |
| 2) Cable tray for control cables | |
| 3) Cable duct for optical fibers | |

2. Lay the cables into their designated trays and cable ducts as seen in Fig. 6–5.

NOTE – When fastening IGCT power supply cables on the rail for IGCT power supply cables of RBU, BCU and VLU, make sure that the cables are at a minimum distance of 5 mm from the closest metal part.

3. Connect all cables and wires according to the “Converter hardware” diagram.

6.4.2. Optical fiber cables for the optional Arc Guard System™

This section applies to drives that are delivered with the optional Arc Guard System™. The arc monitor and the HMI panel are located in the WCU roof extension box (REB).

Each unit with power cable entries and terminals is monitored for arc faults by the Arc Guard System™ with optical detectors:

- 2 detectors in COU/TEU
- 2 detectors in ARU with bottom cable entry (option)
- 1 detector in BCU

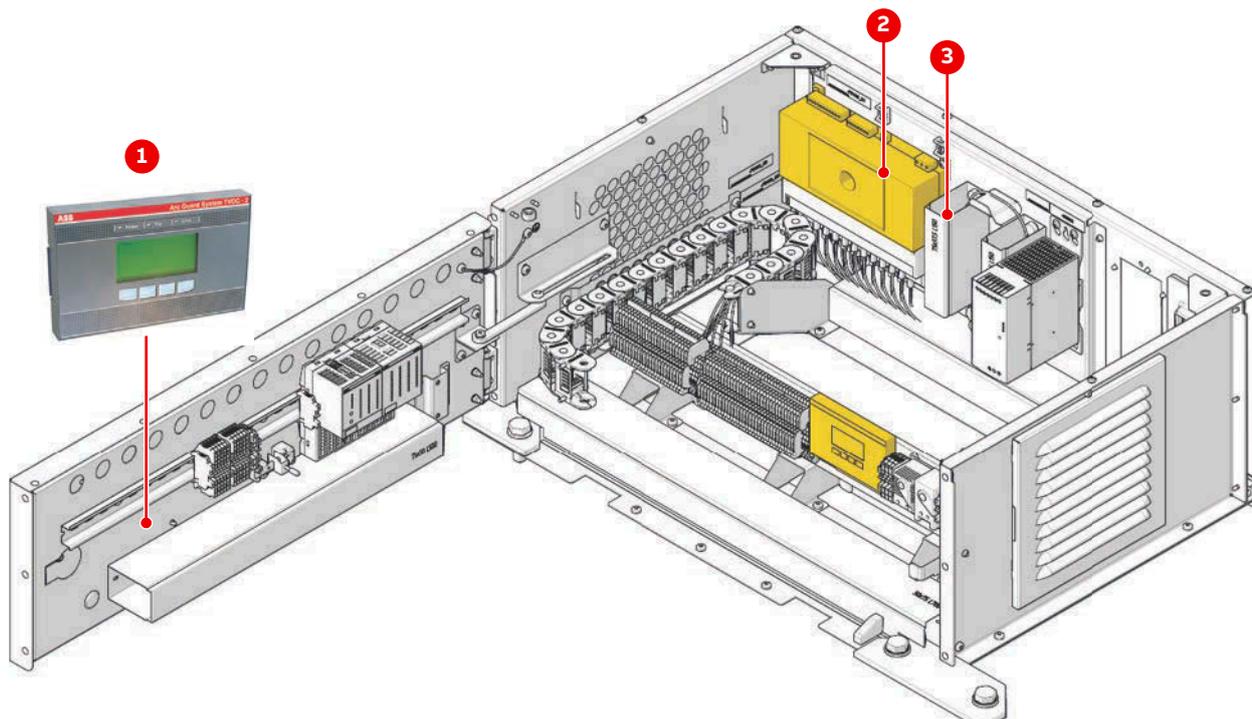


Figure 6–6 Arc Guard System™ in an optional roof extension box (REB)

- | | |
|------------------------|---|
| 1) Arc Guard HMI panel | 3) Reeling device for optical fiber detector cables |
| 2) Arc monitor device | |

The Arc Guard System™ consists of the following:

- Arc Guard unit TVOC-2 with HMI panel
- Optical fiber detectors: pre-installed in the relevant cabinets with the corresponding optical fibers coiled up beside the detectors (Fig. 6–7).

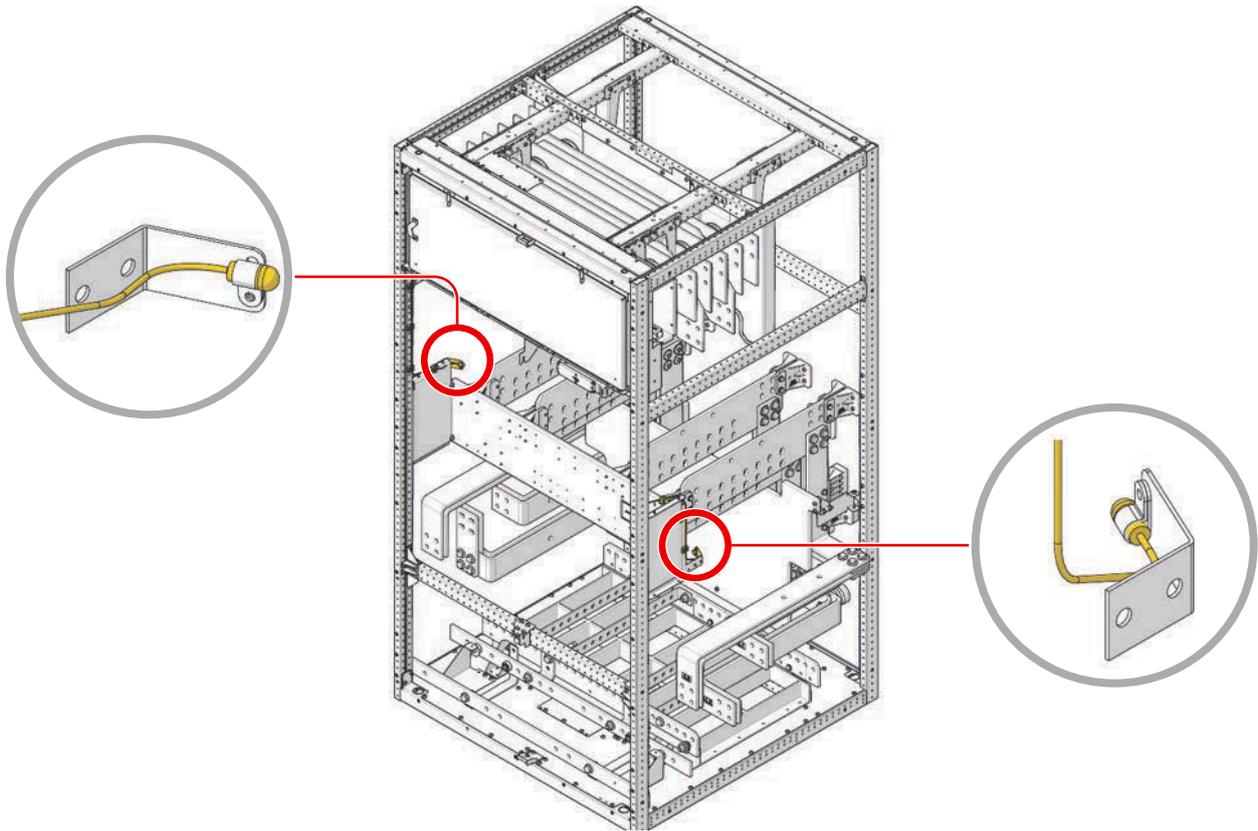


Figure 6–7 Location of Arc Guard sensors in a TEU

6.4.2.1. Connecting the detector cables to the arc monitor device

To complete the optical fiber installation, the optical fibers must be routed to the arc monitor device in the REB.

1. Pull all cables through the cable duct (3 in Fig. 6–8) at the top of the cabinets.

NOTE – Cut-outs in the ducts provide entry into the cabinets.

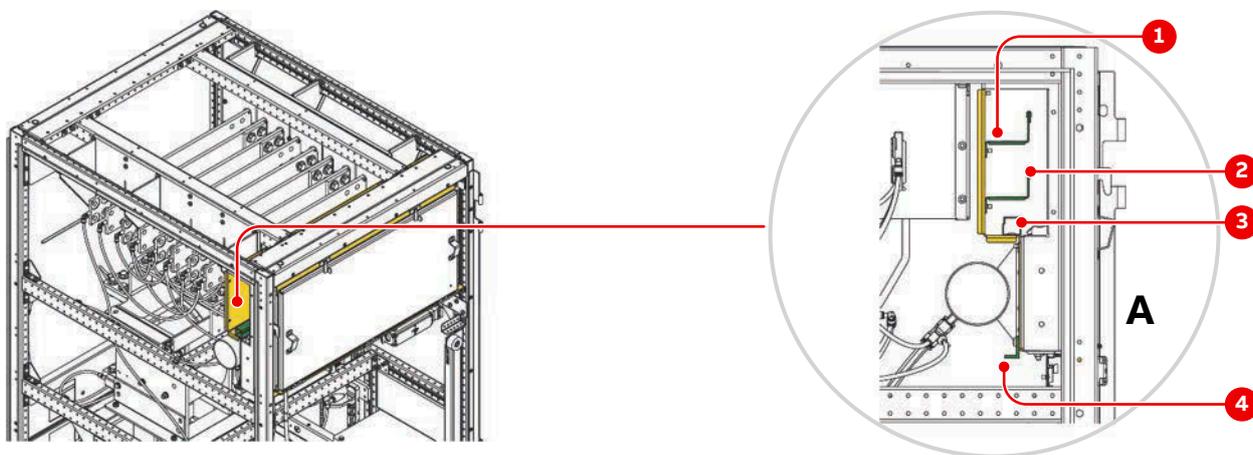


Figure 6–8 Cable tray and cable ducts in an LSU (A = front)

- | | |
|--|--|
| 1) Cable tray for auxiliary power supply cable | 3) Cable duct for optical fibers |
| 2) Cable tray for control cables | 4) Rail for IGCT power supply cables of RBU, BCU and VLU |

2. Lay the cables into their designated trays and cable ducts as seen in Fig. 6–8.
3. Connect the cables to the arc monitor located in the REB according to the drawings.
4. Wind up the excess cable lengths to the reeling device in the REB.

NOTICE These cables are only available in standard lengths. DO NOT cut or extend the cables. Wind the excess cable into coils with a minimum diameter 100 mm.

6.5. Cable entry systems

NOTICE Risk of component damage!

Handling excessively large single core power cables inside ACS6000 modules can damage components.

- ▶ DO NOT use a single core power cable with a cross-sectional area larger than 500 mm²
- ▶ Use a cable lug that is small enough for M12 bolts to connect the power cable to the busbar connection

Depending on your drive configuration, one or a combination of the following cable entry systems might be used on a cabinet for top and/or bottom cable entry:

- **Frames with type 1 sealing modules**, page 132
- **Frame with type 2 sealing modules**, page 134
- **Plates with cable glands**, page 134
- **EMC plates with sealing grommets**, page 135

For information on the location and the dimensions of the cable entry, see “Appendix C - Mechanical drawings”.

6.5.1. Frames with type 1 sealing modules



Figure 6-9 Cable entry with type 1 sealing modules

- | | |
|---------------------------|----------------------|
| 1) Compression wedge | 3) Cable entry frame |
| 2) Sealing module (RM120) | |

Usage	<ul style="list-style-type: none"> – Power cables – Ground cables – Equipotential bonding conductors
Included in delivery	<ul style="list-style-type: none"> – Cable entry frame
Not included in delivery	<ul style="list-style-type: none"> – Sealing modules – Accessories – Tools

Usage

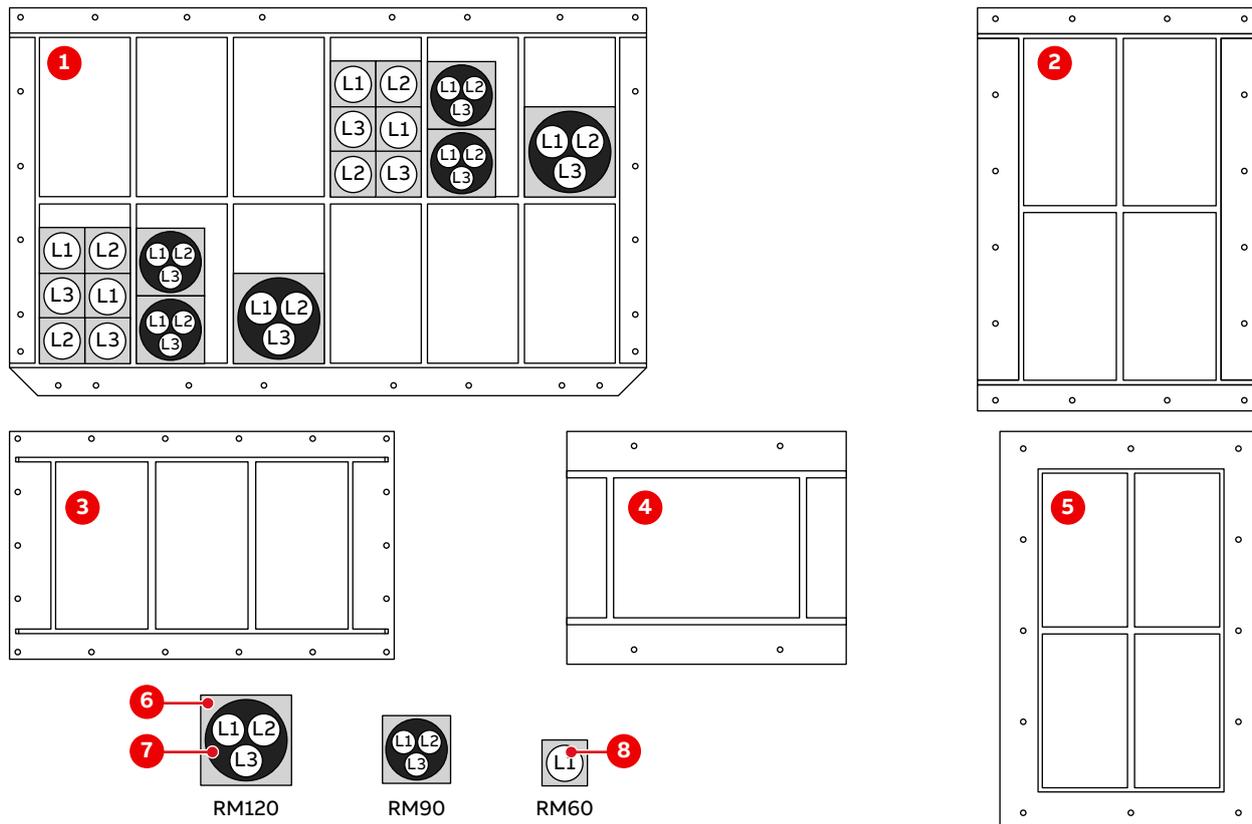


Figure 6–10 Cable entry frame with type 1 sealing modules

- | | |
|------------------------|------------------------|
| 1) Cable entry frame 1 | 5) Cable entry frame 5 |
| 2) Cable entry frame 2 | 6) Sealing module |
| 3) Cable entry frame 3 | 7) Three-core cable |
| 4) Cable entry frame 4 | 8) Single-core cable |

Table 6–1 Cable entry frames for type 1 sealing modules

Cabinet entry frame	Cabinet	Maximum number of sealing modules/openings			Maximum number of cables/openings	
		RM120	RM90	RM60	Single-core Ø28 - 50 mm	Three-core Ø68 - 99 mm
1	TEU 1000 mm	1	2	6	6	1
2	TEU 600 mm	1	2	6	6	1
3	ARU	1	2	6	6	1
4	BCU	1	1	4	3	1
5	EXU	1	2	6	6	1

6.5.2. Frame with type 2 sealing modules

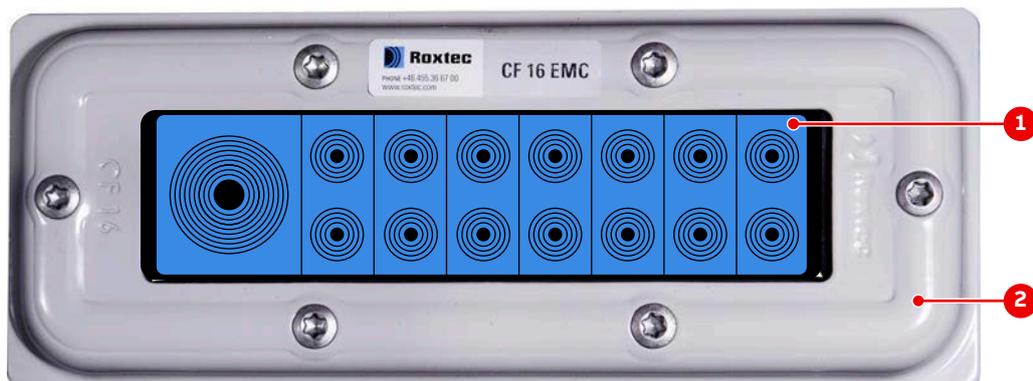


Figure 6–11 Cable entry with type 2 sealing modules

1) EMC sealing modules	2) Frame
Usage	<ul style="list-style-type: none"> – Auxiliary power cables – Control cables
Included in delivery	<ul style="list-style-type: none"> – Cable entry frame
Supplier	<ul style="list-style-type: none"> – Roxtec AB (www.roxtec.com)
Not included in delivery	<ul style="list-style-type: none"> – EMC sealing inserts – Installation tools – Accessories

6.5.3. Plates with cable glands



Figure 6–12 Cable gland

Usage	<ul style="list-style-type: none"> – Power cables, ground cables, bonding conductors – Auxiliary power cables, control cables
Included in delivery	<ul style="list-style-type: none"> – Undrilled gland plate
Not included in delivery	<ul style="list-style-type: none"> – Cable glands – Tools – Accessories

6.5.4. EMC plates with sealing grommets

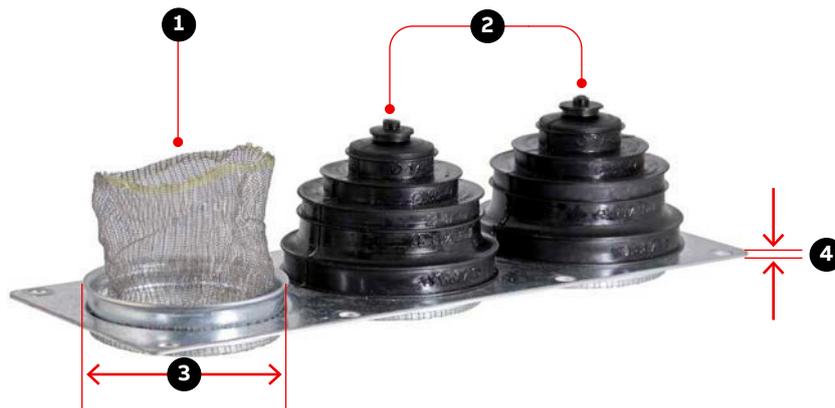


Figure 6–13 Cable entry with EMC plates

1) EMC sleeves	3) Ø45 mm
2) Sealing grommets	4) 1.5 mm

Usage

- Power cables
- Ground cables
- Bonding conductors
- Auxiliary power cables
- Control cables

Included in delivery

- Galvanized plate with net-like EMC sleeves
- Sealing grommets

6.6. Preparing cable entry systems for TEU, ARU and EXU cabinets

This section describes how to prepare cable entry systems for the following cabinets:

- TEU
- ARU
- EXU

6.6.1. TEU cable entry frames with type 1 sealing modules

- Use one sealing module (5) for each conductor of a three-core cable, or one sealing module for the complete cable.
- In the openings facing the back wall of the TEU, place the compression wedge (4) between the frame (1) and the sealing module (5).

This ensures that the minimum distance to the high-voltage busbars is maintained.

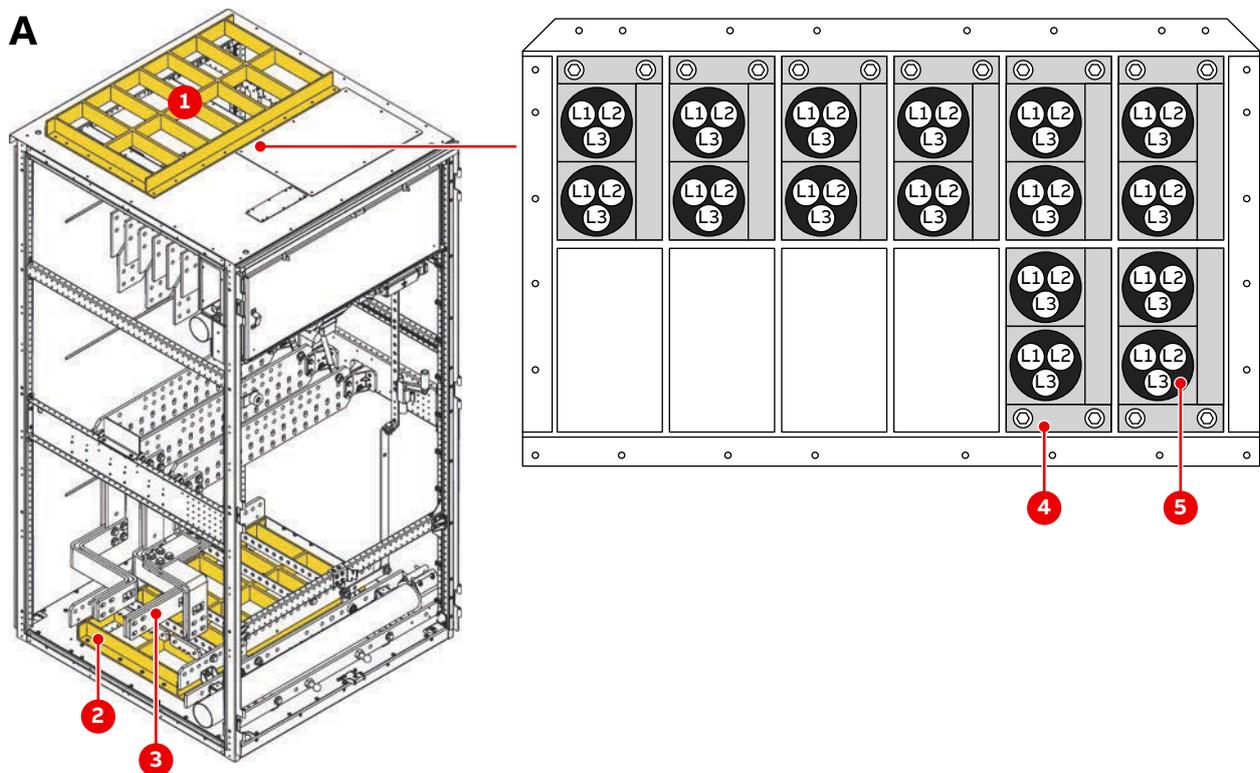


Figure 6–14 TEU 1000 mm cabinet (A = back) with top (1) and bottom (2) cable entries

- | | |
|--------------------------|--|
| 1) Top cable entry frame | 4) Compression wedge |
| 2) Bottom cable entry | 5) RM90 sealing module with 3-core cable |
| 3) High-voltage busbars | |

6.6.2. ARU cable entry frames with type 1 sealing modules

Depending on the configuration of the drive, ARUs can be equipped with 3 cable entry frames (size 3) on the cabinet floor.

In order to connect the cables, you need to remove the phase modules (see section 10.4.10, **Removing and installing a phase module**, page 245) and, if necessary, the short busbars as well (section 6.6.2.0.1, **Removing the short busbars**, page 137).

6.6.2.0.1 Removing the short busbars

1. Remove the phase module according to section 10.4.10, **Removing and installing a phase module**, page 245.
2. If necessary, remove the short busbars (boxes) to facilitate entering the cables.
3. To remove a busbar, unscrew the bottom bracket and the bolts and then move the busbar downward and away from the cabinet.

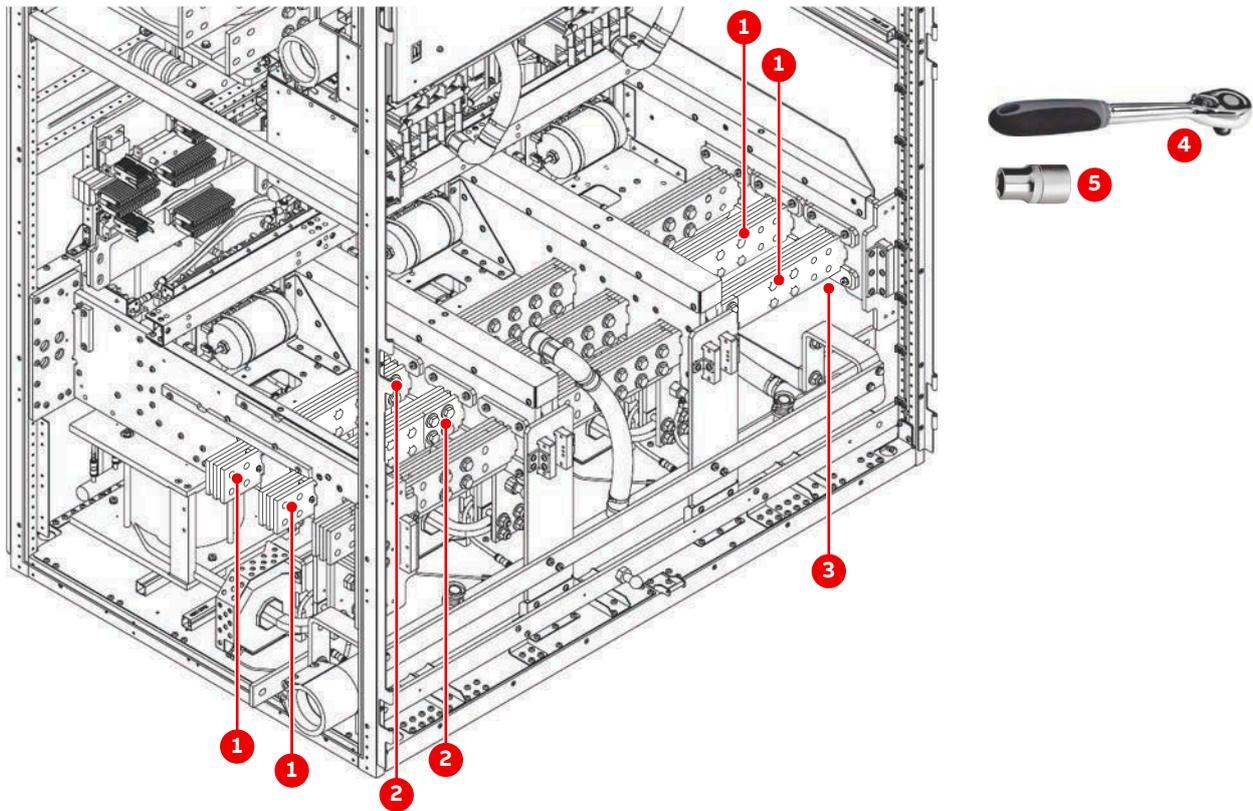


Figure 6–15 Short busbar removal in ARU

- | | |
|-----------------------|--------------------|
| 1) Short busbar | 4) 1/2" wrench |
| 2) Remove these bolts | 5) 17 mm and 19 mm |
| 3) Bottom bracket | |

4. After you have routed the cables, install the busbars in the reverse order of removal.

6.6.3. EXU cable entry with EMC plate and sealing grommets

This section applies to drives that are delivered with an EXU.

1. Insert the power cables through the EMC plates into the cabinet.

NOTE – Depending on the cable entry configuration, the entry plate is either on the top or on the bottom of the cabinet.

2. Cover the unused cable entry with a blanking plate.



Figure 6-16 EXU with top cable entry (A) and EXU with bottom cable entry (B)

1) Top cable entry

2) Bottom cable entry

If the cabinet is only accessible from the front and the cables are entered through the bottom, proceed as follows:

1. Remove the front cover and, if present, unplug the heating cable and remove the cross brace with the heating cable.
2. Remove the cover above the fan unit.
3. Remove the fan unit as explained in section 10.4.17, **Replacing the fan unit in an EXU with a DCS800 D4 size controller**, page 263.
4. Unplug the fan power supply cables and the tube from the air pressure switch.

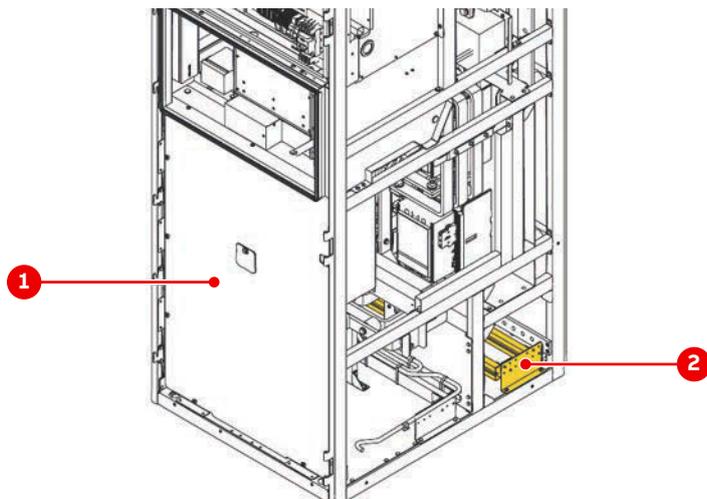


Figure 6-17 EXU cabinet

1) Front cover

2) Pull relief

6.7. Power, ground and equipotential bonding conductor cables

NOTICE Risk of damage or malfunction!

Waste inside the cabinet can cause damage or malfunction.

- If possible, DO NOT cut cables inside the terminal compartment.
- Retrieve any waste which accidentally dropped into the cabinet.

Overview

The following sections describe how to prepare and route cables. For a description on how to prepare the cable entries, see section 6.6, **Preparing cable entry systems for TEU, ARU and EXU cabinets**, page 136.

See “Appendix C - Mechanical drawings” for information on:

- Project-specific cable entry
- Distance between point of cable entry and terminals or busbars
- Busbar and fastening hole dimensions
- Busbar designations

See “Appendix D - Wiring diagrams” for information on:

- Conventions for cross-reference and device identification

6.7.1. Determining the cable length

1. Determine the required length of a cable between the point of entry and the connection point inside the cabinet.
2. Cut the cable to the required length before connection.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	139/272

6.7.2. Preparing cables for sealing modules

1. Prepare cables with an outer cable screen or shield for EMC bonding with the metal enclosure of the cabinet as illustrated in Fig. 6–18.

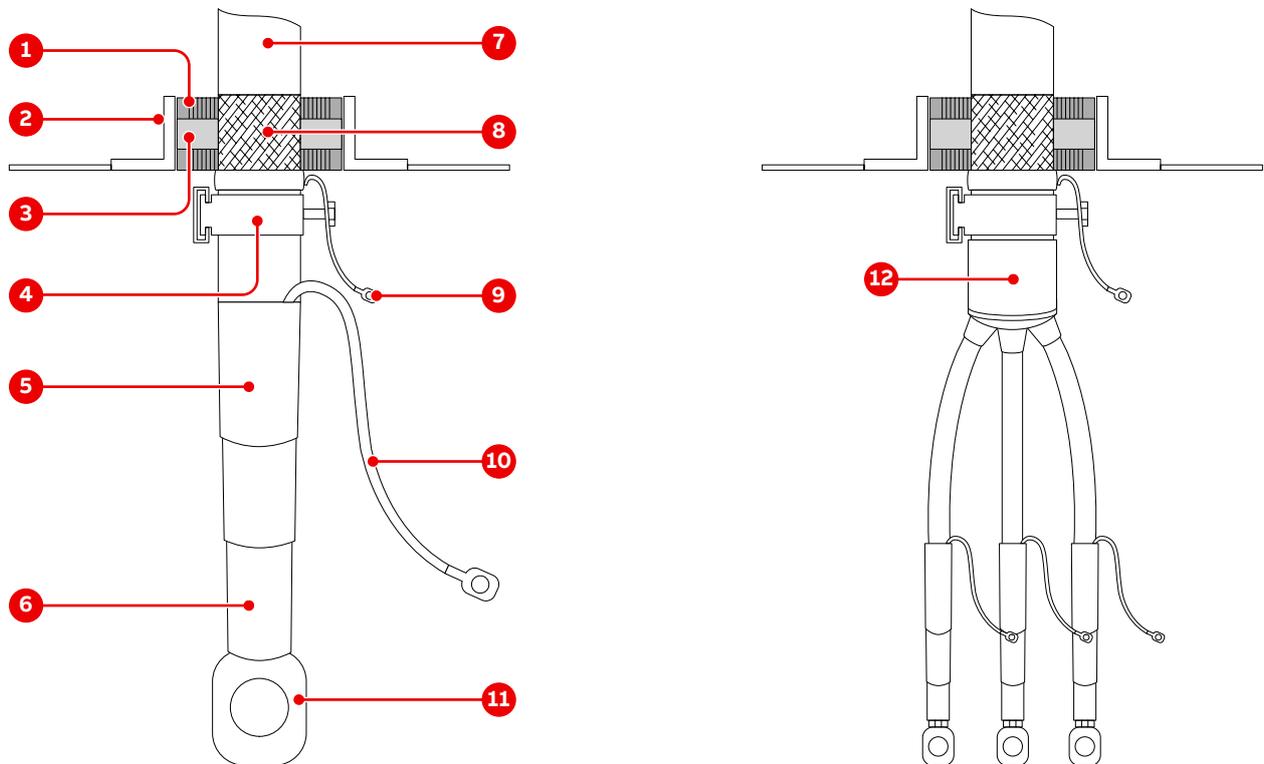


Figure 6–18 Preparing power cables for sealing modules

- | | |
|--------------------------------------|--|
| 1) Sealing module | 8) Cable sheath removed to expose cable shield |
| 2) Frame | 9) Shield extension to connect to PG busbar |
| 3) Conductive foil of sealing module | 10) Cable screen extension to connect to the PG busbar |
| 4) Cable clamp | 11) Cable lug as specified by the cable supplier and suitable for M12 bolt |
| 5) Shrinkable sheath seal | 12) Sheath seal |
| 6) Heat shrinkable termination | |
| 7) Outer cable sheath | |

2. Install the sealing modules according to the instructions of the sealing module supplier.

6.7.3. Preparing cables for cable glands

Prepare cables with an outer cable screen or shield for EMC bonding with the metal enclosure of the cabinet as illustrated in Fig. 6–19.

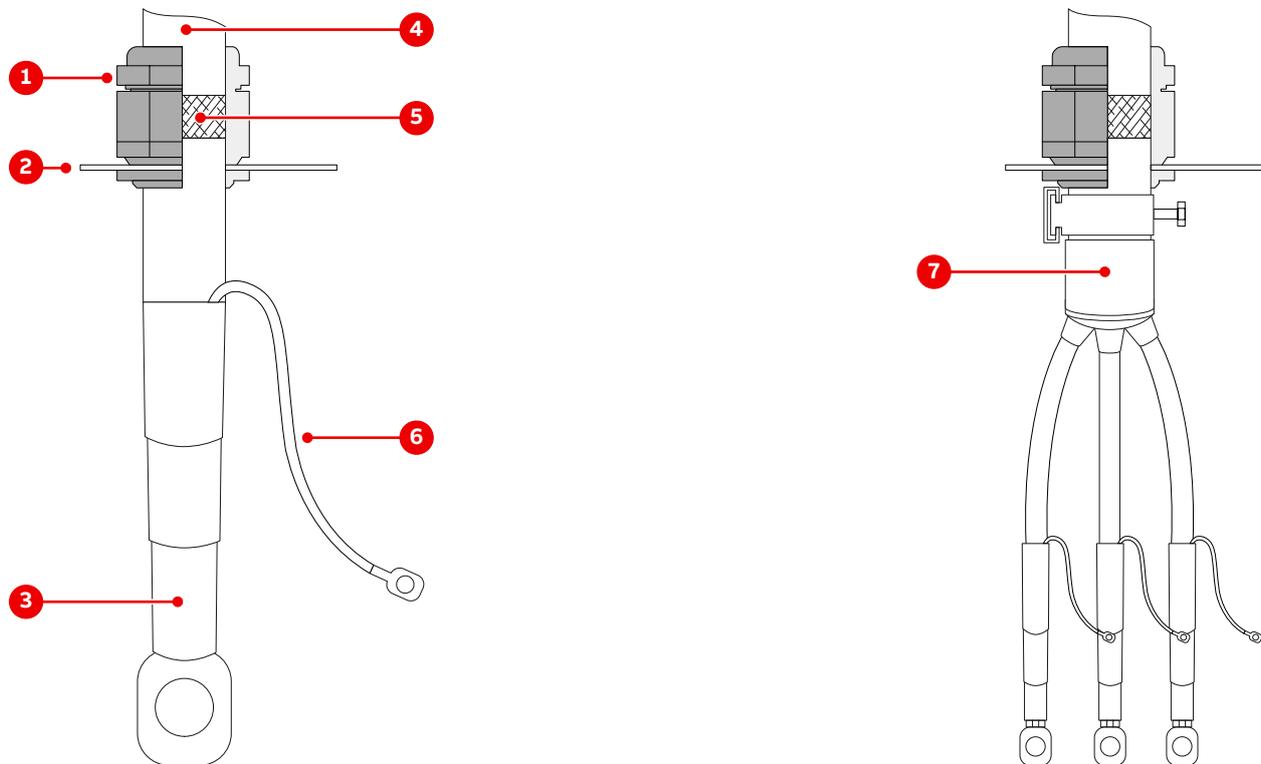


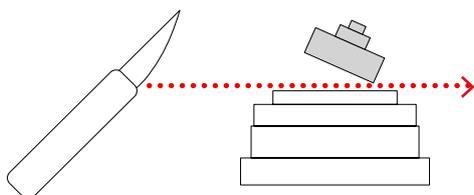
Figure 6–19 Prepare power cables for cable glands

- | | |
|--------------------------------|--|
| 1) Cable gland | 5) Conductor insulation removed to expose cable shield |
| 2) Plate | 6) Cable screen extension to be connected to PG busbar |
| 3) Heat shrinkable termination | 7) Sheath seal |
| 4) Outer cable sheath | |

6.7.4. Preparing cables for EMC plates

This section describes how to prepare standard cables for EMC plates as well as cables for an EXU.

1. Remove the grommets from the entry plate.
2. To ensure proper sealing, cut along the marking that corresponds to the cable diameter.



3. Slide the grommet onto the cable and ensure that the grommet fits tightly to prevent water from entering the cabinet.

NOTE – If cables are entered through the cabinet floor, the grommets can be discarded.

4. If necessary, remove the entry plate and push the cable through the entry holes.

5. Prepare standard cables according to Fig. 6–20.

6. Prepare EXU cables according to Fig. 6–20.

The orientation of the EMC plates in both scenarios is the same for top and bottom cable entries, ie, the sealing grommets face upwards.

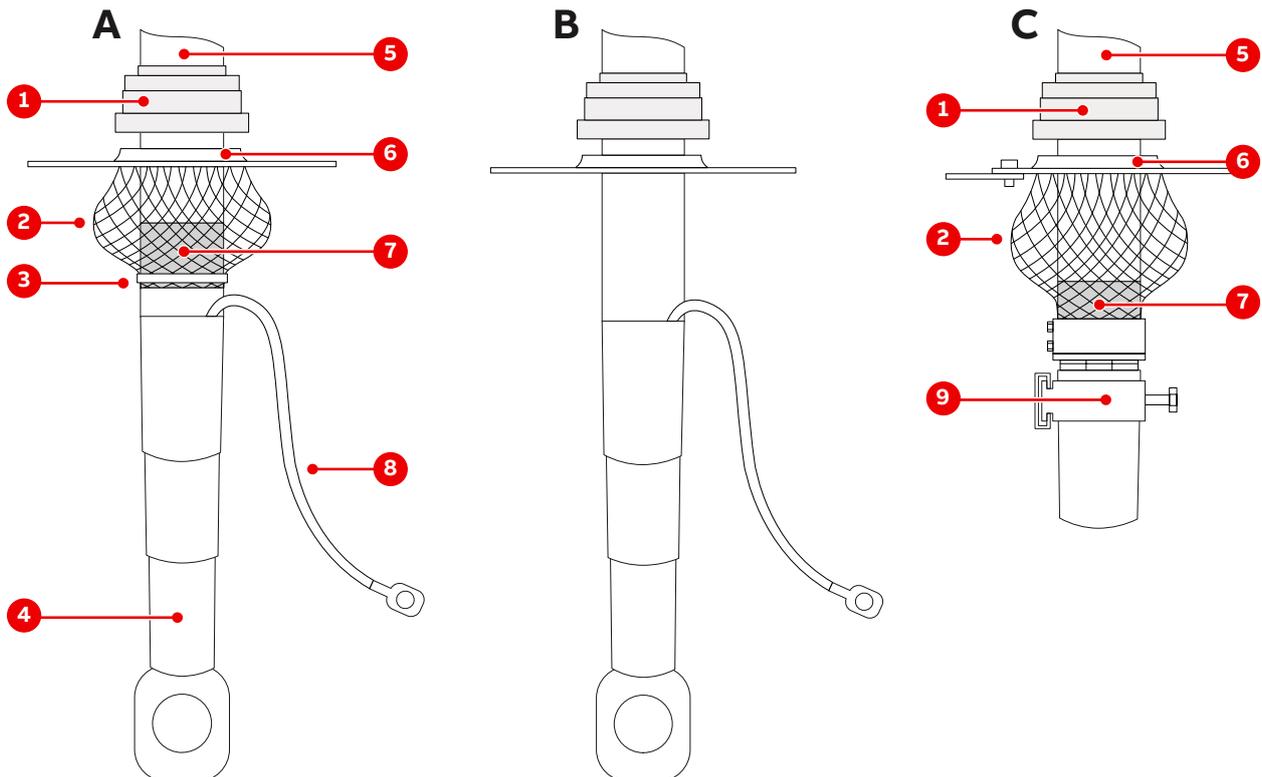


Figure 6–20 Preparing cables for EMC plates: (A) cables with an outer screen or shield, (B) cables without an outer screen or shield or (C) cables in an EXU cabinet

- | | |
|--------------------------------|--|
| 1) Grommet | 6) Entry plate |
| 2) EMC sleeve | 7) Conductor insulation removed to expose cable shield |
| 3) Cable tie | 8) Cable screen extension to connect to the PE busbar |
| 4) Heat-shrinkable termination | 9) Cable clamp |
| 5) Outer cable sheath | |

6.7.5. Connecting the cables



WARNING Risk of flashover!

High voltages in the terminal unit can cause flashover between the electric potential of different conductors and the electric potential of a conductor and earth.

- ▶ Maintain a minimum distance of 55 mm between two different potentials in the terminal unit, including phase to phase distances and ground to phase distances.

6.7.5.1. Checking the cable insulation

- Measure the insulation of each cable before connection and verify that the results are within the specification of the cable manufacturer.
- Leave the conductors unconnected at both ends until the commissioning personnel has given permission to connect them.

6.7.5.2. EXU cabinet connections

1. If multi-core cables are used and several conductors of the same phase are connected to a busbar, attach the cable lugs of the cables on each side of the busbar.
2. Fasten the cables to the strain relief rails with suitable cable clamps.

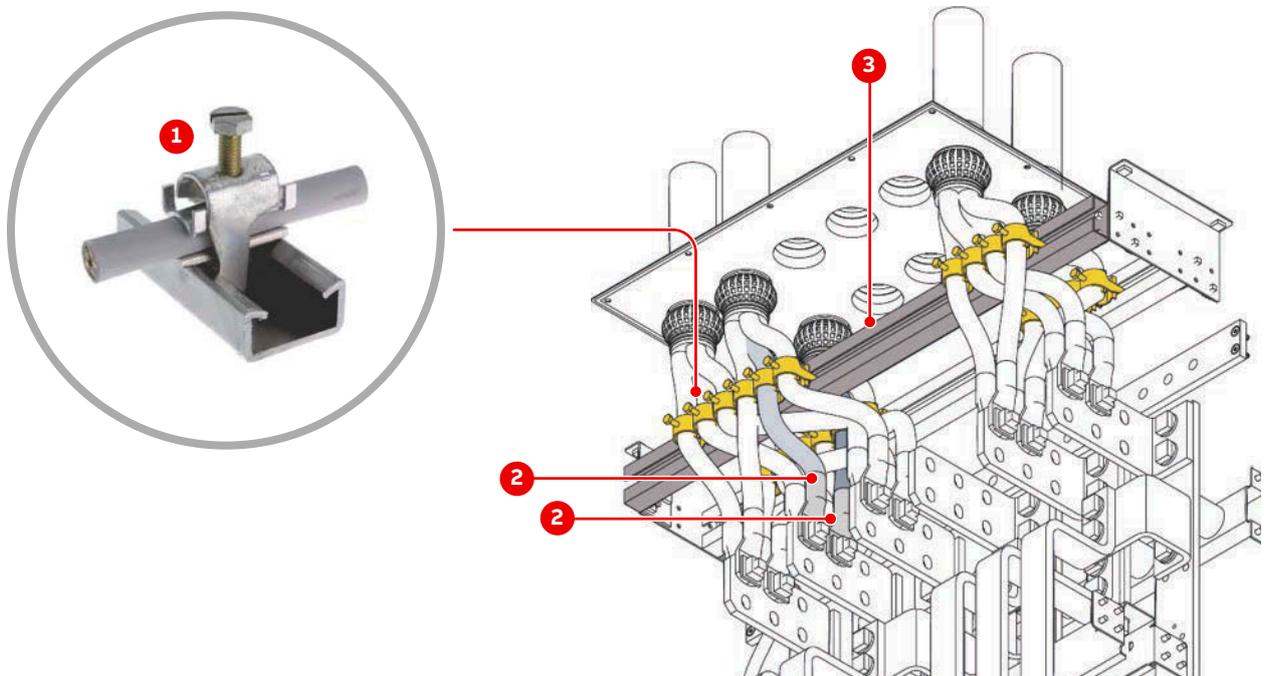


Figure 6–21 Cable connections in an EXU cabinet

- | | |
|--------------------------------------|-----------------------|
| 1) Cable clamp | 3) Strain relief rail |
| 2) Cable lugs on each side of busbar | |

3. Choose the length and the orientation of the bolts so that the distance between bolted joints of different phases is not less than 25 mm.

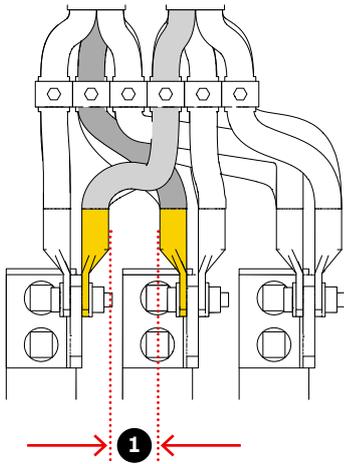


Figure 6–22 Minimum distance between bolted joints of different phases in an EXU

1) 25 mm

6.7.5.3. Bolted busbar connections – marine drives

The following bolts, washers and nuts are supplied and fixed to the busbars in marine drives.

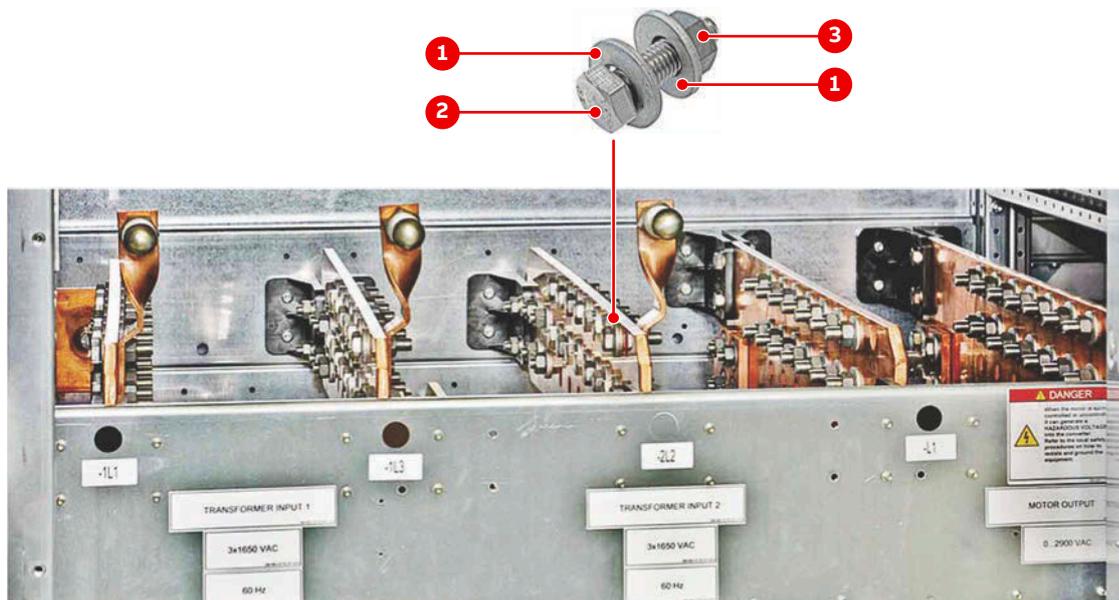


Figure 6–23 Bolted busbar connection - marine drives

Part	Quantity	Identification
Hex-head bolt	M12x40-A2	NB 312350P8119
Coated hex-head nut	M12-A2-70	HZN 452198P1022
Conical spring washer	13 x 29 x 3	HAQN400344P0111

6.7.5.4. Bolted busbar connections – non-marine drives

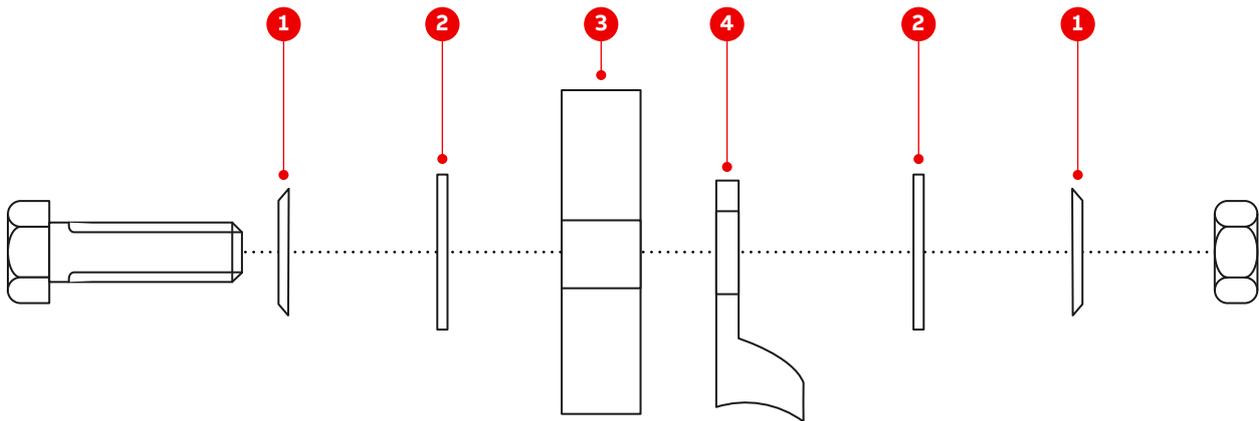


Figure 6–24 Bolted busbar connection - non-marine drive

- | | |
|------------------|--------------|
| 1) Spring washer | 3) Busbar |
| 2) Flat washer | 4) Cable lug |

6.7.5.4.1 Material requirements

Use stainless steel bolts and nuts with the appropriate steel grade and property class for the connection (recommended: A2-70 - designation according to ISO 3506-1).

Nuts with bonded coating can be used as an alternative to uncoated stainless steel nuts.

6.7.5.4.2 Connection type

The following connection type is recommended when connecting a cable lug to a busbar.

- Spring washer and flat washer on each side of the busbar.
The spring washer and flat washer can be replaced by a conical spring washer (Fig. 6–23). Other washers can be used, provided they maintain the required contact pressure.
- Use cable lugs suitable for M12 bolts.

6.7.5.4.3 Lubrication

If stainless steel bolts and nuts are used, lubricate the thread and head contact surface of the bolt using recommended pastes, eg, MOLYKOTE™ D paste.

If a coated nut (eg, with bonded molybdenum-disulfide [MoS₂] coating) is used, the connection does not need to be lubricated.

6.7.5.4.4 Tightening torque

ABB recommends a tightening torque of 40 Nm for M12 bolts. For other sizes, follow the manufacturer's recommendations.

6.8. Auxiliary power, control and serial communication cables

The following sections describe how to prepare and route cables.

For a description on how to prepare the cable entries, see section 6.6, **Preparing cable entry systems for TEU, ARU and EXU cabinets**, page 136.

See “Appendix C - Mechanical drawings” for information on:

- Project-specific cable entry
- Dimensions between point of cable entry and terminals

See “Appendix D - Wiring diagrams” for information on:

- Conventions for cross-references and device identification
- Terminal designations

6.8.1. Determining the cable length

1. Determine the required length of a cable between the point of entry and the connection point inside the cabinet.
2. Cut the cable to the required length before connection.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	146/272

6.8.2. Preparing cables for sealing modules

For information on installing the sealing modules and using the compression wedge, see the Roxtec CF16EMC installation instructions in “Appendix A - Additional manuals”.



Figure 6–25 Cable entry with sealing modules

- | | |
|--------------------|----------------------|
| 1) Sealing modules | 2) Compression wedge |
|--------------------|----------------------|

1. Unscrew the frame.

2. Prepare the cables with an outer cable screen for EMC bonding with the metal enclosure of the cabinet as illustrated in Fig. 6–26.

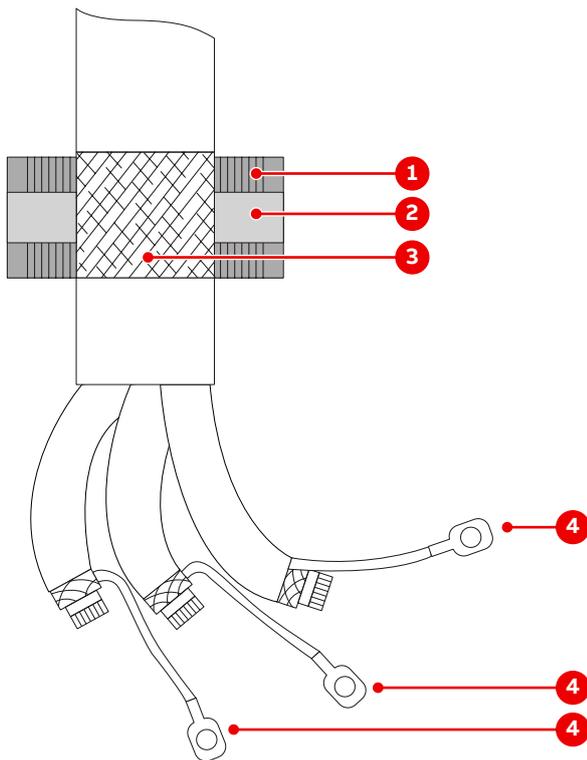


Figure 6–26 Preparing control cables for sealing modules

- | | |
|--|---|
| 1) Sealing module | 4) Conductor screen extension to connect to PE terminal |
| 2) Conductive foil | |
| 3) Cable sheath removed to expose cable shield | |

6.8.3. Preparing cables for cable glands

Prepare the cables with an outer cable screen for EMC bonding with the metal enclosure of the cabinet as illustrated in Fig. 6–26.

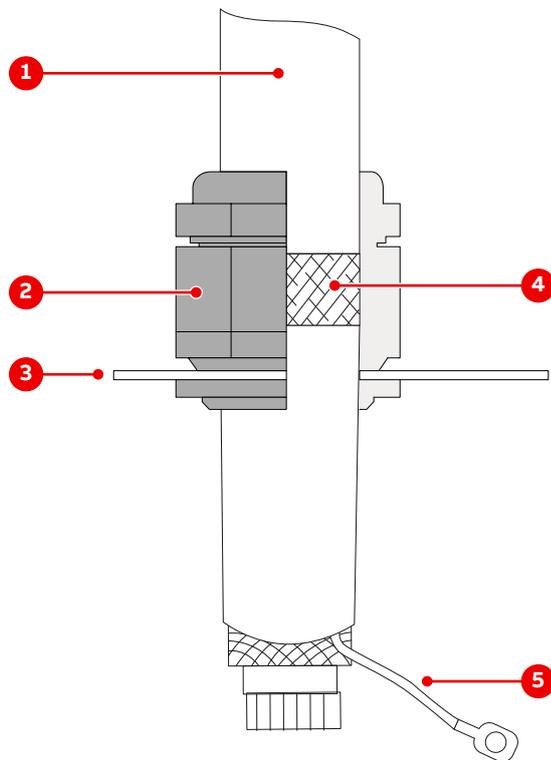
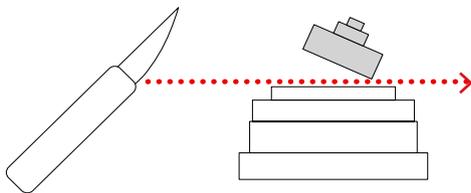


Figure 6–27 Preparing auxiliary control cables for cable glands

- | | |
|-----------------------|---|
| 1) Outer cable sheath | 4) Conductor insulation removed to expose shield |
| 2) Cable gland | 5) Conductor screen extension to connect to PE terminal |
| 3) Plate | |

6.8.4. Preparing cables for EMC plates

1. Remove the grommets from the entry plate.
2. To ensure proper sealing, cut along the marking that corresponds to the cable diameter.



3. Slide the grommet onto the cable and ensure that the grommet fits tightly to prevent water from entering the cabinet.

NOTE – If cables are routed through the cabinet floor, the grommets can be discarded.

4. If necessary, remove the entry plate and pull the cable through the entry holes.

5. If the outer cable screen is conductive, remove the cable insulation at the point of entry (1 in Fig. 6–28).

If the outer cable screen is non-conductive:

1. Cut open the cable screen in the middle of the stripped area (1 in Fig. 6–28).
2. Pull the cable screen ends over the cable insulation to turn the conductive side inside out (2 in Fig. 6–28).
3. Connect the screens ends with a continuous conducting foil (3 in Fig. 6–28).

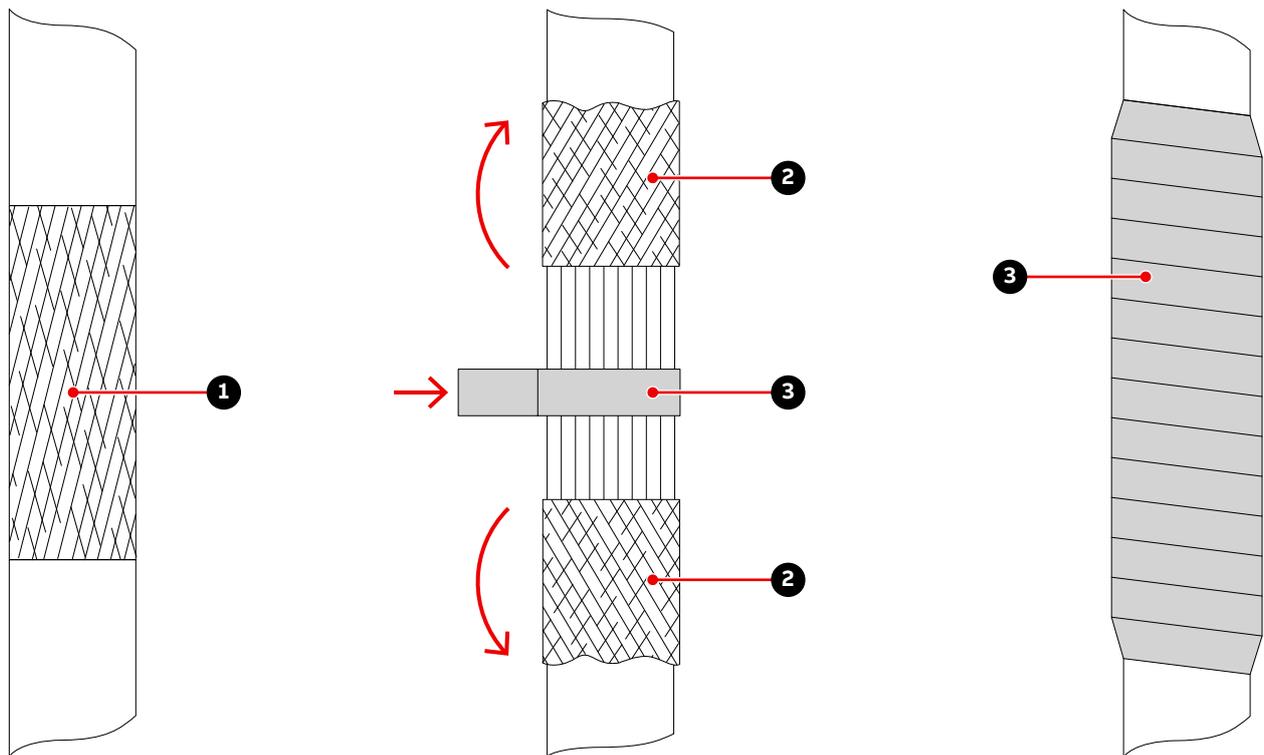


Figure 6–28 Preparing the screens of control cables for EMC plates

- | | |
|----------------------|--------------------|
| 1) Cable screen | 3) Conductive foil |
| 2) Cable screen ends | |

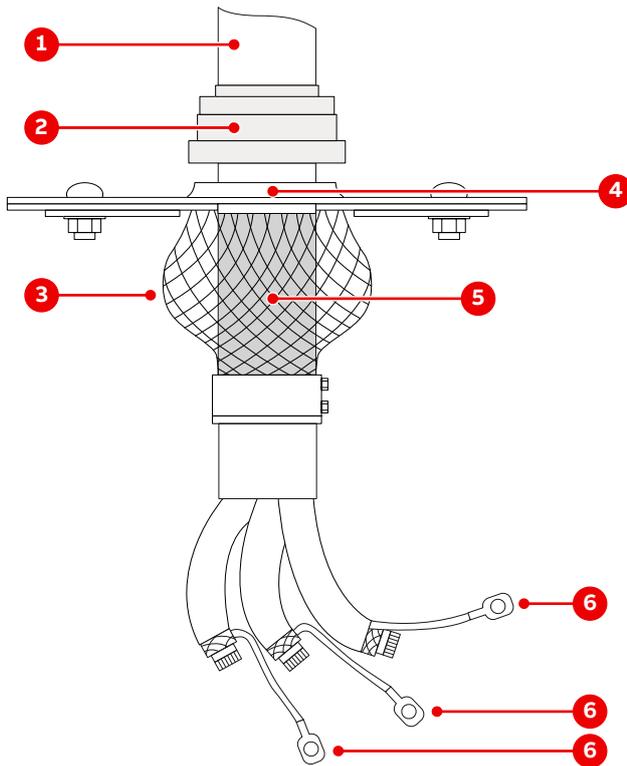


Figure 6–29 Preparing control cables for EMC plates

- | | |
|-----------------------|---|
| 1) Outer cable sheath | 5) Cable sheath removed to expose cable shield |
| 2) Grommet | 6) Conductor screen extension to connect to PE terminal |
| 3) EMC sleeve | |
| 4) Plate | |

6.8.5. Routing cables in a WCU

For the available cable routing options in WCU800 and WCU1400, such as top entry and bottom entry, see “Appendix C - Mechanical drawings”.

6.8.6. Routing cables in a COU cabinet

The serial communications and encoder cables are connected inside a COU.

Top and bottom cable entries are covered with blanking plates.

Materials for cable fitting, EMC requirements and sealing are not supplied.

6.8.6.1. Top cable entry

1. Remove the entry plate.

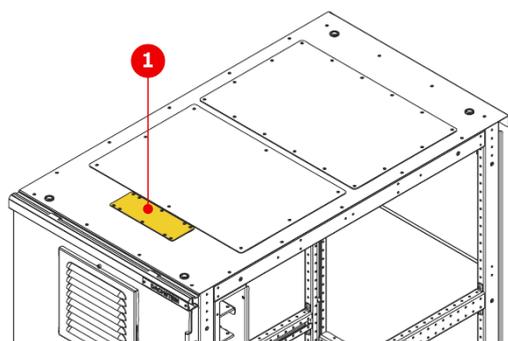


Figure 6–30 Top cable entry of 600 mm COU

- 1) Top cable entry

2. On the length of cable that passes through the cable transit, prepare the cable according to section 6.8.3, **Preparing cables for cable glands**, page 148.

3. Route the cable according to Fig. 6–31.

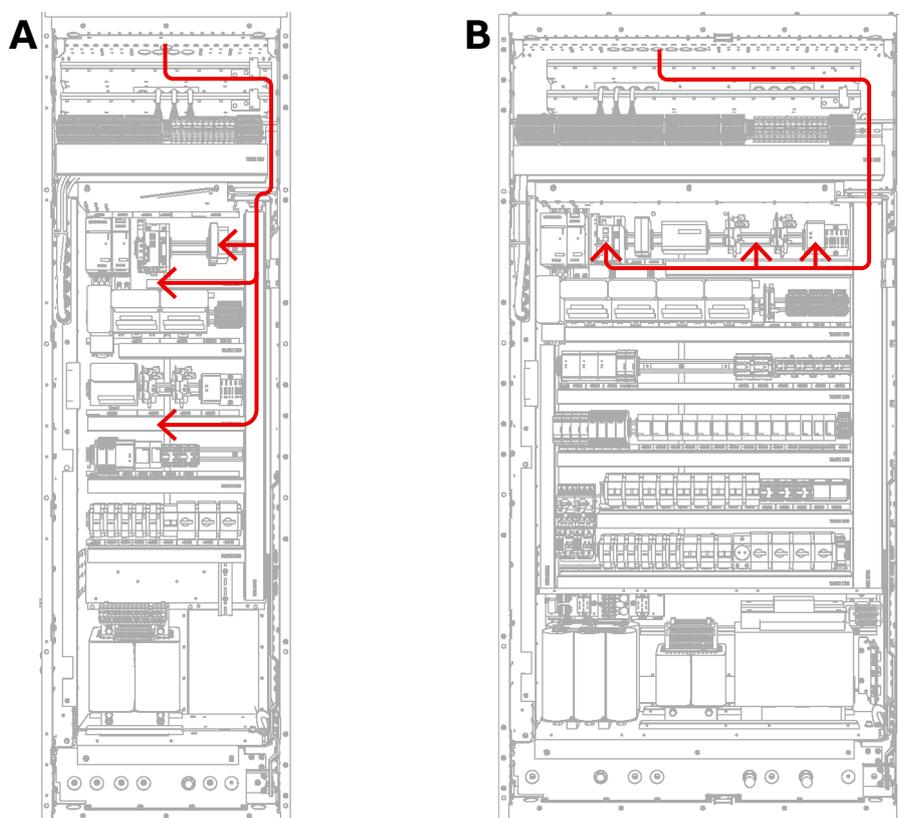


Figure 6–31 Cable route in COU 600 mm (A) and COU 1000 mm (B) top cable entry

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	151/272

6.8.6.2. Bottom cable entry

1. Insert and route the cables as illustrated in Fig. 6–32 and Fig. 6–33.

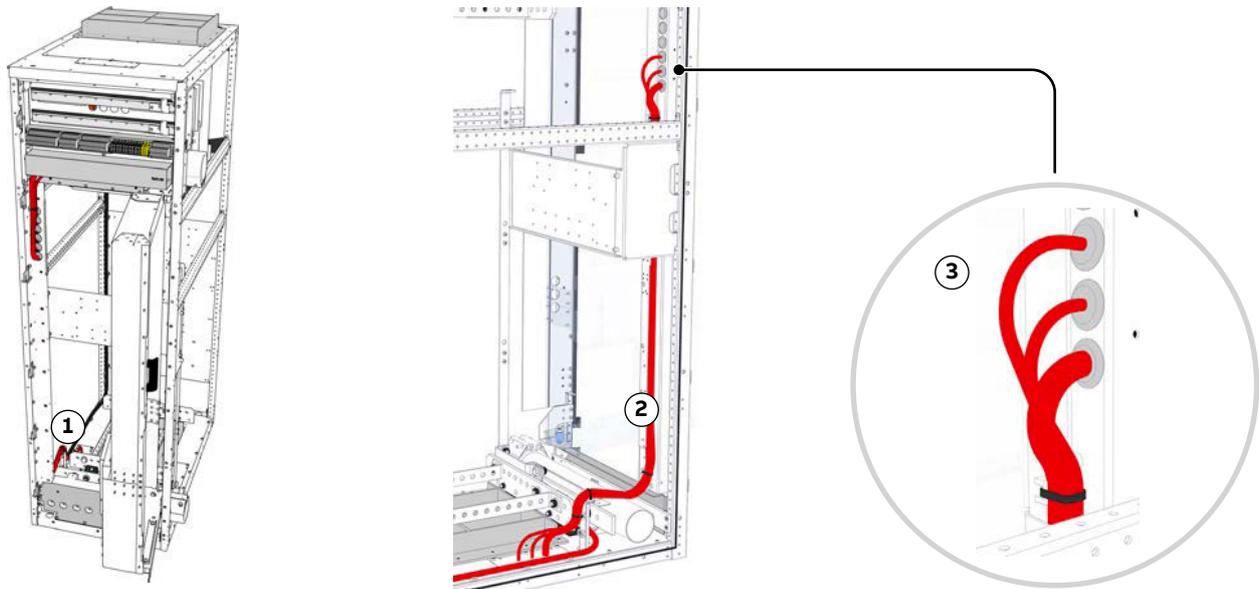


Figure 6–32 Cable route in COU (600 mm) bottom cable entry

- | | |
|-----------------------|-----------|
| 1) Cable entry bottom | 3) Detail |
| 2) Side view | |

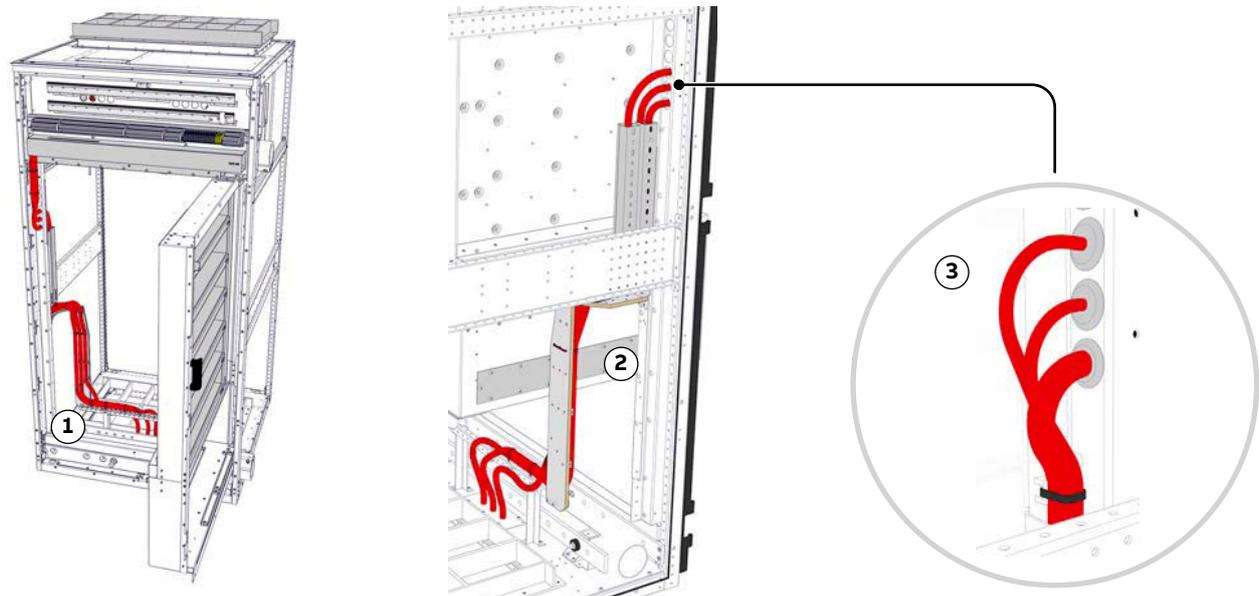


Figure 6–33 Cable route in COU (1000 mm) bottom cable entry

- | | |
|-----------------------|-----------|
| 1) Cable entry bottom | 3) Detail |
| 2) Side view | |

2. Fasten the cables with cable ties.

6.8.6.3. Connecting the cables

Conductors

If a twisted pair cable is used, leave the unshielded cable ends twisted until they reach the terminals.

Leave unshielded conductor ends as short as possible (< 50 mm).

Cable shields

1. Connect the shield of serial communications cables to the fieldbus adapter.
2. Connect the individual shields and the overall shield (if present) of encoder cables to the separate shield grounding point.

IMPORTANT! DO NOT connect the shields to the terminals of the interface.

NOTE – Different-sized ground clamps are supplied.

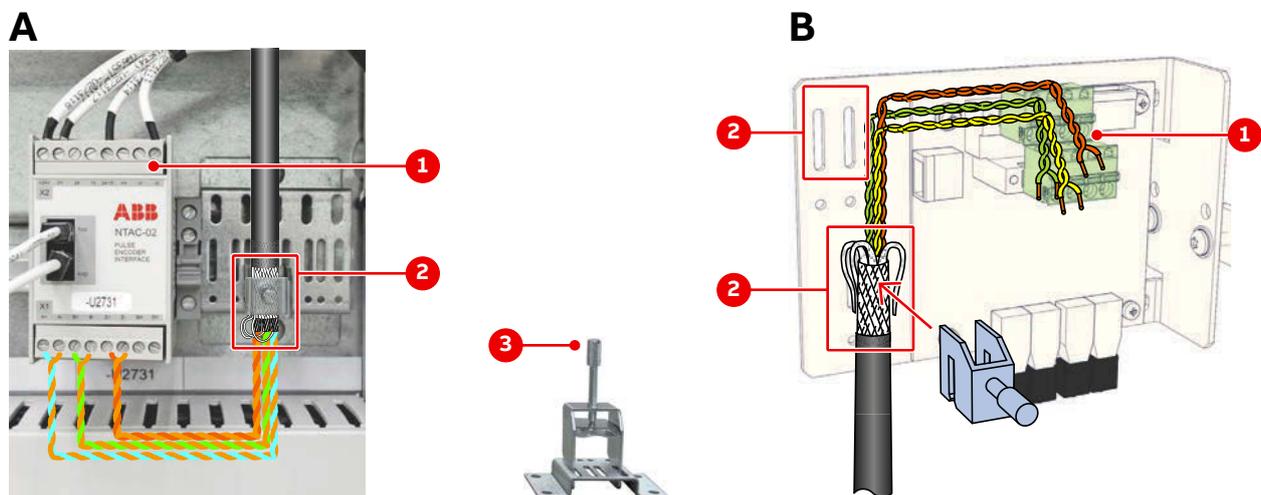


Figure 6–34 Shield grounding point for encoder cable on NTAC pulse encoder (A) and synchronous serial interface (B)

- | | |
|---------------------------|-----------------|
| 1) Terminals | 2) Ground clamp |
| 1) Shield grounding point | |

6.8.7. Routing cables in an EXU cabinet

This section applies to a stand-alone EXU.

6.8.7.1. Auxiliary power and control cables

1. Enter the cables through a free hole of the EMC plate.
2. On the length of cable that passes through the cable transit, prepare the cable according to the following instructions:
 - Cable entries with EMC plates: section 6.8.4, **Preparing cables for EMC plates**, page 148
 - Cable entries with cable glands: section 6.8.3, **Preparing cables for cable glands**, page 148.

NOTE – Materials for cable fitting, EMC requirements and sealing are not supplied for undrilled plates.

3. Route the cables through the designated cable ducts as illustrated.

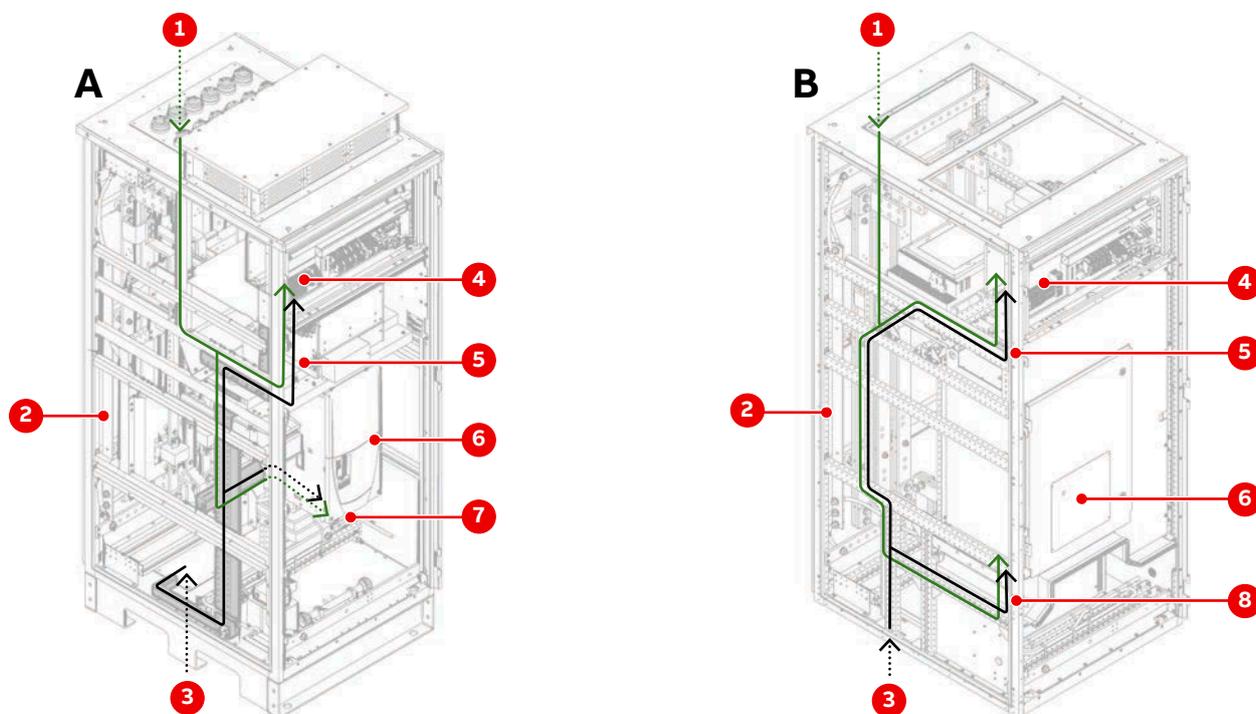


Figure 6–35 Cable routing examples in an EXU cabinet with an ED5V, EB5R, EB5S, EB7P and EB7Q type DCS800 converter (A) and in an EXU cabinet with an ED7Y type DCS800 converter

- | | |
|--|---|
| 1) Cable enters through roof | 5) Auxiliary supply cable |
| 2) PE ground busbar | 6) Terminal for optical fibers behind cover |
| 3) Cable enters through the floor | 7) Optical fibers to DCS800 D4 converter |
| 4) Terminal strip for auxiliary power and control cables | 8) Optical fibers to DCS800 D5 converter |

6.8.7.2. Optical fiber cables

NOTICE Risk of equipment failure!

Handle optical fibers with care. A damaged or incorrectly installed optical fiber cable can degrade data transmission and cause equipment failure.

- ▶ Only use the designated encoder cable conduit that passes through the drive to the EXU.
- ▶ The conduit extends 10 – 20 mm from the entry plate of the drive.
- ▶ Cover the cable end with a cap BEFORE you pull the cable through the conduit.
- ▶ DO NOT exceed the maximum tensile load of 1.0 N and the minimum bend radius of 25 mm.
- ▶ When you tighten the cable ties DO NOT deform the optical fibers and DO NOT use a cable tie gun.
- ▶ Hold the connector when you connect or disconnect an optical fiber.

6.8.7.3. Routing optical fiber cables in an EXU cabinet with an ED5V, EB5R, EB5S, EB7P or EB7Q type DCS800 converter

1. Remove the acrylic protection cover in the cabinet.
2. Unplug the DCS800 control panel.

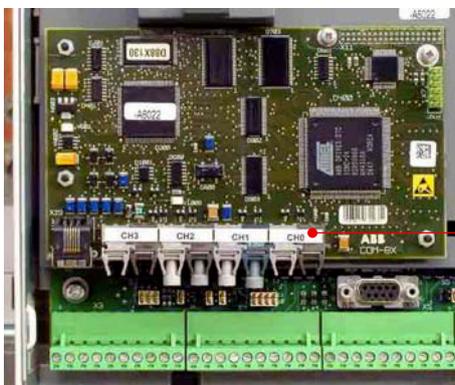


Figure 6–36 DCS800 converter (ED5V, EB5R, EB5S, EB7P and EB7Q types)

- | | |
|------------------|------------------------------------|
| 1) Control panel | 3) Removable cover |
| 2) Indentation | 4) Location of COM8x circuit board |

3. Insert a flat-blade screwdriver into one of the indentations at the bottom of the removable cover.
4. Gently press down the latch tab with the tip of the screwdriver and pull the corner of the cover forward and repeat for the other side.
5. Slide the removable cover up and then remove the cover.
6. Connect the 2 optical fibers to the receptacles of channel CH0 (B) on the COM-8x circuit board (A) according to the terminal numbers printed on the marker sleeves.

A



B

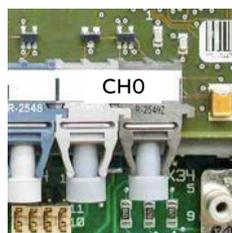


Figure 6–37 COM-8x circuit board (A) in a DCS800 converter (ED5V, EB5R and EB5S types) and a detail of channel CH0 (B) on the board.

7. Route the cables through the designated cable ducts as illustrated in Fig. 6–38.

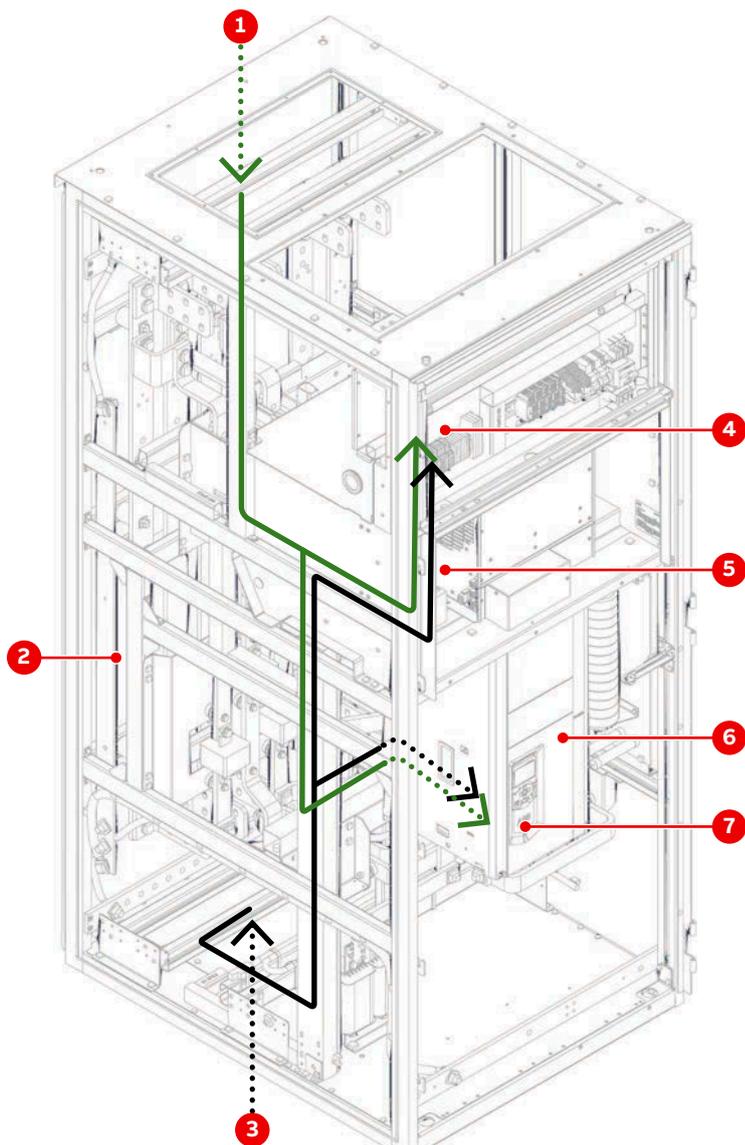


Figure 6–38 Cable routing example in an EXU cabinet with an ED5V, EB5R, EB5S, EB7P or EB7Q type DCS800 converter

- | | |
|--|---|
| 1) Cable enters through roof | 5) Auxiliary supply cable |
| 2) PE ground busbar | 6) Terminal for optical fibers behind cover |
| 3) Cable enters through the floor | 7) Optical fibers to DCS800 D4 converter |
| 4) Terminal strip for auxiliary power and control cables | |

8. Reattach the DCS800 cover.

6.8.7.4. Routing cables in an EXU cabinet with an ED7Y type DCS800 converter

1. Unscrew the rectangular cover from the DCS800 unit.



Figure 6-39 DCS800 converter (ED7Y)

1) Control panel

2) Removable cover

2. Connect the two optical fibers to the receptacles of channel CH0 (B) on the COM-8x circuit board (A) according to the terminal numbers printed on the marker sleeves.

A



B

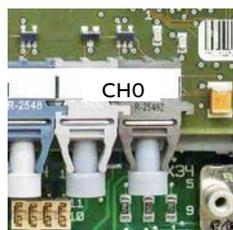


Figure 6-40 COM-8x circuit board (A) in a DCS800 converter (ED7Y type) and a detail of channel CH0 (B) on the board

3. Route the cables through the designated cable ducts as illustrated in Fig. 6–41.

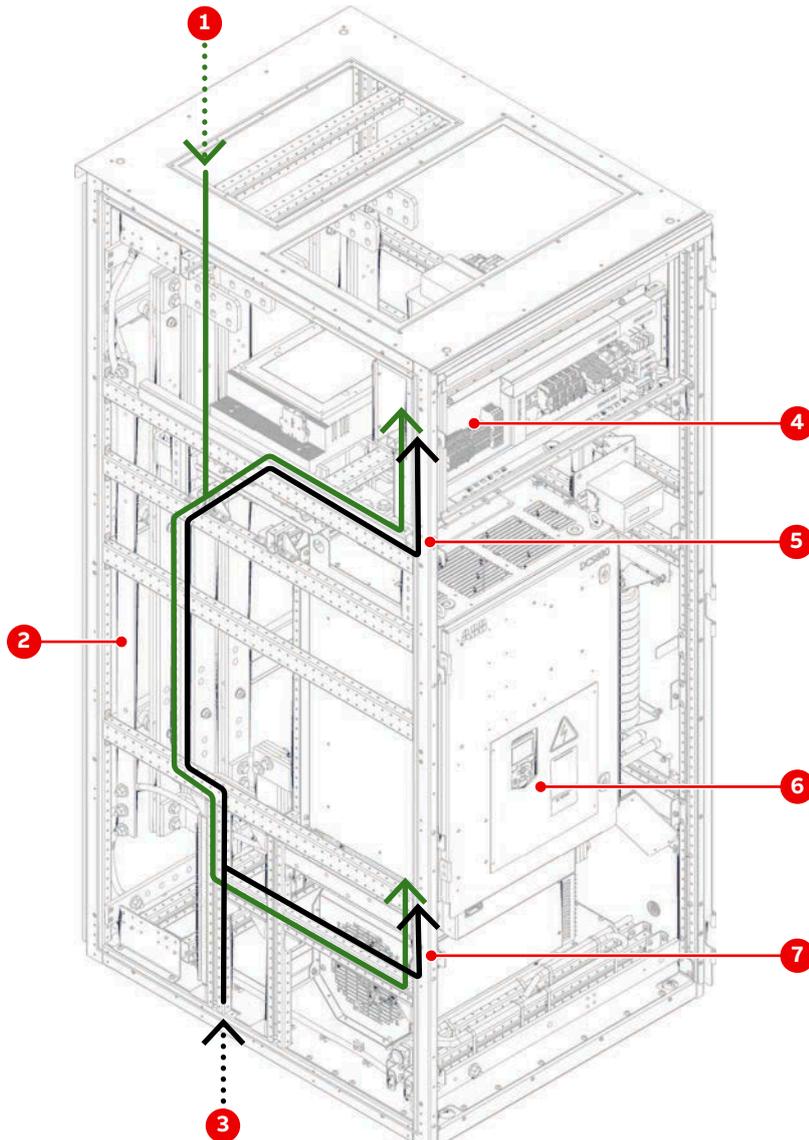


Figure 6–41 Cable routing example in an EXU cabinet with an ED7Y type DCS800 converter

- | | |
|--|---|
| 1) Cable enters through roof | 5) Auxiliary supply cable |
| 2) PE ground busbar | 6) Terminal for optical fibers behind cover |
| 3) Cable enters through the floor | 7) Optical fibers to DCS800 D4 converter |
| 4) Terminal strip for auxiliary power and control cables | |

4. Reattach the DCS800 cover.

6.8.8. Routing Azipod® encoder cables

This section applies to Azipod® propulsion.

The number of the pulse encoders and receivers, and the location of the receivers depend on the configuration of the drive. The receivers are installed in one of the following units:

- CIU
- WCU
- COU

For project-specific details, see the “Converter hardware diagram” in “Appendix D - Wiring diagrams”.

6.8.8.1. Handling and installation

The signals from the position encoders in the Azipod® to the receivers in the drive are transmitted with fiber optics.



NOTICE Risk of equipment failure!

A damaged or incorrectly installed optical fiber cable can degrade data transmission and cause equipment failure.

- Only use the designated encoder cable conduit that passes through the drive to the EXU.
The conduit extends 10 – 20 mm from the entry plate of the drive.
- Cover the cable end with a cap BEFORE you pull the cable through the conduit.
- DO NOT exceed the specified maximum tensile load and the minimum bend radius of the optical fiber.
- When you tighten the cable ties DO NOT deform the optical fibers and DO NOT use a cable tie gun.
- Hold the connector when you connect or disconnect an optical fiber.

6.8.8.2. Routing cables through the REB (WCU)

1. If present, remove the blanking plate.

The plate can either be discarded or used as an entry plate.

2. Route the cable along the WCU side wall, through the cable transit and to the receiver.
3. To fix the cables to the rails on the side wall, use a screw base with a cable tie or cable clamps appropriate for fiber optics.
4. To seal the cable entry, use appropriate sealing inserts for the cable entry frames.

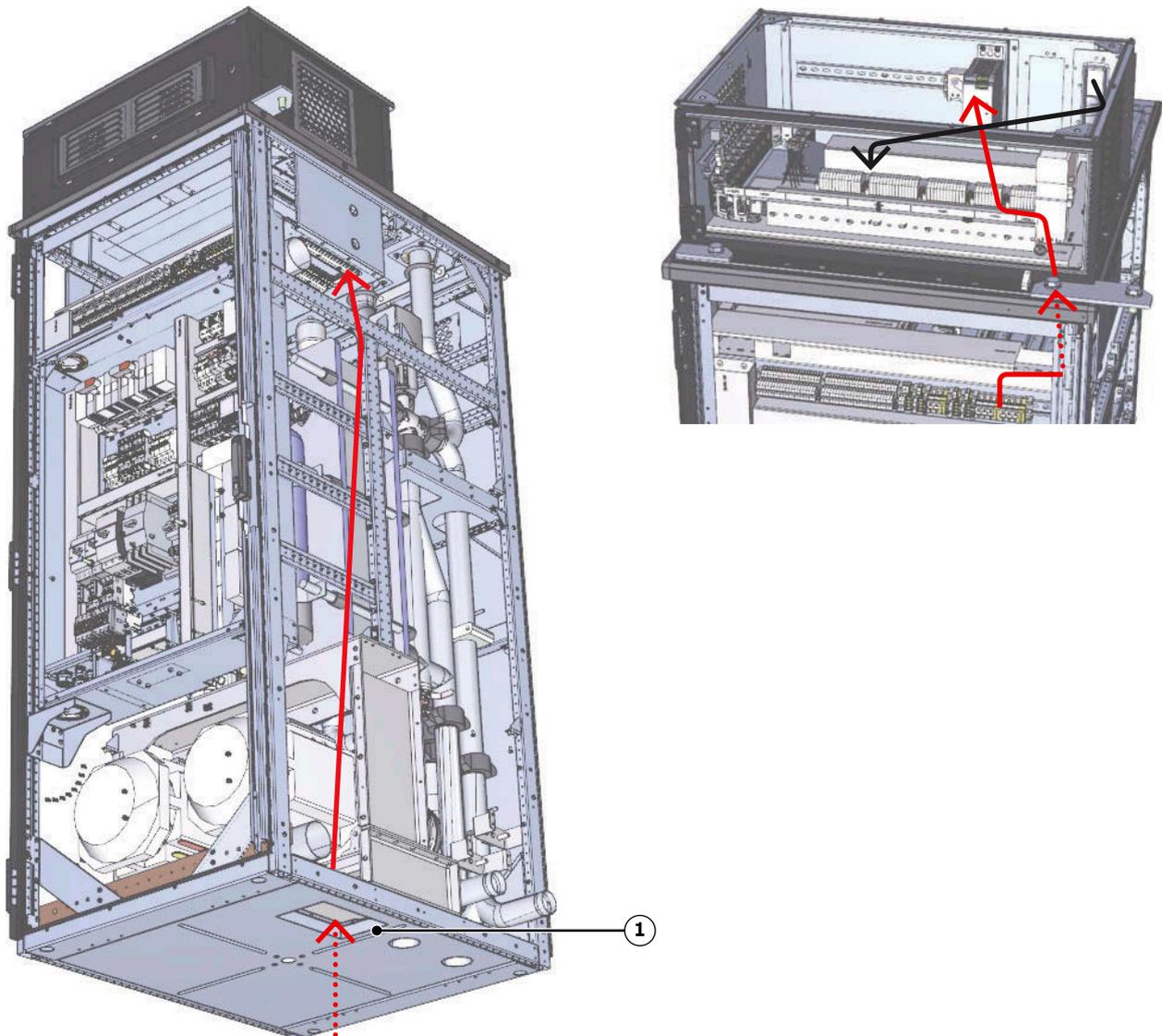


Figure 6-42 REB cable entry

- 1) Blanking plate (removed)

6.9. Heating cable

This section applies to drives that are delivered in multiple transport units and are equipped with a heating cable.

Procedure

1. Connect the power supply of the heating cable.

For more information on power supply connections, see the converter hardware diagram in “Appendix D - Wiring diagrams”.

2. Connect the heating cables of two adjoining transport units with each other.

3. Fasten the connectors with cable ties.

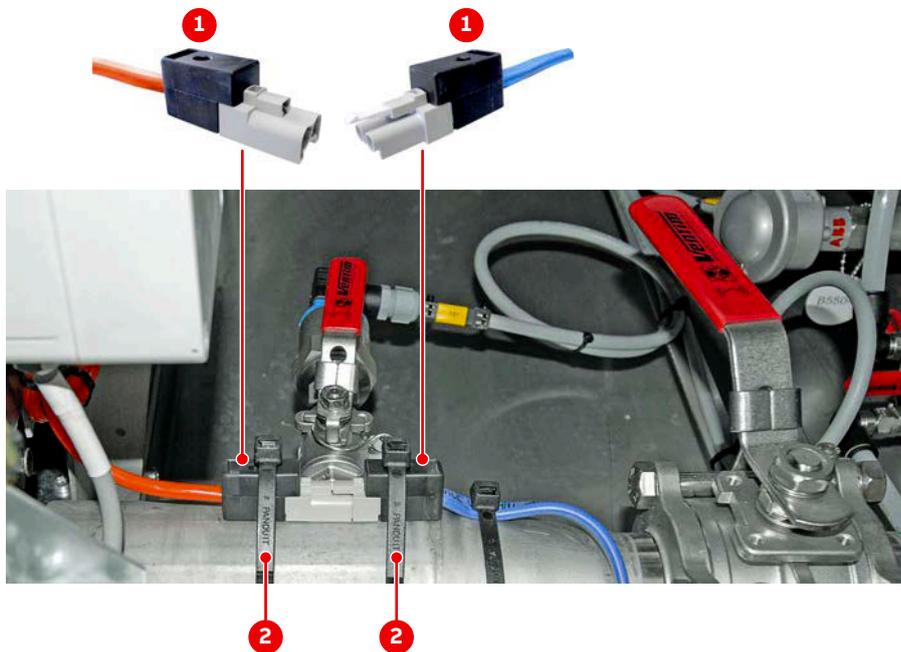


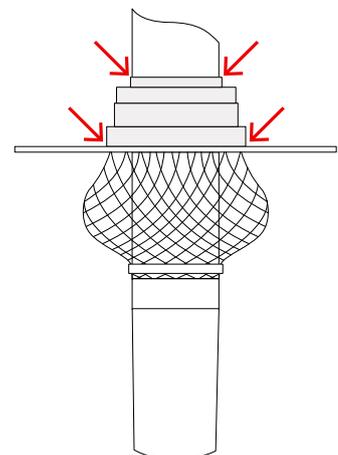
Figure 6-43 Heating cable connection

1) Heating cable plug

2) Cable tie

6.10. Final checks

- Check that the entry plates are properly fastened.
- If EMC entry plates with grommets are used, check that the grommets fit tightly (arrows) to prevent water entering the cabinet.
 - If necessary, seal gaps with silicone.



7. Commissioning

7.1. Required qualification



Commissioning, parameter adjustments and functional tests must be carried out only by qualified commissioning personnel that have been certified by ABB.

7.2. Commissioning procedure



Information on the commissioning procedure and the start conditions for commissioning can be obtained from ABB.

7.3. Commissioning checklist



In order to ensure uncomplicated and speedy commissioning, it is important that drive and associated equipment are ready for commissioning. Reviewing and completing the items in the commissioning checklist before the commissioning personnel arrive on site will help to achieve this.

7.4. Customer assistance



During the commissioning period, the customer is requested to provide qualified personnel for assistance, who are:

- Experienced with medium and low voltage equipment and with the local safety regulations,
- Familiar with the driven process
- Authorized to operate associated medium and low voltage equipment (eg, input circuit breaker, other low and medium voltage switchgear)
- Authorized to operate the driven process for functional tests

7.5. Customer acceptance



When commissioning has been completed, the commissioning report is signed by the responsible commissioning personnel and by the customer as a sign of acceptance. A copy of the report and a copy of the actual parameter settings are handed out to the customer.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	163/272

7.6. Commissioning checklists

The following checklists are designed to help you prepare the drive and associated equipment for commissioning.

7.6.1. Mechanical installation checklist		<input checked="" type="checkbox"/>
1) Drive is aligned according to drive layout drawing (if delivered in several transport units) and installed according to the instructions in this user manual (3BHS212794 E01 Q).		<input type="checkbox"/>
2) Drive is securely fixed to the floor.		<input type="checkbox"/>
3) Roof attachments are installed (if applicable).		<input type="checkbox"/>
4) Pipe joints are orientated and torqued correctly.		<input type="checkbox"/>
5) Joints for DC link and ground busbar are installed and correctly torqued.		<input type="checkbox"/>
6) Roof-mounted fan units are installed (if applicable).		<input type="checkbox"/>
7) Raw water piping is completed and pipes are flanged to the drive (if applicable).		<input type="checkbox"/>
8) Raw water supply is ready.		<input type="checkbox"/>
9) Visual inspection:		<input type="checkbox"/>
– No badly affixed or damaged components		
– No foreign objects left in the cabinet		
– No dirt, dust or moisture in the cabinet		
7.6.2. Electrical installation checklist		<input checked="" type="checkbox"/>
1) Types and cross sections of control cables suitable for the signal type and signal level.		<input type="checkbox"/>
2) Types and cross sections of power cables selected according to the ABB power cable specification.		<input type="checkbox"/>
3) Pulse encoder cable shields are connected to the shield earthing point and not connected directly to the pulse encoder interface (applies only to drives with pulse encoder interface).		<input type="checkbox"/>
4) Cable entries prepared according to the instructions in this user manual (3BHS212794 E01 Q).		<input type="checkbox"/>
5) Control cable screens and conductors are connected as instructed in this user manual (3BHS212794 E01 Q), labeled appropriately, and the customer side connections are completed.		<input type="checkbox"/>

7.6.2. Electrical installation checklist (continued)

- 6) Heating cables (if supplied) is installed according to the instructions in this user manual (3BHS212794 E01 Q).
- 7) Wiring across shipping splits is completed according to the instructions in this user manual (3BHS212794 E01 Q).
- 8) Ground cable of the drive is securely connected at both ends.
- 9) Cable armor and screens of power supply cables are connected to PE ground busbar.
- 10) The transformer and motor cables are installed but the conductors not connected at both ends (cables and drive must be insulation resistance tested, ie, Megger test, before connection).

7.6.3. Main circuit breaker (MCB) checklist

- 1) MCB selected as per “Main circuit breaker specification”⁽¹⁾
- 2) High-voltage power connections completed
- 3) MCB is ready to be tested with drive
- 4) MCB protection relay settings are tested
- 5) Protection devices (eg, door locks) are tested and in operation.
- 6) Local operation of MCB is disabled.
- 7) Emergency-off loop is tested.

⁽¹⁾ Pay attention to MCB opening time and installation of undervoltage coil or second opening coil

7.6.4. Input transformer checklist

- 1) Grounding is completed
- 2) Transformer auxiliaries (eg, dehydrating breathers, cooling, protection devices) are ready.
- 3) Protection devices are tested and in operation.

7.6.5. Motor checklist

- | | |
|--|--------------------------|
| 1) Motor is installed, aligned and alignment protocol available. | <input type="checkbox"/> |
| 2) Motor is not coupled to driven load. | <input type="checkbox"/> |
| 3) Grounding is completed | <input type="checkbox"/> |
| 4) Motor auxiliaries (eg, bearing lubrication) are ready | <input type="checkbox"/> |
| 5) Control and monitoring signals are connected. | <input type="checkbox"/> |

7.6.6. Insulation tests checklist

- | | |
|--|--------------------------|
| 1) Insulation of the cables to input transformer, from input transformer to drive and from drive to motor is tested, and measured values within required limits. | <input type="checkbox"/> |
| 2) Test report is available
If the commissioning personnel carry out the test, an additional day per drive-motor combination must be reserved. After the test, the mains cables can be connected, except at the drive end. Test must comply with the specification. | <input type="checkbox"/> |

7.6.7. Power checklist

- | | |
|---|--------------------------|
| 1) Medium voltage available for startup of drive. | <input type="checkbox"/> |
| 2) Low voltage is available for startup of drive. | <input type="checkbox"/> |

7.6.8. Water Cooling unit checklist

- | | |
|--|--------------------------|
| 1) Auxiliary power is available.
See WCU800 user manual , 3BHS821937 E01 or WCU1400 user manual , 3BHS835714 E01. | <input type="checkbox"/> |
| 1) Water quality matches specification in the WCU800 user manual , 3BHS821937 E01 or WCU1400 user manual , 3BHS835714 E01. | <input type="checkbox"/> |
| 2) Fill the internal cooling circuit according to the instructions in the WCU800 user manual , 3BHS821937 E01 or WCU1400 user manual , 3BHS835714 E01. | <input type="checkbox"/> |
| 3) If you cannot operate the pump(s) continuously, enable the Auto Cooling Control Function according to the software firmware manual in the loading package for the drive software. | <input type="checkbox"/> |

7.6.9. Miscellaneous checklist

- | | |
|---|--------------------------|
| 1) Sufficient number and correct type of spare parts available | <input type="checkbox"/> |
| 2) Sufficient quantity of deionized water according is available. (see "Appendix C - Mechanical drawings"). | <input type="checkbox"/> |
| 3) Air conditioning of drive room ready for load run of drive | <input type="checkbox"/> |
| 4) Optional equipment (eg, chiller) ready | <input type="checkbox"/> |

8. Operation

8.1. Overview

This chapter outlines the local operation of the drive.

NOTE – Control of the drive via a PLC or higher-level control system is not described in this chapter. If the drive is controlled from a remote location, see the applicable manuals for information.

The status messages and parameter settings used in this chapter are typical examples to illustrate the related instructions and display functions and may therefore differ from the actual status messages and parameter settings in the drive.

8.2. Operating conditions

The operating conditions for the drive are according to IEC 60721-3-3.

– **Classification:** 3K22 / 3B1 / 3S6 / 3M11

8.3. Safety



The drive system must only be operated by qualified and authorized personnel, ie, personnel who are familiar with the operation of the drive system and the hazards involved.

8.4 Local control panels

8.4.1. ARU control panel

The control panel is present in drives with an ARU. The control panel is installed on the door of control unit COU1.



Figure 8–1 ARU control panel

Main functions:

- Starts and stops the motor
- Displays status messages of the INU
- Displays alarm and fault messages of the drive and monitored foreign equipment
- Resets alarm and fault messages

8.4.2. INU control panels

The control panel for motor 1 (A in Fig. 8–2) is on the door of control unit COU1.

The location of additional control panels (B in Fig. 8–2) depends on the configuration of the drive (eg, single-motor or multi-motor drive, drive for motors with double windings).

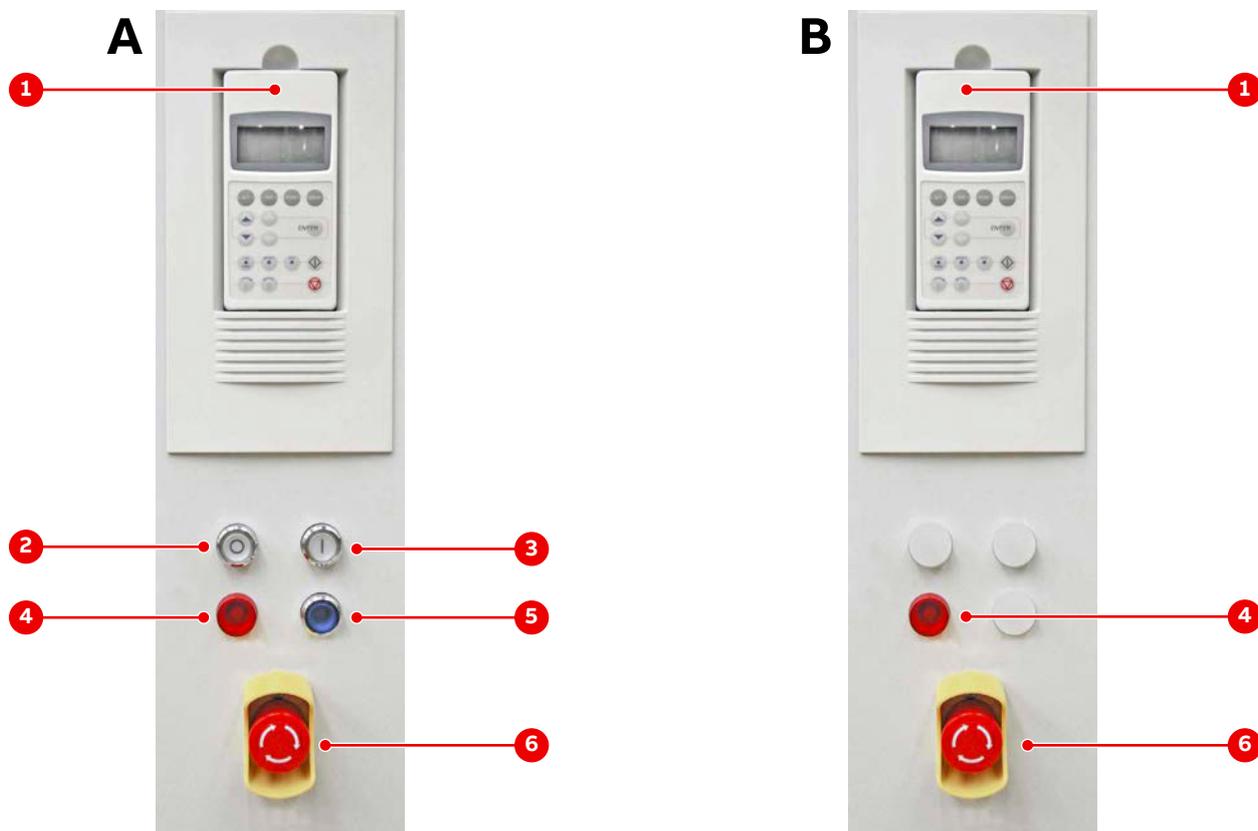


Figure 8–2 INU control panel for motor 1 (A) and additional motors (B)

- | | |
|---|--|
| <p>1) CDP control panel
Main functions:</p> <ul style="list-style-type: none"> • Starts and stops the motor • Displays status messages of the INU • Displays alarm and fault messages of the drive and monitored foreign equipment • Resets alarm and fault messages <p>2) Main power supply off
Illuminated pushbutton opens the main circuit breaker</p> <p>3) Main power supply on Illuminated pushbutton charges the DC link and closes the main circuit breaker</p> <p>4) Alarm / fault lamp</p> <ul style="list-style-type: none"> • Alarm: flashing light • Fault: permanent light | <p>5) EMERGENCY-OFF RESET pushbutton</p> <ul style="list-style-type: none"> • Resets the emergency-off relay in the drive control system • Flashes when the auxiliary voltage is switched on, or when an emergency-off pushbutton is pressed <p>6) EMERGENCY OFF latching pushbutton</p> <ul style="list-style-type: none"> • Prevents starting when pressed at standstill of the drive • Main circuit breaker opens and DC link discharges when pressed during operation of the drive |
|---|--|

8.4.2.1. Lamp test

The illuminated push buttons on the doors can be tested with the lamp test function as described in the firmware manual, see “Appendix G - Signal and parameter table”.

8.4.3. Semi-redundant drive control panel (drive backup control)

The semi-redundant drive system applies to single drives with an even number of inverter units.

A semi-redundant drive system consists of the following features:

- One single-motor drive with double or quadruple inverter units for one common motor.
- One common control unit for the whole drive system.
- Transfer between full- and half-power is not bumpless.
- Line disconnectors are provided in the inverter units to separate the inverters from the motor.

Note: The configurations shown here are typical examples. Different configurations are possible. The optional ISU can be used to split up the drive lineup in half-power mode by opening the DC link.

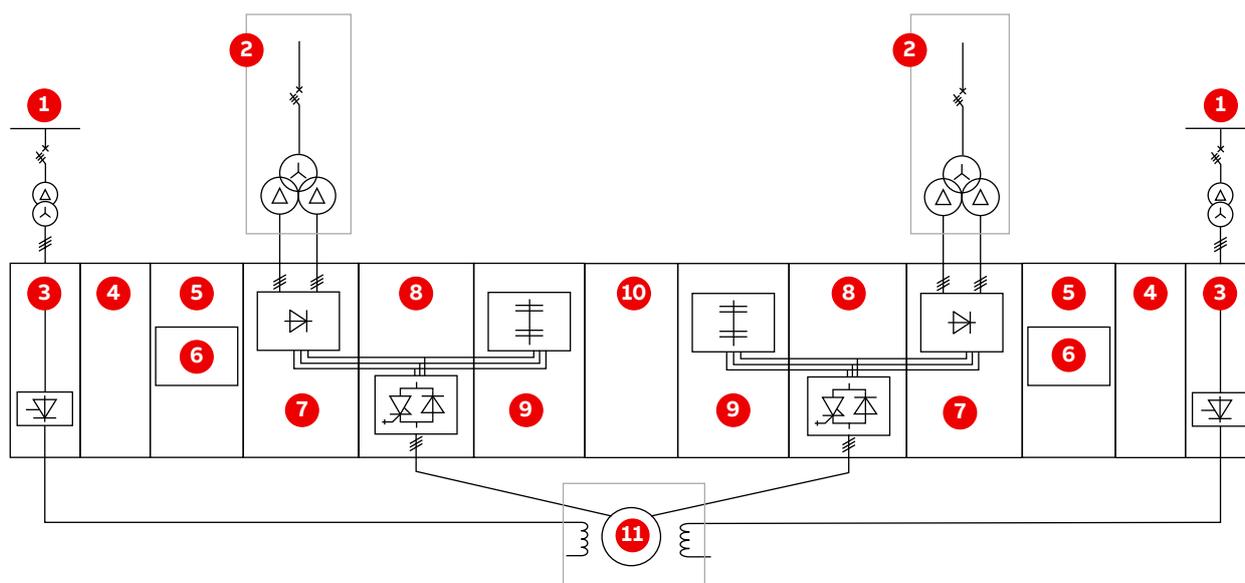


Figure 8-3 Typical semi-redundant drive configuration

1) Excitation power	7) LSU
2) Mains	8) INU
3) EXU	9) CBU/RBU
4) WCU	10) ISU
5) COU	11) Motor
6) Control	

8.4.3.1. Operating modes

Several power operating modes (POMs) are possible in full-power drive mode and in half-power drive mode. The selection of the POM and the control of the inverter output disconnectors is done either by software or a hardware interface on the drive (project specific).

For project specific instructions please consult the corresponding application note.

Fig. 8–4 shows typical full- and half-power modes. For further variants, see “Appendix G - Signal and parameter table”.

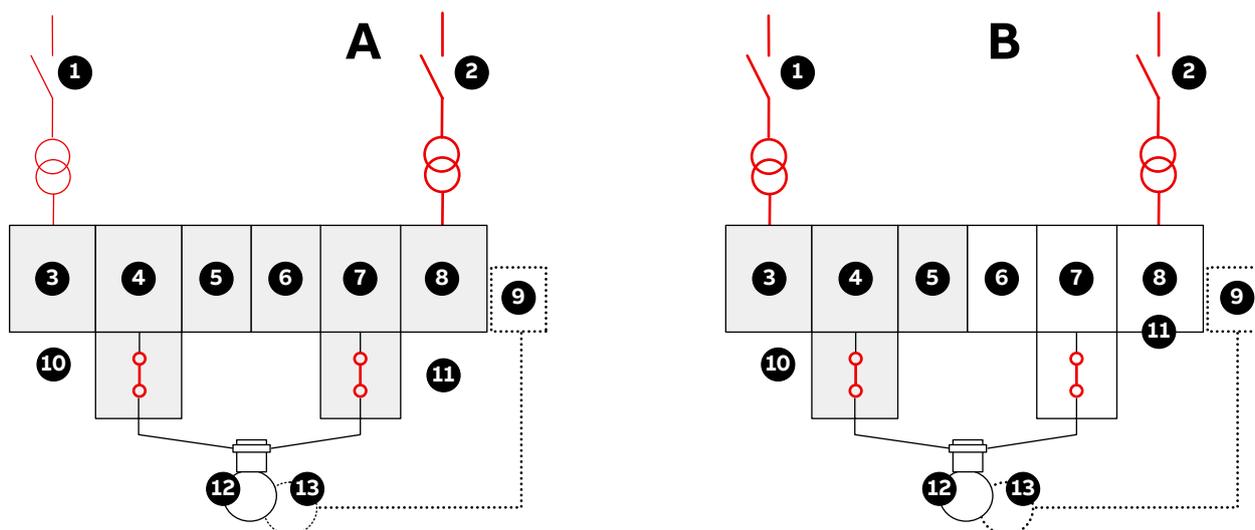


Figure 8–4 Typical full-power (A) and half-power (B) drive modes

- | | |
|-----------------|-----------------------|
| 1) MCB 1 | 8) ARU2 |
| 2) MCB 2 | 9) EXU |
| 3) ARU1 | 10) Output isolator 1 |
| 4) INU1 | 11) Output isolator 2 |
| 5) CBU1 or BCU1 | 12) Motor |
| 6) CBU2 | 13) Synchronous motor |
| 7) INU2 | |

8.4.3.2. Semi-redundant drive control panel

The semi-redundant drive control panel can be operated in both local and remote mode. For more information, see the appropriate application note.

8.5. EXU control panel



Figure 8-5 DCS800 control panel

- | | |
|---|---|
| <p>1) LED</p> <ul style="list-style-type: none"> • Steady green light: normal operation • Flashing green light: alarm • Steady red light: fault <p>2) Soft keys: function changes with the text that is displayed above the soft key</p> <p>3) Local / remote key: changes between local and remote control</p> <p>4) Stop key: stops the DCS800 unit if in local control mode</p> | <p>5) Up (down) key: scrolls up (down) a menu or list, increments (decrements) a value if a parameter is selected, increments (decrements) the reference value in the upper right corner of the display if highlighted</p> <p>6) Help key: When pressed, shows additional information on the message currently displayed</p> <p>7) Start key: starts the DCS800 unit if in local control mode</p> |
|---|---|

The EXU control panel is the user interface for controlling, reading the status data and setting the parameters of the DCS800 unit in the EXU cabinet.

The control panel provides the following functions:

- Alphanumeric LCD display
- Display language selection
- Assistant for commissioning
- Parameter copy function

Parameters can be copied into the control panel memory for backup purposes or for downloading to another DCS800 unit. For this reason, the control panel can be detached and attached to the DCS800 unit at any time.

- Context-sensitive help menu
- Fault and alarm text messages including fault history

For more information, see “DCS800 drives firmware manual” , 3ADW000193R0801.

8.5.1. Operational settings

NOTICE Risk of component damage!

DO NOT unlock local operation and switch the control panel to remote while the drive is in operation!

- ▶ If you attempt to perform these actions, the drive shuts down

NOTE – The control panel is only used if an alarm or a fault condition must be rectified.

After commissioning of the EXU, the control panel is set to remote, and local operation is locked in parameter *16.04 LocLock*. This setting prevents the control panel being switched to local control unintentionally.

The actual values shown on the display can be freely selected. The following default values are shown on the display when the panel is in local mode:

- Motor current in percent (%)
- Actual armature voltage in V
- Actual converter current in A (rectified AC current value)

When the control panel has been set to remote, the **START** / **STOP** keys become inoperable.

8.5.2. Resetting alarm and fault messages

- **Alarm messages:** cannot be reset by pressing the reset soft key.

The alarm resets automatically as soon as the reason causing the alarm has been resolved.

- **Fault messages:** must be reset manually after the reason causing the fault has been resolved.

The message on the display can be reset either by pressing the reset soft key on the EXU control panel, or by pressing the reset button on the control panel of the drive.

8.5.3. Parameter settings

NOTICE Risk of component damage!

Running the drive system with incorrect data can result in improper operation, reduction of control accuracy and damage of equipment!

- ▶ DO NOT change any parameter if the meaning of the parameter and the effects of the change are not fully understood.
- ▶ The parameters are set as required for operation and verified during commissioning and must NOT be changed afterward

8.6. Grounding switch and door locking system

The grounding switch of the CBU is a protection device that enables safe access to the medium voltage units of the drive.

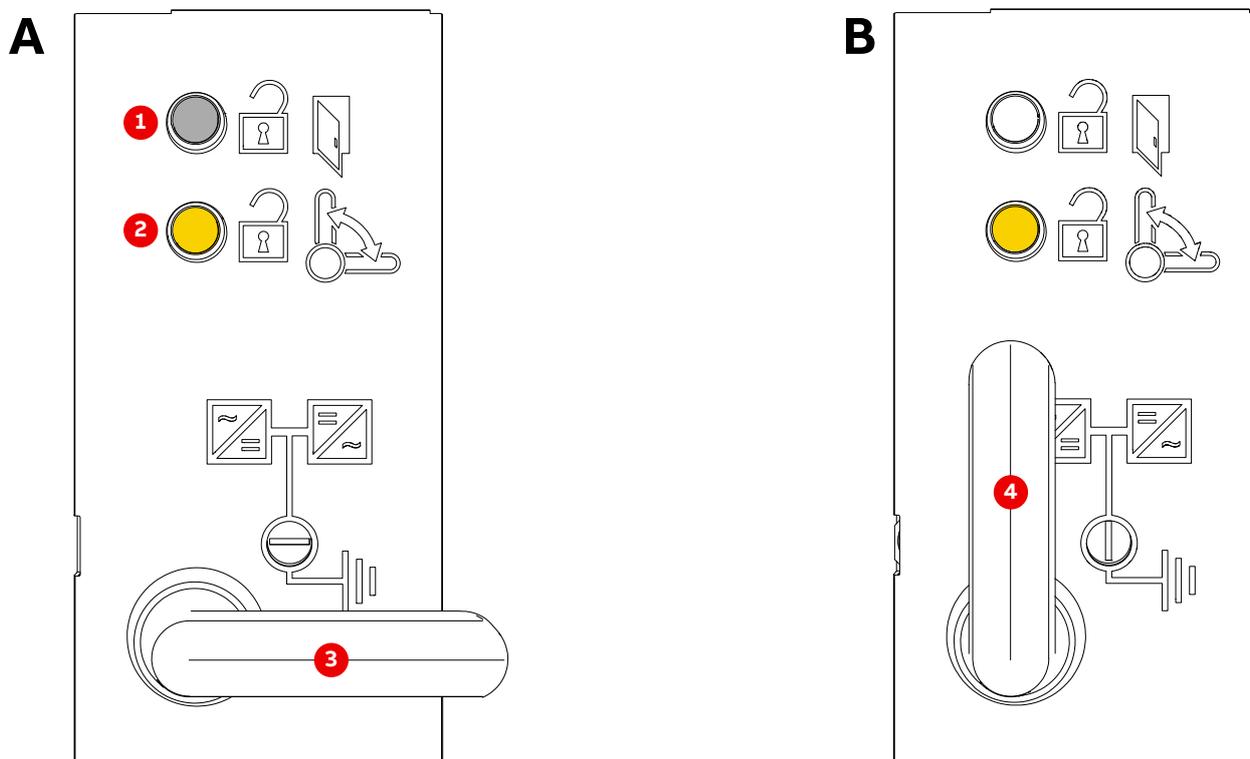


Figure 8-6 CBU grounding switch in ungrounded (A) and grounded (B)

- | | |
|---|--|
| <p>1) White illuminated push button:
DC link is grounded</p> <ul style="list-style-type: none"> Lights up to indicate that the drive is grounded and that the locking bar (see 1 in Fig. 8-7) of each medium voltage unit can be moved to the unlocked or locked position. <p>2) Yellow illuminated push button: grounding switch unlocked</p> <ul style="list-style-type: none"> Lights up to indicate that the grounding switch can be turned to the ungrounded or grounded position. Press the yellow push button to turn the grounding switch to the desired position. | <p>3) Grounding switch in ungrounded position (A)</p> <p>4) Grounding switch in grounded position (B):
When the switch is in grounded position, the DC link of the drive is connected to the ground busbar of the drive.</p> |
|---|--|

The switch is electro-mechanically interlocked with a discharge monitoring circuit that prevents the switch from closing when the DC-link capacitors are still charged.

Grounding the drive is only possible after the main power supply has been disconnected and the DC link has discharged. The yellow lamp lights up when the DC-link voltage is below 50 V(DC).

When the grounding switch is in position grounded, the door safety switches of the medium voltage units are released and the doors can be opened.

8.6.1. Lamp test

The indicator lamp for the grounding switch and the white lamp (Fig. 8–6) have an integrated momentary push button. The lamps light up when the lamp cap is pressed.

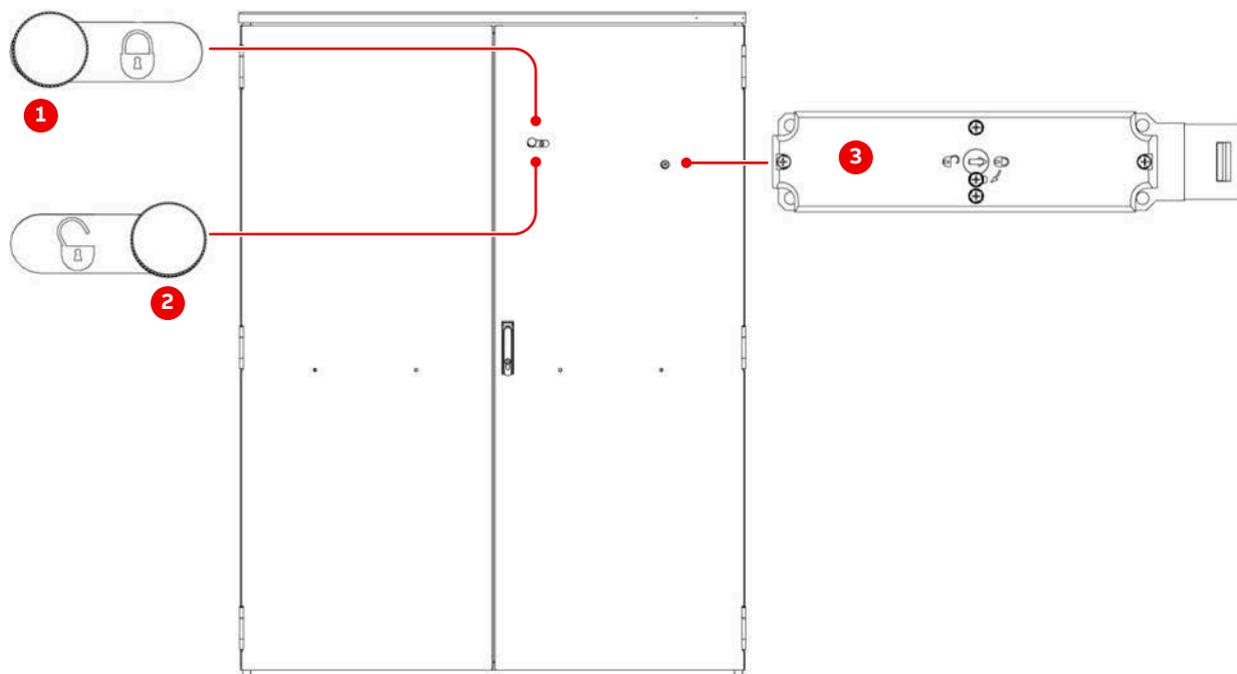
8.6.2. Door locking system

All doors of the drive are lockable. Additionally, the doors of the medium voltage units of the drive are equipped with safety switches and locking bars. The doors labeled CIU, COU, EXU and WCU are not part of the interlocking circuit and can be opened when the drive is energized.

Table 8–1 Medium voltage units with safety switches and locking bars

Standard cabinet units	Optional cabinet units
ARU	INU
LSU	IFU
CBU	IRU
TEU	BCU
	RBU
	VLU
	ISU

NOTE – For more information, see section 10.4.4, **Unlocking and opening the doors**, page 228.



- 1) Locking bar in locked position
- 2) Locking bar in unlocked position
- 3) Safety switch

Figure 8–7 Safety switches

The safety switches are part of an interlocking circuit that prevents the doors being opened as long as the DC link is charged. The interlocking circuit ensures that the:

- Main power can only be connected to the drive if the doors are securely closed, the grounding switch is in position not grounded, and the safety switches are in position locked.
- Doors can only be opened when the main power has been disconnected, the DC-link capacitors have been discharged, and the grounding switch is in position grounded.

The locking bar locks and unlocks the locking mechanism of the door of a medium voltage unit.

For more information, see section 10.4.4, **Unlocking and opening the doors**, page 228.

8.7. Optional switchgear and controlgear

The operating personnel must be informed about the types of switches present in the drive and the parameter settings for opening and closing.

8.7.1. DC-link disconnecter

Drives can be equipped with a manual controlled DC-link disconnecter. The location of the control switch for opening and closing depends on the configuration of the drive. The control switch can be actuated when released by the drive.

8.7.2. Output switches

Drives can be equipped with motorized output disconnectors, or motorized or manually-operated output grounding switches.

NOTICE Risk of component damage!

- ▶ The operator must ensure that the motor does not rotate before the switch is actuated.

The switches for actuating the manual output switches are installed inside the drive cabinets. The location depends on the configuration of the drive. The switches are accessible after the DC link has been discharged and the doors have been opened. The open and closed position of the switches is monitored by the drive.

Depending on the operating state of the drive and the settings of the parameters for this function, the drive opens or closes the motorized switches.

8.7.3. Manual output isolation

The manual output isolation (MOI) disconnects the output of the drive from the motor and creates a visible isolating distance in the supply line to the motor.

For more information, see section 10.4.9, **Drives with the manual output isolation (optional)**, page 237.

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8.8. Status messages

The following section lists the status messages of the main operating states that the drive passes through when:

- Drive is put into operation
- Drive is stopped
- Fault condition has occurred

The status messages are sent to the higher-level control system and are displayed on the control panel of the drive. For information on other status messages (eg, fault status messages), see the status words in “Appendix G - Signal and parameter table”.

NotReadyOn



The DC link cannot be charged and the drive cannot be connected to the main power supply (that is, the main circuit breaker cannot be closed). The status message is displayed, when the doors of medium voltage units are still open, the grounding switch of the drive is in the grounded position, or the motor starter of the fan unit is switched off.

ReadyOn



The drive is healthy and ready for the ON command. The ON command initiates charging of the DC link and the closing of the main circuit breaker of the drive. Depending on the control place, the command can either be sent from the higher-level control system to the drive or be initiated by pressing the SUPPLY ON push button on the control compartment of the drive.

Charging



The status message **ReadyOn** changes to **Charging** when the DC link capacitors of the drive are being charged.

ReadyRun



Informs the operator that the drive is energized and ready for operation. As soon as the start command is initiated, the motor is magnetized and the drive starts to modulate.

ReadyRef



The drive is running and operating according to the set speed or torque reference value. When in remote control mode, the reference value is set at the remote control system. When in local control mode, the value is entered into the control panel.

Stopping



Stopping indicates that the drive has received a stop command and that a ramp or coast stop has been initiated. The stopping mode depends on the parameter setting. The status message changes to **ReadyRun** when the zero speed threshold is reached. When a start command is given while the drive is stopping, the drive resumes operation and the status message changes to **ReadyRef** again.

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Tripped



Indicates that a fault condition has occurred that requires a shutdown of the drive. The status message always alternates with the specific fault message. The type of shutdown depends on the fault class the fault condition is assigned to in the drive software.

8.8.1. Start sequence of the drive



1) NotReadyOn



2) ARU ReadyOn

- Only drives with an ARU (see the next step, **ReadyOn**, for the conditions)



3) ReadyOn

- Auxiliary power supply on
- Doors of medium voltage units closed and locked
- Drive is not grounded
- No emergency-off
- No fault
- WCU ready



4) On command



5) Charging

- DC link charges
- MCB closes
- Cooling system switches on



6) ARU ReadyRef

- Only in drives with an ARU



7) ReadyRun

- INU starts magnetizing (only in drives with an ARU)
- INU starts to modulate



8) Start command



9) ReadyRef



10) Operation

8.8.2. Stop sequence of the drive



1) **Operation**



2) **ReadyRef**



3) **Stop command**



4) **Stopping**

- Speed ramps down
- INU stops modulating



5) **Off command**

- Stop command to ARU (only in drives with an ARU)
- MCB opens
- DC link discharges
- Cooling system switches off after a delay



6) **ReadyRun**



7) **ARU ReadyOn**

- Only in drives with an ARU



8) **ReadyOn**

- Drive is grounded
- Doors in medium voltage units are released for opening
- Auxiliary power supply switched off



9) **NotReadyOn**

8.8.3. Emergency-off sequence



1) **Operation**



2) **ReadyRef**



3) **Emergency-off command**

- **Stop** command to ARU (only in drives with an ARU)
- MCB opens
- INU stops modulating
- Speed coasts down



4) **Emergency-off**

8.8.4. Prevention of unexpected startup sequence



1) Operation



2) ReadyRef



3) Prevention of unexpected startup command

- Drives stops according to **Ramp**, **Torque**, and **Ramp stop** modes
- Open disconnecter
- Prevention of unexpected startup complete
- Drive remains charged, MCB closed



4) INU operation prevention feedback

8.9. Starting the drive

NOTE – The charge cycle of the drive is 3 times per 60 minutes.



! DANGER Hazardous voltages!

- ▶ To prevent unintentional contact with energized components, all covers must be screwed in place.
- ▶ The release dial of the door safety switches must be in the locked position to prevent the doors of the medium voltage compartments from being opened unintentionally during operation.



! CAUTION Cooling system starts automatically!

The cooling system can start automatically when the auxiliary voltage is switched on.

8.9.1. Checks before starting the drive

When the drive is put into service after it has been commissioned, or after it has been taken out of service for a longer period, check the drive according to the following list:

- Tools and foreign objects have not been left inside the cabinet.
- All auxiliary power supplies from external sources are switched on.
- All internal circuit breakers of the drive are closed.
- All covers are fitted.
- All locking screws have been removed from the locking bars on the inside of the doors of medium voltage compartments.
- Doors are closed and locked or bolted.
- Grounding switch is in position not grounded.

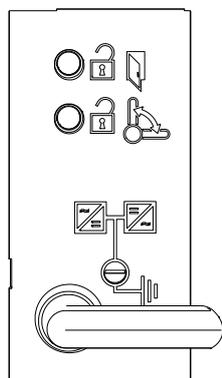


Figure 8–8 Grounding switch in ungrounded position

- MCB is in operating position.
- If the drive is equipped with a DC link disconnecter, check that the control switch for the DC link disconnecter is in the correct position.

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8.9.2. Starting the drive remotely

When the drive system is operated from a higher-level control system or an operator control desk, follow the instructions in the applicable manuals.

8.9.3. Starting the drive locally

1. Set the CDP control panel to local control mode.



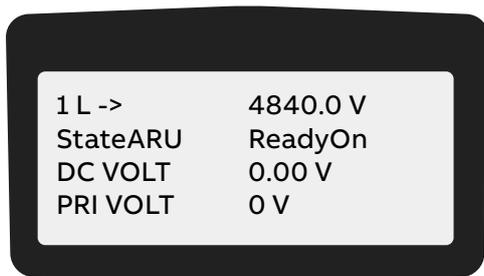
2. If the **EMERGENCY-OFF RESET** push button on the COU is flashing, press the push button to cancel flashing.

NOTE – Each time the auxiliary voltage is switched off and on again, the emergency-off safety relay of the drive is actuated and lets the **EMERGENCY-OFF RESET** push button flash. The **EMERGENCY-OFF RESET** push button also flashes if the **EMERGENCY-OFF** push button on the control compartment door, or any other **EMERGENCY-OFF** push button linked to the drive, is pressed. If the **EMERGENCY-OFF RESET** push button continuous flashing, verify that there is no emergency-off command active. See section 8.10.2, **Stopping the drive with the emergency-off function**, page 188

3. Check that no alarm or fault messages are displayed on the control panel.
 - When a fault message is displayed on the control panel, reset the fault.



- If a fault cannot be reset, the responsible personnel must rectify it.
- (Drives with an ARU) When faults are present and the drive is ready, the INU is **ReadyOn**.



- When alarms and faults are not present and the drive is ready, the INU CDP control panel displays **ReadyOn**.

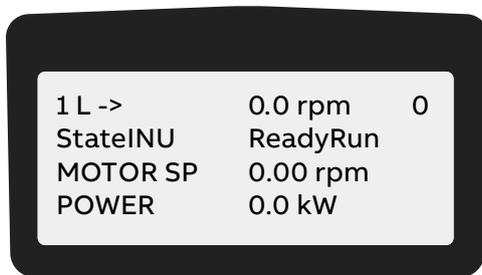


4. Press the **SUPPLY ON** push button on the door of the control unit to charge the DC link.

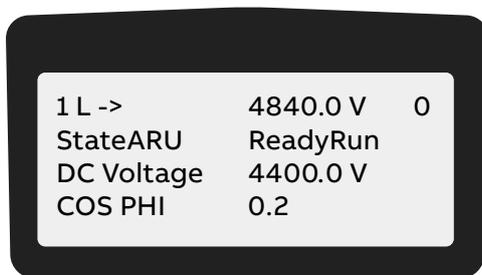
The push button flashes during charging.

The status line of the control panel alternates between **Charging** and **AuxiliaryOn**. NOTE – After charging has been finished, the following takes place:

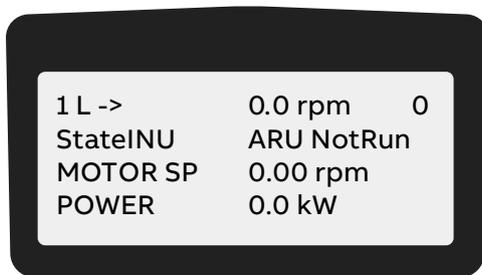
- Main circuit breaker closes automatically.
- SUPPLY ON push button lights up permanently.



- Drives with an ARU:
 - The ARU is now **ReadyRun**.



- INU 1 and other INUs (if present) are now in status **ARU NotRun**

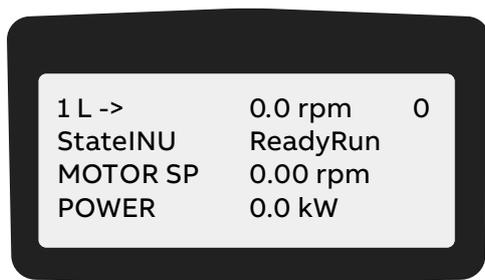


5. (Drives with an ARU) Press the **START** key on the ARU control panel:

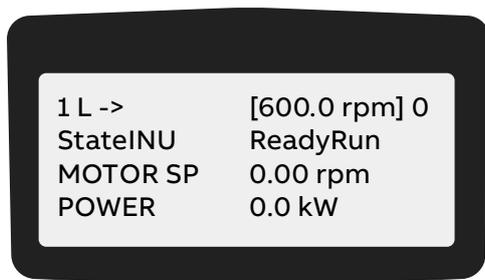


The ARU starts modulating, the control panel displays **Modulating** and the status of the ARU changes to **Modulating**.

When the ARU has reached the status **ReadyRef**, the status of the first INU and the other INUs change to **ReadyRun**.



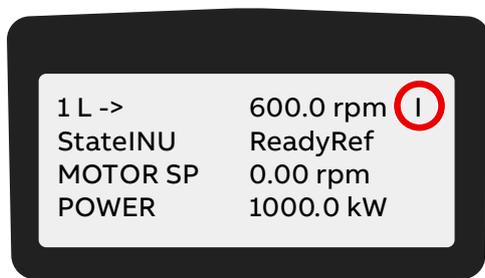
6. Enter the reference value.



7. Start the motor with the INU control panels.



After the motor has been magnetized, the motor speed ramps up to the reference value. While the motor is magnetizing, the run status message on the display blinks. When the motor has finished magnetizing, the run status message lights up permanently. The drive is now in **ReadyReff** to indicate that the drive system is operating.



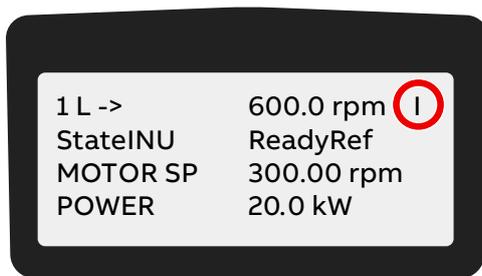
8.10. Stopping the drive

8.10.1. Stopping the drive locally

1. To stop the drive, press the **STOP** key on the control panel.



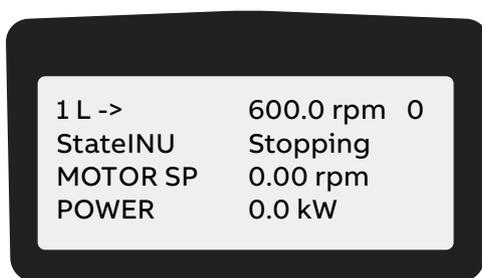
The motor stops according to the preset stop function. While the motor stops, the status line of the display shows **ReadyRef** and the run status message blinks.



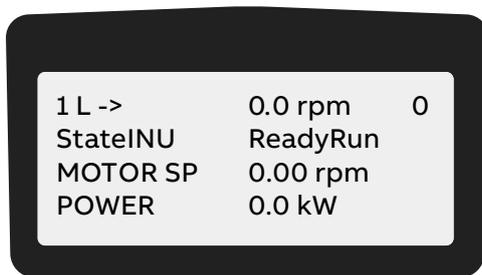
NOTE – During the stop sequence, you can restart the drive by pressing the **START** key.



The drive is now in stopping mode.



2. When the motor has reached zero speed, the drive is **ReadyRun**.



As long as the MCB has not been opened, you can restart the motor at any time.

8.10.2. Stopping the drive with the emergency-off function

The drive is equipped with a hardwired emergency-off circuit. When an emergency situation occurs during operation, this safety feature ensures that the drive system can be disconnected without delay from the main power supply. When the **EMERGENCY-OFF** push button has been pressed while the drive is discharged, the main power supply cannot be connected to the drive, hence the drive cannot be started up.



The **EMERGENCY-OFF** push button of the drive is part of the local control panel (Fig. 8–2) and features a latching switch action.

IMPORTANT! Pressing the **EMERGENCY-OFF** push button does not disconnect the auxiliary power supply from the drive.

For more information, see “Emergency off/stop modes and prevention of operation & safe torque off” , 3BHS196243.

8.10.3. Initiating an emergency-off



An emergency-off is initiated by pressing the **EMERGENCY-OFF** push button on the door of the drive control unit or an external **EMERGENCY-OFF** push button (if present) linked to the emergency-off circuit.

When an emergency-off is initiated during operation, the following sequence of events occurs:

- 1) MCB opens
- 2) Drive system coasts down
- 3) DC-link of the drive discharges
- 4) Status line indication of the CDP control panel alternates between EmergencyOff and NotReadyOn. **EMERGENCY-OFF RESET** button flashes
- 5) **SUPPLY OFF** push button flashes

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8.10.4. Starting the drive system after an emergency-off

1. To start the drive system after an emergency-off, unlatch the **EMERGENCY-OFF** push button.

The **EMERGENCY-OFF** push button returns to its initial position when turned into the direction indicated by the arrows on the push button.

2. Press the **EMERGENCY-OFF RESET** button to reset the emergency-off safety relay of the drive.
 - The drive remains in emergency-off state until the DC-link voltage has dropped to < 50 V (discharged).
 - After resetting, the status message of the drive changes to READYON.
3. The status line of the CDP control panel shows the following: The main power supply can be connected to the drive again and the drive system can be started up.

8.11. Arc detection with the Arc Guard System™ (optional)

The optional Arc Guard System™ detects fast arc faults in the terminal sections of an ACS6000 drive. When the Arc Guard System detects an arc fault the drive performs protection firing and immediately opens the main circuit breaker.



Figure 8-9 Arc Guard System™ in a WCU REB

- | | |
|---|---|
| <ol style="list-style-type: none"> 1) Arc Guard HMI panel 2) Arc monitor device | <ol style="list-style-type: none"> 3) Reeling device for optical fiber detector cables |
|---|---|

8.11.1. Action after the Arc Guard System™ has been triggered

1. De-energize and ground the drive according to section 10.4.2, **De-energizing and grounding the drive**, page 223.
2. Search for the location where the arc has been detected.
3. Check the Arc Guard HMI panel messages and use the circuit diagrams.



Figure 8–10 HMI panel

4. Open the power units and localize the defect.
5. Repair the defect or contact support line if needed.
6. Reset the fault on Arc Guard HMI panel.
7. Acknowledge the firing through with parameter *16.26* on the control panel (only when fault was understood and corrected).
8. Restart the drive.

9. CDP control panel

9.1. Overview

The panel messages and parameter settings in the following sections are typical examples and might differ from the actual ones.

9.1.1. Display and keypad

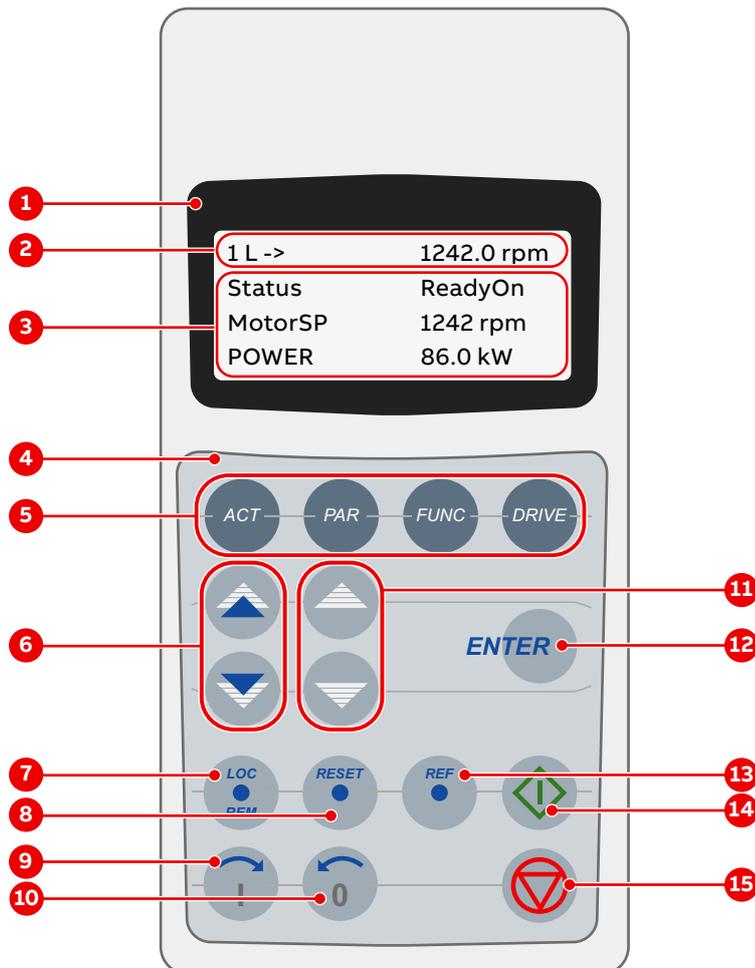


Figure 9–1 CDP control panel

- | | |
|---|---|
| 1) Display | 8) Reset key |
| 2) Status line | 9) Forward key |
| 3) Actual signal names and values | 10) Backward key |
| 4) Keypad | 11) Slow navigation key for selecting signals or fault messages |
| 5) Mode selection keys | 12) Enter key: terminates a procedure |
| 6) Fast navigation key for selecting the actual signals display or the fault memory display | 13) Reference key |
| 7) Local / remote selection key | 14) Start key |
| | 15) Stop key |

9.1.2. Functions

The CDP control panel serves as the basic user interface for operating and monitoring the drive when the local operating mode has been selected.

The CDP control panel can be attached to or detached from the drive without having to switch off the auxiliary power supply first.

Using the CDP control panel, it is possible to:

- Enter startup data
- Enter reference values
- Enter start, stop and direction commands
- Display actual values (three values can be read simultaneously)
- Display and adjust parameters
- Display information on the most recent 64 fault events

9.2. Modes

The CDP control panel provides the following modes:

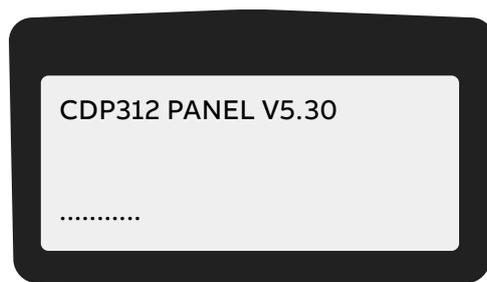
- **Identification mode**, page 192
- **Actual signals mode**, page 194
- **Parameters mode**, page 201
- **Functions mode**, page 206
- Drive mode (not used)

9.2.1. Identification mode

The identification mode informs the user about the CDP control panel version and the ID number of the drive. The information appears on the display

- when the power supply is switched on, or
- when the CDP control panel is connected to the drive and the auxiliary voltage has been switched on already.

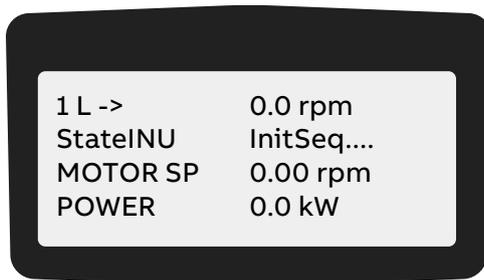
When the CDP control panel is initialized, the display changes as follows:



After 2-3 seconds the display shows the drive name (1, 2), the application software in use (3), and the drive identification (4) is displayed.



After another few seconds.



After another few seconds, the display changes to the actual signals display. The status line of the display alternates between **DCGndNOpen** and **NotReadyOn**.

9.2.2. Actual signals mode

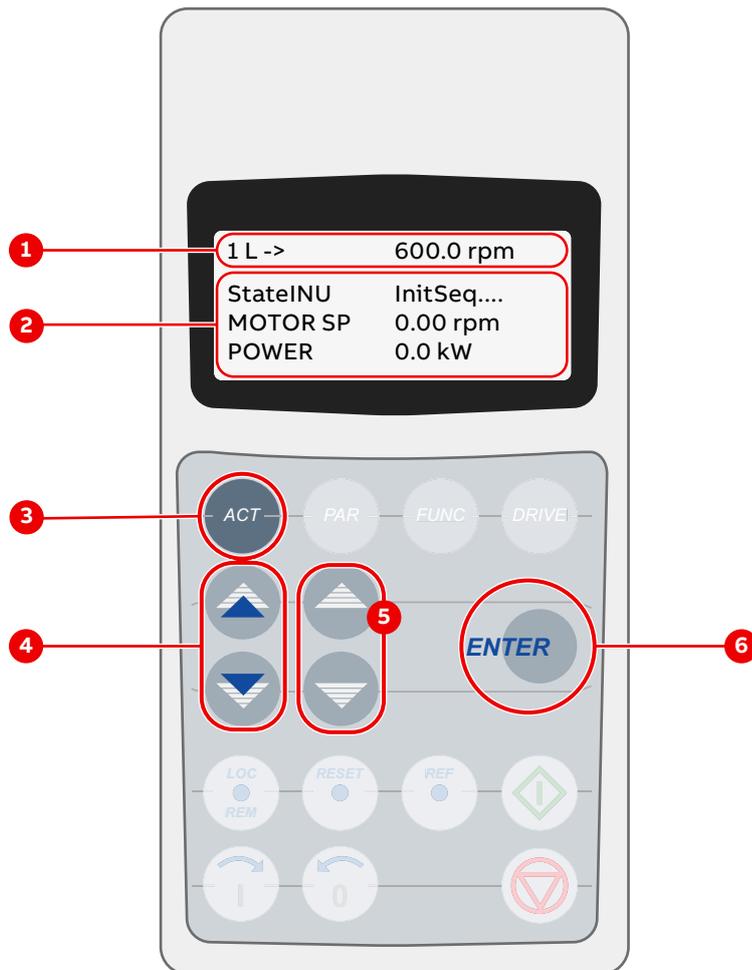


Figure 9–2 Control panel functions for Actual signals mode

- | | |
|---|--|
| 1) Display | 5) Slow navigation key for selecting signals or fault messages |
| 2) Actual signal names and values | 6) Enter key for confirming the selection |
| 3) Selection key for actual signals mode | |
| 4) Fast navigation key for selecting the actual signals display or the fault memory display | |

9.2.2.1. Overview

Two displays can be selected in the actual signals mode:

- Actual signals display
- Fault memory display

The actual signals display appears first when entering the actual signals mode. However, when the drive is in a fault condition, the fault memory display appears instead.

The actual signals display is used to monitor the drive without interfering with its operation. It continuously displays three selectable actual values.

If no key is actuated within one minute (an exception from this is the fault memory display), the CDP control panel automatically returns to the actual signals display from other modes.

Actual values

For the complete list of selectable actual signals, see “Appendix G - Signal and parameter table”.

The actual values are organized in groups.

Group	Description
Group 01	Measured or calculated motor values
Group 02	Measured or calculated drive values
Group 03	Reference values
Group 04	Status signals of S800 I/O system
Group 05	Communication link and MCB status signals
Group 06	Software version, drive and motor nominal values
Group 07	Control words
Group 08	Status words
Group 09	Fault and alarm words

Fault memory

The fault memory display provides information on the 64 most recent fault events that occurred in the drive. It displays the name of the fault and the time it occurred. For instructions on how to display and reset the fault memory, see section 9.2.2.7, **Displaying and resetting an active fault**, page 200.

When the drive generates a fault or alarm, the corresponding message displays immediately.

Changing from the fault memory display to other modes is possible without resetting the fault first. If no key is actuated, the fault or alarm message displays as long as the fault is active.

9.2.2.2. Selecting the actual signals display

To select the actual signals display, press the **ACT** key.



9.2.2.3. Toggling between actual signals display and fault memory

To toggle between actual signals display and fault history display, press a fast navigation key.



9.2.2.4. Displaying three actual signals

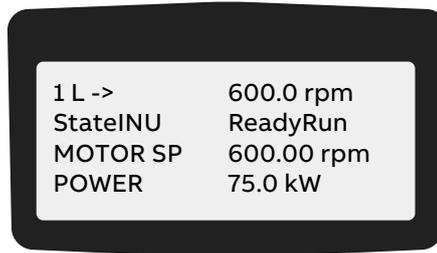
1. To display the full name of three actual signals, press and hold the **ACT** key.



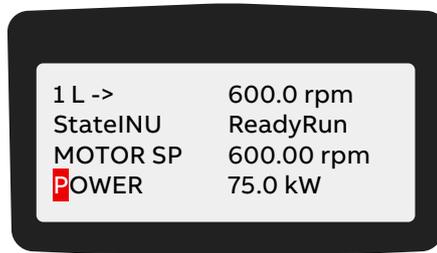
2. To return to the actual signals display, release the **ACT** key.

9.2.2.5. Selecting actual signals

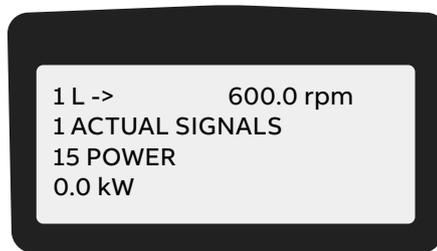
1. To select the actual signals display, press the **ACT** key.



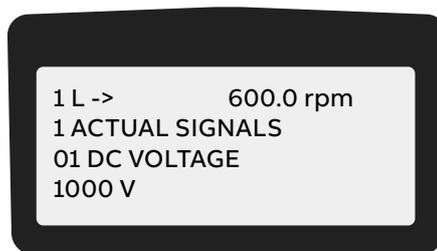
2. To select a line where the actual signal is to be displayed, press the slow navigation keys. A **blinking** cursor indicates the selected line.



3. To enter the actual signals selection function, press the **ENTER** key.



4. To select a parameter group, press a fast navigation keys.



5. To select an actual signal, press a slow navigation keys.



6. To confirm the selection and to return to the actual signals display, press the **ENTER** key.



7. To cancel the selection and keep the original selection, press any of the mode selection keys. The selected keypad mode is entered.



9.2.2.6. Displaying a fault and resetting the fault memory

1. To open the actual signals display, press the **ACT** key.



2. To change to the fault memory display, press a fast navigation key.



3. To display a specific fault, press the slow navigation keys. The up key selects the previous, the down key the next fault.



4. To clear the fault memory, press the **RESET** key.

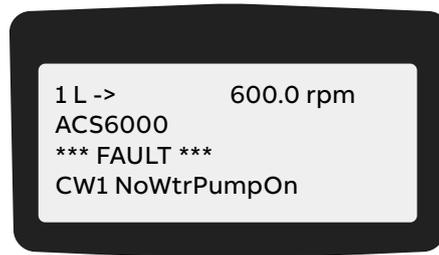


5. To return to the actual signals display, press a fast navigation key.

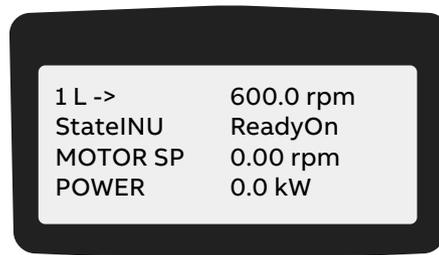


9.2.2.7. Displaying and resetting an active fault

1. To display an active fault, press the **ACT** key.



2. To reset the fault, press the **RESET** key.



9.2.3. Parameters mode

NOTICE Risk of component damage.

Running the drive system with incorrect data can result in improper operation, reduction of control accuracy and damage of equipment.

- Parameters must only be set by qualified personnel.
- DO NOT change any parameter, if the meaning of the parameter and the effects of the change are not fully understood.

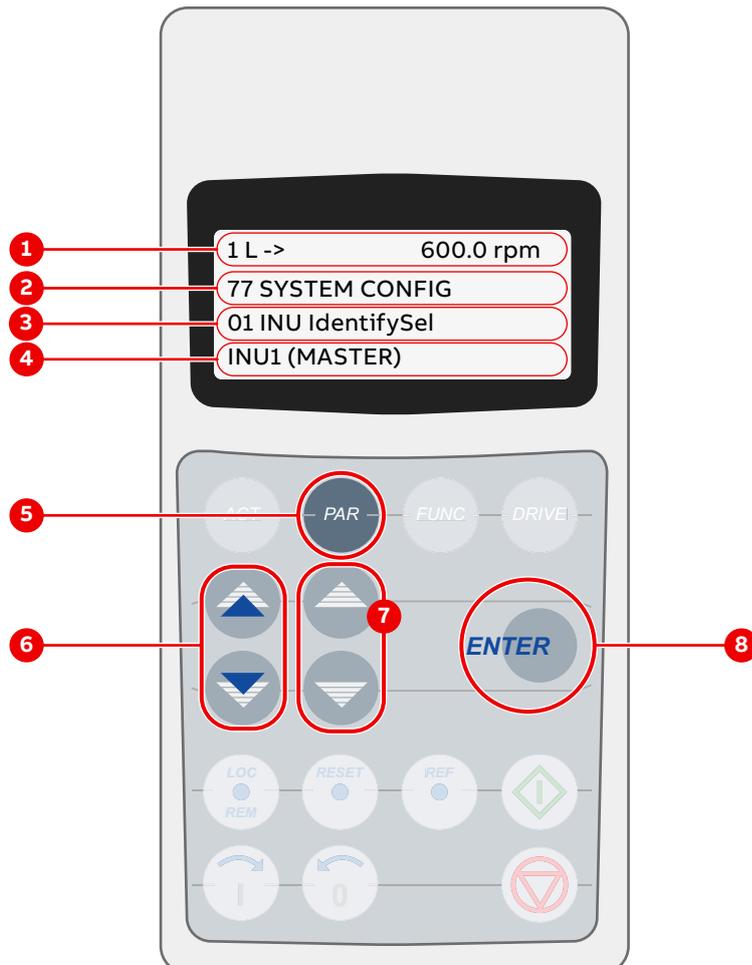


Figure 9–3 Control panel functions for Parameters mode

- | | |
|--------------------------------------|--|
| 1) Status line | 6) Fast navigation key for selecting a parameter group (and a parameter value) |
| 2) Group number and name | 7) Slow navigation key for selecting a parameter (and a parameter value) |
| 3) Parameter number and name | 8) Enter key for confirming the selection |
| 4) Parameter value | |
| 5) Selection key for parameters mode | |

9.2.3.1. Overview

If the parameter lock is disabled or unlocked (see section 9.2.3.3, **Enabling / unlocking a parameter lock**, page 205) the parameters mode allows entering the parameter settings for the required drive configuration depending on the application.

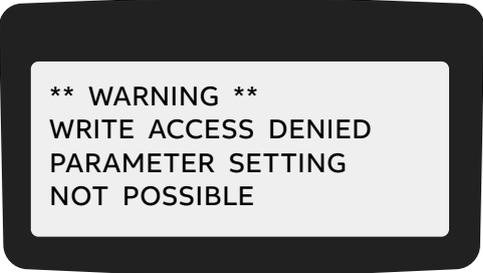
The parameters are organized in functional groups, so called parameter groups.

Group	Description	Parameter	Description
Group 07	Control words	21.01	Start function
Group 08	Status words	21.02	Start function
Group 09	Fault and alarm words	21.03	Off1 stop mode
Group 11	Start, stop, direction or MCB control	21.04	Process stop selection
Group 12	Reference selection	21.05	Process stop signal
Group 16	System control inputs	21.06	Process stop MCB control
Group 17	DC link control	21.07	Process stop mode
Group 18	Utility	.	
Group 19	Data storage	.	
Group 20	Limits	.	
Group 21	Start / stop / process stop	21.17	MCB closing time limit
Group 22	Ramp functions	.	
Group 23	Speed reference	21.19	MCB available signal

NOTE – For details about the parameters, their settings and functions, see “Appendix G - Signal and parameter table”.

When entering the parameters mode for the first time after the auxiliary supply voltage of the drive has been switched on, the CDP control panel displays the first parameter of parameter group 11. The next time the parameters mode is entered, the previously selected parameter displays.

Some parameter settings cannot be changed while the drive is running. If tried, the following warning displays.



**** WARNING ****
WRITE ACCESS DENIED
PARAMETER SETTING
NOT POSSIBLE

9.2.3.2. Changing a parameter setting

1. To enter the parameters mode, press the **PAR** key.



```
1 L ->      600.0 rpm
77 SYSTEM CONFIG
01 INU IdentifySel
INU1 (MASTER)
```

2. To select a different group, press a fast navigation key.



```
1 L ->      600.0 rpm
75 OPTION MODULES
06 C3P1/AI820 Module
DISABLED
```

3. To select a parameter, press a slow navigation key.



```
1 L ->      600.0 rpm
75 OPTION MODULES
06 C3P1/AI820 Module
DISABLED
```

4. To enter the parameter setting function, press the **ENTER** key.



```
1 L ->      600.0 rpm
75 OPTION MODULES
07 C3P1/AI820 Module
[DISABLED]
```

5. To change the parameter value, press:

- Slow navigation keys for numbers and text
- Fast navigation keys for numbers only



```
1 L ->      600.0 rpm
75 OPTION MODULES
07 C3P1/AI820 Module
[DI810 24VDC]
```

6. To confirm the setting and to return to the actual signals display, press the **ENTER** key.



```
1 L ->      600.0 rpm
75 OPTION MODULES
07 C3P1/AI820 Module
DI810 24 VDC
```

7. To cancel the setting and keep the original setting, press any of the mode selection keys. The selected keypad mode is entered.



```
1 L ->      600.0 rpm
75 OPTION MODULES
07 C3P1/AI820 Module
DISABLED
```

9.2.3.3. Enabling / unlocking a parameter lock

Unwanted parameter settings can be prevented by activating the parameter lock function.

The corresponding parameters are *16.02 PARAMETER LOCK* and *16.03 PASSCODE* and belong to parameter group *16 SYSTEM CTRL INPUTS*.

Enabling the parameter lock

1. Select parameter *16.02*.
2. Set parameter *16.02* to **1 (LOCKED)**.
3. Confirm the setting and exit the parameters mode.

Unlocking the parameter lock

1. Select parameter *16.03*.
2. Set the correct pass code.
3. Confirm the setting and exit the parameters mode.

For more information, see “Appendix G - Signal and parameter table”.

9.2.3.4. User lock

NOTICE Risk of component damage.

ABB is not be liable for damages or losses caused by the failure to activate the user lock with a new pass code.

Setting the master pass code

ABB recommends that you set a master pass code to lock the control panel to protect the parameter values.

1. To activate the user lock for the first time, enter the default pass code, ie, **358**, in *16.02 Passcode*.
You can now edit parameters *16.24...16.25*.
2. Enter the old pass code in *16.24 OldUserPasscode*.
3. Enter the new pass code in *16.25 NewUserPasscode*.
4. In *16.02 Parameter Lock*, enable the user lock functionality.

NOTE – To reopen the user lock, ie, to edit parameters *16.24* and *16.25*, enter the new pass code in *16.03 Passcode*.

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9.2.4.1. Adjusting the display contrast

1. To enter the functions mode, press the **FUNC** key.



2. To select the contrast adjustment function, press the slow navigation keys until the **blinking** cursor reaches the **CONTRAST** line.



3. Press the **ENTER** key.



4. To change the contrast, press the slow navigation keys.



5. To confirm the setting and to return to the actual signals display, press the **ENTER** key.



6. To cancel the setting and keep the original setting, press any of the mode selection keys. The selected keypad mode is entered.



9.2.5. Local and remote control mode

The local-remote feature of the CDP control panel allows selecting the control location of the drive. Possible are:

- Local control (L)
- Remote control (R)

NOTE – In this context, remote control is not necessarily equivalent to higher-level control. For more information, see section 9.2.5.4, **Remote control**, page 210.

9.2.5.1. Local control

In local control mode, full operational control of the drive is enabled from the local operator panel. Commands from remote have no effect.

- To enter the local control mode, press the **LOC-REM** key.

Local control is indicated by the letter **L**.



9.2.5.2. Disabling / enabling local lock function

Accidental switching from remote control to local control can be prevented with the local lock function.

The corresponding parameter is *16.04 LOCAL LOCK* and belongs to the parameter group *16 SYSTEM CTRL INPUTS*.

9.2.5.3. Enabling the local lock

- To enable the local lock, set parameter *16.04* to **2 (LOCKED)**.

With this parameter setting, local control (including the **LOC-REM** key) is disabled.

If the CDP control panel or a DriveWindow PC is in local control mode at the time that the local lock is enabled, they remain in local control mode until they are switched to remote control mode. This means that the CDP control panel displays the letter **L** until you press the **LOC-REM** key.

9.2.5.3.1 Disabling the local lock

- To disable the local lock, set parameter *16.04* to **1 (OPEN)**.

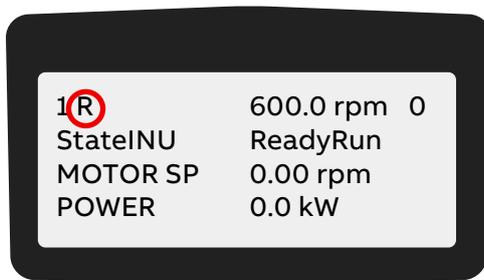
With this parameter setting, switching between remote and local control is enabled.

9.2.5.4. Remote control

In remote control mode, operational commands or reference values usually come from a higher-level control system via fieldbus or remote I/O.

However, with the following parameter settings it is possible to start and stop the drive, to set the direction of rotation, and to enter reference values from the CDP control panel.

- 11.01 EXT1 START/STOP/DIR = 10 (KEYPAD) or
12.03 EXT REF1 SELECT = 1 (KEYPAD) and
12.02 EXT1/EXT2 SELECT = 1 (EXT1)
- 11.02 EXT2 START/STOP/DIR 10 (KEYPAD) or
12.06 EXT REF2 SELECT = 1 (KEYPAD) and
12.02 EXT1/EXT2 SELECT = 2 (EXT2)
- To enter the remote control mode, press the **LOC-REM** key.
 - A blank space indicates full remote control from a higher-level control system.
 - The letter **R** indicates partial remote control (some commands are enabled locally).



NOTE – To prevent accidental switching from remote control to local control, see section 9.2.5.2, **Disabling / enabling local lock function**, page 209.

9.3. Operational commands

For instructions on how to start and stop the drive system from the control panel, see section 8.9, **Starting the drive**, page 183 and section 8.10, **Stopping the drive**, page 187.

9.3.1. Setting the direction of rotation

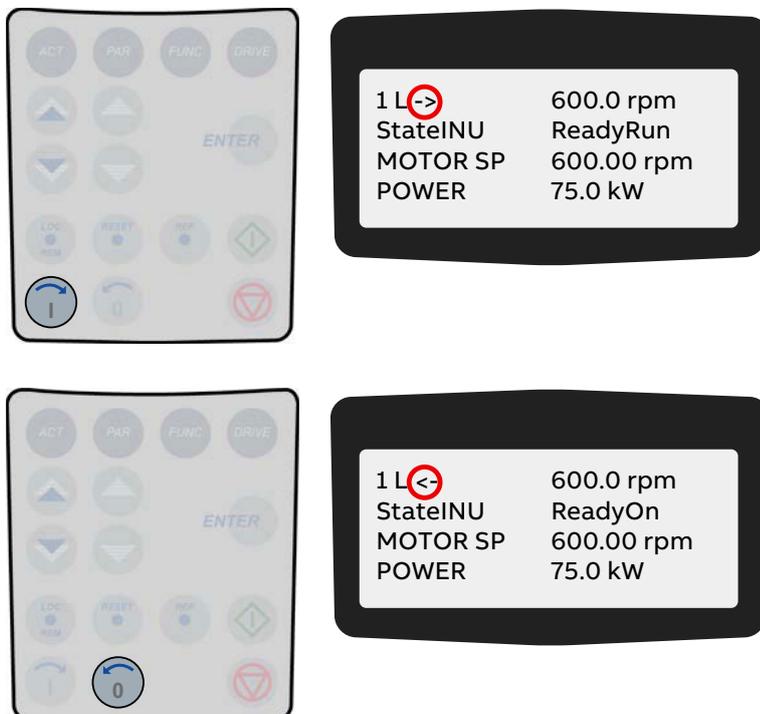
Setting the direction of rotation from the CDP control panel is possible in:

- Local control mode (L)
- Remote control mode (R)

The arrow on the display indicates the direction of rotation:

- When the motor is running, the arrow indicates the actual direction.
- When the motor is not running, the arrow indicates the preselected direction.

To set the direction of rotation, press the forward or backward key.



If you change the direction while the motor is running, the motor automatically ramps down to zero speed and reaccelerates in the opposite direction to the preset speed. The arrow changes at zero speed.

9.3.2. Entering a reference value

Entering a reference value from the CDP control panel is possible in:

- Local control mode (L)
- Remote control mode (R)

Procedure:

1. Press a mode selection key.



```
1 L ->      600.0 rpm  0
StateINU    ReadyRun
MOTOR SP    600.00 rpm
POWER       75.0 kW
```

2. To enter the reference value input mode, press the REF key.



```
1 L ->      [600.0 rpm]  0
StateINU    ReadyRun
MOTOR SP    600.00 rpm
POWER       75.0 kW
```

3. To enter / change the reference value, press the corresponding fast or slow navigation key.



```
1 L ->      [550.0 rpm]  0
StateINU    ReadyRun
MOTOR SP    600.00 rpm
POWER       75.0 kW
```

4. To exit the mode, press a mode selection key.



```
1 L ->      550.0 rpm  0
StateINU    ReadyRun
MOTOR SP    600.00 rpm
POWER       75.0 kW
```

10. Preventive and corrective maintenance

10.1. General information

During the warranty period of the drive, any maintenance must be carried out exclusively by ABB service personnel. After the warranty period, repair work must be carried out by certified personnel.

10.1.1. Required qualification

To maintain safe and reliable operation of the drive, ABB recommends taking out a service contract with the ABB service organization.

10.1.2. Maintenance schedule

Carry out all maintenance tasks according to the maintenance schedule, on time and at the stated intervals in the “ACS6000 preventive maintenance schedule” , 3BHS855273 E01.

10.1.3. Logbook

ABB recommends recording all troubleshooting and maintenance work in a logbook including:

- Date and time
- Detailed description

10.1.4. Spare parts

To ensure safe and reliable operation, use only spare parts recommended and approved by ABB.

- For information on types and identification codes, see “Appendix A - Additional manuals”.
- For information on storing spare parts, see section 4.6.3, **Storing and handling of spare parts**, page 86.

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ACS6000	User manual	3BHS212794 E01	Q	en	213/272

10.2. Identifying electrical equipment

This section describes how to identify electrical devices, cables, and wires.

10.2.1. Device designation

To facilitate the identification in wiring diagrams and parts lists, all devices are labeled in accordance with IEC 81346-1.

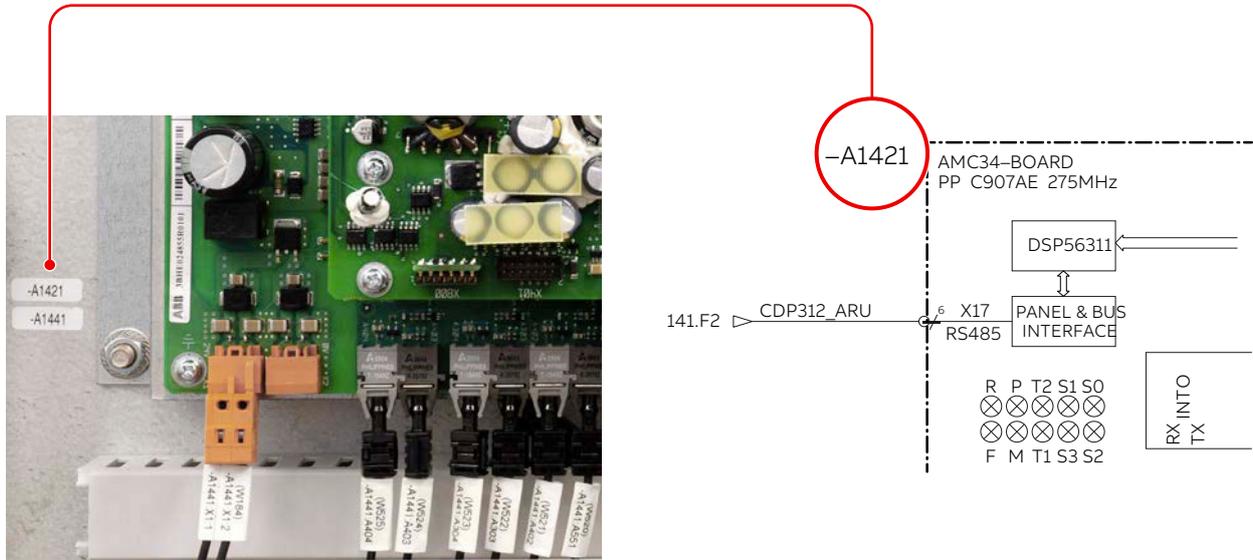


Figure 10-1 Device identification

10.2.2. Cables and wires

Cables and wires in the drive are equipped with marker sleeves that carry the same identifying number as on the wiring diagrams.



Figure 10-2 Cable and wire designation

1) Wire number

2) Terminal number

10.2.2.1. Understanding wiring diagrams

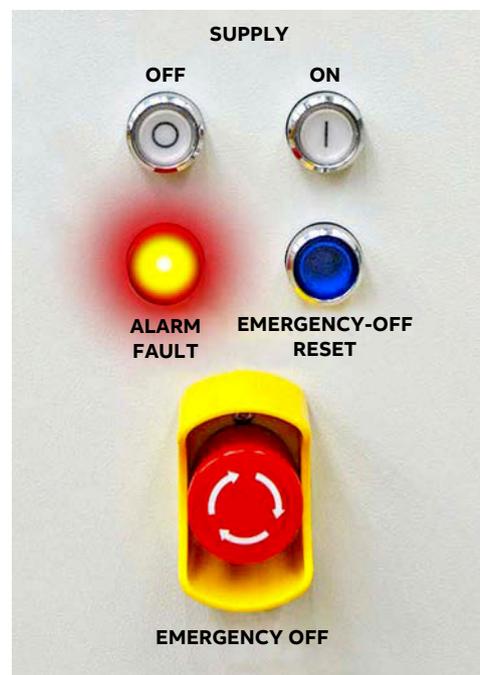
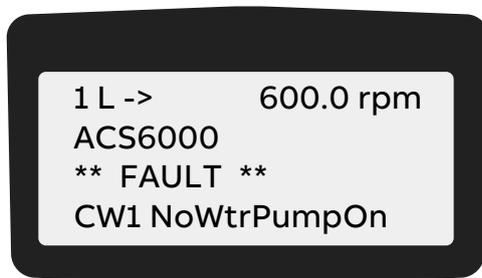
For information on item designation and cross-reference conventions, see “Appendix D - Wiring diagrams”.

10.3. Status indicators

10.3.1. Alarm / fault indications

When a failure occurs in the drive or in the equipment monitored by the drive (eg, main circuit breaker, transformer, cooling system), the control panel displays a corresponding alarm or fault message and the alarm / fault lamp on the control compartment door lights up:

- **Alarm:** flashing light
- **Fault:** permanent light



The message can be saved and viewed in the fault logger of the drive when a PC with Drive Composer is connected to the drive. The fault history can also be called up on the control panel.

10.3.2. Error message levels

Two error message levels are used in the drive:

- **Alarm:** An alarm does not shut down the drive. If the condition causing the alarm is not corrected, a persisting alarm can often lead to a fault. An alarm cannot be reset manually. The alarm message is deleted from the display as soon as the alarm condition has been corrected.
- **Fault:** A fault shuts down the drive. The type of shutdown depends on the origin of the fault.

Depending on the type of fault, the drive opens the main circuit breaker (MCB) or keeps it closed:

- Class 1 faults (FC 1) open the MCB
- Class 2 faults (FC 2) do not open the MCB

Since the MCB is controlled and monitored entirely by the drive, no opening command must be given to the MCB when a fault condition occurs.

A fault condition must be corrected and the fault be manually reset before the drive can be started again.

10.3.2.1. Alarm and fault messages

When an alarm or a fault occurs, a specific message is saved in the fault buffer of the drive. Information on the 64 most recent fault and alarm events are saved.

10.3.2.2. Fault handling

The faults are entered into the fault buffer as they occur and are numbered:

- The last fault entered has number 1.
- The first fault entered has the highest number.

Information of the fault classification (eg, FC 1 or FC 2) is also saved when the first fault of the fault class is active. Date and time stamps facilitate fault tracing, especially when a fault leads to several subsequent faults.

Example:

1) +Fault AMC: Fault Class 2	2008-01-08 16:58:24.3770
2) +Fault PPCS Communication	2008-01-08 16:58:24.3760
3) +Fault AMC: Fault Class 1	2008-01-08 16:56:02.1170
4) +Fault DC Undervoltage	2008-01-08 16:56:02.1170

In the above example:

1) +Fault AMC: Fault Class 2	Classifies the fault.
2) +Fault PPCS Communication	rRepresents a subsequent fault that occurred 2 min. 22 s than the first fault
3) +Fault AMC: Fault Class 1	Classifies the fault.
4) +Fault DC Undervoltage	Is the reason for the failure of the drive system as it occurred first

For more information on alarms and faults, see “Appendix G - Signal and parameter table”.

10.3.2.3. Standard troubleshooting procedure

If a fault shuts down the drive, proceed as follows:



- 1) **DO NOT switch off the auxiliary supply voltage or try to reset a fault message before all information at the time of the occurrence of the fault condition has been saved.**



- 2) **Select the fault history display on the control panel, but do not clear the buffer now!**

See chapter 8, **Operation**, page 169.



- 3) **Identify the fault and make a logbook entry.**



- 4) **Save the content of the data logger when a PC is available which has the Drive Composer/Startup tool installed.**

The data logger provides information (eg, waveforms of voltage, current, torque) for efficient troubleshooting.



- 5) **Contact ABB service if a fault cannot be rectified.**

When calling ABB service, it is recommended to have the following data available at the time when the fault occurred:

- Operating, ambient and load conditions
- Unusual events



- 6) **After the fault has been rectified, start the drive as described in section 8.9, Starting the drive, page 183.**

10.3.3. LEDs and switches on circuit boards and I/O devices

The following section provides an overview of the meaning of LEDs and switches of the main circuit boards and I/O modules. The LEDs presented in the following section can be checked easily while the auxiliary voltage is switched on without having to remove covers first. The LEDs provide information on the status of the devices and can be used for diagnostic purposes.

10.3.3.1. AMC circuit board

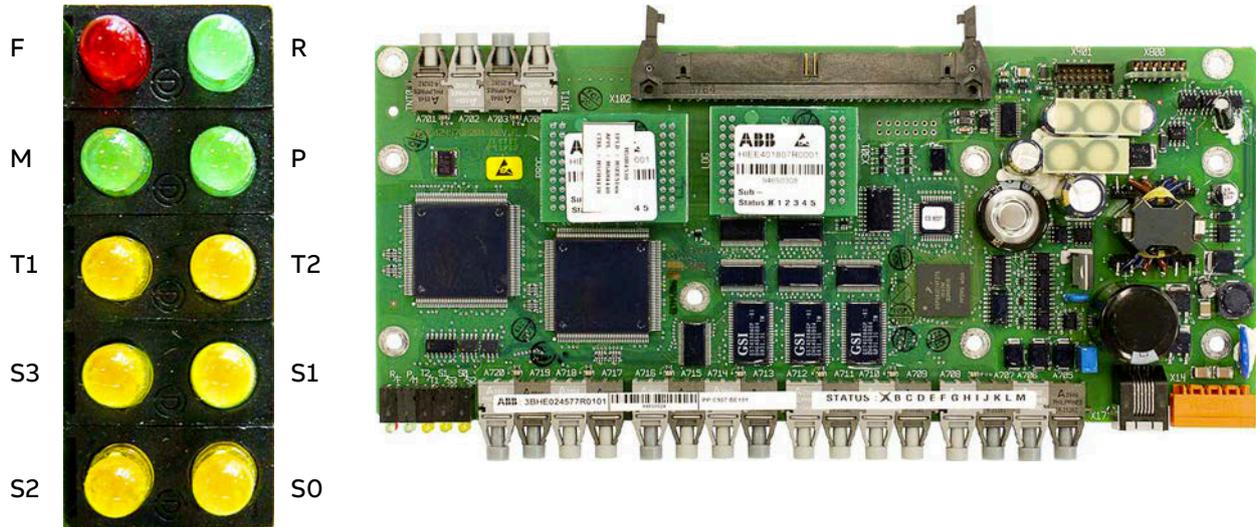


Figure 10–3 LEDs of AMC circuit board

LED	Color	Description	Status when software has loaded		Status when software has not loaded	
			Booting	ON	Booting	ON
F	Red	Fault	ON	OFF	ON	ON
R	Green	Run	OFF	OFF	OFF	OFF
M	Green		ON	OFF	ON	ON
P	Green	Supply OK	ON	ON	ON	ON
T1	Yellow	Receiving data on DDCS channel 0	Flashing	ON / OFF	Flashing	ON / OFF
T2	Yellow	Receiving data on DDCS channel 3	Flashing	ON / OFF	Flashing	ON / OFF
S3	Yellow		OFF	OFF	OFF	OFF
S1	Yellow		Flashing	OFF	Flashing	OFF
S2	Yellow		Flashing	OFF	Flashing	OFF
S0	Yellow		Flashing	OFF	Flashing	OFF

10.3.3.2. S800 I/O bus modem TB820

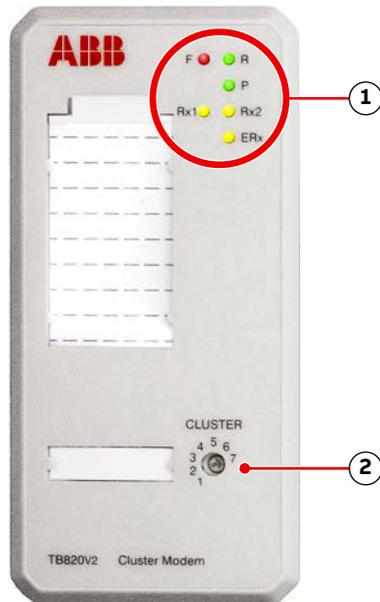


Figure 10–4 TB820 bus modem

LED	Color	Indication
F	Red	Fault in module
R	Green	Device in operation
P	Green	Power supply is healthy
Rx1	Yellow	Traffic on optical module bus
Rx2	Yellow	Traffic on optical module bus
ERx	Yellow	Traffic on electrical module bus

Bus modem address

The TB820 bus modem has a unique cluster address that identifies the module in the software and links it to a parameter.

The address is set with the rotary switch on the module (Fig. 10–4: 1). The factory-set value must not be changed.

10.3.3.3. S800 I/O modules

LEDs on I/O modules having the same meaning on all types of I/O modules are always at the same position. The LEDs are always at the topmost position on each module (Fig. 10–5: 1) and are identified as follows:

- F: fault
- R: run
- W: warning
- O or OSP (only output modules)

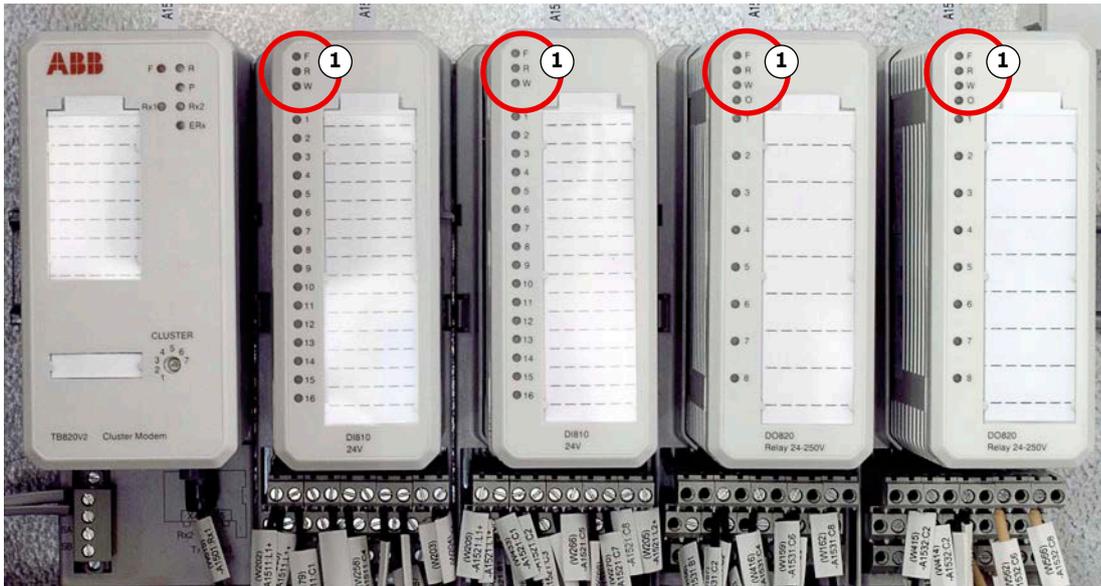


Figure 10–5 Example of S800 I/O station

LED	Color	Indication
F	Red	Indicates failure
R	Green	Device is operating normally
W	Yellow	External fault or minor fault in the module
O	Yellow	Indicates an active signal
OSP	Yellow	Indicates an active signal (Output Set as Predetermined)

For more information, see the following manuals:

- “S800 I/O Getting started” , 3BSE020923
- “S800 I/O Modules and termination units” , 3BSE020924

10.3.3.4. Serial communication interfaces

To identify the serial communication interface in the drive, see “Appendix D - Wiring diagrams”. For more information on the device, select the appropriate manual:

- “AF 100 fieldbus - NAFA-01 installation and start-up guide” , 3BFE58919837
- “Modbus TCP - NETA-21 remote monitoring tool user manual” , 3AUA0000096939
- “Modbus RTU - NMBA-01 installation and startup guide” , 3AFY58919772
- “Profibus - NPBA-12 installation and startup guide” , 3BFE64341588

10.3.3.5. LEDs on optional heat exchangers

Two LEDs on the front of the heat exchanger indicate the status of the unit.

Alarm signals are also shown on the CDP control panel.

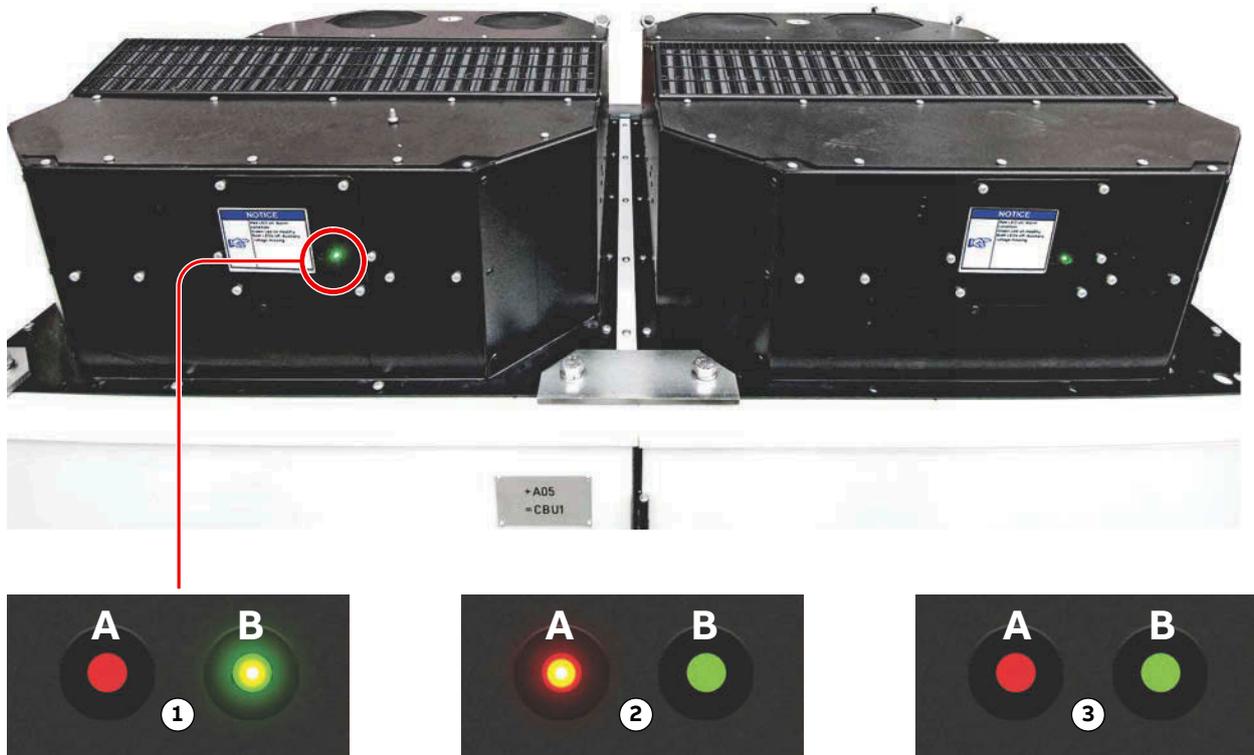


Figure 10–6 Status LEDs on optional air-to-air heat exchangers

- | | |
|--|---|
| <p>1) Red LED off (A) and Green LED on (B): Heat exchanger is healthy</p> <p>2) Red LED on (A) and Green LED off (B): Alarm conditions</p> | <p>3) Red LED off (A) and Green LED off (B): Auxiliary voltage is missing</p> |
|--|---|

10.4. Maintenance tasks

The following sections describe the maintenance tasks and associated actions that you can perform on the drive.

10.4.1. Safety



! DANGER Hazardous voltages!

To avoid serious injury or death, read all instructions before performing the maintenance tasks.

- ▶ Before you work on the drive, verify that:
 - Main and auxiliary power supply to the drive are switched off, locked out, and tagged out
 - Drive is de-energized
 - Grounding connections are in place
 - Personal protective equipment is provided and used when required
 - Everyone involved is informed
- ▶ Before energizing the drive, verify that:
 - All foreign objects are removed from the drive
 - All internal and external covers are securely fastened and all doors are closed, locked and / or secured (locking bar in locked position)
 - Release dials of safety switches are in locked position
- ▶ Before you remove a phase module from a cabinet:
 - Connect the grounding equipment at the appropriate locations.
- ▶ When the motor is spinning, a HAZARDOUS VOLTAGE appears at the output of the IOI switch in the RDC unit, even if the switch is open and the drive is grounded.
 - See the local safety procedures on how to isolate and ground the equipment.



! WARNING Hazardous DC voltage!

Depending on the type of auxiliary supply, the drive can be equipped with buffer capacitors inside the control unit. During operation, the capacitor voltage is 300 V (DC) over ground.

- ▶ Wait 5 minutes for the capacitors to discharge.
- ▶ Before touching a capacitor, verify that the capacitors are discharged.



NOTICE Risk of component damage!

Foreign matter and particularly metallic dust can cause failure and damage when the drive is energized! Ensure that foreign matter cannot enter the cabinet.

- ▶ Close the doors and cover openings completely when work is discontinued.
- ▶ Retrieve any foreign matter which accidentally dropped into the cabinet.

10.4.2. De-energizing and grounding the drive

The following section describes how to de-energize the drive using the local operator panel of the drive. If the drive is controlled from remote, follow the established shutdown procedures.

Procedure

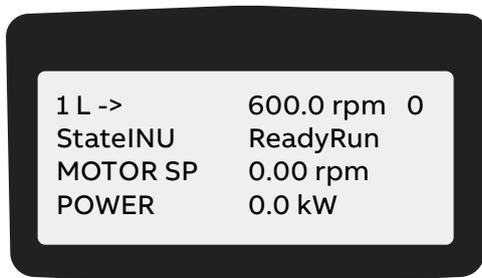
1. Enable the local control mode of the CDP control panel.



2. To stop the motor, press the **STOP** key.



The motor stops according to the preset stop function. When the motor has reached zero speed, the drive is in **ReadyRun**.



3. Press the **SUPPLY OFF** push button to disconnect the drive from the main power supply.



The following takes place:

- MCB opens.
- DC link discharges.
- While the DC link discharges, the CDP control panel shows the following: **SUPPLY OFF** push button flashes and changes to a permanent light when the DC link is discharged.

When the DC link is discharged, the drive is **ReadyOn**.



4. Rack-out, lock-out, ground and tag-out the main power feeder.

5. Wait for the yellow lamp **GROUNDING SWITCH UNLOCKED** on the CBU to light up (see Fig. 10–7).

CAUTION! If the lamp does not light up, **DO NOT** force the grounding switch in any direction before you know the reason why the lamp has not lit up. If you try, the following can happen:

- The switch closes when the DC link is still energized and short-circuits the DC-link capacitors. The short-circuit manifests itself in a loud bang.
- The switch is damaged because it was not released for closing.
- Components inside the drive are damaged.

IMPORTANT! If the yellow lamp does not turn on, continue with section 10.4.3, **Grounding the drive when the grounding switch is not released**, page 227, otherwise continue with step 6.

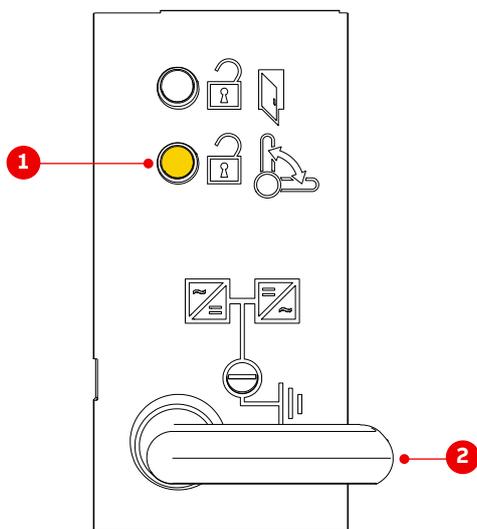


Figure 10–7 Grounding switch ungrounded

1) Yellow light on: Grounding switch is unlocked and can be operated

2) Grounding switch: Ungrounded position

6. If the yellow lamp **GROUNDING SWITCH UNLOCKED** is on, keep the yellow lamp cap pressed while you turn the grounding switch to the grounded position.

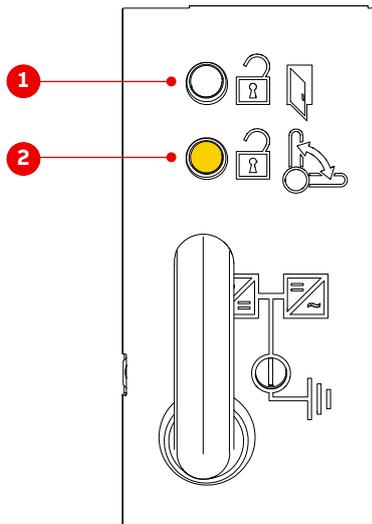
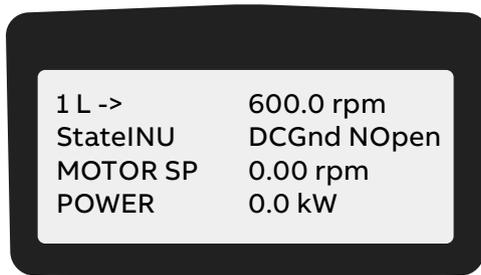


Figure 10–8 Grounding switch grounded

1) White lamp

2) Yellow lamp

When the grounding switch is in the grounded position, the control panel shows the following information:



7. To open the doors of medium voltage units, continue with section 10.4.4, **Unlocking and opening the doors**, page 228.

NOTE – To open the doors of medium voltage units, auxiliary voltage is required.

8. Switch off and lock out all auxiliary voltages from external sources.

9. To connect a grounding set, continue with section 10.4.8, **Connecting a grounding set**, page 234.

10.4.3. Grounding the drive when the grounding switch is not released

When the DC link of the drive has been discharged, the lamp **GROUNDING SWITCH UNLOCKED** lights up to indicate that the grounding switch is released and can be turned to the grounded position. If the lamp does not light up, take the following steps.

1. Check that the auxiliary voltage is switched on.

NOTICE DO NOT use force for turning the grounding switch in any direction

2. Press the lamp cap to test the lamp.

- Lamp does not light up:
 - Lamp is burnt out
 - Lamp-test circuit is faulty.

The lamp-test circuit and the grounding circuit are independent of each other. From the lamp not lighting up, it cannot be concluded that the discharging circuit and / or the grounding circuit are not working.

- Lamp lights up:
 - Discharging circuit and / or the grounding circuit are malfunctioning.

3. Verify that the MCB (main circuit breaker) is open.

- If the MCB is open, secure it against closing.
- Check if the LED of digital input DI14 (input module A2531 in COU1) is lit.
- If the LED is lit, the feedback signal **MCB is open** is present.

4. Verify that hazardous voltages from the motor cannot be fed into the drive.

5. Check if the LED of digital output DO07 (output module A2541 in COU1) is lit.

- If the LED is lit, the grounding switch is released.

6. Check the discharging level of the DC link.

- If the value of the parameter *2.01 DC VOLTAGE* is below 50 V, the DC link is discharged.
- If the DC link is discharged, the drive is in **ReadyOn** status.
- Check that the message **ReadyOn** is displayed on all control panels of the drive.



7. Carefully turn the grounding switch to the grounded position on the following conditions:

- Hazardous voltages cannot be fed into the drive from the main power supply or the motor
- DC link is discharged
- Grounding switch is released (DO07 is energized)
- Drive status is **ReadyOn**

IMPORTANT! If you cannot turn the grounding switch, continue with section 10.4.7, **Emergency release of a door safety switch**, page 232.

For information on the wiring of the control circuit, see:

- Converter hardware diagram
- Wiring diagram of COU1

For information on the wiring of the discharging circuit and/or the grounding circuit, see:

- Wiring diagram of COU1
- Wiring diagram of CBU.

10.4.4. Unlocking and opening the doors

1. Check that the auxiliary voltage is on and wait for the white lamp on the CBU to turn on.

The white lamp indicates that the drive is grounded and that the locking bars are released.

NOTE – If the white lamp does not turn on, continue with section 10.4.6, **Testing the white lamp**, page 231.

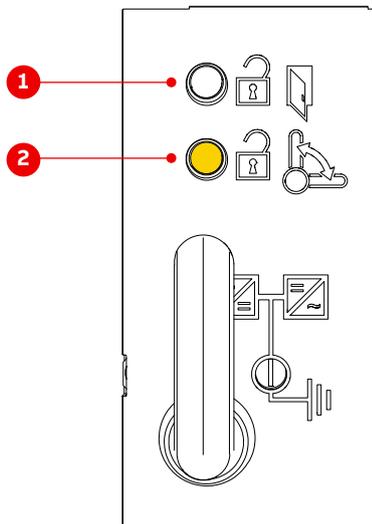


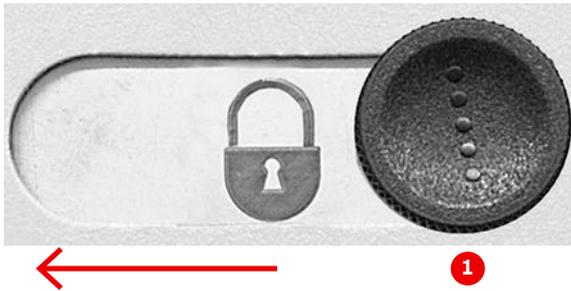
Figure 10–9 Grounding switch grounded

1) White lamp

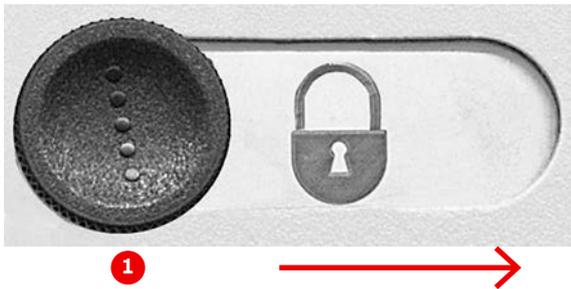
2) Yellow lamp

2. Slide the locking bar from the locked (1) to the unlocked (2) position.

- Door hinged on the left:



- Door hinged on the right:



3. To release the door handle, insert and turn the key to the right.
The door handle pops out.



4. To open the door, turn the door handle to the right if the door is hinged on the right or to the left if the door is hinged on the left.

5. If you cannot open the door, continue with section 10.4.7, **Emergency release of a door safety switch**, page 232.

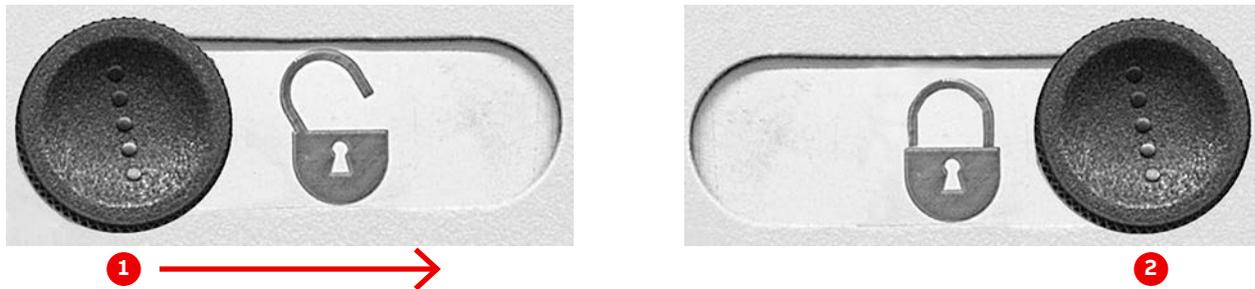
10.4.5. Closing and locking the doors

1. Close the doors.
2. To lock the door, bring the door handle in line with the door plate (1) and press the handle down (2) until it clicks in.

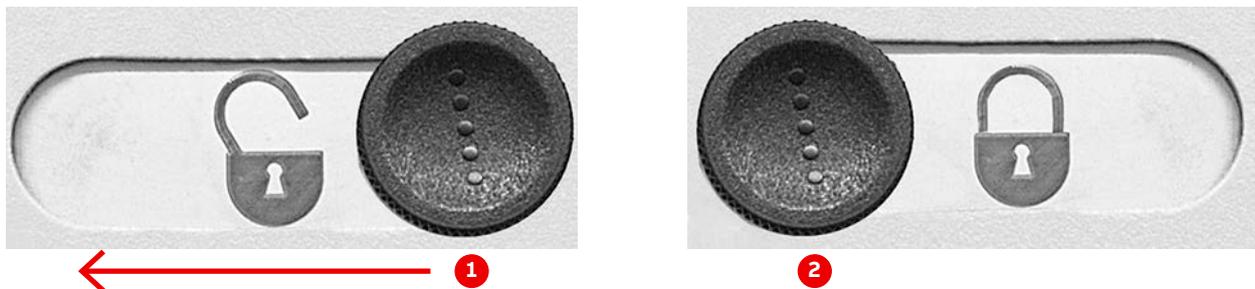


3. Slide the locking bar from the unlocked (1) to the locked (2) position.

- Door hinged on the left:



- Door hinged on the right:



IMPORTANT! A limit switch monitors the locked position. If a door is not locked properly, you cannot start the drive.

10.4.6. Testing the white lamp

If the lamp does not turn on, proceed as follows:

1. To test the lamp, press its lamp cap (1 in Fig. 10–10).

- Lamp does not turn on:
 - Lamp is burnt out
 - Lamp-test circuit is faulty

The lamp-test circuit and the door releasing circuit are independent of each other. From the lamp not lighting up, it cannot be concluded that the door releasing circuit is not working.

- Lamp turns on:
 - Door releasing circuit is malfunctioning.

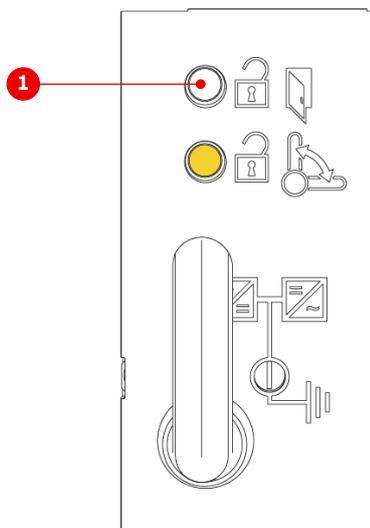


Figure 10–10 Testing the white lamp

1) Press cap to test the white lamp

2. Check if the LED of digital input DI07 (input module A2531 in COU1) is lit.

- If the LED is lit, the drive control system receives the feedback signal “grounding switch is closed”, but the control system has not released the doors.
- If the LED is not lit, the feedback signal is missing.

3. To open the door, continue with section 10.4.7, **Emergency release of a door safety switch**, page 232.

For information on the wiring of the control circuit, see:

- Converter hardware diagram
- Wiring diagram of COU1

For information on the wiring of the discharging circuit and / or the grounding circuit, see:

- Wiring diagram of COU1
- Wiring diagram of CBU

10.4.7. Emergency release of a door safety switch



! DANGER Hazardous voltages!

Touching energized components can be FATAL.

- ▶ Before you unlock a safety switch, verify that the drive is de-energized.
- ▶ DO NOT unlock the safety switches permanently.

10.4.7.1. Location of safety switches

The doors of medium voltage units (LSU, ARU, IFU, IRU, CBU, INU, BCU, RBU, VLU, TEU and ISU) are equipped with safety switches.

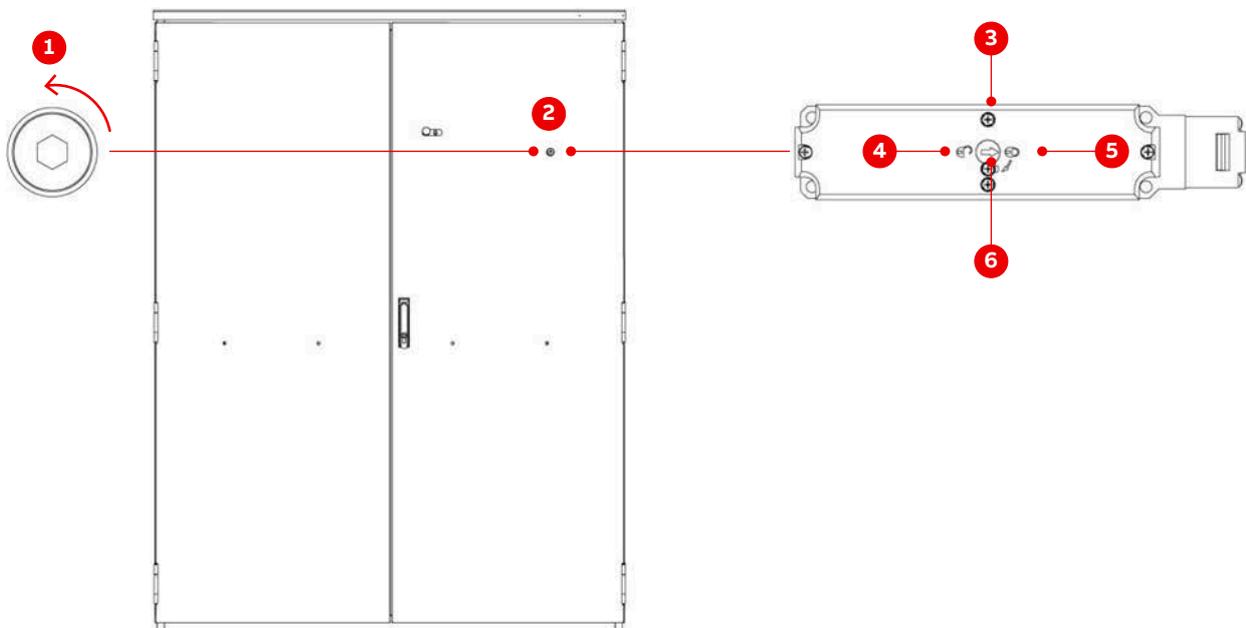


Figure 10–11 Safety switch on an ARU/INU cabinet door

- | | |
|---|----------------------|
| 1) Screw cap on door | 4) Unlocked position |
| 2) Safety switch location (behind door) | 5) Locked position |
| 3) Safety switch | 6) Release dial |

10.4.7.2. Safety-switch settings

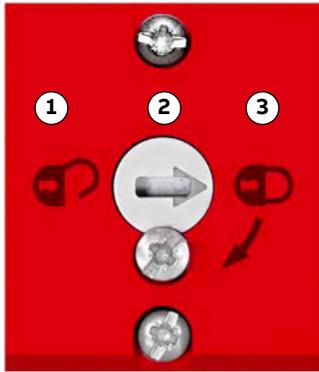
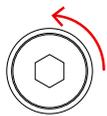


Figure 10–12 Safety switch settings

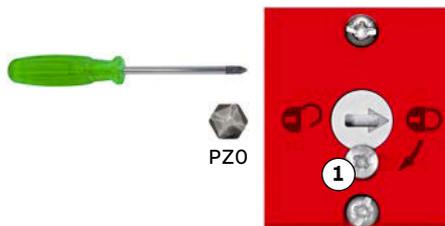
Location	Setting	Description
1)	Unlocked	Enables opening the door of a medium voltage unit whether the auxiliary voltage is switched on or off.
2)	Release dial	Direction of arrow indicates safety switch status, ie, locked or unlocked
3)	Locked	Normal operating setting. To open the door of a medium voltage unit, the DC link must be discharged and the auxiliary voltage must be switched on.

10.4.7.3. Unlocking a safety switch

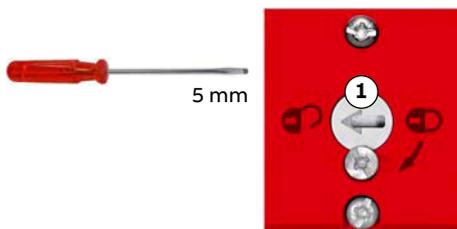
1. To access the release dial, remove the screw cap.



2. Loosen the locking screw (1) until the release dial can be turned.



3. Turn the release dial from the locked to the unlocked position.



You can now actuate the locking bar and open the doors.

4. When the door is open, turn the release dial to the locked position.
5. Tighten the locking screw.
6. Seal the locking screw.
7. Refit the screw cap.
8. To ground the drive, continue with section 10.4.8, **Connecting a grounding set**, page 234.

10.4.8. Connecting a grounding set



DANGER Hazardous voltages!

FATAL voltages can still be fed into an ungrounded drive from the main power supply or motor during maintenance work.

- ▶ Connect grounding equipment at the designated locations before you work on the drive.

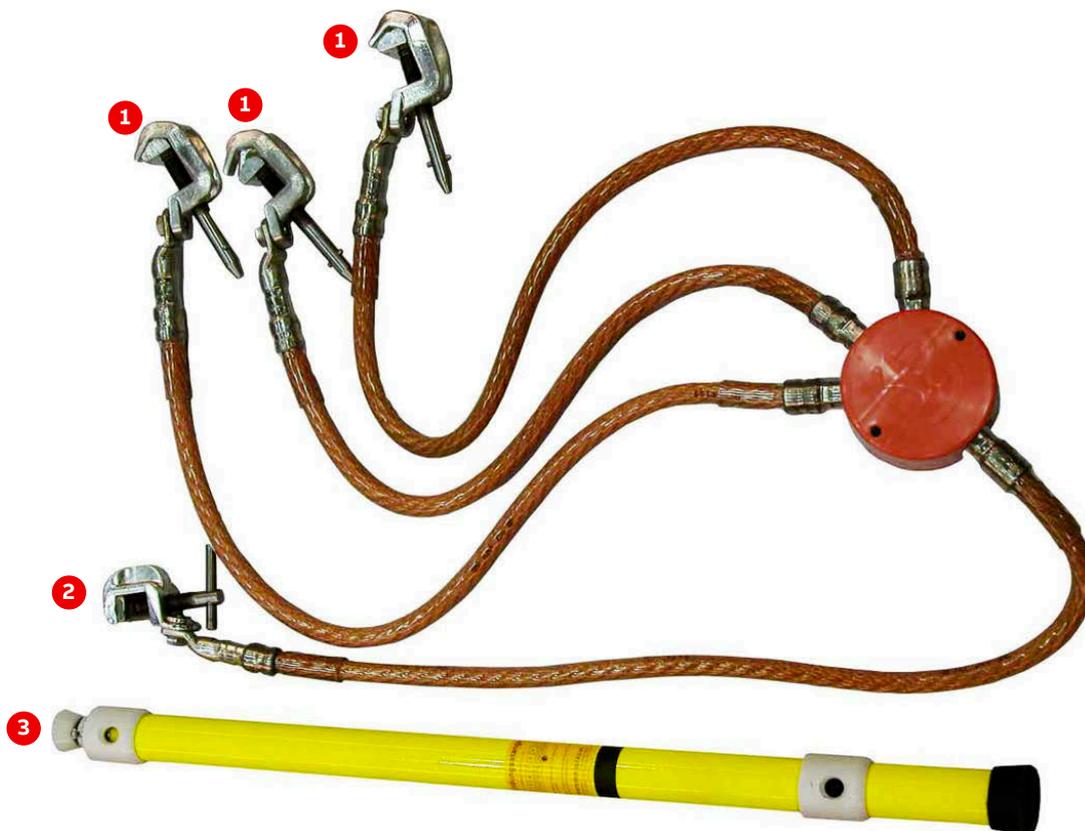


Figure 10–13 Four-way grounding set

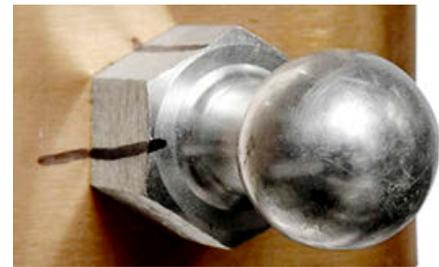
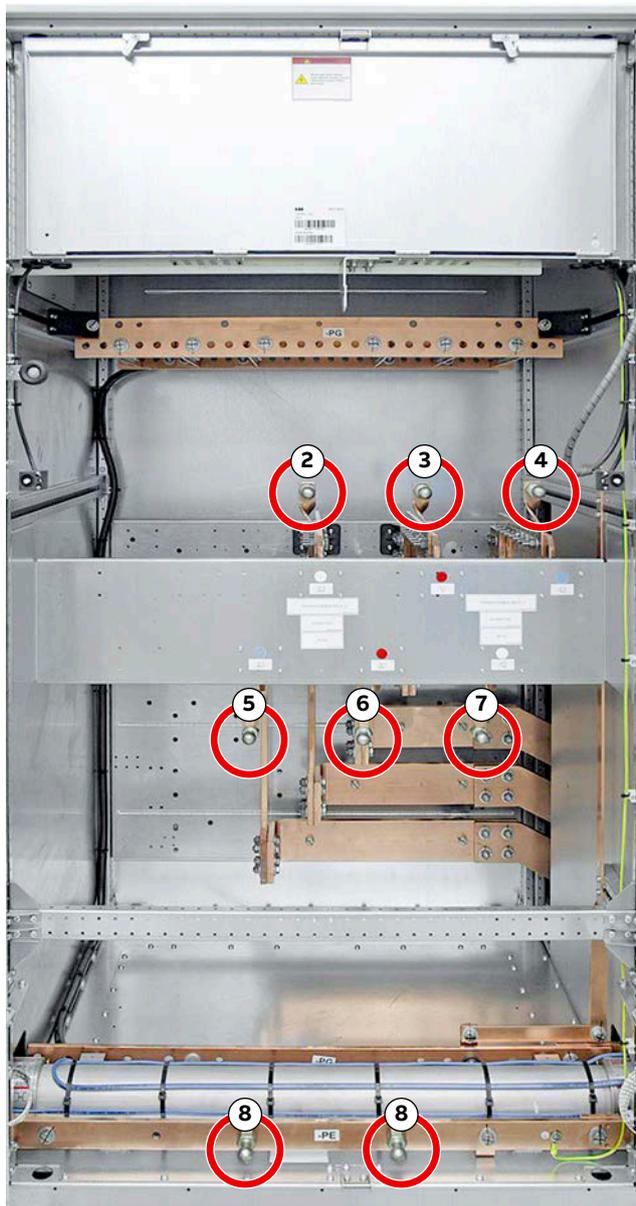
- | | |
|---------------------------|-------------------------------|
| 1) Busbar ground clamps | 3) Telescopic insulating pole |
| 2) Enclosure ground clamp | |

Depending on the type of line-side rectifier, continue with:

- **Drives with LSU**, page 235
- **Drives with ARU**, page 236

10.4.8.1. Drives with LSU

1. Connect the enclosure ground clamp to the ground ball stud of the PE ground busbar inside TEU (Fig. 10–14).
2. Use the telescopic insulating pole to connect and tighten the busbar ground clamps to the ground ball studs (1) of the following busbars:
 - Inside TEU: 1L1, 1L2, 1L3, 2L1, 2L2 and 2L3 in Fig. 10–14
 - Inside INU: L1, L2 and L3 in Fig. 10–15



1

Figure 10–14 TEU ground ball stud locations

- | | |
|-----------------------------|--------|
| 1) Ground ball stud example | 5) 2L3 |
| 2) 2L2 | 6) 2L1 |
| 3) 1L1 | 7) 1L2 |
| 4) 1L3 | 8) PE |

10.4.8.2. Drives with ARU

1. Connect the enclosure ground clamp to the ground ball stud of the PE ground busbar inside ARU and INU (Fig. 10–15).
2. Use the telescopic insulating pole to connect and tighten busbar ground clamps to the ground ball studs of the following busbars inside an ARU and INU:
 - L1, L2 and L3 in Fig. 10–15

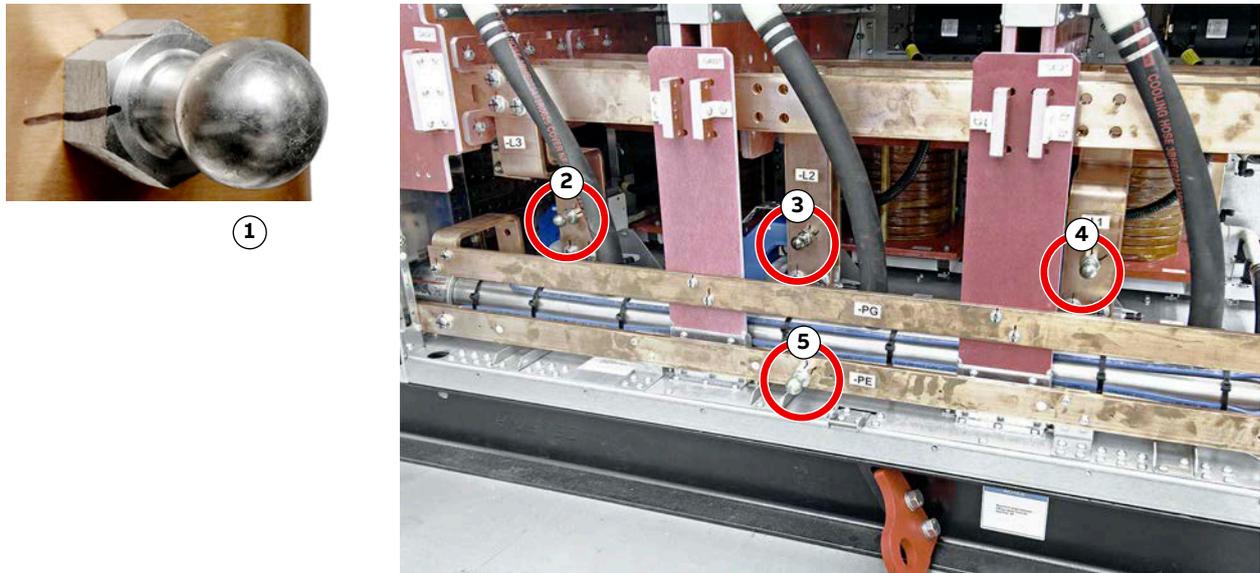


Figure 10–15 ARU/INU ground ball stud locations

- | | |
|---------------------|-------|
| 1) Ground ball stud | 4) L1 |
| 2) L3 | 5) PE |
| 3) L2 | |

10.4.9. Drives with the manual output isolation (optional)

The manual output isolation disconnects the output of the drive (INU1 or INU2) from the motor and creates a visible isolating distance in the supply line to the motor.

The option includes the following items:

- Busbar connectors in TEU1 and COU1
 - Busbar connectors for INU1 are located in TEU1.
 - Busbar connectors for INU2 are located in the terminal compartment inside COU1.
- Lever for removing and fitting the busbar connectors

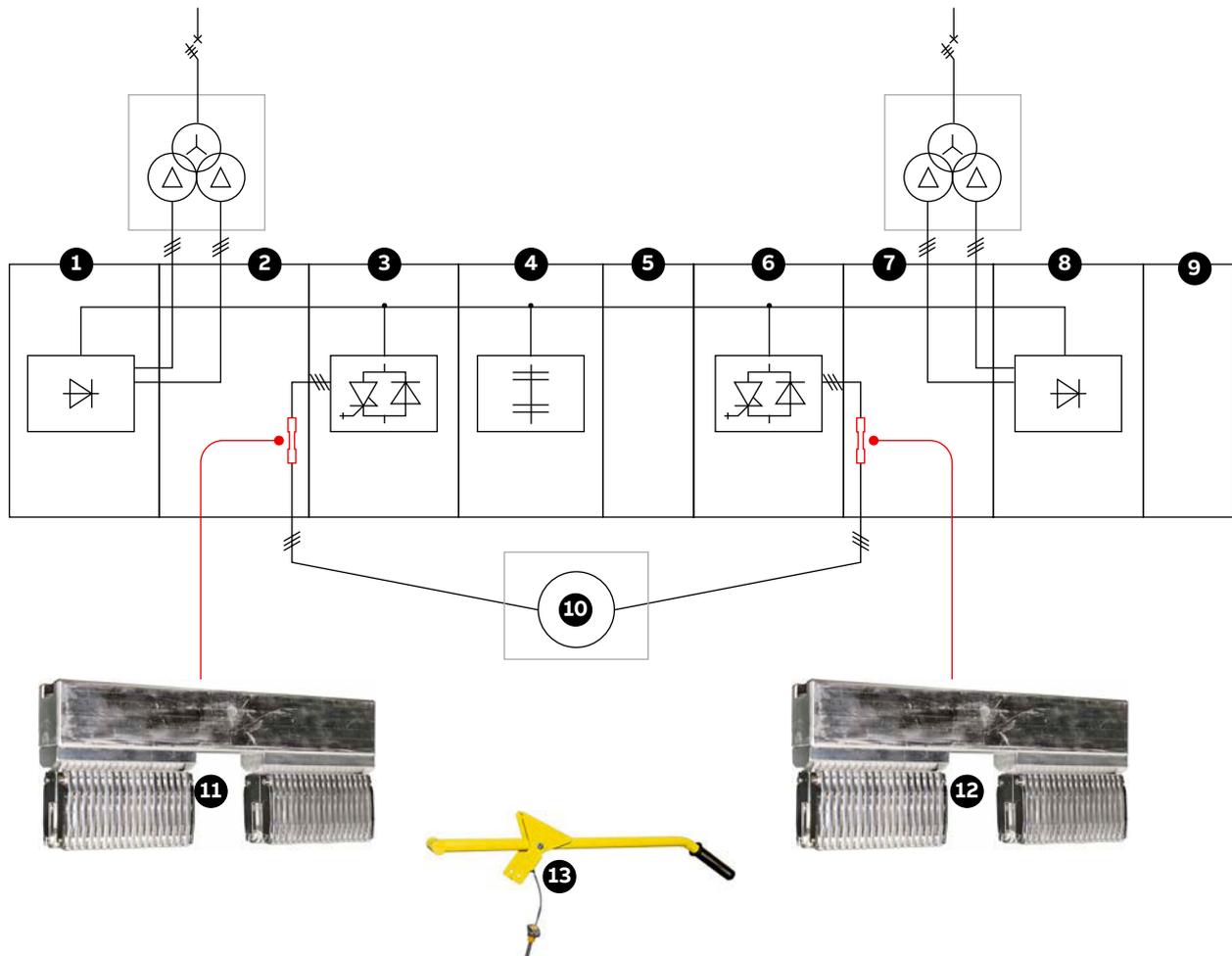


Figure 10-16 Manual output isolation overview

- | | |
|---------|---|
| 1) LSU1 | 8) LSU2 |
| 2) TEU1 | 9) WCU1 |
| 3) INU1 | 10) Motor |
| 4) CBU1 | 11) Busbar connectors (3 x) in TEU |
| 5) BCU1 | 12) Busbar connectors (3 x) in COU1 |
| 6) INU2 | 13) Lever for removing and fitting the busbar connections |
| 7) COU1 | |

The LEDs of input module A2511 inside COU1 indicate whether the busbar connectors are fitted or not.

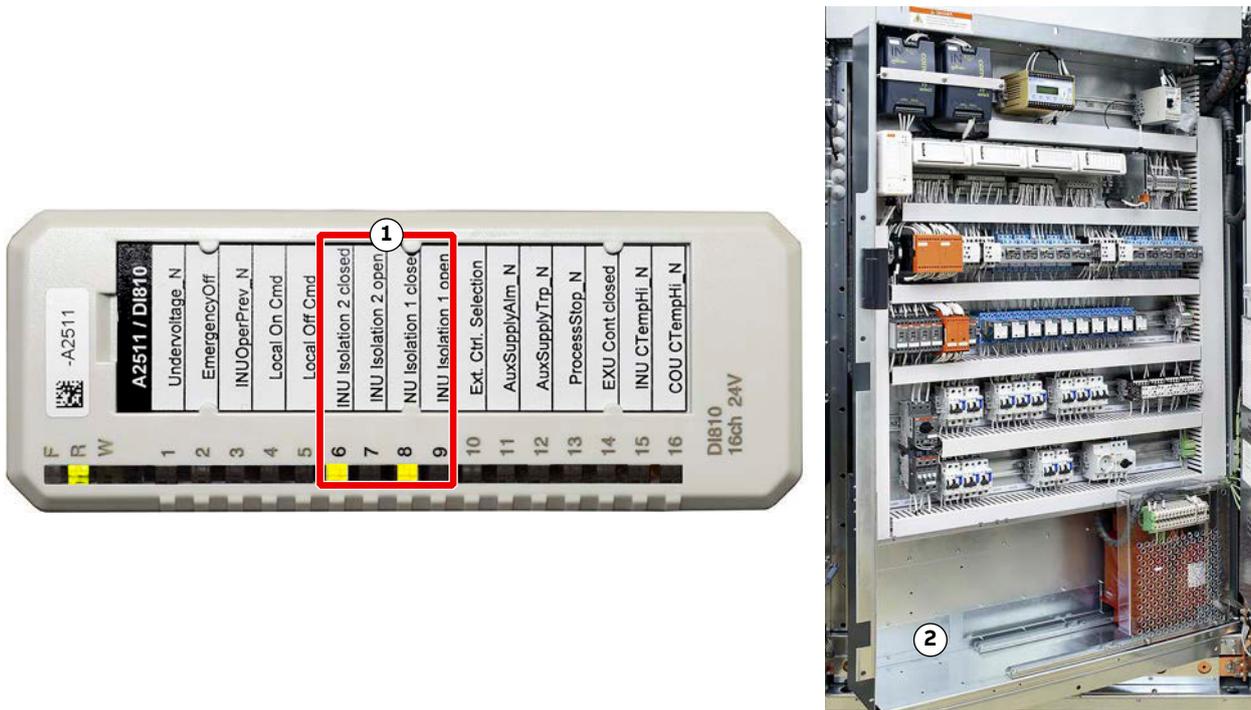


Figure 10–17 Input module A2511

- 1) Location of LEDs 6 - 9
- 2) COU1

Table 10–1 Description of LEDs on input module A2511

LED	LED	Description
6	7	
ON	OFF	The three busbar connectors are fitted in COU1. The motor is connected to INU2.
OFF	ON	The three busbar connectors are not fitted in COU1. The motor is disconnected from INU2.
OFF	OFF	Invalid configuration. Drive will not start.
8	9	
ON	OFF	The three busbar connectors are fitted in TEU1. The motor is connected to INU1.
OFF	ON	The three busbar connectors are not fitted in TEU1. The motor is disconnected from INU1.
OFF	OFF	Invalid configuration. Drive will not start.

10.4.9.1. Removing the busbar connectors



⚠ WARNING Hazardous voltages!

- ▶ Verify that the drive system is de-energized
- ▶ Connect grounding sets at the locations indicated in Fig. 10–20.
- ▶ Be aware of arcing between ground clamp and busbar ground studs when connecting a grounding set to the busbars for the motor cables. Arcing can be caused by voltages being fed into the drive when the motor is driven by the propeller of the ship.
- ▶ Follow local safety procedures

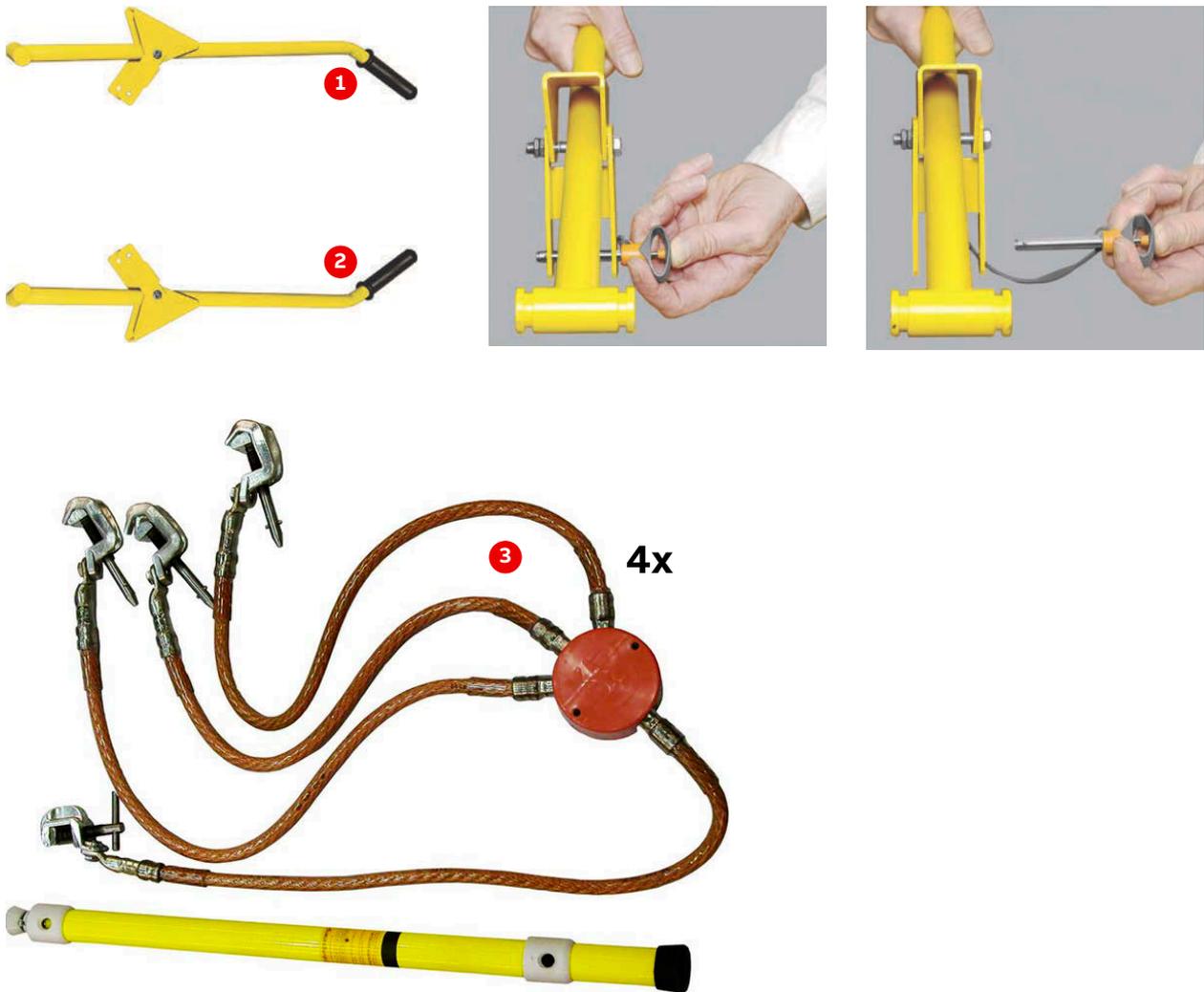


Figure 10–18 Tools for removing the busbar connectors

- | | |
|--|----------------------------------|
| <p>1) Orientation of lever for removing busbar connectors</p> <p>2) Orientation of lever for fitting the busbar connectors</p> | <p>3) Four-way grounding set</p> |
|--|----------------------------------|

Procedure

1. Shut down the drive according to the established procedures.

IMPORTANT! DO NOT switch off the auxiliary voltage.

For general information on de-energizing the drive, see “De-energizing the drive locally” on page 143.

2. Use the telescopic insulating pole (Fig. 10–18) to connect and tighten the enclosure ground clamp to the ground ball stud of the PE ground busbar.
3. Connect the busbar ground clamps to the ground ball studs of the phase busbars in the following sequence:
 - Busbars for the cables to the secondary transformer windings (1 in Fig. 10–20)
 - Busbars for the motor cables (2 in Fig. 10–20)
 - Busbars in the INU (3 in Fig. 10–20)

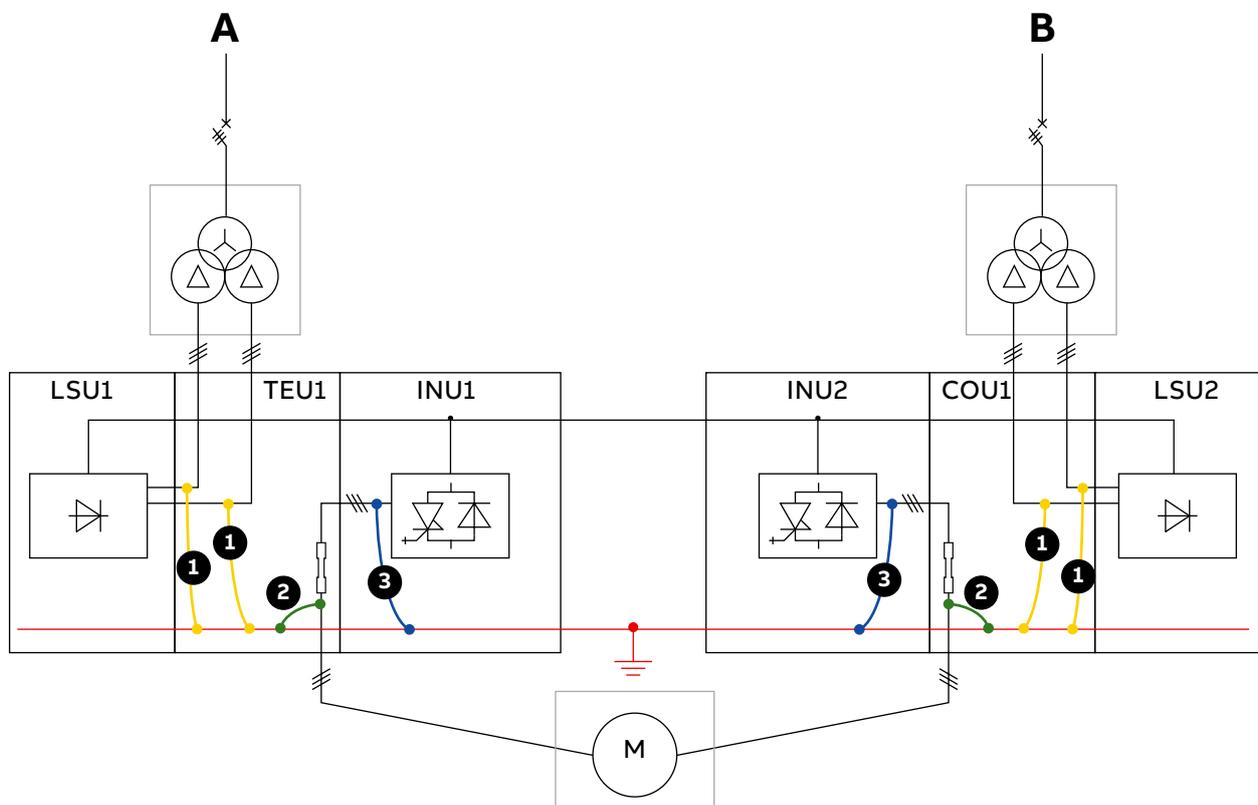


Figure 10–19 Overview of grounding the drive - INU1 is shut down (A) and INU2 is shut down (B). Numbers indicate the connection sequence.

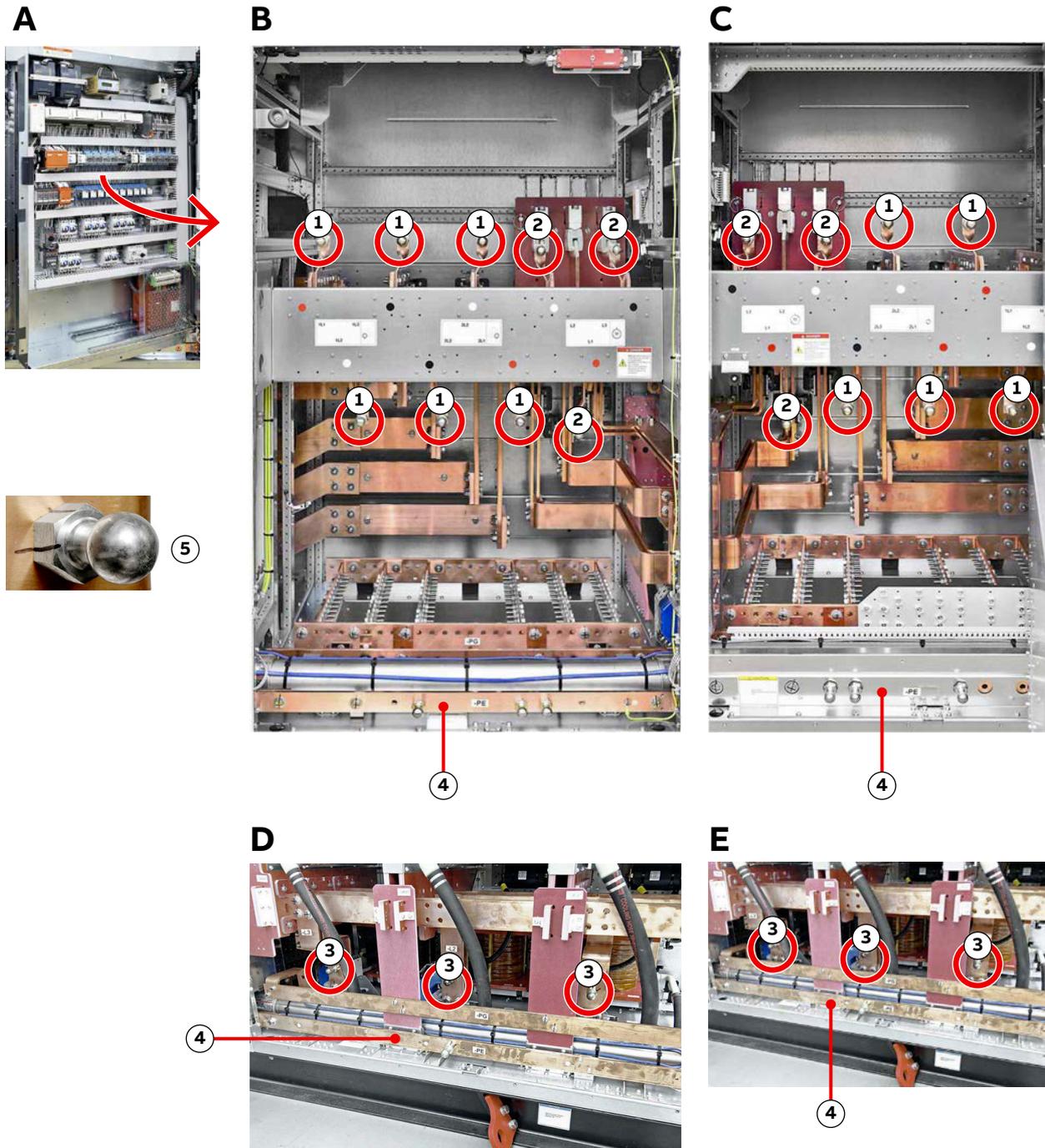


Figure 10–20 Connect the grounding sets in COU1 (A and C), TEU1 (B), INU1 (D) and INU2 (E)

- | | |
|---|---------------------|
| 1) Busbars for secondary transformer windings | 4) PE |
| 2) Busbars for motor cables | 5) Ground ball stud |
| 3) INU busbars | |

4. Inside TEU1 or COU1 remove the busbar connectors in the sequence shown in Fig. 10–21.

CAUTION! A busbar connector weighs approximately **10 kg**.

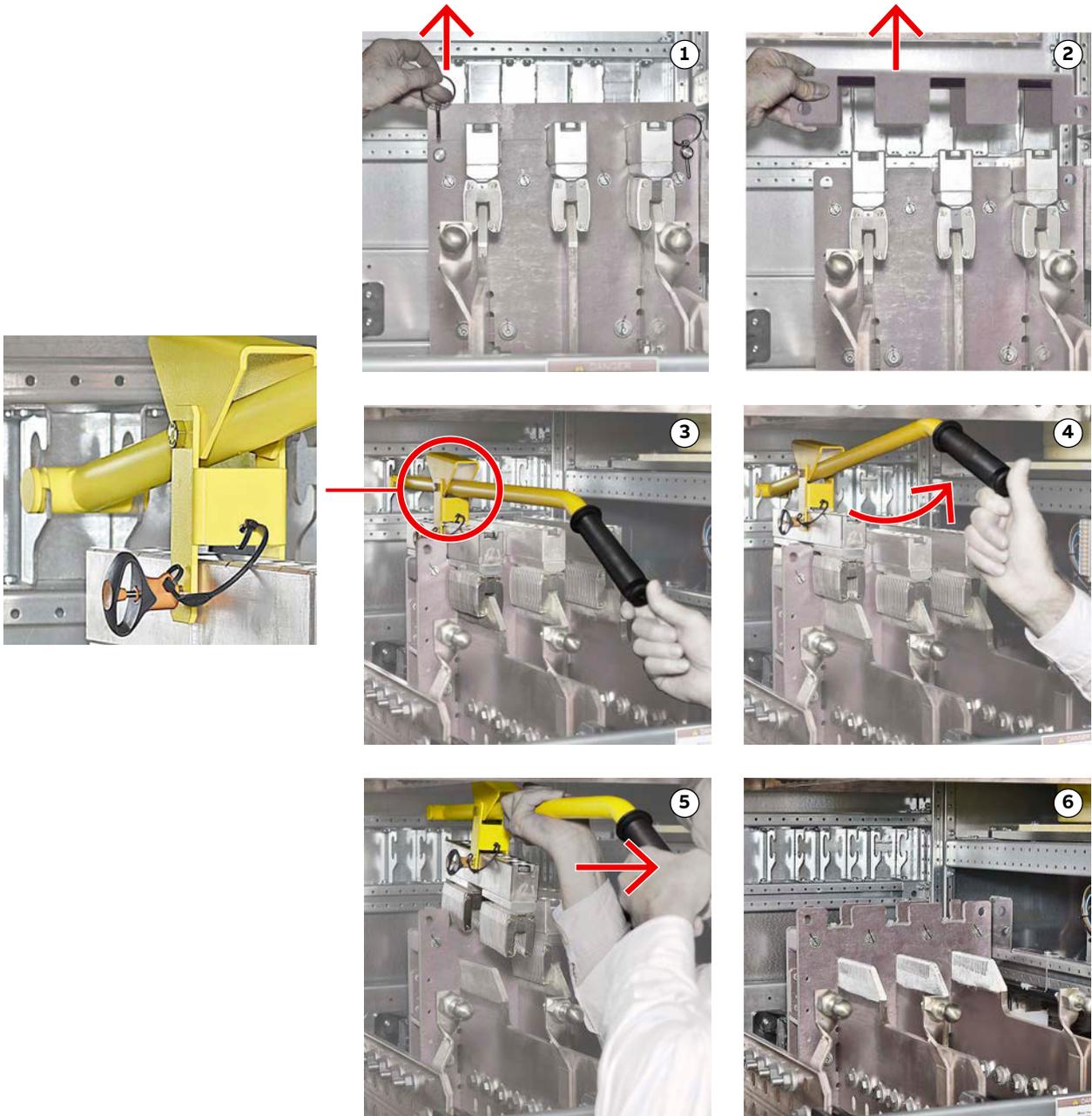
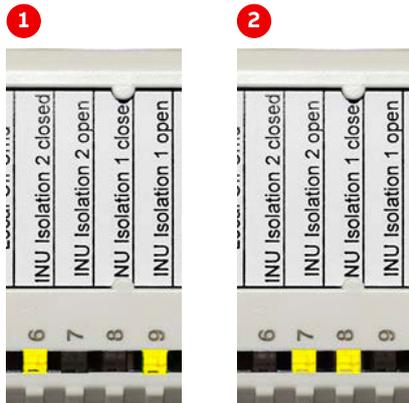


Figure 10–21 Busbar connector removal sequence in TEU1 or COU1

5. Remove the grounding sets.

6. Check that the LEDs are lit as shown.



7. Check that tools and foreign objects are not left inside the cabinets.

8. Close and lock the doors.

9. Check that the power operating mode (POM) of the drive corresponds to the busbar connectors fitted.

10. Start the drive according to the established procedures.

10.4.9.2. Fitting the busbar connectors

1. Shut down the drive according to the established procedures.

2. Fit the busbar connectors in the sequence shown in Fig. 10–22.

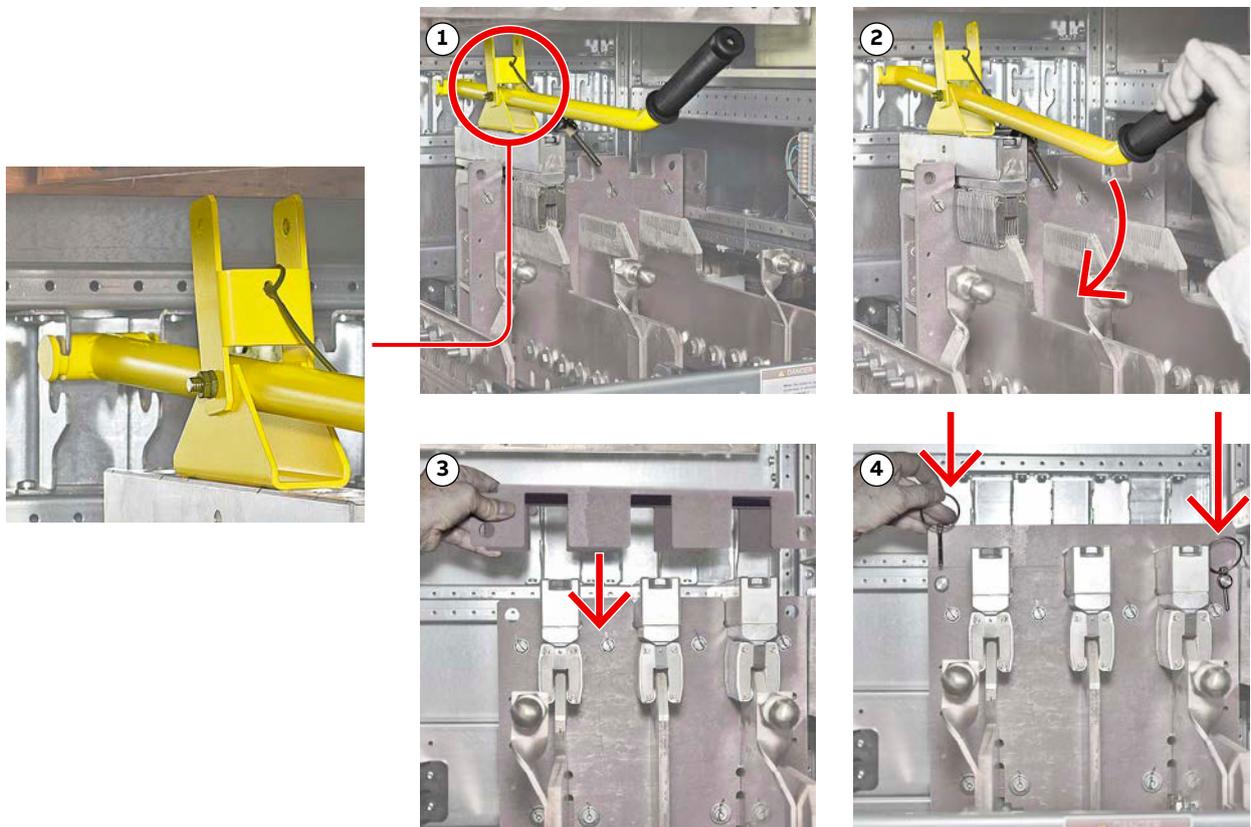
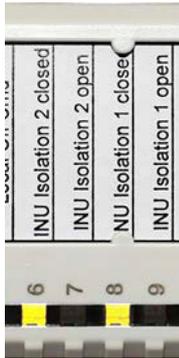


Figure 10–22 Fitting sequence for busbar connectors

3. Remove the grounding sets.
4. Check that the LEDs are lit as shown.



5. Check that tools and foreign objects are not left inside the cabinets.
6. Close and lock the doors.
7. Check that the power operation mode (POM) of the drive corresponds to the busbar connectors fitted.
8. Start the drive according to the established procedures.

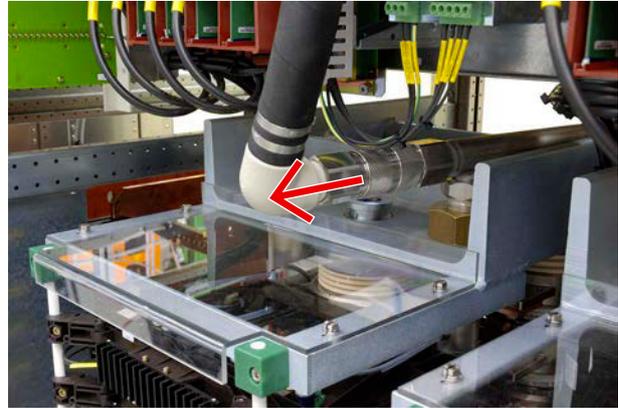
10.4.10. Removing and installing a phase module

Several maintenance actions require the removal of phase module from an ARU/INU, eg, to access the back of the cabinet or to work on the phase module.

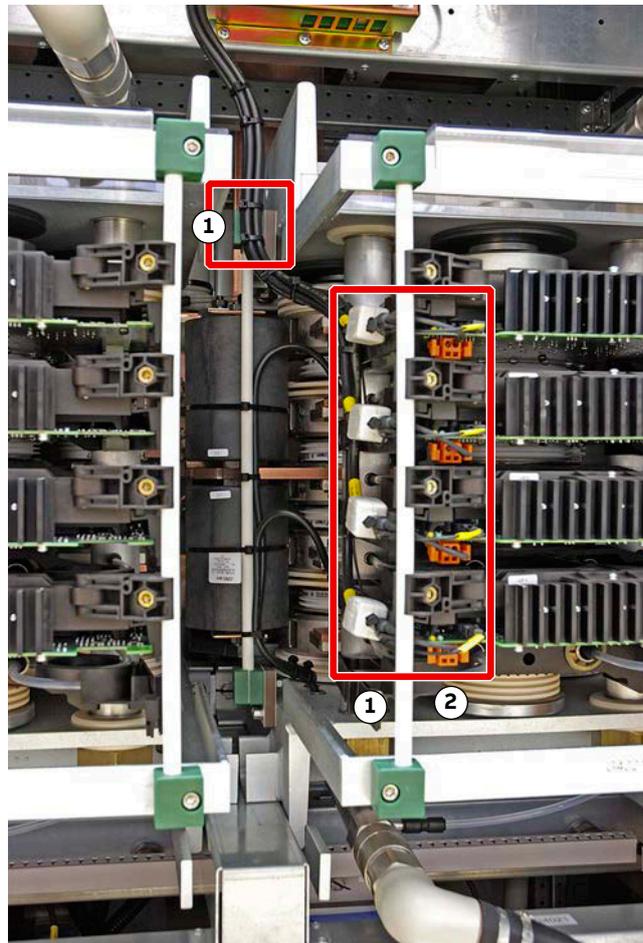
10.4.10.1. Removing a phase module

1. Disconnect the water hoses.

NOTE – To disconnect the water hose, pull the locking sleeve of the coupling towards the front of the cabinet (arrow).



2. Cut off the cable ties (1) and disconnect the optical fibers and the power supply leads (2).



3. Remove the bolts (4) on each side of the phase module.

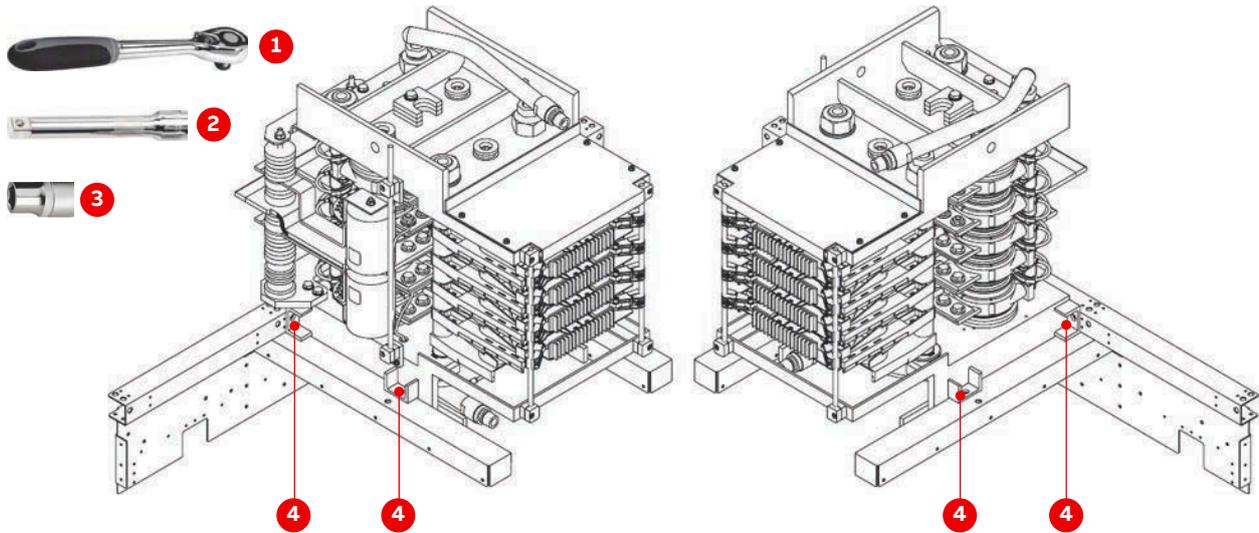


Figure 10–23 Phase module removal

- | | |
|----------|--------------------------------|
| 1) 1/2" | 3) 17 mm |
| 2) 80 mm | 4) Location of bolts to remove |

4. Place the lifting table in front of the phase module.

5. Adjust the height of the table so that it is level with the rails on the underside of the phase module.

6. Pull the phase module onto the table.

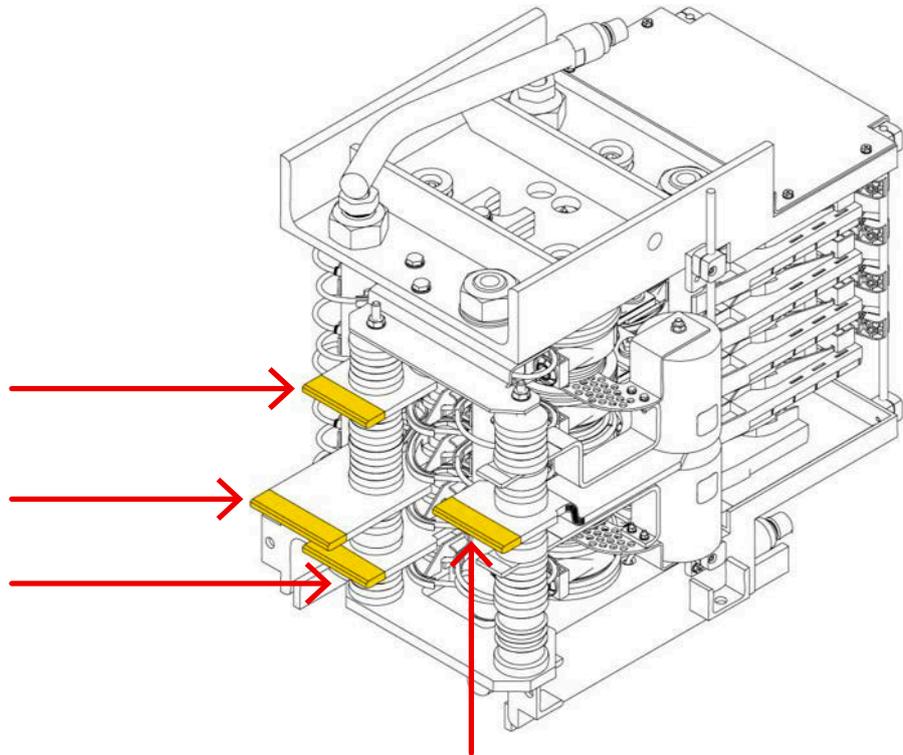
CAUTION! A phase module weighs approximately **190 kg**. When pulling out the phase module, make sure that the disconnected water hoses, optical fibers and power supply leads are out of the way.



10.4.10.2. Installing a phase module

1. Check that the busbars (arrows) of the phase module are lubricated.

NOTE – If necessary, apply a thin layer of the supplied electrical contact grease.



2. Make sure that the disconnected water hoses, fiber optics and power supply leads are out of the way before pushing the phase module into the cabinet.
3. Place the lifting table in front of the cabinet and adjust it to the required height.
4. Push the phase module slowly towards the back of the cabinet until the busbars engage with the connectors at the back of the cabinet.
5. Screw in and tighten the bolts.
6. Pull the locking sleeve of the female half of the water hose coupling back as far as possible.
7. While holding it in this position, push it over the fixed male half of the coupling until it stops.
8. Let go of the locking sleeve and firmly push the female part against the male part until the coupling locks home with a click.
9. Reconnect the optical fibers and power supply leads.

NOTICE DO NOT mix up the cables. The identification on the label must correspond to its counterpart on the phase module. Verify the correct connection with the corresponding wiring diagram.
10. Fasten the cables with cable ties.

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ACS6000	User manual	3BHS212794 E01	Q	en	247/272

10.4.11. Visual checks on the drive

Check the drive and its immediate vicinity visually at the intervals stated in “ACS6000 preventive maintenance schedule” , 3BHS855273 E01 and pay attention to the following items:

- Humidity inside the drive
- Permitted range of ambient air temperature and humidity of the drive
- Dust built-up inside the drive
- Appropriate fastening of cables and wires and connections of cable shields and screens
- Integrity of cable insulation
- The outer cable sheath must not be damaged.
- Signs for overheated components, wires, cables or busbars
- Corrosion on electronic circuit boards, connectors or busbars
- Correct type of signal and power supply cables

For more information, see the applicable cable specifications.

10.4.12. Cleaning

NOTICE Risk of component damage!

Dust and moisture on electrical components and wiring can cause failure and damage the components as well as the loss of low-level signals on loose connections.

- ▶ Check the cabinet regularly for signs of dust and humidity and clean if necessary.
- ▶ Use appropriate and recommended cleansing agents.
- ▶ DO NOT use alcohol and solvents..

10.4.12.1. Cleaning the drive cabinet

When cleaning the drive cabinet, mind the following:

- To keep dirt out, cover the equipment or assemblies.
- Take electrostatic-sensitive precautions and use suitable tools to prevent electrostatic discharge.
- To prevent damage, use antistatic brushes and a vacuum cleaner with a soft nozzle to carefully clean circuit boards with special care.
- Remove dust from assemblies and busbars inside the cabinet with a vacuum cleaner and lint-free cleaning cloths.
- Remove water, oily or greasy deposits on assemblies, components and busbars with water- and oil-absorbing microfibers.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	248/272

- Use a nylon brush or a vacuum cleaner for removing dust or deposits from recesses.
- Clean the outside of the cabinet with a vacuum cleaner and cleaning cloths.

10.4.13. Checking wire and cable connections

NOTICE Risk of component damage!

Vibration can loosen electrical connections and cause equipment failure!
Excessive force damages the capacitor bushings!

- ▶ Tighten to the torque value on the label attached to the capacitor.
IMPORTANT! DO NOT exceed 20 Nm if the tightening torque value is not specified.
- ▶ Check all power and control cable connections and tighten them if necessary.
- ▶ Check that all plugs and connectors are tight.

10.4.14. Checking and replacing filter mats

- **Inspection intervals:** See the “ACS6000 preventive maintenance schedule” , 3BHS855273 E01.
- **Service during operation:** possible.
- **Filter mat class:** G3 (EN779)
- **Location:** installed behind the ventilation grids of control and water cooling units if the drive is prepared for protection class IP 54.

The filter mats are located between the ventilation grid and the wire mesh. The wire mesh is always installed.

Table 10–2 Filter mat specifications

Location	Filter class	Width (mm)	Height (mm)	Depth (mm)	ABB material number
WCU - back wall	G3 T15/150	250	125	10	3BHB028115R0002
COU and roof boxes	G3 T15/150	250	250	10	3BHB028115R0003
EXU	G3 T15/150	745	375	10	3BHB028115R0004

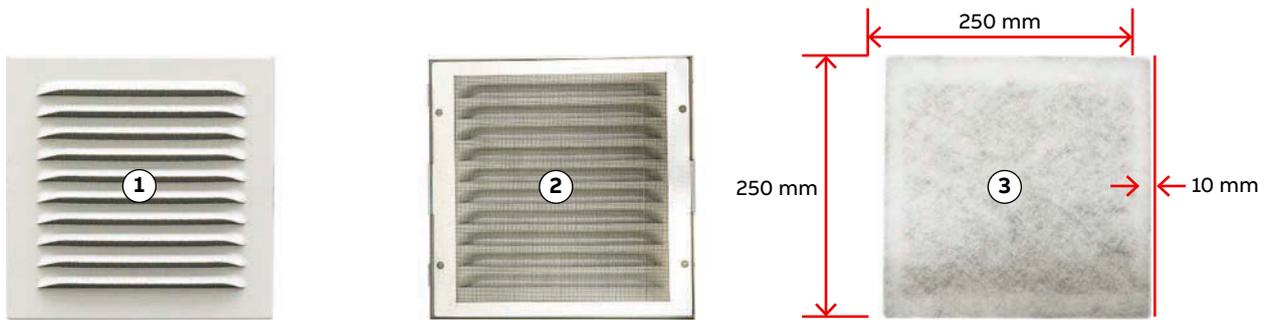


Figure 10-24 COU filter

- | | |
|---------------------|---|
| 1) Ventilation grid | 3) Filter mat (only for protection class IP 54) |
| 2) Wire mesh | |

Procedure

1. Switch off the protection switch of the cooling fans.

CAUTION! The cooling fans behind the ventilation grids start automatically when the temperature rises above a preset level.

2. Remove the bolt at the top of the fan cover.



3. Slide the cover up and pull it out of the slots.



4. Turn the cover over and remove the filter mat.
5. Insert the new filter mat and reinstall the ventilation grid.

10.4.15. Testing and replacing auxiliary fan units

- **Inspection intervals:** see the “ACS6000 preventive maintenance schedule” , 3BHS855273 E01.
- **Service during operation:** possible
- **Location:** installed behind the doors of the following cabinets:
 - COU cabinet (2 fan units)
 - WCU cabinet (2 fan units in WCU and 2 fan units in the optional REB)
 - Water-cooled EXU cabinet

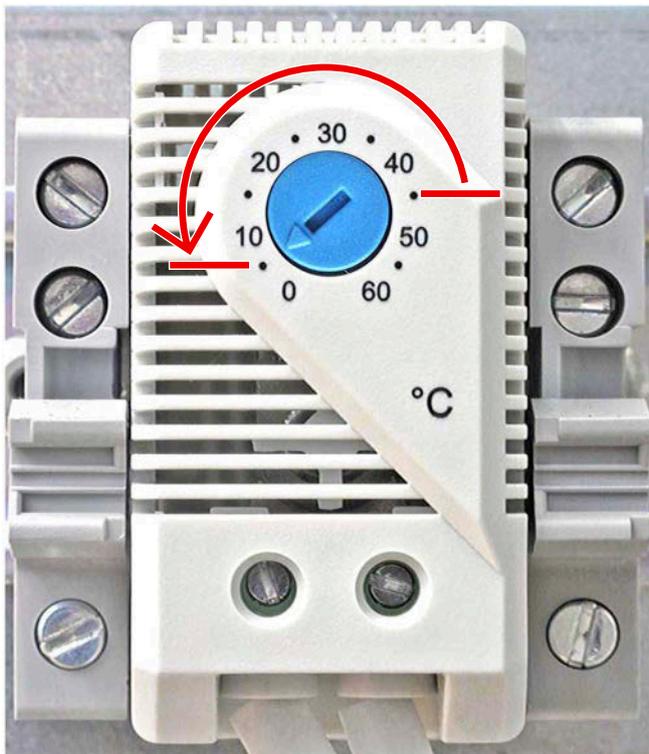
10.4.15.1. Testing auxiliary fan units

To switch the fan units on and off for the test, use the thermostats of the fan units.

Thermostat location	Identification	Factory-set value
COU	B2981	45° C
WCU	B5741	45° C

Procedure

1. Switch on the auxiliary voltage for the fan unit to be tested.
2. Take note the setting of the thermostat.
The factory-set value is also stated on the **Settings** label. The label is attached to the inside of the cabinet door.
3. To switch on a fan unit, turn the dial of the thermostat from the factory-set value to a low value.



4. Check that the fans run smoothly and if a fan is faulty, replace the complete fan unit.
5. Set the thermostat to the factory-set value.

10.4.15.2. Replacing auxiliary fan units

1. Switch off the miniature circuit breaker of the fan unit that you want to replace.
To identify the miniature circuit breaker, see “Appendix D - Wiring diagrams”.
2. (Only for fan units of the optional REB) Unscrew the ventilation grid (circles) and flip the grid downward (arrow).

IMPORTANT! The ventilation grid is hinged. You DO NOT need to remove it.

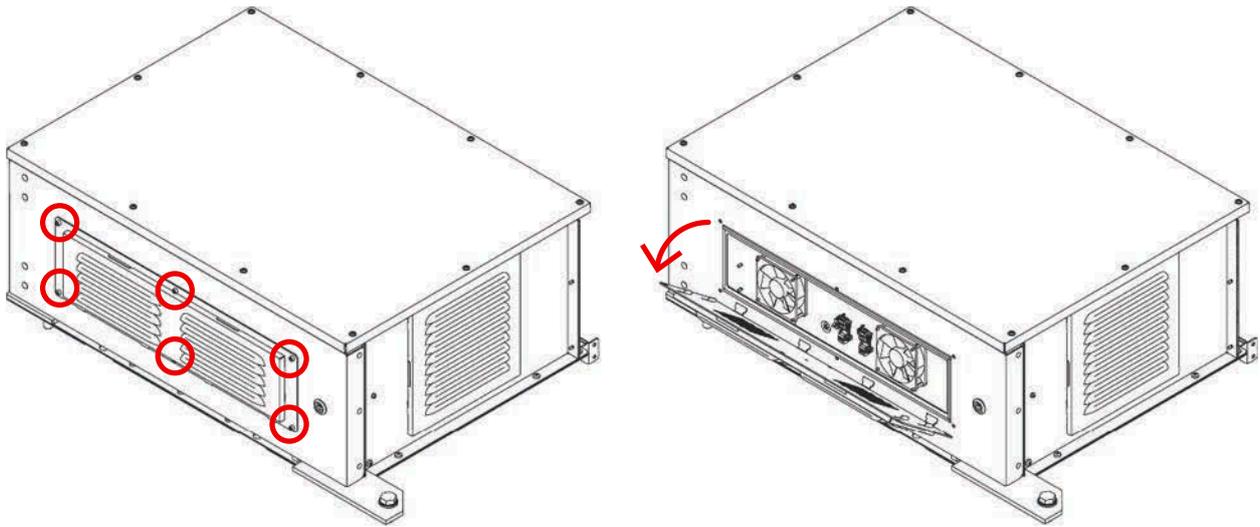
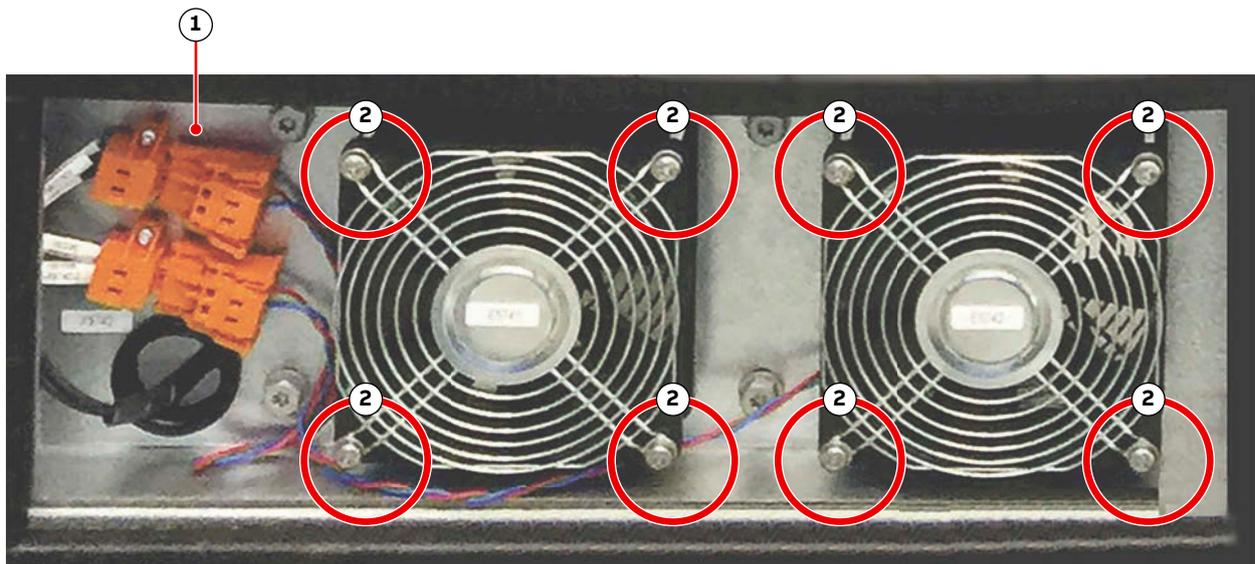


Figure 10–25 Accessing the fan units in the WCU roof box

3. Disconnect the wires (1) and unscrew (2) the fan units.



4. Remove the fan unit.
5. Reinstall the new one in reverse order of removal.

10.4.16. Testing and replacing air-to-air heat exchangers

- **Inspection intervals:** see the “ACS6000 preventive maintenance schedule” , 3BHS855273 E01.
- **Service during operation:** not possible



Figure 10–26 Air-to-air heat exchanger overview (type LT-5-5165-UL)

- | | |
|------------------------------|---|
| 1) Ambient fan 2 | 7) Red LED off and green LED on: Heat exchanger is healthy |
| 2) Ambient fan 1 | 8) Red LED on and green LED off: Alarm condition |
| 3) Internal fan 1 | 9) Red LED off and green LED off: Auxiliary voltage missing |
| 4) Circuit board location | |
| 5) Internal fan 2 | |
| 6) Miniature circuit breaker | |

Table 10–3 Air-to-air heat exchanger specifications

Weight	~65 kg
Length	1025 mm
Width	750 mm
Height	316 mm

A thermostat inside the cabinet where air-to-air heat exchanger is installed controls the internal fans (3 and 5 in Fig. 10–26). The fans are switched on when the cabinet temperature exceeds the value set on the thermostat.

The ambient fans (1 and 2 Fig. 10–26) are switched on by the air-to-air heat exchanger depending on the permanently measured cabinet temperature.

10.4.16.1. Testing the fan units

To switch the fan units on and off for the test, use the thermostats of the fan units.

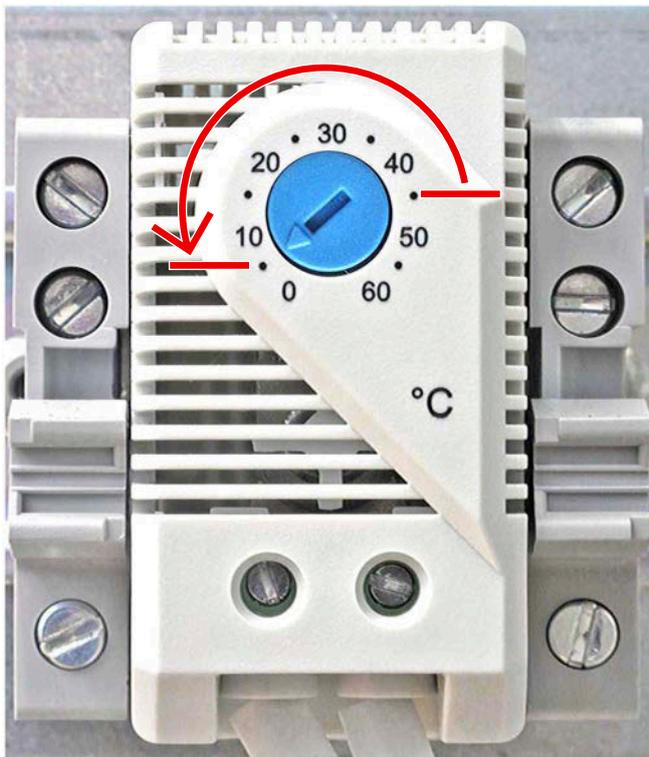
Thermostat location	Identification	Factory-set value
ARU	B7501	45 °C
INU	B7501	45 °C

Procedure

1. Switch on the auxiliary voltage for the air-to-air heat exchanger.
2. Take note of the setting of the thermostat.

The factory-set value is also stated on the **Settings** label. The label is attached to the inside of the cabinet door.

3. To start a fan or a group of fans, adjust the setting of the thermostat to a low value (arrow).



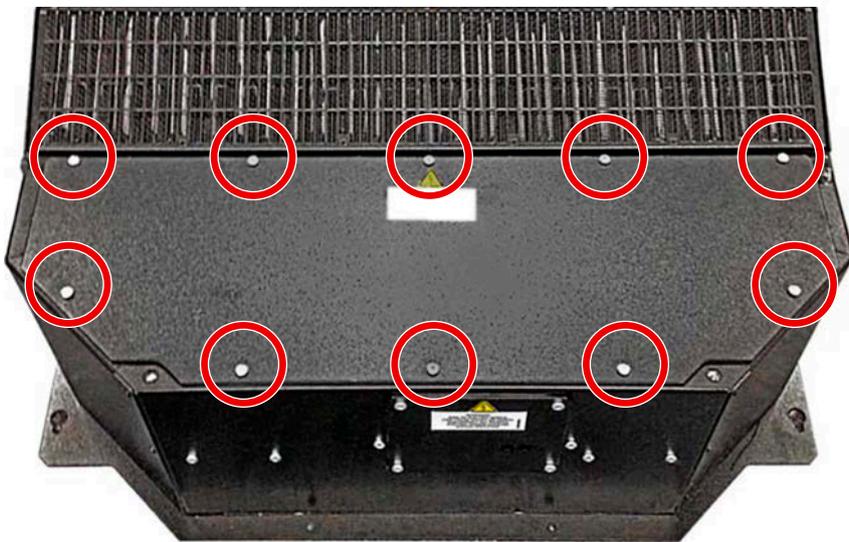
4. Check that the fans run smoothly and if a fan is defective, replace the complete fan unit.
5. Adjust the setting of the thermostat to its original value.

10.4.16.2. Replacing the complete heat exchanger

For information on replacing the complete heat exchanger, see section 5.8, **Installing and removing air-to-air heat exchangers**, page 106.

10.4.16.3. Replacing the circuit board

1. Unscrew the front and top cover.



2. Disconnect the ground wire from the front cover (arrow).



- Take note of the orientation of the circuit board and where the plug-in connectors and wires are connected to.



- Unplug the plug-in connectors and wires from the circuit board.
- Remove the circuit board.
- Place the circuit board on the spacers and gently push the circuit board onto the spacers until they snap in properly.
- Reconnect the wires to the circuit board (Fig. 10–27).

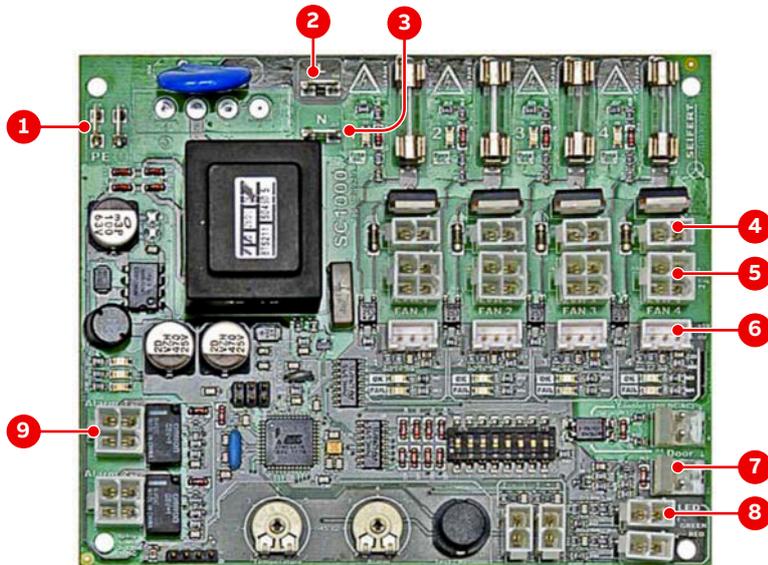


Figure 10–27 Wire connection points on the circuit board

No.	Description	Pin	Pin	Pin	Pin
1	Ground wire	J15			
2	Supply phase	L			
3	Supply neutral	N			
4	4x external capacitors	1x J3	2x J5	3x J7	4x J9
5	4x fan power supply	1x J4	2x J6	3x J8	4x J10
6	4x fan alarm signals	1x J22	2x J23	3x J24	4x J25
7	ON	J11			
8	LEDs	Red J18	Green J19		
9	Alarm 1	J1			

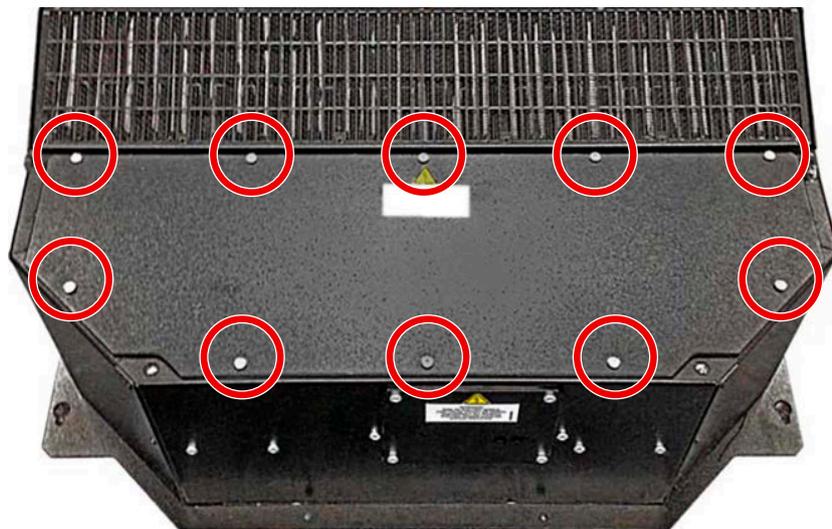
- 8. Reconnect the ground wire to the front cover.
- 9. Fasten the covers.

10.4.16.4. Replacing internal fan 1 - left side

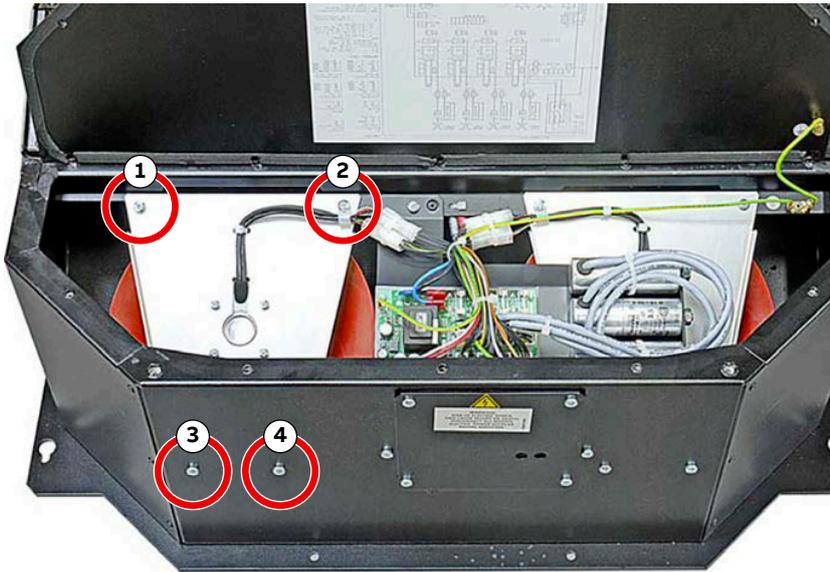


Procedure

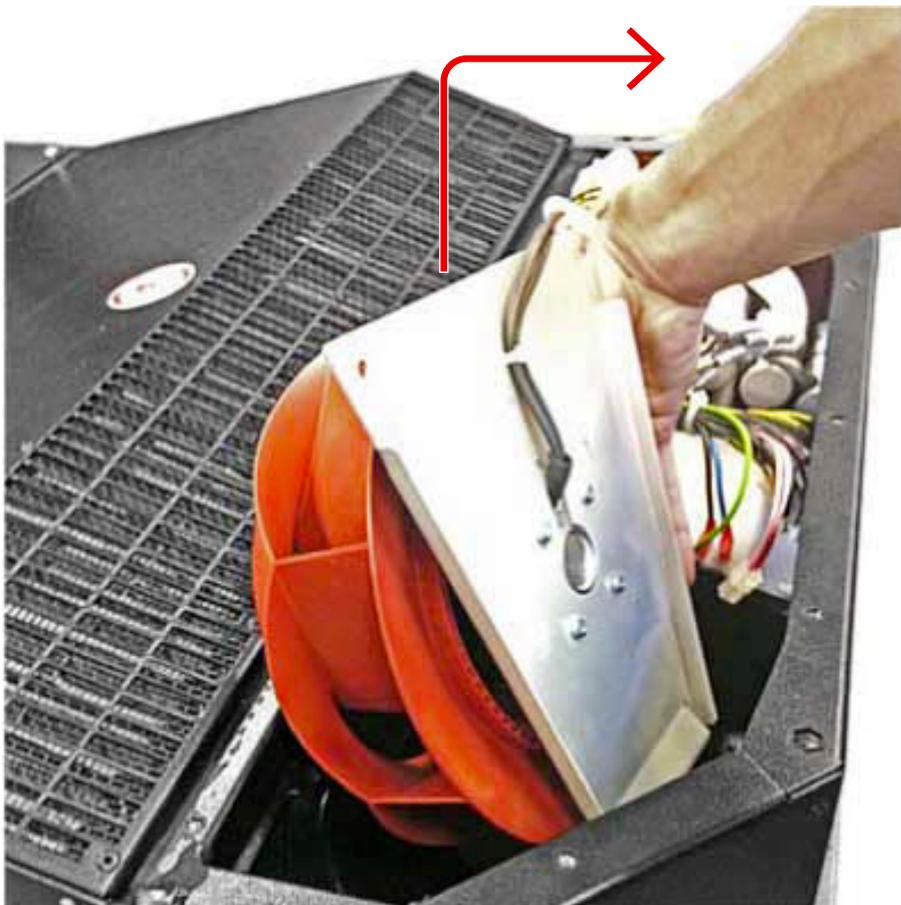
- 1. Unscrew the front top cover.



2. Unplug the plug-in connectors (arrows) and unscrew the screws (1, 2, 3 and 4) which fix the fan mounting bracket to the housing.



3. Remove the fan from the housing and unscrew the fan from the mounting bracket.



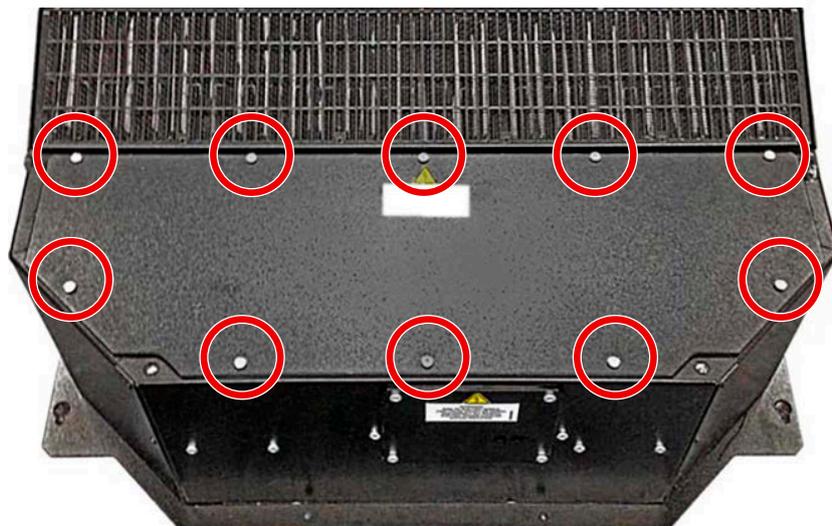
4. Replace the fan and reassemble the unit in reverse order of removal.

10.4.16.5. Replacing internal fan 2 - right side



Procedure

1. Unscrew the front top cover.



2. Remove the front cover and disconnect the ground wire (arrow).



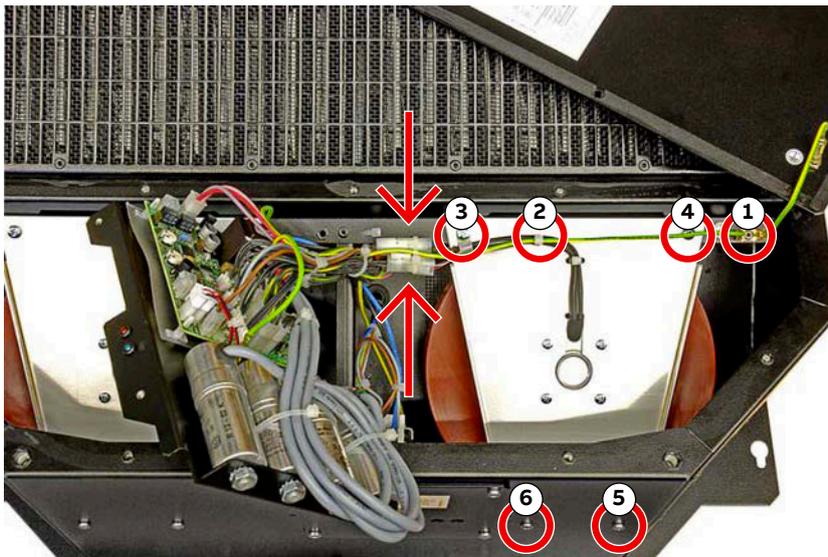
3. Unscrew the circuit board mounting bracket (1, 2 and 3).



4. Take out the circuit board mounting bracket and place it on the heat exchanger housing.



5. Disconnect the ground wire (1), cut off the cable tie (2), unplug the plug-in connectors (arrows), and unscrew the screws (3, 4, 5 and 6) fixing the fan mounting bracket to the housing.



6. Remove the fan from the housing, and unscrew the fan from the mounting bracket.
7. Replace the fan and reassemble the unit in reverse order of removal.

10.4.16.6. Replacing the ambient fans

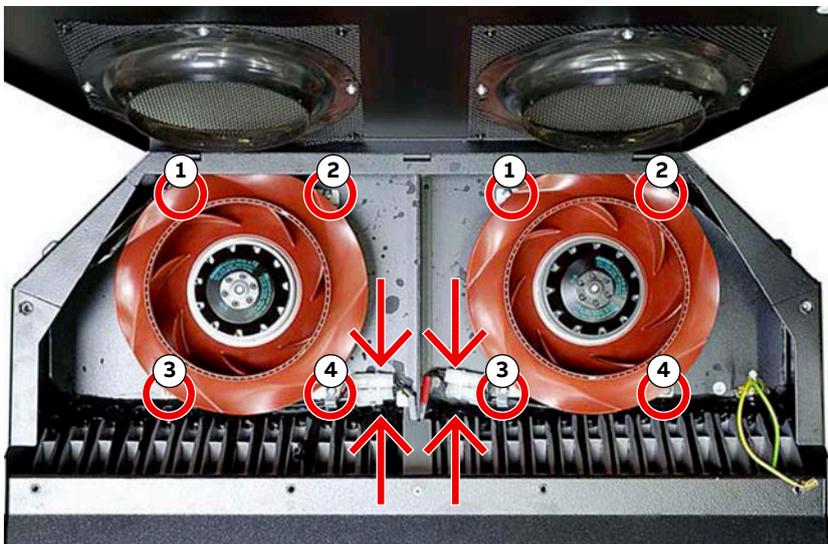
1. Unscrew the rear cover.



2. Lift the hinged cover up a little and disconnect the ground wire (arrow).



3. Disconnect the plug-in connectors (arrows) and remove the fastening screws (1, 2, 3 and 4).



4. Replace the fan, and reassemble the unit in reverse order of removal.

10.4.17. Replacing the fan unit in an EXU with a DCS800 D4 size controller



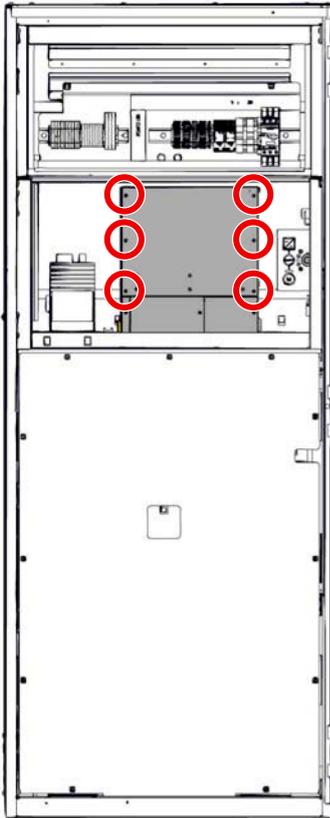
Figure 10–28 DCS800 controller - size D4

Procedure

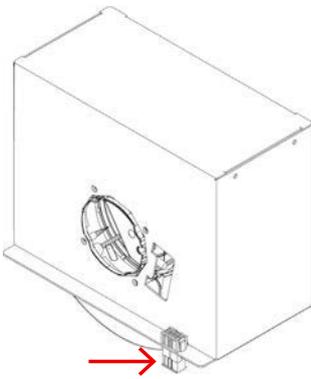
1. Switch off the miniature circuit breaker of the fan unit.
To identify the miniature circuit breaker, see “Appendix D - Wiring diagrams”.

PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	263/272

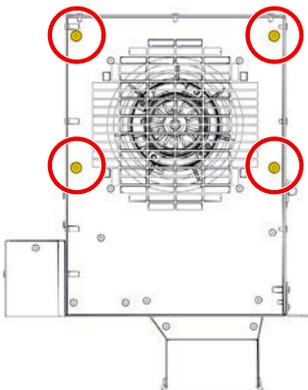
2. Remove the 6 screws from the fan cover and then remove the fan cover.



3. Unplug the fan cables.

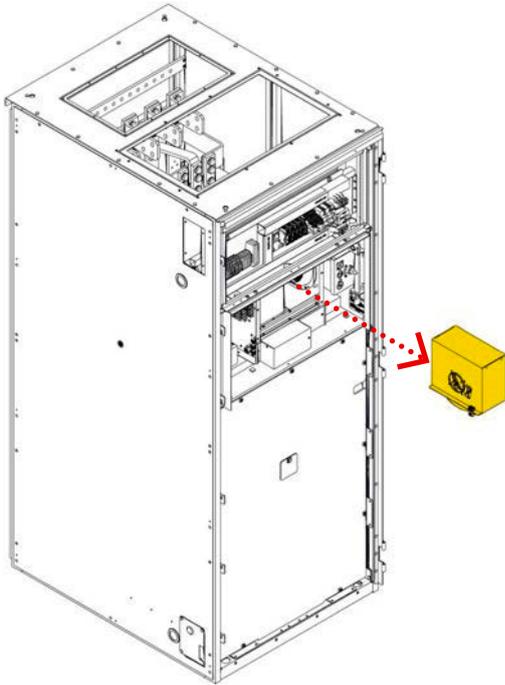


4. Remove the 4 fastening screws from the outside panel of the fan unit.



5. Pull the fan unit out of the cabinet.

CAUTION! To prevent the fan from falling onto you, place a support (ie, a box) underneath.



6. Install the new fan in reverse order of removal.

10.4.18. Replacing the fan unit in an EXU with DCS800 size D5 controller



Figure 10–29 DCS800 controller - size D5

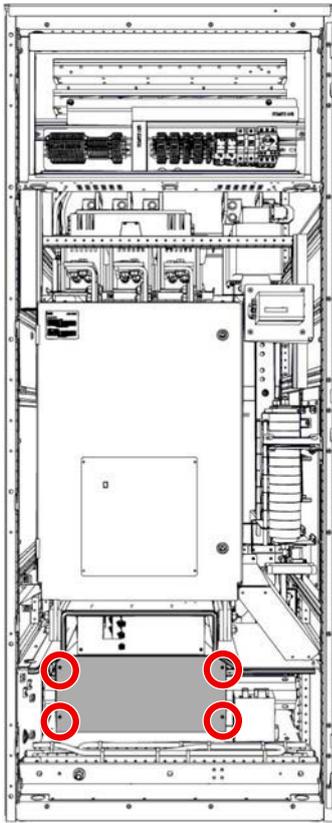
Procedure

1. Switch off the miniature circuit breaker of the fan unit.

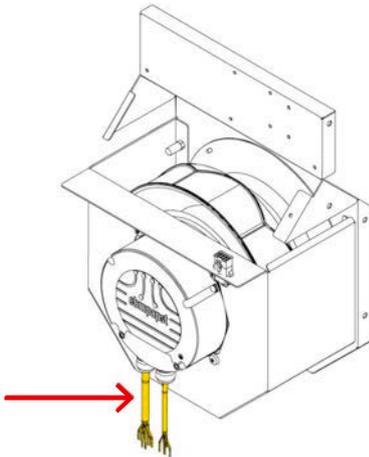
PRODUCT	DOCUMENT KIND	DOCUMENT ID.	REV.	LANG.	PAGE
ACS6000	User manual	3BHS212794 E01	Q	en	265/272

To identify the miniature circuit breaker, see “Appendix D - Wiring diagrams”.

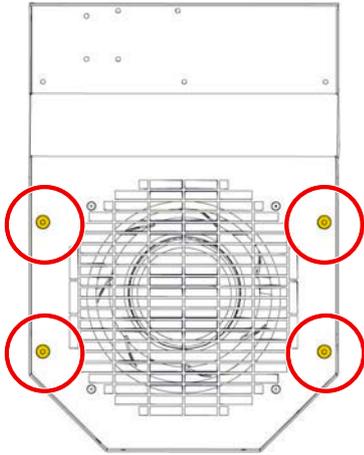
2. Remove the 6 screws from the fan cover and then remove the fan cover.



3. Unplug the fan cables.

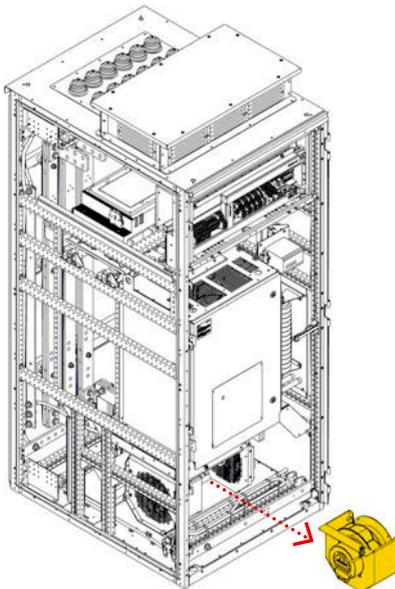


- Remove the 4 fastening screws from the outside panel of the fan unit.



- Pull the fan unit out of the cabinet.

CAUTION! To prevent the fan from falling onto you, place a support (ie, a box) underneath.



- Install the new fan in reverse order of removal.

10.4.19. Replacing the air-to-water heat exchanger of the EXU

- Switch off the miniature circuit breaker of the heat exchanger.

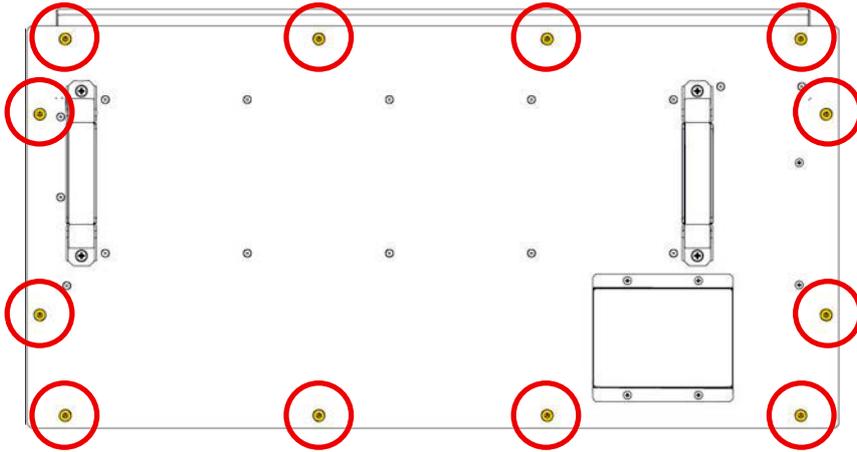
NOTE – To identify the miniature circuit breaker, see “Appendix D - Wiring diagrams”.

- Close valves V30 and V31 in the water-cooling unit.

- Disconnect the hose from valve V30 to drain the WCU.

NOTICE Expect approximately 5 liters of water.

4. Unscrew the top plate.



5. Disconnect the water tubes (1) from the air-to-water heat exchanger, unplug the cables (2) and remove the fastening screws.

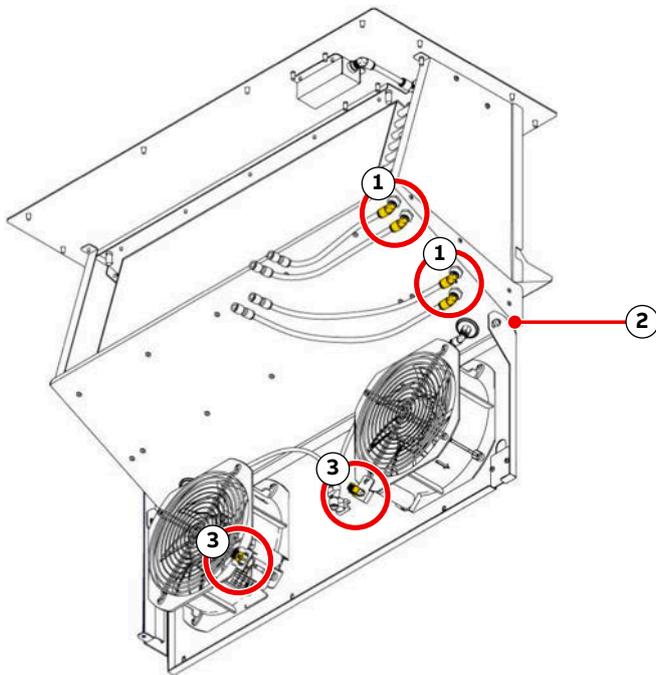


Figure 10–30 Air-to-water heat connections

- | | |
|---------------------------|----------------------|
| 1) Water tube connections | 3) Cable connections |
| 2) Fastening screw | |

6. Lift the heat exchanger out of the cabinet.

CAUTION! The heat exchanger weighs approximately **16 kg** and requires a minimum overhead clearance of 85 cm.

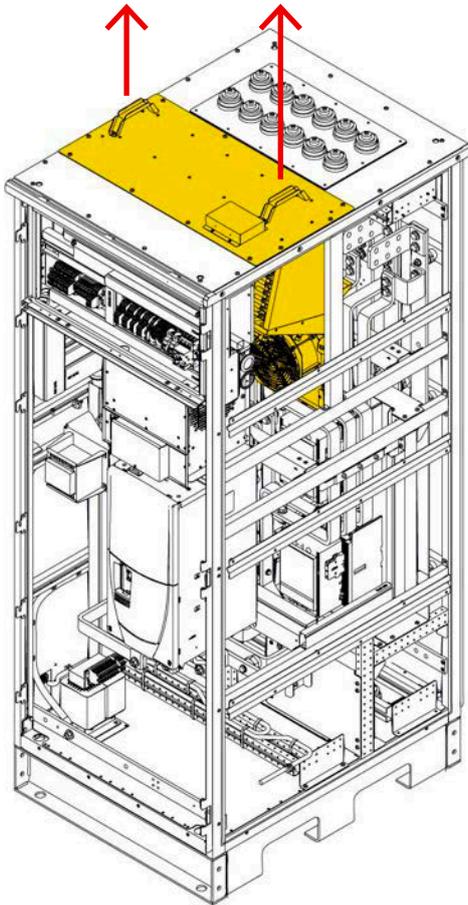


Figure 10–31 Lift heat exchanger out of EXU cabinet

7. To install the new heat exchanger, proceed in reverse order of removal.

For information on adding water to the cooling system, see: “ACS5000, ACS6000 and ACS6080 water cooling unit WCU800 user manual”, 3BHS821937 E01 or “ACS5000, ACS6000 and ACS6080 water cooling unit WCU1400 user manual”, 3BHS835714 E01.



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