User manual

Medium voltage AC drive
ACS5000 air-cooled, 2 - 7 MVA

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Copyright notice

Document identification

Ownership	ABB China Ltd Medium Voltage Drives
Document identification	3BHS221906 ZAB E01
Revision index	D
Issue date	31.05.2018

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Equipment covered by the 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 (eg, layout drawings, wiring diagrams, technical data, engineering notes).

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

Structure of the user documentation

The complete set of user documentation of a standard drive consists of this manual and supplementary documentation that is provided in the following appendices:

- *Appendix A - Additional manuals*

  The appendix provides manuals about additional equipment delivered with the drive (eg, project specific options such as pulse encoder or fieldbus interfaces), or information on modifications of the standard drive.

- *Appendix B - Technical data*

  The appendix contains the technical data sheets of the drive.

- *Appendix C - Mechanical drawings*

  The appendix provides the outline drawing(s) of the drive. The drawings are generated according to the customer-specific project.

- *Appendix D - Wiring diagrams*

  The appendix contains the circuit diagrams with information on cross-reference and device-identification conventions. The diagrams are generated according to the customer-specific project.

- *Appendix E - Parts list*

  The parts list is produced for each project and contains all information to identify a component.

- *Appendix F - Test reports and certificates*

  The appendix provides the test reports of the drive. Quality certificates, and codes and standards the drive complies with are added if required for the project.

- *Appendix G - Signal and parameter table*

  The *Signal and parameter table* includes descriptions of actual signals, control and status words, and control parameters and their default settings.

Target groups and required qualifications

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 must 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 to ensure the safe and reliable functioning of the drive.

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

Handling

The personnel must be skilled and experienced in unpacking and transporting heavy equipment.

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.

Electrical installation

The 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.

Operation

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

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 system and act correspondingly,
- know the safe shutdown and grounding procedures for the drive system.

Responsibilities of the user

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.

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 as 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.

Cyber security disclaimer

This product is designed to be connected to and to communicate information and data via a network interface. It is Customer's sole responsibility to provide and continuously ensure a secure connection between the product and Customer network or any other network (as the case may be).

Customer shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information.

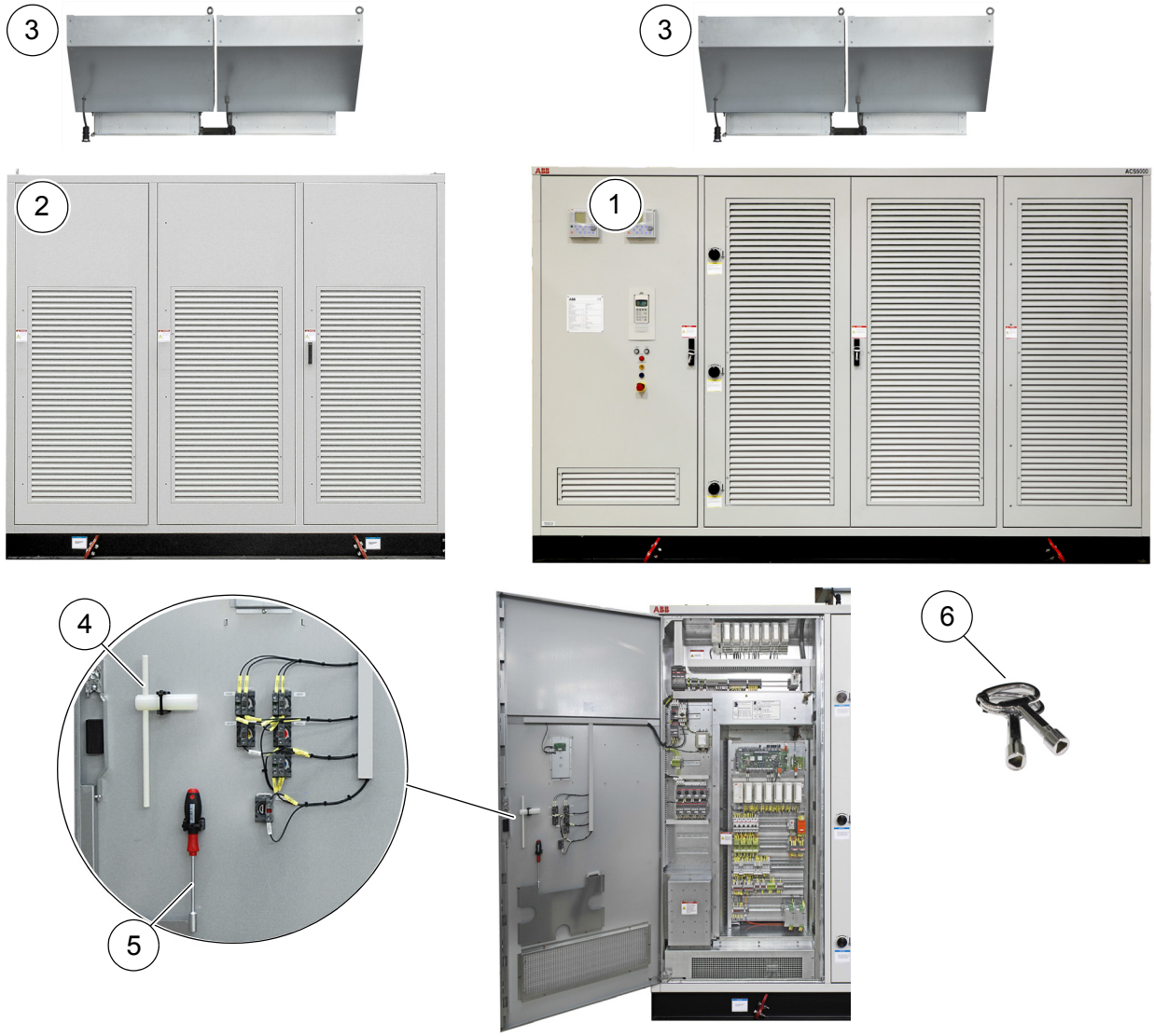
ABB and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

Quality certificates and applicable standards

The following certificates and conformity declarations are available with ABB:

- ISO 9001 / ISO 14001 certificates stating that ABB Switzerland Ltd has implemented and maintains a management system that fulfills the requirements of the normative standards
- EC declaration of conformity
- List of the standards the drive complies with

Items covered by delivery



Delivery typically comprises the following items:

- Drive *(1)* and transformer *(2)*

  The transformer is either an integrated or a non-integrated type.

  The cabinets are either shipped in seafreight or airfreight packaging.
- Fans *(3)*

  The fans are shipped in a separate container. The number of fans depends on the cooling configuration ordered.
- Grounding switch lever *(4)*
- Triangular nut driver *(5)*
- Door keys *(6)*

Fig. 1 Delivered items

Identifying the delivery

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

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.

Identifying transport units

If a delivery comprises transport units for several drives, the transport units need to be identified and assigned to the drive to which they belong. For this purpose, the drives have been numbered on the accompanying papers (eg, drive 1, drive 2). The corresponding information is provided on

- the *Packing list* attached to the packaging of each transport unit

  and

- the *Packing label* on the back wall of each transport unit. The packing label is only visible after the packaging has been removed.

Packing list

Transport units which belong to a particular drive are identified with the help of the commodity description on the packing lists. The identical column of the packing list states the number of the drive to which the transport unit belongs.

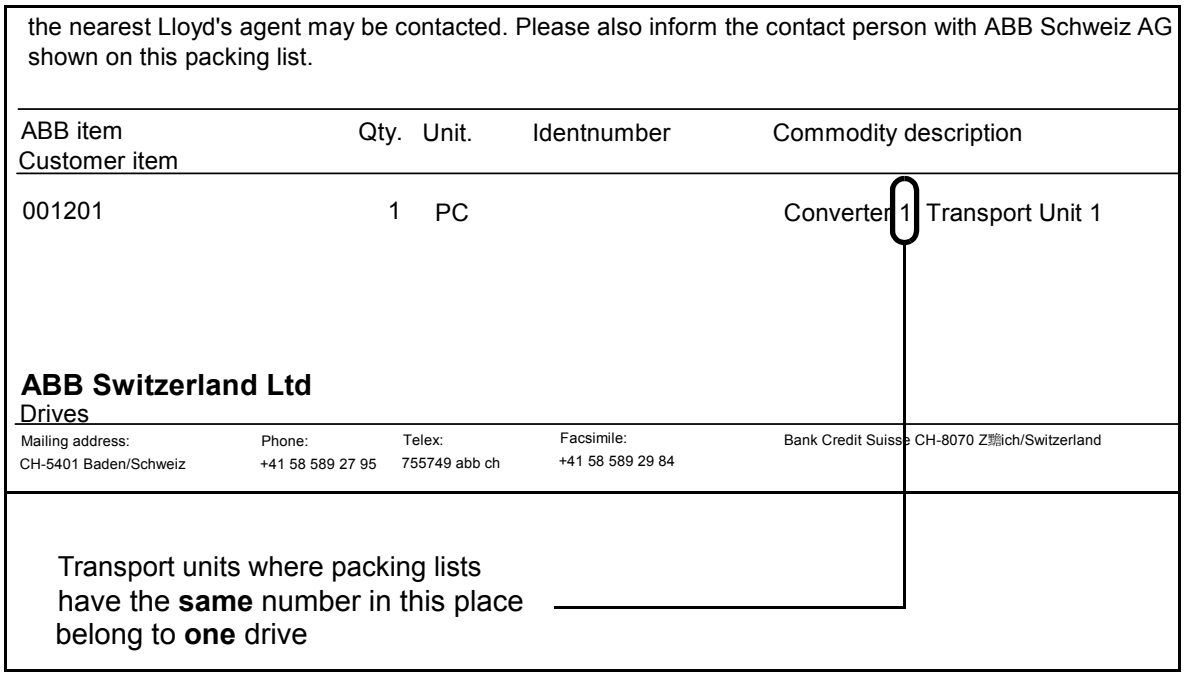


Fig. 2 Identifying the drive on the packing list

Separately delivered crates or boxes with accessories such as tools and installation material are also assigned to a drive by means of the packing list. The item number in column *ABB Item / Customer item* provides the necessary information.

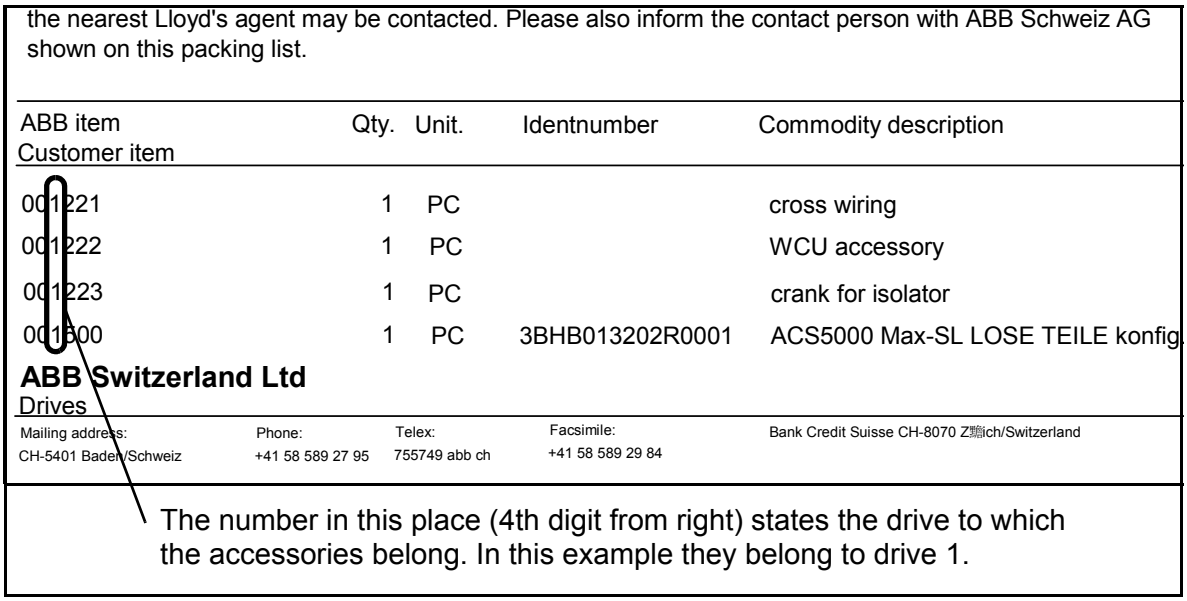


Fig. 3 Identifying the drive on the accessories packing list

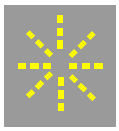
Packing label The packing labels on the back walls of a transport unit can also be used to identify the drive to which the transport unit belongs *(Fig. 4)*.

Fig. 4 Identifying the drive on the packing label

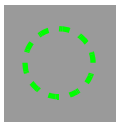
Writing conventions

The following icons and text conventions are used in the manual.

Meaning of icons



Illustrates an illuminated lamp or pushbutton.



Illustrates a button or key to be pressed.

Indicates an alternating display message.

Refers to further information in a separate document.

Text conventions

- marks items in a list.
- marks steps of a procedure when there is no specified sequence.

1 marks steps of a procedure to be followed in the specified sequence (eg, 1, 2, 3).

1 used in figure legends to identify the item in an illustration.

Arial Bold is used to highlight switches to be operated, status messages shown in a display and special terms.

UPPERCASE letters refer to a parameter.

Italic is used for references to illustrations, chapters and supplementary documentation.

Gray-shaded areas highlight text.

Important note on 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 input transformer.

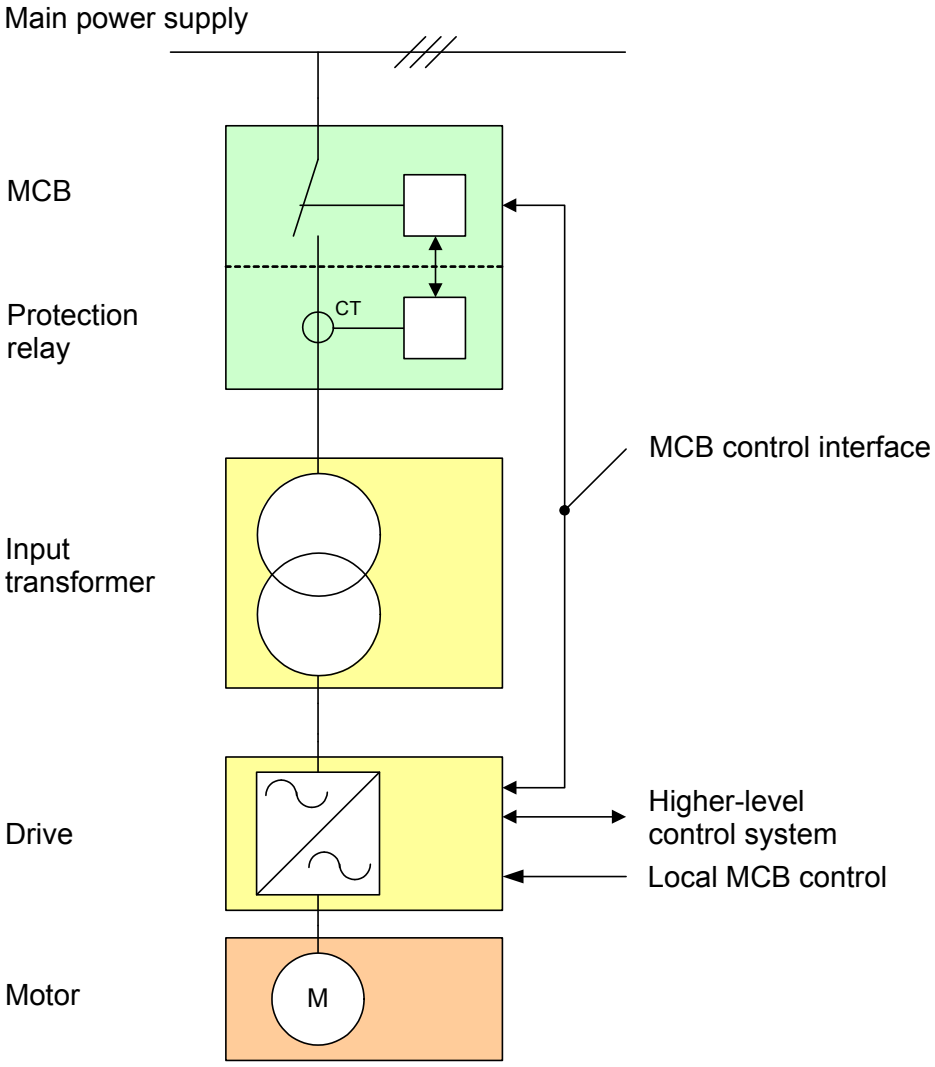


Fig. 1 Drive system overview

Fig. 1 shows the conceptual single-line diagram of a typical drive system, including main power supply, MCB, input transformer, drive and electric motor.

The MCB is defined as a switching device to disconnect the power supply whenever required by the process or when a fault occurs. Typical devices used as MCBs are:

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

A dedicated protection relay is used for:

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

In general, these protective measures are not included in the drive as provided by ABB.

Safety and protection requirements

For safety and protection reasons, the MCB must meet the stipulated minimum requirements of the specifications of ABB MV Drives. It is the system integrator's responsibility to ensure that the minimum requirements are met. The minimum requirements for the MCB are stated in this note and in the respective MCB specifications, which are available for each medium voltage drive from ABB.

The safety requirements for the drive are based on the following standards:

- 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

Minimum requirements for MCB and MCB control

- The MCB open and / or trip command has to be wired directly from the drive to the MCB. It is not permitted to wire the trip command through any PLC or DCS system if it is not certified to meet SIL 3 level requirements, and to fulfill the timing requirements outlined below. Opening of the MCB by the drive must be possible at any time. It is not permitted to interrupt the open and / or trip command, for example by a local-remote switch in the MCB.
- When the MCB is in service position, the drive must have exclusive control of closing the MCB. Local closing of the MCB is not permitted.

- The maximum opening time of the MCB must never exceed the product or project-specific maximum time defined in the 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 permitted breaking time (open and arcing) of the breaking device after the open command has been initiated to prevent further damage to the drive, eg, diode failures.
  - Maximum safety trip time: 500 ms

    The maximum safety trip time is the maximum permitted time to ensure safe disconnection of the main power supply to prevent any hazard to personnel.

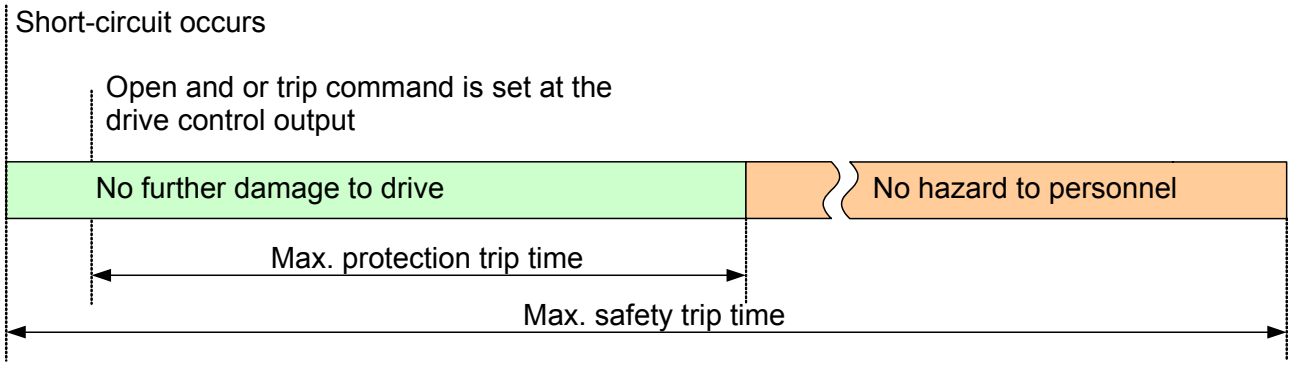


Fig. 2 MCB opening timing diagram

In order to meet the stipulated safety requirements, it is recommended that:

- the MCB is equipped with two independent opening coils, or
- the MCB is equipped with one opening coil and an undervoltage coil for monitoring of the control voltage, or
- an 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. The upstream breaker must open within the maximum safety trip time after a failure has occurred.

Maintenance recommendation

The MCB trip circuits should be checked once yearly.

Chapter 1 - Safety

1.1 Meaning of safety instructions

Safety instructions are used to highlight a potential hazard when working on the equipment. Safety instructions must be strictly followed! Non-compliance can jeopardize the safety of personnel, the equipment and the environment.

DANGER

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

WARNING

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

CAUTION

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

NOTICE

NOTICE is used to address practices not related to personal injury.

The safety instructions are derived from the following standards:

- ISO 3864-2:2004 (E)

  Graphical symbols – Safety colours and safety signs – Part 2: Design principles for product safety labels

- ANSI Z535.6

  American National Standard for Product Safety Information in Product Manuals, Instructions, and Other Collateral Materials

1.2 General safety information

To maintain safety and minimize hazards observe the following:

- Before the drive is energized, make sure 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 bolted.
- Before starting to work on the drive, make sure that:
  - the main and auxiliary power supply to the drive is switched off, locked out, and tagged out,
  - the drive is dead,
  - safety ground connections are in place,
  - appropriate personal protective equipment is provided and used when required,
  - everyone involved is informed.
- When working near the running drive, wear protective earmuffs.
- Before work is carried out simultaneously on the drive and on other drive system equipment, make sure that
  - the relevant safety codes and standards are observed,
  - all energy sources of the equipment are turned off,
  - lockout and tagout devices are in place,
  - barriers and appropriate covers are used on equipment which is still live,
  - everyone involved is informed.
- In case of fire in the drive room:
  - Observe the established rules and regulations for fire protection.
  - Only firemen with appropriate protective equipment are allowed to enter the drive room.

1.3 Possible residual risks

The following risks can arise from a drive system and pose a hazard to people. These risks must therefore be taken into account by the system integrator and / or the plant owner when assessing the risks of the machinery.

- Electric power equipment generates electro-magnetic fields which can cause a hazard to people with metal implants and / or a pacemaker.
- Drive system components can move unintentionally when being commissioned, operated, or serviced due to, for example:
  - Operation of the equipment outside the scope of the specifications
  - Incorrectly assembled or installed equipment
  - Wrongly connected cables
  - External influence on, or damage of the equipment
  - Wrong parameter settings
  - Software errors
  - Faulty hardware
- Hazardous touch voltages can be present on drive system components caused by, for example:
  - 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
- High temperatures, noise, particles, or gases can be emitted from drive system components caused by, for example:
  - Operation of the equipment outside the scope of the specifications
  - External influence on, or damage of the equipment
  - Wrong parameter settings
  - Software errors
  - Faulty hardware
- Hazardous substances can be emitted from drive system components due to, for example:
  - Incorrect disposal of components

1.4 Safety labels and signs

1.4.1 Safety labels

Safety labels are attached to the cabinet to alert personnel of potential hazards when working on the equipment. The instructions on the safety labels must always be followed, and the labels must be kept in a perfectly legible condition.

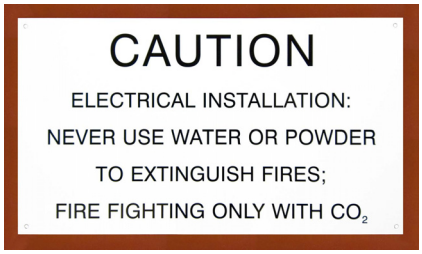
Fig. 1-1 Safety labels

1.4.2 Safety signs

Depending on the delivery, the following additional safety signs are provided:

Fire fighting

The sign explains the procedure when fighting fire in electrical equipment. The sign should be installed well visible near the drive.



Dimensions: 50 x 30 cm

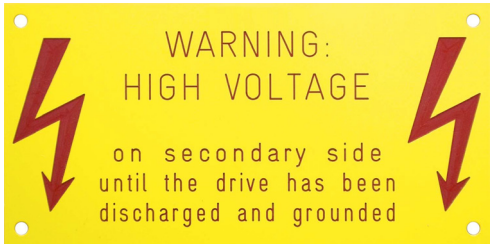
Pacemaker

The magnetic field of the drive can influence the functioning of pacemakers. The sign should be installed at the entrance to the drive room or at a minimum distance of 6 meters (20 ft.) from the drive to stop personnel with pacemakers approaching the drive.

Diameter: 32 cm

High voltage

The sign should be installed clearly visible at the main circuit breaker in the switchgear room. The sign alerts personnel to the high voltage which can be present on the secondary side of the input transformer until the main circuit breaker has been opened and secured and the drive has been de-energized and grounded.



Dimensions: 20 x 10 cm

Chapter 2 - Power electronics and cabinet features

2.1 Overview

The air-cooled ACS5000 is a general-purpose frequency converter for the control of standard induction and synchronous motors.

For information on the power and voltage range of the drive, see the *Technical specifications* and / or the *Rating plate* of the drive.

The following drive configurations are described in the manual:

- ACS5000 *(1)* with integrated transformer *(2)*

- ACS5000 *(1)* with non-integrated transformer *(2)*

The following sections provide an overview of:

- the available main and auxiliary power configurations,
- the power electronic components of the drive,
- the cooling system,
- cabinet features such as the grounding switch and the electro-mechanical door interlock.

2.2 Power supply configurations

The drive requires two independent power supplies:

- Main power supply for the power electronic components
- Auxiliary power supply for the control and cooling equipment

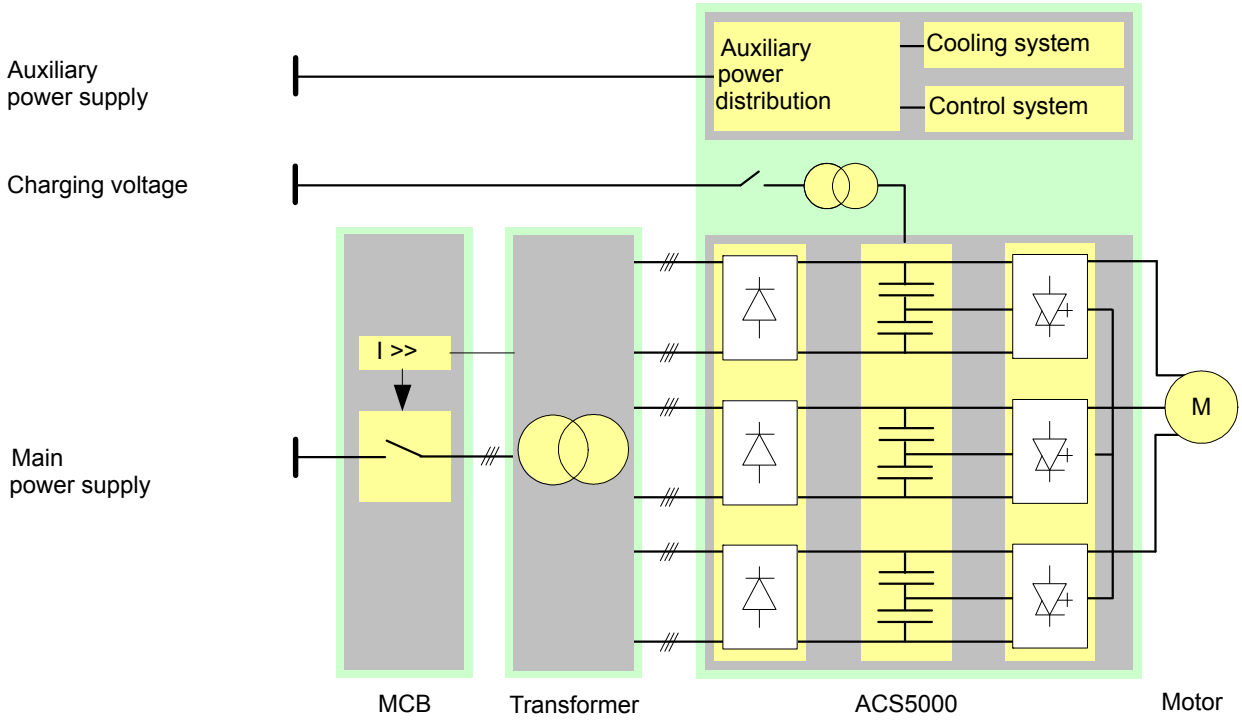


Fig. 2-1 Drive overview

2.2.1 Main power supply with input transformer configurations

The main power is fed to the drive by the input transformer which adapts the line voltage to the required voltage for the drive. The input transformer is always part of the drive system. Two installation solutions are available for the transformer.

- Integrated

  The integrated transformer is always placed on the left side of the drive. The length of the cabinet depends on drive power. For the integrated configuration, a dry-type transformer is used.

- Non-integrated

  The transformer is external to the drive. The transformer can either be an oil-immersed or dry-type device.

2.2.2 Auxiliary power supply configurations

The drive needs auxiliary power for:

- the cooling system and a short-time power demand for the charging unit of the drive.
- the control hardware.

  One single-phase power supply or two single-phase power supplies feed the power to the drive.

The drive can be equipped with the following power supply options:

- Standard power supply

  The auxiliary power for the cooling system and the charging unit is supplied to the drive by a three-phase AC power supply.

  The auxiliary power for the control hardware is supplied by an uninterruptible power supply (UPS) to a separate single-phase AC input.

- Optional power supplies

  The total auxiliary power is supplied to the drive by a three-phase AC power supply. If the power supply is interrupted, drive internal capacitors provide a backup for the control hardware between 0.5 and 3 sec. The backup enables the drive to ride-through or to perform a controlled shutdown.

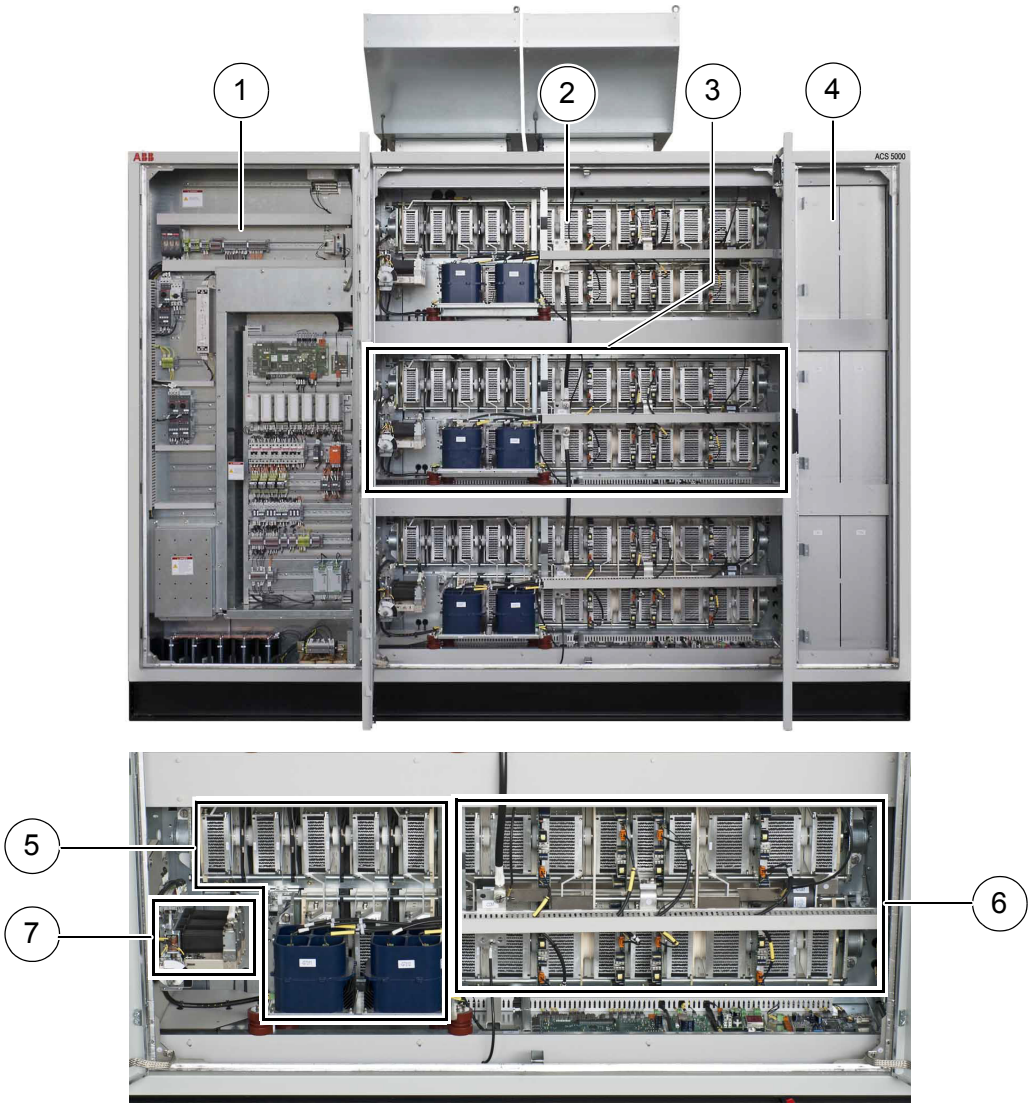
In addition to the above power supplies, a separate power supply is needed for

- optional cabinet space heaters (110 / 230 V (AC)),
- the excitation unit (option),
- the synchronizing bypass unit (option).

For information on the configuration of the auxiliary power interface present in the drive, see *Appendix D – Wiring diagrams*.

For information on the rated voltage(s) and current(s), see *Rating plate* of the drive.

2.3 Drive topology



1 Control compartment
2 Rectifier/inverter compartment
3 Power cell
4 DC-link capacitors
5 Rectifier
6 Inverter
7 Grounding switch

Fig. 2-2 Overview

2.3.1 Front end

The front end of the drive consists of three 12-pulse diode rectifiers. The three rectifiers add up to a network-friendly 36-pulse system. The front end rectifies the AC line voltage of the supply network and connects its output to the minus, neutral point, and plus of the DC link. The front end allows two-quadrant operation.

2.3.2 DC link

The DC link consists of the charging unit *(1)*, the grounding switches *(2)* and the DC capacitors *(3)*.

Fig. 2-3 DC link

Charging unit

Charging

The unit charges the DC-link capacitors before the MCB is closed to connect the drive to the main power supply. Thus, excessive inrush currents are prevented.

The charging unit is fed from the auxiliary power supply and charges the DC link to 90% of the steady state voltages.

The charging sequence is started by pressing the SUPPLY ON push-button on the control compartment door. After the charging sequence has finished, the charging unit is disconnected from the medium voltage circuit, the MCB is closed and the DC link will reach its nominal level.

Stand-by mode

Once the DC link is charged, it is possible to keep the drive in this state to facilitate a more rapid startup procedure. The losses during stand-by mode are approx. 1% of the nominal power and are caused from small losses from the rectifiers, the inverters and the auxiliaries.

Discharging

Discharging is initiated by pressing the SUPPLY OFF pushbutton on the control compartment door. The energy stored in the DC link is dissipated in the parasitic resistors of the power part of the drive.

Grounding switches

The grounding switches are safety devices that enable safe access to the medium voltage compartments of the drive. There is a grounding switch in each power cell.

Fig. 2-4 Grounding switch

When all three switches are in position **grounded**, the rectifier, the DC link and the inverter in each power cell are connected to the PE ground busbar.

The switch is electromechanically interlocked with a discharge monitoring circuit to prevent closing of the switch while the DC-link capacitor is still charged.

Grounding the drive is only possible after the main power supply has been disconnected and the DC link has discharged. When the voltage is below 50 V (DC), the lamp GROUNDING SWITCH UNLOCKED *(Fig. 2-5: 1)* then light up and the grounding switches can be turned to position **grounded** *(Fig. 2-5: 2)*.

When the grounding switches are in position **grounded**, the door safety switch of the rectifier/inverter compartment is released, and the door can be opened.

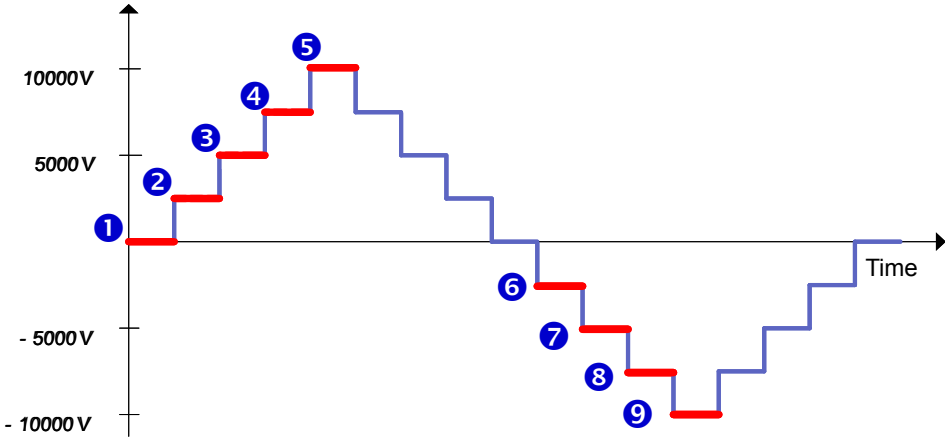
1 Lamp "Grounding switch released"
2 Storage place of grounding switch lever
3 Grounding switch lever inserted
4 Grounding switch position: drive is grounded
5 Grounding switch position: drive is not grounded

Fig. 2-5 Grounding the drive

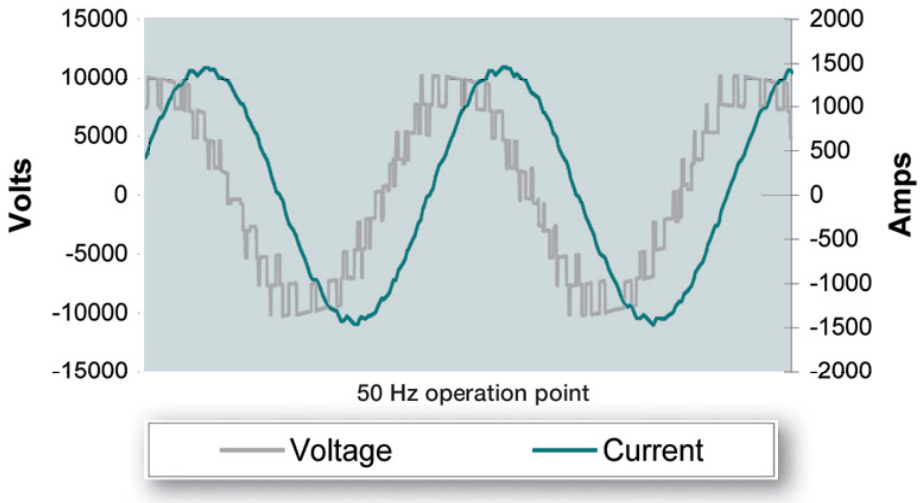
2.3.3 INU - Inverter unit

The three inverters convert the DC-link voltage to the required AC motor voltage and frequency.

The inverters are self-commutated, 5-level voltage source inverters. As a result of the multi-level topology, the drive produces a total of nine switching levels.



The resulting waveforms permit the application of standard motors.



2.4 Terminal compartment

The terminal compartment provides the terminals for the feeder and motor cables and the ground busbar for the termination of the ground cable and the cable screens. The terminal compartment is accessible when the swing frame of the control compartment is open.

Fig. 2-6 Terminal compartment

2.4.1 Cable entry

The cable entry is prepared in the factory according to the cable entry configuration ordered:

- Top or bottom cable entry
- Type of entry plate

For further information, see:

- *Appendix C – Mechanical drawings*
- *6.6 Cable entries*

2.5 Input transformer

The transformer supplies the three 12-pulse rectifier bridges with the required phase-shifted voltages, and voltage levels. This configuration results in a network-friendly 36-pulse system.

2.5.1 Installation solutions

Depending on the ordered configuration, the drive and the transformer are prepared for the following installation solutions:

- Integrated

  The drive and the transformer form a single unit.

The transformer is always placed on the left side of the drive.

The transformer primary and secondary cables are connected inside the terminal compartment of the drive.

- Non-integrated

  The drive and the transformer are installed in different locations. The maximum permitted length for the secondary transformer cables determines the distance between drive and transformer.

  The transformer is equipped with an additional compartment *(1)*. The compartment is divided into the control compartment *(2)*, and the terminal compartment *(3)* for the power cables. The terminal compartment is located behind a bolted door.

2.5.2 Control equipment

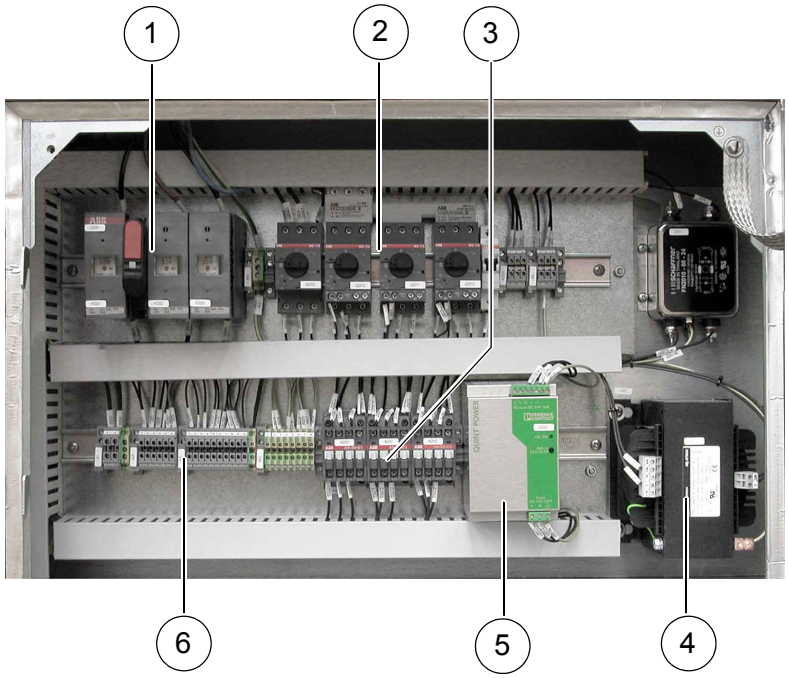
Protection relays

The protection relays monitor the input phase currents of the two primary winding systems of the 36-pulse transformers. The pick-up values for overload and short-circuit are set in the factory and must not be changed.

- For information on the settings, see list of protective devices.
- For information on the associated electric circuits of the relays, see *Appendix D – Wiring diagrams*.

Control compartment

If the non-integrated transformer is supplied by ABB, the transformer cabinet contains a control compartment.



1 Circuit breaker for auxiliary voltage
2 Starters for the fan units
3 Auxiliary contactors for the fan units
4 Auxiliary power transformer
5 Power supply unit for the protection relays
6 Customer terminals

Fig. 2-7 Control compartment of the transformer

2.6 Cabinet design

The riveted and folded cabinet construction of the drive ensures a strong, flexible and self-supporting framework. The construction avoids the need for additional skeletal support and provides effective protection against electromagnetic emissions.

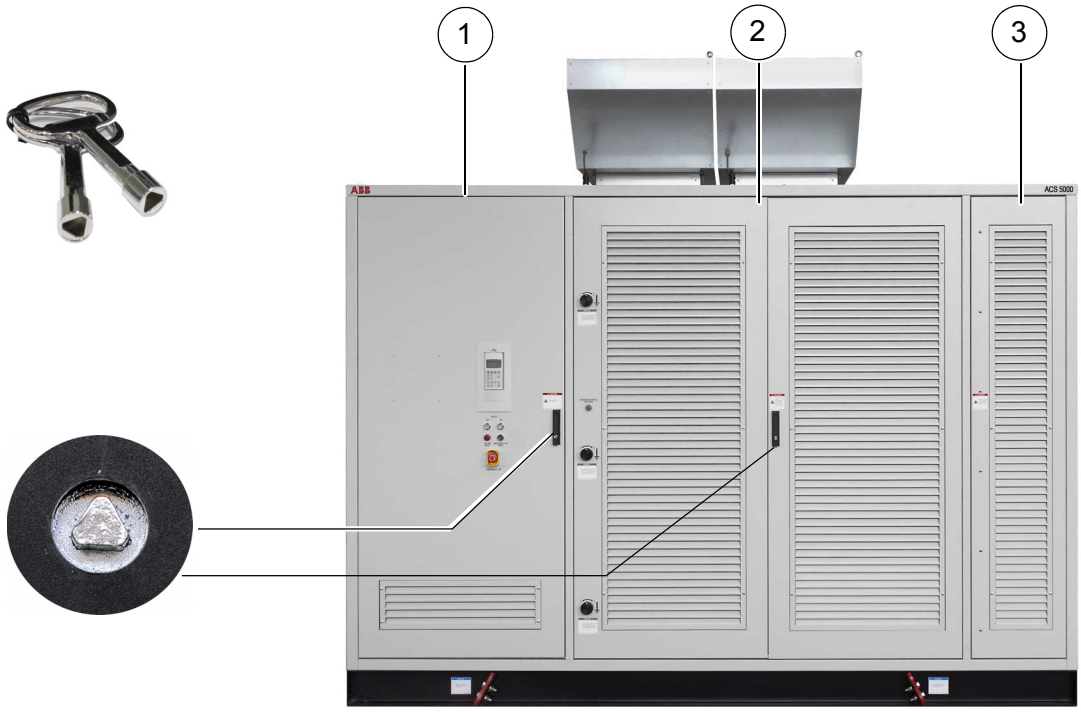
EMC is achieved in two ways:

- The cabinet design consists of folded, galvanized sheet metal plates (the thickness is approximately 2 mm). The space between the rivets is minimized.
- The inside walls are not painted, because paint tends to reduce the effectiveness of metallic bonding which is important to successful EMC. Only the front of the cabinet is painted, all other walls are galvanized.

2.7 Door locking system

The doors of the drive are either lockable or bolted. Additionally, the door of the rectifier/inverter compartment of the drive is electromechanically secured. The lockable doors have locks with different inserts than the control compartment door. The different lock inserts ensure that only authorized personnel can open the doors.

The doors of the integrated transformer are bolted.



1 Door of control compartment: lockable
Swing frame inside control compartment: bolted
2 Door of rectifier/inverter compartment: electromechanically locked
Door cannot be opened when the main power is connected
3 Door of DC-link-capacitor-cabinet: bolted

Fig. 2-8 Door locks

For further information, see *10.6.7 Door handles*.

2.8 Cooling system

2.8.1 Configurations

The standard drive, the integrated transformer, and the non-integrated transformer can each be equipped with a redundant fan configuration. This configuration ensures that the operation of the drive system is not interrupted if one of the standard fan units fails.

The number of fan units on the drive depends on the drive power.

1 Fan 1
2 Fan 2 (stand-by unit)

2.8.2 Function

Operation

The standard fan unit is switched on by the control system of the drive when the DC link has been charged. The fan unit continuous to run for a preset time after the main power has been switched off to remove the heat from the interior of the cabinet.

Fig. 2-9 Air flow through the drive

When a standard fan of the drive or a fan of the transformer fails, the control system of the drive automatically switches on the stand-by fan.

Fault indication

The CDP control panel of the drive indicates a failure of a fan as follows:

- **CoolCircuit1Alm** if a fan of the drive fails
- **CoolCircuit2Alm** if a fan of the integrated transformer fails
- The alarm - fault lamp on the door of the control compartment starts to flash.

Air flow monitoring

Air pressure switches monitor the air flow through the cabinet of the drive and the cabinet of the integrated transformer.

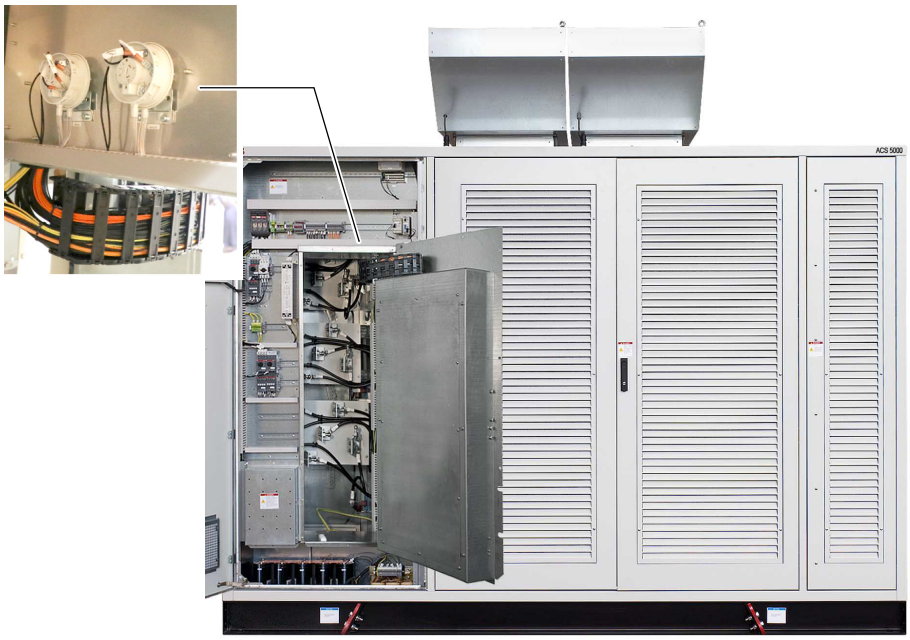


Fig. 2-10 Location of air pressure switch in the drive

Fig. 2-11 Location of air pressure switch in the transformer

Separate air pressure switches in each cabinet monitor the air flow through the filter mats.

When the filter mats are clogged and the pressure drop reaches the specified final pressure loss, the message **Conv1CoolAirFilter** displays on the CDP control panel, and the alarm / fault lamp lights up on the control compartment door.

Chapter 3 - Control system

3.1 Overview

The control compartment 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 devices. Depending on the control concept of the drive system, the remote control devices include a higher-level control system and / or remote operator stations.

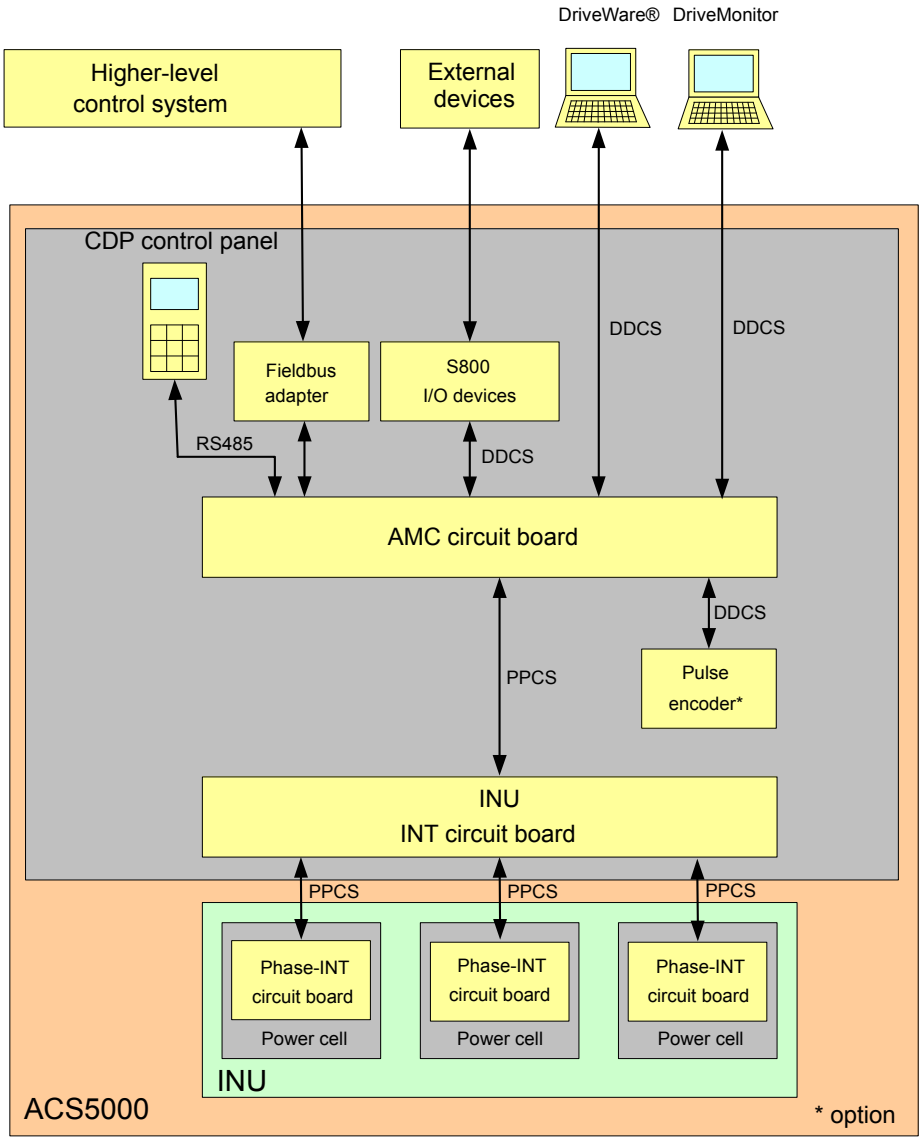
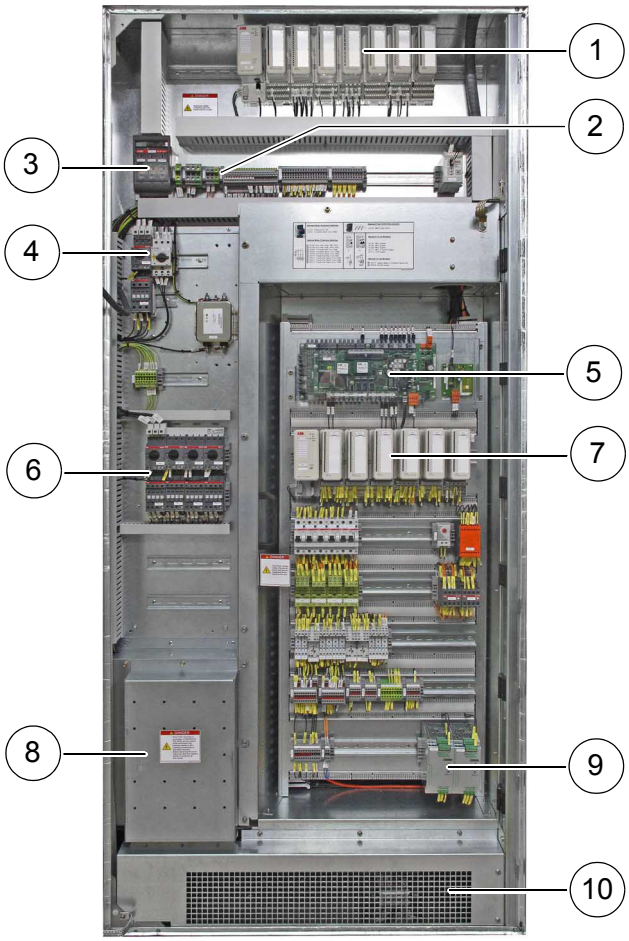


Fig. 3-1 Block diagram of control system

3.2 Main components



1 Optional I/O station
2 Customer terminals
3 Circuit breaker for auxiliary voltage
4 Circuit breaker for charging transformer
5 AMC circuit board and main modulator
6 Starters for fan units
7 Standard I/O station
8 Charging transformer for DC link
9 24 V power supply units
10 230 V (AC) transformer

Fig. 3-2 Control compartment

3.2.1 Local control panel

The local control panel on the door of the control compartment serves as the basic user interface for monitoring, control, operation of the drive, and setting of parameters.

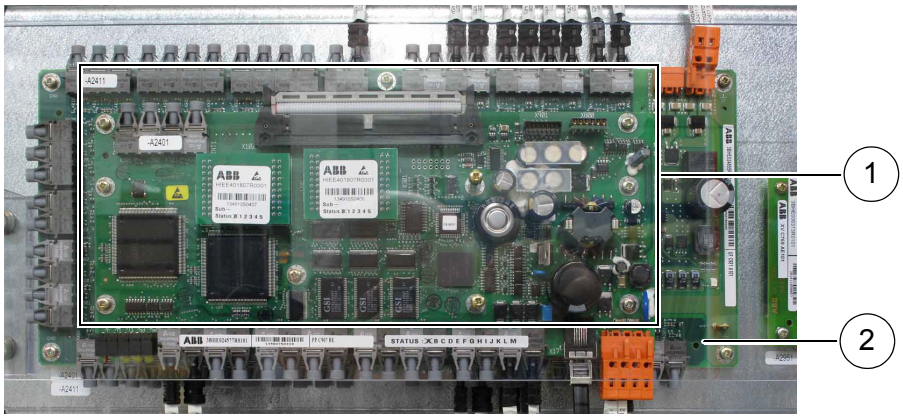
For further information, see *Chapter 8 - Operation* and *Chapter 9 - CDP control panel*.

3.2.2 AMC circuit board

Overview

The AMC circuit board is the major component of the drive's control system and performs general drive, motor control, and closed loop functions. The main internal control devices 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 via the INT circuit boards to the Phase INT circuit boards inside the power cells.



1 AMC circuit board
2 INT circuit board

Fig. 3-3 Location of AMC circuit board

Control tasks

The AMC circuit board has specific control and closed-loop tasks assigned to it.

The AMC circuit board processes drive and status information, performs the speed and torque control tasks, and monitors 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 adjusted by parameter settings.

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

- *Main circuit breaker*
- *Grounding switches*
- *Door locking system*
- *Cooling system*

For further information on control, protection and monitoring functions, see *Signal and parameter table.*

Parameters

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 adjusted during commissioning to the specific application of the drive to activate the specific control, monitoring and protection functions for the driven process, and to define the signals and data to be transferred between drive and external equipment.

For further information on the parameters, signal allocation, signal type selection, signal inversion, scaling and filtering, see *Signal and parameter table* provided.

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 further information, see:

- *Important note on main circuit breaker*
- *Main circuit breaker engineering guideline*

Direct torque control

The speed and torque of the motor is controlled by DTC (direct torque control). The DTC motor control platform is unique to ABB and has been proven in all variable speed drives of the ACS product range. DTC provides accurate speed and torque control, and high dynamic speed response. DTC is implemented on the AMC circuit board.

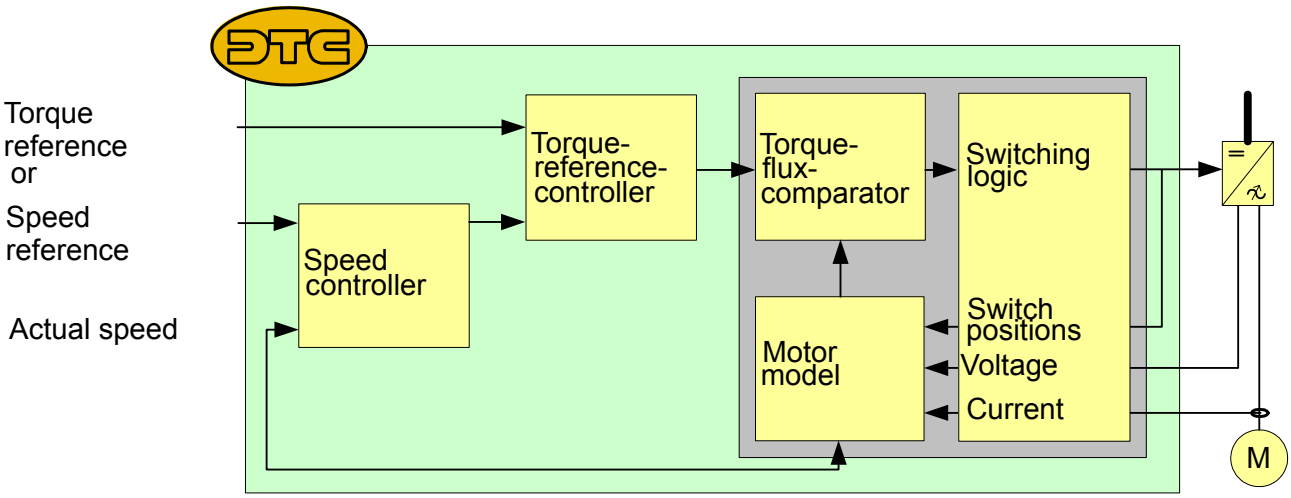


Fig. 3-4 DTC torque control

Switching of the semiconductors in the INU is directly controlled in accordance with the motor core variables flux and torque.

The measured motor currents and DC-link voltages are inputs to an adaptive motor model. The model produces exact values of torque and flux every 25 microseconds. Motor torque and flux comparators compare the actual values to reference values which are produced by the torque and flux reference controllers.

Depending on the outputs from the hysteresis controllers, the switching logic directly determines the optimum switch positions every 50 microseconds and initiates switching whenever required.

Peripheral I/O modules

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

- Local *CDP control panel*
- *I/O modules* for parallel signal transfer to external devices
- Optional fieldbus adapters for serial data transfer to a higher-level control system
- PC-based service tools comprising:
  - DriveWare® software tools

    DriveWare® 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.
  - DriveMonitor (option)

    DriveMonitor is a monitoring and diagnostics tool that allows access to the drive from any location in the world via a secure Internet connection.

3.3 I/O modules

The section provides an overview of the communication devices used in the drive to transfer control, status, monitoring and protection signals between the drive and higher-level control systems or operator desks.

The following communication devices are available:

- *S800 I/O system*
- *Fieldbus communication interfaces (option)*

3.3.1 S800 I/O system

Overview

Internal and external, analog and binary I/O signals are connected to the control system by standard S800 I/O from the ABB Advant control system.

The S800 I/O system is configured from the following interface packages:

Standard package

The standard interface package is always part of the drive.

I/O module	Wiring diagram designation	Cluster position
DI810	A2511	C1P1
DO810	A2521*	C1P2
DI810	A2531	C1P3
DO820	A2541	C1P4
DI810	A2551	C1P5
DO820	A2561*	C1P6
AI810 **	A2571**	C1P7

* *No customer connections. For drive internal use.*
** *For drive internal use (option).*

Optional packages

The packages CI1 and CI2 provide additional I/O modules for controlling and monitoring of external equipment (eg, motor, transformer).

Package	I/O module	Wiring diagram designation	Cluster position
C1, C2	AI820	A5311	C3P1
C1, C2	DI810	A5321	C3P2
C1, C2	AO810	A5331	C3P3
C1, C2	DO820	A5341	C3P4
C2	AI830	A5351	C3P5
C1, C2	DI810	A5361	C3P6
C2	AI830	A5371	C3P7

I/O modules

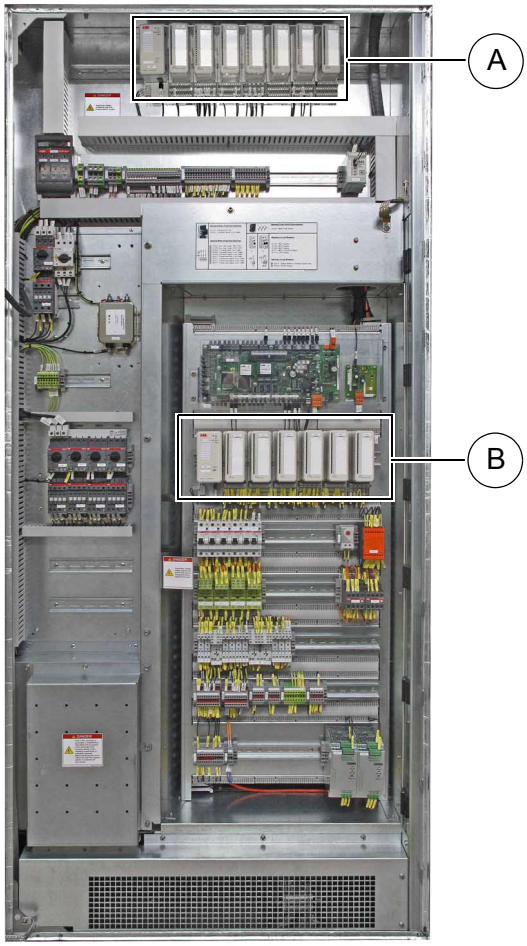
A complete I/O station comprises the I/O modules and the TB 820 bus modem. An I/O module consists of an I/O module and a module terminal unit (MTU).

I/O module type		No. of channels	I/O rating
Digital input	DI810	16	24 V (DC)
Digital output	DO810	16	24 V (DC)
Analog input	AI810	8	0 – 20 mA, 0 – 10 V
Analog input	AI820	4	+/- 20 mA, +/- 10 V, +/-5 V
Analog input	AI830	8	PT100 resistance measurement
Analog output	AO810	8	0 – +20 mA, 4 – +20 mA

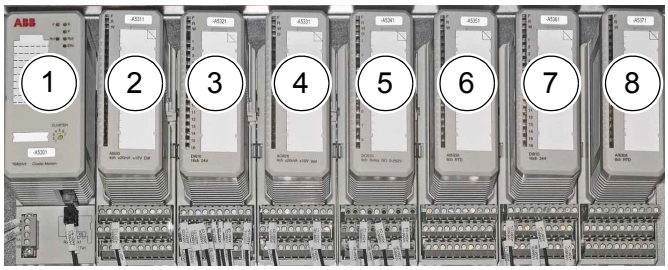
For further information, see the following manuals:

- *S800 I/O - General information and installation, user's guide*
- *S800 I/O - Modules and termination unit, user's guide*

I/O stations



A Optional I/O station



1 TB820 bus modem (A5301)
2 AI820 analog input (A5311)
3 DI810 digital input (A5321)
4 AO810 analog output (A5331)
5 DO820 digital output (A5341)
6 AI830 analog input (A5351)
7 DI810 digital input (A5361)
8 AI830 analog input (A5371)

B Standard I/O station

1 TB820 bus modem (A2501)
2 DI810 digital input (A2511)
3 DO810 digital output (A2521)
4 DI810 digital input (A2531)
5 DO820 digital output (A2541)
6 DI810 digital input (A2551)
7 DO820 digital output (A2561)
8 AI810 analog input (A2571)

Fig. 3-5 S800 I/O stations

For information on the signal allocation of the interfaces, see *Appendix D - Wiring diagrams*.

I/O module identification

The I/O modules are identified in the drive and in the wiring diagrams by their technical designation (eg, A2511). Additionally, a cluster-position designation is used in the wiring diagrams and in the software. This designation has no relevance to the connection of the control cables but is used to help identify a device in the software and the *Signal and parameter table*.

A cluster is a synonym for the group of S800 I/O modules of the control system. Each I/O module belongs to a cluster (C) and occupies a fixed position (P) within the cluster. The relation between cluster and position is expressed by the designation CxPy, with x representing the number of the cluster and y identifying the number of the position.

All I/O modules used in the drive belong to cluster 1 and each I/O module occupies a fixed position between 1 and 10.

The fixed position is the reason why there can be empty MTUs in the control compartment. Example: If interface package CI2 is not part of the control compartment, the MTUs of CI2 are present.

Communication with AMC circuit board

The AMC circuit board communicates with the S800 I/O system via the TB 820 bus modem. A fast optical link connects the devices with each other. The optical link uses the standard DDCS protocol. Data between the bus modem and the I/O modules is transmitted through the S800 ModuleBus. A section of the ModuleBus is contained in each MTU where the I/O module is plugged into.

Wiring

The external I/O signals of the standard S800 I/O station are connected to separate terminals in the control compartment. The internal wiring between terminals and I/O modules is made in the factory.

The wires to the optional S800 I/O station are connected to the module terminal units.

3.3.2 Fieldbus communication interfaces (option)

Overview

Fieldbus communication interfaces are used for the bidirectional communication between the drive and a higher-level process control system. Typically, operational commands, status messages of the drive, speed or torque reference values, and actual values are transmitted.

For further information on data transmission and on data and signal allocation to the transmitted datasets, see

- *Signal and parameter table*
- *Installation and start-up guide* of the installed fieldbus adapter
- *Engineering documents*

Available fieldbusses

The drive can be equipped with one of the following fieldbus adapters.

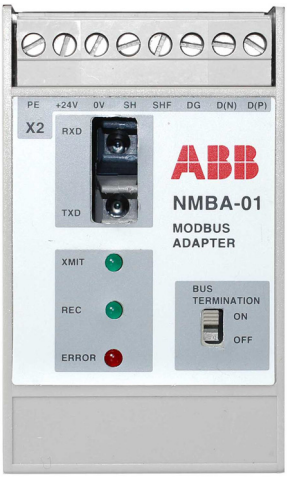
Tab. 3-1 Fieldbus adapters

Fieldbus	Adapter type
Ethernet	NETA-21
Modbus	NMBA-01
Profibus DP	NPBA-12

Ethernet

Terminal assignment	
RJ-45	Ethernet connection
X1:1	+24 V (DC) supply
X1:2	0 V

Modbus



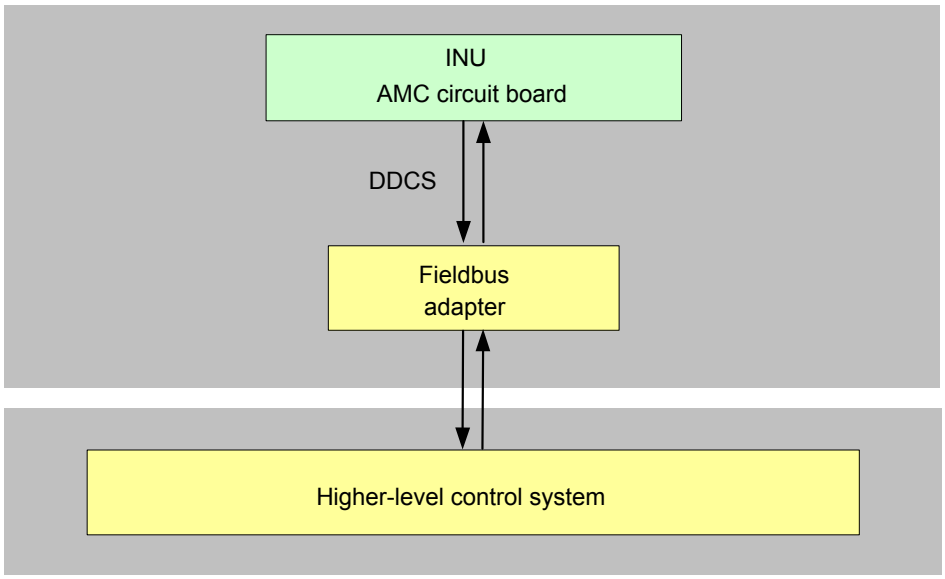
Terminal assignment			
X2:1	D(P)	Data positive	Customer connections
X2:2	D(N)	Data negative	
X2:3	DG	Data ground	
X2:4	SHF	Shield AC ground via RC filter	
X2:5	SH	Shield ground direct	
X2:6	0 V	Power supply (24 V (DC) +/- 10 %)	
X2:7	+24 V		
X2:8	PE	Ground	

Profibus

NPBA-12 terminal assignment			
X1:1	A	Data negative (conductor 2 in twisted pair)	Customer connections
X1:2	B	Data positive (conductor 1in twisted pair)	
X1:3	A	Data negative (conductor 2 in twisted pair)	
X1:4	B	Data positive (conductor 1in twisted pair)	
X2:5	24 V	Power supply (24 V (DC) +/- 10 %)	
X2:6	0 V		
X2:7	DG	Cable data ground (optional 3rd conductor) Connected to module ground via a 1MOhm/15 nF RC network	Customer connections
X2:8	SH	Cable shield. Internally connected to module	

Communication with AMC circuit board

The fieldbus adapter is connected to channel 0 of the AMC circuit board of the INU via optical fibers.



Location

The fieldbus adapter is DIN rail-mounted inside the control compartment *(Fig. 3-6: 1)*.

The indicated mounting position can vary depending on the number of optional devices present in the control compartment.

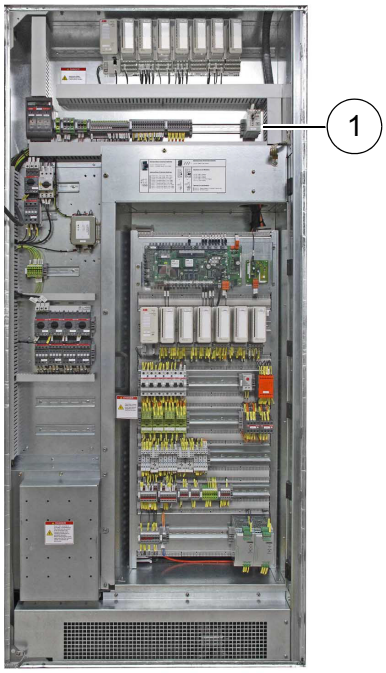


Fig. 3-6 Location of fieldbus and pulse encoder interfaces

3.3.3 Pulse encoder interface NTAC (option)

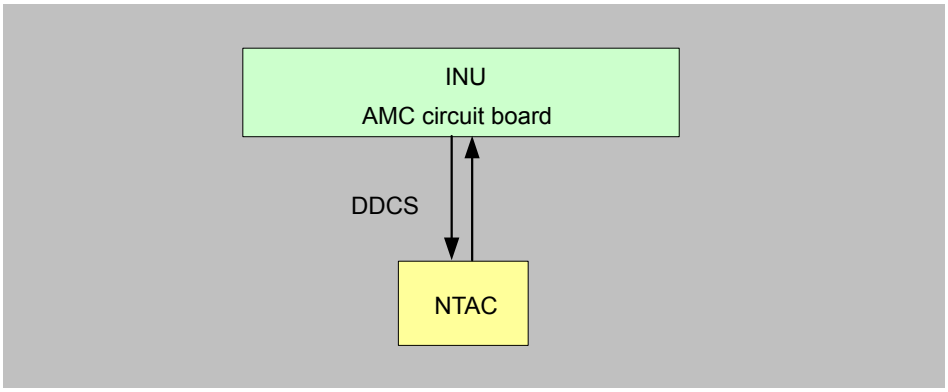
Overview

The NTAC interface is part of the control system of the drive if pulse encoder feedback is used to control the motor.

Terminals X1			Terminals X2		
1	A+	Channel A	1	-V	0 V
2	A-		2	-V	24 V
3	B+	Channel B	3	+V	
4	B-		4	24 / 25	
5	Z+	Channel Z	5	15	
6	Z-		6	24	
7	SH	Shield	7	0 V	
8	SH		8	+24 V	

Communication with AMC circuit board

The NTAC module communicates with the AMC circuit board of the INU via a fast optical link using the standard DDCS protocol. The optical fibers are connected to channel 1 of the AMC circuit board.



Location

The NTAC interface is DIN rail-mounted inside the control compartment *(Fig. 3-6: 1)*.

The indicated mounting position can vary depending on the number of optional devices present in the control compartment.

Chapter 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 of environmental conditions: Classification of groups of environmental parameters and their severities; Transportation'.

2K4 Climatic conditions		
	Low air temperature	-40 °C
	High air temperature ■ Unventilated enclosures ■ Ventilated enclosures / outdoor	 70 °C 40 °C
	Relative humidity	95%
	Absolute humidity	60%
2B1 Biological conditions		
	Flora	No
	Fauna	No
2M1 Mechanical conditions		
	Stationary vibration sinusoidal ■ Displacement amplitude ■ Acceleration amplitude	 3.5 mm (2 – 9 Hz) 10 m/s^2 (9 – 200 Hz) 15 m/s^2 (200 – 500 Hz)
	Stationary vibration random ■ Acceleration spectral density	 1 m^2/s^3 (10 – 200 Hz) 0.3 m^2/s^3 (200 – 2000 Hz)
	Non-stationary vibration (including shock) ■ Shock response spectrum	 100 m/s^2
	Free fall	0.1 m (for masses > 100 kg)
	Toppling	No (for masses > 100 kg)
	Rolling, pitching ■ Angle ■ Period	 No No
	Steady-state acceleration	20 m/s^2

Transport time Two months maximum

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 Lifting and transportation

It is recommended to have the following information at hand before transporting the cabinet:

- *Appendix C – Mechanical drawings* provides details on dimensions, weight, and of center of gravity of the cabinet.
- *10.6 Corrective maintenance* provides instructions if the door of the AFE-INU compartment cannot be opened

4.4.1 General notes on transportation

- The cabinet can be transported using a crane or a forklift.
- Drive components can be damaged during transportation. Therefore, the cabinet must be transported in an upright position.
- When transporting the cabinet, ensure that no dirt enters. Keep the doors closed. Metallic dust in particular may cause damage and lead to malfunction when the cabinet is powered up.

4.4.2 Using a crane

- Use lifting equipment (eg, web slings, chain slings, round slings, safety hooks, shackles) that corresponds to the weight of the cabinet.
- Attach slings to the lifting brackets on the front and on the back of the base frame *(Fig. 4-1: 1)*.
- Do not pass a sling through the hole.
- To attach a sling, use appropriate safety hooks or shackles *(Fig. 4-1: 2)*.
- Very that the slope angle *(Fig. 4-1: 3)* corresponds to the weight of the cabinet.
- Protect the edges of the cabinet *(Fig. 4-1: 4)*.

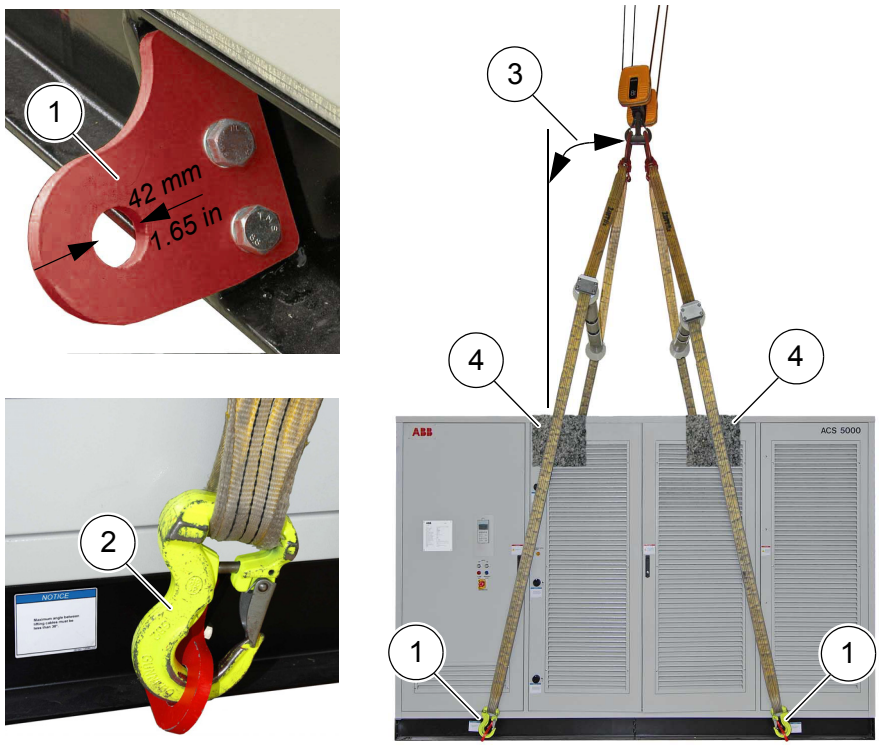


Fig. 4-1 Transporting the cabinet by crane

- Observe the center of gravity.
- Lift the cabinet slowly and steadily to the required clearance height maintaining the cabinet in upright position.
- Check the horizontal position of the cabinet. Reposition the slings if necessary.

4.5 Storage

4.5.1 Storage conditions

The minimum requirements for storage are based on IEC 60721-3-1 'Classification of environmental conditions: Classification of groups of environmental parameters and their severities; Storage'.

1K4 Climatic conditions		
	Air temperature	-25 – +55 °C
	Relative humidity	5 – 100%
	Absolute humidity	0.5 – 29%
1Z3 Special climatic conditions		
	Movement of surrounding air	30 m/s
1B1 Biological conditions		
	Flora	Negligible
	Fauna	Negligible
1M3 Mechanical conditions		
	Vibration ■ Displacement amplitude ■ Acceleration amplitude	 3 mm (2 – 9 Hz) 10 m/s^2 (9 – 200 Hz)

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.

4.5.2 Storage

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

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

2 Add a desiccant of the appropriate quality:

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

The following quantity is needed when using a polyethylene foil:

- 10 units/m^2 foil

3 Close and lock the doors of the cabinet.

4 Use polyethylene or equivalent for packaging:

- 0,3 g/m^2/24h water vapor diffusion

5 Attach humidity indicators to the packaging.

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

4.6 Storage and handling of spare parts

4.6.1 Storage place conditions

- Temperature range: -5 °C – + 55 °C
- 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%
  If in doubt whether the maximum permitted humidity is exceeded, protect the spare parts by an external heater.

4.6.2 Handling precautions

NOTICE

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

Apply static-sensitive precautions when handling these components.

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

- Check the spare parts immediately after receipt for damages. Report any damage to the shipping company and the ABB service organization.
- Keep spare parts in their original packaging.
- Store printed circuit boards in antistatic bags or boxes.
- Ground yourself with a wrist strap before touching a component.
- Hold the component only at the edge.
- Put the component on a grounded working surface protected against electrostatic discharges.

4.7 Disposal of packaging materials and components

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

Chapter 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 on installation work

The installation includes the following work:

- *Preparing the floor*
- *Fixing the cabinet to the floor*
- *Installing the fan units*

5.3 General notes on installation

NOTICE

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.

5.3.1 Dimensions, clearances

For information on cabinet dimensions, clearances to be observed and fixing hole sizes, see *Appendix C – Mechanical drawings*.

5.3.2 Cabinet roof

The cabinet roof is not designed as a mounting base for, eg, foreign devices, cable ducts. Therefore, it is not permitted to install any foreign device on the roof.

5.3.3 Fire protection

Suitable fire protection measures should be applied to prevent fire spreading into the drive.

5.3.4 Cable duct material

Cable ducts should be of non-flammable material with non-abrasive surface.

All cable entries and exits should be protected to prevent dust, humidity and animals entering into the drive.

5.4 Preparing the floor

Condition of the floor

- Must support the weight of the cabinet
- Overall incline across 5 m must not exceed 5 mm
- Even
- Non-flammable, smooth and non- abrasive
- Protected against humidity diffusion

5.5 Fixing the cabinet to the floor

The cabinet provides a hole in each corner of the base for floor fixings. The holes are accessible from the outside.

Floor fixings are not supplied. Anchor bolts as illustrated, or screws and nuts of size M20 are recommended.

Fig. 5-1 Anchor bolt

5.6 Installing the cabinet

The drive and integrated transformer are delivered in separate transport units. The units are joined and fixed to the floor at the installation place.

After a transport unit has been positioned in the final location, do the following:

- Check the cabinets for misaligned doors and any gaps between cabinet walls and cabinet frame.

  To check the horizontal and vertical position of the transport unit, use a spirit level.

NOTICE

It is important that the cabinets are not buckled and that the roof plates are level. Otherwise the fan units cannot be installed properly. Improper installation may affect the cooling.

  If the floor proves to be not level and the incline cannot be corrected, place shims or leveling plates under the base frame to adjust the position of the transport unit.

- To fix joining surfaces with each other, remove the back walls of the adjoining transport units. The doors do not have to be removed.

  Fix the transport units with each other all around the joining surfaces.

  Supplied screws:

Item	Type	Identification
Hexagon head screw	M6x20	3ABD00012503

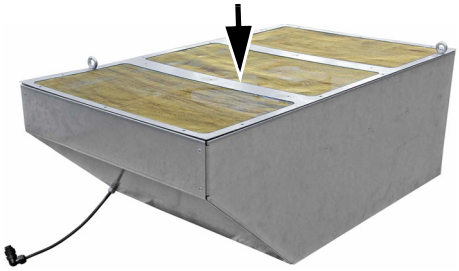
5.7 Installing the fan units

For information on the number of fan units to be installed, their location on the cabinet roof and the dimensions and weight, see *Appendix C – Mechanical drawings*.

1 To lift the fan unit onto the roof, use a crane.

To attach the lifting gear, use the supplied lifting eyes.

2 To access the fastening holes at the bottom of the housing, remove the screen.



~50 kg

3 To fasten the fan unit to the roof, use the supplied screws.

The four fastening holes are accessible through the cutouts in the mounting plate *(arrows).*

For information on the electrical installation, see *6.9 Power supply cables for fan units*.

Chapter 6 - Electrical installation

6.1 Safety

WARNING

Hazardous voltage!

Improper work could lead to life-threatening injury or death.

The electrical installation must be carried out by qualified personnel according to the site and equipment requirements, and the relevant electrical codes.

When the electrical installation is completed, the main and auxiliary power supply to the drive must not be switched on without the consent of the ABB commissioning personnel.

Take appropriate measures to prevent main and auxiliary power supply being switched on during installation.

6.2 Overview of installation work

The electrical installation includes the following wire and cable connections:

- *Power cables, ground cables, equipotential bonding conductor*
- *Auxiliary power, control and serial communication cables*
- *Power supply cables for fan units*
- *Transformer heating cable*

6.3 Cables requirements

Power cables

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

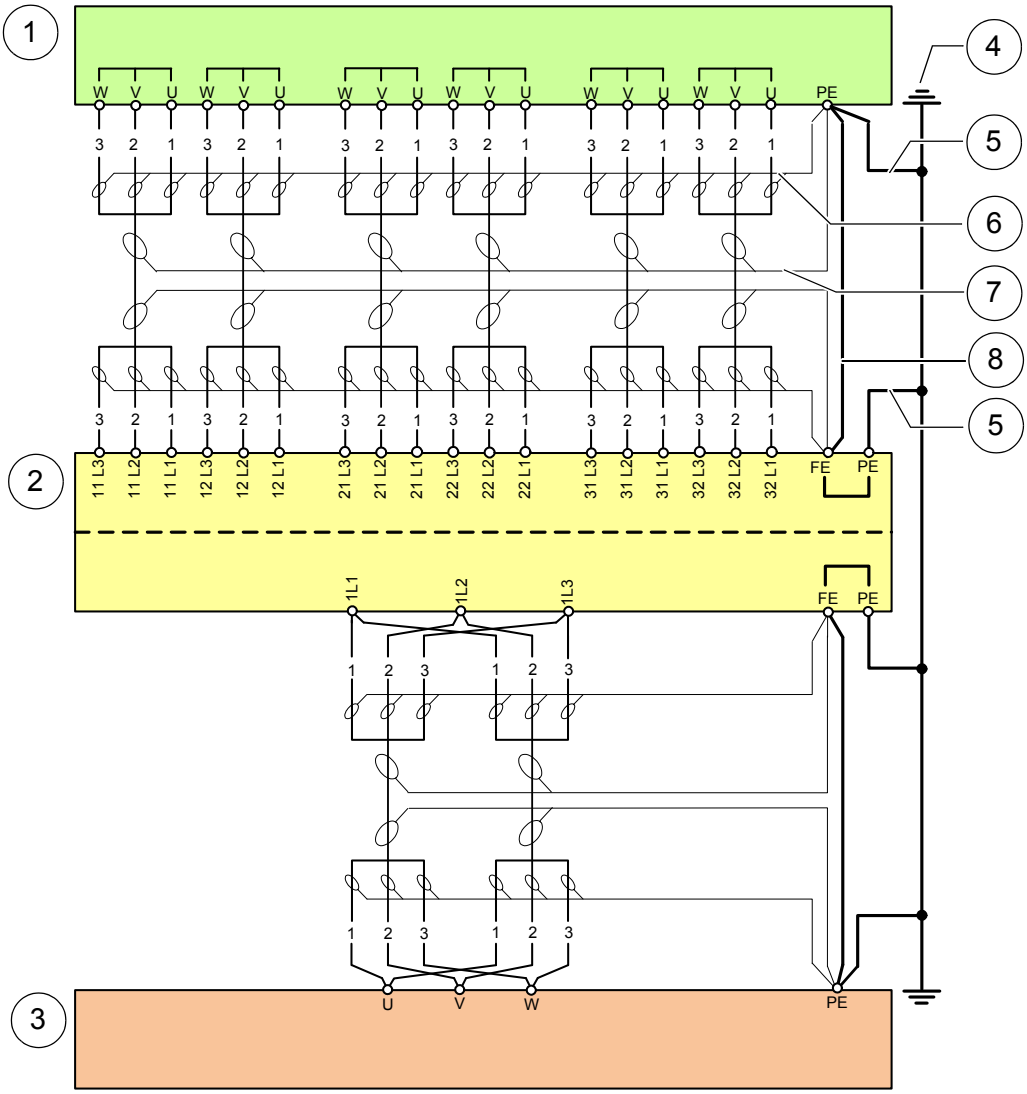
- *ACS5000 power cable specification*
- *Power cables engineering guideline*

Auxiliary and control cables

For information on the requirements for the auxiliary power cable and the control cables, see *Auxiliary power and control cables guideline.*

6.4 Ground cable connection and cable shield connections

Cable shields and cable armor are connected to the FE ground busbar (FE, protective earth) inside the drive. The ground cable is connected to the PE ground busbar of the drive.

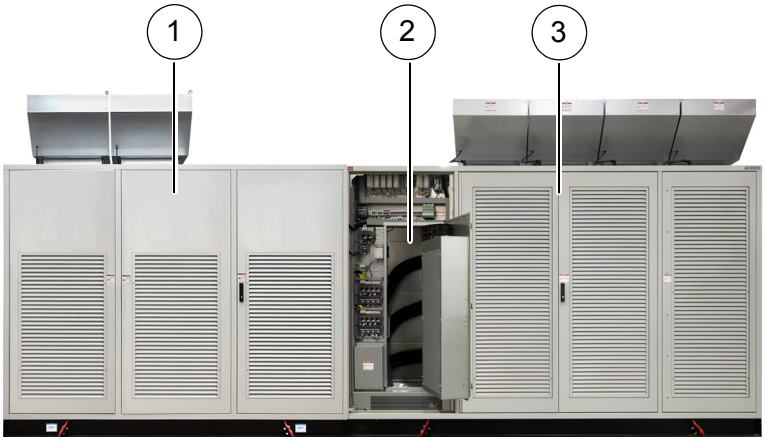


1 Transformer
2 Drive
3 Motor
4 Earth electrode
5 Ground cable
6 Cable screen
7 Cable shield
8 Equipotential bonding conductor

Fig. 6-1 Grounding the drive system

6.5 Cabling between drive and transformer

6.5.1 Drive with integrated transformer



1 Transformer
2 Terminal compartment
3 Drive

Fig. 6-2 Drive with integrated transformer

Cabling of a standard drive configuration includes the following connections between the drive and the transformer:

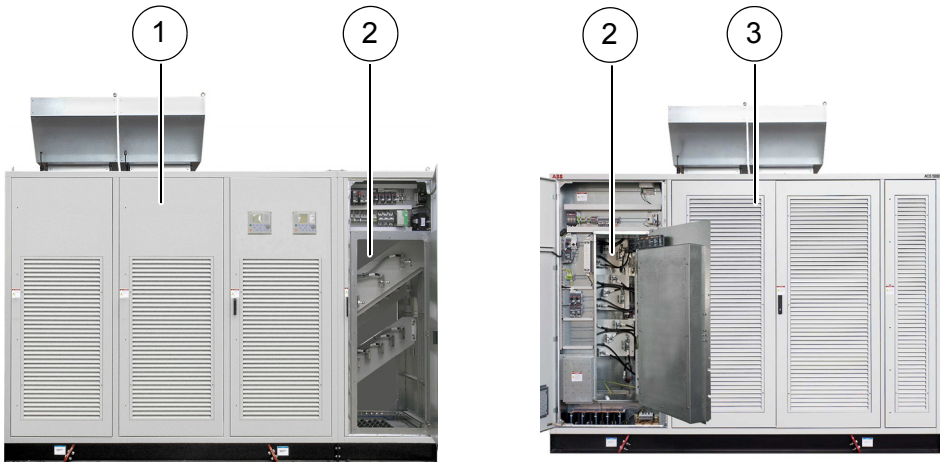
- Transformer secondary cables
- Auxiliary power supply for the two transformer protection relays
- Cable to the solenoid door lock in the transformer cabinet
- Cable from the PT100 temperature sensor in the transformer cabinet
- Three-phase power supply cable to each of the transformer fan units
- Cable for several alarm and trip signals from transformer protection relays, cooling fans, air filter and pressure monitoring
- Heating cable from the drive control compartment to the transformer cabinet (option)
- FE busbars of transformer and drive cabinet

All cables are prepared for connection. Power cables are rolled up in the transformer cabinet, control cables in the drive cabinet.

The cables can be identified by their specific number and are labeled with the designation of the terminal where they are connected to.

For information on each individual connection, see *Appendix D – Wiring diagrams*.

6.5.2 Drive with non-integrated transformer



1 Transformer
2 Terminal compartment
3 Drive

Fig. 6-3 Drive with non-integrated transformer

Cabling includes the following connections between the drive and the transformer:

- Transformer secondary cables
- Cable from the PT100 temperature sensor in the transformer cabinet
- Cable for the start command of the transformer fan units. Cooling fan configurations with a stand-by unit require a separate cable for the stand-by unit.
- Cable for several alarm and trip signals from transformer protection relays, cooling fans, air filter and air pressure monitoring
- Optional power supply cable for the heating cable of the transformer

For information on each individual connection, see *Appendix D – Wiring diagrams*.

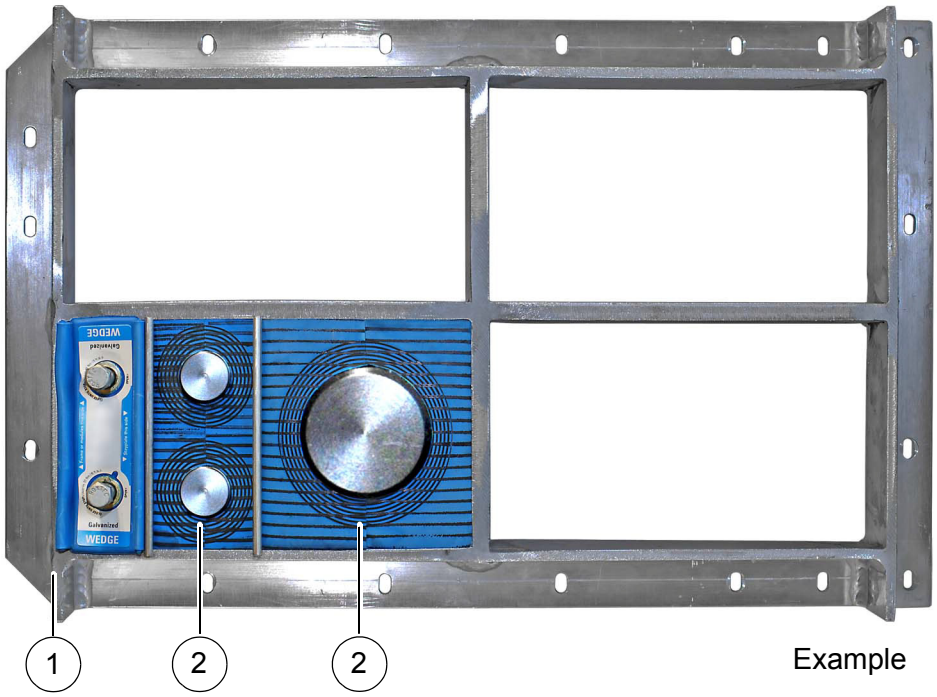
6.6 Cable entries

The drive is prepared for top or bottom cable entry with one or a combination of the following cable entries:

- *Cable entry with sealing modules, type 1*
- *Cable entry with cable glands*
- *Cable entry with EMC plates*

6.6.1 Cable entry with sealing modules, type 1

Usage	Power cables, ground cables, bonding conductors
Included in delivery	Cable entry frame *(1)*
Not included in delivery	Sealing modules *(2)*, accessories, tools

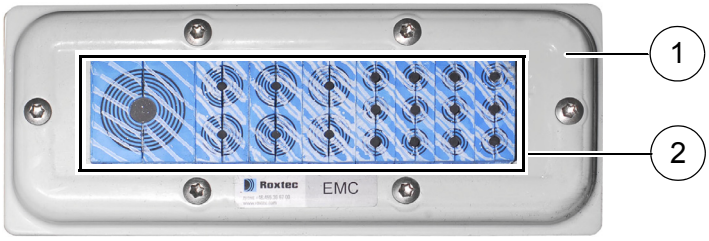


Example

6.6.2 Cable entry with sealing modules, type 2

Usage: Auxiliary power cables, control cables

Included in delivery: Frame *(1)*



Supplier: Roxtec AB (*www.roxtec.com*)

Not included in delivery: EMC sealing inserts *(2)*, installation tools and accessories

6.6.3 Cable entry with cable glands

Usage: Power cables, ground cables, bonding conductors
Auxiliary power cables, control cables

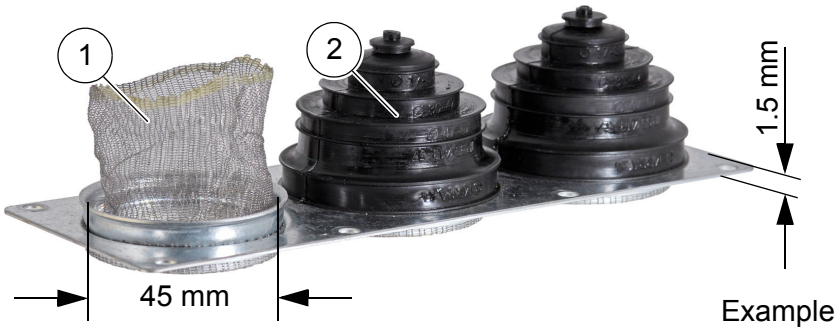
Included in delivery: Undrilled plate for cable glands

Not included in delivery: Cable glands, tools and accessories

6.6.4 Cable entry with EMC plates

Usage: Power cables, ground cables, bonding conductors

Included in delivery: Galvanized plate with net-like EMC sleeves *(1)* and sealing grommets *(2)*



6.7 Power cables, ground cables, equipotential bonding conductor

6.7.1 Further information

See *layout drawing* in *Appendix C – Mechanical drawings* for information on:

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

See *Appendix D – Wiring diagrams* for information on:

- Conventions for cross-references and device identification

6.7.2 Preparing the cable entries and the cables

NOTICE

Risk of damage or malfunction!

Waste inside the cabinet can cause damage or malfunction.

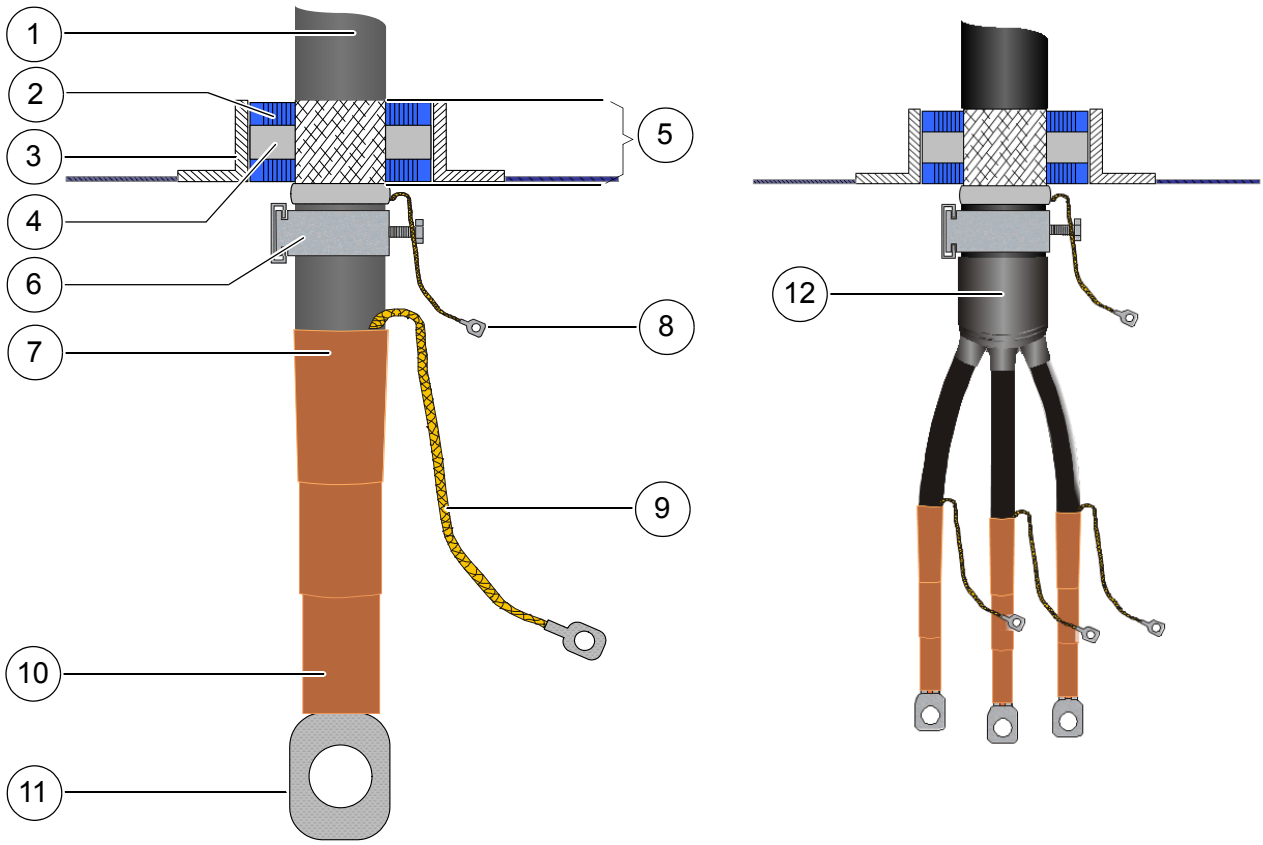
If possible, do not cut cables inside the terminal compartment. Retrieve any waste which accidentally dropped into the cabinet.

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.

Preparing cables for cable entries with sealing modules

- Prepare cables with an outer cable screen or shield for EMC bonding with the metal enclosure of the cabinet as illustrated in *Fig. 6-5*.
- Install the sealing modules according to the instructions of the sealing module supplier.



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

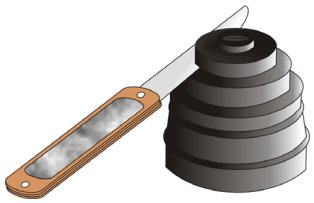
Fig. 6-4 Preparing power cables for sealing modules

Preparing cables for EMC plates

The orientation of the EMC plates is the same for top and bottom cable entry: the sealing grommets always face upwards.

1 Remove the grommets from the entry plate.

2 To ensure proper sealing, cut along the marking that corresponds to the cable diameter.



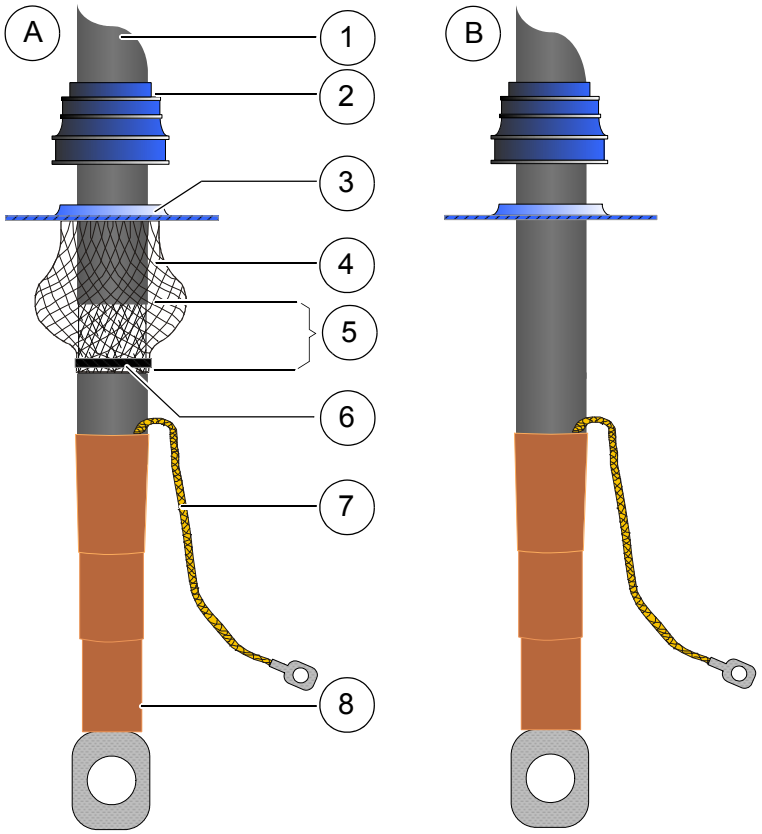
3 Slide the grommet onto the cable. The grommet must fit tightly to prevent water entering the cabinet.

The grommets can be discarded if cables are entered through the cabinet floor.

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

5 Prepare the cables as illustrated in *Fig. 6-5*.

- *(A)* illustrates how cables with an outer cable screen or shield are prepared for EMC bonding with the metal enclosure of the cabinet.
- *(B)* illustrates how cables without an outer screen or shield are prepared

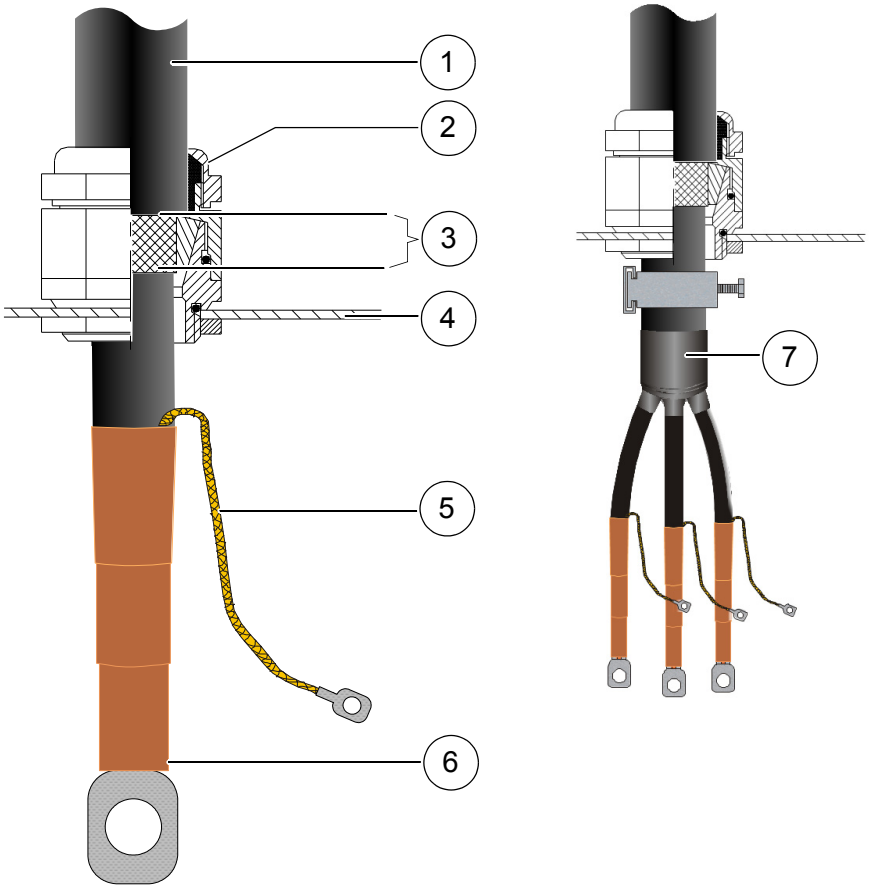


1 Outer cable sheath
2 Grommet
3 Entry plate
4 EMC sleeve
5 Conductor insulation removed to expose cable shield
6 Cable tie
7 Conductor screen extension to be connected to PE ground busbar
8 Heat-shrinkable termination

Fig. 6-5 Preparing power cables for EMC plates

Preparing cables for cable entries with 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. 6-6*.



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

Fig. 6-6 Preparing power cables for cable glands

6.7.3 Connecting the cables

Connecting the cables

NOTICE

Risk of flashover!

High voltages will be present in the terminal compartment. High voltages can cause a flashover between conductors with different electric potential, and between a conductor and earth.

Therefore, maintain a minimum clearance of **55 mm** between a conductor and the terminals of any other conductor, and between a conductor and earth.

Checking the cable insulation

- Measure the insulation resistance of each cable before connecting it 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.

Drive with integrated transformer

- Connect the primary and secondary cables of the transformer, and the motor cables to their corresponding busbars.
- Connect the primary cables of the transformer to the side of the busbars where the arrows point to in *Fig. 6-7*.
- Orientate the bolts for the transformer primary cables as shown in *Fig. 6-7*.

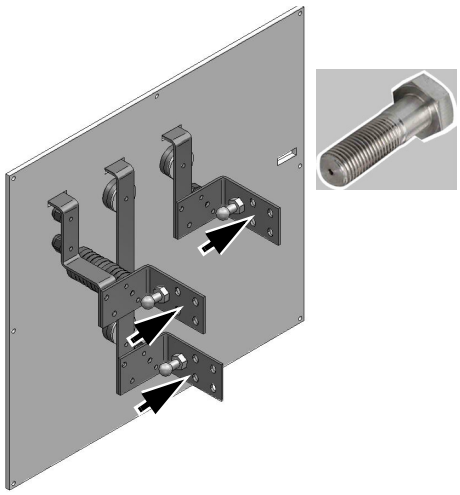


Fig. 6-7 Cable connection and bolt orientation

Drive and non-integrated transformer

Drive

- Connect the secondary cables of the transformer, and the motor cables to their corresponding busbars.
- Connect the secondary cables of the transformer to the side of the busbars where the arrows point to in *Fig. 6-8*.
- Orientate the bolts for the transformer primary cables as shown in *Fig. 6-8*.

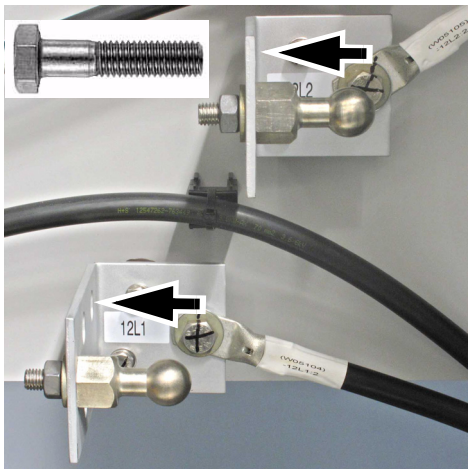


Fig. 6-8 Cable connection and bolt orientation

Transformer

- Connect the primary and the secondary cables of the transformer to their corresponding busbars.
- Connect the cables to the side of the busbars where the arrow points to in *Fig. 6-9*.
- Orientate the bolts as shown in *Fig. 6-9*.

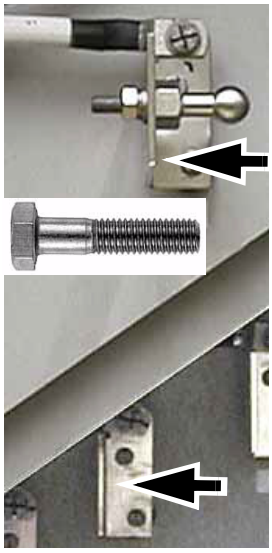
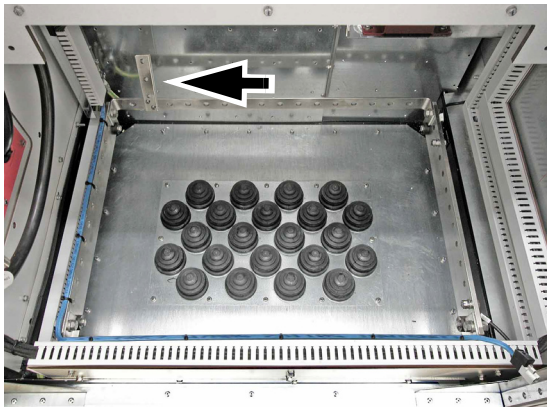


Fig. 6-9 Cable connection and bolt orientation

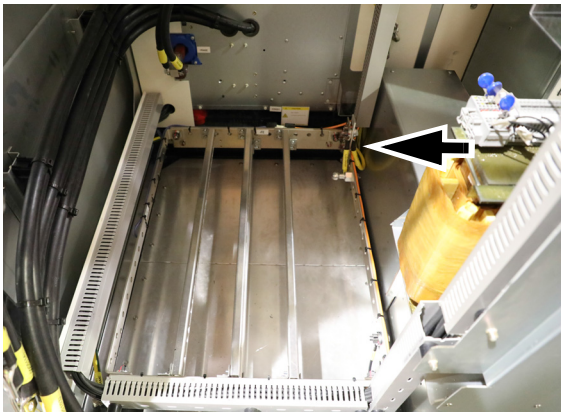
Ground connection to the grounding network

- Connect the ground cable to the ground busbars (marked PE, Protective Earth) inside the terminal compartment of the drive and / or the transformer *(arrows)*.



Cabinet back

Fig. 6-10 Ground busbar inside drive cabinet



Cabinet front

Fig. 6-11 Ground busbar inside non-integrated transformer

Bolted connections

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]).

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

Connection type

The following connection type is recommended when a cable lug *(Fig. 6-12: 4)* is connected to a busbar:

- Spring washer *(Fig. 6-12: 1)* and flat washer *(Fig. 6-12: 2)* on each side of the busbar *(Fig. 6-12: 3)*.

  Other washers can be used, provided they maintain the required contact pressure.

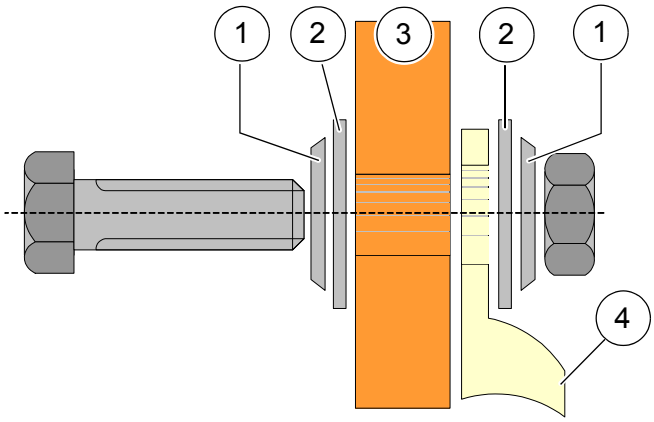


Fig. 6-12 Bolted busbar connection

- Use cable lugs suitable for M12 bolts.

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 [MoS_2] coating) is used, the connection does not have to be lubricated.

Tightening torque

- Tighten bolted connections with bolts of sizes M10 and greater with the recommended nominal torque for the bolt size used.

6.8 Auxiliary power, control and serial communication cables

6.8.1 Further information

See *Outline drawing* in *Appendix C – Mechanical drawings* for information on:

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

See *Appendix D – Wiring diagrams* for information on:

- Designation, cross-reference and device-identification conventions
- Terminal designations

The power feed for the auxiliary power supply must be protected with a suitable circuit protection rated for the inrush current. For information, see *Utility consumption list* of the drive.

6.8.2 Cable entry

The cabinet of the drive and the non-integrated transformer is in the factory for top or bottom cable entry. The top and bottom cable entry is covered by a blanking plate *(Fig. 6-13: 1)* which can be used to install cable glands.

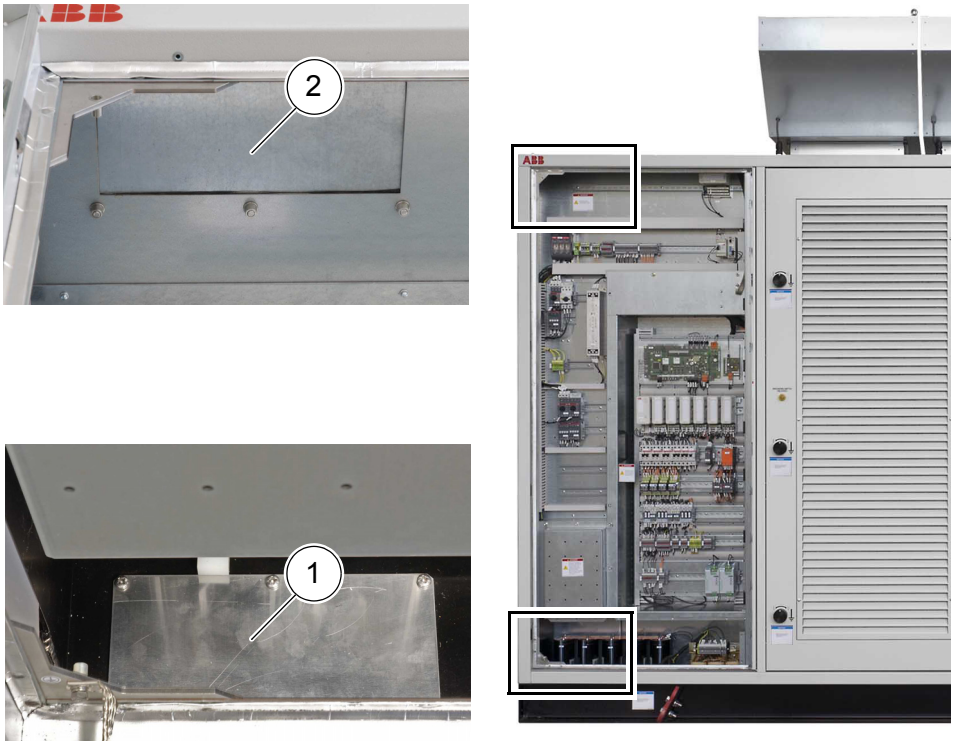


Fig. 6-13 Cable entry for auxiliary and control cables

6.8.3 Routing the cables

- Route the auxiliary power and the control cables through the cable duct on the left side of the control compartment as indicated in *Fig. 6-14*.

Fig. 6-14 Routing control cables

6.8.4 Determining the cable length

- Determine the required length of a cable between the point of entry and the connection point inside the cabinet.
- Cut the cable to the required length before connecting it to avoid excess cable be stored in the cable ducts.

6.8.5 Preparing the cable entry

- Remove the grommet from the outer entry plate (the outer entry plate is only used with top cable entry).

6.8.6 Connecting the cables

I/O stations

- Connect the cables for the standard I/O station *(Fig. 6-15: 1)* to the intermediate terminals *(Fig. 6-15: 2)*.
- Connect the cables for the optional I/O station *(Fig. 6-15: 3)* directly to the terminals of the I/O modules.

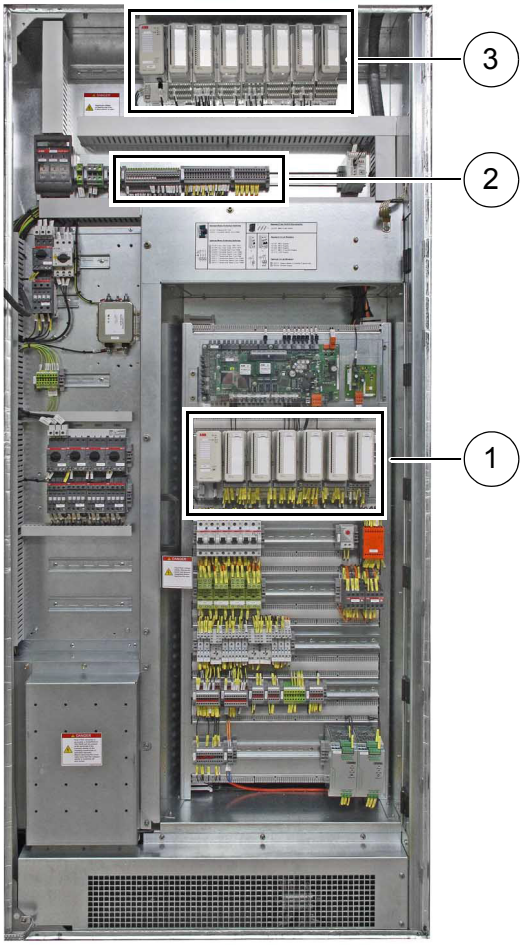


Fig. 6-15 Terminals inside control compartment

Fieldbus interface (option)

- Connect the serial communication cable directly to the fieldbus interface.

  If a twisted pair cable is used, leave the unscreened cable ends as short as possible.
- Connect the individual cable screens to the PE terminals.

Encoder module (option)

- Connect the overall shield and the individual shields of the encoder cable to the separate shield grounding point *(Fig. 6-16: 2)*. Do not connect the cable directly to the encoder *(Fig. 6-16: 1)*.

  The unshielded cable ends must be as short as possible. The shield ends which are fixed to the ground clamp must be not longer than **50 mm**.

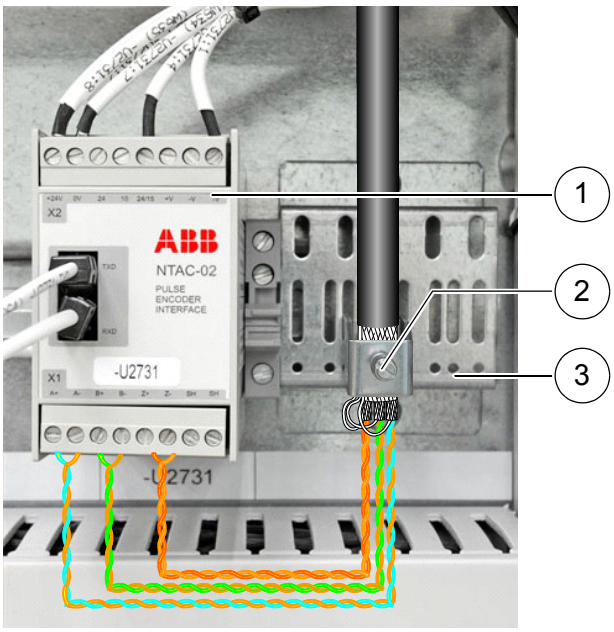


Fig. 6-16 Encoder module – Shield grounding point

A shield grounding point consists of a slotted mounting bracket (*Fig. 6-16: 3)* which has been mounted in the factory, and a ground clamp.

Depending on the layout of the swing frame, the shield grounding points can be mounted at a different place than shown in *Fig. 6-16*.

Three ground clamps of different sizes are supplied to accommodate encoder cables of different diameters. The clamps are tied to each mounting bracket.

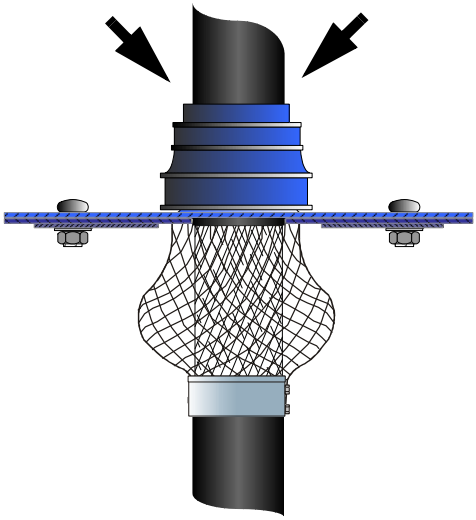
Fig. 6-17 Control cables – Shield grounding clamps

Terminal sizes

The terminals are suitable for wires with a maximum cross-section of 0.2 to 2.5 mm^2.

6.8.7 Final checks

- Check that the entry plates are fastened properly.
- Check that the cable glands fit tightly.
- If EMC entry plates with rubber grommets are used, check that the grommets fit tightly. If necessary, seal the gaps with silicone rubber.



6.9 Power supply cables for fan units

- Connect the power supply cable *(Fig. 6-18: 1)* of each fan to the corresponding socket *(Fig. 6-18: 2)* on the roof of the cabinet. Tighten the coupling ring *(Fig. 6-18: 3)* carefully

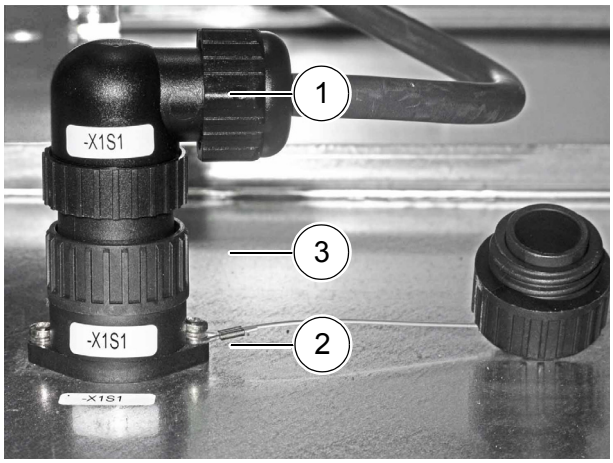


Fig. 6-18 Fan – Power supply connector

6.10 Transformer heating cable

The heating cable inside the terminal compartment of the drive and the extension into the cabinet of the integrated transformer have been installed in the factory. The heating cable inside the drive cabinet has been installed in the factory and does not require any installation work.

- Connect the two cables *(Fig. 6-19: 1, 2)* at the shipping split of the two cabinets.

  The connectors are accessible either from the back of the cabinets, when the back walls have been removed, or from the front of the cabinets.

  If only front access is possible, it is recommended to make the connection before the power cables are installed.

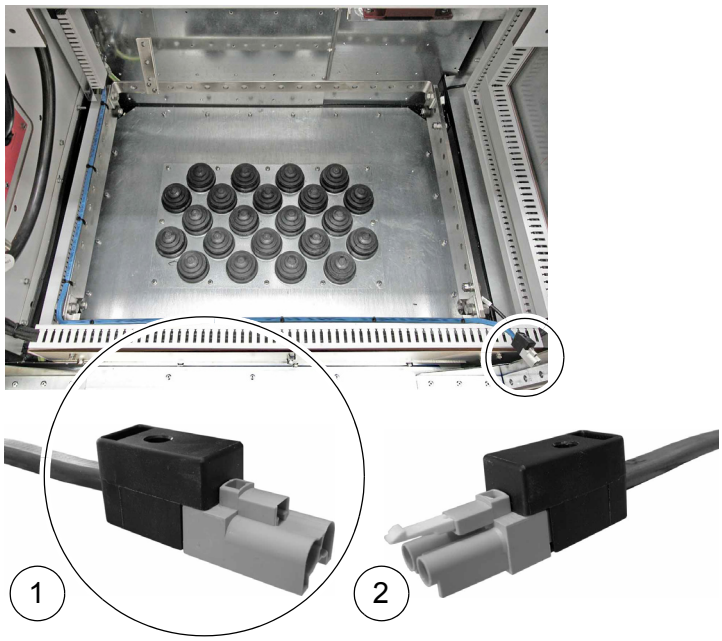


Fig. 6-19 Heating cable connection

Chapter 7 - Commissioning

7.1 Required qualification

Commissioning, parameter settings and functional tests of the drive must be carried out only by commissioning personnel certified by ABB.

7.2 Commissioning procedure

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

To contact the ABB service organization, see *Contact information*.

7.3 Commissioning check list

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 check list* 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, main 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.

Commissioning check list

Mechanical installation

1	Drive installed according to the instructions in the *User manual*	☐
2	Drive securely fastened to the floor (if applicable)	☐
3	Fan unit or fan units installed	☐
4	Visual inspection: - no badly affixed or damaged components - no foreign objects inside cabinet - no dirt, dust and humidity inside cabinet	☐

Electrical installation

1	Types and cross-sections of control cables suitable for the signal type and signal level	☐
2	Types and cross-sections of power cables selected according to the *Power cable specification*	☐
3	Pulse encoder cable screens connected to **screen grounding point** and not connected directly to the pulse encoder interface (only applicable for drives with pulse encoder interface)	☐
4	Cable entry prepared according to the instructions in the *User manual*	☐
5	All control cable screens and conductors are connected according to the instructions of the *User manual*, appropriately labeled, and the customer connections are completed.	☐
6	Heating cable (if supplied) installed according to the instructions in the *User manual*	☐
7	Ground cable of drive securely connected at both ends	☐
8	Input transformer and motor cables not connected at both ends (cables and drive must be meggered before connection)	☐

Main circuit breaker (MCB)

1	Type of MCB selected as per *MCB specification*	☐
2	High-voltage connections completed	☐
3	MCB ready to be tested with drive	☐
4	MCB protection relay settings tested	☐
5	Safety devices (eg, door locks) tested and in operation	☐

Input transformer (if applicable)

1	Ground connection completed	☐
2	Transformer auxiliaries (eg, dehydrating breathers, cooling, protection devices) ready	☐
3	Safety devices (eg, door locks) tested and in operation	☐

Motor

1	Motor installed, aligned and alignment protocol available	☐
2	Motor not coupled to driven load	☐
3	Ground connection completed	☐
4	Motor auxiliaries (eg, bearing lubrication) ready	☐

Insulation tests

1 All power cables to input transformer, between input transformer and drive, and from drive to motor measured, measured values within the required limits. ☐

2 Test report of the megger test available ☐

If the test is carried out by the commissioning personnel of the drive, an additional day per drive-motor combination needs to be reserved. After the test, the feeder cables can be connected, except at the drive end. The test must comply with the specification.

Power supply

1 Medium voltage available for start-up of drive ☐

2 Low voltage auxiliary power available for start-up of drive ☐

Miscellaneous

1 Sufficient number and correct type of spare parts available ☐

2 Air conditioning of drive room ready for load run of drive ☐

3 Optional equipment ready ☐

Chapter 8 - Operation

8.1 Operating conditions

The operating conditions for the drive are based on IEC 60721-3-3 ’Stationary use at weather-protected locations’ (unless indicated otherwise).

3K3 Climatic conditions			
	Air temperature	5 – 40 °C	
	Relative humidity[a]	5 – 85%	
	Absolute humidity	1 – 25 g/m^3	
	Condensation	No	
3B1 Biological conditions			
	Flora	No	
	Fauna	No	
3C2 Chemically active substances			
	Sea salt and road salts	Salt mist	
		Mean value	**Max. value**
	Sulphur dioxide	0.3 mg/m^3	1.0 mg/m^3
	Hydrogen sulfide	0.1 mg/m^3	0.5 mg/m^3
	Chlorine	0.1 mg/m^3	0.3 mg/m^3
	Hydrogen chloride	0.1 mg/m^3	0.5 mg/m^3
	Hydrogen fluoride	0.01 mg/m^3	0.03 mg/m^3
	Ammonia	1 mg/m^3	3 mg/m^3
	Ozone	0.05 mg/m^3	0.1 mg/m^3
	Nitrogen oxides	0.5 mg/m^3	1.0 mg/m^3
3S2 Mechanically active substances			
	Sand	30 mg/m^3	
	Dust (suspension)	0.2 mg/m^3	
	Dust (sedimentation)	1.5 mg/m^3	
3M1 Mechanical conditions			
	Stationary vibration sinusoidal ■ Displacement amplitude ■ Acceleration amplitude	 0.3 mm (2 – 9 Hz) 1 m/s^2 (9 – 200 Hz)	
	Non-stationary vibration (including shock) ■ Shock response spectrum	 40 m/s^2	

a. 5 – 95% in the absence of condensation
5 – 60% in the presence of corrosive gases

If the operating conditions are not within the specifications, contact ABB.

For the maximum ambient temperature, see the *Rating plate* of the drive.

8.2 Safety

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

8.3 Overview

The chapter outlines the local operation of the drive.

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

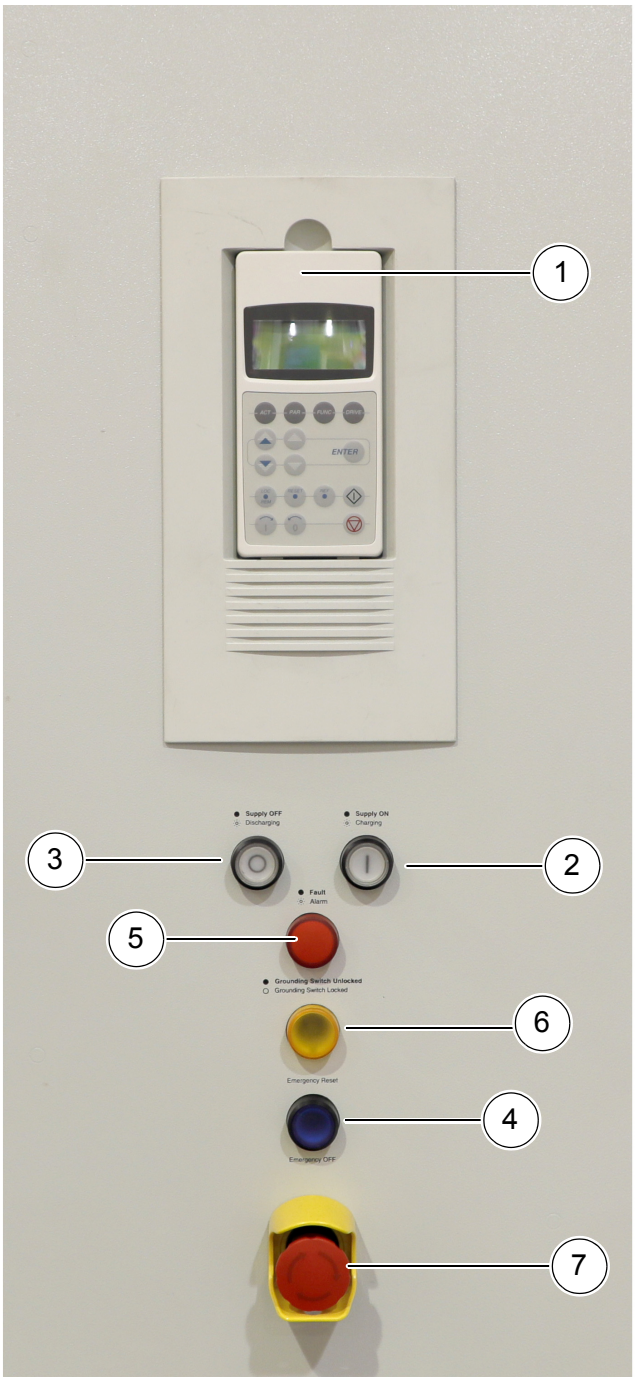
The panel messages and parameter settings used in this chapter are typical examples to illustrate the related instructions and display functions and may therefore differ from the actual messages and parameter settings in the drive.

8.4 Overview of local operator panel

The operator panel on the control compartment door enables the operator to control the drive without restrictions if all requirements for normal operation are met.

The functions of the operator panel include:

- Connecting / disconnecting the main power supply
- Setting the reference value
- Starting, stopping the drive system
- Displaying:
  - Actual values
  - Status messages
  - Alarm and fault messages
- Viewing, setting parameters
- Resetting alarm and fault messages
- Activating the emergency-off circuit
- Testing the bulbs of lamps and illuminated pushbuttons



1 CDP control panel

Main functions:

- Starts and stops the motor
- Displays status messages of the drive

Displays alarm and fault messages of the drive and monitored foreign equipment.

Resets alarm and fault messages

2 Main power supply on

When pressed, the illuminated pushbutton charges the DC link, and closes the main circuit breaker.

3 Main power supply off

When pressed, the illuminated pushbutton opens the main circuit breaker.

4 Emergency-off reset pushbutton

Resets the emergency-off relay of the drive control system.

Flashes when the auxiliary voltage is switched on, or when an emergency-off switch is pressed.

5 Alarm / Fault lamp

- Alarm: flashing light
- Fault: permanent light

6 Grounding switch unlocked

Lights up to indicate that the grounding switch of the drive can be turned to the grounded or ungrounded position.

7 Emergency-off

Latching pushbutton, prevents starting when pressed at standstill of the drive.

When pressed during operation of the drive, the main circuit breaker opens immediately and the DC link discharges.

Fig. 8-1 Local operator panel

For further information on the CDP control panel, see *Chapter 9 - CDP control panel*.

8.4.1 Lamp test

The lamp test is activated via the CDP control panel by setting parameter 16.7 to LAMP TEST. The lamp-test resets itself after a set time.

8.5 Status messages

8.5.1 Overview on status messages

The following section lists the status messages of the main operating states of the drive, the drive passes through, when it is put into operation (see section *8.5.2 Start sequence of the drive*), when it is stopped (see section *8.5.3 Stop sequence of the drive*), or when a fault condition has occurred. The status messages are sent to the higher-level control system and are displayed on the CDP control panel of the drive.

For information on other status messages, such as fault status messages in particular, see the **status words** in the *Signal and parameter table* of the drive.

Not ready on

NotReadyOn means that the DC link cannot be charged and the drive cannot be connected to the main power supply, ie, the main circuit breaker cannot be closed. The status message is displayed, eg, when the doors of medium voltage compartments 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.

Ready on

The status message signals that the drive is healthy and ready for the ON command. The ON command initiates charging of the DC link capacitors and 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 pushbutton on the control compartment door.

Charging

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

Ready run

The message **ReadyRun** tells 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.

Ready ref

When the drive is in **ReadyRef** state, it 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 higher-level control system. When in local control mode, the value is entered into the CDP control panel.

Stopping

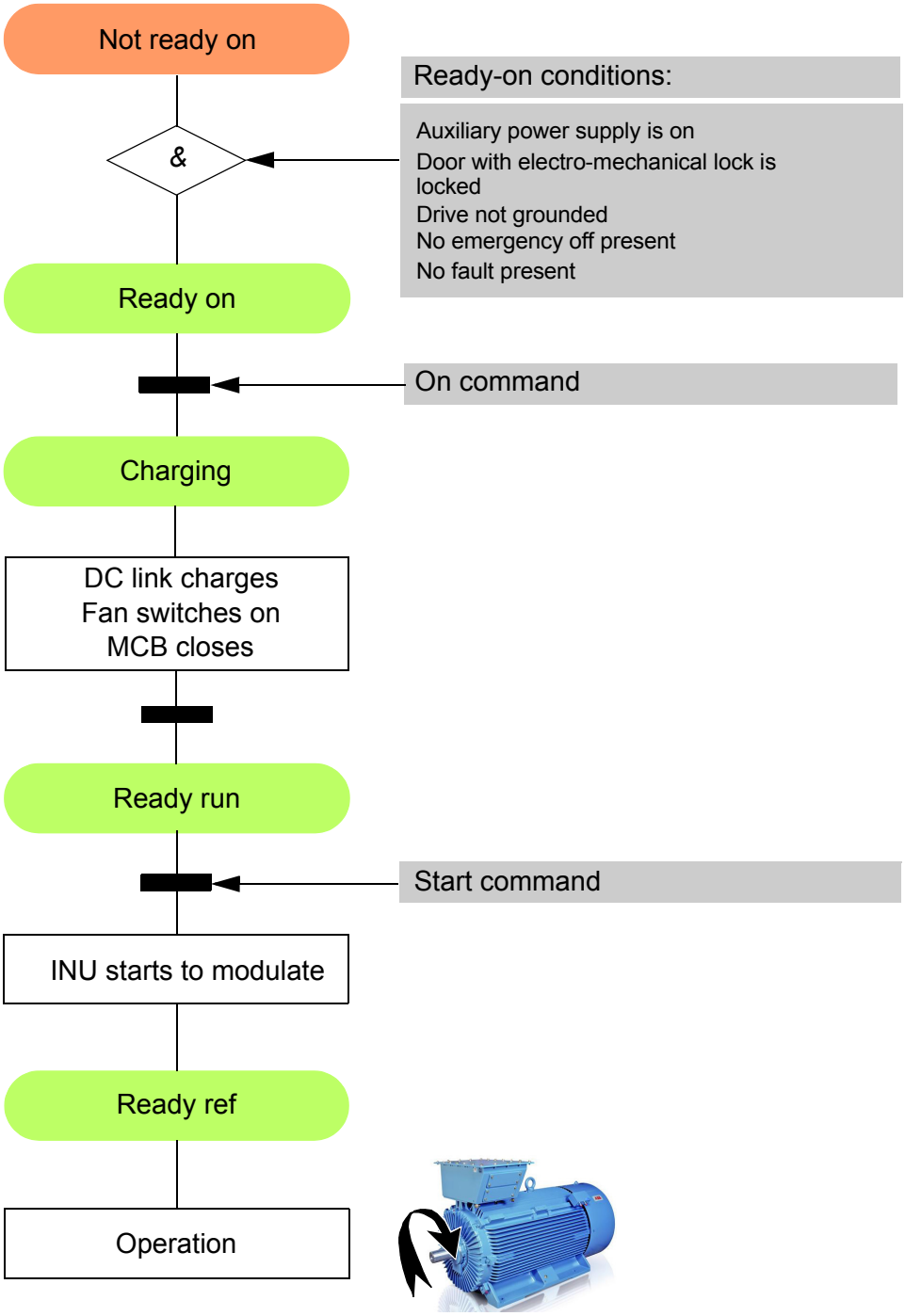
Stopping indicates that the drive has received a stop command and that a ramp or coast stop has been initiated. The stopping mode depends on the parameter setting. The status message changes to **ReadyRun** when the zero speed threshold is reached.

When a start command is given while the drive is stopping, the drive resumes operation and the status message changes to **ReadyRef** again.

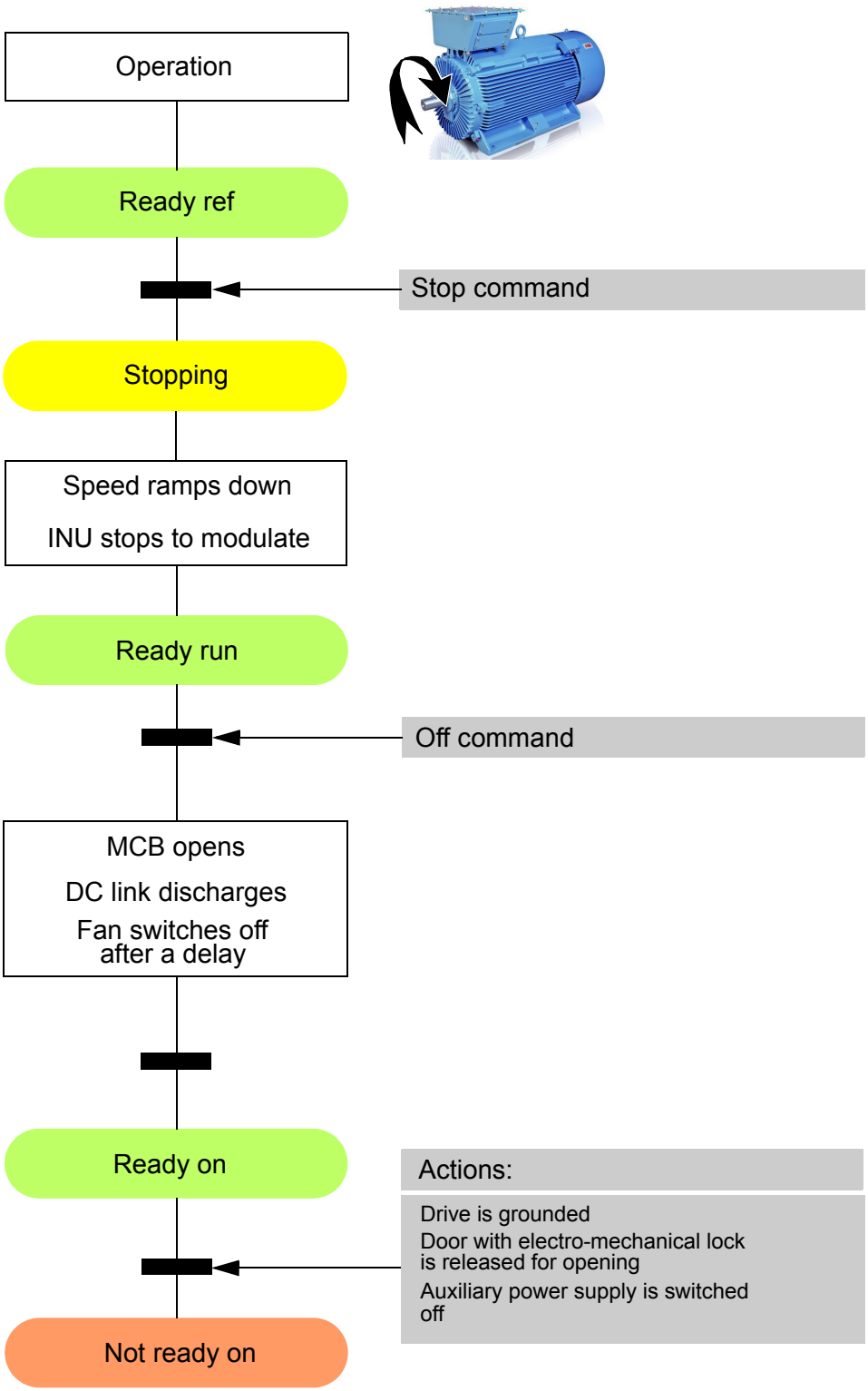
Tripped

The status message 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.

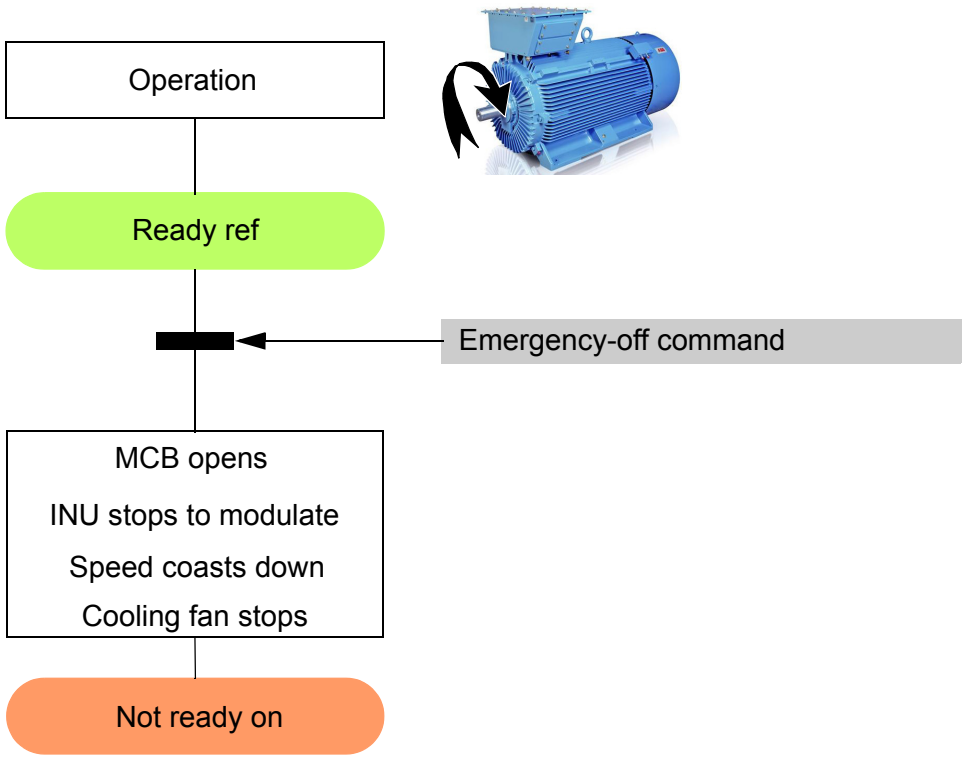
8.5.2 Start sequence of the drive



8.5.3 Stop sequence of the drive



8.5.4 Emergency-off sequence of the drive



8.6 Starting the drive

It is recommended to have the following documents at hand when starting the drive system locally for the first time after commissioning:

- *Appendix D – Wiring diagrams* to identify the circuit breakers to be switched on
- *Chapter 9 - CDP control panel* for information on functions and features of the CDP control panel

8.6.1 Checks before starting the drive

DANGER

Hazardous voltages!

All covers must be screwed in place to prevent unintentional contact with energized components.

The manual release of the safety switch must be in the locked position to prevent the door of the medium voltage compartment being opened unintentionally during operation.

When the drive system 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:

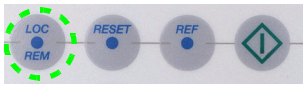
- Check that no tools and foreign objects are left inside the cabinet.
- Check that all auxiliary power supplies from external sources are switched on.
- Check that all internal circuit breakers of the drive are closed.
- Check that all covers are mounted and the doors are closed, locked and / or bolted.
- Check that the grounding switch is in position **not grounded**.
- Check that the MCB is in **operating** position.
- Check that there is no run interlock active.

8.6.2 Starting the drive from remote

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

8.6.3 Starting the drive locally

1 Enable the local control mode of the CDP control panel.



2

This step only applies to drives which are equipped with the optional safety relay.

3 If the EMERGENCY-OFF RESET pushbutton is flashing, press the EMERGENCY-OFF RESET pushbutton to cancel flashing.

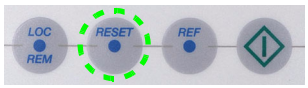
Each time the auxiliary voltage is switched off and on again, the emergency-off safety relay of the drive is actuated and lets the EMERGENCY-OFF RESET pushbutton flash.

The EMERGENCY-OFF RESET pushbutton also flashes if the EMERGENCY-OFF pushbutton on the control compartment door, or any other emergency-off switch linked to the drive, is pressed. If the EMERGENCY-OFF RESET pushbutton continues flashing, verify that there is no emergency-off command active.

For further information, see *8.8 Emergency-off*.

4 Check that no alarm or fault messages are displayed on the CDP control panel.

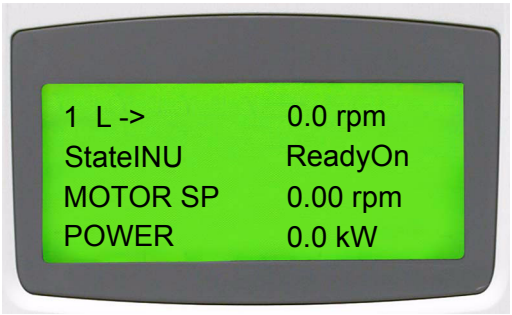
When a fault message is displayed on the CDP control panel, reset the fault.



If a fault cannot be reset, it must be rectified by the responsible personnel.

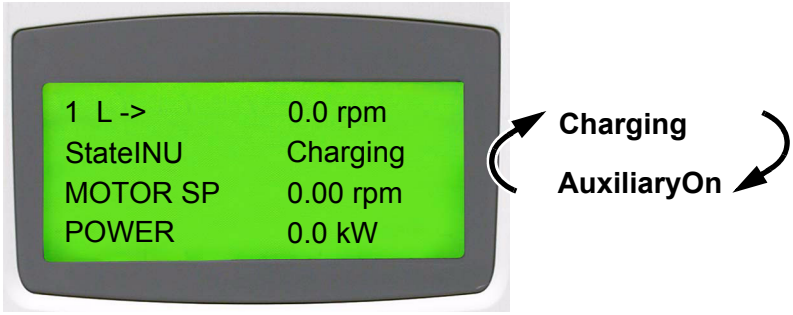
For further information, see *10.3 Alarm / fault indications*.

When no alarms and faults are present and the drive is ready, the CDP control panel displays **ReadyOn**:



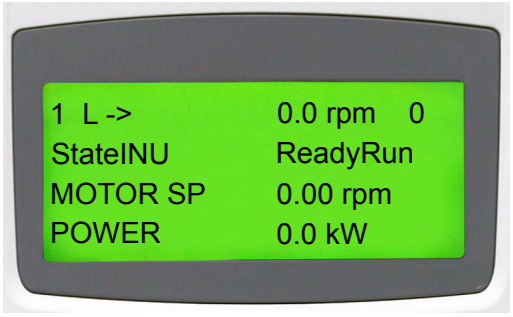
5 Press the SUPPLY ON pushbutton on the control compartment door to charge the DC link. The SUPPLY ON pushbutton flashes while the DC link is charged.

The status line of the CDP control panel alternates between **Charging** and **AuxiliaryOn**.



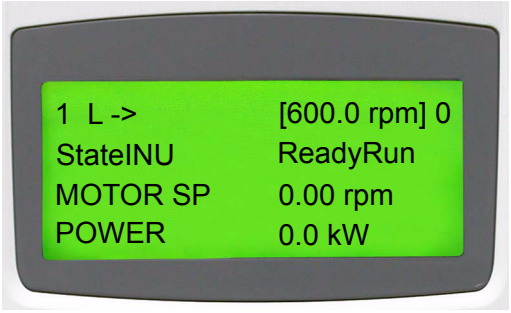
When charging has been finished, the following takes place:

- The MCB closes automatically.
- The SUPPLY ON pushbutton lights up permanently.

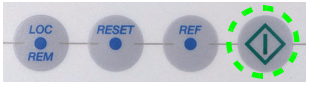


6 Enter the reference value.

For further information, see *9.9.2 Entering a reference value*.



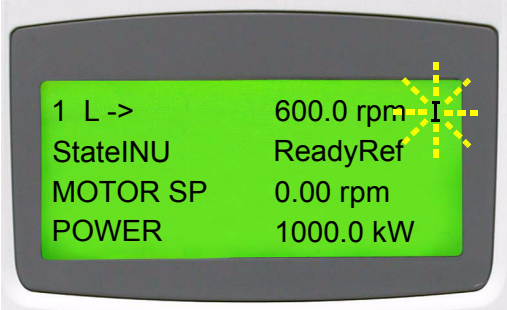
7 Start the motor.



When the motor has been magnetized, the motor speed ramps up to the reference value.

While the motor is accelerating, the run status message on the display blinks. When the motor speed has reached the reference value, the run status message lights up permanently.

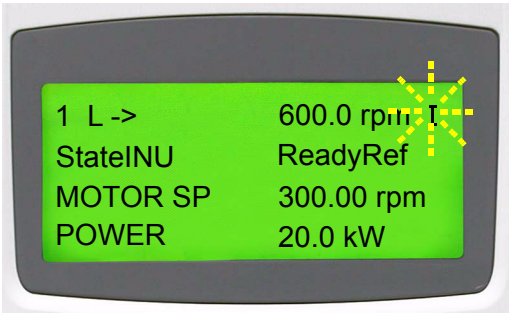
To indicate that the drive system is operating, the display shows **ReadyRef**.



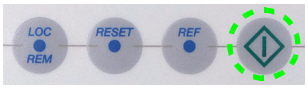
8.7 Stopping the drive

Press the STOP key on the CDP control panel.

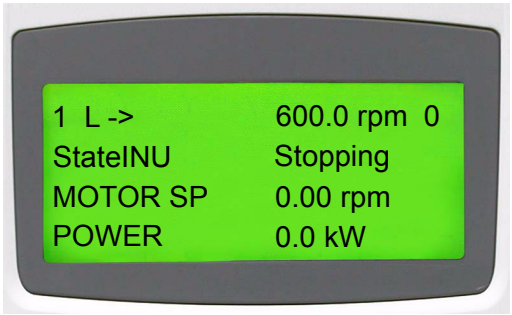
The motor stops according to the preset stop function and the drive stops modulating. While the motor stops, the status line of the display shows **ReadyRef**. The run status message blinks during the stop sequence.



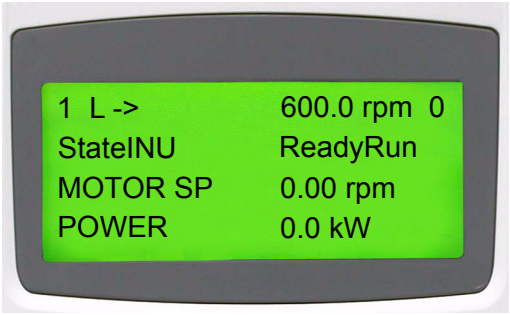
As long as the stop sequence is in progress, the drive can always be restarted by pressing the START key on the CDP control panel.



Just before the motor will come to a standstill, the CDP control panel displays shortly the message **Stopping**.



When the drive has stopped modulating, the CDP control panel displays **ReadyRun**.



As long as the MCB has not been opened, the motor can be started again.

8.8 Emergency-off

8.8.1 Function

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

The EMERGENCY-OFF pushbutton of the drive is part of the operator control panel *(Fig. 8-1)* and features a latching switch action.

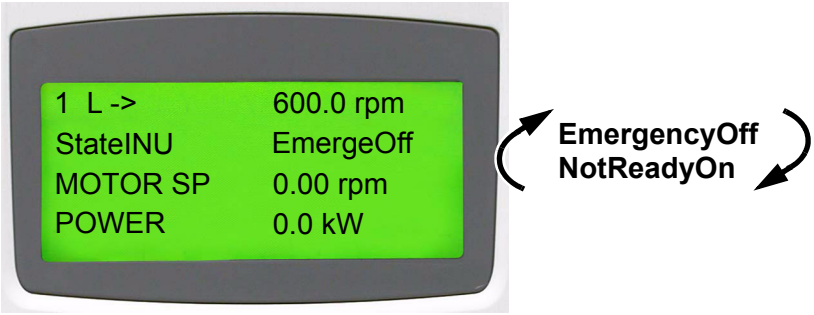
Pressing the EMERGENCY-OFF pushbutton does not disconnect the auxiliary power supply from the drive.

8.8.2 Initiating an emergency-off

To initiate an emergency-off, press the EMERGENCY-OFF pushbutton on the control compartment door or an external EMERGENCY-OFF pushbutton (if present) linked to the emergency-off circuit.

When an emergency-off is initiated during drive operation, the following takes place:

- The MCB opens.
- The drive system coasts down.
- The DC link of the drive discharges.
- The status line of the CDP control panel alternates between the message **EmergencyOff, NotReadyOn.**



- The EMERGENCY-OFF RESET pushbutton flashes.
- The SUPPLY OFF pushbutton flashes.

8.8.3 Starting the drive after an emergency-off

1. To start the drive after an emergency-off reference value, unlatch the EMERGENCY-OFF pushbutton.
2. Turn the EMERGENCY-OFF pushbutton into the direction indicated by the arrows on the pushbutton to return the pushbutton to its initial position.
3. Press the RESET key on the CDP control panel to cancel the emergency-off message on the display.
4. To reset the emergency-off safety relay of the drive, press the EMERGENCY-OFF RESET pushbutton.

   After resetting, the status message of the drive changes to **ReadyOn**.

The main power supply can be connected to the drive, and the drive can be started again.

Chapter 9 - CDP control panel

9.1 Overview

The panel 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 messages and parameter settings in the drive.

9.1.1 Display and keypad

1 Display
2 Keypad
3 Mode selection keys
4 Fast navigation keys, select and / or change a value fast
5 Slow navigation keys, select and / or change a value slowly
6 Enter key, terminates a procedure
7 Local / remote selection key
8 Reset key
9 Reference key
10 Start key
11 Forward key
12 Reverse key
13 Stop key

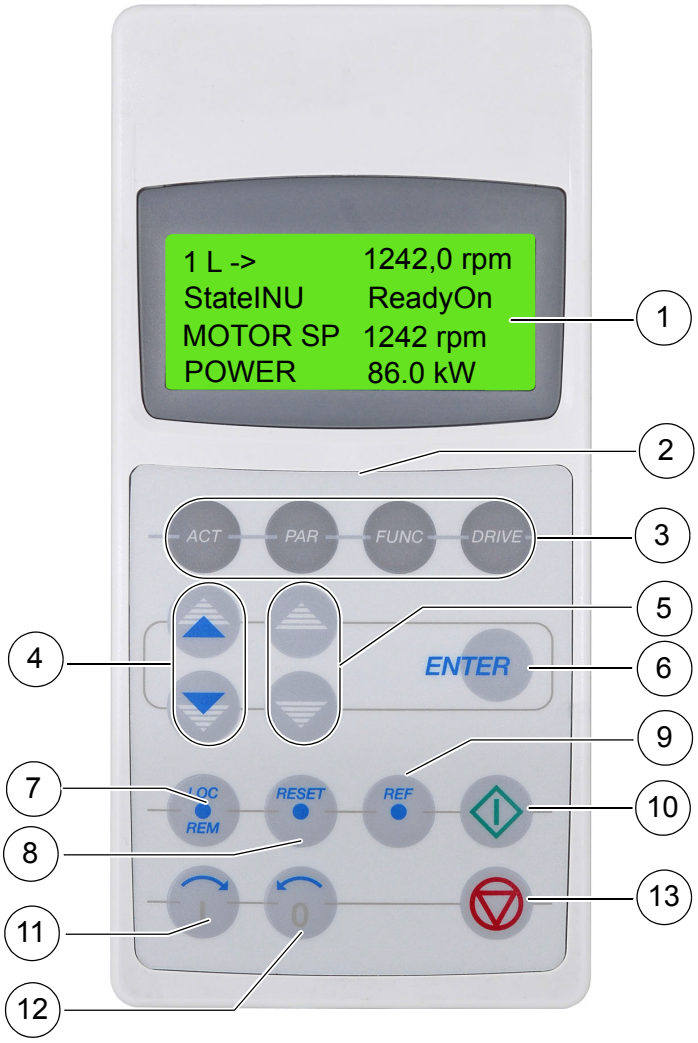


Fig. 9-1 CDP control panel

9.2 CDP control panel 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 start-up data,
- to control the drive with a reference value, and start, stop and direction commands,
- to display actual values (three values can be read simultaneously),
- to display and adjust parameters,
- to display information on the most recent 40 fault events,
- to upload and download complete parameter sets from one drive to another.

9.3 CDP control panel modes

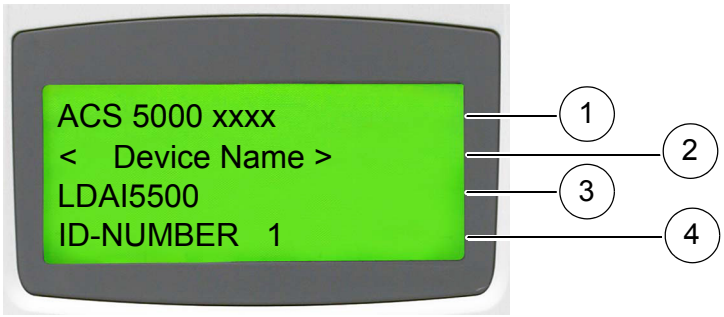
The CDP control panel provides the following modes:

- *Identification mode*
- *Actual signals mode*
- *Parameters mode*
- *Functions mode*
- Drive selection mode (not used)

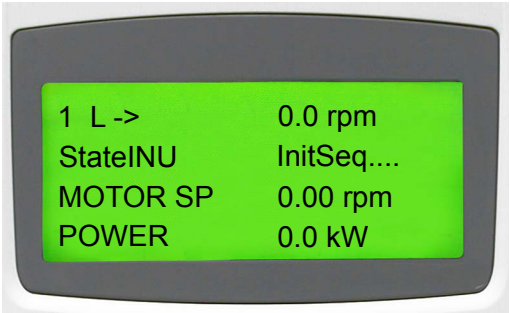
9.4 Identification mode

When the power supply is switched on, or the CDP control panel is connected to the drive and the auxiliary voltage has been switched on already, the identification display appears showing the CDP control panel version and then the ID number of the drive. When the CDP control panel is initialized, the display changes as follows:

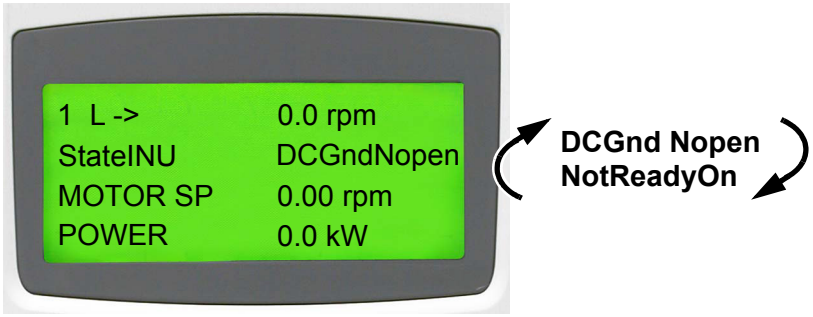
After 2-3 seconds, information on the drive *(1, 2)*, the application software in use *(3)*, and the drive identification *(4)* is displayed.



After another few seconds:



After another few seconds, the display changes to the actual signals mode. The status line of the display alternates between **DCGnd NOpen, NotReadyOn.**



9.5 Actual signals mode

9.5.1 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 display 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..

The CDP control panel automatically returns to the actual signals display from other modes if no key is actuated within one minute (an exception from this is the fault memory display).

Actual values

The actual values are organized in groups.

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

For the complete list of selectable actual signals, see *Signal and parameter table*.

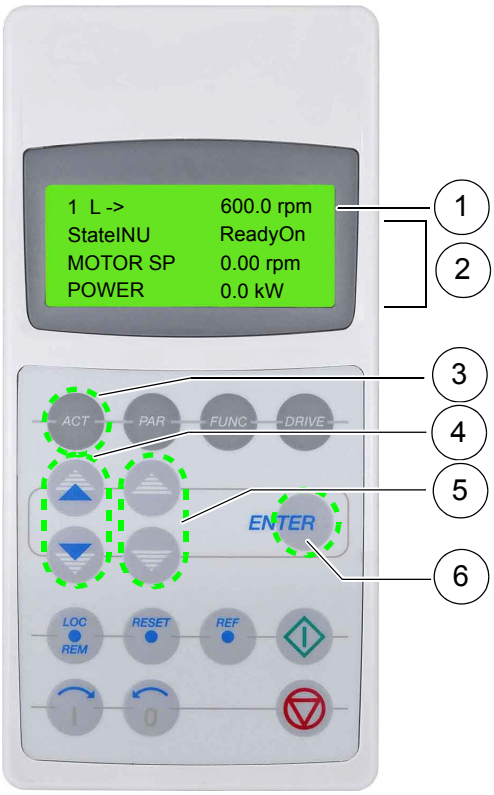
Fault memory

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 *9.5.7 Displaying and resetting an active fault*.

When the drive generates a fault or alarm, the corresponding message displays immediately.

Changing from the fault memory mode to other modes is possible without resetting the fault first. When no keys are actuated, the fault or warning text is displayed as long as the fault is active.

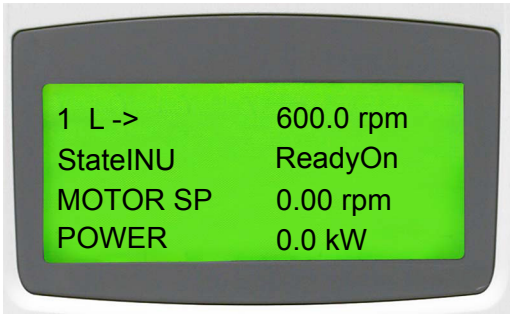
Control panel overview



1 Status line
2 Actual signal names and values
3 Selection key for actual signals mode
4 Fast navigation key for selecting the actual signals display or the fault memory display
5 Slow navigation key for selecting signals or fault messages
6 Enter key for confirming the selection

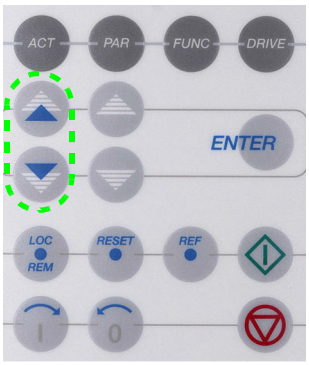
9.5.2 Selecting the actual signals display

To open the actual signals display, press the ACT key.



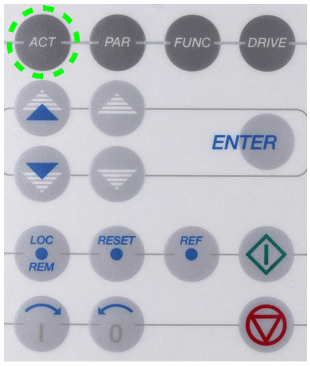
9.5.3 Toggle between actual signals display and fault history

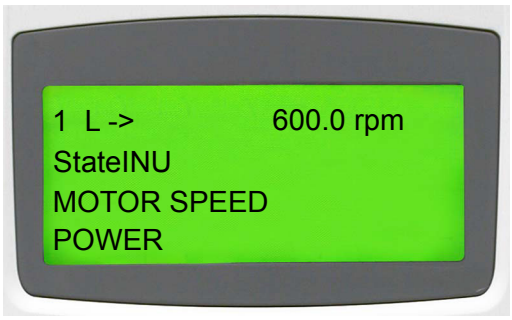
To toggle between actual signals display and fault history display, press a fast navigation key.



9.5.4 Displaying three actual signals

1 To display the full name of three actual signals, press and hold the ACT key.

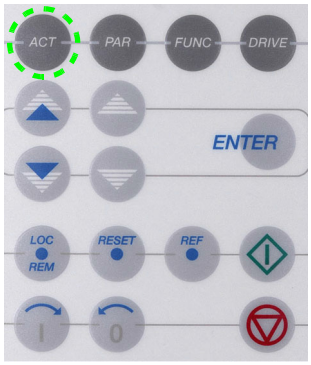


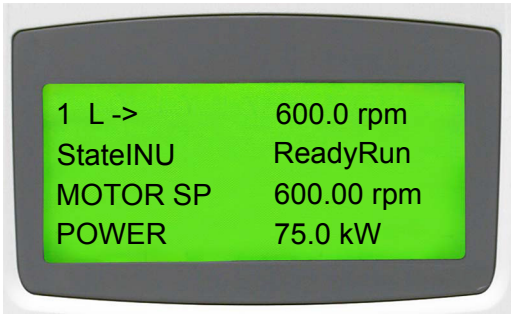


2 To return to the actual signals display, release the ACT key.

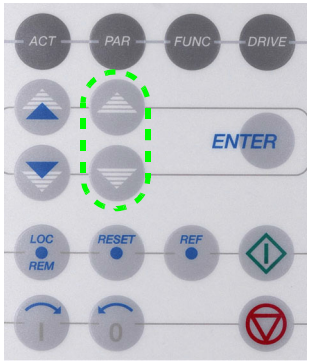
9.5.5 Selecting actual signals

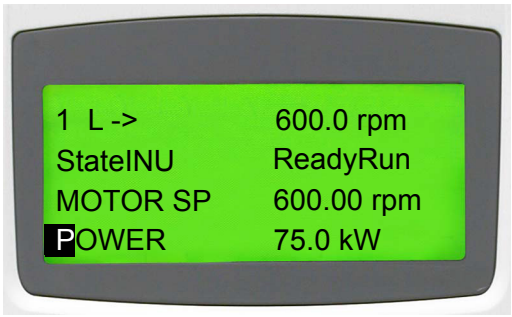
1 To select the actual signals display, press the ACT key.



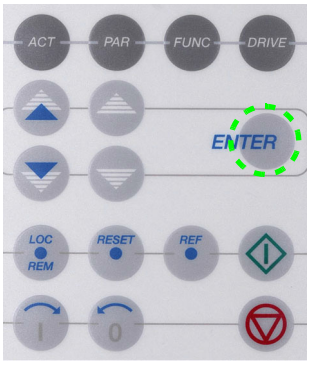


2 To select a line where the actual signal is to be displayed, press the corresponding slow navigation key. A blinking cursor indicates the selected line.

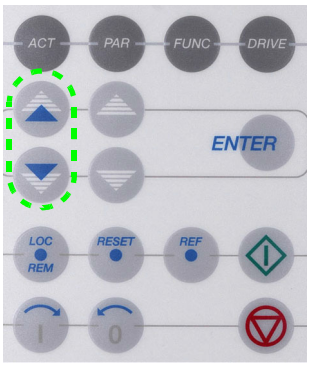


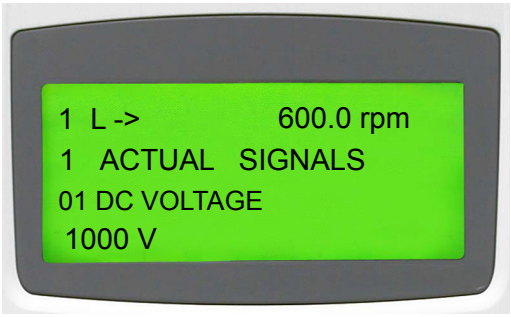


3 To enter the actual signal selection function, press the ENTER key.

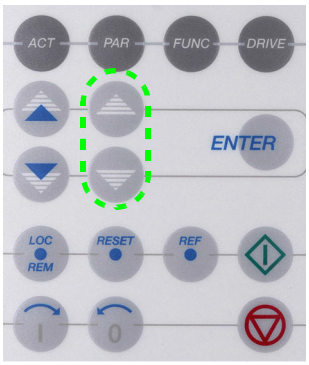


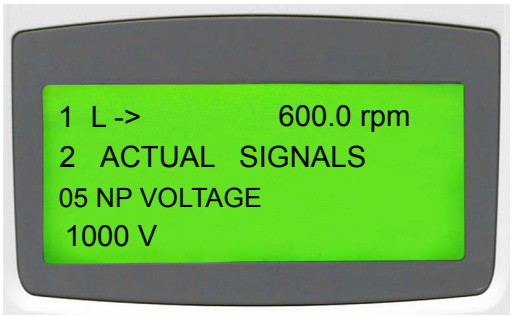
4 To select a parameter group, press a fast navigation key.



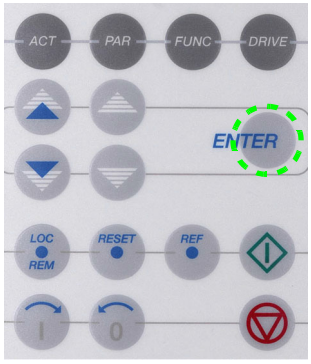


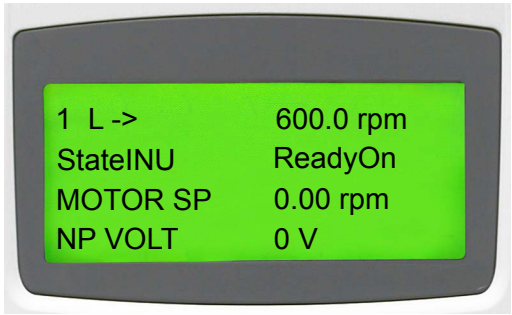
5 To select an actual signal, press a slow navigation key.



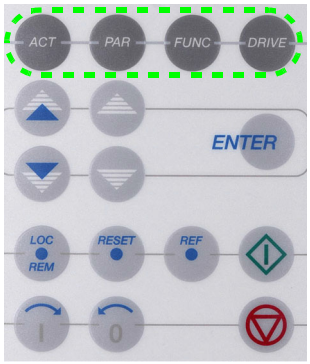


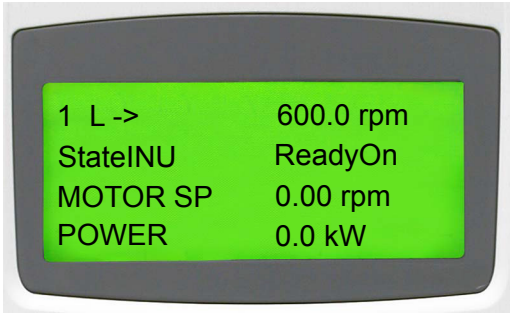
6 To confirm the selection and to return to the actual signals mode, press the ENTER key.





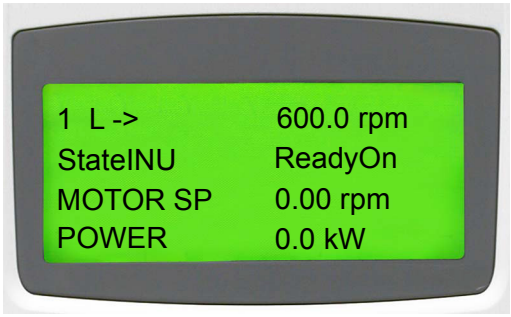
7 To cancel the selection and keep the original selection, press any of the mode selection keys. The selected CDP control panel mode is entered.



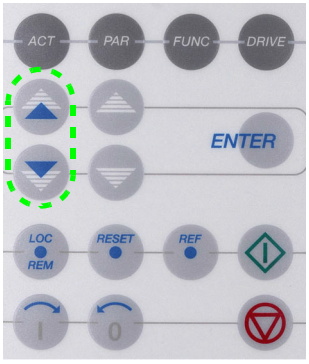


9.5.6 Displaying a fault and resetting the fault history

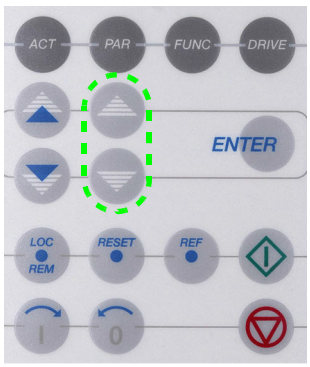
1 To open the actual signals mode, press the ACT key.

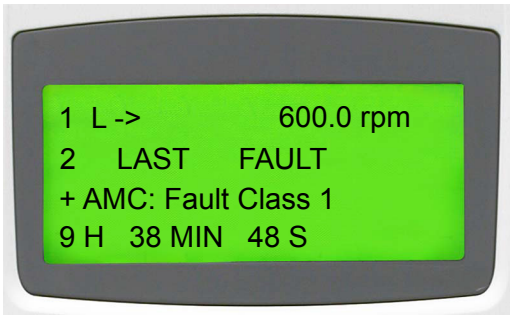


2 To change to the fault memory display, press a fast navigation key.

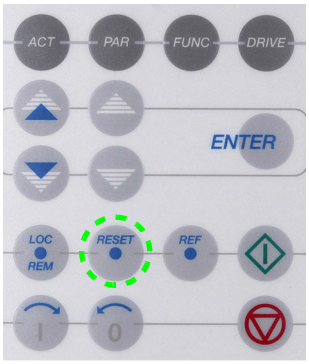


3 To display a specific fault, press the slow navigation keys. The UP key selects the previous, the DOWN key the next fault.

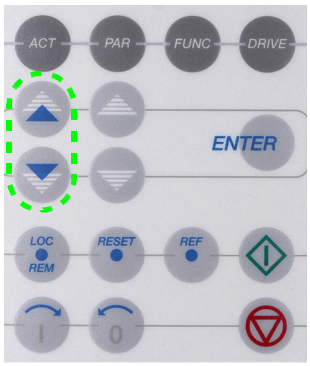


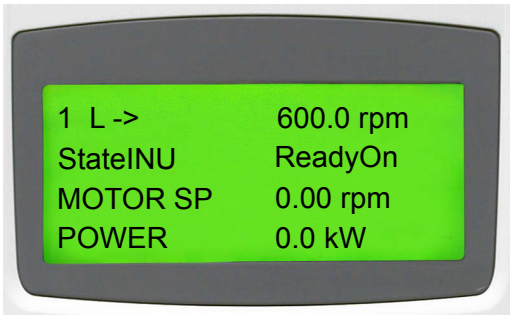


4 To clear the fault history, press the RESET key.



5 To return to the actual signals display, press a fast navigation key.

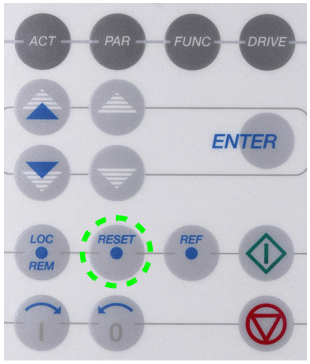


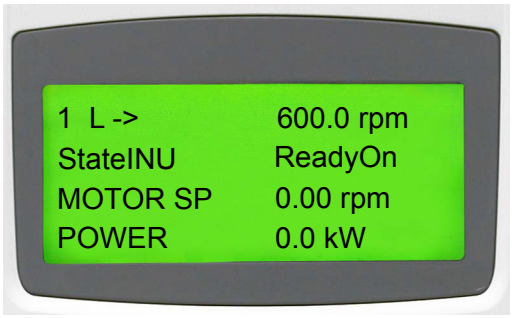


9.5.7 Displaying and resetting an active fault

1 To display an active fault, press the ACT key.

2 To reset the fault, press the RESET key.





9.6 Parameters mode

NOTICE

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

9.6.1 Overview

If the parameter lock is disabled or unlocked (see *9.6.3 Enabling / unlocking a parameter lock*) 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.

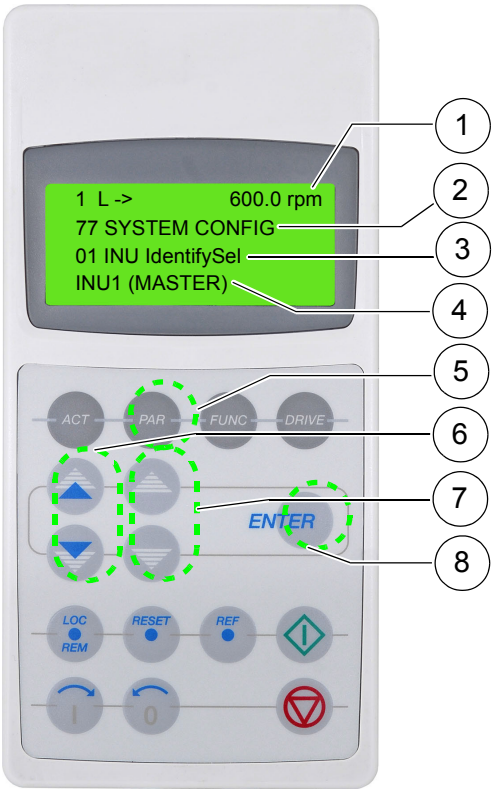
Group 07	Control words	21.01	Start function
Group 08	Status words	21.02	Start function
Group 09	Fault and alarm words	21.03	Off1 stop mode
Group 11	Start / stop / direction / MCB control	21.04	Process stop selection
Group 12	Reference selection	21.05	Process stop signal
Group 16	System control inputs	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	21.17	
Group 23	Speed reference	21.19	MCB available signal

For further information on 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 values cannot be changed while the drive is running. If tried, the following warning displays.

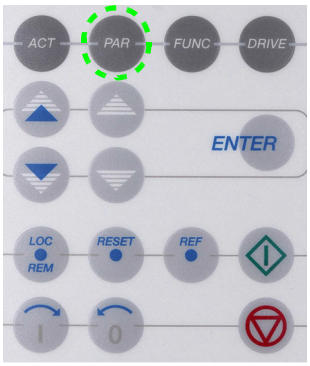
Control panel overview

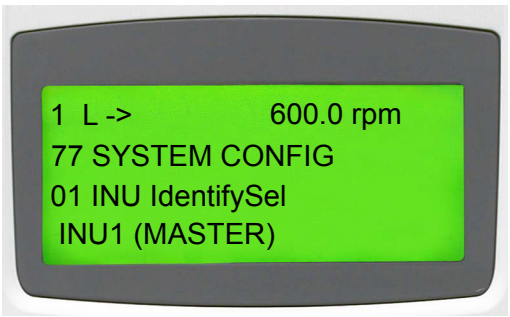


1 Status line
2 Group number and name
3 Parameter number and name
4 Parameter value
5 Selects the parameters mode
6 Selects the parameter number and name
7 Selects the parameter value
8 Enters change mode
Acknowledges the selection

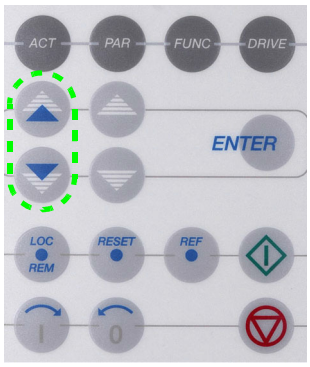
9.6.2 Selecting and changing parameters

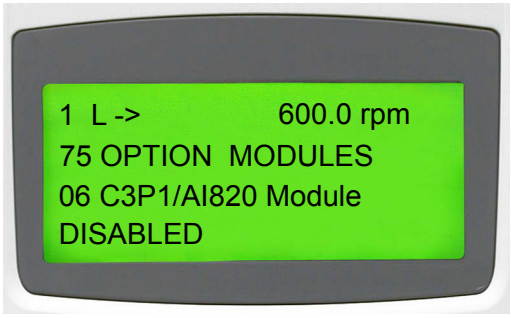
1 To enter the parameters mode, press the PAR key.



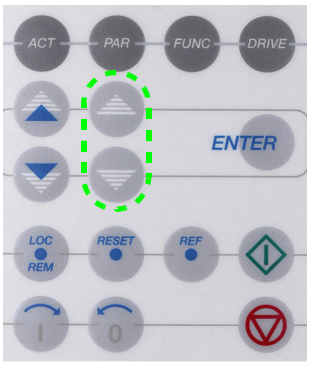


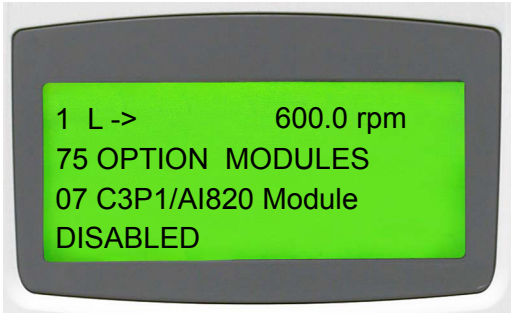
2 To select a different group, press a fast navigation key.



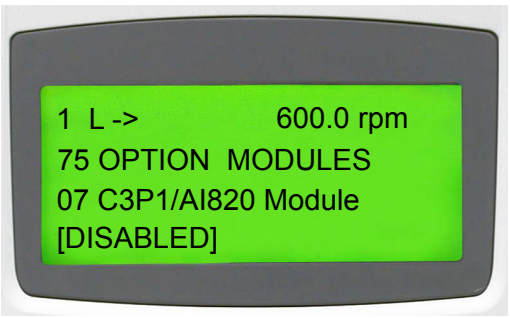


3 To select a parameter, press a slow navigation key.



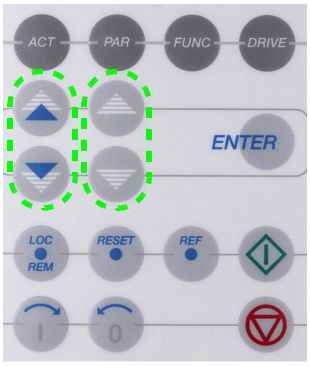


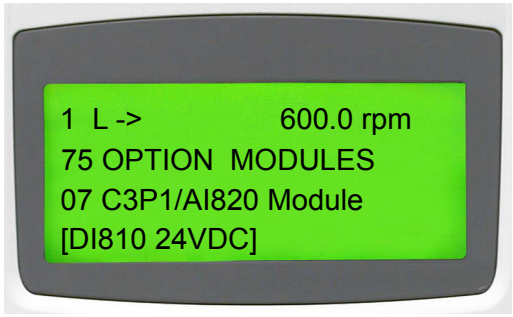
4 To enter the parameter setting function, press the ENTER key.



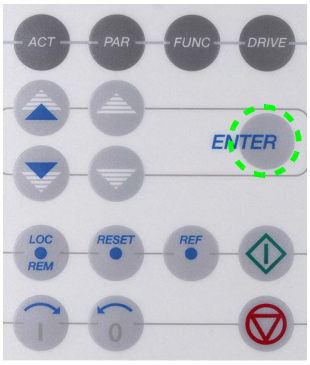
5 To change the parameter value, press:

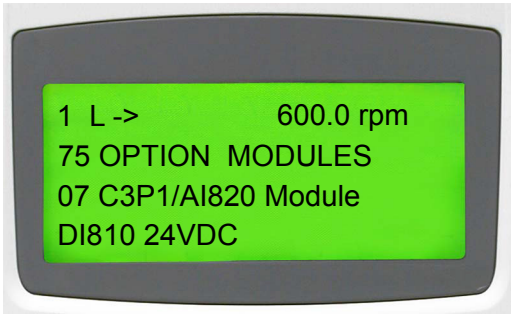
- a slow navigation key for numbers and text,
- a fast navigation key for numbers only.



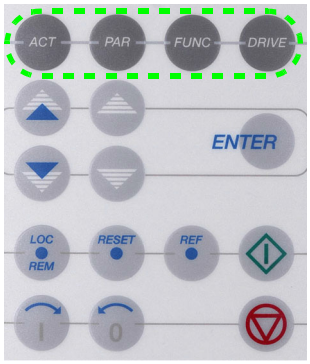


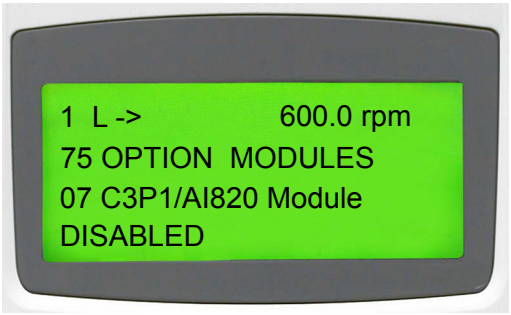
6 To confirm the setting and to return to the actual signals mode, press the ENTER key.





7 To cancel the setting and keep the original selection, press any of the mode selection keys. The selected keypad mode is entered.





9.6.3 Enabling / unlocking a parameter lock

Unwanted parameter entry 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

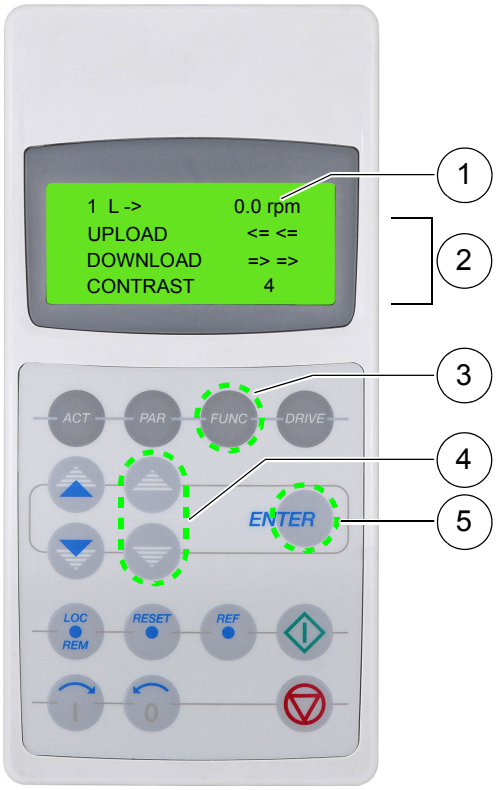
1. Select parameter 16.03.
2. Set the correct pass code.
3. Confirm the setting and exit the parameters mode.

For further information, see *Appendix G – Signal and parameter table*.

9.7 Functions mode

9.7.1 Overview

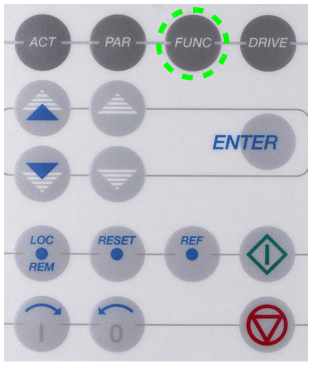
The functions mode is used to set the display contrast.

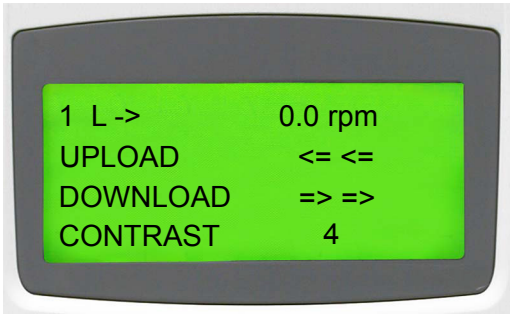


1 Status line
2 Selectable functions
3 Selects the functions mode
4 Selects the line
5 Acknowledges the selection

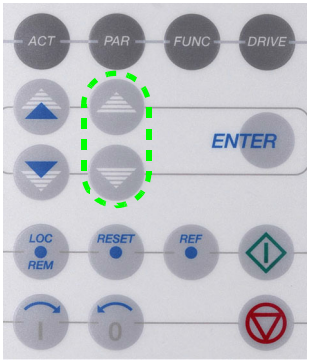
9.7.2 Adjusting the display contrast

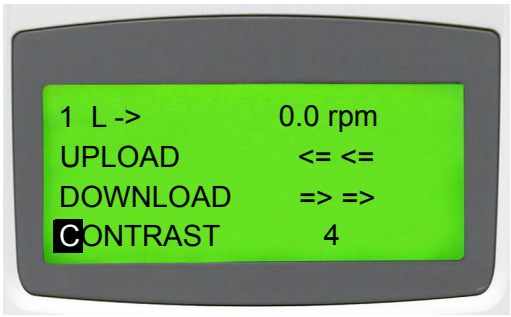
1 To enter the functions mode, press the FUNC key.



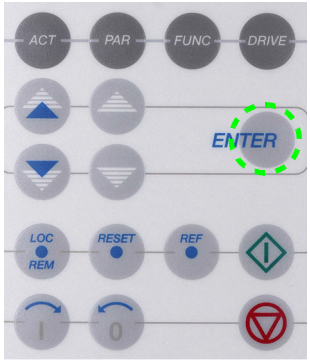


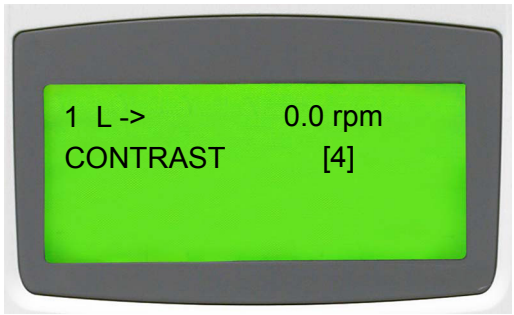
2 To select the contrast adjustment function, press the slow navigation keys until the blinking cursor reaches the CONTRAST line.



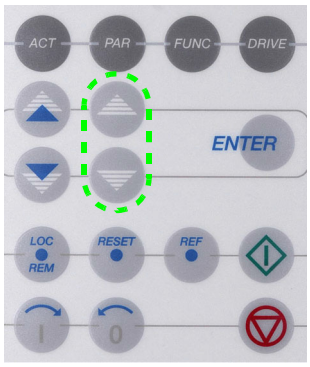


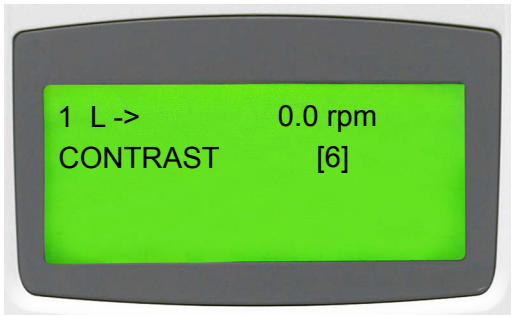
3 To enter the contrast setting function, press the ENTER key.



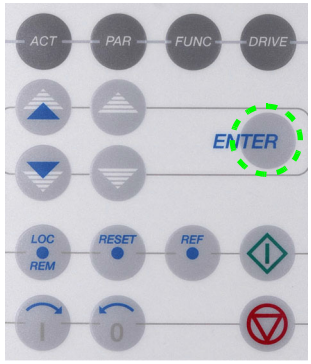


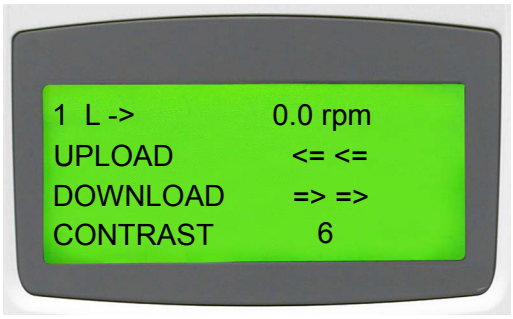
4 To change the contrast value, press a slow navigation key.



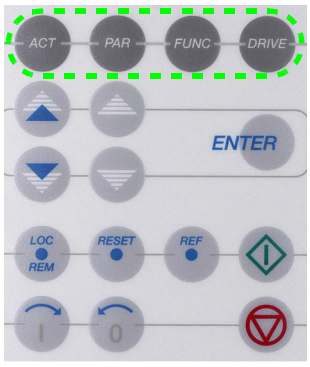


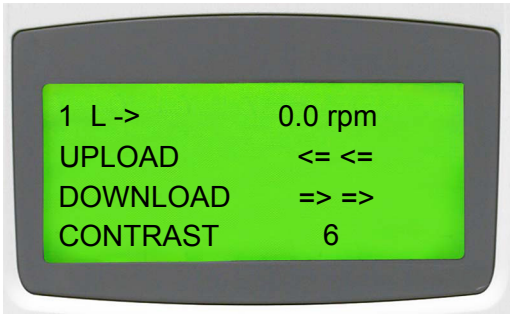
5 To confirm the selection and to return to the actual signals display, press the ENTER key.





6 To cancel the setting and keep the original setting, press any of the mode selection keys. The selected keypad mode is entered.





9.8 Local and remote control

The local-remote feature of the CDP control panel allows selecting the control location of the drive. Possible are:

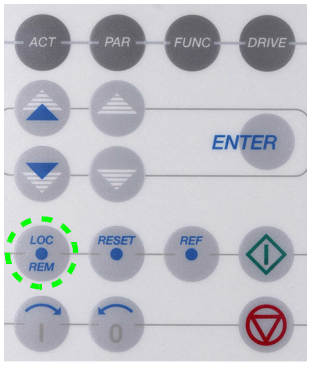
- Local control
- Remote control

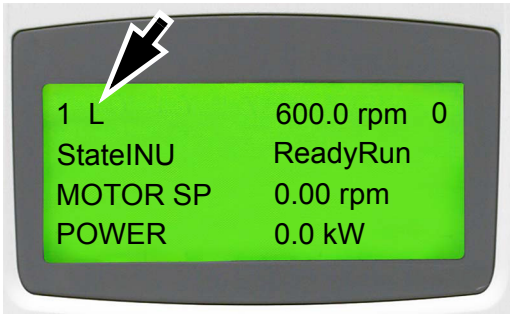
In this context, remote control is not necessarily equivalent to higher-level control. For further information, see *9.8.2 Remote control*.

9.8.1 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.





9.8.2 Remote control

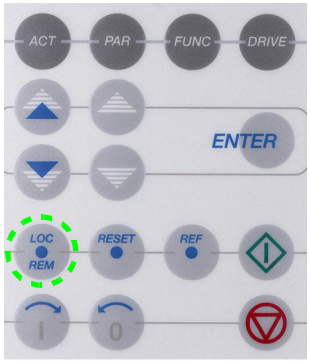
In remote control mode, operational commands or reference values usually come from a higher-level control system via fieldbus or remote I/O.

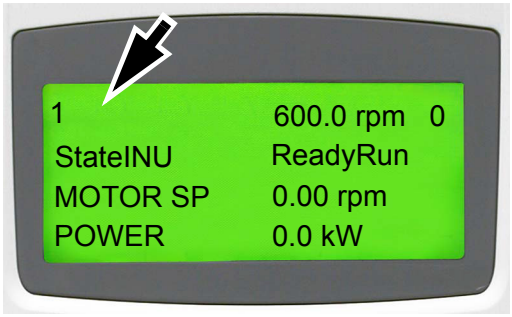
However, with the following parameter settings it is possible to start and stop the drive, to set the motor's direction of rotation, and to enter reference values from the CDP control panel.

- 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)

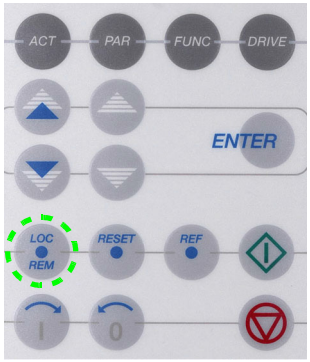
To enter remote control, press the LOC-REM key.

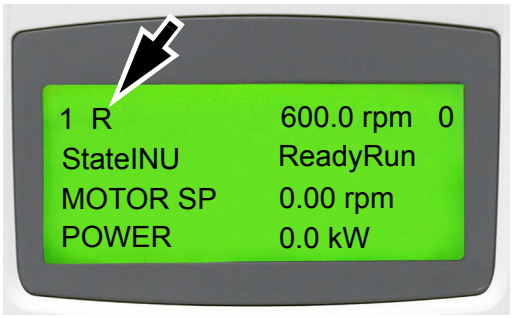
- Full remote control from a higher-level control system is indicated by a blank space.





- Partial remote control (some commands enabled locally) is indicated by the letter R.





9.8.3 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.

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.

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.

9.9 Operational commands

For instructions on how to start and stop the drive system from the CDP control panel, see *8.6 Starting the drive* and *8.7 Stopping the drive*.

9.9.1 Setting the direction of rotation

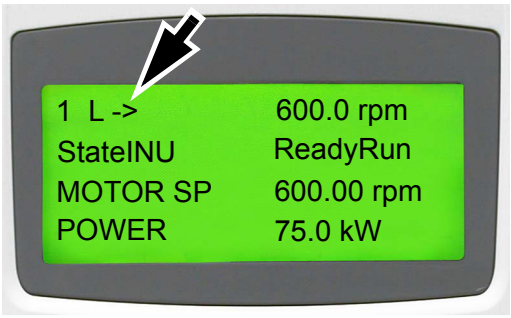
Setting the direction of rotation from the CDP control panel is possible in:

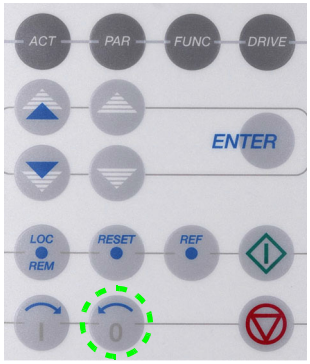
- Local control mode L
- Remote control mode R

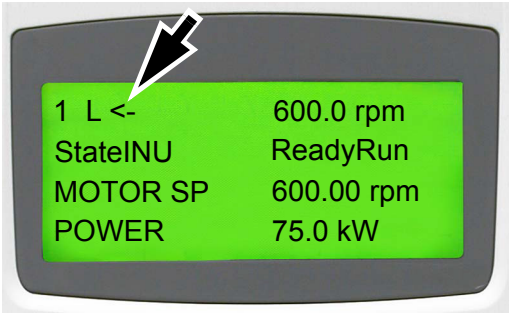
The arrow on the display indicates the direction of rotation:

- 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.







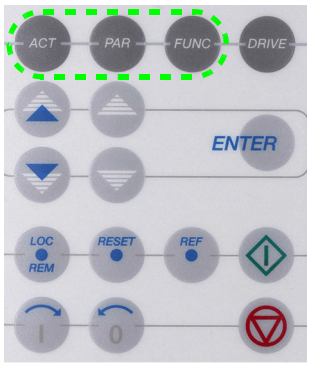
If you change the direction while the motor is running, the motor automatically ramps down to zero speed and reaccelerates in the opposite direction to the preset speed. The arrow changes at zero speed.

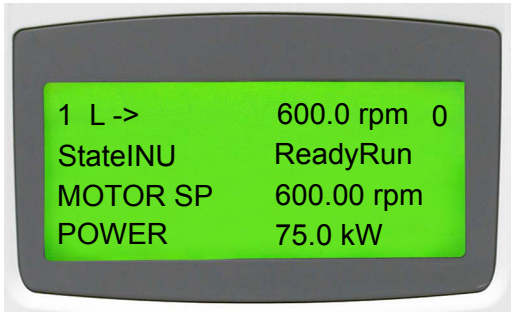
9.9.2 Entering a reference value

Entering a reference value from the CDP control panel is possible in:

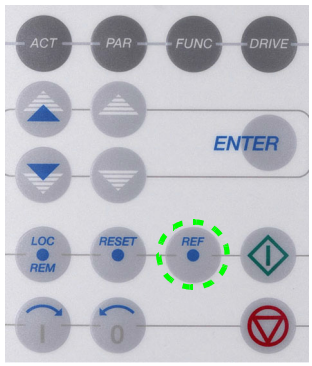
- Local control mode L
- Remote control mode R

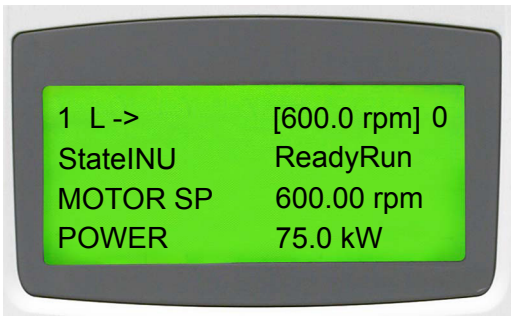
1 Press a mode selection key.



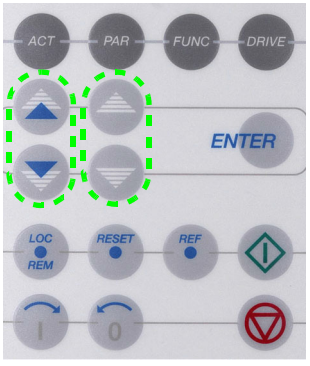


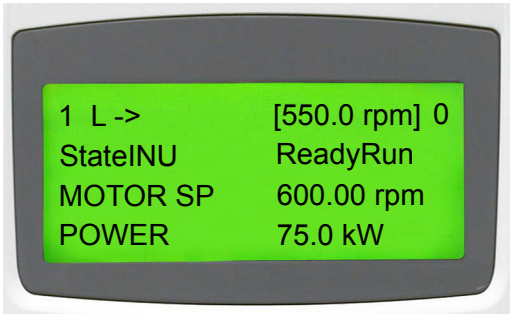
2 To enter the reference value setting function, press the REF key.



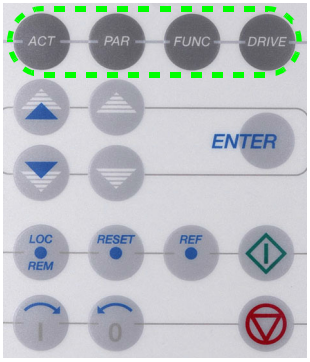


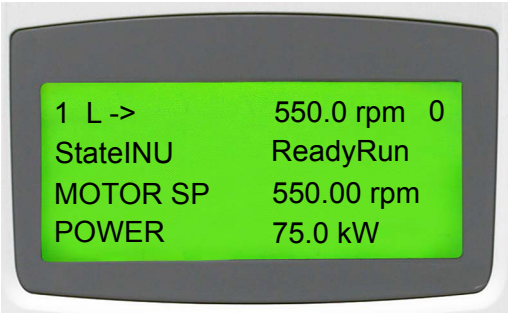
3 To change the reference value, press either the corresponding fast or slow navigation key.





4 To exit the reference value setting mode, press any of the mode selection keys.





Chapter 10 - Preventive and corrective maintenance

10.1 General information

10.1.1 Required qualification

During the warranty period of the drive, any maintenance must be carried out exclusively by ABB service personnel. After the warranty period, maintenance must only be carried out by certified personnel.

To maintain safe and reliable operation of the drive, ABB recommends taking out a service contract with the ABB service organization.

To contact the ABB service organization, see *Contact information*.

10.1.2 Maintenance schedule

Carry out all maintenance tasks according to the maintenance schedule and the applicable service instructions, on time and at the stated intervals.

10.1.3 Logbook

It is recommended to record 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 *Spare parts list.*

10.2 Identifying electrical equipment

10.2.1 Device identification

To facilitate the identification in wiring diagrams and parts lists, all devices are labeled in accordance with IEC 81346-1.

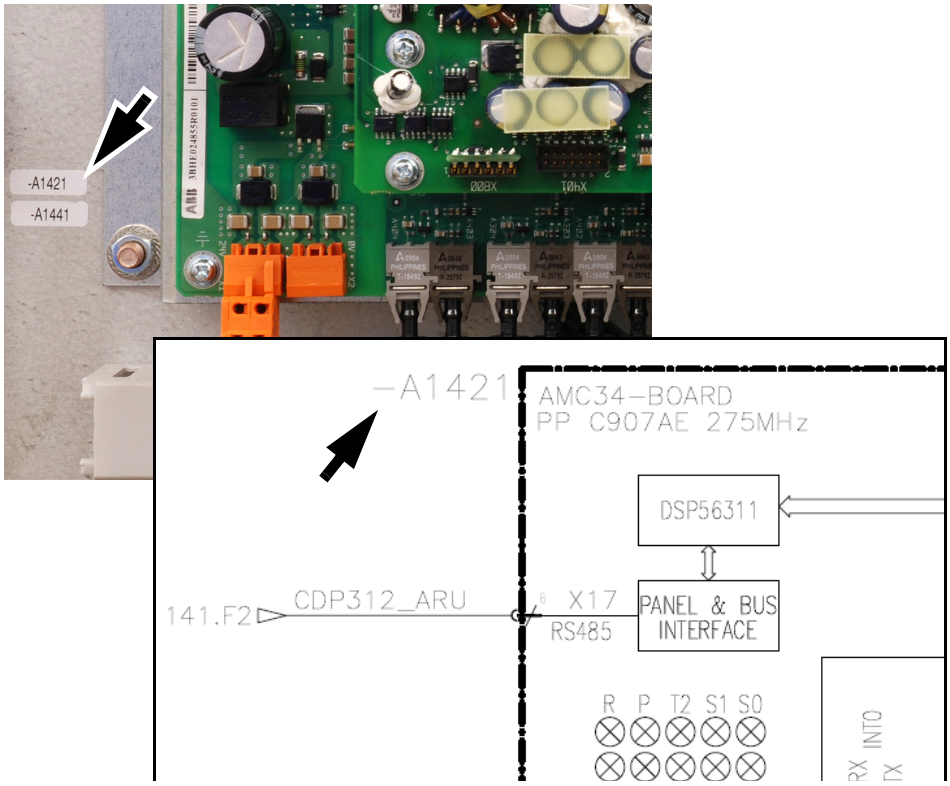


Fig. 10-1 Device identification

10.2.2 Cables and wires

Cables and wires in the drive are equipped with marker sleeves that carry the same identification number as in the wiring diagrams.

10.2.3 Understanding wiring diagrams

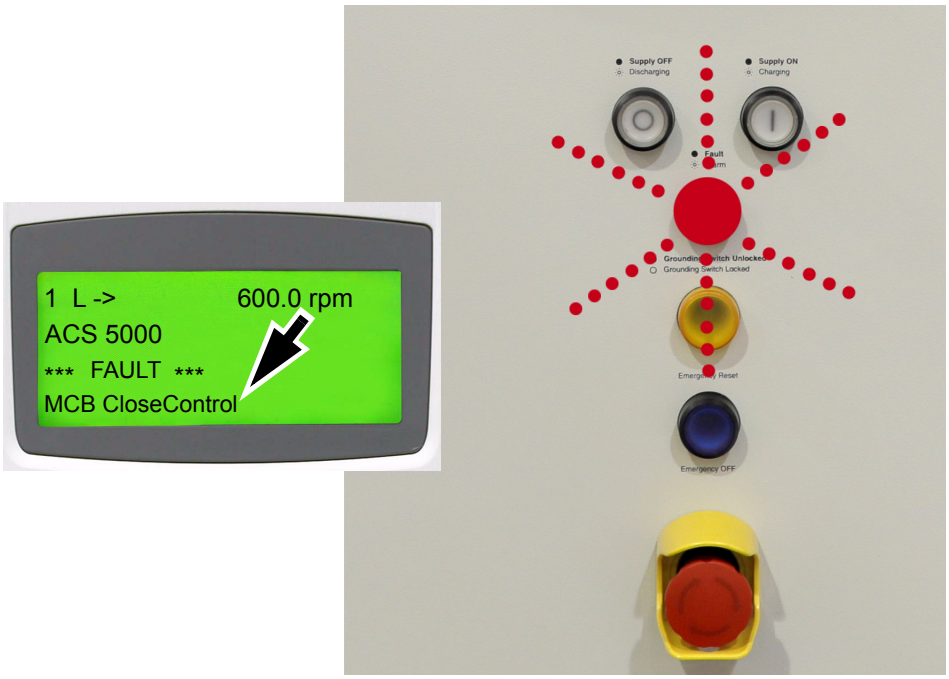
For information on item designation and cross-reference conventions, see, *Appendix D – Wiring diagrams*.

10.3 Alarm / fault indications

10.3.1 Messages

When a failure occurs in the drive or in the equipment monitored by the drive (eg, MCB, transformer, cooling system), the CDP 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 the DriveWindow, DriveDebug or DriveMonitor is connected to the drive. The fault logger can also be called up on the CDP 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 main circuit breaker (MCB) is opened by the drive or stays 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 external 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.

Alarm / fault messages If 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.

10.3.3 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 on 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:

- **4. +Fault DC Undervoltage** is the reason for the failure of the drive, as it occurred first.
- **3. +Fault AMC: Fault Class 1** classifies the fault.

- **2. +Fault PPCS Communication** occurred 2 min 22 sec later than the first fault due to another fault in the drive.
- **1. +Fault AMC: Fault Class 2** informs about the pending fault class.

For further information on alarms and faults, see *Appendix G – Signal and parameter table*.

10.3.4 Troubleshooting procedure

If a fault shuts down the drive, proceed as follows:

1. Do not switch off the auxiliary power supply or try to reset a fault message before all information at the time of the occurrence of the fault condition has been saved.
2. Call up the Fault History Display on the CDP control panel.

   For further information, see *Chapter 9 - CDP control panel*.

   Do **not** clear the fault buffer of the drive now!
3. Identify the fault and make a logbook entry.

   Note the fault message displayed on the CDP control panel and look up the fault message in the *Alarms and Faults Troubleshooting Guide* for further information.
4. Save the content of the data logger when a PC is available that has the DriveWindow or DriveDebug installed.

   The data logger provides information (eg, waveforms of voltage, current, torque) for efficient troubleshooting.
5. If a fault cannot be rectified, contact ABB service.

   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

After the fault has been rectified, start the drive as described in *Chapter 8 - Operation*.

10.4 Removing the CDP control panel

1 When the panel is removed while the drive is in operation, check the setting of parameter 31.01 PANEL LOSS SUPERVISION first.

If the parameter is set to NOT USED, the panel can be removed without interrupting drive operation.

For information on setting parameters, see *Appendix G – Signal and parameter table*.

When the CDP control panel has been removed during operation, the drive can only be stopped by pressing the EMERGENCY-OFF pushbutton.

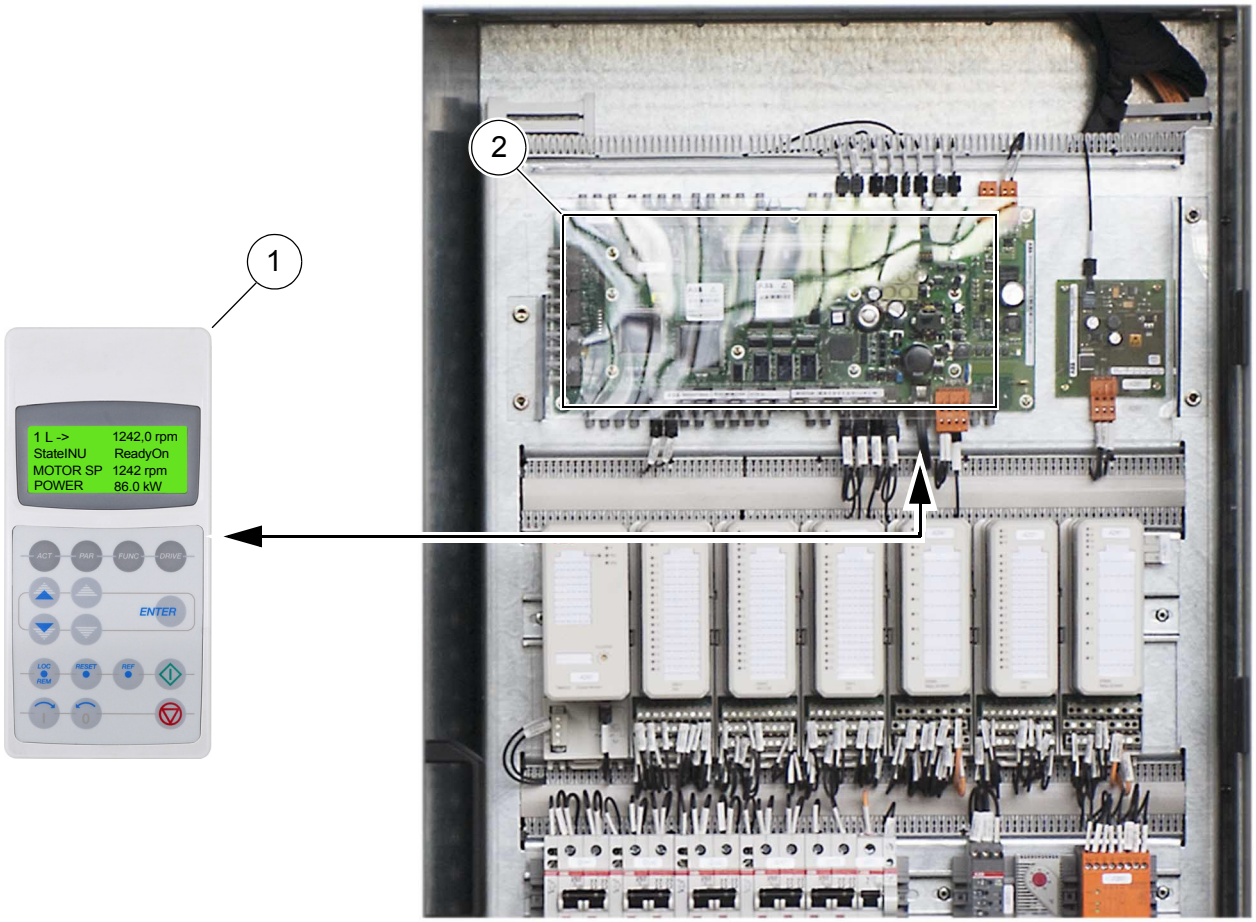
2 To remove the panel, proceed as illustrated below.

Meaning of the LEDs

The green LED *(4)* signals that the control voltage has been switched on.

Communication with AMC circuit board

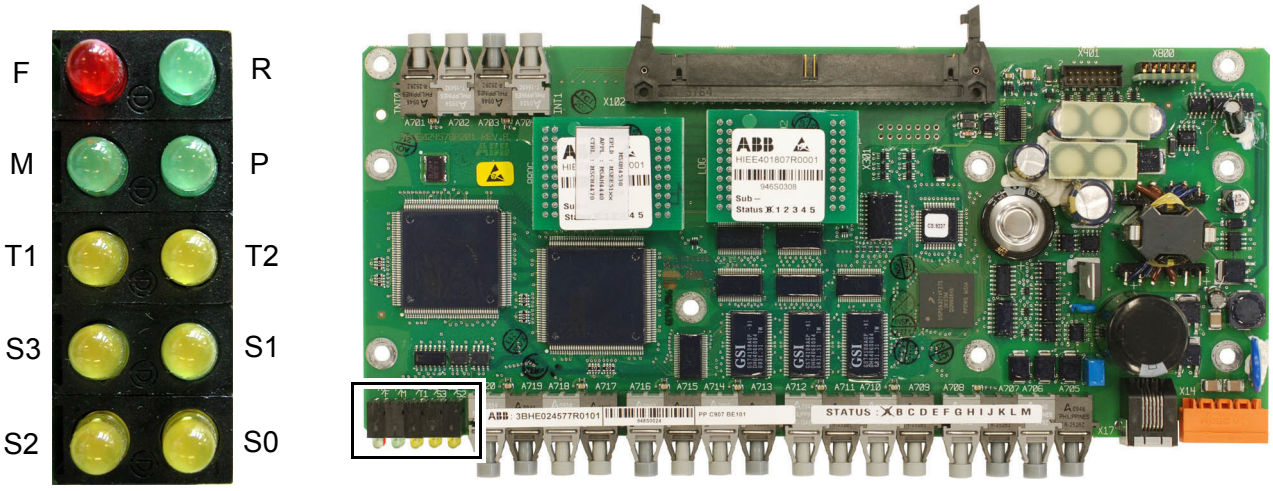
The CDP control panel *(1)* is connected to the AMC circuit board via an RS485-Interface.



10.5 LEDs and switches on circuit boards and I/O modules

The following section provides an overview on 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.

10.5.1 AMC circuit board



LED	Color	Meaning	Status when SW loaded		Status when SW 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

Fig. 10-2 AMC circuit board

10.5.2 S800 I/O - TB820 bus modem

LED	Color	Meaning	
F	Red	Fault	Fault in module
R	Green	Run	Device in operation
P	Green	Power	Power supply is healthy
Rx1	Green	-	Traffic on optical ModuleBus
Rx2	Green	-	Traffic on optical ModuleBus
ERx	Green	-	Traffic on electrical ModuleBus

Fig. 10-3 TB820 bus modem

Modem address

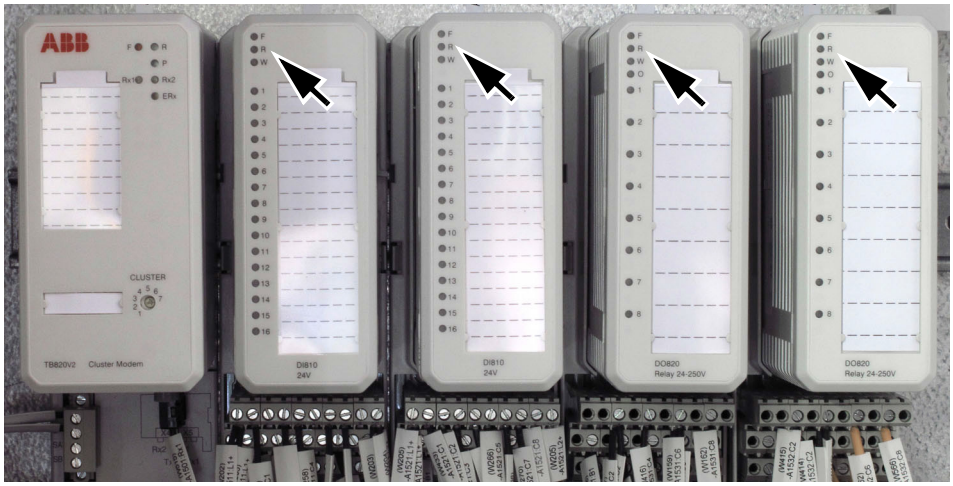
The TB820 bus modem has a unique cluster address that identifies the module in the software and links it to a parameter.

The address is set with the rotary switch on the module *(Fig. 10-3: 1)*. The factory set value must not be changed.

10.5.3 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 located at the topmost position on each module *(Fig. 10-4: arrows)* and are identified as follows:

- F: fault
- R: run
- W: warning
- O or OSP (only output modules).



LED	Color	Meaning	
F	Red	Fault	Indicates malfunction
R	Green	Run	Device is operating normally
W	Yellow	Warning	External fault or minor fault in the module
O (OSP)	Yellow	-	(Output Set as Predetermined) Indicates an active signal
-	Yellow	-	Indicates an active signal

Fig. 10-4 Example of S800 I/O station

For further information, see the following manuals:

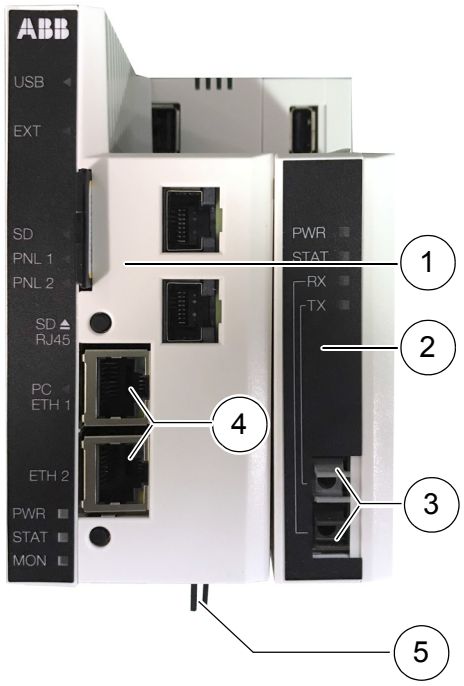
- *S800 I/O - General information and installation, user's guide*
- *S800 I/O - Modules and termination unit, user's guide*

10.5.4 Serial communication interfaces

To identify the serial communication interface in the drive, see *Appendix D – Wiring diagrams*. For further information on the device, select the appropriate manual from the list below:

- *Ethernet - NETA-21 installation and start-up guide*
- *Modbus - NMBA-01 installation and start-up guide*
- *Profibus - NPBA-12 installation and start-up guide*

Ethernet interface



1 NETA-21 remote monitoring tool
2 NEXA-21 extension module
3 Fiber-optic connectors for communication cable to the drive
- TXD = transmitter
- RXD = receiver

4 RJ-45 connector for Ethernet cable
5 Power supply connection on underside

Fig. 10-5 Ethernet interface

LED indications of the NETA-21

Name	Color	Function
USB	Off	No USB mass storage devices attached
	Green	USB mass storage device attached and mounted.
	Blinking green	Device attached, initialization in progress
	Yellow	Device can be removed.
	Red	Unidentified error when settings are imported from an USB memory device.
	Blinking red	Initialization failed. Unsupported file system on a USB stick. Only FAT file systems with 8.3 character filenames are supported. Basically, NTFS-formatted USB sticks and external hard disks are not supported.

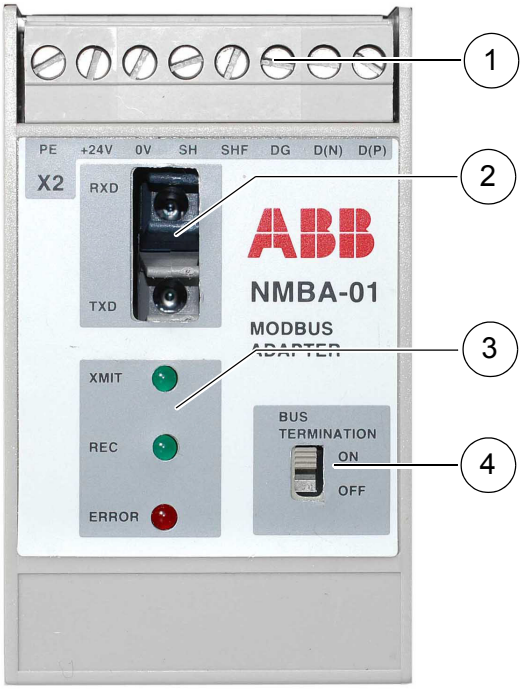
Name	Color	Function
EXT	Off	No NEXA-21 connected
	Green	NEXA-21 found and initialized
	Blinking green	NEXA-21 support is being initialized (when the remote monitoring tool boots up)
	Red	NEXA-21 malfunctions
	Blinking red	NEXA-21 not supported
SD	Off	No SD/SDHC card
	Green	Card attached and taken into use
	Blinking green	Card attached and initialization in progress
	Yellow	Card can be safely removed
	Blinking yellow	Card attached, removal in progress
	Blinking yellow	**Together with the blinking red STAT LED:** System waits for confirmation of reboot operation or network override
	Red	Card error, for example write protection prevents from writing data to the card
	Blinking red	Card initialization failed. Unsupported card type, for example, SDXC (extra capacity) cards and MMC cards are not supported.
PNL 1/ PNL 2	Off	No devices (no wire) connected to the PNL port
	Green	All devices connected, identified and commissioned
	Blinking green	Manual or automatic discovery of devices in progress
	Yellow	Communication OK, but device connectivity limited. All devices are ready to be unplugged/disconnected.
	Red	Communication error caused the panel port network initialization to fail. Unknown device in the network, or something is interfering the network and preventing proper detection of monitored devices.
	Blinking red	Unsupported device is found in the network, or there are too many devices in the network to be monitored

Name	Color	Function
PC ETH 1	Off	PC not connected. If an Ethernet cable is connected to the PC ETH 1 port but no one uses the tool, the LED remains blank.
	Green	Connection set up and in operation, for example, DHCP is active and at least one PC has got an IP-address
	1/2-second blinking green	DHCP server is active. NETA-21 provides IP addresses for local devices.
	1-second blinking green	At least one user has been logged on to the user interface
	Blinking yellow	Factory-level access/operation. Firmware update in progress. **Note:** System status (STAT LED) blinks during the firmware update.
PWR	Off	Power off
	Green	Power on
	Yellow	Timed power off or standby. NETA-21 can go to the standby mode as a protective measure (eg, if the environmental temperature is too high). To wake up the NETA-21, press the SD RJ45 button.
STAT	Green	System in operation, OK
	Yellow	System starts up, services not yet fully operational
	1/4-second blinking yellow	System waits for a confirmation of the reboot operation or network override.
	1-second blinking yellow	Firmware update in progress
	Blinking red	Error occurred during the start-up of the NETA-21. If the start-up fails, the NETA-21 restarts itself automatically after a few seconds. During the reboot operation, all LEDs excluding the PWR LED flash before the STAT LED turns yellow again. **Note:** If the yellow STAT LED and blinking red STAT LED alternate and the STAT LED does not turn green, the start-up of the NETA-21 fails continuously. Try resetting the NETA-21 to factory settings.
MON	Blinking green	NETA-21 sends data (eg, email) to an external destination.
	Blinking red	NETA-21 fails to send data (eg, email) to an external destination. Log on to the web user interface and go to **Reports –> Events** for error details.

LED indications of the NEXA-21

Name	Color	Function
PWR	Off	NEXA-21 not controlled by the NETA-21 or the NETA-21 boots up
	Green	NEXA-21 detected by the NETA-21 and the NEXA-21 turned on
STAT	Green	System in operation, OK. DDCS drives (/converters/inverters) commissioned. Communication with drives (/converters/inverters) OK.
	Yellow	System reboots, the NEXA-21 temporarily out-of-order
	Blinking yellow	Limited connectivity. Devices not found.
	Red	Internal error. DDCS network not physically OK, or no devices detected.
	Blinking red	Incompatible device in DDCS. NEXA-21 has lost connection to a configured device. **Note:** DDCS is running.
RX	Off	Not receiving data
	Yellow	Receiving data
TX	Off	Not transmitting data
	Yellow	Transmitting data

Modbus interface



1 Bus-cable terminals
2 Fiber-optic connectors for communication cable to the drive
- TXD = transmitter
- RXD = receiver

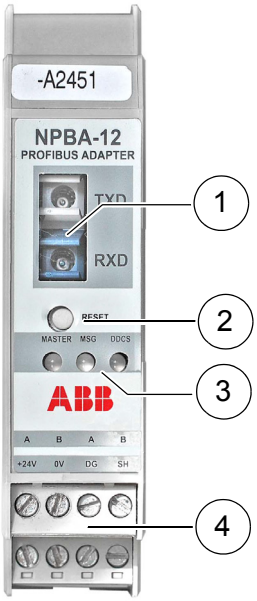
3 Status LEDs
4 Switch for bus termination

LED		Meaning
XMIT	Flashing	Interface transmits a response or an exception
REC	Flashing	Interface receives a command from the Modbus network
ERROR	Flashing	If the received command has a parity error, or if the received command has a CRC error, or if the received command is not supported by the interface, or if the interface has detected an error

LED	Error indication	Meaning
XMIT, REC, ERROR	On	ROM checksum test failed
REC, ERROR	On	RAM test failed
ERROR	On	DDCS-ASIC-register-access test failed

Fig. 10-6 Modbus interface

Profibus interface



1 Fiber-optic connectors for communication cable to the drive
- TXD = transmitter
- RXD = receiver

2 Reset button for initialization of module

3 Status LEDs

4 Bus-cable terminals

During start-up	LED		
	Master	MSG	DDCS
Power-on	Off	Off	Green then red then off
	Off	Green then red then off	Off
	Green then red then off	Off	Off
DDCS link initialization	Off	Off	Flashing green then green
Transfer-rate detection	Flashing green then green	Off	Green
Communication established	Green	Flashing green then green	Green
Operation	Green	Green	Green

LED			Cause
Master	MSG	DDCS	
Red	Red	Off	RAM test failure
Off	Red	Red	ROM test failure
Last valid state	Last valid state	Red	DDCS link failure
Green	Flashing red	Flashing green	Communication failure
Flashing red	Red	Flashing green	Link failure

Fig. 10-7 Profibus interface

10.6 Corrective maintenance

10.6.1 Overview on maintenance tasks

- *Visual checks on the drive*
- *Cleaning*
- *Checking wire and cable connections*
- *Replacing the filter mats*
- *Replacing a fan*

10.6.2 Safety

DANGER

Hazardous voltages!

Before starting to work on the drive, make sure that:

- the main and auxiliary power supply to the drive is switched off, locked out, and tagged out,
- the drive is dead,
- safety ground connections are in place,
- personal protective equipment is provided and used when required,
- everyone involved is informed.

Before energizing the drive again, make sure 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 bolted,
- the manual release of the safety switches is in the locked position.

DANGER

Hazardous voltages!

When a phase cell is removed from the cabinet, the grounding path between grounding switch and PE ground busbar is interrupted.

For this reason, connect grounding equipment at the appropriate locations. The grounding equipment ensures that hazardous voltages cannot be fed into the drive from the main power supply or the motor.

NOTICE

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.

10.6.3 De-energizing the drive locally

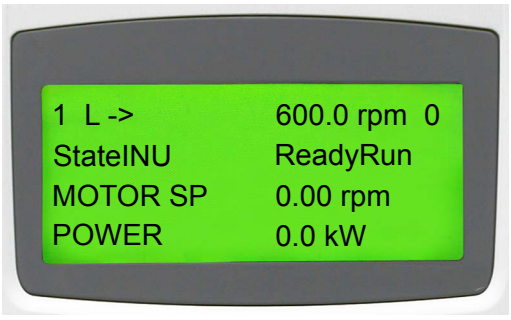
The following section describes how to de-energize the drive using the local operator panel of the drive. If the drive is controlled from remote, follow the established shutdown procedures.

Stopping the motor

1. Check that the CDP control panel is connected.
2. Enable the local control mode of the CDP control panel.

   For further information, see *Chapter 9 - CDP control panel*.
3. Stop the motor.

When the motor has reached zero speed, the display shows **ReadyRun**:

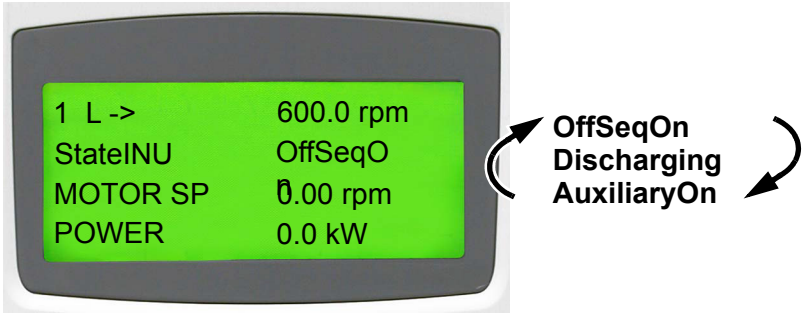


De-energizing the drive

4 To disconnect the drive from the main power supply, press the MAIN SUPPLY OFF pushbutton. The following takes place:

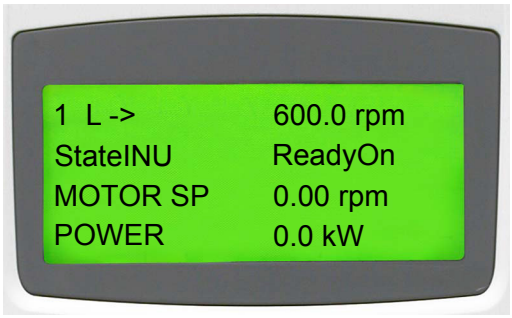
- The MCB opens.
- The DC link discharges.

  While the DC link discharges, the display shows the following.



- The **SUPPLY OFF** pushbutton flashes and changes to a permanent light when the DC link is discharged.

When the DC link is discharged, the display shows **ReadyOn**.



5 Rack-out, lock-out, ground and tag-out the main power feeder.

6 Wait until the yellow lamp GROUNDING SWITCH UNLOCKED lights up.

CAUTION

If the lamp does not light up, do not force the grounding switches in any direction before you know the reason why the lamp does not light 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 is not released for closing.

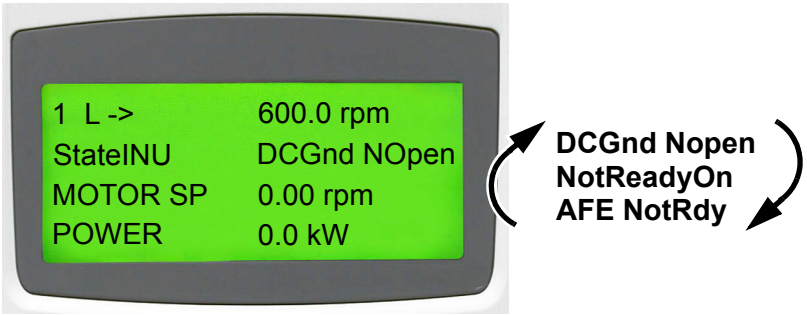
If the lamp is on, continue with *Grounding*.

If the yellow lamp is not on, continue with *10.6.4 Grounding switches are not released*.

Grounding

7 If the yellow lamp GROUNDING SWITCH UNLOCKED is on, turn the grounding switches to the grounded position.

When the grounding switches are in the grounded position, the CDP control panel shows the following:



8 If necessary, open the doors of medium voltage compartments.

To open the doors of medium voltage compartments, auxiliary voltage is required.

9 Switch off and lockout all auxiliary voltages from external sources.

10 Verify that the drive system is de-energized.

11 To connect a grounding set, continue with *10.6.5 Connecting a grounding set*.

10.6.4 Grounding switches are not released

When the DC link of the drive has been discharged, the lamp GROUNDING SWITCH UNLOCKED lights up to indicate that the grounding switches are released and can be turned to the grounded position. If the lamp does not light up, proceed as follows:

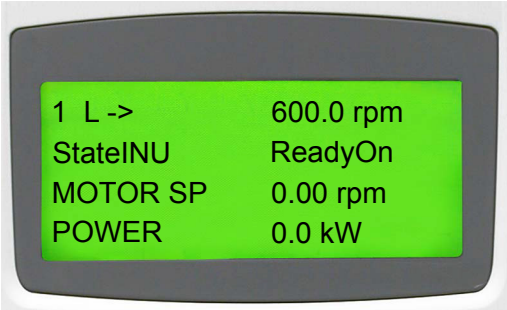
1 Do not force the grounding switches in any direction.

2 Check the discharging level of the DC link.

If the value of parameter 2.01 DC VOLTAGE is below 50 V, the DC link is discharged.

(For information on viewing actual values, see *9.5 Actual signals mode*.)

If the DC link is discharged, the message **ReadyOn** is displayed on the CDP control panel.



If the DC-link voltage does not decrease below 50 V, do not continue but call ABB. To contact the ABB service organization, see *Contact information.*

3 To test the lamp GROUNDING SWITCH UNLOCKED, activate the lamp test with parameter 16.7.

(For information on setting parameters, see *9.6 Parameters mode*.)

- If the lamp does not light up, replace it.
- If the lamp lights up after it was replaced, continue with step *7*.
- If the lamp does not light up after it was replaced, continue with step *4*.

4 Verify that the MCB (main circuit breaker) is open.

1 If the MCB is open, check that it is locked out.

2 Check if the SUPPLY OFF lamp is lit.

When the lamp is lit, the feedback signal “main circuit breaker open” is present at digital input DI14 of I/O module A2531.

5 Check if the LED of digital output DO07 (I/O module A2541) is lit.

When the LED is lit, the grounding switches are released.

6 Switch off the circuit breaker (Q1002) for the charging transformer. This prevents hazardous charging voltages being fed into the drive.

7 Carefully turn the grounding switches to the grounded position if it has been verified:

- that hazardous voltages cannot be fed into the drive from the main power supply or the motor,
- that the DC link is discharged,
- that the grounding switches are released (DO07 is energized).
- that the drive status is **ReadyOn**.

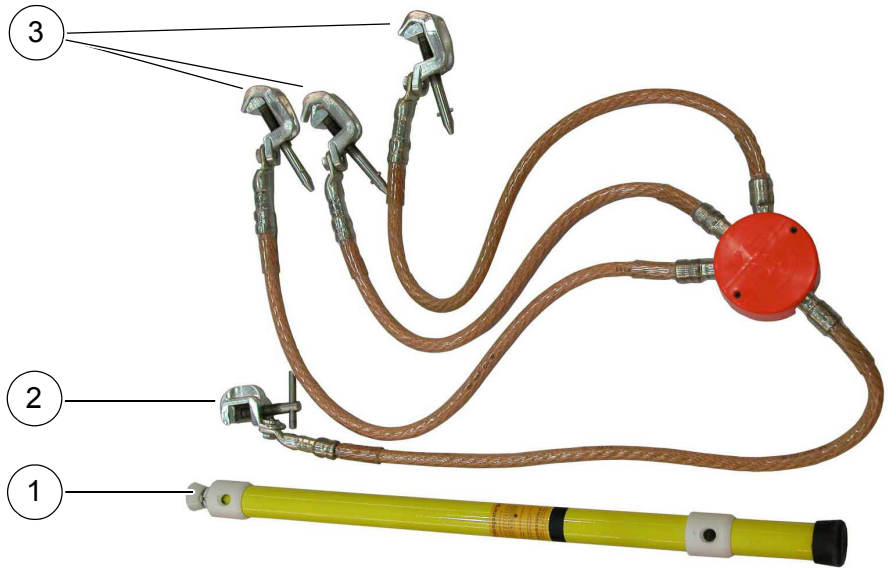
8 If you cannot turn the grounding switches, continue with *10.6.6 Emergency release of the door safety switch*.

9 Switch off and lockout all auxiliary voltages from external sources.

10 Verify that the drive system is de-energized.

11 Ground the drive with a grounding set (option).

10.6.5 Connecting a grounding set



1 Telescopic insulating pole
2 Enclosure ground clamp
3 Busbar ground clamp

Fig. 10-8 Four-way grounding set (option)

1 Connect the enclosure grounding clamp *(Fig. 10-8: 2)* to the ground ball stud of the cabinet's grounding frame.

2 Use the telescopic insulating pole to connect the busbar ground clamps *(Fig. 10-8: 3)* to the ground ball studs of the busbars, and to tighten each connection.

The drive is now dead, and safe access is possible.

10.6.6 Emergency release of the door safety switch

The door of the rectifier/inverter compartment is secured with a safety switch. The safety switch is tied into an interlocking circuit that operates in conjunction with the grounding switches of the drive and the interlocks from the main circuit breaker of the drive. The interlocking system ensures:

- that the main power cannot be connected to the drive unless the door is securely closed and the grounding switches are in position **not grounded**,
- that the door cannot be opened until the main power is disconnected, the DC-link capacitors are discharged and the grounding switches are in position **grounded**.

The door of the rectifier/inverter compartment also cannot be opened

- if the drive is disconnected from the auxiliary power and
- if the safety switch of the door is in position **locked**.

If the auxiliary voltage is switched off and the door is locked and cannot be opened, check the position of the release dial of the safety switch. If the release dial is in the locked position, unlock the safety switch as described in the following section.

DANGER

Hazardous voltages!

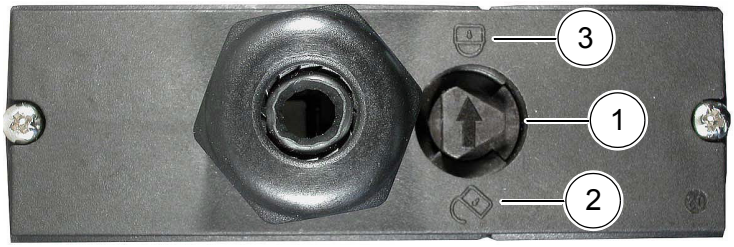
Touching energized components can be fatal.

- Before you unlock a safety switch, verify that the drive is de-energized.
- Do not unlock the safety switch permanently.

Location

Fig. 10-9 Location of the door safety switch

Safety switch settings



1 Release dial

2 Unlocked position

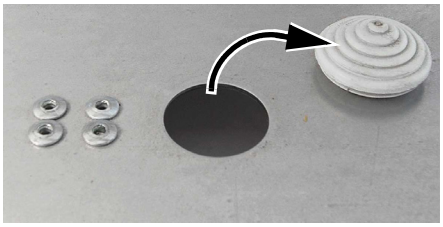
The unlocked position enables opening the door of a medium voltage compartment whether the auxiliary voltage is switched on or off.

3 Locked position

Locked is the normal operating setting. To open the door of a medium voltage compartment, the DC link must be discharged and the auxiliary voltage must be switched on.

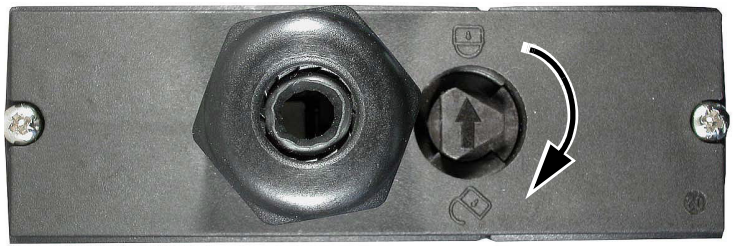
Unlocking

1 On the roof of the drive, remove the cap of the access hole to the safety switch.



2 Insert the supplied triangular nut driver into the triangular counterpart of the safety switch.

3 Turn the release dial from the **locked** to the **unlocked** position (the symbols on the safety switch are visible when looking through the opening at an angle).



4 When the door has been opened, turn the release dial to the locked position.

5 Refit the cap.

10.6.7 Door handles

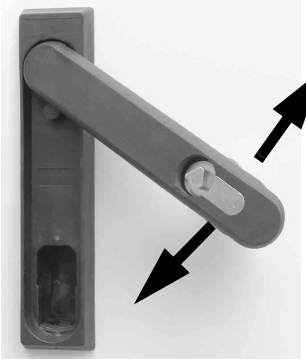


Fig. 10-10 Pivoted door handle

To open a door:

1. To release the door handle, insert and turn the key to the right. The door handle pops out.
2. To open the door, turn the door handle
   - to the right if the door is hinged on the right,
   - to the left if the door is hinged on the left.
3. To lock the door, bring the door handle in line with the door plate and press the handle down until it clicks in.

10.6.8 Visual checks on the drive

Check the drive and its immediate vicinity visually at the intervals stated in the maintenance schedule 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
- Signs for overheated components, wires, cables or busbars
- Corrosion on circuit boards, connectors or busbars
- Correct type of signal and power cables

For information, see the applicable cable specifications.

10.6.9 Cleaning

NOTICE

Risk of component damage!

- Dust on electrical components and wiring can cause failure and damage the components. Dust and moisture can build up in loose connections and cause loss of low-level signals.

  Check the cabinet regularly for signs of dust and humidity and clean if necessary.
- Alcohol and solvents can damage the components.

  Use appropriate and recommended cleansing agents.

When cleaning the drive cabinet, mind the following:

- To prevent dirt falling into equipment, cover the equipment.
- The drive contains components which are sensitive to electrostatic discharge. Therefore, take electrostatic-sensitive precautions and use suitable tools.

  Clean circuit boards with special care. To prevent the components being damaged, use antistatic brushes and a vacuum cleaner with a soft nozzle.
- Remove dust on 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 such as "3M Scotch Brite".
- 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.

10.6.10 Checking wire and cable connections

Vibration can loosen electrical connections and cause occasional malfunction or equipment failure.

- Check all power and control cable connections and tighten them if necessary.
- Check that all plugs and connectors are tight.

NOTICE

Capacitor bushings are damaged when excessive force is applied.

Do not exceed the maximum tightening torque. The tightening torque value is printed on a label which is attached to the capacitor. If not specified, the maximum tightening torque must not exceed **20 Nm.**

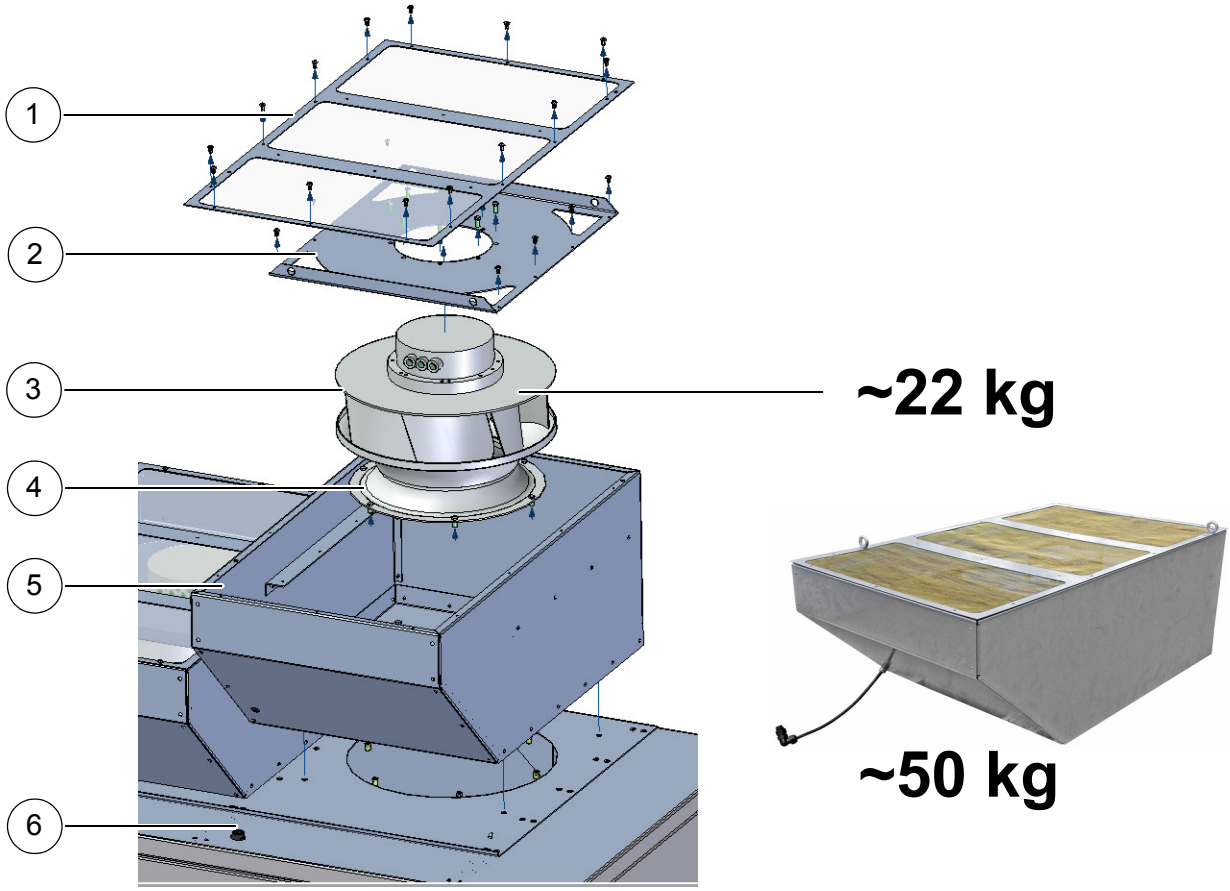
10.6.11 Replacing the filter mats

Filter class	G3 (according to EN779)			
Dimensions (mm)	①	②	③	④
3.5 MVA drive	230 x 738	1839 x 648	1839 x 698	1839 x 277
7 MVA drive	230 x 738	1839 x 648	1839 x 698	1839 x 677
2.4 MVA transformer	1258 x 574	1258 x 599	1258 x 574	
3.4 MVA transformer	1258 x 674	1258 x 699	1258 x 674	
4.5 MVA transformer	1258 x 774	1258 x 799	1258 x 774	
7 MVA transformer	1258 x 774	1258 x 799	1258 x 774	
Thickness (mm)	10			

- For information on replacement intervals, see *Maintenance schedule*.
- To remove a filter mat, roll down the filter mat beginning at the top
- Clean the filter mat away from the drive so that dust cannot enter the drive. Use compressed air or a vacuum cleaner.
- To prevent foreign matter entering the drive, do not discontinue work for a longer time.

10.6.12 Replacing a fan

For information on replacement intervals, see *Maintenance schedule*.



1 Screen
2 Mounting plate
3 Impeller and motor
4 Flange
5 Housing
6 Motor cable connector

Fig. 10-11 Fan – Exploded view

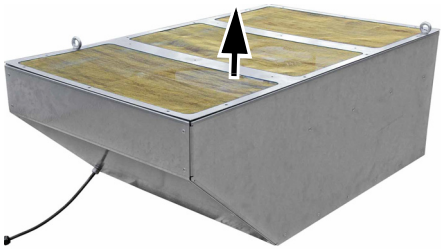
1 Disconnect all power supplies to the drive and ground the drive.

For further information, see *De-energizing the drive locally*.

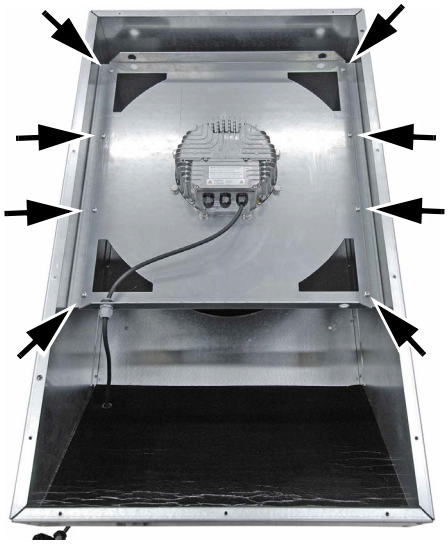
To isolate the fan unit from the auxiliary power supply, switch off the motor starter of the fan unit.

To identify the motor starter, see *Appendix D – Wiring diagrams.*

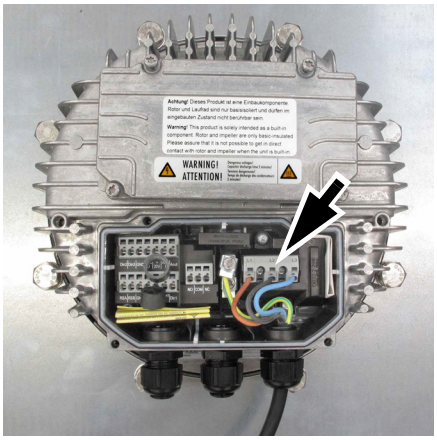
2 Remove the screen.



3 Remove the fastening screws of the mounting plate *(arrows)*.



4 Disconnect the power supply cable inside the terminal box of the fan motor *(arrow)*.

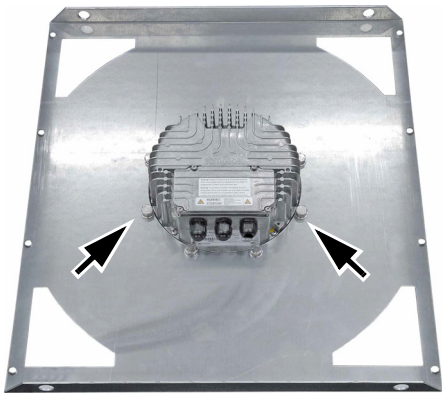


5 Unscrew the locknut of the cable gland and pull the power supply cable through the cable gland *(arrow)*.

6 Attach lifting gear appropriate for the weight of the impeller and the motor.

Lift off the mounting plate with the impeller attached to it.

7 To separate the motor-impeller-assembly from the mounting plate, remove the fastening screws of the motor.



8 Replace the motor. Assemble the fan unit in reverse order of removal.

Terms, trademarks, related documentation

Terms and abbreviations

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

Term / Abbreviation	Meaning
AMC circuit board	Application and Motor Controller The digital signal processor is the heart of the control system of the drive. A separate AMC circuit board is assigned to the line-side rectifier (AFE) and the motor inverter (INU) of the drive.
Converter	Short form for ACS5000 frequency converter
Cluster	A cluster is a synonym for a group of hardware modules of the drive control system.
DDCS	Distributed drive control system DDCS is an acronym for a serial communication protocol designed for data transfer via optical fibers.
Drive	Short form for ACS5000 frequency converter
Drive system	The drive system includes all equipment used to convert 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 drives using the DDCS communications protocol. DriveDebug runs on computers with Windows® operating systems. DriveDebug is a specialist's tool used to diagnose, tune and troubleshoot ABB drives.
DriveWindow	DriveWindow is a DriveWare® product. DriveWindow is a 32-bit Windows® application for commissioning and maintaining ABB drives equipped with optical communication links.
DriveMonitor	DriveMonitor is a monitoring and diagnostics system that allows secure access to the drive via the Internet from a remote location. DriveMonitor provides long-term monitoring functions that allow to infer equipment status and improve equipment performance.
Equipment	Frequency converter and related equipment
EMC	Electromagnetic compatibility All measures to suppress electromagnetic disturbances caused by different electrical equipment in the same electromagnetic environment, and to strengthen the immunity of the equipment to such disturbances.
Ground	Earth
To ground	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.
INU	Inverter unit of the drive. The INU converts the DC voltage to the required AC motor voltage and frequency.

Term / Abbreviation	Meaning
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.
Line voltage	RMS voltage of the main power supply of the drive
MCB	Main circuit breaker The MCB is a major protection device of the drive system and connects / disconnects the main power supply to the drive. The MCB is controlled entirely by the drive.
ModuleBus	Term of ABB's S800 I/O system. The ModuleBus is an electrical bus for the interconnection of I/O devices.
MTU	Module termination unit The MTU is a passive component containing the process terminals and a section of the ModuleBus.
PCB	Printed circuit board
PCC	Point of common coupling. The PCC is the point in the electrical power supply system where the responsibility of the utility changes to the industrial customer. The utility is responsible to provide clean voltage and current concerning harmonic distortion up to the PCC. The industrial customer is responsible not to distort voltage and current by its electrical systems.
PE	Protective earth
Power cell	The power cell is an assembly of wired components including power semiconductors and circuit boards that serves as a standardized building block for the rectifier and inverter of the drive.
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.
RTD	Resistance temperature detector or device The RTD is a temperature sensor where the change in electrical resistance is used to measure the temperature.
Safeline	ABB synonym for uninterruptible power supply
Supervisory signal	Indicates the operating condition of a circuit or device.
SW	Software
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.
TC	Short form for terminal compartment 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).

Trademarks

Names that are believed to be trademarks of other companies and organizations are designated as such. The absence or presence of such a designation should however not be regarded as an offense of the legal status of any trademark. The following registrations and trademarks are used in this manual:

Term / Abbreviation	Meaning
Windows®	Registered trademark of Microsoft Corporation
Industrial IT™	Trademark of ABB
DriveWare®	Registered trademark of ABB
Advant®	Registered trademark of ABB
Advant Fieldbus™	Trademark of ABB
Ethernet®	Registered trademark of Xerox Corporation
Profibus®	Registered trademark of Profibus International (P.I.)
Modbus®	Registered trademark of the Modbus IDA organization

Related documentation

The following documents are available for supplementary information:

Title		Document identification
Technical data		
	Technical data from drive smart [1]	-
Schematics		
	Layout drawing	Project-specific
Specifications, guidelines		
	Retrofit guideline	3BHS301179
	ACS5000 Main circuit breaker specification	3BHS125149
	ABB MVD ACS transformer specification	3BHS356582
	ABB MVD ACS motor specification	3BHS824803
	ACS5000 Power cable specification	3BHS215798
	Power cables engineering guideline	3BHS542290
	Auxiliary power and control cables guideline	3BHS813742
Drive monitoring		
	DriveMonitor user manual	3BHS799844
Serial communications interfaces		
	Ethernet - user’s manual Ethernet adapter module NETA-01	3AUA0000096881
	Modbus - NMBA-01 installation and start-up guide	3AFY58919772
	Profibus - NPBA-12 installation and start-up guide	3BFE64341588
Maintenance schedule		
	ACS5000A Preventive Maintenance Schedule	2UBB021271

1 Configuration software for medium voltage drives

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