General information

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## Contents

1. **About this manual**  
   1.1 Equipment covered by this manual  27  
   1.2 Structure of the user documentation  27  
   1.3 Terms and abbreviations  28  
   1.4 Trademarks  34  
   1.5 Related documentation  34  
   1.6 Target groups and required qualification  37  
     1.6.1 Handling  37  
     1.6.2 Mechanical installation  37  
     1.6.3 Electrical installation  37  
     1.6.4 Operation  37  
     1.6.5 Maintenance  37  
   1.7 User’s responsibilities  38  
   1.8 Intended use of equipment  38  
   1.9 Cyber security disclaimer  38  
   1.10 Quality certificates and applicable standards  39  
   1.11 Identifying the delivery  40  
   1.12 Tools  40  
2. **Important safety information**  41  
   2.1 Safety standards  41  
   2.2 Safety messages  41  
   2.3 Product safety labels  42  
   2.4 General safety instructions  43  
   2.5 The 7 steps that save lives  44  
   2.6 Possible residual risks  46
3. Power electronics and cabinet features

3.1 Drive system topology
3.1.1 Drive
3.1.1.1 ACS6000 cabinet units
3.1.1.2 Final drive configuration
3.1.2 Motor
3.2 Standard cabinet units
3.2.1 Active rectifier unit (ARU)/inverter unit (INU)
3.2.2 Line supply unit (LSU)
3.2.3 Capacitor bank unit (CBU)
3.2.4 Terminal unit (TEU)
3.2.5 Control unit (COU)
3.2.5.1 COU versions
3.2.5.2 Control system configuration
3.2.5.3 AMC circuit board
3.2.5.4 Main circuit breaker
3.2.5.5 Speed and torque control
3.2.5.6 Peripheral I/O devices
3.2.5.7 Local control panels
3.2.5.8 S800 I/O system
3.2.6 Water cooling unit (WCU)
3.2.6.1 Cooling circuit
3.2.6.2 External cooling connection
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3</td>
<td>Optional cabinet units</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Input reactor unit (IRU)</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Input filter unit (IFU)</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Voltage limiter unit (VLU)</td>
</tr>
<tr>
<td>3.3.4</td>
<td>Braking units</td>
</tr>
<tr>
<td>3.3.4.1</td>
<td>Braking chopper unit</td>
</tr>
<tr>
<td>3.3.4.2</td>
<td>Resistor braking unit</td>
</tr>
<tr>
<td>3.3.5</td>
<td>Excitation unit (EXU)</td>
</tr>
<tr>
<td>3.3.5.1</td>
<td>DCS800 control panel</td>
</tr>
<tr>
<td>3.3.5.2</td>
<td>Reversing switch</td>
</tr>
<tr>
<td>3.3.5.3</td>
<td>Output disconnector</td>
</tr>
<tr>
<td>3.3.6</td>
<td>Customer interface unit (CIU)</td>
</tr>
<tr>
<td>3.3.6.1</td>
<td>Arc detection with Arc Guard (optional)</td>
</tr>
<tr>
<td>3.4</td>
<td>Air cooling</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Air-to-air heat exchangers</td>
</tr>
<tr>
<td>3.4.2</td>
<td>Auxiliary fan units</td>
</tr>
<tr>
<td>3.5</td>
<td>Cabinet design</td>
</tr>
<tr>
<td>3.6</td>
<td>Door locking system</td>
</tr>
<tr>
<td>3.7</td>
<td>Arc resistant design</td>
</tr>
<tr>
<td>3.7.1</td>
<td>Internal arc classification</td>
</tr>
<tr>
<td>3.8</td>
<td>Busbars and grounding</td>
</tr>
<tr>
<td>3.8.1</td>
<td>AC busbars</td>
</tr>
<tr>
<td>3.8.2</td>
<td>DC busbars</td>
</tr>
<tr>
<td>3.8.3</td>
<td>PE busbar</td>
</tr>
<tr>
<td>3.8.4</td>
<td>PG busbar</td>
</tr>
</tbody>
</table>

4. Transportation, storage and disposal

4.1 Safety
5. **Mechanical installation**

5.1 Safety

5.2 Overview

5.3 General notes on installation

5.3.1 Dimensions and clearances

5.3.2 Access to the cabinets

5.3.3 Cabinet roof

5.3.4 Fire protection

5.3.5 Cable duct material

5.3.6 Installation material

5.3.7 Tools

5.3.8 Floor preparation

5.3.9 Floor fixation

5.3.10 Raw water circuit

5.4 Aligning transport units

5.5 Joining transport units

5.6 Joining water pipes

5.6.1 Removing a pipe joint
5.7 Joining busbars
5.7.1 DC busbars
5.7.2 Ground busbars
5.7.3 AC busbars between COU/TEU and LSU (5/7/9 MVA)
5.7.4 AC busbars between COU/TEU and LSU (14 MVA)
5.7.5 AC busbars between COU/TEU and ARU/INU
5.7.6 AC busbar joints - without disconnector
5.7.7 AC busbar joints - with motorized disconnector
5.8 Installing and removing air-to-air heat exchangers
5.8.1 Installing air-to-air heat exchangers
5.8.1.1 Installation
5.8.2 Removing air-to-air heat exchangers
5.8.2.1 Removing an air-to-air heat exchanger
5.8.2.2 Reinstalling an air-to-air heat exchanger
5.8.3 Installing the transformers of air-to-air heat exchangers
5.9 Installing the pressure relief vents
5.10 Attaching the sealing tapes
5.11 Installing the roof joints and the roof attachments
5.11.1 Installing roof joints
5.11.2 Installing roof attachments
6. Electrical installation
6.1 Safety
6.2 Cable requirements
6.2.1 Power cables
6.2.2 Auxiliary and control cables
6.2.3 Synchronization cables
6.3 Grounding the drive system
6.3.1 Grounding diagrams 129
6.3.2 Ground cable connection 130
6.3.3 Cable shield ground connection 130
6.3.4 EXU cabinet ground connections 131
6.4 Internal wiring 131
6.4.1 Optical fiber cables 132
6.4.1.1 Installing the standard optical fibers 132
6.4.2 Optical fiber cables for the optional Arc Guard System™ 133
6.4.2.1 Connecting the detector cables to the arc monitor device 134
6.5 Cable entry systems 135
6.5.1 Frames with type 1 sealing modules 135
6.5.2 Frame with type 2 sealing modules 137
6.5.3 Plates with cable glands 137
6.5.4 EMC plates with sealing grommets 138
6.6 Preparing cable entry systems for TEU, ARU and EXU cabinets 138
6.6.1 TEU cable entry frames with type 1 sealing modules 139
6.6.2 ARU cable entry frames with type 1 sealing modules 140
6.6.3 EXU cable entry with EMC plate and sealing grommets 141
6.7 Power, ground and equipotential bonding conductor cables§ 142
6.7.1 Determining the cable length 142
6.7.2 Preparing cables for sealing modules 143
6.7.3 Preparing cables for cable glands 144
6.7.4 Preparing cables for EMC plates 144
6.7.5 Connecting the cables 146
6.7.5.1 Checking the cable insulation 146
6.7.5.2 EXU cabinet connections
6.7.5.3 Bolted busbar connections – marine drives
6.7.5.4 Bolted busbar connections – non-marine drives
6.8 Auxiliary power, control and serial communication cables
6.8.1 Determining the cable length
6.8.2 Preparing cables for sealing modules
6.8.3 Preparing cables for cable glands
6.8.4 Preparing cables for EMC plates
6.8.5 Routing cables in a WCU
6.8.6 Routing cables in a COU cabinet
6.8.6.1 Top cable entry
6.8.6.2 Bottom cable entry
6.8.6.3 Connecting the cables
6.8.7 Routing cables in an EXU cabinet
6.8.7.1 Auxiliary power and control cables
6.8.7.2 Optical fiber cables
6.8.7.3 Routing optical fiber cables in an EXU cabinet with an ED5V, EB5R, EB5S, EB7P or EB7Q type DCS800 converter
6.8.7.4 Routing cables in an EXU cabinet with an ED7Y type DCS800 converter
6.8.8 Routing Azipod® encoder cables
6.8.8.1 Handling and installation
6.8.8.2 Routing cables through the REB (WCU)
6.9 Heating cable
6.10 Final checks

7. **Commissioning**

7.1 Required qualification
7.2 Commissioning procedure 169
7.3 Commissioning checklist 169
7.4 Customer assistance 169
7.5 Customer acceptance 169
7.6 Commissioning checklists 170
7.6.1 Mechanical installation checklist 170
7.6.2 Electrical installation checklist 170
7.6.3 Main circuit breaker (MCB) 171
7.6.4 Input transformer checklist 171
7.6.5 Motor checklist 172
7.6.6 Insulation tests checklist 172
7.6.7 Power checklist 172
7.6.8 Miscellaneous checklist 172
8. Operation 173
8.1 Overview 173
8.2 Operating conditions 173
8.3 Safety 173
8.4.1 ARU control panel 174
8.4.2 INU control panels 175
8.4.2.1 Lamp test 176
8.4.3 Semi-redundant drive control panel (drive backup control) 176
8.4.3.1 Operating modes 177
8.4.3.2 Semi-redundant drive control panel 177
8.5 EXU control panel 178
8.5.1 Operational settings 179
8.5.2 Resetting alarm and fault messages 179
8.5.3 Parameter settings 179
9.2 Modes
  9.2.1 Identification mode
  9.2.2 Actual signals mode
    9.2.2.1 Overview
    9.2.2.2 Selecting the actual signals display
    9.2.2.3 Toggling between actual signals display and fault memory
    9.2.2.4 Displaying three actual signals
    9.2.2.5 Selecting actual signals
    9.2.2.6 Displaying a fault and resetting the fault memory
    9.2.2.7 Displaying and resetting an active fault
  9.2.3 Parameters mode
    9.2.3.1 Overview
    9.2.3.2 Changing a parameter setting
    9.2.3.3 Enabling / unlocking a parameter lock
    9.2.3.4 User lock
  9.2.4 Functions mode
    9.2.4.1 Adjusting the display contrast
  9.2.5 Local and remote control mode
    9.2.5.1 Local control
    9.2.5.2 Disabling / enabling local lock function
    9.2.5.3 Enabling the local lock
    9.2.5.4 Remote control
  9.3 Operational commands
    9.3.1 Setting the direction of rotation
    9.3.2 Entering a reference value
10. Preventive and corrective maintenance
  10.1 General information
10.1.1 Required qualification 221
10.1.2 Maintenance schedule 221
10.1.3 Logbook 221
10.1.4 Spare parts 221

10.2 Identifying electrical equipment 222
10.2.1 Device designation 222
10.2.2 Cables and wires 222
10.2.2.1 Understanding wiring diagrams 223

10.3 Status indicators 223
10.3.1 Alarm / fault indications 223
10.3.2 Error message levels 223
10.3.2.1 Alarm and fault messages 224
10.3.2.2 Fault handling 224
10.3.2.3 Standard troubleshooting procedure 225
10.3.3 LEDs and switches on circuit boards and I/O devices 225
10.3.3.1 AMC circuit board 226
10.3.3.2 S800 I/O bus modem TB820 227
10.3.3.3 S800 I/O modules 227
10.3.3.4 Serial communication interfaces 228
10.3.3.5 LEDs on optional heat exchangers 229

10.4 Maintenance tasks 230
10.4.1 Safety 230
10.4.2 De-energizing and grounding the drive 231
10.4.3 Grounding the drive when the grounding switch is not released 234
10.4.4 Unlocking and opening the doors 236
10.4.5 Closing and locking the doors 237
10.4.6 Testing the white lamp 238
10.4.7 Emergency release of a door safety switch 240
10.4.7.1 Location of safety switches 240
10.4.7.2 Safety-switch settings 241
10.4.7.3 Unlocking a safety switch 241
10.4.8 Connecting a grounding set 242
10.4.8.1 Drives with LSU 243
10.4.8.2 Drives with ARU 244
10.4.9 Drives with the manual output isolation (optional) 244
10.4.9.1 Removing the busbar connectors 247
10.4.9.2 Fitting the busbar connectors 251
10.4.10 Removing and installing a phase module 253
10.4.10.1 Removing a phase module 253
10.4.10.2 Installing a phase module 255
10.4.11 Visual checks on the drive 256
10.4.12 Cleaning 256
10.4.12.1 Cleaning the drive cabinet 256
10.4.13 Checking wire and cable connections 257
10.4.14 Checking and replacing filter mats 257
10.4.15 Testing and replacing auxiliary fan units 259
10.4.15.1 Testing auxiliary fan units 259
10.4.15.2 Replacing auxiliary fan units 260
10.4.16 Testing and replacing air-to-air heat exchangers 261
10.4.16.1 Testing the fan units 262
10.4.16.2 Replacing the complete heat exchanger 263
10.4.16.3 Replacing the circuit board 263
10.4.16.4 Replacing internal fan 1 - left side 265
10.4.16.5 Replacing internal fan 2 - right side 266
10.4.16.6 Replacing the ambient fans 269
10.4.17 Replacing the fan unit in an EXU with a DCS800 D4 size controller 270
10.4.18 Replacing the fan unit in an EXU with DCS800 size D5 controller 272
10.4.19 Replacing the air-to-water heat exchanger of the EXU 274
## Figures

| Figure 2-1 | Product warning label examples (label placement depends on the drive) | 42 |
| Figure 2-2 | Drive system overview | 47 |
| Figure 2-3 | MCB opening timing diagram | 49 |
| Figure 3-1 | Common DC-bus principle for single motor drive (A) and multi-motor drive (B) | 51 |
| Figure 3-2 | ACS6000 drive example | 52 |
| Figure 3-3 | ARU/INU block diagram | 54 |
| Figure 3-4 | ARU/INU circuit diagram | 54 |
| Figure 3-5 | ARU/INU (A) and phase modules with IGCTs (B) | 55 |
| Figure 3-6 | LSU block diagram | 56 |
| Figure 3-7 | LSU (12-pulse) circuit diagram | 56 |
| Figure 3-8 | LSU (12-pulse) | 57 |
| Figure 3-9 | CBU | 58 |
| Figure 3-10 | TEU (1000 mm) | 59 |
| Figure 3-11 | Control units: 1000 mm COU (A) and 600 mm COU (B) | 61 |
| Figure 3-12 | Block diagram of control system | 62 |
| Figure 3-13 | Examples of AMC circuit boards in 1000 mm COU (A) and 600 mm COU (B) | 63 |
| Figure 3-14 | AMC circuit board example | 64 |
| Figure 3-15 | DTC control platform | 65 |
| Figure 3-16 | Local control panels on 1000 mm COU (A) and 600 mm COU (B) | 66 |
| Figure 3-17 | Typical S800 I/O station | 67 |
| Figure 3-18 | WCU1400 (A) and WCU800 (B) cabinet and system components | 69 |
Figure 3-19 Cooling circuit in an ACS6000 drive
Figure 3-20 IRU circuit diagram
Figure 3-21 IRU cabinet
Figure 3-22 IFU circuit diagram
Figure 3-23 IFU cabinet
Figure 3-24 VLU circuit diagram
Figure 3-25 VLU cabinet
Figure 3-26 BCU circuit diagram
Figure 3-27 BCU cabinet
Figure 3-28 RBU circuit diagram
Figure 3-29 RBU cabinet
Figure 3-30 EXU D4 frame cabinet (A) and EXU D5 frame cabinet (B)
Figure 3-31 CIU cabinet (A) and WCU800 cabinet (B)
Figure 3-32 ACS6000 example drive with air-to-air heat exchanger
Figure 3-33 Auxiliary fan unit
Figure 3-34 Air circulation through ventilation grids in 600 mm COU (A), 1000 mm COU (B) and WCU800 (C)
Figure 3-35 Basic cabinet design
Figure 3-36 IAC label example
Figure 3-37 Busbars
Figure 4-1 Lifting bracket (1) on base frame of a drive, safety hook (2) secured to lifting bracket and eye bolt (3).
Figure 4-2 Lift frame (A) and lift spreader (B)
Figure 5-1 Connection point locations on transport units
Figure 5-2 Minimum distances and locking bolt orientation (A = front)
Figure 5-3 Bolted busbar connection
Figure 6-4  Grounding the EXU  
Figure 6-5  Cable tray and cable ducts in an LSU (A = front)  
Figure 6-6  Arc Guard System™ in an optional roof extension box (REB)  
Figure 6-7  Location of Arc Guard sensors in a TEU  
Figure 6-8  Cable tray and cable ducts in an LSU (A = front)  
Figure 6-9  Cable entry with type 1 sealing modules  
Figure 6-10  Cable entry frame with type 1 sealing modules  
Figure 6-11  Cable entry with type 2 sealing modules  
Figure 6-12  Cable gland  
Figure 6-13  Cable entry with EMC plates  
Figure 6-14  TEU 1000 mm cabinet (A = back) with top (1) and bottom (2) cable entries  
Figure 6-15  Short busbar removal in ARU  
Figure 6-16  EXU with top cable entry (A) and EXU with bottom cable entry (B)  
Figure 6-17  EXU cabinet  
Figure 6-18  Preparing power cables for sealing modules  
Figure 6-19  Prepare power cables for cable glands  
Figure 6-20  Preparing cables for EMC plates: (A) cables with an outer screen or shield, (B) cables without an outer screen or shield or (C) cables in an EXU cabinet  
Figure 6-21  Cable connections in an EXU cabinet  
Figure 6-22  Minimum distance between bolted joints of different phases in an EXU  
Figure 6-23  Bolted busbar connection - marine drives  
Figure 6-24  Bolted busbar connection - non-marine drive  
Figure 6-25  Cable entry with sealing modules
Figure 6-26   Preparing control cables for sealing modules  
Figure 6-27   Preparing auxiliary control cables for cable glands  
Figure 6-28   Preparing the screens of control cables for EMC plates  
Figure 6-29   Preparing control cables for EMC plates  
Figure 6-30   Top cable entry of 600 mm COU  
Figure 6-31   Cable route in COU (600 mm) top cable entry  
Figure 6-32   Cable route in COU (1000 mm) top cable entry  
Figure 6-33   Cable route in COU (600 mm) bottom cable entry  
Figure 6-34   Cable route in COU (1000 mm) bottom cable entry  
Figure 6-35   Shield grounding point for encoder cable on NTAC pulse encoder (A) and synchronous serial interface (B)  
Figure 6-36   Cable routing examples in an EXU cabinet with an ED5V, EB5R, EB5S, EB7P and EB7Q type DCS800 converter (A) and in an EXU cabinet with an ED7Y type DCS800 converter  
Figure 6-37   DCS800 converter (ED5V, EB5R, EB5S, EB7P and EB7Q types)  
Figure 6-38   COM-8x circuit board (A) in a DCS800 converter (ED5V, EB5R and EB5S types) and a detail of channel CH0 (B) on the board.  
Figure 6-39   Cable routing example in an EXU cabinet with an ED5V, EB5R, EB5S, EB7P or EB7Q type DCS800 converter  
Figure 6-40   DCS800 converter (ED7Y)  
Figure 6-41   COM-8x circuit board (A) in a DCS800 converter (ED7Y type) and a detail of channel CH0 (B) on the board  
Figure 6-42   Cable routing example in an EXU cabinet with an ED5V, EB5R or EB5S type DCS800 converter
Figure 6-43  REB cable entry 165
Figure 6-44  Heating cable connection 166
Figure 8-1  ARU control panel 174
Figure 8-2  INU control panel for motor 1 (A) and additional motors (B) 175
Figure 8-3  Typical semi-redundant drive configuration 176
Figure 8-4  Typical full-power (A) and half-power (B) drive modes 177
Figure 8-5  DCS800 control panel 178
Figure 8-6  CBU grounding switch in ungrounded (A) and grounded (B) 180
Figure 8-7  Location on the safety switches 181
Figure 8-8  Grounding switch in ungrounded position 189
Figure 8-9  Arc Guard System™ in a WCU REB 197
Figure 8-10  HMI panel 197
Figure 9-1  CDP control panel 199
Figure 9-2  Control panel functions for Actual signals mode 202
Figure 9-3  Control panel functions for Parameters mode 209
Figure 9-4  Control panel functions for Functions mode 214
Figure 10-1  Device identification 222
Figure 10-2  Cable and wire designation 222
Figure 10-3  LEDs of AMC circuit board 226
Figure 10-4  TB820 bus modem 227
Figure 10-5  Example of S800 I/O station 228
Figure 10-6  Status LEDs on optional air-to-air heat exchangers 229
Figure 10-7  Grounding switch ungrounded 233
Figure 10-8  Grounding switch grounded 234
Figure 10-9  Grounding switch grounded 236
Figure 10-10  Testing the white lamp
Figure 10-11  Safety switch on an ARU/INU cabinet door
Figure 10-12  Safety switch settings
Figure 10-13  Four-way grounding set
Figure 10-14  TEU ground ball stud locations
Figure 10-15  ARU/INU ground ball stud locations
Figure 10-16  Manual output isolation overview
Figure 10-17  Input module A2511
Figure 10-18  Tools for removing the busbar connectors
Figure 10-19  Overview of grounding the drive - INU1 is shut down (A) and INU2 is shut down (B). Numbers indicate the connection sequence.
Figure 10-20  Connect the grounding sets in COU1 (A and C), TEU1 (B), INU1 (D) and INU2 (E)
Figure 10-21  Busbar connector removal sequence in TEU1 or COU1
Figure 10-22  Fitting sequence for busbar connectors
Figure 10-23  Phase module removal
Figure 10-24  COU filter
Figure 10-25  Accessing the fan units in the WCU roof box
Figure 10-26  Air-to-air heat exchanger overview (type LT-5-5165-UL)
Figure 10-27  Wire connection points on the circuit board
Figure 10-28  DCS800 controller - size D4
Figure 10-29  DCS800 controller - size D5
Figure 10-30  Air-to-water heat connections
Figure 10-31  Lift heat exchanger out of EXU cabinet
Tables

Table 1-1 Terms and abbreviations 28
Table 1-2 Trademarks 34
Table 1-3 Maintenance 34
Table 1-4 Technical data 34
Table 1-5 Schematics 34
Table 1-6 Specifications and guidelines 35
Table 1-7 Service 35
Table 1-8 Communication interfaces 35
Table 1-9 User manuals related to drive units 36
Table 1-10 Standards 39
Table 3-1 Main components in an ARU/INU cabinet 54
Table 3-2 Main components in a 12-pulse LSU cabinet 56
Table 3-3 Main components in a CBU cabinet 58
Table 3-4 Main components in a WCU cabinet 67
Table 3-5 BCU braking power 74
Table 3-6 RBU braking power 74
Table 3-7 ABB arc resistant classes 83
Table 5-1 Installation material for AC busbars (COU/TEU – ARU/INU) 109
Table 5-2 Installation material for roof joints 124
Table 6-1 Cable entry frames for type 1 sealing modules 136
Table 8-1 Medium voltage units with safety switches and locking bars 181
Table 10-1 Description of LEDs on input module A2511 246
Table 10-2 Filter mat specifications 257
Table 10-3 Air-to-air heat exchanger specifications 261
1. **About this manual**

1.1 **Equipment covered by this manual**

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

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

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

1.2 **Structure of the user documentation**

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

- **Appendix B - Technical data**: contains the technical data sheets of the drive.

- **Appendix C - Mechanical drawings**: provides the outline drawings of the drive. The drawings are generated according to the customer-specific project.

- **Appendix D - Wiring diagrams**: contains the circuit diagrams with information on device identification, cross-reference and device identification conventions. The diagrams are generated according to the customer-specific project.

  **Note**: “Setting of protective devices” is generated according to the customer-specific project.

- **Appendix E - Parts list**: produced for each project and contains all information to identify a component.

- **Appendix F - Test reports and certificates**: provides the test reports of the drive. Quality certificates, and codes and standards the drive complies with are added if necessary for the project.

- **Appendix G - Signal and parameter table**: includes descriptions of actual signals, control and status words, and control parameters and their default settings.
1.3 Terms and abbreviations

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

<table>
<thead>
<tr>
<th>Term/Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Alternating current</td>
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<tr>
<td>ACDA</td>
<td>Auxiliary Control Device Adapter</td>
</tr>
<tr>
<td>ACS6000</td>
<td>ACS6000 medium voltage AC drive</td>
</tr>
<tr>
<td>ACU</td>
<td>Air Cooling Unit</td>
</tr>
<tr>
<td>AF100</td>
<td>Advant Fieldbus 100 Communications interface between the I/O stations and the Advant Controllers</td>
</tr>
<tr>
<td>AI</td>
<td>Analog input</td>
</tr>
<tr>
<td>AMC</td>
<td>The application and motor controller (AMC) is a digital signal processor and the heart of the drive control system.</td>
</tr>
<tr>
<td>AMCOS</td>
<td>Application and Motor Controller Operating System</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>AO</td>
<td>Analog Output</td>
</tr>
<tr>
<td>APU</td>
<td>Auxiliary Pump Unit</td>
</tr>
<tr>
<td>ARU</td>
<td>Active Rectifier Unit The ARU rectifies the voltage of the supply network to the DC voltage and maintains the DC-link voltage at a constant level irrespective of changes in the supply network. The unit is designed as a self-commutated, 3-level voltage source inverter consisting of three identical phase modules. The unit allows regenerative braking.</td>
</tr>
<tr>
<td>ASE</td>
<td>Anti Saturation Equipment</td>
</tr>
<tr>
<td>Azipod®</td>
<td>ABB’s electric propulsion system for ships</td>
</tr>
<tr>
<td>BCU</td>
<td>Braking Chopper Unit</td>
</tr>
<tr>
<td>BOD</td>
<td>Break Over Diode. Bods protect semiconductors such as thyristors and diodes against transient voltages.</td>
</tr>
<tr>
<td>CBU</td>
<td>Capacitor Bank Unit</td>
</tr>
<tr>
<td>CCB</td>
<td>Converter Control Board</td>
</tr>
<tr>
<td>CDP Control panel</td>
<td>Serves as the basic user interface for operating and monitoring the drive when the local operating mode has been selected, also known as assistant control panel.</td>
</tr>
<tr>
<td>CHU</td>
<td>Charging Unit</td>
</tr>
</tbody>
</table>
### Table 1-1 Terms and abbreviations (continued)

<table>
<thead>
<tr>
<th>Term/Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIT</td>
<td>Conductivity Transmitter</td>
</tr>
<tr>
<td>CIU</td>
<td>Customer Interface Unit</td>
</tr>
<tr>
<td>CIW</td>
<td>Customer interface unit integrated into the water cooling unit (WCU)</td>
</tr>
<tr>
<td>C_NP_N</td>
<td>C_N stands for the cluster number of an S800 I/O device. P_N stands for the position of an S800 I/O device within the cluster.</td>
</tr>
<tr>
<td>Converter</td>
<td>Short form for ACS6000 frequency converter</td>
</tr>
</tbody>
</table>
| COU               | Control Unit  
The COU consists of a control compartment and a customer interface compartment. The control compartment incorporates the hardware for control, monitoring and protection functions of the drive and the communication interface to the door-mounted control panel. |
| CW1               | Control water system 1 |
| CW2               | Control water system 2 |
| CVMI              | Current and Voltage Measuring Interface |
| DBC               | Drive Backup Control |
| DC                | Direct Current |
| DC_NP             | DC Neutral Point. Neutral point of the DC link of the drive |
| DCS               | Acronym for the AC-to-DC converter or the three-phase AC power controller of an excitation unit |
| DDCS              | Distributed drive control system. DDCS is an acronym for a serial communications protocol designed for data transfer via optical fibers. |
| DI                | Digital Input |
| DIN               | Deutsches Institut für Normung |
| DIU               | Discharging Unit |
| DO                | Digital Output |
| Drive             | Synonym for ACS6000 frequency converter |
| Drive system      | The drive system includes all equipment for converting electrical into mechanical power to give motion to the machine. |
| Drivebus          | Communication link dedicated for ABB drives |
| DriveDebug        | DriveDebug is part of ABB's DriveWare® software tools for devices using the DDCS communications protocol. DriveDebug runs on computers with Windows® operating systems. DriveDebug is a specialist tool used to diagnose, tune and troubleshoot frequency converters. |
### Table 1-1 Terms and abbreviations (continued)

<table>
<thead>
<tr>
<th>Term/Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>DriveWindow</td>
<td>DriveWindow is a DriveWare® product. DriveWindow is a 32 bit Windows® application for commissioning and maintaining ABB drives equipped with fiber-optic communication.</td>
</tr>
<tr>
<td>DTC</td>
<td>Direct Torque Control</td>
</tr>
<tr>
<td>DTL</td>
<td>Direct-to-line</td>
</tr>
<tr>
<td>EAF</td>
<td>Earth Fault monitoring device</td>
</tr>
<tr>
<td>ECB</td>
<td>Excitation Circuit Breaker</td>
</tr>
<tr>
<td>EIC</td>
<td>Excitation Input Contactor</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic Compatibility</td>
</tr>
<tr>
<td>EOB</td>
<td>Excitation Output Breaker</td>
</tr>
<tr>
<td>EPLD</td>
<td>Erasable Programmable Logic Device</td>
</tr>
<tr>
<td>Equipment</td>
<td>Frequency converter and related equipment</td>
</tr>
<tr>
<td>ESP</td>
<td>Electric Submersible Pump</td>
</tr>
<tr>
<td>EXU</td>
<td>Excitation Unit The EXU supplies excitation power to a synchronous motor.</td>
</tr>
<tr>
<td>FBA</td>
<td>Fieldbus Adapter</td>
</tr>
<tr>
<td>FCB</td>
<td>Function Chart Builder</td>
</tr>
<tr>
<td>FCI</td>
<td>Fieldbus Communication Interface</td>
</tr>
<tr>
<td>FFU</td>
<td>Fin Fan Unit</td>
</tr>
<tr>
<td>FIR filter</td>
<td>Fast Impulse Response filter</td>
</tr>
<tr>
<td>FIS</td>
<td>Flow meter</td>
</tr>
<tr>
<td>FT</td>
<td>Firing Through Synonym for protective firing. Meaning: simultaneous gating of the power semiconductors of the inverter unit to effectively protect the semiconductors against overvoltage and overcurrent.</td>
</tr>
<tr>
<td>FSCD</td>
<td>Fast Short-Circuit Detection</td>
</tr>
<tr>
<td>Ground (noun)</td>
<td>Earth</td>
</tr>
<tr>
<td>ground (verb)</td>
<td>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.</td>
</tr>
<tr>
<td>GCT</td>
<td>Gate-Commutated Thyristor</td>
</tr>
<tr>
<td>GDR</td>
<td>Gate Driver Board</td>
</tr>
<tr>
<td>GRAY</td>
<td>Gray-coded interface for determining the absolute position of a rotor.</td>
</tr>
</tbody>
</table>
### Table 1-1 Terms and abbreviations (continued)

<table>
<thead>
<tr>
<th>Term/Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTO</td>
<td>Gate Turn-Off thyristor</td>
</tr>
<tr>
<td>GUSP</td>
<td>Gate Unit Supply Power</td>
</tr>
<tr>
<td>HVD</td>
<td>High Voltage Divider</td>
</tr>
<tr>
<td>I/O</td>
<td>Input / Output</td>
</tr>
<tr>
<td>ID</td>
<td>Induced Draft fan</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IFU</td>
<td>Input Filter Unit</td>
</tr>
<tr>
<td>IGBT</td>
<td>Insulated-Gate Bipolar Transistor</td>
</tr>
<tr>
<td>IGCT</td>
<td>Integrated Gate-Commutated Thyristor</td>
</tr>
<tr>
<td>ISU</td>
<td>Isolation Unit</td>
</tr>
<tr>
<td>IM</td>
<td>Induction Motor</td>
</tr>
<tr>
<td>INT</td>
<td>Interface circuit board</td>
</tr>
<tr>
<td>INU</td>
<td>Inverter Unit</td>
</tr>
<tr>
<td></td>
<td>The INU converts the three DC voltages to the required AC motor voltage. The unit is designed as a self-commutated, 3-level voltage source inverter consisting of three identical power modules.</td>
</tr>
<tr>
<td>I/O device</td>
<td>Term of ABB’s S800 I/O system. An I/O device consists of a module termination unit (MTU) and one I/O module.</td>
</tr>
<tr>
<td>I/O module</td>
<td>Term of ABB’s S800 I/O system. The I/O module is an active input or output device for digital or analog signals.</td>
</tr>
<tr>
<td>I/O station</td>
<td>Term of ABB’s S800 I/O system. The I/O station typically consists of a bus modem and several input and output devices.</td>
</tr>
<tr>
<td>IOI</td>
<td>Inverter Output Isolator</td>
</tr>
<tr>
<td></td>
<td>The IOI is a switching device that disconnects the inverter from the motor.</td>
</tr>
<tr>
<td>IP</td>
<td>Ingress Protection</td>
</tr>
<tr>
<td></td>
<td>The IP code specifies the degree of protection provided by an enclosure.</td>
</tr>
<tr>
<td>Line voltage</td>
<td>RMS voltage of the main power supply of the drive</td>
</tr>
<tr>
<td>LSU</td>
<td>Line Supply Unit</td>
</tr>
<tr>
<td></td>
<td>The LSU rectifies the AC line voltage and supplies the electrical energy to the DC link capacitors.</td>
</tr>
<tr>
<td>MCB</td>
<td>Main Circuit Breaker</td>
</tr>
<tr>
<td></td>
<td>The MCB is a major protection device of the drive and the main connection and disconnection point between the main power supply and the drive.</td>
</tr>
<tr>
<td>MSM</td>
<td>Main State Machine</td>
</tr>
<tr>
<td>MVD</td>
<td>Medium Voltage Drive</td>
</tr>
<tr>
<td>Term/Abbreviation</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
</tr>
<tr>
<td>NBIO</td>
<td>Fast I/O module</td>
</tr>
<tr>
<td>NDBU-95</td>
<td>DDCS branching unit</td>
</tr>
<tr>
<td>NETA-21</td>
<td>Monitoring and diagnostics tool that allows access to the drive from any location in the world via a secure Internet connection.</td>
</tr>
<tr>
<td>NP</td>
<td>Neutral Point. The term refers to the neutral point of the DC link.</td>
</tr>
<tr>
<td>NTAC</td>
<td>Pulse encoder interface module</td>
</tr>
<tr>
<td>PAI</td>
<td>Pulse Amplifier Interface board</td>
</tr>
<tr>
<td>PCB</td>
<td>Printed Circuit Board</td>
</tr>
<tr>
<td>PE</td>
<td>Protective Earth. Ground bus for the connection of the ground cable.</td>
</tr>
<tr>
<td>PFF</td>
<td>Power Feed Forward</td>
</tr>
<tr>
<td>PF</td>
<td>Power Failure</td>
</tr>
<tr>
<td>PG</td>
<td>Power Ground. Ground bus for the connection of cable shields.</td>
</tr>
<tr>
<td>Phase module</td>
<td>The phase module is a compact assembly of wired components including the power semiconductors that serves as a standardized building block for the ARU, LSU and INU of the drive.</td>
</tr>
<tr>
<td>PINT</td>
<td>Pulse Interface Circuit Board</td>
</tr>
<tr>
<td>POM</td>
<td>Power Operation Mode</td>
</tr>
<tr>
<td>PPCC</td>
<td>Power Plate Communication Circuit</td>
</tr>
<tr>
<td>PPCS</td>
<td>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.</td>
</tr>
<tr>
<td>PUB</td>
<td>PPCS unit for branching software running on an INT circuit board that is used for data branching</td>
</tr>
<tr>
<td>PUPA</td>
<td>Pulse pattern</td>
</tr>
<tr>
<td>PWM</td>
<td>Pulse width modulation</td>
</tr>
<tr>
<td>RAL</td>
<td>German color standard</td>
</tr>
<tr>
<td>RBU</td>
<td>Resistor Braking Unit</td>
</tr>
<tr>
<td>RDC</td>
<td>Redundant Drive Control</td>
</tr>
<tr>
<td>RDI</td>
<td>Redundant Drive Interface</td>
</tr>
<tr>
<td>RDR</td>
<td>Receive Data Register</td>
</tr>
<tr>
<td>RMD</td>
<td>Rolling Mill Drive</td>
</tr>
<tr>
<td>RPM</td>
<td>Revolutions Per Minute</td>
</tr>
<tr>
<td>Term/Abbreviation</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------</td>
</tr>
<tr>
<td>S800 I/O</td>
<td>The S800 I/O is a distributed process input output system that can be connected to various process controllers from ABB and other companies.</td>
</tr>
<tr>
<td>SC</td>
<td>Short-Circuit</td>
</tr>
<tr>
<td>SM</td>
<td>Synchronous Motor</td>
</tr>
<tr>
<td>SRD</td>
<td>Semi-Redundant Drive</td>
</tr>
</tbody>
</table>
| SSI               | Synchronous Serial Interface  
  The SSI is a point-to-point, serial communication interface for digital data transmission between a master (eg, drive) and a slave (eg, sensor). |
| TCSM              | Torque Controller State Machine |
| TEU               | Terminal Unit  
  The TEU provides the terminals for the transformer and motor cables, the ground frame for the cable screens and the ground cable, and the grounding accessories. |
| THD               | Total Harmonic Distortion |
| TT                | Temperature Transmitter |
| UPS               | Uninterruptible Power Supply |
| USB               | Universal Serial Bus |
| VLSCD             | Voltage Limiting Short Circuit Detection |
| VLU               | Voltage Limiter Unit |
| VSD               | Variable Speed Drive |
| VSI               | Voltage Source Inverter |
| WCU               | Water Cooling Unit  
  The WCU dissipates the heat from the power electronics components of the drive. |
| Zero speed threshold | Used in the manual to indicate that the drive has reached the value “zero speed” that is set in a parameter. The value can be set in the range of 0 and maximum speed (the unit for the speed is rpm). |
1.4 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:

<table>
<thead>
<tr>
<th>Trademark</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABB Ability™</td>
<td>Registered trademark of ABB</td>
</tr>
<tr>
<td>Advant Fieldbus™</td>
<td>Trademark of ABB</td>
</tr>
<tr>
<td>Arc Guard System™</td>
<td>Registered trademark of ABB</td>
</tr>
<tr>
<td>Carboweld®</td>
<td>Registered trademark of ABB</td>
</tr>
<tr>
<td>DriveWare®</td>
<td>Registered trademark of ABB</td>
</tr>
<tr>
<td>Ethernet®</td>
<td>Registered trademark of Xerox Corporation</td>
</tr>
<tr>
<td>Industrial IT™</td>
<td>Trademark of ABB</td>
</tr>
<tr>
<td>Modbus®</td>
<td>Registered trademark of the Modbus Organization, Inc.</td>
</tr>
<tr>
<td>Profibus®</td>
<td>Registered trademark of Profibus International (PI)</td>
</tr>
<tr>
<td>Windows®</td>
<td>Registered trademark of Microsoft Corporation</td>
</tr>
</tbody>
</table>

1.5 Related documentation

The following documents are available for supplementary information:

<table>
<thead>
<tr>
<th>Title</th>
<th>Document number</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] ACS6000 preventive maintenance schedule</td>
<td>3BHS855273 E01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Document number</th>
</tr>
</thead>
<tbody>
<tr>
<td>[2] Technical data from drive smart</td>
<td>3BHS855273 E01</td>
</tr>
<tr>
<td>[3] Air-cooled excitation units, brush brushless excitation technical data</td>
<td>3BHS299399 E01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Document number</th>
</tr>
</thead>
<tbody>
<tr>
<td>[4] Layout drawing</td>
<td>Project-specific</td>
</tr>
</tbody>
</table>
### Table 1-6 Specifications and guidelines

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

### Table 1-7 Service

<table>
<thead>
<tr>
<th>Title</th>
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<tbody>
<tr>
<td>Service equipment</td>
<td>3BHS264536 E01</td>
</tr>
<tr>
<td>ACS6000 Service manual</td>
<td>3BHS202077 E01</td>
</tr>
<tr>
<td>Permission for working and permit to work for test work at test stations</td>
<td>3BHS817511 E30</td>
</tr>
</tbody>
</table>

### Table 1-8 Communication interfaces

<table>
<thead>
<tr>
<th>Title</th>
<th>Document number</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF 100 fieldbus - NAFA-01 installation and start-up guide</td>
<td>3BFE58919837</td>
</tr>
<tr>
<td>DCS800 drives firmware manual</td>
<td>3ADW000193R0801</td>
</tr>
<tr>
<td>Emergency off/stop modes and prevention of operation &amp; safe torque off</td>
<td>3BHS196243</td>
</tr>
</tbody>
</table>

01 ABOUT THIS MANUAL

ACS6000 USER MANUAL

35/278
### Table 1-8 Communication interfaces (continued)

<table>
<thead>
<tr>
<th>Title</th>
<th>Document number</th>
</tr>
</thead>
<tbody>
<tr>
<td>[28] Modbus TCP - NETA-21 remote monitoring tool user manual</td>
<td>3AUA0000096939</td>
</tr>
<tr>
<td>[29] Modbus RTU - NMBA-01 installation and startup guide</td>
<td>3AFY58919772</td>
</tr>
<tr>
<td>[30] Profibus - NPBA-12 installation and startup guide</td>
<td>3BFE64341588</td>
</tr>
<tr>
<td>[31] S800 I/O Getting started</td>
<td>3BSE020923</td>
</tr>
<tr>
<td>[32] S800 I/O Modules and Termination Units</td>
<td>3BSE020924</td>
</tr>
</tbody>
</table>

### Table 1-9 User manuals related to drive units

<table>
<thead>
<tr>
<th>Title</th>
<th>Document number</th>
</tr>
</thead>
<tbody>
<tr>
<td>[33] ACS5000, ACS6000 and ACS6080 water cooling unit WCU800 user manual</td>
<td>3BHS821937 E01</td>
</tr>
<tr>
<td>[34] ACS5000, ACS6000 and ACS6080 water cooling unit WCU1400 user manual</td>
<td>3BHS835714 E01</td>
</tr>
</tbody>
</table>
1.6 **Target groups and required qualification**

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

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

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

1.6.1 **Handling**

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

1.6.2 **Mechanical installation**

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

1.6.3 **Electrical installation**

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

1.6.4 **Operation**

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

1.6.5 **Maintenance**

The personnel include all persons who

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

1.7 User’s responsibilities

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

1.8 Intended use of equipment

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

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

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

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

1.9 Cyber security disclaimer

This product is designed to be connected to and to communicate information and data via a network interface. It is the 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.
1.10 **Quality certificates and applicable standards**

The following certificates and conformity declarations are available with ABB:

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

**Table 1-10 Standards**

<table>
<thead>
<tr>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>[35] ANSI Z535.6 ‘American national standard for product safety information in product manuals, instructions, and other collateral materials’</td>
</tr>
<tr>
<td>[37] ISO 7010 :2011 (E) - Graphical symbols - Safety colours and safety signs - Registered safety sign</td>
</tr>
<tr>
<td>[38] EN 50110 ‘European standard code for electrical work safety’</td>
</tr>
<tr>
<td>[39] ISO 13849-1 Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design, section 6.2.6 Category 3</td>
</tr>
<tr>
<td>[40] IEC 60204-1 Safety of machinery - Electrical equipment of machines - Part 1: General requirements</td>
</tr>
<tr>
<td>[41] IEC 60721-3-1 Classification of environmental conditions: Classification of groups of environmental parameters and their severities; Storage</td>
</tr>
<tr>
<td>[42] IEC 60721-3-2 Classification of environmental conditions: Classification of groups of environmental parameters and their severities; Transportation</td>
</tr>
<tr>
<td>[43] IEC 60721-3-3 Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 3: Stationary use at weather-protected locations</td>
</tr>
<tr>
<td>[46] IEC 62477-2 : Safety requirements for power electronic converter systems and equipment – Part 2: Power electronic converters from 1 000 V AC or 1 500 V DC up to 36 kV AC or 54 kV DC</td>
</tr>
</tbody>
</table>
1.11 Identifying the delivery

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

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

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

1.12 Tools

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

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

2.1 Safety standards

The following industry standards are observed:

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

2.2 Safety messages

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

Is used to address practices not related to physical injury, but which can result in equipment damage.
2.3 Product safety labels

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

![Figure 2-1 Product warning label examples (label placement depends on the drive)](image)

<table>
<thead>
<tr>
<th>(1) Danger label</th>
<th>(3) Caution label</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Warning label</td>
<td>(4) Notice label</td>
</tr>
</tbody>
</table>

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

Electricity warning
This sign can also have additional text below it, e.g., “High voltage”.

Hot surface

Crushing of hands

No access for people with active implanted cardiac device
The magnetic field of the drive can influence the functioning of pacemakers. The pacemaker sign should be installed at the entrance to the drive room or at a minimum distance of 6 m from the drive to stop personnel with pacemakers approaching the drive.

Firefighting sign
Outlines the procedure when fighting fire in electrical equipment. The sign must be installed well visible near the drive.

High voltage sign
Must 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.
2.4 General safety instructions

1) Minimize hazards

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

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

4) While working on the drive:
   - Do not step on the roof
   - Do not install foreign objects on the roof

5) Before working on a water cooling unit (WCU):
   In addition to the safety instructions for working on a drive, always read the WCU safety data sheet for relevant safety information, eg, the type of ion exchange resin and glycol.

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

7) In case of fire in the drive room:
   - Observe the established rules and regulations for fire safety
   - Only allow firefighters with the appropriate PPE to enter the drive room
2.5 The 7 steps that save lives

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

1) Prepare for the work: do an on-site risk assessment or job hazard analysis that considers the limits of approach for shock and arc-flash.
   • Be in possession of a clear work order to execute the work.
   • When required, the access or work permit is to be obtained by a person who is authorized for the specific electrical system.
   • Engage the person responsible for electrical equipment or system to review single-line diagrams, schematics, switching plans, etc.
   • Ensure the competence of workers.
   • Check for proper tools for the job.
   • Determine and select the proper arc-rated Personal Protective Equipment (PPE).
   • Decide of the appropriate work methods and initiate the Permit To Work (PTW) process.
     For an example “Permit to Work”, see “Permission for working and permit to work for test work at test stations” (3BHS817511 E30)

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

3a. Disconnect all sources of supply.
   • If ABB is responsible for switching and it cannot be done remotely, then the person performing the switching must be properly trained and wearing the proper PPE identified in step 1.
   • The Person in Charge of Work (PICW) must ensure that switching is performed in the proper manner by witnessing it from a safe distance if present on site or by engaging the person responsible for switching to identify all isolation points.

3b. Secure against reconnection by applying Lockout/Tagout.
   • Apply Lockout/Tagout (LOTO) to the energy isolation device and if multiple energy isolation devices are involved, then Group LOTO must be implemented with the PICW serving as the Group LOTO Leader.
4) **Verify the absence of operating voltage: always test before you touch!**

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

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

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

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

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

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

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

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

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

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

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

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

2) Drive system components can move unintentionally when being commissioned, operated, or serviced due to:
   - Operation of the equipment outside the scope of the specifications
   - Incorrectly assembled or installed equipment
   - Wrongly connected cables
   - External influence on, or damage of the equipment
   - Wrong parameter settings
   - Software errors
   - Faulty hardware

3) Hazardous touch voltages can be present on drive system components, which can be caused by:
   - Operation of the equipment outside the scope of the specifications
   - External influence on, or damage of the equipment
   - Induced voltages by external equipment
   - Condensation on equipment components, or pollution
   - Faulty hardware

4) High temperatures, noise, particles, or gases can be emitted from drive system components caused by:
   - Operation of the equipment outside the scope of the specifications
   - External influence on or damage of the equipment
   - Wrong parameter settings
   - Software errors
   - Faulty hardware

5) Hazardous substances can be emitted from drive system components, eg, due to incorrect disposal of components
2.7 Important note - main circuit breaker

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

![Figure 2-2 Drive system overview](image)

<table>
<thead>
<tr>
<th>(1) Main power supply</th>
<th>(6) Protection relay</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) MCB control interface</td>
<td>(7) Converter transformer</td>
</tr>
<tr>
<td>(3) Higher-level control system</td>
<td>(8) Drive</td>
</tr>
<tr>
<td>(4) Local MCB control</td>
<td>(9) Motor</td>
</tr>
<tr>
<td>(5) MCB</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** MCBs and protection relays are not included in the drive supply.

**Typical MCBs devices**

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

**Dedicated protection relay**

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

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

- ISO 13849-1
- IEC 60204-1

2.7.2 Safety and protection requirements for the MCB

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

- **MCB open and/or trip command**: must be wired directly from the drive to the MCB. If you want to wire the command through a PLC or DCS system, the system must be certified to meet SIL three-level requirements and to fulfill the maximum MCB opening timing requirements. The drive must also be able to open the MCB at any time. It is not permitted to interrupt the open and/or trip command, e.g., with a local-remote switch in the MCB.

- **Closing control of the MCB**: when the MCB is in service position, the drive must have exclusive control over closing the MCB, i.e., local closing of the MCB is not permitted.

- **MCB maximum opening time**: cannot exceed the maximum time that is defined in the product or project-specific MCB specifications.

Typical maximum values for the drive are defined as follows:

- **Maximum protection trip time**: 75 ms
  
The maximum protection trip time is the maximum allowed breaking time (open and arcing) of the breaking device after the open command has been initiated to prevent further damage to the drive, such as diode failures.

- **Maximum safety trip time**: 500 ms
  
The maximum safety trip time is the maximum allowed time to ensure safe disconnection of the main power supply to prevent any hazard to personnel.
In order to meet the stipulated safety requirements, ABB recommends one of the following:

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

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

### 2.8 Maintenance recommendation

The MCB trip circuits should be checked annually.
3. **Power electronics and cabinet features**

3.1 **Drive system topology**

The ACS6000 drive system consists of the following components:

- **Main circuit breaker**: For more information, see “2.8 Maintenance recommendation” on page 49.

- **Input transformer**: Required if the line voltage must be adapted to the motor voltage. For more information, see the “Main transformer specification”.

- **Drive**

- **Motor**

3.1.1 **Drive**

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

![Diagram showing the common DC-bus principle for single motor drive (A) and multi-motor drive (B)](image)

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

(1) Motor
The ACS6000 has a flexible modular design with standard and optional cabinet units. Each cabinet unit is dedicated to a specific function.

![Figure 3-2 ACS6000 drive example](image)

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

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

**Note:** For more information on the cabinet units in your drive, see the Layout drawing in “Appendix C – Mechanical drawings”.
3.1.1 ACS6000 cabinet units

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

3.1.2 Final drive configuration

The final drive configuration depends on the following factors:

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

3.2 Motor

See the “Motor specification”.

3.2 Standard cabinet units

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

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

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

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

  The active 6-pulse rectifier allows for regenerative braking.

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

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

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

Figure 3-4 ARU/INU circuit diagram

(1) EMC filter
(2) Phase modules
(3) Clamping circuit

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

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

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

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

To achieve 24-pulse rectification or to increase the drive power, units with the same power rating can be operated in parallel.
Figure 3-6 LSU block diagram

1. LSU
2. DC-link
3. INU
4. Motor

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

1. Thyristor crowbar
2. Diode rectifier
3. Snubber circuit
4. di/dt choke

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

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-pulse diode rectifier</td>
<td></td>
</tr>
<tr>
<td>Snubber circuit</td>
<td>Limits the rate of the voltage rise (dv/dt) across the diodes and the crowbar thyristors.</td>
</tr>
<tr>
<td>di/dt limiting reactors</td>
<td>Define the current rise in the thyristor crowbar.</td>
</tr>
<tr>
<td>Thyristor crowbar</td>
<td>Protection circuit that activates when a short-circuit occurs. By applying protection firing, the thyristor crowbar short-circuits the rectifier to prevent further damage of the drive.</td>
</tr>
</tbody>
</table>
Figure 3-8 LSU (12-pulse)

(1) Snubber resistor     (4) di/dt limiting reactors
(2) Snubber capacitor    (5) Diode stacks
(3) Rectifier monitoring unit
3.2.3 Capacitor bank unit (CBU)

The capacitor bank unit (CBU) smooths the DC-link voltage and decouples the rectifier from the inverter. A CBU consists of DC-link capacitors, a charging unit and a grounding switch.

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

The CBU is based on a modular design and the amount of DC-link capacitors in the CBU depends on the converter power rating.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid-cooled DC-link capacitors</td>
<td></td>
</tr>
<tr>
<td>Charging unit</td>
<td>To avoid excessive inrush currents after the main circuit breaker has been closed, the capacitors are charged before the drive is connected to the main power source.</td>
</tr>
<tr>
<td>Discharging unit</td>
<td>This optional unit discharges the DC-link capacitors if the drive is not equipped with a voltage limiter unit, resistor braking unit or braking chopper unit.</td>
</tr>
<tr>
<td>Grounding switch</td>
<td>The grounding switch is a safety switch to ground the DC bus of the drive. These can only be closed if the DC-link capacitors have been discharged. For more information, see “8.5 EXU control panel” on page 178.</td>
</tr>
</tbody>
</table>

Figure 3-9 CBU

(1) Grounding switch       (2) DC-link capacitor
3.2.4 Terminal unit (TEU)

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

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

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

![Figure 3-10 TEU (1000 mm)](image)

- (1) DC busbars
- (2) AC busbars
- (3) Cable entry frame
- (4) PE ground busbars
3.2.5 Control unit (COU)

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

3.2.5.1 COU versions

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

- Typically, an ARU in combination with an inverter unit (INU) shares the control unit of the first INU. Depending on the selected options and the configuration of the drive, a separate control unit is used for the ARU.
  
  If an LSU is part of the drive, all rectifier- and line-related functions are implemented in the control unit of the INU.

- A separate control unit is assigned to each INU that supplies a single motor.

- If several INUs supply one motor, they share one control unit.

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

The hardware components of a COU are fitted on a swing frame. The size of the swing frame and the mounting position of the components depend on the cabinet version where the swing frame is installed in Fig. 3-11.
Figure 3-11 Control units: 1000 mm COU (A) and 600 mm COU (B)
3.2.5.2 Control system configuration

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

Figure 3-12 Block diagram of control system

(1) Higher-level control system  (8) S800 I/O devices
(2) External devices  (9) NETA-21
(3) DriveWare  (10) DDCS
(4) Cloud connectivity  (11) AMC circuit board
(5) CDP control panel  (12) PPCS
(6) RS485  (13) Pulse encoder (option)
(7) Fieldbus adapter  (14) INT circuit board
The control system is configured, customized and tuned with a set of application parameters. The application parameters are organized in functional groups and have factory-set default values. The default parameter values are set during commissioning to the specific application of the drive. The settings activate the specific control, monitoring and protection functions for the driven process, and define the signals and data transferred between drive and external equipment.

**Note:** For more information on the parameters, see the “Appendix G – Signal and parameter table”.

### 3.2.5.3 AMC circuit board

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

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

![AMC circuit board](image)

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

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

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

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

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

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

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

### 3.2.5.4 Main circuit breaker

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

**Note:** For more information, see:

- "Main circuit breaker specification" (3BHS125149 E60)
- “2.7 Important note - main circuit breaker” on page 47.
3.2.5.5 **Speed and 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 of the INU.

![Figure 3-15 DTC control platform]

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Torque reference</td>
</tr>
<tr>
<td>2</td>
<td>Speed reference</td>
</tr>
<tr>
<td>3</td>
<td>Actual speed</td>
</tr>
<tr>
<td>4</td>
<td>Speed controller</td>
</tr>
<tr>
<td>5</td>
<td>Torque reference controller</td>
</tr>
<tr>
<td>6</td>
<td>Torque-flux comparator</td>
</tr>
<tr>
<td>7</td>
<td>Motor model</td>
</tr>
<tr>
<td>8</td>
<td>Switching logic</td>
</tr>
<tr>
<td>9</td>
<td>Switch positions</td>
</tr>
<tr>
<td>10</td>
<td>Voltage</td>
</tr>
<tr>
<td>11</td>
<td>Current</td>
</tr>
<tr>
<td>12</td>
<td>Motor</td>
</tr>
</tbody>
</table>

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 voltage 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 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.

3.2.5.6 **Peripheral I/O devices**

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

- Local control panels
- S800 I/O system for parallel signal transfer to external devices
• Optional fieldbus adapters for serial data transfer to a higher-level control system

• **DriveWare® software tools:** includes software tools such as the commissioning and maintenance tools DriveWindow and DriveDebug, and DriveOPC for data transfer between ABB drives and Windows®-based applications.

• **NETA-21:** monitoring and diagnostics tool that allows access to the drive from any location in the world via a secure Internet connection.

### 3.2.5.7 Local control panels

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

![Local control panels on 1000 mm COU (A) and 600 mm COU (B)](image)

**Note:** For more information, see:

- “8 Operation” on page 173
- “9 CDP control panel” on page 199

### 3.2.5.8 S800 I/O system

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

An S800 I/O station consists of up to 12 I/O modules and a TB 820 bus modem that serves as an interface to the AMC circuit boards. Each I/O module is plugged into a module termination unit that contains the S800 I/O module bus. The module bus transmits the data between the bus modem and the I/O modules. The number of S800 I/O stations per drive depends on the drive configuration.
Figure 3-17 Typical S800 I/O station

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

Note: For more information, see:
- S800 I/O - General information and installation, user’s guide
- S800 I/O - Modules and termination unit, user’s guide

3.2.6 Water cooling unit (WCU)

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

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

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

Note: For more information, see "ACS5000, ACS6000 and ACS6080 water cooling unit WCU800 user manual" (3BHS821937 E01) and "ACS5000, ACS6000 and ACS6080 water cooling unit WCU1400 user manual" (3BHS835714 E01).

Table 3-4 Main components in a WCU cabinet

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swing frame</td>
<td>Contains the auxiliary power supply switch, the pump motor starters and digital and analog I/O modules for controlling and monitoring the water-cooling circuit.</td>
</tr>
<tr>
<td>Control and monitoring devices</td>
<td>Measure the temperature, pressure and conductivity of the coolant. A solution based on a double-sensor configuration is available as an option, to guarantee full operation in case of single sensor failure.</td>
</tr>
</tbody>
</table>
Table 3-4 Main components in a WCU cabinet (continued)

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pump</td>
<td>Circulates the coolant through the internal cooling circuit. The standard solution is based on redundant pumps (one of the two pumps is always on standby and starts automatically if the running pump fails). An alternative solution based on one pump is also available.</td>
</tr>
<tr>
<td>Water-to-water heat exchanger</td>
<td>Transfers the heat from the internal cooling circuit to the external cooling circuit.</td>
</tr>
<tr>
<td>Expansion vessel</td>
<td>Used for pressure compensations</td>
</tr>
<tr>
<td>Ion exchange vessel</td>
<td>The ion exchange vessel in the water treatment circuit deionizes the coolant of the internal cooling circuit and maintains the conductivity.</td>
</tr>
<tr>
<td>3-way valve</td>
<td>The three-way valve controls the flow of the external cooling liquid through the water-to-water heat exchanger.</td>
</tr>
</tbody>
</table>
Figure 3-18 WCU1400 (A) and WCU800 (B) cabinet and system components

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

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

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

- **External cooling circuit**: transfers the heat losses from the water-to-water heat exchanger to the exterior.

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

![Figure 3-19 Cooling circuit in an ACS6000 drive](image)

**Figure 3-19 Cooling circuit in an ACS6000 drive**

<table>
<thead>
<tr>
<th></th>
<th>(1) Return pipes</th>
<th>(6) Heat exchanger</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2)</td>
<td>LSU</td>
<td>(7) External cooling circuit</td>
</tr>
<tr>
<td>(3)</td>
<td>CBU</td>
<td>(8) Internal cooling circuit</td>
</tr>
<tr>
<td>(4)</td>
<td>INU</td>
<td>(9) Feeding pipes</td>
</tr>
<tr>
<td>(5)</td>
<td>WCU</td>
<td></td>
</tr>
</tbody>
</table>

3.2.6.2 External cooling connection

Two flanges connect the external cooling circuit water pipes to the cooling unit. They are part of the shipment. The feeding and return pipe can either be entered through the top, bottom, side or back. The desired pipe entry is specified when ordering the drive.
3.3 Optional cabinet units

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

3.3.1 Input reactor unit (IRU)

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

![Figure 3-20 IRU circuit diagram](image)

Figure 3-20 IRU circuit diagram

(1) IRU  (4) Diode rectifier
(2) LSU  (5) Snubber circuit
(3) Thyristor crowbar  (6) di/dt choke

![Figure 3-21 IRU cabinet](image)

Figure 3-21 IRU cabinet

(1) Three-phase reactor
3.3.2 Input filter unit (IFU)

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

![Figure 3-22 IFU circuit diagram](image)

Figure 3-22 IFU circuit diagram

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L1</td>
<td>L1</td>
</tr>
<tr>
<td>2</td>
<td>L2</td>
<td>L2</td>
</tr>
<tr>
<td>3</td>
<td>L3</td>
<td>L3</td>
</tr>
</tbody>
</table>

![Resistor](image)

(1) Resistor

![Capacitor](image)

(2) Capacitor

![Reactors](image)

(3) Reactor
3.3.3 Voltage limiter unit (VLU)

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

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

![VLU circuit diagram](image1)

**Figure 3-24 VLU circuit diagram**

![VLU cabinet](image2)

**Figure 3-25 VLU cabinet**

1. Air-cooled resistors
2. IGCT
3.3.4 Braking units

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

<table>
<thead>
<tr>
<th>Braking resistor (ohm)</th>
<th>Single braking power (kW)</th>
<th>Double braking power (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBU</td>
<td>800</td>
<td>1600</td>
</tr>
<tr>
<td>10</td>
<td>1100</td>
<td>2200</td>
</tr>
<tr>
<td>8</td>
<td>1400</td>
<td>2800</td>
</tr>
<tr>
<td>7</td>
<td>1600</td>
<td>2800</td>
</tr>
<tr>
<td>6</td>
<td>1900</td>
<td>3200</td>
</tr>
<tr>
<td>5</td>
<td>2200</td>
<td>3700</td>
</tr>
<tr>
<td>4</td>
<td>2800</td>
<td>4500</td>
</tr>
<tr>
<td>3.6</td>
<td>3100</td>
<td>5600</td>
</tr>
</tbody>
</table>

Table 3-6 RBU braking power

<table>
<thead>
<tr>
<th>Single braking power (kW)</th>
<th>Double braking power (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>1600</td>
</tr>
</tbody>
</table>

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

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

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

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

![BCU circuit diagram](image)

Figure 3-26 BCU circuit diagram

1. Resistor (external)
2. BCU

![BCU cabinet](image)

Figure 3-27 BCU cabinet

1. IGCT
3.3.4.2 Resistor braking unit

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

![RBU Circuit Diagram](image)

**Figure 3-28 RBU circuit diagram**

![RBU Cabinet](image)

**Figure 3-29 RBU cabinet**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IGCT</td>
</tr>
<tr>
<td>2</td>
<td>Water-cooled resistor</td>
</tr>
</tbody>
</table>
3.3.5 **Excitation unit (EXU)**

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

- **Brush excitation (DC excitation):** Uses a DCS800 AC-to-DC converter which is supplied by the mains. The converter controls the direct current for generating the magnetic field. Brushes and slip-rings feed the DC current to the rotor.

- **Brushless excitation (AC excitation):** Uses a three-phase DCS800 AC-power controller. The power controller feeds an exciter which is mounted on the shaft of the main motor. The rotating armature of the exciter supplies a rectifier which generates the DC current for producing the magnetic field in the synchronous motor.

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

---

**Figure 3-30 EXU D4 frame cabinet (A) and EXU D5 frame cabinet (B)**

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

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

Note: For more information, see “8.5 EXU control panel” on page 178.

3.3.5.2 Reversing switch

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

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

3.3.5.3 Output disconnector

The optional output disconnector is used to disconnect the EXU from the motor for maintenance purposes.
3.3.6 Customer interface unit (CIU)

The optional customer interface unit (CIU) provides I/O modules to monitor the transformer and motors (Fig. 3-27). The following units are available:

- CIU provides predefined I/O modules for controlling and monitoring the auxiliaries of motors and the transformers. The I/O module modules are connected to the drive controller.

- CIUe provides engineered project-specific interfaces and an application controller with customer-specific software.

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

![Figure 3-31 CIU cabinet (A) and WCU800 cabinet (B)]

(1) CIU  
(2) Roof extension box (REB)  
(3) WCU800
3.3.6.1 Arc detection with Arc Guard (optional)

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

Note: For more information, see “8.11 Arc detection with the Arc Guard System™ (optional)” on page 197.

3.4 Air cooling

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

3.4.1 Air-to-air heat exchangers

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

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

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

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

![Figure 3-32 ACS6000 example drive with air-to-air heat exchanger](image)

(1) Air-to-air heat exchanger (2) Additional transformer
3.4.2 Auxiliary fan units

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

![Figure 3-33 Auxiliary fan unit](image)

**Figure 3-33 Auxiliary fan unit**

![Figure 3-34 Air circulation through ventilation grids in 600 mm COU (A), 1000 mm COU (B) and WCU800 (C)](image)

**Figure 3-34 Air circulation through ventilation grids in 600 mm COU (A), 1000 mm COU (B) and WCU800 (C)**

*Note:* The number of fans varies depending on the cabinet.
3.5 Cabinet design

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

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

![Figure 3-35 Basic cabinet design](image)

**Electromagnetic compatibility (EMC)**

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

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

**Degree of protection**

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

**Painting**

The standard color for the cabinets is RAL 7035 (light gray), which is applied as a powder coat paint. Other colors are available on request. For more information, see the "Painting specification for ACS1000, ACS2000, ACS5000 and ACS6000/ACS6080" (3BHS104301 E01).
Transportation
Small drives are shipped as one unit. Larger drives are shipped in separate transport units. All transport units are fitted with lifting lugs for a crane that must be used to position the units.

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

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

Note: For more information, see “2.3 Product safety labels” on page 42.

3.6 Door locking system
For more information on the door locking system, including grounding switches, locking bars, and safety switches, see “8.5 EXU control panel” on page 178.

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

<table>
<thead>
<tr>
<th>ABB class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Protection based on arc prevention (NOT certified according to IEC 62477-2)</td>
</tr>
<tr>
<td>Class II</td>
<td>Protection based on arc resistant cabinet structure(^{(1)})</td>
</tr>
<tr>
<td>Class III</td>
<td>Protection based on external arc fault limitation and elimination. HV fuses are applied externally to limit the arc fault current(^{(1)})</td>
</tr>
<tr>
<td>Class IV</td>
<td>Fast arc detection and elimination(^{(1)})</td>
</tr>
</tbody>
</table>

\(^{(1)}\) IAC certified by 3\(^{rd}\) body according to IEC 62477-2

3.7.1 Internal arc classification
The arc fault rating, which is based on arc fault tests, is on the label underneath the drive rating plate of the drive.
3.8 Busbars and grounding

The ACS6000 drive contains busbars for various types of connections.

### 3.8.1 AC busbars

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

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

---

**Table: Internal Arc Classification (IAC)**

<table>
<thead>
<tr>
<th>IAC</th>
<th>F</th>
<th>L</th>
<th>R</th>
<th>T</th>
<th>B</th>
<th>IA</th>
<th>tA</th>
<th>APR</th>
<th>SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 62477-2</td>
<td>2b</td>
<td>2b</td>
<td>2b</td>
<td>1</td>
<td>1</td>
<td>20kA</td>
<td>0.5s</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Distance [m]</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 3-36 IAC label example**

**IMPORTANT!** The Main Circuit Breaker (MCB) for the drive fulfills the APR (Associated Protection Requirement) without the need for additional devices. The MCB requirements are described in “2.7 Important note - main circuit breaker” on page 47.
3.8.2 DC busbars
The DC busbars connect the ARU or the LSU with INU(s) and CBU. A multi-motor configuration, can have up to four DC busbar arrangements. The busbars are mounted in the upper part of the drive and are marked with DC (+), DC (-) and DC (neutral point).

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

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

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

4.1 Safety

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

4.2 Transport conditions

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

- Classification: 2K12 / 2B1 / 2C2 / 2S5 / 2M4\(^{(1)}\)

\(^{(1)}\) Special conditions apply to marine drives

4.3 Unpacking and inspection

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

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

4.4 Identifying transport units

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

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

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

<table>
<thead>
<tr>
<th>ABB item</th>
<th>Qty.</th>
<th>Unit.</th>
<th>Identnumber</th>
<th>Commodity description</th>
</tr>
</thead>
<tbody>
<tr>
<td>001201</td>
<td>1</td>
<td>PC</td>
<td></td>
<td>Converter 1(1), Transport Unit 1</td>
</tr>
</tbody>
</table>

ABB item
Customer item

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

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

<table>
<thead>
<tr>
<th>ABB item</th>
<th>Qty.</th>
<th>Unit.</th>
<th>Identnumber</th>
<th>Commodity description</th>
</tr>
</thead>
<tbody>
<tr>
<td>001221(1)</td>
<td>1</td>
<td>PC</td>
<td></td>
<td>cross wiring</td>
</tr>
<tr>
<td>001222</td>
<td>1</td>
<td>PC</td>
<td></td>
<td>WCU accessory</td>
</tr>
<tr>
<td>001223</td>
<td>1</td>
<td>PC</td>
<td></td>
<td>crank for isolator</td>
</tr>
<tr>
<td>001500</td>
<td>1</td>
<td>PC</td>
<td>3BHB013202R0001</td>
<td>ACS6000 Max-SL LOOSE PARTS config.</td>
</tr>
</tbody>
</table>

ABB item
Customer item

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

4.4.2 Packing label

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

<table>
<thead>
<tr>
<th>ABB</th>
<th>Packing Label</th>
<th>0000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material no</td>
<td>3BHB009964R1500</td>
<td>1 ST</td>
</tr>
<tr>
<td>Material</td>
<td>Cabinet ARU/INU LSU config.</td>
<td></td>
</tr>
<tr>
<td>Order no/positions</td>
<td>11027727 00124(1) Project CBA</td>
<td></td>
</tr>
</tbody>
</table>

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

**NOTICE**

**Risk of component damage!**

Improper lifting and transportation can damage the drive.

- Refer to “Appendix C – Mechanical drawings” before transporting the drive. This appendix provides details on dimensions, weight, and center of gravity of the drive.
- DO NOT lift and move the drive or a transport unit with a forklift.
- If the transport units are joined but not yet on the base frame, DO NOT lift and move them with a crane.
  - Use appropriate transport means, such as heavy load hydraulics rollers or air cushions. If in doubt, contact ABB for instructions.
- To prevent damage to drive components, transport and move the drive or a transport unit only in upright position.
- To prevent dirt from entering the drive, keep the doors of the drive or a transport unit closed.
  Metallic dust in particular can cause damage and failure when the drive is energized.

4.5.1 **Using a crane to lift a transport unit or the drive by the base frame**

**CAUTION**

**Tipping hazard!**

- To prevent the drive or transport unit from tipping when following these instructions, use an extra sling around the cabinet for stabilization (Fig. 4-2).

**NOTICE**

**Risk of cabinet damage!**

- Only use a crane to lift single transport units or the drive by the base frame.
- Always observe the center of gravity!
4.5.1.1 Lifting recommendations

Refer to Fig. 4-1 and Fig. 4-2 when following these ABB recommendations:

- Use a lift frame or a lift spreader with the crane.
- Use lifting equipment (e.g., web slings, chain slings, round slings, safety hooks, shackles) that corresponds to the weight that is to be lifted.
- Attach the slings to the lifting brackets at the base frame.
- To attach the slings, screw an eye bolt (not supplied) into each of the four corners of the cabinet roof.
- Use appropriate safety hooks or shackles to attach a sling.
- **DO NOT** pass a sling through the hole of the bracket.
- Protect the edges and the door handles if the slings are too close to the cabinet.
- If a lift frame or lift spreader is not available, make sure that the slope angle is a maximum of 15° (see Fig. 4-2).
- Observe the center of gravity.
- Lift the drive or a transport unit slowly and steadily to the required clearance height, maintaining it in upright position.
- Check the horizontal position and reposition the slings if necessary.

![Figure 4-1 Lifting bracket (1) on base frame of a drive, safety hook (2) secured to lifting bracket and eye bolt (3).](image)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Lifting bracket (hole Ø42 mm)</td>
</tr>
<tr>
<td>(2)</td>
<td>Safety hook</td>
</tr>
<tr>
<td>(3)</td>
<td>Eye bolt</td>
</tr>
</tbody>
</table>
Figure 4-2 Lift frame (A) and lift spreader (B)

(1) Safety hook  
(2) Lift frame  
(3) Strap  
(4) Protect the edges, door handles and levers  
(5) Safety hook or shackle  
(6) Lifting bracket  
(7) Slope angle (maximum 15°)  
(8) Lift spreader
4.6 Storage

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

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

4.6.1 Storage conditions

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

- Classification: 1K22 / 1B1 / 1C2 / 1S11 / 1M11\(^{(1)}\)

\(^{(1)}\) Special conditions apply to marine drives

4.6.2 Storing the drive

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

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

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

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

3. Add a desiccant of the appropriate quality:

4. 1 unit desiccant (30 g) absorbs 6 g water vapor

   IMPORTANT! If you use polyethylene foil to cover the cabinets, use 10 units of desiccant/m\(^2\) foil.

5. Close and lock the doors of the drive.

6. Use polyethylene or equivalent for packaging:

   - 0.3 g/m\(^2\) /24 h water vapor diffusion

7. Attach humidity indicators to the packaging.

   NOTICE The storage conditions and the packaging should be checked regularly. Any damages which occur during the storage period must be repaired immediately.
4.7 Storing and handling of spare parts

**NOTICE**

Risk of component damage!
Electronic devices (eg, circuit boards, semiconductors) are sensitive to electrostatic discharge (ESD).
- Apply ESD handling precautions before handling these devices.

4.7.1 Warranty information

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

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

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

**Note:** For more information on the disposal of packaging materials and drive components, see the recycling instructions.
5. Mechanical installation

5.1 Safety

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

5.2 Overview

The installation includes the following work:

- All drives
  - “5.3.8 Floor preparation” on page 97
  - “5.3.9 Floor fixation” on page 97
  - “5.3.10 Raw water circuit” on page 97
- Only drives with separately delivered units
  - “5.4 Aligning transport units” on page 98
  - “5.5 Joining transport units” on page 100
  - “5.6 Joining water pipes” on page 101
  - Joining the busbars
  - “5.11 Installing the roof joints and the roof attachments” on page 124
- Only for optional components
  - “5.8 Installing and removing air-to-air heat exchangers” on page 112
  - “5.9 Installing the pressure relief vents” on page 121
  - “5.10 Attaching the sealing tapes” on page 123
5.3 General notes on installation

**NOTICE**

Risk of component damage!

Observe the following during installation:

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

5.3.1 Dimensions and clearances

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

5.3.2 Access to the cabinets

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

5.3.3 Cabinet roof

**NOTICE**

Risk of damage.

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

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

5.3.4 Fire protection

**CAUTION**

- To prevent fire from spreading into the drive, apply suitable fire protection measures.
5.3.5 Cable duct material

**NOTICE**

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

5.3.6 Installation material

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

5.3.7 Tools

See “1.12 Tools” on page 40.

5.3.8 Floor preparation

See “Appendix C – Mechanical drawings”.

5.3.9 Floor fixation

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

**CAUTION**

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

5.3.10 Raw water circuit

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

▲

**NOTICE**

Risk of component damage!
- Use cable ducts of non-flammable material with non-abrasive surface.
- To prevent dust, humidity and animals from entering the drive, protect all cable entries and exits of cable ducts.
5.4 **Aligning transport units**

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

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

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

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

**Note:** The units can be lined-up either beginning from the left or the right.
4. Align the transport units and verify the following:
   - Maximum values for the axial misalignment and the angular deflection of two adjoining water pipes are not exceeded.
     - Axial misalignment: ± 3 mm
     - Axial deflection: 5°
   - Bolt holes are aligned where transport units are joined (see the connection points on Fig. 5-1)
   - Cabinet doors are not misaligned and that there are no gaps between cabinet walls and cabinet frame
   - Adjoining surfaces of transport units meet perfectly all around
5.5 Joining transport units

**NOTICE**

Risk of component damage!

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

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

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

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

---

**Figure 5-1 Connection point locations on transport units**

1. Connection point locations

2. M6 x 16 (9ABA450093R0259 SCR-CBS-M6X16-8_8-FLZNNC)
5.6 Joining water pipes

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

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

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

3. Center the pipe joint.

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

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

Figure 5-2 Minimum distances and locking bolt orientation (A = front)

(1) 40 mm minimum  (2) Locking bolt orientation
5. After adjusting a pipe joint, alternately tighten the bolts lightly.
6. Tighten the bolts to the torque indicated on the pipe joint.

5.6.1 Removing a pipe joint

1. Loosen the bolts alternately but do not remove them completely.
2. Slide the pipe joint to the side.
   
   **Note:** The sealing lip can touch the pipe end.
3. Turn and move the pipe joint smoothly.
4. Clean the pipe joint and treat the bolts with an appropriate lubricant before refitting.
5.7 Joining busbars

⚠ **CAUTION**
Flashover hazard!
Incorrect orientation of the busbar bolts can cause flashover when the drive is energized.
- Orientate the bolts and the nuts of each connection as shown in this section to maintain the required minimal distances between busbars of different polarity.

⚠ **NOTICE**
Risk of component damage!
Tightening torque for M12 bolts:
- 40 Nm if two busbars are joined
- 60 Nm if three and more busbars are joined

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

![Bolted busbar connection](image)

Figure 5-3 Bolted busbar connection

(1) Conical spring washer
5.7.1 DC busbars

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

**Note:** If you need to remove the air-to-air heat exchangers to access the top plates, see “5.8.2 Removing air-to-air heat exchangers” on page 117.

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

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

---

**Figure 5-4 Top view of DC busbar configuration 1**

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Technical parameters</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Connecting plate</td>
<td>3</td>
<td>Flex</td>
<td>3BHB010246R0001/R0051</td>
</tr>
<tr>
<td>(2) Hex-head bolt</td>
<td>6</td>
<td>M12 x 35-A2</td>
<td>NB 312350P8118</td>
</tr>
<tr>
<td>(3) Hex-head nut</td>
<td>6</td>
<td>M12-A2-70, coated</td>
<td>HZN 452198P1022</td>
</tr>
<tr>
<td>(4) Conical spring washer</td>
<td>6</td>
<td>13 x 29 x 3</td>
<td>HAQN400344P0111</td>
</tr>
<tr>
<td>(5) Busbar with positive potential</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Busbar with neutral potential</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7) Busbar with negative potential</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) Front of cabinet</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 5-5 Top view DC busbar configurations 2 (A), 3 (B) and 4 (C)

(1) Busbar with negative potential  (3) Busbar with positive potential
(2) Busbar with neutral potential  (4) Front of cabinet
5.7.2 Ground busbars

Figure 5-6 Ground busbar joints

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Technical parameters</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Connecting plate</td>
<td>2</td>
<td>Flex</td>
<td>3BHB010246R0001/R0051</td>
</tr>
<tr>
<td>(2) Hex-head bolt</td>
<td>4</td>
<td>M12 x 40-A2</td>
<td>NB 312350P8119</td>
</tr>
<tr>
<td>(3) Hex-head nut</td>
<td>4</td>
<td>M12-A2-70, coated</td>
<td>HZN 452198P1022</td>
</tr>
<tr>
<td>(4) Conical spring washer</td>
<td>8</td>
<td>13 x 29 x 3</td>
<td>HAQN400344P0111</td>
</tr>
<tr>
<td>(5) Water pipe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Cabinet front</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.7.3 AC busbars between COU/TEU and LSU (5/7/9 MVA)

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

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Technical parameters</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Connection bus bar</td>
<td>1</td>
<td>LSU-TEU 1b</td>
<td>3BHB045554R0001</td>
</tr>
<tr>
<td>(2) Connection bus bar</td>
<td>1</td>
<td>LSU-TEU 2b</td>
<td>3BHB045556R0001</td>
</tr>
<tr>
<td>(3) Connection bus bar</td>
<td>4</td>
<td>LSU-TEU 3b</td>
<td>3BHB045558R0001</td>
</tr>
<tr>
<td>(4) Bus bar spacer</td>
<td>4</td>
<td>80 mm spacer 10 mm</td>
<td>3BHB031095R0001</td>
</tr>
<tr>
<td>(5) Hex-head bolt</td>
<td>32</td>
<td>M12 x 45-A2-70</td>
<td>NB 312450P8120</td>
</tr>
<tr>
<td>(6) Hex-head bolt</td>
<td>16</td>
<td>M12 x 50-A2-70</td>
<td>NB 312450P8121</td>
</tr>
<tr>
<td>(7) Conical spring washer</td>
<td>80</td>
<td>DIN6796-13 x 29 x 3</td>
<td>HAQN400344P0111</td>
</tr>
<tr>
<td>(8) Hex-head nut</td>
<td>32</td>
<td>M12-A2-70</td>
<td>HZN 452198P1022</td>
</tr>
<tr>
<td>(9) Flange nut</td>
<td>16</td>
<td>M12-A2</td>
<td>3BHB038117R0001</td>
</tr>
</tbody>
</table>
5.7.4 AC busbars between COU/TEU and LSU (14 MVA)

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

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Technical parameters</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Connection bus bar</td>
<td>1</td>
<td>LSU-TEU 1a</td>
<td>3BHB045554R0001</td>
</tr>
<tr>
<td>(2) Connection bus bar</td>
<td>1</td>
<td>LSU-TEU 2a</td>
<td>3BHB045556R0001</td>
</tr>
<tr>
<td>(3) Connection bus bar</td>
<td>4</td>
<td>LSU-TEU 3a</td>
<td>3BHB045558R0001</td>
</tr>
<tr>
<td>(4) Hex-head bolt</td>
<td>32</td>
<td>M12 x 45-A2-70</td>
<td>NB 312450P8120</td>
</tr>
<tr>
<td>(5) Hex-head bolt</td>
<td>16</td>
<td>M12 x 65-A2-70</td>
<td>NB 312450P8124</td>
</tr>
<tr>
<td>(6) Conical spring washer</td>
<td>9</td>
<td>DIN6796-13x29x3</td>
<td>HAQN400344P0111</td>
</tr>
<tr>
<td>(7) Hex-head nut</td>
<td>4</td>
<td>DIN934-M12-A2-70</td>
<td>HZN 452198P1022</td>
</tr>
</tbody>
</table>
5.7.5 AC busbars between COU/TEU and ARU/INU

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Technical parameter</th>
<th>Identification</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hex-head bolt</td>
<td>M12 x 40-A2-70</td>
<td>NB 312350P8119</td>
<td>Single busbar</td>
</tr>
<tr>
<td>Hex-head bolt</td>
<td>M12 x 60-A2-70</td>
<td>NB 312450P8123</td>
<td>Double busbars</td>
</tr>
<tr>
<td>Hex-head bolt</td>
<td>M12 x 80-A2-70</td>
<td>NB 312450P8127</td>
<td>Triple busbars</td>
</tr>
<tr>
<td>Conical spring washer</td>
<td>13 x 29 x 3</td>
<td>HAQN400344P0111</td>
<td></td>
</tr>
<tr>
<td>Hex-head nut</td>
<td>M12-A2, coated</td>
<td>HZN 452198P1022</td>
<td></td>
</tr>
</tbody>
</table>

5.7.6 AC busbar joints - without disconnector

<table>
<thead>
<tr>
<th>Modules</th>
<th>Busbar joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>• ARU/INU - COU/TEU</td>
<td></td>
</tr>
<tr>
<td>• ARU/INU: 5 MVA (without MOI)</td>
<td></td>
</tr>
<tr>
<td>• COU/TEU:</td>
<td></td>
</tr>
<tr>
<td>- 600 mm</td>
<td></td>
</tr>
<tr>
<td>- 1000 mm</td>
<td></td>
</tr>
<tr>
<td>• COU/TEU - ARU/INU</td>
<td></td>
</tr>
<tr>
<td>• ARU/INU: 5 MVA (without MOI)</td>
<td></td>
</tr>
<tr>
<td>• COU/TEU:</td>
<td></td>
</tr>
<tr>
<td>- 600 mm</td>
<td></td>
</tr>
<tr>
<td>- 1000 mm</td>
<td></td>
</tr>
<tr>
<td>• ARU/INU - COU/TEU</td>
<td></td>
</tr>
<tr>
<td>• ARU/INU:</td>
<td></td>
</tr>
<tr>
<td>- 7, 9, 13 peak MVA</td>
<td></td>
</tr>
<tr>
<td>- 5 MVA (with MOI)</td>
<td></td>
</tr>
<tr>
<td>• COU/TEU:</td>
<td></td>
</tr>
<tr>
<td>- 600 mm</td>
<td></td>
</tr>
<tr>
<td>- 1000 mm</td>
<td></td>
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### Modules

<table>
<thead>
<tr>
<th></th>
<th>Busbar joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>COU/TEU - ARU/INU</td>
<td></td>
</tr>
<tr>
<td>ARU/INU:</td>
<td></td>
</tr>
<tr>
<td>- 7, 9, 13 peak MVA</td>
<td></td>
</tr>
<tr>
<td>- 5 MVA (with MOI)</td>
<td></td>
</tr>
<tr>
<td>COU/TEU:</td>
<td></td>
</tr>
<tr>
<td>- 600 mm</td>
<td></td>
</tr>
<tr>
<td>- 1000 mm</td>
<td></td>
</tr>
</tbody>
</table>

| ARU/INU - COU/TEU |               |
| ARU/INU: |               |
| - 12 MVA |               |
| COU/TEU: |               |
| - 1000 mm |               |

| COU/TEU - ARU/INU |               |
| ARU/INU: |               |
| - 12 MVA |               |
| COU/TEU: |               |
| - 1000 mm |               |

### 5.7.7 AC busbar joints - with motorized disconnector

<table>
<thead>
<tr>
<th>Module</th>
<th>Busbar joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARU/INU - COU/TEU</td>
<td></td>
</tr>
<tr>
<td>ARU/INU:</td>
<td></td>
</tr>
<tr>
<td>- 5, 7, 9, 13 peak MVA</td>
<td></td>
</tr>
<tr>
<td>COU/TEU:</td>
<td></td>
</tr>
<tr>
<td>- 1000 mm</td>
<td></td>
</tr>
</tbody>
</table>
### Module Busbar joints

<table>
<thead>
<tr>
<th>Module</th>
<th>Busbar joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>COU/TEU - ARU/INU</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>ARU/INU:</td>
<td>- 5, 7, 9, 13 peak MVA</td>
</tr>
<tr>
<td>COU/TEU:</td>
<td>- 1000 mm</td>
</tr>
</tbody>
</table>

| ARU/INU - COU/TEU | ![Image](image2.png) |
| ARU/INU:          | - 12 MVA |
| COU/TEU:          | - 1000 mm |

| COU/TEU - ARU/INU | ![Image](image3.png) |
| ARU/INU:          | - 12 MVA |
| COU/TEU:          | - 1000 mm |
5.8 Installing and removing air-to-air heat exchangers

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

5.8.1 Installing air-to-air heat exchangers

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

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

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

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

1. Cordless drill
2. Wire cutter
3. Torx drill bit
4. M6 x 12 Torx screw
5. Cable tie
5.8.1.1 Installation

**NOTICE**

Risk of damage!
Incorrect installation of the heat exchanger cables can cause:

- Ground fault
- Unexpected shutdown of the drive
- Damage to the heat exchanger

Procedure:

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

2. Loop the cables as illustrated and fasten them to the cable tie mounts (circles).
3. Loop a length of the cables and fasten them to the cable tie mount (circle).

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

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

5. Lift the heat exchanger above the opening in the roof and orientate the heat exchanger with the LEDs (circle) pointing to the front of the cabinet.
6. Route the cables through the designated openings (circle) at the front of the cabinet.

7. While lowering the heat exchanger onto the roof, pull the cables through the openings.
8. From the openings (1), route the cables to the terminals (2) as illustrated in the examples for ARU / INU / IFU 9 MVA and LSU.

![Figure 5-12 ARU/INU/IFU cable routing](image1)

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

![Figure 5-13 LSU cable routing](image2)

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

![image3]

11. In the lower part (2), tie the cables together at regular distances.
12. Check that the cables do not touch the DC busbars.

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

5.8.2 Removing air-to-air heat exchangers

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

⚠ CAUTION

Heavy object!
An air-air height exchanger weighs approximately 65 kg.

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

Figure 5-14 Air-to-air heat exchangers (type LT-5-5165-UL)
Air-to-air heat exchangers must be removed and refitted where two transport units are joined.
Depending on the drive configuration, at least one heat exchanger must be removed for joining the DC busbars of two adjacent transport units.

**Figure 5-15 Tools for removing an air-to-air heat exchanger**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Cordless drill</td>
</tr>
<tr>
<td>(2)</td>
<td>Wire cutter</td>
</tr>
<tr>
<td>(3)</td>
<td>Torx drill bit</td>
</tr>
<tr>
<td>(4)</td>
<td>Cable tie</td>
</tr>
</tbody>
</table>

### 5.8.2.1 Removing an air-to-air heat exchanger

1. Loosen the 4 self-tapping M6x12 screws (HAQN401205P0257) that fasten the heat exchanger to the roof.

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

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

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

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

5.8.2.2 Reinstalling an air-to-air heat exchanger

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

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

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

1. Install the transformer and hood as illustrated.

![Installation example of transformers in an air-to-air heat exchanger](image)

**Figure 5-16 Installation example of transformers in an air-to-air heat exchanger**

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>8 x M6x12 (HAQN401205P0257)</td>
<td>~17 kg</td>
</tr>
<tr>
<td>(2)</td>
<td>Transformer hood</td>
<td>~49 kg</td>
</tr>
<tr>
<td>(3)</td>
<td>4 x M8x20 (9ABA450093R0310)</td>
<td>~49 kg</td>
</tr>
<tr>
<td>(4)</td>
<td>Transformer connection plate</td>
<td>~66 kg</td>
</tr>
<tr>
<td>(5)</td>
<td>1.5 kVA transformer</td>
<td>~17 kg</td>
</tr>
<tr>
<td>(6)</td>
<td>2.8 kVA transformer</td>
<td>~49 kg</td>
</tr>
<tr>
<td>(7)</td>
<td>3.5 kVA transformer</td>
<td>~49 kg</td>
</tr>
<tr>
<td>(8)</td>
<td>6 kVA transformer</td>
<td>~66 kg</td>
</tr>
</tbody>
</table>
2. Connect each wire to the terminal block according to the terminal numbers printed on the marker sleeves.

Figure 5-17 Connect wires to terminal block

5.9 Installing the pressure relief vents

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

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

Figure 5-18 Pressure relief vents

- Weight: ~26 kg
- Length: 840 mm
- Width: 520 mm
- Height: 210 mm
Figure 5-19 Tools required to fasten the pressure relief vent to the roof

(1) Cordless drill  
(2) Torx bit  
(3) 24 x M6x20 Self-tapping (HAQN40105P0260)

Procedure

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

Note: The orientation of the baffle blades can be seen through the grille on the underside.

Figure 5-20 Installation example of pressure relief vents

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

2. Fasten the pressure relief vent to the roof with the supplied screws (Fig. 5-20).
5.10 Attaching the sealing tapes

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

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

Procedure

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

![Figure 5-21 Attach sealing tape to the joining crossbar (1)](image)

4. Reinstall the roof plates.
5.11 Installing the roof joints and the roof attachments

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

5.11.1 Installing roof joints

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Technical parameter</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecting plate</td>
<td>8 x 80 x 220 mm</td>
<td>3BHB011552R0001</td>
</tr>
<tr>
<td>Hex-head bolt</td>
<td>M16 x 40-A2</td>
<td>NB 312350P0464</td>
</tr>
<tr>
<td>Washer</td>
<td>17 x 30 x 3</td>
<td>9ABA450078P0008</td>
</tr>
</tbody>
</table>

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

**Note:** The joints (1) within a transport unit are factory-installed.

![Figure 5-22 Roof joints (1)]
5.11.2 Installing roof attachments

This section applies to marine drives.

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

**Note:** For information on the fitting location, see “Appendix C – Mechanical drawings”.

![Diagram of roof attachment parts](image)

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

1. Assemble the roof attachment.
2. Tighten the bolts firmly.
3. To fix the drive to the ceiling or the back wall, use two suitable struts per roof attachment.
   
   The struts are not supplied.
   
   **WARNING!** Do not install the struts at a 90° angle to the cabinet roof (Fig. 5-24).
4. If you fix the drive to the ceiling, use two struts per roof attachment (1 in Fig. 5-24).
5. If you fix the drive to the back wall, install one strut in a 90° angle to the drive (2 in Fig. 5-24).

![Figure 5-24 Recommended ceiling and wall fixings](image)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Two struts at 45° to ceiling</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>One strut at 90° to wall</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram showing recommended ceiling and wall fixings](image)
6. Electrical installation

6.1 Safety

DANGER

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.
- To prevent main and auxiliary power supply being switched on during installation, take appropriate measures.

The installation includes the following items:

- “6.3 Grounding the drive system” on page 129
- “6.4 Internal wiring” on page 131
- “6.5 Cable entry systems” on page 135
- “6.8 Auxiliary power, control and serial communication cables” on page 149
- “6.9 Heating cable” on page 166

Figure 6-1 Phase module on lift table
6.2 Cable requirements

Power, auxiliary and control cables have different requirements.

6.2.1 Power cables

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

- "Power cable specification" (3BHS125090 E01)
- "Power cables engineering guideline" (3BHS542290 E01)

6.2.2 Auxiliary and control cables

**NOTICE**

Risk of false signals!

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

**Note:** For information on the requirements for the auxiliary power cable and the control cables, see "Auxiliary power and control cables guideline" (3BHS813742 E01).

6.2.3 Synchronization cables

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

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

### 6.3.1 Grounding diagrams

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

<table>
<thead>
<tr>
<th>Diagram A</th>
<th>Diagram B</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Diagram A" /></td>
<td><img src="image2" alt="Diagram B" /></td>
</tr>
</tbody>
</table>

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

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

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

![Figure 6-3 System ground connection (1) in a 600 mm TEU](image)

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

6.3.3 Cable shield ground connection

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

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

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

![Figure 6-4 Grounding the EXU](image)

(1) Transformer  (2) EXU  (3) Motor  (4) Ground cable

6.4 Internal wiring

This section applies to a drive that is delivered as multiple transport units. Cables for internal wiring are delivered separately. The pre-assembled cables are fitted with terminal identifications at each end.

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

The data provide information on:

- Cable identification
- Cable type
- Cross-sectional area
- Location of terminals
6.4.1 Optical fiber cables

**NOTICE**

**Risk of equipment failure!**

- Handle optical fibers with care.
  - DO NOT touch the ends of the fibers, they are sensitive to dirt.
  - When unplugging, hold the connector and not the fiber.
  - If an optical fiber is damaged or improperly installed, data transmission can be affected and the equipment can fail.
  - To prevent such problems, follow the handling and installation guidelines.

- Observe the maximum long-term tensile load of **1.0 N** and the minimum bend radius of **25 mm**.

6.4.1.1 Installing the standard optical fibers

1. Pull all cables through the cable duct (3) at the top of the cabinets.
   **Note:** Cut-outs in the ducts provide entry into the cabinets.

![Figure 6-5 Cable tray and cable ducts in an LSU (A = front)](image)

2. Lay the cables into their designated trays and cable ducts as illustrated in Fig. 6-5.
   **Note:** When fastening IGCT power supply cables on the rail for IGCT power supply cables of RBU, BCU and VLU, make sure that the cables are at a minimum distance of 5 mm from the closest metal part.

3. Connect all cables and wires according to the “Converter Hardware” diagram.
6.4.2 Optical fiber cables for the optional Arc Guard System™

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

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

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

The Arc Guard System™ consists of the following:

- Arc Guard unit TVOC-2 with HMI panel
- Optical fiber detectors

The detectors are pre-installed in the relevant cabinets with the corresponding optical fibers coiled up beside the detectors (Fig. 6-7).
6.4.2.1 Connecting the detector cables to the arc monitor device

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

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

   **Note:** Cut-outs in the ducts provide entry into the cabinets.

2. Lay the cables into their designated trays and cable ducts as illustrated in Fig. 6-8.

3. Connect the cables to the arc monitor located in the REB according to the drawings.
4. Wind up the excess cable lengths to the reeling device in the REB.

**NOTICE** These cables are only available in standard lengths and cannot be cut or extended. The excess cable must be wound up in coils with a diameter of at least 100 mm.

### 6.5 Cable entry systems

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

- “6.5.1 Frames with type 1 sealing modules” on page 135
- “6.5.2 Frame with type 2 sealing modules” on page 137
- “6.5.3 Plates with cable glands” on page 137
- “6.5.4 EMC plates with sealing grommets” on page 138

**Note:** For information on the location and the dimensions of the cable entry, see “Appendix C – Mechanical drawings”.

#### 6.5.1 Frames with type 1 sealing modules

![Figure 6-9 Cable entry with type 1 sealing modules](image)

<table>
<thead>
<tr>
<th>Number</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Compression wedge</td>
</tr>
<tr>
<td>2</td>
<td>Sealing module (RM120)</td>
</tr>
<tr>
<td>3</td>
<td>Cable entry frame</td>
</tr>
</tbody>
</table>

**Usage**

- Power cables
- Ground cables
- Equipotential bonding conductors

**Included in delivery**

- Cable entry frame

**Not included in delivery**

- Sealing modules
- Accessories
- Tools
Usage

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

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

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

<table>
<thead>
<tr>
<th>Cabinet entry frame</th>
<th>Cabinet maximum number of sealing modules/openings</th>
<th>Maximum number of cables/openings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RM12, RM9, RM6</td>
<td>Single-core Ø28 - 50 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Three-core Ø68 - 99 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Single-core Ø48 - 71 mm</td>
</tr>
<tr>
<td>1 TEU 1000 mm</td>
<td>1 2 6</td>
<td>6 1 2</td>
</tr>
<tr>
<td>2 TEU 600 mm</td>
<td>1 2 6</td>
<td>6 1 2</td>
</tr>
<tr>
<td>3 ARU</td>
<td>1 2 6</td>
<td>6 1 2</td>
</tr>
<tr>
<td>4 BCU</td>
<td>1 1 4</td>
<td>3 1 1</td>
</tr>
<tr>
<td>5 EXU</td>
<td>1 2 6</td>
<td>6 1 2</td>
</tr>
</tbody>
</table>
### 6.5.2 Frame with type 2 sealing modules

![Frame with type 2 sealing modules](image)

**Figure 6-11 Cable entry with type 2 sealing modules**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>EMC sealing modules</td>
</tr>
<tr>
<td>(2)</td>
<td>Frame</td>
</tr>
</tbody>
</table>

**Usage**
- Auxiliary power cables
- Control cables

**Included in delivery**
- Cable entry frame

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

**Not included in delivery**
- EMC sealing inserts
- Installation tools
- Accessories

### 6.5.3 Plates with cable glands

![Plate with cable gland](image)

**Figure 6-12 Cable gland**

**Usage**
- Power cables, ground cables, bonding conductors
- Auxiliary power cables, control cables

**Included in delivery**
- Undrilled gland plate

**Not included in delivery**
- Cable glands
- Tools
- Accessories
6.5.4 EMC plates with sealing grommets

Figure 6-13 Cable entry with EMC plates

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EMC sleeves</td>
</tr>
<tr>
<td>2</td>
<td>Sealing grommets</td>
</tr>
<tr>
<td>3</td>
<td>Ø45 mm</td>
</tr>
<tr>
<td>4</td>
<td>1.5 mm</td>
</tr>
</tbody>
</table>

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

**Included in delivery**
- Galvanized plate with net-like EMC sleeves
- Sealing grommets

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

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

- TEU
- ARU
- EXU
6.6.1 **TEU cable entry frames with type 1 sealing modules**

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

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

---

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

(1) Top cable entry frame
(2) Bottom cable entry
(3) High-voltage busbars
(4) Compression wedge
(5) RM90 sealing module with 3-core cable
6.6.2 ARU cable entry frames with type 1 sealing modules

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

In order to connect the cables, you need to remove the phase modules (see “10.4.10 Removing and installing a phase module” on page 253) and, if necessary, the short busbars as well (“6.6.2.0.1 Removing the short busbars” on page 140).

6.6.2.0.1 Removing the short busbars

1. Remove the phase module according to “10.4.10 Removing and installing a phase module” on page 253.

2. If necessary, remove the short busbars (boxes) to facilitate entering the cables.

3. To remove a busbar, unscrew the bottom bracket and the bolts and then move the busbar downward and away from the cabinet.

(1) Short busbar (4) 1/2” wrench
(2) Remove these bolts (5) 17 mm and 19 mm
(3) Bottom bracket

4. After you have routed the cables, install the busbars in the reverse order of removal.
6.6.3 EXU cable entry with EMC plate and sealing grommets

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

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

   **Note:** Depending on the cable entry configuration, the entry plate is either on the top or on the bottom of the cabinet.

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

![Figure 6-16 EXU with top cable entry (A) and EXU with bottom cable entry (B)](image)

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

1. Remove the front cover and, if present, unplug the heating cable and remove the cross brace with the heating cable.

2. Remove the cover above the fan unit.

3. Remove the fan unit as explained in “10.4.17 Replacing the fan unit in an EXU with a DCS800 D4 size controller” on page 270.

4. Unplug the fan power supply cables and the tube from the air pressure switch.

![Figure 6-17 EXU cabinet](image)
6.7 **Power, ground and equipotential bonding conductor cables**

**NOTICE**

Risk of damage or malfunction!
- Waste inside the cabinet can cause damage or malfunction.
- If possible, DO NOT cut cables inside the terminal compartment.
- Retrieve any waste which accidentally dropped into the cabinet.

The following sections describe how to prepare and route cables. For a description on how to prepare the cable entries, see “6.6 Preparing cable entry systems for TEU, ARU and EXU cabinets” on page 138. See “Appendix C – Mechanical drawings” for information on:
- Project-specific cable entry
- Distance between point of cable entry and terminals or busbars
- Busbar and fastening hole dimensions
- Busbar designations

See “Appendix D – Wiring diagrams” for information on:
- Conventions for cross-reference and device identification

### 6.7.1 Determining the cable length

1. Determine the required length of a cable between the point of entry and the connection point inside the cabinet.
2. Cut the cable to the required length before connection.
6.7.2 Preparing cables for sealing modules

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

2. Install the sealing modules according to the instructions of the sealing module supplier.
6.7.3 Preparing cables for cable glands

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

![Figure 6-19 Prepare power cables for cable glands](image)

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

6.7.4 Preparing cables for EMC plates

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

1. Remove the grommets from the entry plate.
2. To ensure proper sealing, cut along the marking that corresponds to the cable diameter.
3. Slide the grommet onto the cable and ensure that the grommet fits tightly to prevent water from entering the cabinet.

**Note:** If cables are entered through the cabinet floor, the grommets can be discarded.

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

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

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

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

---

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

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

**WARNING**

**Risk of flashover!**

- High voltages will be present in the terminal compartment.
- High voltages can cause flashover between the electric potential of different conductors, and the electric potential of a conductor and earth.
- To prevent a flashover, a minimum distance of 55 mm must be maintained between two different potentials in the terminal unit, including phase to phase distances and ground to phase distances.

6.7.5.1 Checking the cable insulation

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

6.7.5.2 EXU cabinet connections

1. If multi-core cables are used and several conductors of the same phase are connected to a busbar, attach the cable lugs of the cables on each side of the busbar.

2. Fasten the cables to the strain relief rails with suitable cable clamps.

![Figure 6-21 Cable connections in an EXU cabinet](image)

| (1) Cable clamp | (2) Cable lugs on each side of busbar | (3) Strain relief rail |
3. Choose the length and the orientation of the bolts so that the distance between bolted joints of different phases is not less than 25 mm.

![Figure 6-22 Minimum distance between bolted joints of different phases in an EXU](image)

(1) 25 mm

6.7.5.3 Bolted busbar connections – marine drives

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

![Figure 6-23 Bolted busbar connection - marine drives](image)

<table>
<thead>
<tr>
<th>Part</th>
<th>Quantity</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hex-head bolt</td>
<td>M12x40-A2</td>
<td>NB 312350P8119</td>
</tr>
<tr>
<td>Coated hex-head nut</td>
<td>M12-A2-70</td>
<td>HZN 452198P1022</td>
</tr>
<tr>
<td>Conical spring washer</td>
<td>13 x 29 x 3</td>
<td>HAQN400344P0111</td>
</tr>
</tbody>
</table>
6.7.5.4 Bolted busbar connections – non-marine drives

**Material requirements**

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

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

**Connection type**

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

- Spring washer and flat washer on each side of the busbar.

The spring washer and flat washer can be replaced by a conical spring washer (Fig. 6-23). Other washers can be used, provided they maintain the required contact pressure.

- Use cable lugs suitable for M12 bolts.

**Lubrication**

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

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

**Tightening torque**

ABB recommends a tightening torque of 40 Nm for M12 bolts. For other sizes, follow the manufacturer’s recommendations.
6.8 Auxiliary power, control and serial communication cables

The following sections describe how to prepare and route cables.

For a description on how to prepare the cable entries, see “6.6 Preparing cable entry systems for TEU, ARU and EXU cabinets” on page 138.

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

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

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

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

6.8.1 Determining the cable length

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

2. Cut the cable to the required length before connection.
6.8.2 Preparing cables for sealing modules

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

1. Unscrew the frame.

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

![Figure 6-25 Cable entry with sealing modules](image)

1. Sealing modules
2. Compression wedge

![Figure 6-26 Preparing control cables for sealing modules](image)

1. Sealing module
2. Conductive foil
3. Cable sheath removed to expose cable shield
4. Conductor screen extension to connect to PE terminal
6.8.3 **Preparing cables for cable glands**

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

![Diagram of cable gland installation]

**Figure 6-27 Preparing auxiliary control cables for cable glands**

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

6.8.4 **Preparing cables for EMC plates**

1. Remove the grommets from the entry plate.

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

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

   **Note:** If cables are routed through the cabinet floor, the grommets can be discarded.

4. If necessary, remove the entry plate and pull the cable through the entry holes.
5. If the outer cable screen is conductive, remove the cable insulation at the point of entry (1 in Fig. 6-28).

If the outer cable screen is non-conductive:

1. Cut open the cable screen in the middle of the stripped area (1 in Fig. 6-28).

2. Pull the cable screen ends over the cable insulation to turn the conductive side inside out (2 in Fig. 6-28).

3. Connect the screens ends with a continuous conducting foil (3 in Fig. 6-28).

![Figure 6-28 Preparing the screens of control cables for EMC plates](image)
6.8.5 Routing cables in a WCU

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

6.8.6 Routing cables in a COU cabinet

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

Top and bottom cable entries are covered with blanking plates.

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

1. Remove the entry plate.

2. On the length of cable that passes through the cable transit, prepare the cable according to “6.8.3 Preparing cables for cable glands” on page 151.

3. Route the cable to its destination as illustrated in:
   - Fig. 6-31 (COU 600 mm)
   - Fig. 6-32 (COU 1000 mm)
6.8.6.2 Bottom cable entry

1. Insert and route the cables as illustrated in Fig. 6-33 and Fig. 6-34.

Figure 6-32 Cable route in COU (1000 mm) top cable entry

Figure 6-33 Cable route in COU (600 mm) bottom cable entry

(1) Cable entry bottom  (3) Detail
(2) Side view
2. Fasten the cables with cable ties.

6.8.6.3 Connecting the cables

Conductors

- If a twisted pair cable is used, leave the unshielded cable ends twisted until they reach the terminals.
- Leave unshielded conductor ends as short as possible (not longer than 50 mm).

Cable shields

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

**IMPORTANT!** DO NOT connect the shields to the terminals of the interface.
- Different-sized ground clamps are supplied.
6.8.7 Routing cables in an EXU cabinet

This section applies to a stand-alone EXU.

6.8.7.1 Auxiliary power and control cables

1. Enter the cables through a free hole of the EMC plate.

2. On the length of cable that passes through the cable transit, prepare the cable according to the following instructions:

   • **Cable entries with EMC plates**: “6.8.4 Preparing cables for EMC plates” on page 151
   • **Cable entries with cable glands**: “6.8.3 Preparing cables for cable glands” on page 151.

   **Note:** Materials for cable fitting, EMC requirements and sealing are not supplied for undrilled plates.
3. Route the cables through the designated cable ducts as illustrated.

Figure 6-36 Cable routing examples in an EXU cabinet with an ED5V, EB5R, EB5S, EB7P and EB7Q type DCS800 converter (A) and in an EXU cabinet with an ED7Y type DCS800 converter

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

**NOTICE**

Risk of equipment failure!

- If an optical fiber is damaged or improperly installed, data transmission can be affected, and the equipment can fail. To prevent such problems, follow the handling and installation guidelines.

- To protect the optical fibers against damages, lay them in a steel or plastic conduit, that is only used for the encoder cables. The conduit starts at the drive and ends inside the EXU. At the drive, the conduit enters through the entry plate with about **10 – 20 mm** of conduit extending from the entry plate.

- To protect the tip of the optical fiber against scratches, cover the cable end with a cap before pulling the cable through the conduit.

- DO NOT exceed the specified maximum tensile load and the minimum bend radius of the optical fiber.

- When using cable ties, be careful not to deform the optical fibers and do not use a cable tie gun.

- When connecting or unplugging an optical fiber, hold it at the connector and not at the fiber.
6.8.7.3 Routing optical fiber cables in an EXU cabinet with an ED5V, EB5R, EB5S, EB7P or EB7Q type DCS800 converter

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

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

Figure 6-37 DCS800 converter (ED5V, EB5R, EB5S, EB7P and EB7Q types)

<table>
<thead>
<tr>
<th>(1) Control panel</th>
<th>(3) Removable cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Indentation</td>
<td>(4) Location of COM8x circuit board</td>
</tr>
</tbody>
</table>

Figure 6-38 COM-8x circuit board (A) in a DCS800 converter (ED5V, EB5R and EB5S types) and a detail of channel CH0 (B) on the board.
7. Route the cables through the designated cable ducts as illustrated in Fig. 6-39.

8. Reattach the DCS800 cover.

Figure 6-39 Cable routing example in an EXU cabinet with an ED5V, EB5R, EB5S, EB7P or EB7Q type DCS800 converter

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<thead>
<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Cable enters through roof</td>
</tr>
<tr>
<td>2</td>
<td>PE ground busbar</td>
</tr>
<tr>
<td>3</td>
<td>Cable enters through the floor</td>
</tr>
<tr>
<td>4</td>
<td>Terminal strip for auxiliary power and control cables</td>
</tr>
<tr>
<td>5</td>
<td>Auxiliary supply cable</td>
</tr>
<tr>
<td>6</td>
<td>Terminal for optical fibers behind cover</td>
</tr>
<tr>
<td>7</td>
<td>Optical fibers to DCS800 D4 converter</td>
</tr>
</tbody>
</table>
6.8.7.4 Routing cables in an EXU cabinet with an ED7Y type DCS800 converter

1. Unscrew the rectangular cover from the DCS800 unit.

![Diagram of DCS800 converter](image)

*Figure 6-40 DCS800 converter (ED7Y)*

(1) Control panel  (2) Removable cover

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

![Diagram of COM-8x circuit board](image)

*Figure 6-41 COM-8x circuit board (A) in a DCS800 converter (ED7Y type) and a detail of channel CH0 (B) on the board*
3. Route the cables through the designated cable ducts as illustrated in Fig. 6-42.

![Figure 6-42 Cable routing example in an EXU cabinet with an ED5V, EB5R or EB5S type DCS800 converter](image)

Figure 6-42 Cable routing example in an EXU cabinet with an ED5V, EB5R or EB5S type DCS800 converter

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Cable enters through roof</td>
</tr>
<tr>
<td>2</td>
<td>PE ground busbar</td>
</tr>
<tr>
<td>3</td>
<td>Cable enters through the floor</td>
</tr>
<tr>
<td>4</td>
<td>Terminal strip for auxiliary power and control cables</td>
</tr>
<tr>
<td>5</td>
<td>Auxiliary supply cable</td>
</tr>
<tr>
<td>6</td>
<td>Terminal for optical fibers behind cover</td>
</tr>
<tr>
<td>7</td>
<td>Optical fibers to DCS800 D4 converter</td>
</tr>
</tbody>
</table>

4. Reattach the DCS800 cover.
6.8.8 **Routing Azipod® encoder cables**

This section applies to Azipod® propulsion.

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

- CIU
- WCU
- COU

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

6.8.8.1 **Handling and installation**

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

**NOTICE**

**Risk of equipment failure!**

- If an optical fiber is damaged or improperly installed, data transmission can be affected, and the equipment can fail. To prevent such problems, follow the handling and installation guidelines.

- To protect the optical fibers against damages, lay them in a steel or plastic conduit, that is only used for the encoder cables. The conduit starts at the drive and ends inside the EXU. At the drive, the conduit enters through the entry plate with about 10 – 20 mm of conduit extending from the entry plate.

- To protect the tip of the optical fiber against scratches, cover the cable end with a cap before pulling the cable through the conduit.

- DO NOT exceed the specified maximum tensile load and the minimum bend radius of the optical fiber.

- When using cable ties, be careful not to deform the optical fibers and DO NOT use a cable tie gun.

- When connecting or unplugging an optical fiber, hold it at the connector and not at the fiber.
6.8.8.2  Routing cables through the REB (WCU)

1. If present, remove the blanking plate.
   The plate can either be discarded or used as an entry plate.

2. Route the cable along the WCU side wall, through the cable transit and to the receiver.

3. To fix the cables to the rails on the side wall, use a screw base with a cable tie or cable clamps appropriate for fiber optics.

4. To seal the cable entry, use appropriate sealing inserts for the cable entry frames.

Figure 6-43 REB cable entry

(1) Blanking plate (removed)
6.9 Heating cable

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

Procedure

1. Connect the power supply of the heating cable.

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

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

3. Fasten the connectors with cable ties.

![Diagram of heating cable connection](image)

**Figure 6-44 Heating cable connection**

(1) Heating cable plug  (2) Cable tie
6.10 Final checks

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

7.1 Required qualification

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

7.2 Commissioning procedure

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

7.3 Commissioning checklist

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

7.4 Customer assistance

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

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

7.5 Customer acceptance

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

This checklist is designed to help you prepare the drive and associated equipment for commissioning.

7.6.1 Mechanical installation checklist

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drive is aligned according to drive layout drawing (if delivered in several transport units) and installed according to the instructions in this user manual (3BHS212794 E01 Rev M).</td>
</tr>
<tr>
<td>2</td>
<td>Drive is securely fixed to the floor.</td>
</tr>
<tr>
<td>3</td>
<td>Roof attachments are installed (if applicable).</td>
</tr>
<tr>
<td>4</td>
<td>Pipe joints are orientated and torqued correctly.</td>
</tr>
<tr>
<td>5</td>
<td>Joints for DC link and ground busbar are installed and correctly torqued.</td>
</tr>
<tr>
<td>6</td>
<td>Roof-mounted fan units are installed (if applicable).</td>
</tr>
<tr>
<td>7</td>
<td>Raw water piping is completed and pipes are flanged to the drive (if applicable).</td>
</tr>
<tr>
<td>8</td>
<td>Raw water supply is ready.</td>
</tr>
</tbody>
</table>
| 9 | Visual inspection:  
   • No badly affixed or damaged components  
   • No foreign objects left in the cabinet  
   • No dirt, dust or moisture in the cabinet | □ |

7.6.2 Electrical installation checklist

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Types and cross sections of control cables suitable for the signal type and signal level.</td>
</tr>
<tr>
<td>2</td>
<td>Types and cross sections of power cables selected according to the ABB power cable specification.</td>
</tr>
<tr>
<td>3</td>
<td>Pulse encoder cable shields are connected to the shield earthing point and not connected directly to the pulse encoder interface (applies only to drives with pulse encoder interface).</td>
</tr>
<tr>
<td>4</td>
<td>Cable entries prepared according to the instructions in this user manual (3BHS212794 E01 Rev M).</td>
</tr>
<tr>
<td>5</td>
<td>Control cable screens and conductors are connected as instructed in this user manual (3BHS212794 E01 Rev M), labeled appropriately, and the customer side connections are completed.</td>
</tr>
<tr>
<td>6</td>
<td>Heating cables (if supplied) is installed according to the instructions in this user manual (3BHS212794 E01 Rev M).</td>
</tr>
</tbody>
</table>
7.6.2 Electrical installation checklist (continued)

7) Wiring across shipping splits is completed according to the instructions in this user manual (3BHS212794 E01 Rev M).

8) Ground cable of the drive is securely connected at both ends.

9) Cable armor and screens of power supply cables are connected to PE ground busbar.

10) The transformer and motor cables are installed but the conductors not connected at both ends (cables and drive must be insulation resistance tested, ie, Megger test, before connection).

7.6.3 Main circuit breaker (MCB)

1) MCB selected as per “Main circuit breaker specification”\(^{(1)}\)

2) High-voltage power connections completed

3) MCB is ready to be tested with drive

4) MCB protection relay settings are tested

5) Protection devices (eg, door locks) are tested and in operation.

6) Local operation of MCB is disabled.

7) Emergency-off loop is tested.

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

7.6.4 Input transformer checklist

1) Grounding is completed

2) Transformer auxiliaries (eg, dehydrating breathers, cooling, protection devices) are ready.

3) Protection devices are tested and in operation.
### 7.6.5 Motor checklist

1) Motor is installed, aligned and alignment protocol available.

2) Motor is not coupled to driven load.

3) Grounding is completed

4) Motor auxiliaries (e.g., bearing lubrication) are ready

5) Control and monitoring signals are connected.

### 7.6.6 Insulation tests checklist

1) Insulation of the cables to input transformer, from input transformer to drive and from drive to motor is tested, and measured values within required limits.

2) Test report is available

   If the commissioning personnel carry out the test, an additional day per drive-motor combination must be reserved. After the test, the mains cables can be connected, except at the drive end. Test must comply with the specification.

### 7.6.7 Power checklist

1) Medium voltage available for startup of drive.

2) Low voltage is available for startup of drive.

### 7.6.8 Miscellaneous checklist

1) Sufficient number and correct type of spare parts available

2) Sufficient quantity of deionized water according is available. (see “Appendix C – Mechanical drawings”).

3) Air conditioning of drive room ready for load run of drive

4) Optional equipment (e.g., chiller) ready
8. Operation

8.1 Overview
This chapter outlines the local operation of the drive.

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

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

8.2 Operating conditions
The operating conditions for the drive are according to IEC 60721-3-3.
- Classification: 3K22 / 3B1 / 3S6 / 3M11

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

8.4.1 ARU control panel

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

Figure 8-1 ARU control panel

Main functions:

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

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

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

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

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(1) CDP control panel
Main functions:
- Starts and stops the motor
- Displays status messages of the INU
- Displays alarm and fault messages of the drive and monitored foreign equipment
- Resets alarm and fault messages

(2) Main power supply off
Illuminated pushbutton opens the main circuit breaker

(3) Main power supply on
Illuminated pushbutton charges the DC link and closes the main circuit breaker

(4) Alarm / fault lamp
- Alarm: flashing light
- Fault: permanent light

(5) EMERGENCY-OFF RESET pushbutton
- Resets the emergency-off relay in the drive control system
- Flashes when the auxiliary voltage is switched on, or when an emergency-off pushbutton is pressed

(6) EMERGENCY OFF latching pushbutton
- Prevents starting when pressed at standstill of the drive
- Main circuit breaker opens and DC link discharges when pressed during operation of the drive
8.4.2.1 Lamp test

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

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

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

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

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

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

![Figure 8-3 Typical semi-redundant drive configuration](image_url)

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<tr>
<td></td>
<td></td>
<td>Excitation power</td>
<td>Mains</td>
<td>EXU</td>
<td>WCU</td>
<td>COU</td>
<td>Control</td>
<td>LSU</td>
<td>INU</td>
<td>CBU/RBU</td>
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</table>

**Figure 8-3 Typical semi-redundant drive configuration**
8.4.3.1 Operating modes

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

For project specific instructions please consult the corresponding application note.

Fig. 8-4 shows typical full- and half-power modes. For further variants, refer to the Signal and Parameter Table document.

![Figure 8-4 Typical full-power (A) and half-power (B) drive modes](image)

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

8.4.3.2 Semi-redundant drive control panel

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

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

The control panel provides the following functions:

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

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

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

**Note:** For more information, see "DCS800 drives firmware manual" (3ADW000193R0801).
8.5.1 Operational settings

**NOTICE**

**Risk of component damage!**

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

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

**Note:** The control panel is only used if an alarm or a fault condition must be rectified.

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

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

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

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

8.5.2 Resetting alarm and fault messages

- **Alarm messages:** cannot be reset by pressing the reset soft key.
  
  The alarm resets automatically as soon as the reason causing the alarm has been resolved.

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

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

8.5.3 Parameter settings

**NOTICE**

**Risk of component damage!**

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

- DO NOT change any parameter if the meaning of the parameter and the effects of the change are not fully understood.

The parameters are set as required for operation and verified during commissioning and must not be changed afterwards.
8.6 Grounding switch and door locking system

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

![Diagram of CBU grounding switch in ungrounded (A) and grounded (B) positions]

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

  1. Grounding switch in ungrounded position (A)
  2. Grounding switch in grounded position (B): When the switch is in grounded position, the DC link of the drive is connected to the ground busbar of the drive.
  3. White illuminated pushbutton: DC link is grounded: Lights up to indicate that the drive is grounded and that the locking bar (see 1 in Fig. 8-7) of each medium voltage unit can be moved to the unlocked or locked position.
  4. Yellow illuminated pushbutton: grounding switch unlocked
     - Lights up to indicate that the grounding switch can be turned to the ungrounded or grounded position.
     - Press the yellow pushbutton to turn the grounding switch to the desired position.

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

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

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

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

8.6.2 Door locking system

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

Note: For more information, see “10.4.4 Unlocking and opening the doors” on page 236.

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

<table>
<thead>
<tr>
<th>Standard cabinet units</th>
<th>Optional cabinet units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARU</td>
<td>INU</td>
</tr>
<tr>
<td>LSU</td>
<td>IFU</td>
</tr>
<tr>
<td>CBU</td>
<td>IRU</td>
</tr>
<tr>
<td>TEU</td>
<td>BCU</td>
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<tr>
<td></td>
<td>RBU</td>
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<tr>
<td></td>
<td>VLU</td>
</tr>
<tr>
<td></td>
<td>ISU</td>
</tr>
</tbody>
</table>

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

Figure 8-7 Location on the safety switches

The safety switches are part of an interlocking circuit that prevents the doors being opened as long as the DC link is charged. The interlocking circuit ensures that the:
• Main power can only be connected to the drive if the doors are securely closed, the grounding switch is in position not grounded, and the safety switches are in position locked.

• Doors can only be opened when the main power has been disconnected, the DC-link capacitors have been discharged, and the grounding switch is in position grounded.

The locking bar locks and unlocks the locking mechanism of the door of a medium voltage unit.
8.7 **Optional switchgear and controlgear**

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

8.7.1 **DC-link disconnector**

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

8.7.2 **Output switches**

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

**NOTICE**

**Risk of component damage!**

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

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

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

8.7.3 **Manual output isolation**

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

**Note:** For more information, see “10.4.9 Drives with the manual output isolation (optional)” on page 244.
8.8 Status messages

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

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

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

NotReadyOn

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

ReadyOn

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

Charging

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

ReadyRun

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

ReadyRef

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

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

Tripped

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

1) NotReadyOn

2) ARU ReadyOn
   • Only drives with an ARU (see the next step, ReadyOn, for the conditions)

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

4) On command

5) Charging
   • DC link charges
   • MCB closes
   • Cooling system switches on

6) ARU ReadyRef
   • Only in drives with an ARU

7) ReadyRun
   • INU starts magnetizing (only in drives with an ARU)
   • INU starts to modulate

8) Start command

9) ReadyRef

10) Operation
8.8.2 Stop sequence of the drive

1) Operation

2) ReadyRef

3) Stop command

4) Stopping
   • Speed ramps down
   • INU stops modulating

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

6) ReadyRun

7) ARU ReadyOn
   • Only in drives with an ARU

8) ReadyOn
   • Drive is grounded
   • Doors in medium voltage units are released for opening
   • Auxiliary power supply switched off

9) NotReadyOn
8.8.3 Emergency-off sequence

1) Operation

2) ReadyRef

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

4) Emergency-off

8.8.4 Prevention of unexpected startup sequence

1) Operation

2) ReadyRef

3) Prevention of unexpected startup command
   • Drives stops according to Ramp, Torque, and Ramp stop modes
   • Open disconnector
   • Prevention of unexpected startup complete
   • Drive remains charged, MCB closed

4) INU operation prevention feedback
8.9 Starting the drive

Note: The charge cycle of the drive is 3 times per 60 minutes.

**DANGER**

Hazardous voltages!

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

**CAUTION**

Cooling system starts automatically!

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

8.9.1 Checks before starting the drive

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

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

![Figure 8-8 Grounding switch in ungrounded position](image)

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

8.9.2 Starting the drive remotely

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

8.9.3 Starting the drive locally

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

1.

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

   Note: Each time the auxiliary voltage is switched off and on again, the emergency-off safety relay of the drive is actuated and lets the EMERGENCY-OFF RESET pushbutton flash. The EMERGENCY-OFF RESET push button also flashes if the EMERGENCY-OFF push button on the control compartment door, or any other EMERGENCY-OFF push button linked to the drive, is pressed. If the EMERGENCY-OFF RESET push button continuous flashing, verify that there is no emergency-off command active. See “8.10.2 Stopping the drive with the emergency-off function” on page 195

3. Check that no alarm or fault messages are displayed on the control panel.
   • When a fault message is displayed on the control panel, reset the fault.
     • If a fault cannot be reset, the responsible personnel must rectify it.
     • (Drives with an ARU) When faults are present and the drive is ready, the INU is “ReadyOn”.

   | 1 L -> | 4840.0 V |
   | StateARU | ReadyOn |
   | DC VOLT  | 0.00 V   |
   | PRI VOLT  | 0 V      |
• When alarms and faults are not present and the drive is ready, the INU CDP control panel displays ReadyOn.

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

The push button flashes during charging.

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

**Note:** After charging has been finished, the following takes place:

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

• Drives with an ARU:
  - The ARU is now “ReadyRun”.

Alternating display message:

- Charging
- AuxiliaryOn
INU 1 and other INUs (if present) are now in status “ARU NotRun”

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

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

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

6. Enter the reference value.

7. Start the motor with the INU control panels.

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

While the motor is magnetizing, the run status message on the display blinks. When the motor has finished magnetizing, the run status message lights up permanently.
The drive is now in “ReadyRef” to indicate that the drive system is operating.

8.10 Stopping the drive

8.10.1 Stopping the drive locally

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

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

Note: During the stop sequence, you can restart the drive by pressing the START key.

The drive is now in stopping mode.
2. When the motor has reached zero speed, the drive is “ReadyRun”.

As long as the MCB has not been opened, you can restart the motor at any time.
8.10.2 Stopping the drive with the emergency-off function

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

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

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

**Note:** For more information, see "Emergency off/stop modes and prevention of operation & safe torque off" (3BHS196243).

8.10.3 Initiating an emergency-off

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

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

1) MCB opens
2) Drive system coasts down
3) DC-link of the drive discharges
4) Status line indication of the CDP control panel alternates between EmergencyOff and NotReadyOn.

```
1 L -> 600.0 rpm
StateINU EmergencyOff
MOTOR SP 0.00 rpm
POWER 0.0 kW
```

Alternating display message:
- EmergencyOff
- NotReadyOn

5) **EMERGENCY-OFF RESET** button flashes
6) **SUPPLY OFF** push button flashes
8.10.4 Starting the drive system after an emergency-off

1. To start the drive system after an emergency-off, unlatch the EMERGENCY-OFF push button. The EMERGENCY-OFF push button returns to its initial position when turned into the direction indicated by the arrows on the push button.

2. Press the EMERGENCY-OFF RESET button to reset the emergency-off safety relay of the drive.
   - The drive remains in emergency-off state until the DC-link voltage has dropped to < 50 V (discharged).
   - After resetting, the status message of the drive changes to “ReadyOn”.
   
   The status line of the CDP control panel shows the following:

   ![status line](image)

   **Alternating display message:**
   - EmergencyOff
   - EOFF<DCVolt

3. The main power supply can be connected to the drive again and the drive system can be started up.
8.11  Arc detection with the Arc Guard System™ (optional)

The optional Arc Guard System™ detects fast arc faults in the terminal sections of an ACS6000 drive. When the Arc Guard System detects an arc fault the drive performs protection firing and immediately opens the main circuit breaker.

8.11.1  Action after the Arc Guard System™ has been triggered

1. De-energize and ground the drive according to “10.4.2 De-energizing and grounding the drive” on page 231.
2. Search for the location where the arc has been detected.
3. Check the Arc Guard HMI panel messages and use the circuit diagrams.

![Figure 8-9 Arc Guard System™ in a WCU REB](image)

Figure 8-9 Arc Guard System™ in a WCU REB

![Figure 8-10 HMI panel](image)

Figure 8-10 HMI panel
4. Open the power units and localize the defect.

5. Repair the defect or contact support line if needed.

6. Reset the fault on Arc Guard HMI panel.

7. Acknowledge the firing through with parameter 16.26 on the control panel (only when fault was understood and corrected).

8. Restart the drive.
9. CDP control panel

9.1 Overview

The panel messages and parameter settings in the following sections are typical examples and might differ from the actual ones.

9.1.1 Display and keypad

<p>| | | | | | | | | | |</p>
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<tbody>
<tr>
<td>(1)</td>
<td>Display</td>
<td>(8)</td>
<td>Reset key</td>
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<td>(2)</td>
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<td>(9)</td>
<td>Forward key</td>
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<td>(3)</td>
<td>Actual signal names and values</td>
<td>(10)</td>
<td>Backward key</td>
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<tr>
<td>(4)</td>
<td>Keypad</td>
<td>(11)</td>
<td>Slow navigation key for selecting signals or fault messages</td>
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<td>(5)</td>
<td>Mode selection keys</td>
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<tr>
<td>(6)</td>
<td>Fast navigation key for selecting the actual signals display or the fault memory display</td>
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<td>(7)</td>
<td>Local / remote selection key</td>
<td>(12)</td>
<td>Enter key, terminates a procedure</td>
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<td>(13)</td>
<td>Reference key</td>
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<td>(14)</td>
<td>Start key</td>
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<td></td>
<td></td>
<td>(15)</td>
<td>Stop key</td>
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</tbody>
</table>

Figure 9-1 CDP control panel
9.1.2 Functions

The CDP control panel serves as the basic user interface for operating and monitoring the drive when the local operating mode has been selected.

The CDP control panel can be attached to or detached from the drive without having to switch off the auxiliary power supply first.

Using the CDP control panel, it is possible to:

- Enter startup data
- Enter reference values
- Enter start, stop and direction commands
- Display actual values (three values can be read simultaneously)
- Display and adjust parameters
- Display information on the most recent 64 fault events

9.2 Modes

The CDP control panel provides the following modes:

- “9.2.1 Identification mode” on page 200
- “9.2.2 Actual signals mode” on page 202
- “9.2.3 Parameters mode” on page 209
- “9.2.4 Functions mode” on page 214
- Drive mode (not used)

9.2.1 Identification mode

The identification mode informs the user about the CDP control panel version and the ID number of the drive. The information appears on the display

- when the power supply is switched on, or
- when the CDP control panel is connected to the drive and the auxiliary voltage has been switched on already.

When the CDP control panel is initialized, the display changes as follows:

After 2-3 seconds the display shows the drive name (1, 2), the application software in use (3), and the drive identification (4) is displayed.
After another few seconds.

Alternating display message:
- DCGndNopen
- NotReadyOn
9.2.2 Actual signals mode

Two displays can be selected in the actual signals mode:

- Actual signals display
- Fault memory display

The actual signals display appears first when entering the actual signals mode. However, when the drive is in a fault condition, the fault memory display appears instead.

The actual signals display is used to monitor the drive without interfering with its operation. It continuously displays three selectable actual values.
If no key is actuated within one minute (an exception from this is the fault memory display), the CDP control panel automatically returns to the actual signals display from other modes.

**Actual values**

For the complete list of selectable actual signals, see “Appendix G – Signal and parameter table”.

The actual values are organized in groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 01</td>
<td>Measured or calculated motor values</td>
</tr>
<tr>
<td>Group 02</td>
<td>Measured or calculated drive values</td>
</tr>
<tr>
<td>Group 03</td>
<td>Reference values</td>
</tr>
<tr>
<td>Group 04</td>
<td>Status signals of S800 I/O system</td>
</tr>
<tr>
<td>Group 05</td>
<td>Communication link and MCB status signals</td>
</tr>
<tr>
<td>Group 06</td>
<td>Software version, drive and motor nominal values</td>
</tr>
<tr>
<td>Group 07</td>
<td>Control words</td>
</tr>
<tr>
<td>Group 08</td>
<td>Status words</td>
</tr>
<tr>
<td>Group 09</td>
<td>Fault and alarm words</td>
</tr>
</tbody>
</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 “9.2.2.7 Displaying and resetting an active fault” on page 208.

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

Changing from the fault memory display to other modes is possible without resetting the fault first. If no key is actuated, the fault or alarm message displays as long as the fault is active.

9.2.2.2 **Selecting the actual signals display**

To select the actual signals display, press the ACT key.
9.2.2.3 Toggling between actual signals display and fault memory
To toggle between actual signals display and fault history display, press a fast navigation key.

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

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

9.2.2.5 Selecting actual signals
1. To select the actual signals display, press the ACT key.
2. To select a line where the actual signal is to be displayed, press the slow navigation keys. A blinking cursor indicates the selected line.

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

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

5. To select an actual signal, press a slow navigation keys.
6. To confirm the selection and to return to the actual signals display, press the ENTER key.

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

9.2.2.6 Displaying a fault and resetting the fault memory

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

2. To change to the fault memory display, press a fast navigation key.
3. To display a specific fault, press the slow navigation keys. The up key selects the previous, the down key the next fault.

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

5. To return to the actual signals display, press a fast navigation key.
9.2.2.7 Displaying and resetting an active fault

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

2. To reset the fault, press the RESET key.
9.2.3 Parameters mode

**NOTICE**

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

- Parameters must only be set by qualified personnel.
- DO NOT change any parameter, if the meaning of the parameter and the effects of the change are not fully understood.

![Control panel functions for Parameters mode](image)

Figure 9-3 Control panel functions for Parameters mode

1. Status line
2. Group number and name
3. Parameter number and name
4. Parameter value
5. Selection key for parameters mode
6. Fast navigation key for selecting a parameter group (and a parameter value)
7. Slow navigation key for selecting a parameter (and a parameter value)
8. Enter key for confirming the selection
9.2.3.1 Overview

If the parameter lock is disabled or unlocked (see “9.2.3.3 Enabling / unlocking a parameter lock” on page 213) 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.

<table>
<thead>
<tr>
<th>Group</th>
<th>Description</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 07</td>
<td>Control words</td>
<td>21.01</td>
<td>Start function</td>
</tr>
<tr>
<td>Group 08</td>
<td>Status words</td>
<td>21.02</td>
<td>Start function</td>
</tr>
<tr>
<td>Group 09</td>
<td>Fault and alarm words</td>
<td>21.03</td>
<td>Off1 stop mode</td>
</tr>
<tr>
<td>Group 11</td>
<td>Start, stop, direction or MCB control</td>
<td>21.04</td>
<td>Process stop selection</td>
</tr>
<tr>
<td>Group 12</td>
<td>Reference selection</td>
<td>21.05</td>
<td>Process stop signal</td>
</tr>
<tr>
<td>Group 16</td>
<td>System control inputs</td>
<td>21.06</td>
<td>Process stop MCB control</td>
</tr>
<tr>
<td>Group 17</td>
<td>DC link control</td>
<td>21.07</td>
<td>Process stop mode</td>
</tr>
<tr>
<td>Group 18</td>
<td>Utility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 19</td>
<td>Data storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 20</td>
<td>Limits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 21</td>
<td>Start / stop / process stop</td>
<td>21.17</td>
<td>MCB closing time limit</td>
</tr>
<tr>
<td>Group 22</td>
<td>Ramp functions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 23</td>
<td>Speed reference</td>
<td>21.19</td>
<td>MCB available signal</td>
</tr>
</tbody>
</table>

Note: For details about the parameters, their settings and functions, see “Appendix G – Signal and parameter table”.

When entering the parameters mode for the first time after the auxiliary supply voltage of the drive has been switched on, the CDP control panel displays the first parameter of parameter group 11. The next time the parameters mode is entered, the previously selected parameter displays.

Some parameter settings cannot be changed while the drive is running. If tried, the following warning displays.

** WARNING **
WRITE ACCESS DENIED
PARAMETER SETTING NOT POSSIBLE
9.2.3.2 Changing a parameter setting

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

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
6. the slow navigation keys for numbers and text,
7. the fast navigation keys for numbers only.

8. To confirm the setting and to return to the actual signals display, press the ENTER key.

9. To cancel the setting and keep the original setting, press any of the mode selection keys. The selected keypad mode is entered.
9.2.3.3 Enabling / unlocking a parameter lock

Unwanted parameter settings can be prevented by activating the parameter lock function.

The corresponding parameters are 16.02 PARAMETER LOCK and 16.03 PASSCODE and belong to parameter group 16 SYSTEM CTRL INPUTS.

9.2.3.3.1 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.

9.2.3.3.2 Unlocking the parameter lock

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

Note: For more information, see “Appendix G – Signal and parameter table”.

9.2.3.4 User lock

ABBB is not be liable for damages or losses caused by the failure to activate the user lock with a new pass code.

For more information, see “1.9 Cyber security disclaimer” on page 38.

For better cyber security, it is highly recommended that you set a master pass code for the control panel to prevent the parameter values from being changed.

- To activate the user lock for the first time, enter the default pass code, 358, into 16.02 Passcode. This will make parameters 16.24...16.25 changeable. Then enter the old pass code to 16.24 OldUserPasscode and change user pass code in 16.25 NewUserPasscode. In 16.02 Parameter Lock, the user lock functionality can now be enabled.

- To reopen the lock, enter your pass code into 16.03 Passcode. This will again make parameters 16.24 and 16.25 visible.
9.2.4 Functions mode

The functions mode is used for adjusting the display contrast.

Figure 9-4 Control panel functions for Functions mode

(1) Status line
(2) Selectable functions
(3) Selection key for functions mode
(4) Slow navigation key for selecting a line (and adjusting the contrast)
(5) Enter key for confirming the selection

9.2.4.1 Adjusting the display contrast

1. To enter the functions mode, press the FUNC key.
2. To select the contrast adjustment function, press the slow navigation keys until the blinking cursor reaches the CONTRAST line.

3. Press the ENTER key.

4. To change the contrast, press the slow navigation keys.

5. To confirm the setting and to return to the actual signals display, press the ENTER key.
6. To cancel the setting and keep the original setting, press any of the mode selection keys. The selected keypad mode is entered.

9.2.5 Local and remote control mode

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

- Local control (L)
- Remote control (R)

**Note:** In this context, remote control is not necessarily equivalent to higher-level control. For more information, see “9.2.5.4 Remote control” on page 217.

9.2.5.1 Local control

In local control mode, full operational control of the drive is enabled from the local operator panel. Commands from remote have no effect.

- To enter the local control mode, press the LOC-REM key. Local control is indicated by the letter L.

9.2.5.2 Disabling / enabling local lock function

Accidental switching from remote control to local control can be prevented with the local lock function.

The corresponding parameter is 16.04 LOCAL LOCK and belongs to the parameter group 16 SYSTEM CTRL INPUTS.
9.2.5.3 Enabling the local lock

- To enable the local lock, set parameter 16.04 to 2 (LOCKED).
  
  With this parameter setting, local control (including the LOC-REM key) is disabled.

  If the CDP control panel or a DriveWindow PC is in local control mode at the time that the local lock is enabled, they remain in local control mode until they are switched to remote control mode. This means that the CDP control panel displays the letter L until you press the LOC-REM key.

9.2.5.3.1 Disabling the local lock

- To disable the local lock, set parameter 16.04 to 1 (OPEN).
  
  With this parameter setting, switching between remote and local control is enabled.

9.2.5.4 Remote control

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

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

- 11.01 EXT1 START/STOP/DIR = 10 (KEYPAD) or
  12.03 EXT REF1 SELECT = 1 (KEYPAD) and
  12.02 EXT1/EXT2 SELECT = 1 (EXT1)

- 11.02 EXT2 START/STOP/DIR 10 (KEYPAD) or
  12.06 EXT REF2 SELECT = 1 (KEYPAD) and
  12.02 EXT1/EXT2 SELECT = 2 (EXT2)

- To enter the remote control mode, press the LOC-REM key.
  - A blank space indicates full remote control from a higher-level control system.
  - The letter R indicates partial remote control (some commands are enabled locally).
Note: To prevent accidental switching from remote control to local control, see “9.2.5.2 Disabling / enabling local lock function” on page 216.

9.3 Operational commands

For instructions on how to start and stop the drive system from the control panel, see “8.9 Starting the drive” on page 189 and “8.10 Stopping the drive” on page 193.

9.3.1 Setting the direction of rotation

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

- Local control mode (L)
- Remote control mode (R)

The arrow on the display indicates the direction of rotation:

- When the motor is running, the arrow indicates the actual direction.
- When the motor is not running, the arrow indicates the preselected direction.

To set the direction of rotation, press the forward or backward key.
If you change the direction while the motor is running, the motor automatically ramps down to zero speed and reaccelerates in the opposite direction to the preset speed. The arrow changes at zero speed.

### 9.3.2 Entering a reference value

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

- Local control mode (L)
- Remote control mode (R)

1. Press a mode selection key.

2. To enter the reference value input mode, press the REF key.
3. To enter / change the reference value, press the corresponding fast or slow navigation key.

4. To exit the mode, press a mode selection key.
10. Preventive and corrective maintenance

10.1 General information

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

10.1.1 Required qualification

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

10.1.2 Maintenance schedule

Carry out all maintenance tasks according to the maintenance schedule, on time and at the stated intervals in the "ACS6000 preventive maintenance schedule" (3BHS855273 E01).

10.1.3 Logbook

ABB recommends recording all troubleshooting and maintenance work in a logbook including:

- Date and time
- Detailed description

10.1.4 Spare parts

To ensure safe and reliable operation, use only spare parts recommended and approved by ABB.

- For information on types and identification codes, see “Appendix E – Parts list”.
- For information on storing spare parts, see “4.7 Storing and handling of spare parts” on page 93.
10.2 Identifying electrical equipment

This section describes how to identify electrical devices, cables, and wires.

10.2.1 Device designation

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

![Figure 10-1 Device identification](image1)

10.2.2 Cables and wires

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

![Figure 10-2 Cable and wire designation](image2)

<table>
<thead>
<tr>
<th>(1) Wire number</th>
<th>(2) Terminal number</th>
</tr>
</thead>
</table>

(1) Wire number
(2) Terminal number
10.2.2.1 Understanding wiring diagrams

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

10.3 Status indicators

10.3.1 Alarm / fault indications

When a failure occurs in the drive or in the equipment monitored by the drive (e.g., main circuit breaker, transformer, cooling system), the control panel displays a corresponding alarm or fault message and the alarm / fault lamp on the control compartment door lights up:

- **Alarm**: flashing light
- **Fault**: permanent light

The message can be saved and viewed in the fault logger of the drive when a PC with Drive Composer is connected to the drive. The fault history can also be called up on the control panel.

10.3.2 Error message levels

Two error message levels are used in the drive:

- **Alarm**: An alarm does not shut down the drive. If the condition causing the alarm is not corrected, a persisting alarm can often lead to a fault. An alarm cannot be reset manually. The alarm message is deleted from the display as soon as the alarm condition has been corrected.
- **Fault**: A fault shuts down the drive. The type of shutdown depends on the origin of the fault.
Depending on the type of fault, the drive opens the main circuit breaker (MCB) or keeps it closed:

- Class 1 faults (FC 1) open the MCB
- Class 2 faults (FC 2) do not open the MCB

Since the MCB is controlled and monitored entirely by the drive, no opening command must be given to the MCB when a fault condition occurs.

A fault condition must be corrected and the fault be manually reset before the drive can be started again.

10.3.2.1 Alarm and fault messages

When an alarm or a fault occurs, a specific message is saved in the fault buffer of the drive. Information on the 64 most recent fault and alarm events are saved.

10.3.2.2 Fault handling

The faults are entered into the fault buffer as they occur and are numbered:

- The last fault entered has number 1.
- The first fault entered has the highest number.

Information of the fault classification (e.g., 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:

+Fault DC Undervoltage: is the reason for the failure of the drive system as it occurred first.

+Fault AMC: Fault Class 1 classifies the fault.

+Fault PPCS Communication: represents a subsequent fault that occurred 2 min. 22 s than the first fault.

+Fault AMC: Fault Class 2 classifies the fault.

Note: For more information on alarms and faults, see “Appendix G – Signal and parameter table”.

+Fault AMC: Fault Class 1 2008-01-08 16:56:02.1170
+Fault PPCS Communication 2008-01-08 16:58:24.3760
+Fault AMC: Fault Class 2 2008-01-08 16:58:24.3770
+Fault DC Undervoltage 2008-01-08 16:56:02.1170
10.3.2.3 Standard troubleshooting procedure

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

1) **DO NOT** switch off the auxiliary supply voltage or try to reset a fault message before all information at the time of the occurrence of the fault condition has been saved.

2) Select the fault history display on the control panel, but do not clear the buffer now!
   See “8 Operation” on page 173.

3) Identify the fault and make a logbook entry.

4) Save the content of the data logger when a PC is available which has the Drive Composer/Startup tool installed.
   The data logger provides information (eg, waveforms of voltage, current, torque) for efficient troubleshooting.

5) **Contact ABB service if a fault cannot be rectified.**
   When calling ABB service, it is recommended to have the following data available at the time when the fault occurred:
   - Operating, ambient and load conditions
   - Unusual events

6) **After the fault has been rectified, start the drive as described in “8.9 Starting the drive” on page 189.**

10.3.3 LEDs and switches on circuit boards and I/O devices

The following section provides an overview of the meaning of LEDs and switches of the main circuit boards and I/O modules. The LEDs presented in the following section can be checked easily while the auxiliary voltage is switched on without having to remove covers first. The LEDs provide information on the status of the devices and can be used for diagnostic purposes.
### 10.3.3.1 AMC circuit board

**Figure 10-3 LEDs of AMC circuit board**

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Description</th>
<th>Status when software has loaded</th>
<th>Status when software has not loaded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Booting</td>
<td>ON</td>
</tr>
<tr>
<td>F</td>
<td>Red</td>
<td>Fault</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>R</td>
<td>Green</td>
<td>Run</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>M</td>
<td>Green</td>
<td></td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>P</td>
<td>Green</td>
<td>Supply OK</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>T1</td>
<td>Yellow</td>
<td>Receiving data on DDCS channel 0</td>
<td>Flashing</td>
<td>ON / OFF</td>
</tr>
<tr>
<td>T2</td>
<td>Yellow</td>
<td>Receiving data on DDCS channel 3</td>
<td>Flashing</td>
<td>ON / OFF</td>
</tr>
<tr>
<td>S3</td>
<td>Yellow</td>
<td></td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>S1</td>
<td>Yellow</td>
<td></td>
<td>Flashing</td>
<td>OFF</td>
</tr>
<tr>
<td>S2</td>
<td>Yellow</td>
<td></td>
<td>Flashing</td>
<td>OFF</td>
</tr>
<tr>
<td>S0</td>
<td>Yellow</td>
<td></td>
<td>Flashing</td>
<td>OFF</td>
</tr>
</tbody>
</table>
10.3.3.2 S800 I/O bus modem TB820

Figure 10-4 TB820 bus modem

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Red</td>
<td>Fault in module</td>
</tr>
<tr>
<td>R</td>
<td>Green</td>
<td>Device in operation</td>
</tr>
<tr>
<td>P</td>
<td>Green</td>
<td>Power supply is healthy</td>
</tr>
<tr>
<td>Rx1</td>
<td>Yellow</td>
<td>Traffic on optical module bus</td>
</tr>
<tr>
<td>Rx2</td>
<td>Yellow</td>
<td>Traffic on optical module bus</td>
</tr>
<tr>
<td>ERx</td>
<td>Yellow</td>
<td>Traffic on electrical module bus</td>
</tr>
</tbody>
</table>

**Bus modem address**

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

The address is set with the rotary switch on the module (Fig. 10-4: 1). The factory-set value must not be changed.

10.3.3.3 S800 I/O modules

LEDs on I/O modules having the same meaning on all types of I/O modules are always at the same position. The LEDs are always at the topmost position on each module (Fig. 10-5: 1) and are identified as follows:

- F: fault
- R: run
- W: warning
- O or OSP (only output modules)
Figure 10-5 Example of S800 I/O station

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Red</td>
<td>Indicates failure</td>
</tr>
<tr>
<td>R</td>
<td>Green</td>
<td>Device is operating normally</td>
</tr>
<tr>
<td>W</td>
<td>Yellow</td>
<td>External fault or minor fault in the module</td>
</tr>
<tr>
<td>O</td>
<td>Yellow</td>
<td>Indicates an active signal</td>
</tr>
<tr>
<td>OSP</td>
<td>Yellow</td>
<td>Indicates an active signal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Output Set as Predetermined)</td>
</tr>
</tbody>
</table>

**Note:** For more 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

### 10.3.3.4 Serial communication interfaces

To identify the serial communication interface in the drive, see “Appendix D – Wiring diagrams”. For more information on the device, select the appropriate manual:

- "AF 100 fieldbus - NAFA-01 installation and start-up guide" (3BFE58919837)
- "Modbus TCP - NETA-21 remote monitoring tool user manual" (3AUA0000096939)
- "Modbus RTU - NMBA-01 installation and startup guide" (3AFY58919772)
- "Profibus - NPBA-12 installation and startup guide" (3BFE64341588)
10.3.3.5 LEDs on optional heat exchangers

Two LEDs on the front of the heat exchanger indicate the status of the unit.

Alarm signals are also shown on the CDP control panel.

![Figure 10-6 Status LEDs on optional air-to-air heat exchangers](image)

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red LED off (A) and Green LED on (B): Heat exchanger is healthy</td>
<td>Red LED on (A) and Green LED off (B): Alarm conditions</td>
<td>Red LED off (A) and Green LED off (B): Auxiliary voltage is missing</td>
</tr>
</tbody>
</table>
10.4 Maintenance tasks

The following sections describe the maintenance tasks and associated actions that you can perform on the drive.

10.4.1 Safety

⚠️ DANGER

Hazardous voltages!

To avoid serious injury or death, read all instructions before performing the maintenance tasks.

- Before you work on the drive, verify that:
  - Main and auxiliary power supply to the drive are switched off, locked out, and tagged out
  - Drive is de-energized
  - Grounding connections are in place
  - Personal protective equipment is provided and used when required
  - Everyone involved is informed

- Before energizing the drive, verify that:
  - All foreign objects are removed from the drive
  - All internal and external covers are securely fastened and all doors are closed, locked and / or secured (locking bar in locked position)
  - Release dials of safety switches are in locked position

- Before you remove a phase module from a cabinet:
  - Connect the grounding equipment at the appropriate locations.

- When the motor is spinning, a HAZARDOUS VOLTAGE appears at the output of the IOI switch in the RDC unit, even if the switch is open and the drive is grounded.
  - See the local safety procedures on how to isolate and ground the equipment.
10.4.2 De-energizing and grounding the drive

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

Procedure

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

2. To stop the motor, press the STOP key.

The motor stops according to the preset stop function. When the motor has reached zero speed, the drive is in “ReadyRun.”

**WARNING**

Hazardous DC voltage!

Depending on the type of auxiliary supply, the drive can be equipped with buffer capacitors inside the control unit. During operation, the capacitor voltage is 300 V (DC) over ground.

- Wait 5 minutes for the capacitors to discharge.
- Before touching a capacitor, verify that the capacitors are discharged.

**NOTICE**

Risk of component damage!

Foreign matter and particularly metallic dust can cause failure and damage when the drive is energized! Ensure that foreign matter cannot enter the cabinet.

- Close the doors and cover openings completely when work is discontinued.
- Retrieve any foreign matter which accidentally dropped into the cabinet.
3. Press the **SUPPLY OFF** push button to disconnect the drive from the main power supply.

The following takes place:
- MCB opens.
- DC link discharges.

While the DC link discharges, the CDP control panel shows the following:

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

When the DC link is discharged, the drive is “ReadyOn”.

4. Rack-out, lock-out, ground and tag-out the main power feeder.
5. Wait for the yellow lamp **GROUNDING SWITCH UNLOCKED** on the CBU to light up (see Fig. 10-7).

**CAUTION!** If the lamp does not light up, DO NOT force the grounding switch in any direction before you know the reason why the lamp has not lit up. If you try, the following can happen:

- The switch closes when the DC link is still energized and short-circuits the DC-link capacitors. The short-circuit manifests itself in a loud bang.
- The switch is damaged because it was not released for closing.
- Components inside the drive are damaged.

**IMPORTANT!** If the yellow lamp does not turn on, continue with “10.4.3 Grounding the drive when the grounding switch is not released” on page 234, otherwise continue with step 6.

![Figure 10-7 Grounding switch ungrounded](image)

6. If the yellow lamp **GROUNDING SWITCH UNLOCKED** is on, keep the yellow lamp cap pressed while you turn the grounding switch to the grounded position.
When the grounding switch is in the grounded position, the control panel shows the following information:

7. To open the doors of medium voltage units, continue with “10.4.4 Unlocking and opening the doors” on page 236.

   **Note:** To open the doors of medium voltage units, auxiliary voltage is required.

8. Switch off and lock out all auxiliary voltages from external sources.

9. To connect a grounding set, continue with “10.4.8 Connecting a grounding set” on page 242.

### 10.4.3 Grounding the drive when the grounding switch is not released

When the DC link of the drive has been discharged, the lamp **GROUNDING SWITCH UNLOCKED** lights up to indicate that the grounding switch is released and can be turned to the grounded position. If the lamp does not light up, take the following steps.

1. Check that the auxiliary voltage is switched on.

   **NOTICE** DO NOT use force for turning the grounding switch in any direction

2. Press the lamp cap to test the lamp.
• Lamp does not light up:
  - Lamp is burnt out
  - Lamp-test circuit is faulty.
  The lamp-test circuit and the grounding circuit are independent of each other. From the lamp not lighting up, it cannot be concluded that the discharging circuit and / or the grounding circuit are not working.

• Lamp lights up:
  - discharging circuit and / or the grounding circuit are malfunctioning.

3. Verify that the MCB (main circuit breaker) is open.
   • If the MCB is open, secure it against closing.
   • Check if the LED of digital input DI14 (input module A2531 in COU1) is lit.
   • If the LED is lit, the feedback signal “MCB is open” is present.

4. Verify that hazardous voltages from the motor cannot be fed into the drive.

5. Check if the LED of digital output DO07 (output module A2541 in COU1) is lit.
   • If the LED is lit, the grounding switch is released.

6. Check the discharging level of the DC link.
   • If the value of the parameter 2.01 DC VOLTAGE is below 50 V, the DC link is discharged.
   • If the DC link is discharged, the drive is in “ReadyOn” status.
   • Check that the message ReadyOn is displayed on all control panels of the drive.

7. Carefully turn the grounding switch to the grounded position on the following conditions:
   • Hazardous voltages cannot be fed into the drive from the main power supply or the motor
   • DC link is discharged
   • Grounding switch is released (DO07 is energized)
   • Drive status is “ReadyOn”
10.4.4 Unlocking and opening the doors

1. Check that the auxiliary voltage is on and wait for the white lamp on the CBU to turn on.

The white lamp indicates that the drive is grounded and that the locking bars are released.

Note: If the white lamp does not turn on, continue with “10.4.6 Testing the white lamp” on page 238.

2. Slide the locking bar from the locked (1) to the unlocked (2) position.
   - Door hinged on the left:
• Door hinged on the right:

3. To release the door handle, insert and turn the key to the right. The door handle pops out.

4. To open the door, turn the door handle to the right if the door is hinged on the right or to the left if the door is hinged on the left.

5. If you cannot open the door, continue with “10.4.7 Emergency release of a door safety switch” on page 240.

10.4.5 Closing and locking the doors

1. Close the doors.

2. To lock the door, bring the door handle in line with the door plate (1) and press the handle down (2) until it clicks in.
3. Slide the locking bar from the unlocked (1) to the locked (2) position.
   - Door hinged on the left:
     ![Diagram showing locking bar movement]
   - Door hinged on the right:
     ![Diagram showing locking bar movement]

**IMPORTANT!** A limit switch monitors the locked position. If a door is not locked properly, you cannot start the drive.

### 10.4.6 Testing the white lamp

If the lamp does not turn on, proceed as follows:

1. To test the lamp, press its lamp cap (1 in Fig. 10-10).
   - Lamp does not turn on:
     - Lamp is burnt out
     - Lamp-test circuit is faulty
     The lamp-test circuit and the door releasing circuit are independent of each other. From the lamp not lighting up, it cannot be concluded that the door releasing circuit is not working.
   - Lamp turns on:
     - Door releasing circuit is malfunctioning.
10 PREVENTIVE AND CORRECTIVE MAINTENANCE

2. Check if the LED of digital input DI07 (input module A2531 in COU1) is lit.
   - If the LED is lit, the drive control system receives the feedback signal "grounding switch is closed", but the control system has not released the doors.
   - If the LED is not lit, the feedback signal is missing.

3. To open the door, continue with “10.4.7 Emergency release of a door safety switch” on page 240.

**Note:** For information on the wiring of the control circuit, see:

- Converter hardware diagram
- Wiring diagram of COU1

For information on the wiring of the discharging circuit and / or the grounding circuit, see:

- Wiring diagram of COU1
- Wiring diagram of CBU

Figure 10-10 Testing the white lamp

(1) Press cap to test the white lamp
10.4.7 Emergency release of a door safety switch

DANGER

Hazardous voltages!
- Touching energized components can be fatal.
- Before you unlock a safety switch, verify that the drive is de-energized.
- DO NOT unlock the safety switches permanently.

10.4.7.1 Location of safety switches

The doors of medium voltage units (LSU, ARU, IFU, IRU, CBU, INU, BCU, RBU, VLU, TEU and ISU) are equipped with safety switches.

Figure 10-11 Safety switch on an ARU/INU cabinet door

<table>
<thead>
<tr>
<th>(1) Screw cap on door</th>
<th>(4) Unlocked position</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Safety switch location (behind door)</td>
<td>(5) Locked position</td>
</tr>
<tr>
<td>(3) Safety switch</td>
<td>(6) Release dial</td>
</tr>
</tbody>
</table>
10.4.7.2  Safety-switch settings

Figure 10-12 Safety switch settings

<table>
<thead>
<tr>
<th>Location</th>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Unlocked</td>
<td>Enables opening the door of a medium voltage unit whether the auxiliary voltage is switched on or off.</td>
</tr>
<tr>
<td>(2)</td>
<td>Release dial</td>
<td>Direction of arrow indicates safety switch status, ie, locked or unlocked</td>
</tr>
<tr>
<td>(3)</td>
<td>Locked</td>
<td>Normal operating setting. To open the door of a medium voltage unit, the DC link must be discharged and the auxiliary voltage must be switched on.</td>
</tr>
</tbody>
</table>

10.4.7.3 Unlocking a safety switch

1. To access the release dial, remove the screw cap.

2. Loosen the locking screw (1) until the release dial can be turned.

3. Turn the release dial from the locked to the unlocked position.

You can now actuate the locking bar and open the doors.
4. When the door is open, turn the release dial to the locked position.
5. Tighten the locking screw.
6. Seal the locking screw.
7. Refit the screw cap.
8. To ground the drive, continue with “10.4.8 Connecting a grounding set” on page 242.

### 10.4.8 Connecting a grounding set

**DANGER**

**Hazardous voltages!**

Grounding equipment ensures that FATAL voltages cannot be fed into the drive from the main power supply or the motor during maintenance work, e.g., the removal of phase modules.

- Connect grounding equipment at the appropriate locations.

![Four-way grounding set](image)

**Figure 10-13 Four-way grounding set**

(1) Busbar ground clamps  (2) Enclosure ground clamp  (3) Telescopic insulating pole

Depending on the type of line-side rectifier, continue with:

- “10.4.8.1 Drives with LSU” on page 243
- “10.4.8.2 Drives with ARU” on page 244
10.4.8.1 Drives with LSU

1. Connect the enclosure ground clamp to the ground ball stud of the PE ground busbar inside TEU (Fig. 10-14).

2. Use the telescopic insulating pole to connect and tighten the busbar ground clamps to the ground ball studs (1) of the following busbars:
   - **Inside TEU**: 1L1, 1L2, 1L3, 2L1, 2L2 and 2L3 in Fig. 10-14
   - **Inside INU**: L1, L2 and L3 in Fig. 10-15

![Figure 10-14 TEU ground ball stud locations](image)

<table>
<thead>
<tr>
<th>(1) Ground ball stud example</th>
<th>(5) 2L3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) 2L2</td>
<td>(6) 2L1</td>
</tr>
<tr>
<td>(3) 1L1</td>
<td>(7) 1L2</td>
</tr>
<tr>
<td>(4) 1L3</td>
<td>(8) PE</td>
</tr>
</tbody>
</table>
10.4.8.2 Drives with ARU

1. Connect the enclosure ground clamp to the ground ball stud of the PE ground busbar inside ARU and INU (Fig. 10-15).

2. Use the telescopic insulating pole to connect and tighten busbar ground clamps to the ground ball studs of the following busbars inside an ARU and INU:
   - L1, L2 and L3 in Fig. 10-15

![Figure 10-15 ARU/INU ground ball stud locations](image)

**Table 10-15 ARU/INU ground ball stud locations**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Ground ball stud</td>
</tr>
<tr>
<td>(2)</td>
<td>L3</td>
</tr>
<tr>
<td>(3)</td>
<td>L2</td>
</tr>
<tr>
<td>(4)</td>
<td>L1</td>
</tr>
<tr>
<td>(5)</td>
<td>PE</td>
</tr>
</tbody>
</table>

10.4.9 Drives with the manual output isolation (optional)

The manual output isolation disconnects the output of the drive (INU1 or INU2) from the motor and creates a visible isolating distance in the supply line to the motor.

The option includes the following items:

- Busbar connectors in TEU1 and COU1
  - Busbar connectors for INU1 are located in TEU1.
  - Busbar connectors for INU2 are located in the terminal compartment inside COU1.
- Lever for removing and fitting the busbar connectors
10 PREVENTIVE AND CORRECTIVE MAINTENANCE

Figure 10-16 Manual output isolation overview

(1) LSU1
(2) TEU1
(3) INU1
(4) CBU1
(5) BCU1
(6) INU2
(7) COU1
(8) LSU2
(9) WCU1
(10) Motor
(11) Busbar connectors (3 x) in TEU
(12) Busbar connectors (3 x) in COU1
(13) Lever for removing and fitting the busbar connections
The LEDs of input module A2511 inside COU1 indicate whether the busbar connectors are fitted or not.

**Figure 10-17 Input module A2511**

(1) Location of LEDs 6 - 9  (2) COU1

**Table 10-1 Description of LEDs on input module A2511**

<table>
<thead>
<tr>
<th>LED</th>
<th>LED</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>ON</td>
<td>The three busbar connectors are fitted in COU1. The motor is connected to INU2.</td>
</tr>
<tr>
<td>7</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>OFF</td>
<td>The three busbar connectors are fitted in TEU1. The motor is connected to INU1.</td>
</tr>
<tr>
<td>9</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>Invalid configuration. Drive will not start.</td>
</tr>
</tbody>
</table>
10.4.9.1 Removing the busbar connectors

**WARNING**

Hazardous voltages!
- Verify that the drive system is de-energized
- Connect grounding sets at the locations indicated in Fig. 10-20.
- Be aware of arcing between ground clamp and busbar ground studs when connecting a grounding set to the busbars for the motor cables. Arcing can be caused by voltages being fed into the drive when the motor is driven by the propeller of the ship.
- Follow local safety procedures

![Image 10-18 Tools for removing the busbar connectors](image)

(1) Orientation of lever for removing busbar connectors
(2) Orientation of lever for fitting the busbar connectors
(3) Four-way grounding set (4x)
Procedure

1. Shut down the drive according to the established procedures.
   IMPORTANT! DO NOT switch off the auxiliary voltage.
   For general information on de-energizing the drive, see “De-energizing the drive locally” on page 143.

2. Use the telescopic insulating pole (Fig. 10-18) to connect and tighten the enclosure ground clamp to the ground ball stud of the PE ground busbar.

3. Connect the busbar ground clamps to the ground ball studs of the phase busbars in the following sequence:
   - Busbars for the cables to the secondary transformer windings (1 in Fig. 10-20)
   - Busbars for the motor cables (2 in Fig. 10-20)
   - Busbars in the INU (3 in Fig. 10-20)

Figure 10-19 Overview of grounding the drive - INU1 is shut down (A) and INU2 is shut down (B). Numbers indicate the connection sequence.
Figure 10-20 Connect the grounding sets in COU1 (A and C), TEU1 (B), INU1 (D) and INU2 (E)

(1) Busbars for secondary transformer windings
(2) Busbars for motor cables
(3) INU busbars
(4) PE
(5) Ground ball stud
4. Inside TEU1 or COU1 remove the busbar connectors in the sequence shown in Fig. 10-21.

**CAUTION** A busbar connector weighs approximately **10 kg**.

Figure 10-21 Busbar connector removal sequence in TEU1 or COU1

5. Remove the grounding sets.
6. Check that the LEDs are lit as shown.

7. Check that tools and foreign objects are not left inside the cabinets.

8. Close and lock the doors.

9. Check that the power operating mode (POM) of the drive corresponds to the busbar connectors fitted.

10. Start the drive according to the established procedures.

10.4.9.2 Fitting the busbar connectors

1. Shut down the drive according to the established procedures.

2. Fit the busbar connectors in the sequence shown in Fig. 10-22.

Figure 10-22 Fitting sequence for busbar connectors
3. Remove the grounding sets.
4. Check that the LEDs are lit as shown.

![LEDs Image]

5. Check that tools and foreign objects are not left inside the cabinets.
6. Close and lock the doors.
7. Check that the power operating mode (POM) of the drive corresponds to the busbar connectors fitted.
8. Start the drive according to the established procedures.
10.4.10 Removing and installing a phase module

Several maintenance actions require the removal of phase module from an ARU/INU, eg, to access the back of the cabinet or to work on the phase module.

10.4.10.1 Removing a phase module

1. Disconnect the water hoses.
   
   **Note:** To disconnect the water hose, pull the locking sleeve of the coupling towards the front of the cabinet (arrow).

2. Cut off the cable ties (1) and disconnect the optical fibers and the power supply leads (2).
3. Remove the bolts (4) on each side of the phase module.

4. Place the lifting table in front of the phase module.

5. Adjust the height of the table so that it is level with the rails on the underside of the phase module.

6. Pull the phase module onto the table.

**CAUTION** A phase module weighs approximately 190 kg. When pulling out the phase module, make sure that the disconnected water hoses, optical fibers and power supply leads are out of the way.
10.4.10.2 Installing a phase module

1. Check that the busbars (arrows) of the phase module are lubricated.
   **Note:** If necessary, apply a thin layer of the supplied electrical contact grease.

2. Make sure that the disconnected water hoses, fiber optics and power supply leads are out of the way before pushing the phase module into the cabinet.

3. Place the lifting table in front of the cabinet and adjust it to the required height.

4. Push the phase module slowly towards the back of the cabinet until the busbars engage with the connectors at the back of the cabinet.

5. Screw in and tighten the bolts.

6. Pull the locking sleeve of the female half of the water hose coupling back as far as possible.

7. While holding it in this position, push it over the fixed male half of the coupling until it stops.

8. Let go of the locking sleeve and firmly push the female part against the male part until the coupling locks home with a click.

9. Reconnect the optical fibers and power supply leads.
   **NOTICE** DO NOT mix up the cables. The identification on the label must correspond to its counterpart on the phase module. Verify the correct connection with the corresponding wiring diagram.

10. Fasten the cables with cable ties.
10.4.11 Visual checks on the drive

Check the drive and its immediate vicinity visually at the intervals stated in "ACS6000 preventive maintenance schedule" (3BHS855273 E01) and pay attention to the following items:

- Humidity inside the drive
- Permitted range of ambient air temperature and humidity of the drive
- Dust built-up inside the drive
- Appropriate fastening of cables and wires and connections of cable shields and screens
- Integrity of cable insulation
- The outer cable sheath must not be damaged.
- Signs for overheated components, wires, cables or busbars
- Corrosion on electronic circuit boards, connectors or busbars
- Correct type of signal and power supply cables

Note: For more information, see the applicable cable specifications.

10.4.12 Cleaning

10.4.12.1 Cleaning the drive cabinet

When cleaning the drive cabinet, mind the following:

- To keep dirt out, cover the equipment or assemblies.
- Take electrostatic-sensitive precautions and use suitable tools to prevent electrostatic discharge.
- To prevent damage, use antistatic brushes and a vacuum cleaner with a soft nozzle to carefully clean circuit boards with special care.
- Remove dust from assemblies and busbars inside the cabinet with a vacuum cleaner and lint-free cleaning cloths.
- Remove water, oily or greasy deposits on assemblies, components and busbars with water- and oil-absorbing microfibers.

▲ NOTICE

Risk of component damage!

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

- Check the cabinet regularly for signs of dust and humidity and clean if necessary.
- Use appropriate and recommended cleansing agents.
- DO NOT use alcohol and solvents.
• Use a nylon brush or a vacuum cleaner for removing dust or deposits from recesses.

• Clean the outside of the cabinet with a vacuum cleaner and cleaning cloths.

### 10.4.13 Checking wire and cable connections

**NOTICE**

**Risk of component damage!**

Vibration can loosen electrical connections and cause equipment failure! Excessive force damages the capacitor bushings!

- Tighten to the torque value on the label attached to the capacitor.

**IMPORTANT!** DO NOT exceed 20 Nm if the tightening torque value is not specified.

- Check all power and control cable connections and tighten them if necessary.

- Check that all plugs and connectors are tight.

### 10.4.14 Checking and replacing filter mats

- **Inspection intervals:** See the "ACS6000 preventive maintenance schedule" (3BHS855273 E01).

- **Service during operation:** possible.

- **Filter mat class:** G3 (EN779)

- **Location:** installed behind the ventilation grids of control and water cooling units if the drive is prepared for protection class IP 54.

  The filter mats are located between the ventilation grid and the wire mesh. The wire mesh is always installed.

<table>
<thead>
<tr>
<th>Location</th>
<th>Filter class</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
<th>Depth (mm)</th>
<th>ABB material number</th>
</tr>
</thead>
<tbody>
<tr>
<td>WCU - back wall</td>
<td>G3 T15/150</td>
<td>250</td>
<td>125</td>
<td>10</td>
<td>3BHB028115R0002</td>
</tr>
<tr>
<td>COU and roof boxes</td>
<td>G3 T15/150</td>
<td>250</td>
<td>250</td>
<td>10</td>
<td>3BHB028115R0003</td>
</tr>
<tr>
<td>EXU</td>
<td>G3 T15/150</td>
<td>745</td>
<td>375</td>
<td>10</td>
<td>3BHB028115R0004</td>
</tr>
</tbody>
</table>
Figure 10-24 COU filter

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ventilation grid</td>
</tr>
<tr>
<td>2</td>
<td>Wire mesh</td>
</tr>
<tr>
<td>3</td>
<td>Filter mat (only for protection class IP 54)</td>
</tr>
</tbody>
</table>

Procedure

1. Switch off the protection switch of the cooling fans.
   
   **CAUTION!** The cooling fans behind the ventilation grids start automatically when the temperature rises above a preset level.

2. Remove the bolt at the top of the fan cover.

3. Slide the cover up and pull it out of the slots.

4. Turn the cover over and remove the filter mat.

5. Insert the new filter mat and reinstall the ventilation grid.
10.4.15 Testing and replacing auxiliary fan units

- **Inspection intervals**: see the "ACS6000 preventive maintenance schedule" (3BHS855273 E01).
- **Service during operation**: possible
- **Location**: installed behind the doors of the following cabinets:
  - COU cabinet (2 fan units)
  - WCU cabinet (2 fan units in WCU and 2 fan units in the optional REB)
  - Water-cooled EXU cabinet

10.4.15.1 Testing auxiliary fan units

To switch the fan units on and off for the test, use the thermostats of the fan units.

<table>
<thead>
<tr>
<th>Thermostat location</th>
<th>Identification</th>
<th>Factory-set value</th>
</tr>
</thead>
<tbody>
<tr>
<td>COU</td>
<td>B2981</td>
<td>45° C</td>
</tr>
<tr>
<td>WCU</td>
<td>B5741</td>
<td>45° C</td>
</tr>
</tbody>
</table>

**Procedure**

1. Switch on the auxiliary voltage for the fan unit to be tested.
2. Take note the setting of the thermostat.
   - The factory-set value is also stated on the **Settings** label. The label is attached to the inside of the cabinet door.
3. To switch on a fan unit, turn the dial of the thermostat from the factory-set value to a low value.
4. Check that the fans run smoothly and if a fan is faulty, replace the complete fan unit.
5. Set the thermostat to the factory-set value.
10.4.15.2 Replacing auxiliary fan units

1. Switch off the miniature circuit breaker of the fan unit that you want to replace.

   **Note:** To identify the miniature circuit breaker, see “Appendix D – Wiring diagrams”.

2. (Only for fan units of the optional REB) Unscrew the ventilation grid (circles) and flip the grid downward (arrow).

   **IMPORTANT!** The ventilation grid is hinged. You DO NOT need to remove it.

![Figure 10-25 Accessing the fan units in the WCU roof box](image)

3. Disconnect the wires (1) and unscrew (2) the fan units.

![Figure 10-25 Accessing the fan units in the WCU roof box](image)

4. Remove the fan unit.

5. Reinstall the new one in reverse order of removal.
10.4.16 Testing and replacing air-to-air heat exchangers

- **Inspection intervals:** see the "ACS6000 preventive maintenance schedule" (3BHS855273 E01).

- **Service during operation:** not possible

---

**Figure 10-26** Air-to-air heat exchanger overview (type LT-5-5165-UL)

(1) Ambient fan 2
(2) Ambient fan 1
(3) Internal fan 1
(4) Circuit board location
(5) Internal fan 2
(6) Miniature circuit breaker
(7) Red LED off and green LED on:
(8) Heat exchanger is healthy
(9) Red LED on and green LED off:
(10) Alarm condition
(11) Red LED off and green LED off:
(12) Auxiliary voltage missing

---

**Table 10-3** Air-to-air heat exchanger specifications

<table>
<thead>
<tr>
<th>Thermostat location</th>
<th>Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>~65 kg</td>
</tr>
<tr>
<td>Length</td>
<td>1025 mm</td>
</tr>
<tr>
<td>Width</td>
<td>750 mm</td>
</tr>
<tr>
<td>Height</td>
<td>316 mm</td>
</tr>
</tbody>
</table>
A thermostat inside the cabinet where air-to-air heat exchanger is installed controls the internal fans (3 and 5 in Fig. 10-26). The fans are switched on when the cabinet temperature exceeds the value set on the thermostat.

The ambient fans (1 and 2 Fig. 10-26) are switched on by the air-to-air heat exchanger depending on the permanently measured cabinet temperature.

10.4.16.1 Testing the fan units

To switch the fan units on and off for the test, use the thermostats of the fan units.

<table>
<thead>
<tr>
<th>Thermostat location</th>
<th>Identification</th>
<th>Factory-set value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARU</td>
<td>B7501</td>
<td>45 °C</td>
</tr>
<tr>
<td>INU</td>
<td>B7501</td>
<td>45 °C</td>
</tr>
</tbody>
</table>

Procedure

1. Switch on the auxiliary voltage for the air-to-air heat exchanger.

2. Take note of the setting of the thermostat.
   The factory-set value is also stated on the Settings label. The label is attached to the inside of the cabinet door.

3. To start a fan or a group of fans, adjust the setting of the thermostat to a low value (arrow).

4. Check that the fans run smoothly and if a fan is defective, replace the complete fan unit.

5. Adjust the setting of the thermostat to its original value.
10.4.16.2 Replacing the complete heat exchanger

For information on replacing the complete heat exchanger, see “Mechanical installation” on page 56.

10.4.16.3 Replacing the circuit board

1. Unscrew the front and top cover.

2. Disconnect the ground wire from the front cover (arrow).
3. Take note of the orientation of the circuit board and where the plug-in connectors and wires are connected to.

4. Unplug the plug-in connectors and wires from the circuit board.

5. Remove the circuit board.

6. Place the circuit board on the spacers and gently push the circuit board onto the spacers until they snap in properly.

7. Reconnect the wires to the circuit board (Fig. 10-27).

**Figure 10-27 Wire connection points on the circuit board**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Pin</th>
<th>Pin</th>
<th>Pin</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground wire</td>
<td>J15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Supply phase</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Supply neutral</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4x external capacitors</td>
<td>1x J3</td>
<td>2x J5</td>
<td>3x J7</td>
<td>4x J9</td>
</tr>
<tr>
<td>5</td>
<td>4x fan power supply</td>
<td>1x J4</td>
<td>2x J6</td>
<td>3x J8</td>
<td>4x J10</td>
</tr>
<tr>
<td>6</td>
<td>4x fan alarm signals</td>
<td>1x J22</td>
<td>2x J23</td>
<td>3x J24</td>
<td>4x J25</td>
</tr>
<tr>
<td>7</td>
<td>ON</td>
<td>J11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>LEDs</td>
<td>Red J18</td>
<td>Green J19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Alarm 1</td>
<td>J1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. Reconnect the ground wire to the front cover.
9. Fasten the covers.

10.4.16.4 Replacing internal fan 1 - left side

Procedure
1. Unscrew the front top cover.

2. Unplug the plug-in connectors (arrows) and unscrew the screws (1, 2, 3 and 4) which fix the fan mounting bracket to the housing.
3. Remove the fan from the housing and unscrew the fan from the mounting bracket.

4. Replace the fan and reassemble the unit in reverse order of removal.

10.4.16.5 Replacing internal fan 2 - right side
Procedure

1. Unscrew the front top cover.

2. Remove the front cover and disconnect the ground wire (arrow).
3. Unscrew the circuit board mounting bracket (1, 2 and 3).

4. Take out the circuit board mounting bracket and place it on the heat exchanger housing.

5. Disconnect the ground wire (1), cut off the cable tie (2), unplug the plug-in connectors (arrows), and unscrew the screws (3, 4, 5 and 6) fixing the fan mounting bracket to the housing.
6. Remove the fan from the housing, and unscrew the fan from the mounting bracket.
7. Replace the fan and reassemble the unit in reverse order of removal.

10.4.16.6 Replacing the ambient fans

1. Unscrew the rear cover.

2. Lift the hinged cover up a little and disconnect the ground wire (arrow).
3. Disconnect the plug-in connectors (arrows) and remove the fastening screws (1, 2, 3 and 4).

4. Replace the fan, and reassemble the unit in reverse order of removal.

10.4.17 Replacing the fan unit in an EXU with a DCS800 D4 size controller

Procedure
1. Switch off the miniature circuit breaker of the fan unit.

   **Note:** To identify the miniature circuit breaker, see “Appendix D – Wiring diagrams”.

---

**Figure 10-28 DCS800 controller - size D4**
2. Remove the 6 screws from the fan cover and then remove the fan cover.

3. Unplug the fan cables.

4. Remove the 4 fastening screws from the outside panel of the fan unit.
5. Pull the fan unit out of the cabinet.

**CAUTION** To prevent the fan from falling onto you, place a support (i.e., a box) underneath.

6. Install the new fan in reverse order of removal.

### 10.4.18 Replacing the fan unit in an EXU with DCS800 size D5 controller

**Procedure**

1. Switch off the miniature circuit breaker of the fan unit.

   **Note:** To identify the miniature circuit breaker, see “Appendix D – Wiring diagrams”.

**Figure 10-29 DCS800 controller - size D5**
2. Remove the 6 screws from the fan cover and then remove the fan cover.

3. Unplug the fan cables.

4. Remove the 4 fastening screws from the outside panel of the fan unit.
5. Pull the fan unit out of the cabinet.

   **CAUTION** To prevent the fan from falling onto you, place a support (i.e., a box) underneath.

6. Install the new fan in reverse order of removal.

10.4.19 Replacing the air-to-water heat exchanger of the EXU

1. Switch off the miniature circuit breaker of the heat exchanger.

   **Note:** To identify the miniature circuit breaker, see “Appendix D – Wiring diagrams”.

2. Close valves V30 and V31 in the water-cooling unit.

3. Disconnect the hose from valve V30 to drain the WCU.

   **NOTICE** Expect approximately 5 liters of water.

4. Unscrew the top plate.
5. Disconnect the water tubes (1) from the air-to-water heat exchanger, unplug the cables (2) and remove the fastening screws.

![Figure 10-30 Air-to-water heat connections](image)

<table>
<thead>
<tr>
<th>(1) Water tube connections</th>
<th>(2) Cable connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Fastening screw</td>
<td></td>
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</tbody>
</table>

6. Lift the heat exchanger out of the cabinet.

**CAUTION** The heat exchanger weighs approximately **16 kg** and requires a minimum overhead clearance of 85 cm.

![Figure 10-31 Lift heat exchanger out of EXU cabinet](image)
7. To install the new heat exchanger, proceed in reverse order of removal.

**Note:** For information on adding water to the cooling system, see the manual for the "ACS5000, ACS6000 and ACS6080 water cooling unit WCU800 user manual" (3BHS821937 E01) and "ACS5000, ACS6000 and ACS6080 water cooling unit WCU1400 user manual" (3BHS835714 E01).