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<td>ACS880-87LC-3328A/4100A-7 wind turbine converters start-up guide</td>
<td>3AXD50000028545</td>
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<tr>
<td>ACS880-87LC-3328A/4100A-7 wind turbine converters firmware manual</td>
<td>3AXD50000031295</td>
</tr>
<tr>
<td>Drive composer Start-up and maintenance PC tool user's manual</td>
<td>3AUA0000094606</td>
</tr>
<tr>
<td>Manuals for I/O extension modules, fieldbus adapters, etc.</td>
<td></td>
</tr>
</tbody>
</table>

**Other documents**
- Circuit diagrams set
- Fieldbus interface description
- Firmware release note with the download instructions

For manuals, contact your local ABB representative.
Hardware manual

ACS880-87LC-3328A/4100A-7 wind turbine converters

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Introduction to the manual

Contents of this chapter
This chapter describes the intended audience and contents of the manual. It also contains a flowchart of steps in checking the delivery, installing and commissioning the wind turbine converter. The flowchart refers to chapters/sections in this manual and other manuals.

Safety instructions
See ACS880-87LC-3328A/4100A-7 wind turbine converters safety instructions (3AXD50000028543 [English]).

Target audience
This manual is intended for people who plan the installation, install, commission, use and service the converter. Read the manual before working on the converter. The reader is expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.
The manual is written for readers worldwide.

Purpose of the manual
This manual helps in planning the installation, installing, using and servicing the converter.
12 Introduction to the manual

Contents of the manual

• Operation principle and hardware description
• Mechanical installation
• Planning the electrical installation
• Electrical installation
• Installation checklist
• Maintenance
• Technical data
• Control units of the converter
• Dimension drawings
• Cooling and heating

Related documents

See List of related documents on the inside of the front cover.

Categorization by frame size and option code

This manual deals with the wind turbine converters made of the modules of the frame size R9iLC. The frame size of each converter type is indicated in section Type equivalence table on page 108.

The instructions, technical data and dimensional drawings which concern only certain optional selections are marked with + codes. The options included in the converter can be identified from the + codes visible on the type designation label. The + code selections are listed in chapter Operation principle and hardware description under Type designation key.
# Quick installation, commissioning and operation flowchart

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<th>Task</th>
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| Plan the installation. Check: ambient conditions, ratings, required external cooling circuit arrangements, compatibility of the generator, power cable connection, etc. | Technical data, page 107  
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Option manuals (if optional equipment is included) |
| Select the cables.                                                   | Technical data, page 107  
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Option manuals (if optional equipment is included) |
| Unpack and check the equipment. Check the type code indicated on the type designation label against the original order. | Checklist before mechanical installation, page 28  
Checklist before mechanical installation, page 28 |
| Check that all necessary option modules and equipment are present and correct. | Checklist before mechanical installation, page 28  
Checklist before mechanical installation, page 28 |
| Only intact converters may be started up!                           | Checklist before mechanical installation, page 28  
Checklist before mechanical installation, page 28 |
| Check the installation site.                                       | Checklist before mechanical installation, page 28  
Checklist before mechanical installation, page 28 |
| Route the cables.                                                   | Routing the cables, page 57 |
| Move the converter to the installation site and attach it to the floor. | Mechanical installation, page 27  
Mechanical installation, page 27 |
| Connect an external cooling circuit to the converter.               | Cooling and heating, page 129 |
| Check the insulation of the generator and the generator cable.      | Checking the insulation of the assembly, page 61  
Checking the insulation of the assembly, page 61 |
| Connect the power cables. Connect the control and the auxiliary control cables. | Electrical installation, page 61  
Electrical installation, page 61 |
| Check the installation.                                             | Installation checklist, page 71 |
| Commission the converter.                                           | Start-up guide and firmware manual |
### Terms and abbreviations

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<th>Term/abbreviation</th>
<th>Explanation</th>
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<tr>
<td>Auxiliary voltage switch</td>
<td>Main switch for the auxiliary voltage</td>
</tr>
<tr>
<td>Auxiliary control cubicle (ACU)</td>
<td>The cubicle with auxiliary devices such as auxiliary voltage circuit breakers, control electronics, measurement boards, etc.</td>
</tr>
<tr>
<td>BAMU</td>
<td>Main voltage measurement board</td>
</tr>
<tr>
<td>BCON</td>
<td>Type of control board</td>
</tr>
<tr>
<td>BCU</td>
<td>Type of control unit, a BCON board in a metal housing. See <strong>BCON</strong>.</td>
</tr>
<tr>
<td>DC chopper</td>
<td>Protects the converter by cutting down a peak overvoltage in the converter DC link: conducts the surplus energy from the intermediate circuit of the wind turbine converter to the DC resistor when necessary. The chopper operates when the DC link voltage exceeds a maximum limit. A sudden disturbance in turbine operation or grid can cause the DC voltage rise.</td>
</tr>
<tr>
<td>DC resistor</td>
<td>Dissipates the surplus energy conducted by the DC chopper to heat. Essential part of the chopper circuit. See <strong>DC chopper</strong>.</td>
</tr>
<tr>
<td>CCU</td>
<td>Control cubicle</td>
</tr>
<tr>
<td>Control board</td>
<td>Circuit board in which the control program runs. See <strong>BCON</strong>.</td>
</tr>
<tr>
<td>Control unit</td>
<td>Control board built in a rail-mountable housing. See <strong>BCU</strong>.</td>
</tr>
<tr>
<td>Converter</td>
<td>Converts direct current and voltage to alternating current and voltage, or vice versa.</td>
</tr>
<tr>
<td>Converter module</td>
<td>Grid-side converter or generator-side converter module</td>
</tr>
<tr>
<td>Cubicle</td>
<td>One section of a cabinet-installed wind turbine converter. A cubicle is typically behind a door of its own.</td>
</tr>
<tr>
<td>DC link</td>
<td>DC circuit between grid-side converter and generator-side converter</td>
</tr>
<tr>
<td>DC link capacitors</td>
<td>Energy storage which stabilizes the intermediate circuit DC voltage.</td>
</tr>
<tr>
<td>DDCS</td>
<td>Distributed drives communication system; a protocol used in optical fiber communication</td>
</tr>
<tr>
<td>DTC</td>
<td>Direct torque control; a generator control method by ABB.</td>
</tr>
<tr>
<td>EMC</td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td>FCAN</td>
<td>Optional CANopen® adapter module</td>
</tr>
<tr>
<td>FEA</td>
<td>Optional extension adapter module</td>
</tr>
<tr>
<td>FEN-31</td>
<td>Optional HTL incremental encoder interface module</td>
</tr>
<tr>
<td>FENA</td>
<td>Optional Ethernet adapter module for EtherNet/IP™, Modbus TCP® and PROFINET IO® protocols</td>
</tr>
<tr>
<td>FIO-01</td>
<td>Optional digital I/O extension module</td>
</tr>
<tr>
<td>FIO-11</td>
<td>Optional analog I/O extension module</td>
</tr>
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| Frame (size) | Refers to converter modules that share a similar mechanical construction, for example:  
• frame 5×R9iLC + 6×R9iLC includes five R9iLC generator-side converter modules and six R9iLC grid-side converter modules. |
<table>
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<tr>
<th>Term/abbreviation</th>
<th>Explanation</th>
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<tr>
<td>Generator-side converter</td>
<td>The converter part that is connected to the generator stator and controls the generator operation. It converts the AC power from the generator to the converter DC bus.</td>
</tr>
<tr>
<td>Grid-side converter</td>
<td>A converter that is connected to the grid and is capable of transferring energy from the converter DC link to the grid and vice versa.</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/Output</td>
</tr>
<tr>
<td>IGBT</td>
<td>Insulated gate bipolar transistor; a voltage-controlled semiconductor type widely used in various converters because of their easy controllability and high switching frequency.</td>
</tr>
<tr>
<td>Intermediate circuit</td>
<td>See DC link.</td>
</tr>
<tr>
<td>Main circuit breaker</td>
<td>Electrically-controlled main switching and protecting device. A withdrawable breaker can also be used as the main disconnector.</td>
</tr>
<tr>
<td>MBC</td>
<td>Main breaker cubicle containing main switching and disconnecting devices, power terminals, etc.</td>
</tr>
<tr>
<td>NETA-21</td>
<td>Remote monitoring tool</td>
</tr>
<tr>
<td>Parameter</td>
<td>User-adjustable operation instruction to the converter, or signal measured or calculated by the converter.</td>
</tr>
<tr>
<td>PE</td>
<td>Protective Earth</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable logic controller</td>
</tr>
<tr>
<td>PSL</td>
<td>Power stage link</td>
</tr>
<tr>
<td>R9iLC</td>
<td>Converter module size, see Frame (size).</td>
</tr>
<tr>
<td>UPS</td>
<td>Uninterruptible power supply</td>
</tr>
<tr>
<td>Wind turbine converter</td>
<td>A converter for controlling AC generators in wind turbine applications.</td>
</tr>
<tr>
<td>Wind turbine system</td>
<td>Wind turbine system consists of the wind turbine, wind turbine converter, generator etc.</td>
</tr>
<tr>
<td>WTC</td>
<td>Wind turbine controller. The wind turbine controller controls the whole wind turbine system.</td>
</tr>
<tr>
<td>ZMU</td>
<td>Memory unit attached to the BCU control unit connector X205 MEMORY UNIT.</td>
</tr>
</tbody>
</table>
Introduction to the manual
Operation principle and hardware description

Contents of this chapter
This chapter describes the operation principle and the construction of the wind turbine converter.

Operation principle
The ACS880-87LC is a four-quadrant, cabinet-mounted liquid-cooled converter intended for full power conversion turbines with an induction generator or a permanent magnet generator. The converter is connected between the generator stator and the grid. The converter can be installed up in the nacelle or down on the ground level.

The converter consists of back-to-back connected cubicles that contain the grid-side converter modules, generator-side converter modules, LCL filter, terminals or grid busbars for grid cables and generator cables, internal control circuits, external control cable terminals, auxiliary circuits and external auxiliary power supply terminals.
Generator control

The generator power flows through the generator-side converter to the converter intermediate DC circuit.

The generator control is based on the Direct torque control (DTC) method. Two phase currents and intermediate DC circuit voltage are measured and used for the control. The third phase current is measured for ground fault protection.
Overview diagram of the wind turbine converter

A single-line diagram of the wind turbine converter is shown below.
## Layout drawing

Layout of the wind turbine converter is shown below.

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<tr>
<td>2.</td>
<td>Generator-side converter cubicles</td>
</tr>
<tr>
<td>3.</td>
<td>Main breaker cubicle</td>
</tr>
<tr>
<td>4.</td>
<td>Generator-side converter modules</td>
</tr>
<tr>
<td>5.</td>
<td>DC fuses</td>
</tr>
<tr>
<td>6.</td>
<td>Generator cable terminals [U2, V2, W2]</td>
</tr>
<tr>
<td>7.</td>
<td>Main circuit breaker [Q1]</td>
</tr>
<tr>
<td>8.</td>
<td>Grid cable terminals [L1, L2, L3]</td>
</tr>
<tr>
<td>9.</td>
<td>Cooling fans of the main breaker cubicle</td>
</tr>
<tr>
<td>10.</td>
<td>Upper cooling fan of the main breaker cubicle</td>
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<tr>
<td>11.</td>
<td>Auxiliary voltage switch [Q2]</td>
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<td>Charging circuit switch [Q10]</td>
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<td>Overvoltage protection devices</td>
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<td>14.</td>
<td>BCU control units for the grid-side converter and generator-side converter</td>
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<td>15.</td>
<td>Cooling fan of the auxiliary control cubicle</td>
</tr>
<tr>
<td>16.</td>
<td>Generator cable lead-throughs</td>
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<tr>
<td>17.</td>
<td>Capacitor of the LCL filter</td>
</tr>
<tr>
<td>18.</td>
<td>Auxiliary terminals</td>
</tr>
<tr>
<td>19.</td>
<td>Clamping filter</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
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<td>LCL filter cubicle</td>
</tr>
<tr>
<td>2.</td>
<td>Grid-side converter cubicle</td>
</tr>
<tr>
<td>3.</td>
<td>Control cubicle</td>
</tr>
<tr>
<td>4.</td>
<td>Coolant out</td>
</tr>
<tr>
<td>5.</td>
<td>Coolant in</td>
</tr>
<tr>
<td>6.</td>
<td>Upper cooling fans of the LCL filter cubicle</td>
</tr>
<tr>
<td>7.</td>
<td>Lower cooling fans of the LCL filter cubicle</td>
</tr>
<tr>
<td>8.</td>
<td>Grid-side converter modules</td>
</tr>
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<td>9.</td>
<td>Grid-side converter DC fuses</td>
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<td>10.</td>
<td>Grid-side converter AC fuses</td>
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<td>11.</td>
<td>Control cable terminals for customer connections</td>
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<td>DC resistors</td>
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<td>Clamping filter fuses</td>
</tr>
</tbody>
</table>
Overview of power and control connections

The diagram shows the power connections and internal control interfaces of the wind turbine converter. The option module slots on the control unit are reserved for internal use and communication.

External control via Ethernet
Both BCU control units are connected to Ethernet switch
**Circuit boards**

For the interconnections between the control boards of the converter, see the circuit diagrams.

**BAMU board**

The BAMU board is a multipurpose measurement unit for voltage and current measurement. It has two three-phase voltage inputs and three current inputs.

When the option +F276 (grid fault ride-through) is selected, the BAMU board is included in the delivery for measuring three grid voltages.

**Smoke detector**

The wind turbine converter is equipped with smoke detector to provide additional protection. Smoke detector is located in the upper part of the incoming cubicle and the signal is connected to K112:slot 3: DI2. The smoke detector is equipped with NC (normally closed) contact which opens if smoke is detected.

Smoke detector alarm can be reset only with auxiliary power reboot. In case of smoke detector alarm it is mandatory to check the converter for possible hardware related issues. Especially LCL filter capacitor requires visual inspection and capacitance measurement between phases.
Type designation labels

The type designation label of the wind turbine converter is attached inside the cabinet door. The type designation label includes ratings, valid markings, type code and serial number of the converter. Each converter module is also individually labeled.

Typical labels are shown below.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Serial number. The first digit of the serial number refers to the manufacturing plant. The next four digits refer to the converter’s manufacturing year and week, respectively. The remaining digits complete the serial number so that there are no two converters with the same number.</td>
</tr>
<tr>
<td>2</td>
<td>Type code. See section Type designation key. If the delivery contains a DC chopper, option code +D150 is marked in the converter label.</td>
</tr>
</tbody>
</table>
The type code of the wind turbine converter contains information on the specifications and configuration.

- The first 23 digits form the basic code. It describes the basic construction of the wind turbine converter. The fields in the basic code are separated with hyphens.
- The option codes follow the basic code. Each option code starts with an identifying letter (common for the whole product series), followed by descriptive digits. The option codes are separated by plus signs.

The selections are listed below. For more information, contact your local ABB representative.
Operation principle and hardware description

## Basic code

<table>
<thead>
<tr>
<th>Digit no.</th>
<th>Name/Description</th>
<th>Alternatives</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1…6</td>
<td>Product series</td>
<td>ACS880</td>
<td>ACS880 product series</td>
</tr>
<tr>
<td>8…11</td>
<td>Construction</td>
<td>87LC</td>
<td>Cabinet mounted liquid-cooled wind turbine converter</td>
</tr>
<tr>
<td>13…23</td>
<td>Size</td>
<td>See section Ratings on page 107</td>
<td>Generator-side converter current rating / Grid-side converter current rating</td>
</tr>
<tr>
<td>25</td>
<td>Voltage rating</td>
<td>7</td>
<td>7 – Voltage range 525…690 V. This is indicated in the type designation label as a typical input voltage level (3~ 690 V AC).</td>
</tr>
</tbody>
</table>

## Option codes (plus codes)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/O options</td>
<td></td>
</tr>
<tr>
<td>L502</td>
<td>FEN-31 HTL incremental encoder interface module</td>
</tr>
<tr>
<td>Fieldbus</td>
<td>FCAN-01 CANopen adapter module</td>
</tr>
<tr>
<td>Ethernet</td>
<td>NETA-21 remote monitoring tool (EIP, MB/TCP)</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td>C143</td>
<td>Cooling connections on the right side (when looking the converter from the main breaker cubicle side)</td>
</tr>
<tr>
<td>H372</td>
<td>Cable conduit entry for 1-phase cabling – generator cable (3·10·[27…35] mm + 10·[27…35] mm PE)</td>
</tr>
<tr>
<td>H373</td>
<td>Cable conduit entry for 1-phase cabling – grid cable (3·10·[27…35] mm + 10·[27…35] mm PE)</td>
</tr>
<tr>
<td>L520</td>
<td>Fast connector plugs for I/O terminals</td>
</tr>
<tr>
<td>Grid control options</td>
<td></td>
</tr>
<tr>
<td>D150</td>
<td>DC chopper</td>
</tr>
<tr>
<td>D151</td>
<td>DC resistor</td>
</tr>
<tr>
<td>F276</td>
<td>Grid fault ride-through</td>
</tr>
<tr>
<td>Documentation language (delivered set may include documents in English)</td>
<td></td>
</tr>
<tr>
<td>R701</td>
<td>German</td>
</tr>
<tr>
<td>R707</td>
<td>French</td>
</tr>
<tr>
<td>Specialities</td>
<td></td>
</tr>
<tr>
<td>P902</td>
<td>Customized (described in Technical Appendix)</td>
</tr>
<tr>
<td>P911</td>
<td>Extended warranty</td>
</tr>
</tbody>
</table>
Mechanical installation

Contents of this chapter
This chapter describes the mechanical installation procedure of the wind turbine converter.

Safety instructions
See ACS880-87LC-3328A/4100A-7 wind turbine converters safety instructions (3AXD50000028543 [English]).
Checklist before mechanical installation

<table>
<thead>
<tr>
<th>The installation site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check the installation site. See section Ambient conditions on page 113 for the allowed operating conditions, and section Dimensions, weights and free space requirements on page 109 for the requirements for free space around the converter.</td>
</tr>
<tr>
<td>Check that the floor that the converter is installed on is of non-flammable material, as smooth as possible, and strong enough to support the weight of the converter.</td>
</tr>
<tr>
<td>Check the floor flatness with a spirit level. The maximum allowed deviation from the surface level is 5 mm (0.2 in) in every 3 meters (9.8 ft).</td>
</tr>
<tr>
<td>If necessary, level the installation site, as the cabinet is not equipped with adjustable feet.</td>
</tr>
<tr>
<td>Check that the wall behind the converter is of non-flammable material.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Required tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check that you have following tools for moving the converter to its final position, fastening it to the floor and tightening the connections:</td>
</tr>
<tr>
<td>• crane or fork-lift (check the load capacity); iron bar and piece of planked wood</td>
</tr>
<tr>
<td>• Pozidriv and Torx (2.5 … 6 mm, 0.98 … 0.2 in) screwdrivers for the tightening of the frame screws (Screws needed for fastening the cabling boxes and other accessories delivered by ABB are included in the delivery. They are inside the cabinet. The delivery does not contain screws or tools to install the cabinet to the floor.)</td>
</tr>
<tr>
<td>• torque wrench</td>
</tr>
<tr>
<td>• set of wrenches and sockets.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>For unpacking the delivery, see page 30.</td>
</tr>
<tr>
<td>Check that the delivery contains:</td>
</tr>
<tr>
<td>• converter cabinet</td>
</tr>
<tr>
<td>• cabling boxes for the generator-side converter</td>
</tr>
<tr>
<td>• option modules (installed at the factory)</td>
</tr>
<tr>
<td>• DC chopper(s) and DC resistor(s) (optional)</td>
</tr>
<tr>
<td>• appropriate wind turbine converter manual(s) and option module manual(s)</td>
</tr>
<tr>
<td>• delivery documents (dimension drawings, circuit diagrams, etc.)</td>
</tr>
<tr>
<td>• lifting bars (see disassembly instructions starting on page 35)</td>
</tr>
<tr>
<td>• LCL capacitors (see assembly instructions starting on page 37)</td>
</tr>
<tr>
<td>• DC resistor adapters (see assembly instructions starting on page 42).</td>
</tr>
<tr>
<td>• accessories for cable lead-throughs (see assembly instructions starting on page 45).</td>
</tr>
<tr>
<td>The manual(s) are delivered inside the converter.</td>
</tr>
<tr>
<td>Check that there are no signs of damage.</td>
</tr>
<tr>
<td>Check the information on the type designation label of the converter to verify that the delivery is of correct type.</td>
</tr>
</tbody>
</table>
Moving the converter package

- Moving the converter package by fork-lift

**WARNING!** Only use a heavy duty forklift that can carry the weight of the converter.

- Make sure that the reach of the fork lift is long enough. The package is wide and the center of gravity is far from the edges.
- Do not tilt. The center of gravity is high.
- Move only in the upright position.
Lifting the converter package

Moving the converter on rollers
Do not move the converter on rollers.

Unpacking
Unpack the wind turbine converter when you have moved the converter to its final installation location, or near it.

1. Cut the attachment clamps with side cutters and pull them away.
2. Remove the fastening screws/nails/rivets and unpack the converter from the wooden package.
3. Cut the plastic covering the converter with a carpet knife and remove it.
4. Detach the converter from its platform, lift the converter and remove the platform.
**Lifting the converter**

Obey these instructions when there are no ABB lift adapter bars in use:

1. Attach the lifting slings to holes of the lifting bars (a). Use long enough slings. See the minimum lifting angle in the figure below.

   ![Diagram showing lifting slings and converter]

   **WARNING!** Divide the weight to all lifting bars and all holes. If you do not divide the load evenly, the lifting bars cannot carry the weight of the converter.

2. Tighten the slings steadily and make sure that the load is evenly divided.
3. Lift steadily.
4. Position the converter as near its final position as possible.
5. Remove the lifting bars and refasten the roof bolts to retain the degree of protection of the cabinet. Store the loose lifting bars for later use.
32 Mechanical installation

Placing the converter

The cabinet can be placed into its final position with an iron bar and a wooden piece at the bottom edge of the cabinet. Place the wooden piece carefully to avoid damage to the cabinet frame.

The cabinet has a back-to-back design, and thus you cannot install it with a longer side against a wall.

The converter must be installed in an upright vertical position.

Notes:
• Leave a 400 mm (16 in) clearance above the converter cabinet to allow pressure release lids to open in an arc fault situation.
• Leave space at the side for the coolant pipes.
• You can adjust the height, for example, if the floor is uneven by using metal shims between the cabinet frame and floor.
Fastening the cabinet to the floor

Bolt the converter to the floor through the holes in each flat bar at the base of the cabinet using M12 screws.

We do not recommend welding (see section Electric welding on page 34).

Internal cooling circuit

For installations related to cooling, see chapter Cooling and heating on page 132.

DC chopper (option +D150)

Option +D150: There is a DC chopper with no ABB-installed DC resistor. The customer connects a customer-acquired DC resistor at the installation site.

- Arrange sufficient cooling and mechanical protection (eg, shrouds) for the DC resistor assembly.
- Do not install the DC resistors near flammable materials.
- You can assemble the DC resistors eg, on top of the converter cabinet.
Lifting the door

1. Open the handles.
2. Detach the upper part of the door.
3. Lift the door upwards.

Miscellaneous

- **Cable duct in the floor below the cabinet**

You can construct cable ducts below the cabinet. The duct width must not exceed 450 mm (18 in). The cabinet weight lies on the 100 mm (4 in) wide sections in front, middle and back which the floor must carry.

Prevent the cooling air flow from the cable duct to the cabinet by bottom plates. To ensure the degree of protection for the cabinet use the original bottom plates delivered with the converter. With user-defined cable entries, take care of the degree of protection, fire protection and EMC compliance.

- **Electric welding**

It is not recommended to fasten the cabinet by welding. If you must do it for some reason:
  - Weld only the flat bar under the cabinet, never the cabinet frame itself.
  - Clamp the welding electrode onto the flat bar about to be welded or to the next flat bar of the cabinet (within 0.5 meters of the welding point).

---

**WARNING!** If the welding return wire is connected improperly, the welding circuit may damage electronic circuits in the cabinet. The thickness of the zinc coating of the cabinet frame is 100 … 200 micrometers; on the flat bars the coating is approximately 20 micrometers. Ensure that the welding fumes are not inhaled.
Removing the lifting bars

1. Remove lifting bars 3AUA00000118772 with 3AUA0000062977, 27898157 M16×50 screws, 3AXD50000013704 M16 spring washers, 26380766 M16 washers and 27044271 M16 nuts.
2. Remove lifting bars 3AXD50000026342 with 3AXD50000013597 M16×40 screws, 3AXD50000013704 M16 spring washers, 26380766 washers and 64595091 M16 gaskets. Store the screws for later use.
Installing the capacitor unit

1. Remove the transportation cover (3AXD50000028594). Remove the plug screws M6 8 pcs (36623110, 68578850, 68452317). Remove the cover of the connection hole 3AXD50000027957.

2. Install the capacitor unit.

The capacitor unit is pre-assembled.
The mass of the capacitor unit: 155 kg (341.7 lb)

The capacitor unit is hoisted to be installed.
The max. angle between ropes is 60°.
3. Connect the temperature measuring wires.

3. Connect the busbar with
   M12×35 screw 3 pcs
   M12 spring washer 3 pcs
   M12 washer 3 pcs
   Tighten the screws, torque 70 N·m (52 lbf·ft).

Install M6 gasket 2+2=4 pcs
M6×16 combiscrew 2+2=4 pcs
Tighten the screws later.

Install M6 gasket 5+5=10 pcs
M6 combiscrew 5+5=10 pcs
Tighten the screws, torque 9 N·m (6.6 lbf·ft).
4. Install the front cover and the connection cover.

Install the front cover with M6 gasket 10 pcs
M6×16 combiscrew 10 pcs
Tighten the screws, torque 9 N·m (6.6 lbf·ft).
5. Install the box and cover.

Lift the box to install. The mass of the capacitor unit cover: 20 kg (44 lb)

Install M6 gasket 3+3=6 pcs
M6×16 combiscrew 3+3=6 pcs
Tighten the screws, torque 9 N·m (6.6 lbf·ft).

Tighten the screws 2+2=4 pcs,
torque 9 N·m (6.6 lbf·ft).
Install M6 gasket 13 pcs
M6×16 combiscrew 13 pcs
Tighten the screws, torque 9 N·m (6.6 lbf·ft).

Install 3AXD50000028068 with M6 gasket
18 pcs
M6×16 combiscrew 18 pcs
Tighten the screws, torque 9 N·m (6.6 lbf·ft).
Installing the DC resistors

1. Remove the covers 3AXD50000027506 with 36623101 combiscrews.

2. Connect the resistor cables with M10×25 combiscrews (8 pcs). Tighten the screws, torque 42 N·m (31 lbf·ft).

3. Tighten the M32 cable glands 3AXD50000031112 and locking nuts 68336945.
4. Install the cover 3AXD50000027506 with M6×12 combiscrews. Tighten the screws, torque 9 N·m (6.6 lbf·ft).

![Diagram of mechanical installation](image1.png)

5. Assemble the support frame. Tighten the screws, torque 42 N·m (31 lbf·ft).

![Diagram of support frame assembly](image2.png)

6. Assemble the resistors with the support frame. Tighten the screws, torque 42 N·m (31 lbf·ft).

![Diagram of resistor assembly](image3.png)
7. Install the support frame with the resistors to the roof top.

Hoist the support frame with the resistors and install to the roof.

The maximum angle between the ropes: 45°.

The mass of the resistor unit: 220 kg (485 lb).

Turn the lifting eyes toward force axis before hoisting.

Additionally, fix the roof with 4 pcs of M16 screws, washers and gaskets in the middle of the cabinet. Re-use the detached M16 fastenings.

8. Connect the cables (8 pcs) between the resistor and converter frame. Tighten the screws, torque 42 N·m (31 lbf·ft).
Installing the lead-through box for generator cables

1. Remove the covers (3AXD50000027658 and 3AXD50000128426) with 68578850 and 36623110 combiscrews.

2. Install the generator-side roof boxes (3AXD50000027891, 3AXD50000134694 and 3AXD50000136162) with 68578850 and 36623110 combiscrews. Tighten the screws, torque 9 N·m (6.6 lbf·ft).
3. Install the covers (3AXD50000030459 and 3AXD50000133468). Install 40 pcs M50 cable glands 3AXD5000027887. Re-tighten the covers with 68578850 and 36623128 combiscrews, torque 9 N·m (6.6 lbf·ft).

4. Connect 2 pcs PE cables 3AXD50000034332 between generator lead-through box and converter frame. Tighten the screws, torque 22 N·m (16.2 lbf·ft).
Installing the lead-throughs for grid cables

1. Open the doors and remove the plate 3AXD50000026897 with 68343071 combiscrew. Remove the plate 3AXD50000031773 with 36623110 combiscrews.
2. Open the doors and install Roxtec 3AXD50000027645 and 3AXD50000027650.
3. Install 40 pcs cable glands 3AXD50000027887.
4. Re-tighten the plate with 36623110 combiscrews, torque 9 N·m (6.6 lbf·ft).
Planning the electrical installation

Contents of this chapter

This chapter contains the instructions that you must follow when selecting the generator, cables, protections, cable routing and way of operation for the converter system.

Note: The installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches the local laws and/or other regulations. Furthermore, if the recommendations given by ABB are not followed, the converter may experience problems that the warranty does not cover.

Selecting the grid disconnecting device

The converter is equipped with a main circuit breaker as standard. The breaker is withdrawable: when withdrawn (cranked out), the breaker operates as a main disconnector for the converter. However, the withdrawn main circuit breaker does not isolate the grid cable terminals of the converter from the grid. Equip the installation with another disconnecting device placed in between the power grid and the grid cable terminals of the converter. For example, the main circuit breaker of the grid transformer could also be used as the extra disconnecting device if it meets the requirements for a disconnecting device.
Checking the compatibility of the generator and the converter

The converter is compatible with induction generators and permanent magnet generators.

1. Select the generator according to the ratings table in chapter Technical data on page 107.

2. Check that the generator and the converter have the same voltage rating. Check also that the voltage ratings match the voltage to be connected to the grid-side converter. **Note:** You can rise the converter DC link voltage 10% of its natural level (by a parameter setting). The effect is equivalent to a 10% voltage rise at the generator terminals. Before you use this feature, make sure that the generator insulation can withstand the higher voltage level.

<table>
<thead>
<tr>
<th>When</th>
<th>the generator voltage rating should be</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC bus voltage is not increased from nominal (default)</td>
<td>$U_N$</td>
</tr>
<tr>
<td>DC bus voltage is increased from nominal by parameter setting</td>
<td>$U_{AC_{eq}}$</td>
</tr>
</tbody>
</table>

$U_N$ \(\triangleq\) rated grid-side voltage of the converter

$U_{AC_{eq}}$ \(\triangleq\) equivalent grid-side voltage of the converter in V AC, $U_{AC_{eq}} = \frac{U_{DC}}{1.41}$

$U_{DC}$ \(\triangleq\) maximum DC bus voltage of the converter in V DC. You can set the voltage reference with parameter in grid-side converter control program for $1.1 \times 1.41 \times U_N$ at maximum. You can set the reference to a lower value but the program restricts it to a value of at least $1.41 \times U_N$.

3. Make sure that the generator is suitable for the converter use, ie, it can withstand the voltage peaks at of the converter:
   • Use insulated N end (non-driven end) bearing in the generator.
   • Make sure that the generator insulation meets the requirements in the table below.
   • Select the cables according to the instruction in this manual.
   • Install the converter and its cabling as instructed in this manual.

Protecting the generator insulation and bearings

The generator-side converter output of the wind turbine converter comprises – regardless of output frequency – pulses of approximately the converter DC bus voltage with a very short rise time. This is the case with all converters employing modern IGBT technology.

The voltage of the pulses can be almost double at the generator terminals, depending on the attenuation and reflection properties of the generator cable and the terminals. This in turn can cause additional stress on the generator and generator cable insulation.

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

You can avoid the stress on generator insulation by using ABB du/dt filters. du/dt filters also reduce bearing currents. The converter is equipped with the following output filters:
   • du/dt filter protects generator insulation system and reduces bearing currents
   • common mode filter mainly reduces bearing currents
   • clamping filter reduces voltage peaks.
To avoid damage to generator bearings, the cables must be selected and installed according to the instructions given in this manual. In addition, insulated N-end (non-converter end) bearings must be used.

Selecting the power cables

General rules

Dimension the grid cable or busbar and generator cable according to local regulations:

- The cable must be able to carry the converter load current. See chapter Technical data on page 107 for the rated currents.
- The cable must be rated for at least 90 °C (194 °F) maximum permissible temperature of conductor in continuous use. See also section Additional US and Canada requirements on page 54.
- The inductance and impedance of the PE conductor/cable (grounding wire) must be rated according to permissible touch voltage appearing under fault conditions (so that the fault point voltage will not rise excessively when a ground fault occurs).
- The rated voltage between the conductors of the cable should be minimum 1 kV.

For generators, the symmetrical shielded generator cable is highly recommended. See section Alternative power cable types on page 52.

Note: When continuous conduit is employed, shielded cable is not required.

Note: When using a four-conductor system, consult the generator manufacturer regarding bearing and disturbance shielding.

In a non-symmetrical four-conductor system, voltage can be induced to the separate PE conductor, which rises generator frame potential and causes current to ground through the generator bearings and shaft. This causes extra wear. Whereas, in a symmetrical shielded cable, the high capacitance between the PE conductor and the phase conductors forms an LC filter reducing bearing currents and voltage changes.

A four-conductor system is allowed for grid cabling, but shielded symmetrical cable is highly recommended.

Sufficient conductivity of the protective conductor

The protective conductor must always have an adequate conductivity.

Unless local wiring regulations state otherwise, the cross-sectional area of the protective conductor must agree with the conditions that require automatic disconnection of the supply required in 411.3.2. of IEC 60364-4-41:2005 and be capable of withstanding the prospective fault current during the disconnection time of the protective device.

The cross-sectional area of the protective conductor can either be selected from the table below or calculated according to 543.1 of IEC 60364-5-54.
This table shows the minimum cross-sectional area related to the phase conductor size according to IEC 61800-5-1 when the phase conductor and the protective conductor are made of the same metal. If this is not so, the cross-sectional area of the protective earthing conductor shall be determined in a manner which produces a conductance equivalent to that which results from the application of this table.

<table>
<thead>
<tr>
<th>Cross-sectional area of the phase conductors</th>
<th>Minimum cross-sectional area of the corresponding protective conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>S (mm²)</td>
<td>Sₚ (mm²)</td>
</tr>
<tr>
<td>S ≤ 16</td>
<td>S</td>
</tr>
<tr>
<td>16 &lt; S ≤ 35</td>
<td>16</td>
</tr>
<tr>
<td>35 &lt; S ≤ 400</td>
<td>S/2</td>
</tr>
<tr>
<td>400 &lt; S ≤ 800</td>
<td>200</td>
</tr>
<tr>
<td>800 &lt; S</td>
<td>S/4</td>
</tr>
</tbody>
</table>

Compared to a four-conductor system, the use of symmetrical shielded cable reduces electromagnetic emission of the whole converter system as well as generator bearing currents and wear.

The generator cable and its PE pigtail (twisted screen) should be kept as short as possible in order to reduce electromagnetic emission as well as capacitive current.

- **Typical power cable sizes**
  See the Technical appendix.

- **Alternative power cable types**
  The power cable types that you can use with the converter are shown below.

  | PE | Symmetrical shielded cable with three phase conductors and a concentric PE conductor as shield. The shield must meet the requirements of IEC 61800-5-1. Check with local / state / country electrical codes for allowance. |
  | PE | Symmetrical shielded cable with three phase conductors and a concentric PE conductor as shield. A separate PE conductor is required if the shield does not meet the requirements of IEC 61800-5-1. |
  | PE | Symmetrical shielded cable with three phase conductors and symmetrically constructed PE conductor, and a shield. The PE conductor must meet the requirements of IEC 61800-5-1. |

- **Power cable types for limited use**
  | PE | A four-conductor system (three phase conductors and a protective conductor on a cable tray) is not recommended for cabling. |
Not allowed power cable types

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>A four-conductor system (three phase conductors and a PE conductor in a PVC conduit)</td>
</tr>
<tr>
<td>EMT</td>
<td>Corrugated cable with three phase conductors and a protective conductor or cable in EMT conduit</td>
</tr>
<tr>
<td>PE</td>
<td>A well-shielded (Al/Cu shield) four-conductor system (three phase conductors and a PE conductor or four conductors)</td>
</tr>
<tr>
<td></td>
<td>Symmetrical shielded cable with individual shields for each phase conductor is not allowed on any cable size for grid and generator cabling.</td>
</tr>
</tbody>
</table>

Generator cable shield

If the generator cable shield is used as the sole protective earth conductor of the generator, make sure that the conductivity of the shield is sufficient. See subsection General rules above, or IEC 61800-5-1.

To effectively suppress radiated and conducted radio-frequency emissions, the cable shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminum shield. The minimum requirement of the generator cable shield of the converter is shown below. It consists of a concentric layer of copper wires with an open helix of copper tape or copper wire. The better and tighter the shield, the lower the emission level and bearing currents.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Insulation jacket
2. Helix of copper tape or copper wire
3. Copper wire screen
4. Inner insulation
5. Cable core
## Single core vs multicore cables in grid cabling

Use symmetrical grid cabling. Asymmetry leads to unequal current distribution between the conductors which may cause disturbances and fault trips. To avoid asymmetry, use symmetrical multicore (three-phase) cables where possible. Single core cabling is also allowed if the cables are grouped symmetrically.

The table below shows three possible cabling options.

<table>
<thead>
<tr>
<th>No.</th>
<th>Layout</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image" alt="Multicore cabling" /></td>
<td>Multicore cabling (recommended). See subsection Alternative power cable types for the possible constructions of the PE (protective earth/ground).</td>
</tr>
<tr>
<td>2</td>
<td><img src="image" alt="Single core cables in trefoil" /></td>
<td>Single core cables in trefoil (preferable single core cabling option).</td>
</tr>
<tr>
<td>3</td>
<td><img src="image" alt="Single core cables laid flat" /></td>
<td>Single core cables laid flat.</td>
</tr>
</tbody>
</table>

## Additional US and Canada requirements

Use copper, copper-clad aluminum or aluminum conductors. Use conductors rated for 75 °C (167 °F) only.

Run the cabling in metallic conduits, or use type MC continuous corrugated aluminum armor cable with symmetrical grounds or shielded power cable for the generator cables if metallic conduit is not used.

**Conduit**

Bridge the joints of the conduits with a ground conductor bonded to the conduit on each side of the joint. Bond the conduits also to the converter enclosure. Use separate conduits for grid, generator, DC resistors, and control wiring. A dedicated ground cable is always required.

**Note:** Do not run generator wiring from more than one converter in the same conduit.

**Armored cable / shielded power cable**

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

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

Shielded power cables are available from Belden, Lapp Kabel (ÖLFLEX) and Pirelli, among others.
Selecting the DC resistors

For the technical data of the DC resistors, see page 112.

■ Resistor sizing (no option +D151)

These instructions describe how to select and plan the installation of the DC resistors for those deliveries which do not include them as factory-installed (no option +D151).

- Ensure that the resistance value is within the allowed minimum and maximum values defined for the chopper circuit. See chapter Technical data.
- Select a resistor with power rating that exceeds the maximum power rating. See chapter Technical data.
- Ensure that the resistor withstands the energy pulse during the load cycle. If you do not know the load cycle, contact your local ABB representative.
- Ensure that the resistor inductance value is less than 10 μH.

■ Resistor cabling

Keep the DC resistor cable as short as possible in order to minimize the EMC emissions and stress on the DC chopper IGBTs. The longer the cable, the higher the inductive load and voltage peaks over the IGBT semiconductors of the DC chopper.

The DC resistor and DC resistor cables are protected by the chopper DC fuses. Therefore resistor cable short-circuit protection is handled by them as long as the cable is dimensioned properly according to the chopper current. When customer-installed resistor and resistor cable are used (converter with no option +D151), ensure that the DC resistor cable conductor size is equal or exceeds the specified minimum conductor size. See chapter Technical data.

<table>
<thead>
<tr>
<th>DC resistor cable (per one resistor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum conductor size Al (mm²)</td>
</tr>
<tr>
<td>50</td>
</tr>
</tbody>
</table>

■ Relative heat energy accumulated in DC resistors

The BCU control unit calculates the actual relative heat (0%…100%) accumulated in a DC resistor. The calculation is based on a thermal model with a single time constant. When the function is on, heat accumulates in the resistor. When the function is off, heat dissipates and the DC resistor cools down. When the actual relative heat value is 100%, the DC resistor has reached its maximum temperature rise. The value is calculated based on the resistor parameters.

For further information, contact your local ABB representative.

Selecting the control cables

■ General rules

All control cables must be shielded.

As a general rule, the control signal cable shield should be grounded directly in the wind turbine converter. The other end of the shield should be left unconnected or grounded indirectly via a high frequency, high voltage capacitor of a few nanofarads. The screen can also be grounded directly at both ends if they are in the same earth line with no significant voltage drop between the end points.
Use a double shielded twisted pair cable (see figure a) for analog signals. This type of cable is recommended for the pulse encoder signals as well. Employ one individually shielded pair for each signal. Do not use common return for different analog signals.

A double shielded cable is the best alternative for low voltage digital signals but single shielded twisted multipair cable (figure b) is also acceptable.

Run analog and digital signals in separate, shielded cables.

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

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

■ Relay cable

The cable type with braided metallic screen (for example, ÖLFLEX from Lapp Kabel, Germany) has been tested and approved by ABB.
Routing the cables

Route the generator cable away from other cable routes. It is recommended that the generator cable, grid cable and control cables are installed on separate trays. Avoid long parallel runs of generator cables with other cables in order to decrease electromagnetic interference caused by the rapid changes in the converter output voltage.

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

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

A diagram of the cable routing is below.

Control cable ducts

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

Lead 24 V and 230/120 V control cables in separate ducts into the inside of the cabinet.
Protecting the converter installation

- **Protecting the grid cable in short-circuit situations**

  Equip the cable with fuses. Size the fuses according to local safety regulations, appropriate voltage and the rated current of the converter.

- **Protecting the generator and generator cable in short-circuit situations**

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

- **Protecting the converter, generator cable and grid cable against thermal overload**

  The converter protects itself, the grid cables and generator cables against thermal overload when the cables are sized according to the nominal current of the converter and ambient conditions are within the limits specified under Ambient conditions on page 113. No additional thermal protection devices are needed.

- **Protecting the converter against ground faults in the generator or generator cable**

  Both the grid-side converter and generator-side converter are equipped with an internal ground fault protective function to protect them against ground faults in the converter itself, the generator and generator cable. (This is not a personal safety or a fire protection feature.) You can disable both ground fault protective functions (not recommended); refer to the firmware manual.

- **Protecting the converter against ground faults in the converter or grid cable**

  Both the grid-side converter and generator-side converter are equipped with an internal ground fault protective function to protect them against ground faults in the converter itself and grid cable. (This is not a personal safety or a fire protection feature.) You can disable both ground fault protective functions (not recommended); refer to the firmware manual.
Planning the electrical installation

Implementing the emergency stop function

The converter is equipped with subsystems which can be used to implement the emergency stop, stop category 0 function:

- Emergency stop push buttons on the cabinet doors of the auxiliary control cubicle and the control cubicle (see chapter Dimension drawings).
- The main circuit breaker (and relays controlling the breaker), which can be used as the actuator subsystem in the safety function.

The emergency stop function is to be implemented, wired and verified by the customer. A logic subsystem (safety relay; safety PLC) must be added to the circuit. Appropriate standards (EN ISO 13850; EN ISO 13849 or EN 62061; EN 60204-1) must be applied. According to EN 13850, the emergency stop function shall achieve at least Safety Integrity level 1 (SIL 1) or Performance Level c (PL c).

Note: In the ACS880-87LC converter delivery, a contact of the emergency stop push buttons are wired into the digital inputs of the control boards by ABB on customer’s request. These connections cannot be used in the safety-related control of the actuator of emergency stop functions, it can only be used for indication purposes. Similarly, the stop implemented by the ACS880-87LC control board is a non-safety related stop. A safety-related relay or PLC must be used to control the main circuit breaker in the safety-related stop. See the circuit diagrams delivered with the converter.

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

WARNING! Because there is no safety relay installed in the emergency stop circuit of the wind turbine converter, the converter does not comply with the Machinery Directive requirements for emergency stop. Make sure that the aforementioned requirements are fulfilled and the emergency stop circuit functions properly before commissioning the converter.

Implementing the grid fault ride-through function

See the firmware manual.

Supplying power for the auxiliary circuits

The converter is not equipped with an auxiliary voltage transformer. Always connect an external auxiliary power supply. For the power rating, see section Auxiliary circuit current consumption on page 114.

As standard, the converter auxiliary circuit is to be supplied from the electrical power network through an external transformer.

The converter is equipped with connectors for 3-phase 400 V AC non-uninterruptible power supply, and 230 V AC uninterruptible power supply. The customer has to supply uninterruptible power from an external on-line power supply.
Using a safety switch between the converter and generator

To minimize the emission level when safety switches are installed in the generator cable between the converter and the generator:
- Install the equipment in a metal enclosure in a way that the conduit or generator cable shielding runs consistently without breaks from the converter to the generator.

Protecting the contacts of relay outputs

Inductive loads (such as relays, contactors and generators) cause voltage transients when switched off.

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

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

![Diagram of electrical installation](image)

1) Relay outputs; 2) Varistor; 3) RC filter; 4) diode
Electrical installation

Contents of this chapter

This chapter describes the electrical installation procedure of the wind turbine converter.

WARNING! Only qualified electricians are allowed to carry out the work described in this chapter. Read the complete safety instructions of the converter. If you ignore them, injury or death, or damage to the equipment can occur.

See the circuit diagrams delivered with the converter. The diagrams of this chapter do not necessarily match the installation-specific circuit diagrams of a tailor-made wind turbine converter.

Checking the insulation of the assembly

WARNING! See and obey the safety instructions of the converter. If you ignore them, injury or death, or damage to the equipment can occur.

Converter

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

Check the insulation of the grid cable according to local regulations before connecting it to the converter.

Generator stator and generator cable

Check the insulation of the generator stator and cable as follows:

- Check that all cables are disconnected from the converter output terminals U2, V2 and W2.
- Measure the insulation resistance between each phase conductor and the protective ground conductor using a measuring voltage of 1000 V DC. The insulation resistance of an ABB generator must exceed 100 Mohm (reference value at 25 °C or 77 °F). For the insulation resistance of other generators, please consult the manufacturer’s instructions.
- **Note:** Make sure that there is no condensed moisture inside the generator casing. If you suspect that there is moisture, dry the generator before measurement.
- **Note:** When using permanent magnet generator, it must be stable at the time of the measurement.

User-defined DC resistor and resistor cable

Option +D150: There is a DC chopper with no ABB-installed DC resistor. The customer connects a customer-acquired DC resistor at the installation site.

- Check that the resistor cable is connected to the resistor and disconnected from the converter output terminals R+ and R-. At the converter end, connect the R+ and R- conductors of the resistor cable together.
- Measure the insulation resistance between the conductors and the PE conductor by using a measuring voltage of 1 kV DC. The insulation resistance must be higher than 1 Mohm.
Connecting the grid cables

Connection diagram
## Connection procedure

**WARNING!** See and obey the safety instructions of the converter. If you ignore them, injury or death, or damage to the equipment can occur.

**WARNING!** Apply grease to stripped aluminum conductors before attaching them to non-coated aluminum cable lugs. Obey the grease manufacturer’s instructions. Aluminum-aluminum contact can cause oxidation in the contact surfaces.

1. Open the door of the main breaker cubicle. Unlock the handle, release it from the holder and turn upwards to release the door locking mechanism.
2. Remove the shroud that protects the grid cable terminals.
3. Lead the grid cables into the inside of the cubicle.
4. Fasten the grid cables to the grid connection terminals. Connect the phase conductors to terminals L1, L2 and L3. Tighten the conductors to 120 N·m (89 lbf·ft). Tightening torques are also given in chapter *Technical data*.
5. Connect ground conductors or cables to the cabinet PEN (ground) busbar.
6. Provide support for the connections whenever necessary.
7. Refit all shrouds removed earlier.
8. Close the door.
Connecting the generator cables

Connection diagram

![Connection diagram]

Connection procedure

**WARNING!** See and obey the safety instructions of the converter. If you ignore them, injury or death, or damage to the equipment can occur.

**WARNING!** Apply grease to stripped aluminum conductors before attaching them to non-coated aluminum cable lugs. Obey the grease manufacturer's instructions. Aluminum-aluminum contact can cause oxidation in the contact surfaces.

1. Open the door of the generator cable connection cubicle (see figures on the next page).
2. Remove the shroud that protects the generator cable connection busbars and cable entries.
3. Ensure that foreign objects (screws, etc.) cannot fall inside the converter module. During installation, cover the top of the module with plastic, fabric etc.

**WARNING!** Foreign objects inside the converter module can cause eg, short-circuit. Injury or death, or damage to the equipment can occur.

4. **When shielded cable is used:**
   - Lead the cables into the inside of the cubicle. Ground a shielded cable 360° at the lead-through with an EMC cable gland (to be supplied by the customer).
   - Connect the cables as follows:
   - Cut the cables to suitable length. Strip the cables and conductors. Fasten the cable lugs to the conductor ends.
   - Twist the cable shields into bundles and connect to the cabinet PE (ground) busbar. Connect any separate ground conductors or cables to the cabinet PE (ground) busbar.
   - Connect the phase conductors to terminals U2, V2 and W2. See the appropriate connection diagram above. Tighten the phase conductors and PE to a 120 N·m (89 lbf·ft) torque.
When single-core cables without metal shield are used:

- Lead the cables into the inside of the cubicle through the IP sealing glands.
- Connect the phase conductors to terminals U2, V2 and W2, and the PE conductors to the PE terminal. Tighten the phase and PE conductors (see page 110).

5. Provide support for the cables whenever necessary.

6. Remove the cover on top of the converter module.

**WARNING!** The cover on top of the converter module can cause overheating. Injury or death, or damage to the equipment can occur.

7. Refit the shroud removed earlier and close the door.

8. Connect the generator end of the cable. For minimum radio frequency interference and generator bearing current, ground the cable shield 360° at the lead-through of the generator terminal box. For the generator specific instructions, see the manufacturer's user manual.
Connecting the external power supply cable for the auxiliary circuit

Power supply terminals for the auxiliary circuit are located in the upper part of the main breaker cubicle (see section Layout drawing on page 20). See the circuit diagrams delivered with the converter, and section Auxiliary circuit current consumption on page 114.
Connecting the control cables

Control cable connectors are located in the lower part of the control cubicle and on the cabinet roof (see section *Layout drawing* on page 20). See the circuit diagrams delivered with the converter.
### Control connections in the lower part of the control cubicle

![Image](image1.png)

### Control connections on the roof of the control cubicle

![Image](image2.png)

<table>
<thead>
<tr>
<th>Connector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UMR-XD001</td>
<td>Auxiliary supply 400/230 V AC</td>
</tr>
<tr>
<td>UMR-XD002</td>
<td>UPS 230 V AC (located on the cabinet roof) (1)</td>
</tr>
<tr>
<td>KUM-XG001</td>
<td>Signal interface (located on the cabinet roof) (2)</td>
</tr>
<tr>
<td>KUM-XD001</td>
<td>Voltage supply</td>
</tr>
<tr>
<td>KUM-XD002</td>
<td>Voltage supply</td>
</tr>
<tr>
<td>KUM-XD003</td>
<td>Voltage supply</td>
</tr>
<tr>
<td>KUM-XD004</td>
<td>Voltage supply</td>
</tr>
<tr>
<td>KUM-XD005</td>
<td>Voltage supply</td>
</tr>
<tr>
<td>KUM-XD006</td>
<td>Voltage supply</td>
</tr>
<tr>
<td>KUM-XD007</td>
<td>Voltage supply</td>
</tr>
<tr>
<td>KUM-XD008</td>
<td>Voltage supply</td>
</tr>
<tr>
<td>KUM-XD009</td>
<td>Voltage supply</td>
</tr>
<tr>
<td>UMR-XF001</td>
<td>SUB-D connector</td>
</tr>
<tr>
<td>UMR-XF002</td>
<td>Ethernet</td>
</tr>
<tr>
<td>UMR-XG001</td>
<td>I/O connections (located on the cabinet roof) (3)</td>
</tr>
<tr>
<td>UMR-XG002</td>
<td>Current measurement</td>
</tr>
<tr>
<td>UMR-XG003</td>
<td>Voltage measurement</td>
</tr>
</tbody>
</table>
Default I/O connection diagrams
See the circuit diagrams delivered with the converter.

Connecting a PC
See the start-up guide.

Connecting a DC resistor
Option +D150: There is a DC chopper with no ABB-installed DC resistor. The customer connects the customer-acquired DC resistor at the installation site.

Connection procedure
1. Lead the resistor cable in through the roof of the cubicle.
2. Seal the lead-through properly to resume the degree of protection.
3. Connect the conductors to R+ and R- terminals.

Measuring the resistance of the DC resistor
Test the DC resistor installation by measuring:
1. Measure the resistance of each DC resistor from the cabinet DC resistor connectors (see the figure below).
2. Make sure that the resistance value is within the allowed minimum and maximum values defined for the chopper circuit (see page 112).
Installation checklist

Contents of this chapter
This chapter contains instructions for checking the installation of the wind turbine converter.

Before you start
Check the mechanical and electrical installation of the converter before start-up. Go through the checklist together with another person.

WARNING! Only qualified electricians are allowed to carry out the work described below. Do the tasks described in the safety instructions of the converter. If you ignore them, injury or death, or damage to the equipment can occur.

1. Open the main disconnector of the converter and lock it to open position.
2. Ensure by measuring that the converter is not powered.
## Checklist

<table>
<thead>
<tr>
<th>Make sure that …</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The ambient operating conditions meet the specifications given in chapter <em>Technical data</em>.</td>
<td></td>
</tr>
<tr>
<td>The converter has been fixed properly on an even, horizontal and non-flammable floor and if necessary due to vibration etc, also from top to the wall or roof.</td>
<td></td>
</tr>
<tr>
<td>The cooling circuit joints are tight.</td>
<td></td>
</tr>
<tr>
<td>All bleed and drain valves have been closed.</td>
<td></td>
</tr>
<tr>
<td>The internal cooling circuit has been filled with coolant that meets the specification. See section <em>Specifications</em> on page 139.</td>
<td></td>
</tr>
<tr>
<td>The internal cooling circuit has been bled. See section <em>Filling up and bleeding the internal cooling circuit</em> on page 133.</td>
<td></td>
</tr>
<tr>
<td>There is an adequately sized protective earth (ground) conductor between the converter and the main grounding busbar of the wind turbine.</td>
<td></td>
</tr>
<tr>
<td>The generator is properly grounded.</td>
<td></td>
</tr>
<tr>
<td>All protective earth (ground) conductors have been connected to the appropriate terminals and the terminals have been tightened (pull the conductors to check).</td>
<td></td>
</tr>
<tr>
<td>The voltage of the grid transformer matches the nominal voltage of the grid-side converter. Check the type designation label.</td>
<td></td>
</tr>
<tr>
<td>The grid cable or grid busbars have been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull the conductors to check.) For tightening torques, see section <em>Tightening torques</em> on page 110.</td>
<td></td>
</tr>
<tr>
<td>The generator cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull the conductors to check.) For tightening torques, see section <em>Tightening torques</em> on page 110.</td>
<td></td>
</tr>
<tr>
<td>The generator cable (and DC resistor cable, if present) has been routed away from other cables.</td>
<td></td>
</tr>
<tr>
<td><strong>Converters which have a DC chopper (option +D150) with a customer-acquired and installed DC resistor:</strong> The DC resistor has been installed, connected to the appropriate terminals, and the terminals have been tightened. (Pull the conductors to check.) Test the DC resistor installation by measuring. Measure the resistance of each DC resistor from the cabinet DC resistor connectors. Ensure that the resistance value is within the allowed minimum and maximum values defined for the chopper circuit (see page 112).</td>
<td></td>
</tr>
</tbody>
</table>
**Make sure that ...**

<table>
<thead>
<tr>
<th>The control cables have been connected to the appropriate terminals, and the connections are tight. (Pull the conductors to check.) Check and connect the following terminals:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• UMR-XD001</td>
</tr>
<tr>
<td>• UMR-XD002</td>
</tr>
<tr>
<td>• KUM-XG001</td>
</tr>
<tr>
<td>• KUM-XD001</td>
</tr>
<tr>
<td>• KUM-XD002</td>
</tr>
<tr>
<td>• KUM-XD003</td>
</tr>
<tr>
<td>• KUM-XD004</td>
</tr>
<tr>
<td>• KUM-XD005</td>
</tr>
<tr>
<td>• KUM-XD006</td>
</tr>
<tr>
<td>• KUM-XD007</td>
</tr>
<tr>
<td>• KUM-XD008</td>
</tr>
<tr>
<td>• KUM-XD009</td>
</tr>
<tr>
<td>• UMR-XF001</td>
</tr>
<tr>
<td>• UMR-XF002</td>
</tr>
<tr>
<td>• UMR-XG001</td>
</tr>
<tr>
<td>• UMR-XG002</td>
</tr>
<tr>
<td>• UMR-XG003</td>
</tr>
</tbody>
</table>

The capacitor unit of the LCL filter has been connected to the appropriate terminals, and the terminals have been tightened. (Pull the conductors to check.) For tightening torques, see section *Tightening torques* on page 110.

Test the LCL filter installation by measuring. Measure the LCL filter capacitance symmetrically in each phase in the grid-side converter cubicle. The capacitance should be about 990 μF.

There are no tools, foreign objects or dust from drilling inside the converter.

All shrouds and cover of the generator connection box are in place. Cabinet doors have been closed.

The converter is ready for start-up.
Maintenance

Contents of this chapter
This chapter contains preventive maintenance intervals and instructions.
## Maintenance intervals

The table below shows the maintenance tasks which can be done by the end user. For more information, contact your local ABB Service representative (www.abb.com/searchchannels).

<table>
<thead>
<tr>
<th>Maintenance task/object</th>
<th>Years from start-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>Replacement</strong></td>
<td></td>
</tr>
<tr>
<td>Cooling fans</td>
<td></td>
</tr>
<tr>
<td>Cooling fan power supply</td>
<td></td>
</tr>
<tr>
<td>Water-glycol coolant with inhibitor (see Note 1 below)</td>
<td>I</td>
</tr>
<tr>
<td>Electrolytic capacitors (DC circuit), if used (see Note 2 below)</td>
<td>R</td>
</tr>
<tr>
<td>ABB-SACE main circuit breaker maintenance (see Note 3 below)</td>
<td>P</td>
</tr>
<tr>
<td>BDPs, BINT, BGDR and flat cables</td>
<td></td>
</tr>
<tr>
<td>Control unit battery</td>
<td>R</td>
</tr>
<tr>
<td>Smoke detectors</td>
<td>R</td>
</tr>
<tr>
<td><strong>Inspection and/or performance</strong></td>
<td></td>
</tr>
<tr>
<td>Checking the pH of the coolant</td>
<td>P</td>
</tr>
<tr>
<td>Adding coolant corrosion inhibitor (if coolant with separate inhibitor is used) (see Note 1 below)</td>
<td>I</td>
</tr>
<tr>
<td>Checking cooling liquid pipe connections</td>
<td>I</td>
</tr>
<tr>
<td>Checking the connections of fiber optic cables</td>
<td>I</td>
</tr>
<tr>
<td>Checking the quick connector of the converter module</td>
<td>I</td>
</tr>
<tr>
<td>Checking the condition of contactors</td>
<td>I</td>
</tr>
<tr>
<td>Checking the condition of the main contactors (maintenance according to the manufacturer’s instructions)</td>
<td>I</td>
</tr>
<tr>
<td>Checking ambient conditions (dustiness, corrosion, temperature)</td>
<td>I</td>
</tr>
<tr>
<td>Checking the quality of auxiliary voltage</td>
<td>I</td>
</tr>
<tr>
<td>Testing the smoke detectors with test smoke</td>
<td>I</td>
</tr>
<tr>
<td><strong>Improvements</strong></td>
<td></td>
</tr>
<tr>
<td>Firmware and hardware upgrade based on product notes</td>
<td>I</td>
</tr>
<tr>
<td><strong>Measurements and tests</strong></td>
<td></td>
</tr>
<tr>
<td>Basic measurements with supply voltage</td>
<td>P</td>
</tr>
<tr>
<td><strong>Spare parts</strong></td>
<td></td>
</tr>
<tr>
<td>Spare part stock</td>
<td>I</td>
</tr>
</tbody>
</table>

3AXD10000258568
Symbols
I Inspection (visual inspection and maintenance action if needed)
P Performance of on/off-site work (commissioning, tests, measurements or other work)
R Replacement

Maintenance and component replacement intervals are based on the assumption that the equipment is operated within the specified ratings and ambient conditions. ABB recommends annual inspections to ensure the highest reliability and optimum performance.

Long term operation near the specified maximum ratings or ambient conditions may require shorter maintenance intervals for certain components. Contact your local ABB Service representative for additional maintenance recommendations.

**Note 1:** Cooling liquid to be used is Antifrogen N mixed with tapwater. For more details, see chapter *Cooling and heating.* In case practical examples or specific tests carried with the above mentioned cooling mixture together with the cooling system materials the maintenance interval can be revised.

**Note 2:** The capacitor lifetime and the resulting maintenance interval can be calculated based on the operational, ambient and environmental conditions.

**Note 3:** The maintenance schedule of the main circuit breaker is according to maximum 1,000 operations of the breaker per each year. Replacement after 6000 operations. For more information, refer to the maintenance manual of the ABB SACE breaker.

**Maintenance timers and counters**

The control program has maintenance timers or counters that can be configured to generate a warning when a pre-defined limit is reached. Each timer/counter can be set to monitor any parameter. This feature is especially useful as a service reminder. For more information, see the firmware manual.
Power connections

- **Tightening**

  > **WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

  1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
  2. Check the tightness of the cable connections. Use the tightening torques given in chapter *Technical data*.

**Fans**

The lifespan of the cooling fans of the converter depend on the running time of the fan, ambient temperature and dust concentration. See the firmware manual for the parameter or actual value which indicates the running time of the cooling fan of the converter modules. For resetting the running time after a fan replacement, contact ABB.

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

All the fans in the converter are of the same type.
Replacing the cooling fan of the converter module

WARNING! Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
2. Cooling fan of the converter module (a) is located on top of the module. Open the door of the converter module cubicle and remove the shroud in front of the fan.
3. Disconnect the wiring plug of the fan (b).
4. Remove the fastening screws (c) of the fan support.
5. Lift the fan unit out of the cabinet.
6. Detach the fan from the support plate by loosening the fastening screws of the fan. The fan grille is detached then too.
7. Install a new fan in reverse order. Check that the air flow direction is correct (an arrow indicating the direction is marked on the side of the fan). Remember to install the fan grille before lifting the fan into the cabinet.
Replacing the fan of the main breaker cubicle

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
2. Detach the shroud in front of the fan of the main breaker cubicle.
3. Pull the shroud carefully out of the cabinet. Observe the cable rail on top of the main circuit breaker when removing the shroud.
4. Disconnect the wiring plug of the fan.
5. Remove the fastening screws of the plate in front of the fans and remove the plate.
6. Remove the fastening screws of the fan support plate and pull the support plate and the fan out.
7. Remove the fastening screws of the fan grille (M4×60, 4 pcs) and detach the fan grille together with the fan.
8. Replace the fan.
9. Install a new fan in reverse order. Check that the air flow direction is correct (an arrow indicating the direction is marked on the side of the fan).
Replacing the upper cooling fan of the main breaker cubicle

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
2. Remove the shroud in front of the upper cooling fan.
3. Disconnect the wiring plug in front of the fan support plate.
4. Remove the fastening screws of the fan support plate and pull the support plate and the fan out.
5. Remove the fastening screws of the fan and detach the fan.
6. Replace the fan.
7. Install a new fan in reverse order. Check that the air flow direction is correct (an arrow indicating the direction is marked on the side of the fan).
## Replacing the cooling fan of the auxiliary control cubicle

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
2. The cooling fan of the auxiliary control cubicle is located in the lower part of the cubicle. Open the door of the auxiliary control cubicle.
3. Disconnect the wiring plug of the fan.
4. Undo the four fastening screws of the fan.
5. Pull the fan out.
6. Install a new fan in reverse order. Check that the air flow direction is correct (an arrow indicating the direction is marked on the side of the fan). For the correct air flow circulation, see the picture below.
Air flow circulation
Replacing the upper cooling fan of the LCL filter cubicle

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
2. Open the door of the LCL filter cubicle. The upper cooling fans of the LCL filter cubicle are attached to the metal plate.
3. Disconnect the wiring plug of the fan (a).
4. Undo the fastening screws of the fan (b).
5. Pull the fan out.
6. Install a new fan in reverse order. Check that the air flow direction is correct (an arrow indicating the direction is marked on the side of the fan). In this case, the air flow direction is towards the inner part of the cabinet.
Air flow direction, side view of the cubicle

Door of the LCL filter cubicle

Upper cooling fans
Replacing the lower cooling fan of the LCL filter cubicle

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

1. Disconnect the converter from the all power sources and make sure it is safe to start the work. See the safety instructions.
2. Open the door of the LCL filter cubicle. There are three cooling fans in the lower part of the cubicle.
3. Disconnect the wiring plugs (3 pcs, a) of the fans and detach the thermostat (B27, b).
4. Remove the fastening screws (M6, 6 pcs, c) and pull the fan cassette out.
5. Remove the fastening screws of the fan (M4 × 60 mm, 4 pcs, d)

6. Replace the fan.

7. Install a new fan in reverse order. Check that the air flow direction is correct (an arrow indicating the direction is marked on the side of the fan). In this case, the air flow direction is upwards.
Fuses

Replacing the DC fuses

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
2. Remove the shrouds in front of the fuses.
3. Open the M10 screws and remove the fuses.
4. Insert new fuses.
5. Re-assemble the parts in reverse order. The tightening torque for the M10 screws is 42 N·m (31 lbf·ft).
**Replacing the AC fuses**

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
2. Remove the shrouds in front of the fuses.
3. Open the M10 screws and remove the fuses.
4. Insert new fuses.
5. Re-assemble the parts in reverse order. The tightening torque for the M10 screws is 42 N·m (31 lbf·ft).
- Replacing the DC chopper fuses

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

The DC chopper fuses are located in the top part of the grid-side converter cubicle. See section *Layout drawing* on page 20.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
2. Remove the shrouds in front of the fuses.
3. Open the nuts and remove the fuses.
4. Insert new fuses.
5. Re-assemble the parts in reverse order. Tightening torque for the M10 screws is 42 N·m (31 lbf·ft).
Replacing the clamping filter fuses

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

The clamping filter fuses are located in the lower part of the grid-side converter cubicle. See section *Layout drawing* on page 20.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
2. Remove the sealing ring.
3. Detach the screws and nuts.
4. Remove the insulation cover and insulation sheet.
5. Detach the bolts and remove the fuse.
6. Re-assemble the parts in reverse order. Tightening torque for the M10 joint is 42 N·m (31 lbf·ft). Make sure that you install the fuse in the correct position: the indicator towards the cable end.
Converter module

Replacing the converter module

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

**WARNING!** If you ignore the following instructions, physical injury, death, or damage to the equipment can occur:

- The modules are heavy and have a high center of gravity. They topple over easily if handled carelessly.
- When removing a module, pull the module carefully out of the cubicle along the installation stand. Prevent the module from falling.
- Keep your fingers away from the edge of the module front plate to avoid pinching them between the module and the cubicle.
- Use protective gloves! The edges of the module are sharp!
- Beware not to drop the screws inside the module!
- Do not tilt the module. Do not leave the module unattended on a sloping floor.

1. Disconnect the converter from the all power sources and make sure it is safe to start the work. See the safety instructions. Secure the main circuit breaker [Q1] to the disconnected (racked out) position. If the disconnecting equipment is located outside the cabinet, make sure that it is in the disconnected position. Close the inlet and outlet valves of the liquid cooling unit, and drain the cooling circuit. See section *Draining the internal cooling circuit* on page 134.
2. Open the door of the module cubicle.
3. Remove the shrouds on top and bottom of module cubicle.
4. Remove the shroud supports.
5. Remove the plastic covers in front of the fiber optic cables.
6. Unplug the fiber optic cables and X50 connectors. Carefully place the cables on top of the fan.

7. Remove the pipe clamps from top tubes.
8. Open top liquid connection nut with 30 mm wrench. Pull the pipe upwards to release it.
9. Open two module support bolts from top.

10. Open bottom liquid connection with 30 mm wrench. Pull the pipe downwards to release it.
11. Remove the module bottom support by opening 3 pcs of M6 screws and 2 pcs of M8 screws.
12. Open 2 pcs of Taptite® M6 screws.
13. Open Taptite® M6 screw on the floor.

14. Open the installation stand (optional) and place it in front of the module.
15. Install 3 pcs of M6 Taptite® screws (removed earlier) to secure the installation stand. Tightening torque is 5 N·m (3.7 lbf·ft).
16. Insert M8 bolt to the hole on the top part of the module and turn it clockwise. This will help in pushing the module out. It also helps in pulling simultaneously from the handle while turning the screw.

17. Pull the module out a bit (5 cm [20 in]) and install the lifting hook to the lifting hole.
18. Pull the whole module onto the installation stand. Keep the pipes and wires away from the sharp edges and be careful not to damage the coolant connections.

19. Lift the module onto a pallet or other platform for transportation.

20. Install a new module in reverse order. Tightening torque for cooling connectors is 10 N·m (7.4 lbf-ft) in room temperature (around +20 °C [68 °F]).

**Capacitors**

The converter intermediate circuit employs film capacitors. Their lifespan depends on the operating time of the converter, loading and ambient temperature. Capacitor life can be prolonged by lowering the ambient temperature.

Capacitor failure is usually followed by the converter module and module fuse failure, or a fault trip. Contact ABB if capacitor failure is suspected. Replacements are available from ABB. Do not use other than ABB specified spare parts.
BCU control unit

**WARNING!** Only qualified electricians are allowed to do this work. Do not remove or insert a memory unit when the converter is powered or the control unit is powered from an external power source. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.

- **Replacing the memory unit**

  The memory unit is located on the BCU control unit.

  **WARNING!** Do not remove or insert the memory unit when the control unit is powered.

  See b in figure *Replacement illustration* on page 102.
  1. To remove the memory unit, undo the fastening screw and pull the memory unit out.
  2. Insert the new memory unit and fasten the screw.

- **Replacing the real-time clock battery**

  Replace the real-time clock battery if the BATT LED is not illuminated when the control unit is powered.

  See a in figure *Replacement illustration* on page 102.
  1. Undo the fastening screw and remove the battery.
  2. Insert the new battery according to figure *Replacement illustration*.
  3. Dispose the old battery according to local disposal rules or applicable laws.
  4. Set the real-time clock.

- **Replacing the SD/SDHC memory card**

  **Note:** Do not remove the SD card while the yellow WRITE LED is lit. Writing to the SD card is in progress.

  See c in figure *Replacement illustration* on page 102.
  1. Undo the fastening screw (Torx T10) of the clip covering the memory card and press the card to remove it. For the card location, see the following figure.
  2. Insert the new card in reverse order. Tightening torque for fastening screw is 0.7 N·m (0.5 lbf·ft). Repeat the replacement procedure for other BCU control unit if needed.
Replacement illustration

See also chapter *Control units of the converter*.

**Main circuit breaker**

For ABB-SACE main circuit breaker maintenance, refer to the manufacturer’s instructions (1SDH001000R0002).
Checking the pH of the coolant

The coolant pH must be below 8.5. Measure the coolant pH every second year before you possibly add inhibitor.

**Note:** The addition of inhibitor can temporarily increase the liquid pH level over the limits specified in this manual. This depends on the water quality and is not harmful to the system.

Keep a log of the test results.

1. If the pH is below 8.5, add only inhibitor in the internal cooling circuit. See section Freeze protection and corrosion inhibition on page 140.

2. If the pH is between 8.5 and 9, replace the coolant.

If the pH is below 6 or more than 9, contact your local ABB representative for instructions on how to flush the system and replace the coolant.
Smoke detectors

- Testing the smoke detectors with test smoke

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. Only external control voltage can be supplied. See the safety instructions.
2. Wait for five minutes for the capacitors to discharge.
3. Remove the upper door of the incoming cubicle.
4. Remove the plug (M5).
5. Push the straw to the hole.
7. Check that the converter sets the fault: 5E63 Grid Smoke detector fault. Status of the alarm can be checked also from K112:slot 3: DI2.
8. Clear the fault with auxiliary power reboot.
9. After test, save and write down the inspection date.
10. Fasten the plug.
Replacing the smoke detector

**WARNING!** Only qualified electricians are allowed to do this work. Read the complete safety instructions of the converter. If you ignore the instructions, physical injury, death, or damage to the equipment can occur.

1. Disconnect the converter from all power sources and make sure it is safe to start the work. See the safety instructions.
2. Wait for five minutes for the capacitors to discharge.
3. Unplug the connector XAI by pulling it upward.
4. Detach the five fixing screws (M6).
5. Pull the smoke detector kit out.
6. Detach the four fixing screws (M5) of the EMC cover.
7. Detach the EMC cover.
8. Remove the smoke detector by rotating.
9. Remove the base by detaching the two screws (M4).
10. Install a new base. See the delivery-specific circuit diagrams.
11. Install a new smoke detector by rotating.
12. Assemble and fasten the smoke detector kit in reverse order.
13. When the installation is complete, test the operation of the smoke detector. See section *Testing the smoke detectors with test smoke* on page 104.
EMC cover

Smoke detector
Technical data

Contents of this chapter
This chapter contains the technical data of the ACS880-87LC-3328A/4100A-7.

Ratings

<table>
<thead>
<tr>
<th>Converter type ACS880-87LC-3328A/4100A-7</th>
<th>Generator-side converter ratings</th>
<th>Grid-side converter ratings</th>
<th>Cos phi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( P_{\text{gen}} ) kW</td>
<td>( I_2 ) A</td>
<td>( P_{\text{grid}} ) kW</td>
</tr>
<tr>
<td>( U_N = 580 ) V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3328A/4100A-7</td>
<td>3580</td>
<td>3328</td>
<td>4410</td>
</tr>
</tbody>
</table>

Power flow:
- Grid-side converter (AC/DC): 4900 kVA
- Generator-side converter (DC/AC): 3978 kVA
**Technical data**

**Definitions**

Generator-side converter ratings

- $U_N$: Nominal voltage (see also section Grid specification on page 111)
- $P_{gen}$: Typical generator power. The power ratings apply at nominal voltage 690 V.
- $I_2$: Continuous rms current of the generator-side converter

Grid-side converter ratings

- $P_{grid}$: Rated grid-side converter power. The power ratings apply at nominal voltage 690 V.
- $I_1$: Continuous rms current of the grid-side converter
- $S_n$: Apparent power
- $\cos \phi$: Controllable cos phi with full rated power capacity. Range: -value...+value.

**Derating**

The load capacity (current and power) decreases if the installation site altitude exceeds 1000 meters (3281 ft), or if the ambient temperature exceeds 45 °C (113 °F).

**Temperature derating**

In the temperature range +45 °C (+113 °F) ... +55 °C (+131 °F), the rated output current is decreased by 2.5 % for every additional 1 °C (1.8 °F). The output current is calculated by multiplying the current given in the rating table by the derating factor.

Example: If the ambient temperature is 55 °C (+131 °F), the derating factor is $100\% - 2.5 \% \cdot 10 ^\circ \text{C} = 75\%$ or 0.75. The output current is then $0.75 \cdot \alpha_{gen}$.

**Altitude derating**

At altitudes from 1000 ... 2000 m (3281 ... 6562 ft) above sea level, the derating is 0.5% for every 100 m (328 ft). Derating is allowed only on maximum continuous current for grid and generator. If the installation site is situated higher than 2000 m (6562 ft) above sea level, contact ABB.

Alternatively, the derating can be handled with cooling liquid temperature derating. 1 °C for every 100 m. This means that in eg, 2000 m installation, the maximum liquid temperature is 40 °C (instead of 50 °C) instead of 5% current derating.

**Type equivalence table**

<table>
<thead>
<tr>
<th>Converter type</th>
<th>Construction type</th>
<th>Basic module type (R9iLC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS880-87LC-</td>
<td>Generator-side converter modules + Grid-side converter modules+ LCL</td>
<td>ACS880-104LC-... (+E205)</td>
</tr>
<tr>
<td>$U_N = 580 \text{ V}$</td>
<td></td>
<td>ACS880-104LC-... (+E205)</td>
</tr>
<tr>
<td>3328A/4100A-7</td>
<td>$4 \times R9iLC + 6 \times R9iLC + 1 \times LCL$</td>
<td>-0860A-7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0800A-7</td>
</tr>
</tbody>
</table>

3AXD10000011539
Fuses

- **Main circuit AC fuses**

<table>
<thead>
<tr>
<th>Converter type</th>
<th>AC fuses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS880-87LC-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U_N = 580$ V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3328A/4100A-7</td>
<td>Bussmann 170M6116</td>
<td>1250</td>
</tr>
</tbody>
</table>

- **Main circuit DC fuses**

<table>
<thead>
<tr>
<th>Converter type</th>
<th>DC fuses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS880-87LC-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U_N = 580$ V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3328A/4100A-7</td>
<td>Bussmann 170M6151</td>
<td>1400</td>
</tr>
</tbody>
</table>

- **Fuses for the voltage measurement board BAMU**
  The fuse type is Mersen cartridge fuse 1021 CP URB 27x60/32, 32 A 1000 V AC (IEC/UL); 2 pcs

- **Fuses for the clamping filter**
  The fuse type is Bussmann 170M3141,100 A 1250 V AC; 2 pcs

**Dimensions, weights and free space requirements**

See also chapter *Dimension drawings.*

<table>
<thead>
<tr>
<th>Converter type</th>
<th>Dimensions</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS880-87LC-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U_N = 580$ V</td>
<td>Height: 2000 (78.7)</td>
<td>Depth: 1200 (47.2)</td>
</tr>
</tbody>
</table>

For free space requirements, see chapter *Dimension drawings.*
110  Technical data

Losses, cooling data and noise

<table>
<thead>
<tr>
<th>Converter type</th>
<th>Losses</th>
<th>Cooling data</th>
<th>Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS880-87LC-</td>
<td>Liquid</td>
<td>Air</td>
<td>Mass flow (tolerance -2%...+20%)</td>
</tr>
<tr>
<td></td>
<td>kW</td>
<td>kW</td>
<td>l/min</td>
</tr>
<tr>
<td>U_N = 580 V</td>
<td>3328A/4100A-7</td>
<td>155</td>
<td>3</td>
</tr>
</tbody>
</table>

- **Internal cooling circuit data**
  See chapter *Cooling and heating.*

**Terminal and lead-through data for the grid connection**

Each busbar consists of two parts placed against each other. You can connect cable lugs to both sides of the connection busbar. Grid-side power connection enters the cabinet at the bottom of the cabinet.

- **Tightening torques**

<table>
<thead>
<tr>
<th>Screw size</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5</td>
<td>4 N·m (3 lbf·ft)</td>
</tr>
<tr>
<td>M6</td>
<td>9 N·m (6.6 lbf·ft)</td>
</tr>
<tr>
<td>M8</td>
<td>22 N·m (16.2 lbf·ft)</td>
</tr>
<tr>
<td>M10</td>
<td>42 N·m (31 lbf·ft)</td>
</tr>
<tr>
<td>M12</td>
<td>70 N·m (52 lbf·ft)</td>
</tr>
<tr>
<td>M16</td>
<td>120 N·m (89 lbf·ft)</td>
</tr>
</tbody>
</table>

For the drawings and dimensions of the grid cable terminals, see chapter *Dimension drawings.*
Terminal and lead-through data for the generator cable

You can connect cable lugs to both sides of the connection busbar. The lead-throughs are acquired separately by the customer. Generator cables enter the cabinet at the top of the cabinet.

Generator cable connection busbars are presented below. See also chapter Dimension drawings.

Grid specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage ($U_1$)</td>
<td>525/550/575/580/600/660/690 V AC 3-phase for 690 V AC converters. This is indicated in type designation label as typical input voltage level (3~ 690 V AC). ±10% variation from the converter nominal voltage is allowed as default.</td>
</tr>
<tr>
<td>Frequency ($f_1$)</td>
<td>50 ± 5 Hz or 60 ± 5 Hz. Maximum rate of change 17%/s.</td>
</tr>
<tr>
<td>Maximum allowable prospective short-circuit current (IEC 60439-1, UL 508 C)</td>
<td>75 kA when protected by fuses given under Fuses. According to UL 508C, the converter is not rated for short-circuits with a power factor less than 1.</td>
</tr>
<tr>
<td>Power factor</td>
<td>-1…0…1</td>
</tr>
<tr>
<td>Harmonic distortion</td>
<td>Total harmonic current distortion ($n = 2...40$) &lt; 5%.</td>
</tr>
<tr>
<td></td>
<td>Total harmonic voltage distortion ($n = 2...40$) &lt; 5%, when $R_{sc} ≥ 7$.</td>
</tr>
</tbody>
</table>

Requirements for the grid connection

For applicable grid codes, contact your local ABB representative.
Generator connection data

Generator types: AC induction generators, permanent magnet generators
Voltage ($U_2$): $0 \ldots 110\% U_1$, 3-phase symmetrical, $U_{\text{max}}$ 750 V
Output frequency ($f_2$): 8...200 Hz
Switching frequency:
  - Grid-side converter: 2.6 kHz
  - Generator-side converter: 1.5 kHz
Frequency resolution: 0.01 Hz
Current: See section Ratings on page 107.
Field weakening point: 8 ... 300 Hz

DC chopper (option +D150) and DC resistor connection data

Option +D150: There is a DC chopper with no ABB-installed DC resistor. The customer connects a customer-acquired DC resistor at the installation site.
See also chapter Dimension drawings.

- **DC chopper fuses**

<table>
<thead>
<tr>
<th>Type</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bussmann 170M4243</td>
<td>2 per DC resistor</td>
</tr>
</tbody>
</table>

- **DC resistor data (per one resistor)**

<table>
<thead>
<tr>
<th>Resistance</th>
<th>1.0 ohm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal voltage (between live and earthed parts)</td>
<td>1300 V DC</td>
</tr>
<tr>
<td>Peak power (duration)</td>
<td>900 kW (3 s)</td>
</tr>
<tr>
<td>Continuous power</td>
<td>9 kW</td>
</tr>
<tr>
<td>Energy absorption capacity</td>
<td>2700 kW</td>
</tr>
</tbody>
</table>

BCU control unit
See chapter Control units of the converter.

Efficiency
96.5% at nominal load with power factor 1.0 at 580 V.

Degree of protection
The converter is labeled as IP54, IP2x with cubicle doors open.

Environmental and corrosion classification
The expected lifetime for the converter cabinet enclosure is considered to be at least 20 years under the following environmental classifications and corrosion class.

Environmental classifications in accordance with IEC60721-3-3

- Climatic conditions 3K5 1)
Notes:
1) Condensation and/or formation of ice inside the converter cabinet is not allowed in any operational circumstances.
2) ABB additional extension to ambient surrounding temperature, outside the cabinet, -30 °C … 55 °C (-22 °F … 131 °F). See also section Temperature derating on page 108.
3) L denotes service life >15 years.

Disclaimer
The customer shall ensure that the environmental conditions inside the wind turbine is maintained in order to fulfill the environmental classifications and/or corrosion class, as herein stated. If the operational condition is out of any environmental classifications and/or corrosion class, the expected lifetime of the converter may be risked and the ABB converter warranty is terminated. If the customer is unsure about the environmental conditions and/or corrosive class inside the wind turbine, the customer is responsible for contacting ABB before the converter installation, and get an approval from ABB to use the converter in such an environmental condition and/or corrosive class.

Ambient conditions

Environmental limits for the converter are given below. The converter must be used in a heated, indoor controlled environment.

<table>
<thead>
<tr>
<th></th>
<th>Operation installed for stationary use</th>
<th>Storage in the protective package</th>
<th>Transportation in the protective package</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Installation site altitude</strong></td>
<td>0 … 1000 m (3281 ft) above sea level. Above 1000 m (3281 ft), see section Derating on page 108.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Air temperature</strong></td>
<td>-30 … +45 °C (-22 … +113 °F) (with heating procedure below +5 °C before start-up) Freezing of coolant is not allowed. Above +45 °C (+113 °F), see section Derating on page 108.</td>
<td>-40 … +70 °C (-40 … +158 °F)</td>
<td>-40 … +70 °C (-40 … +158 °F)</td>
</tr>
<tr>
<td><strong>Relative humidity</strong></td>
<td>0 … 95%</td>
<td>0 … 95%</td>
<td>0 … 95%</td>
</tr>
<tr>
<td><strong>Contamination levels</strong></td>
<td>No conductive dust allowed.</td>
<td>Maximum allowed relative humidity is 60% in the presence of corrosive gases.</td>
<td></td>
</tr>
<tr>
<td>(IEC 60721-3-3, IEC 60721-3-2, IEC 60721-3-1)</td>
<td>Boards with coating: Chemical gases: Class 3C2, Solid particles: Class 3S2</td>
<td>Boards with coating: Chemical gases: Class 1C2, Solid particles: Class 1S3</td>
<td>Boards with coating: Chemical gases: Class 2C2, Solid particles: Class 2S2</td>
</tr>
<tr>
<td><strong>Atmospheric pressure</strong></td>
<td>70 … 106 kPa 0.7 … 1.05 atmospheres</td>
<td>70 … 106 kPa 0.7 … 1.05 atmospheres</td>
<td>60 … 106 kPa 0.6 … 1.05 atmospheres</td>
</tr>
</tbody>
</table>
Materials

<table>
<thead>
<tr>
<th>Cabinet</th>
<th>Hot-dip zinc-coated (thickness approx. 20 µm) steel sheet (thickness 1.5 mm) with polyester thermosetting powder coating (thickness approx. 80 µm) on visible surfaces. Color: RAL 7035 (light beige, semi-gloss). Color of the side panels: RAL 9017 (black, semi-gloss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Busbars</td>
<td>Tin- or silver-plated copper or aluminum</td>
</tr>
<tr>
<td>Internal cooling circuit piping</td>
<td>Aluminum, acid-fast stainless steel, PA pipes</td>
</tr>
<tr>
<td>Fire safety of materials (IEC 60332-1)</td>
<td>Insulating materials and non-metallic items: Mostly self-extinctive</td>
</tr>
<tr>
<td>Packaging</td>
<td>Frame: Wood or plywood. Plastic wrapping: PE-LD. Bands: PP or steel. The main parts of the converter can be recycled to preserve natural resources and energy. Product parts and materials should be dismantled and separated. Generally all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, cardboard and other packaging material can be used in energy recovery. Printed circuit boards and large electrolytic capacitors need selective treatment according to IEC 62635 guidelines. To aid recycling, plastic parts are marked with an appropriate identification code. Please contact your local ABB distributor for further information on environmental aspects and recycling instructions for professional recyclers. End of life treatment must follow international and local regulations.</td>
</tr>
</tbody>
</table>

Auxiliary circuit current consumption

Auxiliary circuit current consumption varies depending on the size of the converter and selected options. For detailed information, contact your local ABB representative.

- **ACS880-87LC-3328A/4100A-7**

**UPS supply**

Voltage 230 V AC ± 5%, frequency 50 Hz or 60 Hz, typical power consumption 431 VA, peak power and current consumption 8487 VA and 36.9 A.

**Non-UPS supply**

Voltage 400 V AC ± 5%, frequency 50 Hz or 60 Hz, typical continuous power consumption 6659.3 VA, maximum peak power consumption 41569 VA.
Applicable standards

The converter complies with the standards below. The compliance with the European Low Voltage Directive is verified according to standards EN 61800-5-1.


- **EN 60529:1991**
  Degrees of protection provided by enclosures (IP code)

- **EN/IEC 61439:2011**
  Low-voltage switchgear and controlgear assemblies

- **EN/IEC 60146**
  Semiconductor converters - General requirements and line commutated converters

- **EN/IEC 50178**
  Electronic equipment for use in power installations

- **IEC 60664-1:2007**
  Insulation coordination for equipment within low-voltage systems. Part 1: Principles, requirements and tests.

- **IEC 61400-1:2005**
  Wind turbines. Part 1: Design requirements

- **IEC 61800-3:2017**
  Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods

- **EN 61800-5-1:2007**
  Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – electrical, thermal and energy.

- **BS7671**
  Requirements for electrical installations

- **NEMA 250:2003**
  Enclosures for Electrical Equipment (1000 Volts Maximum)

- **UL 61800-5-1**
  Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy. See ETL marking on page 117.

- **GL-IV-1:2010**
  Guideline for Certification of Wind Turbines

- **CSA C22.2 No.274-13**
  Adjustable Speed Drives

CE marking

A CE mark is attached to the converter to verify that the converter follows the provisions of the European Low Voltage Directive 2014/35/EU (previously 2006/95/EC) and EMC Directive 2014/30/EU (previously 2004/108/EC).

- **Compliance with the European Low Voltage Directive**
  The compliance with the European Low Voltage Directive has been verified according to standard EN 61800-5-1.

- **Compliance with the European EMC Directive**

Compliance with the European Machinery Directive

**Note:** In standard texts, the term 'drive' stands for 'converter' in case of wind turbine applications.

The drive is an electronic product which is covered by the European Low Voltage Directive. The drive is equipped with emergency stop push buttons and a main circuit breaker with related relays, which can be used in implementing an emergency stop function for machinery. This safety function is in the scope of the Machinery Directive as safety component, and appropriate harmonized standards (EN ISO 13850, EN ISO 13849 or EN 62061) shall be applied.
Regulatory Compliance Mark (RCM)

RCM marking is pending. Applies as Compliance with EN 61800-3:2004.

EAC marking

The converter has EAC certification. EAC marking is required in Russia, Belarus and Kazakhstan.


- Definitions

EMC stands for Electromagnetic Compatibility. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality.

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

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

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

The requirements of the standard can be met as follows:

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

![Diagram](image)

2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available from the local ABB representative.

3. The generator and control cables are selected as specified in the hardware manual.

4. The converter is installed according to the instructions given in the hardware manual.

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

**ETL marking**

cETLus certified.

The converters are ETL certified in accordance with UL 61800-5-1 *Adjustable Speed Electrical Power Drive Systems First Edition* and CSA C22.2 No. 274-13 *Adjustable Speed Drive*.

The converter provides overload protection in accordance with the National Electrical Code (US) and Canadian Electrical Code (Canada). See the firmware manual for setting. Default setting is off; the setting must be activated at start-up.

The converters are to be used in a heated indoor controlled environment. See section *Ambient conditions* for specific limits.

**DNV-GL Renewable Certification marking**

This converter type is GL2010 Component Certified according to *GL-IV-1:2010 Guideline for Certification of Wind Turbines* by DNV-GL, and is allowed to bear the DNV-GL Renewable Certification mark (Certificate No. CC-GL-IV-1-00282-1):

- ACS880-87LC-3328A/4100A-7.
WEEE marking

The converter is marked with the wheelie bin symbol. It indicates that at the end of life the converter should enter the recycling system at an appropriate collection point and not placed in the normal waste stream. See section Materials on page 114.

Disclaimers

- **Generic disclaimer**

  The manufacturer shall have no obligation with respect to any product which (i) has been improperly repaired or altered; (ii) has been subjected to misuse, negligence or accident; (iii) has been used in a manner contrary to the manufacturer's instructions; or (iv) has failed as a result of ordinary wear and tear.

- **Cybersecurity disclaimer**

  This product is designed to be connected to and to communicate information and data via a network interface. It is Customer's sole responsibility to provide and continuously ensure a secure connection between the product and Customer network or any other network (as the case may be). Customer shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.
Control units of the converter

Contents of this chapter

This chapter describes the layout and connections of the control units and contains the specifications of the inputs and outputs of the control units.

For the actual connections of the control units used in the ACS880-87LC converter, see the circuit diagrams delivered with the converter.

General

- BCU control unit

The BCU control unit consists of a BCON control board (and a BIOC I/O and power supply board) built in a metal housing. The BCU is mounted separately from the converter module(s), and connected to the module(s) by fiber optic cables. In this manual, the name “BCU” represents the control unit type BCU-12.
Layout and connections

BCU layout and connections

<table>
<thead>
<tr>
<th>Description</th>
<th>I/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/O terminals (see the following diagram)</td>
<td></td>
</tr>
<tr>
<td>SLOT 1</td>
<td>I/O extension, encoder interface or fieldbus adapter module connection. (This is the sole location for an FDPI-02 diagnostics and panel interface.)</td>
</tr>
<tr>
<td>SLOT 2</td>
<td>I/O extension, encoder interface or fieldbus adapter module connection</td>
</tr>
<tr>
<td>SLOT 3</td>
<td>I/O extension, encoder interface, fieldbus adapter connection</td>
</tr>
<tr>
<td>SLOT 4</td>
<td>RDCO-ox DDCS communication option module connection</td>
</tr>
<tr>
<td>X205</td>
<td>Memory unit connection</td>
</tr>
<tr>
<td>BATTERY</td>
<td>Holder for real-time clock battery</td>
</tr>
<tr>
<td>A11</td>
<td>Mode selector for analog input A11 (I = current, U = voltage)</td>
</tr>
<tr>
<td>A12</td>
<td>Mode selector for analog input A12 (I = current, U = voltage)</td>
</tr>
<tr>
<td>D2D TERM</td>
<td>Termination switch for drive-to-drive link (D2D)</td>
</tr>
<tr>
<td>DICOM= DIOGND</td>
<td>Ground selection. Determines whether DICOM is separated from DIOGND (ie, the common reference for the digital inputs floats).</td>
</tr>
</tbody>
</table>

7-segment display
Multicharacter indications are displayed as repeated sequences of characters

- ("U" is indicated briefly before "o"): Control program startup in progress
- (Flashing) Firmware cannot be started. Memory unit missing or corrupted
- Firmware download from PC to control unit in progress
- At power-up, the display may show short indications of eg. “1”, “2”, “b” or “U”. These are normal indications immediately after power-up. If the display ends up showing any other value than those described, it indicates a hardware failure.
<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XAI</td>
</tr>
<tr>
<td>XAO</td>
</tr>
<tr>
<td>XDI</td>
</tr>
<tr>
<td>XDIO</td>
</tr>
<tr>
<td>XD2D</td>
</tr>
<tr>
<td>XD24</td>
</tr>
<tr>
<td>XETH</td>
</tr>
<tr>
<td>XPOW</td>
</tr>
<tr>
<td>XRO1</td>
</tr>
<tr>
<td>XRO2</td>
</tr>
<tr>
<td>XRO3</td>
</tr>
<tr>
<td>XSTO</td>
</tr>
<tr>
<td>XSTO OUT</td>
</tr>
<tr>
<td>X12</td>
</tr>
<tr>
<td>X13</td>
</tr>
<tr>
<td>X485</td>
</tr>
</tbody>
</table>

- **V1T/V1R, V2T/V2R**: Fiber optic connection to converter modules 1 and 2 (VxT = transmitter, VxR = receiver)
- **V3T/V3R…VT7/V7R**: Fiber optic connection to converter modules 3…7 (BCU-12/22 only) (VxT = transmitter, VxR = receiver)
- **V8T/V8R…V12T/V12R**: Fiber optic connection to converter modules 8…12 (BCU-22 only) (VxT = transmitter, VxR = receiver)

- **SD CARD**: Data logger memory card for converter module communication

- **BATT OK**: Real-time clock battery voltage is higher than 2.8 V. If the LED is off when the control unit is powered, replace the battery.
- **FAULT**: The control program has generated a fault. See the firmware manual.
- **PWR OK**: Internal voltage supply is OK
- **WRITE**: Writing to memory card in progress. Do not remove the memory card.
Control unit connector data

**Power supply**

- **(XPOW)**
  - Connector pitch 5 mm, wire size 2.5 mm²
  - 24 V (±10%) DC, 2 A
  - External power input. Two supplies can be connected to BCU for redundancy.

**Relay outputs RO1…RO3**

- **(XRO1…XRO3)**
  - Connector pitch 5 mm, wire size 2.5 mm²
  - 250 V AC / 30 V DC, 2 A
  - Protected by varistors

**+24 V output**

- **(XD24:2 and XD24:4)**
  - Connector pitch 5 mm, wire size 2.5 mm²
  - Total load capacity of these outputs is 4.8 W (200 mA / 24 V) minus the power taken by DIO1 and DIO2.

**Digital inputs D1…D6**

- **(XDI:1…XDI:6)**
  - Connector pitch 5 mm, wire size 2.5 mm²
  - 24 V logic levels: “0” < 5 V, “1” > 15 V
  - Input type: NPN/PNP (D1…D5), NPN (D6)
  - Hardware filtering: 0.04 ms, digital filtering up to 8 ms
  - D6 (XDI:6) can alternatively be used as an input for a PTC thermistor.
  - “0” > 4 kohm, “1” < 1.5 kohm
  - $I_{\text{max}}$: 15 mA (D1…D5), 5 mA (D6)

**Start interlock input DIIL**

- **(XDI:7)**
  - Connector pitch 5 mm, wire size 2.5 mm²
  - 24 V logic levels: “0” < 5 V, “1” > 15 V
  - Input type: NPN/PNP
  - Hardware filtering: 0.04 ms, digital filtering up to 8 ms

**Digital inputs/outputs DIO1 and DIO2**

- **(XDIO:1 and XDIO:2)**
  - Input/output mode selection by parameters.
  - DIO1 can be configured as a frequency input (0…16 kHz with hardware filtering of 4 microseconds) for 24 V level square wave signal (sinusoidal or other wave form cannot be used), DIO2 can be configured as a 24 V level square wave frequency output. See the firmware manual, parameter group 11/111.

**Reference voltage for analog inputs**

- **(XAI:1 and XAI:2)**
  - Connector pitch 5 mm, wire size 2.5 mm²
  - 10 V ±1% and –10 V ±1%, $R_{\text{load}}$ 1…10 kohm
  - Maximum output current: 10 mA

**Analog inputs AI1 and AI2**

- **(XAI:4 … XAI:7)**
  - Current/voltage input mode selection by switches.
  - Current input: –20…20 mA, $R_{\text{in}} = 100$ ohm
  - Voltage input: –10…10 V, $R_{\text{in}} > 200$ kohm
  - Differential inputs, common mode range ±30 V
  - Sampling interval per channel: 0.25 ms
  - Hardware filtering: 0.25 ms, adjustable digital filtering up to 8 ms
  - Resolution: 11 bit + sign bit
  - Inaccuracy: 1% of full scale range
Control units of the converter  123

Analog outputs AO1 and AO2 (XAO)
Connector pitch 5 mm, wire size 2.5 mm²
0…20 mA, $R_{\text{load}} < 500$ ohm
Frequency range: 0…500 Hz
Resolution: 11 bit + sign bit
Inaccuracy: 2% of full scale range

Drive-to-drive link (XD2D)
Connector pitch 5 mm, wire size 2.5 mm²
Physical layer: RS-485
Termination by switch

RS-485 connection (X485)
Connector pitch 5 mm, wire size 2.5 mm²
Physical layer: RS-485

Safe torque off connection (XSTO)
Connector pitch 5 mm, wire size 2.5 mm²
Input voltage range: -3…30 V DC
Logic levels: “0” < 5 V, “1” > 17 V
For the converter to start, both connections must be “1”
EMC (immunity) according to IEC 61326-3-1

Safe torque off output (XSTO OUT)
Connector pitch 5 mm, wire size 2.5 mm²

Control panel connection (X13)
Connector: RJ-45
Cable length < 3 m

Ethernet connection (XETH)
Connector: RJ-45

SDHC memory card slot (SD CARD)
Memory card type: SDHC
Maximum memory size: 4 GB

The terminals of the control unit fulfill the Protective Extra Low Voltage (PELV) requirements. The PELV requirements of a relay output are not fulfilled if a voltage higher than 48 V is connected to the relay output.
Control units of the converter
Dimension drawings

Contents of this chapter
This chapter contains dimension drawings of the wind turbine converter. See also the dimension drawings delivered with the converter.
Transportation state without packing
Mass during transportation: 4460 kg (9833 lb)
Cooling and heating

Contents of this chapter
This chapter deals with the internal cooling circuit.

Hardware description

- **General**
  The internal cooling circuit covers the heat-generating electrical components and transfers the heat to the external cooling circuit that is usually part of a larger external cooling system.

- **Diagram of the internal cooling and heating circuit**
  The following diagram shows how coolant circulates in the auxiliary control, grid-side converter, LCL filter, main breaker and generator-side converter cubicles of the wind turbine converter.
Coolant OUT

<table>
<thead>
<tr>
<th>MBC/cap</th>
<th>LCL</th>
<th>Grid-side converter</th>
<th>Generator-side converter</th>
<th>ACU</th>
<th>CCU</th>
</tr>
</thead>
<tbody>
<tr>
<td>+01.5</td>
<td>+01.4</td>
<td>+01.1</td>
<td>+01.2</td>
<td>+01.1</td>
<td>+01.2</td>
</tr>
</tbody>
</table>

Coolant IN

B31 = inlet coolant temperature monitoring
B32 = outlet coolant temperature monitoring
PT1 = inlet pressure sensor
PT2 = outlet pressure sensor (pressure difference is monitored, PT1-PT2, to ensure sufficient flow)
V201 = bleeding valve
V101 = draining valve
Planning the cooling system

Connection to a customer cooling unit

General requirements
Equip the system with an expansion tank to damp pressure rise due to volume changes when the temperature varies. Keep the pressure within the limits specified in Specifications below. Install a pressure regulator to ensure that the maximum permissible operating pressure is not exceeded.

Install a bleeding valve at the highest point of the cooling circuit. Bleeding valve is not included in the ABB converter delivery as standard.

The materials used in the cooling system are listed in Specifications on page 139.

Coolant temperature control
The temperature of the coolant in the internal cooling circuit must be kept within the limits specified in Specifications on page 139. Note that the minimum temperature depends on ambient temperature and relative humidity.

The following diagram shows an example of coolant temperature control using the three-way valve in the external cooling circuit. Part of the infeed coolant flow is directed into the return pipe through a three-way valve without letting it circulate in the internal cooling circuit if the coolant in the internal circuit is too cold.
Mechanical installation

- **Connecting the internal cooling circuit to a customer cooling unit**

The converter delivery does not include the liquid cooling unit that is to be connected to the converter cabinet.

**Connecting the liquid pipes**

**Note:** It is recommended to use closing valves in the pipe connections of the cooling circuit.

1. Ensure that there is sufficient space and free access to make proper cooling pipe connections between the liquid cooling unit and the converter. It is not allowed to use inflexible and fixed cooling pipe connections between two separate units (e.g., liquid cooling unit and the converter connection). Always use a flexible connector that can reduce possible stress caused by e.g., vibration.

2. Check visually that the converter liquid pipes are not damaged (threads and flange joint not damaged).

3. Connect the external cooling circuit directly to the coupling pipes on the side of the converter. Lay liquid piping with extreme care. Secure the pipes properly mechanically and check for leaks. See chapter *Technical data* for the pipe materials.

4. Position the liquid pipe ends against each other.

5. Centre the connector onto the pipe ends.

6. Tighten the
   - threaded connector carefully and ensure that it is slid on the pipe ends. The use of appropriate sealant is recommended.
   - flange bolts to a minimum torque of 70 N·m (52 lbf·ft).

7. Make sure that the liquid pipes are securely connected.
Filling up and bleeding the internal cooling circuit

Both the converter and coolant must be at room temperature before filling in the cooling circuit.

**WARNING!** Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

- Make sure that the maximum permissible operating pressure is not exceeded. When necessary control the pressure to appropriate level by draining excess coolant out of the system.
- Do not drain propylene glycol into the sewer system.
- Be careful when you bleed the cooling circuit. Air bubbles in the circuit may reduce or completely block coolant flow and cause overheating. Fill up and bleed the pumps in the cooling circuit carefully as they can get damaged when run dry. Obey the instructions of the external the cooling unit.

### Converters with a customer cooling unit

**Notes:**
- The bleed valves in the converter are used only to vent the air from the circuit so that it can be displaced by the coolant. The actual bleeding of the circuit must be done via an external bleed valve installed at the highest point of the cooling circuit. The most practical location for the valve is usually near or at the cooling unit. Bleeding and draining valves are not included in the standard delivery of the ABB converter.
- Observe the instructions given by the manufacturer of the cooling unit. Pay special attention to filling up and bleeding the pumps properly as they may be damaged if operated when dry.
- Draining propylene glycol into the sewer system is not allowed.

1. Open the bleed valve at the cooling unit.
2. Lead the bleed hoses into buckets or other suitable containers. Extend the standard hoses if necessary.
3. Fill the circuit with coolant. For coolant specification, see below.
4. After the converter is filled up, coolant will start flowing from the bleed hose of the converter. Let some coolant flow out before closing the bleed valve.
5. Let any air remaining in the system out through the bleed valve at the cooling unit.
6. Close the bleed valve at the cooling unit.
7. Continue to fill in coolant until a base pressure of 100…150 kPa is achieved.
8. Open the bleed valve of the pump to allow any air out.
9. Re-check the pressure and add coolant if necessary.
10. Start the coolant pump. Let any air remaining in the system out through the bleed valve at the cooling unit.
11. After one to two minutes, stop the pump or block the coolant flow with a valve.
12. Re-check the pressure and add coolant if necessary.
13. Repeat steps 10...12 a few times until all air is let out of the cooling circuit. Listen for a humming sound and/or feel the piping for vibration to find out if there is still air left in the circuit.

Adjustments
- Set the base pressure to 100...150 kPa by draining coolant from the fill/drain coupling.
- Control the coolant temperature so that it stays between the limits stated in Specifications on page 139.

Draining the internal cooling circuit

You can drain the internal cooling circuit through the cooling unit as follows:

Note: Draining coolant into the sewer system is not allowed.

WARNING! High-pressure hot coolant may be present in the internal cooling circuit. No work on the cooling circuit is allowed until the pressure is lowered down by stopping the pumps and draining coolant.

1. Lead the bleed hose into a bucket or other suitable container. Extend the standard hoses when necessary.
2. Open the bleed valve to let air displace the liquid.
3. If required, dry the piping with compressed oil-free air of less than 6 bar (600 kPa).
4. If the converter is to be stored in temperatures below 0 °C (32 °F),
   - dry the cooling circuit with air
   - fill the cooling circuit with a mixture of water and coolant according to section Freeze protection and corrosion inhibition on page 140
   - drain the cooling circuit again.

Cooling station control

The purpose of this instruction is to explain the cooling station control in general level. Details can be found in the customer circuit diagrams and in the firmware manual of the converter.

Cooling station is controlled by the converter. One converter type is compatible with all four variants of cooling station:
- cold climate variant with speed-controlled cooling fans,
- cold climate variant with start/stop controlled cooling fans,
- standard climate variant with speed-controlled cooling fans,
- standard climate variant with start/stop controlled cooling fans.

The converter controls and supervises cooling station operation during:
- heating
- drying
- cooling operation phases.

Start

At first, the auxiliary power is not switched on and the printed circuit boards are not energized. The system is started when the auxiliary power 230 V AC (UPS) or 400 V AC (non-UPS) is connected. The temperature of the auxiliary control cubicle is monitored by
using a thermostat. If the temperature is below T1, heating of the auxiliary control cubicle is started by using the electrical heater. Cooling unit changes to ACU heating state. The value of temperature T1 depends on thermostat hysteresis level in use.

- Cold -> warm \( T_1 = +15 \, ^\circ C \) (59 °F)
- Warm -> cold \( T_1 = +5 \, ^\circ C \) (41 °F)

When temperature is above T1, there may be condensed moisture inside the converter and the converter has two options for start:

- OnSiteMode ON: A person checks at the turbine that no condensation occurs. Dry-out phase can be bypassed with a push button which is located in the auxiliary control cubicle. Cooling unit control changes to Booting state.
- OnSiteMode OFF: Nobody checks at the turbine if condensation has occurred. Dry-out phase of the auxiliary control cubicle is required to avoid possible damage due to condensed water. Cooling unit control changes to ACU dry-out state.

**ACU heating**

The auxiliary control cubicle is equipped with electrical heating elements. The auxiliary control cubicle needs to be heated before the BCU control units can be powered. Heating will take up to one hour.

**ACU dry-out**

Electrical heating elements are used to dry out the auxiliary control cubicle. The auxiliary control cubicle needs to be dried out before the BCU control units can be powered. It will take one hour.

**Booting**

BCU control units are powered. Converter communication as CAN slave starts. Maximum time for booting the control units and CAN communication wake-up is one minute. The firmware checks the re-cooling unit, see the firmware manuals for details.

Temperature in each converter cubicle is monitored separately by using thermostats. If temperature of any cubicle is below T1, cooling unit control changes the state to Converter heating.

If temperature in all cubicles is above T1, condensation inside the converter may have occurred and the converter has two options for start:

- OnSiteMode ON / short black-out: A person has checked at the turbine that no condensation occurs. Dry-out phase can be bypassed with a push button which is located in the auxiliary control cubicle. If black-out was so short that no condensation may have occurred, the dry-out phase is bypassed. The length of the black-out is evaluated by using a real time clock in control units. Cooling unit control changes the state to Run.
- OnSiteMode OFF: Converter dry-out phase required. Cooling unit control changes to Converter dry-out state.
Faulted
- The pump is stopped.
- Switch off the coolant heater.
- Switch off the fans.
- Switch off the fan heaters.
- If the fault is reset, the state will change back to Booting and the firmware checks will start over.

Converter heating
- Coolant pump is running.
- Coolant heaters started after parameter-based delay.
- Coolant pressure is monitored by pressure sensor. When the temperature of the main breaker cubicle is above -20 °C (-4 °F), the fans inside the converter cabinet start and speed up the warming process.
- The electrical heater in the auxiliary control cubicle is re-started if the temperature of the auxiliary control cubicle drops below 5 °C (41 °F).
- The fan located on the heat exchanger of the auxiliary control cubicle is controlled by the control unit. The purpose is to avoid re-cooling of already heated auxiliary control cubicle. The fan is started when the measured coolant inlet temperature is above +10 °C (50 °F).
- ABB recommends to use 15 kW heating power. Converter heating time with 15 kW heating power is:
  - -25...+15 °C (-13...59 °F): 3h 30min
  - -20...+15 °C (-4...59 °F): 2h 30min
  - -15...+15 °C (5...59 °F): 2h 15min
  - -10...+15 °C (14...59 °F): 2h
  - -5...+15 °C (23...59 °F): 1h 45min
- When all temperatures are above 15 °C (59 °F), the state will change to Run.

Converter dry-out
As converter heating state with following exceptions:
- To dry-out the converter cabinet: 12 hours warming with converter fans running
- When the dry-out time has elapsed, the state will change to Run.

Run
- Coolant pump will run all the time to avoid concentration of possible particles and deterioration of gaskets.
- Coolant pressure is monitored by pressure sensor.
- Condensation is prevented by keeping the coolant temperature higher (+5 °C (41 °F)) than the ambient temperature, but never less than +15 °C (59 °F). This will override the normal cooling level activation criteria or can activate the heaters (temperature hysteresis limits to switch on/off heater and stopping/staring all fans).
- For details of the Run mode, see the firmware manual of the converter.
State diagram

Auxiliary power is connected to connector XD001

Start

ACU temp < T1

ACU heating and dry-out
• ACU heating and dry-out using electrical heater
• HW timer for dry-out (A hours)

ACU temp > T1 AND
OnSiteMode OFF

ACU temp > T1 AND
OnSiteMode ON

Temp > T1
AND
Timer > A hours

Faulted
• Pump stopped
• Return to Booting when reseted

Booting
• Control units booting
• Required system level healthy checks

Faulted
Converter temp all < T1

Converter temp all > T1
AND
(OnSiteMode ON OR Black out < C hours)

Converter heating
• Heat converter using coolant heaters
• ACU electrical heater used if needed

Heating time depends on used heating power in recooling unit

Converter temp all > 15 °C (59 °F)

B hours

Faulted
Converter dry-out
• Dry-out converter using coolant heaters

Fault in recooling unit

Run
• Normal operation: heating / cooling as needed

Fault in recooling unit

Faulted
OnSiteMode push button is located in the upper part of the auxiliary control cubicle.

**Manual control**

**WARNING!** Do not use manual control constantly. Use it only in special cases, e.g., when adding cooling liquid to the system. Normally, use automatic mode.

You can control the cooling station manually. To switch to manual mode, set parameter 86.71 *Cooling unit control enable* to *Manual mode*. Select the features you want to activate with parameter 86.24 *Manual control word*.

To switch back to automatic control, set parameter 86.71 *Cooling unit control enable* to *Automatic mode*. 
Specifications

Temperature limits

Ambient temperature: See chapter Technical data on page 107.

Minimum coolant inlet temperature: Condensation or frost is not allowed. The minimum coolant temperature to avoid condensation (at an atmospheric pressure of 1 bar / 100 kPa) is shown below as a function of the relative humidity ($\phi$) and the ambient temperature ($T_{\text{air}}$). To avoid all kind of condensation inside the converter: ABB highly recommends to maintain / heat up the cooling liquid $+10 \, ^\circ\text{C} \ (+50 \, ^\circ\text{F})$ above the ambient temperature (ie, air temperature outside the converter), within the limits that the cooling liquid minimum temperature is $+5 \, ^\circ\text{C} \ (41 \, ^\circ\text{F})$ and maximum temperature is $+50 \, ^\circ\text{C} \ (122 \, ^\circ\text{F})$.

<table>
<thead>
<tr>
<th>$T_{\text{air}}$ ($^\circ\text{C}$)</th>
<th>$\phi = 95%$</th>
<th>$\phi = 80%$</th>
<th>$\phi = 65%$</th>
<th>$\phi = 50%$</th>
<th>$\phi = 40%$</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4.3</td>
<td>1.9</td>
<td>-0.9</td>
<td>-4.5</td>
<td>-7.4</td>
</tr>
<tr>
<td>10</td>
<td>9.2</td>
<td>6.7</td>
<td>3.7</td>
<td>-0.1</td>
<td>-3.0</td>
</tr>
<tr>
<td>15</td>
<td>14.2</td>
<td>11.5</td>
<td>8.4</td>
<td>4.6</td>
<td>1.5</td>
</tr>
<tr>
<td>20</td>
<td>19.2</td>
<td>16.5</td>
<td>13.2</td>
<td>9.4</td>
<td>6.0</td>
</tr>
<tr>
<td>25</td>
<td>24.1</td>
<td>21.4</td>
<td>17.9</td>
<td>13.8</td>
<td>10.5</td>
</tr>
<tr>
<td>30</td>
<td>29.1</td>
<td>26.2</td>
<td>22.7</td>
<td>18.4</td>
<td>15.0</td>
</tr>
<tr>
<td>35</td>
<td>34.1</td>
<td>31.1</td>
<td>27.4</td>
<td>23.0</td>
<td>19.4</td>
</tr>
<tr>
<td>40</td>
<td>39.0</td>
<td>35.9</td>
<td>32.2</td>
<td>27.6</td>
<td>23.8</td>
</tr>
<tr>
<td>45</td>
<td>44.0</td>
<td>40.8</td>
<td>36.8</td>
<td>32.1</td>
<td>28.2</td>
</tr>
<tr>
<td>50</td>
<td>49.0</td>
<td>45.6</td>
<td>41.6</td>
<td>36.7</td>
<td>32.8</td>
</tr>
<tr>
<td>55</td>
<td>53.9</td>
<td>50.4</td>
<td>46.3</td>
<td>42.2</td>
<td>37.1</td>
</tr>
</tbody>
</table>

Not allowed as standard but the coolant temperature must be $5 \, ^\circ\text{C} \ (41 \, ^\circ\text{F})$ or above. Consult an ABB representative if operation below coolant temperature $5 \, ^\circ\text{C} \ (41 \, ^\circ\text{F})$ is required.

Example: At an air temperature of $45 \, ^\circ\text{C} \ (113 \, ^\circ\text{F})$ and relative humidity of $65\%$ the coolant temperature may not be below $+36.8 \, ^\circ\text{C} \ (98.2 \, ^\circ\text{F})$.

Maximum coolant inlet temperature: $50 \, ^\circ\text{C} \ (122 \, ^\circ\text{F})$ without derating of the converter output capacity. Range above $50 \, ^\circ\text{C} \ (122 \, ^\circ\text{F})$ is allowed as follows:

<table>
<thead>
<tr>
<th>Range</th>
<th>Converter output current derating</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 \ ... 55 , ^\circ\text{C} \ (122 \ ... 131 , ^\circ\text{F})</td>
<td>2.5% per 1 , ^\circ\text{C} \ (1.8 , ^\circ\text{F}) temperature increase</td>
</tr>
</tbody>
</table>

Maximum temperature rise: $13 \, ^\circ\text{C} \ (55.4 \, ^\circ\text{F})$; depends on mass flow.

Pressure limits

Base pressure: 100…150 kPa (recommended); 200 kPa (maximum). Base pressure denotes the pressure of the system compared with the atmospheric pressure when the cooling circuit is filled with coolant.

Maximum design pressure: 500 kPa

Recommended design maximum pressure: 380 kPa. Note: Contact ABB if you need to rise the pressure over this limit. The pressure difference must be within given limits to avoid malfunction due to excessive coolant flow.
Nominal pressure difference: 110 kPa / 120 kPa (hydrostatic)
Maximum pressure difference: 170 kPa / 180 kPa (hydrostatic)

Water quality

Tap water
The use of drinking water without gas/bubbles is allowed as follows:

Note: The following requirements apply to the water to be used in the coolant, not the water-glycol-inhibitor mixture.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH value</td>
<td>6.0…8.0</td>
</tr>
<tr>
<td>Chloride</td>
<td>&lt; 50 mg/l</td>
</tr>
<tr>
<td>Fluoride</td>
<td>&lt; 50 mg/l</td>
</tr>
<tr>
<td>Sulphate</td>
<td>&lt; 100 mg/l</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>&lt; 200 mg/l; no deposits are allowed at the temperature of +57 °C (153 °F)</td>
</tr>
<tr>
<td>Total hardness as CaCO₃</td>
<td>&lt; 250 mg/l</td>
</tr>
<tr>
<td>Conductivity</td>
<td>&lt; 400 µS/cm (this equals the resistance of &gt; 2500 ohm/cm)</td>
</tr>
<tr>
<td>The water must be clean of solid matter.</td>
<td>The use of purified water which is not intended for human consumption is forbidden.</td>
</tr>
</tbody>
</table>

Freeze protection and corrosion inhibition

WARNING! Pay special attention to the composition of the coolant. ABB allows only Antifrogen N type coolant, and no additional inhibitor/freeze protector must not be used. ABB recommends 44% concentration of Antifrogen N. For other coolants, contact your local ABB representative. THE WARRANTY DOES NOT COVER DAMAGE OCCURRING FROM USE OF IMPROPER COOLANT.

Coolant concentration

ABB recommends diluting coolant 50:50 with water. Note that the concentration of coolant should not be less than 33% and not more than 60%. Following table shows how the diluting portion affects to frost protection.

<table>
<thead>
<tr>
<th>Frost protection down to</th>
<th>Coolant concentration</th>
<th>Water concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20 °C (-4 °F)</td>
<td>33%</td>
<td>66%</td>
</tr>
<tr>
<td>-27 °C (-16.6 °F)</td>
<td>40%</td>
<td>60%</td>
</tr>
<tr>
<td>-38 °C (-36.4 °F)</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>-54 °C (-65.2 °F)</td>
<td>60%</td>
<td>40%</td>
</tr>
</tbody>
</table>

WARNING! Operation at liquid temperatures below 0 °C (32 °F) is not permitted even with antifreeze.

Liquid mixture quality

The pH level of the coolant must not be manipulated by adding chemicals not specified in this document. This may build up sediment in the liquid.
Approved coolants

- Antifrogen N. For other coolants, contact your local ABB representative.

**WARNING!** Do not mix different approved coolants in any conditions! Replace the cooling liquid always with same cooling liquid! Mixing different coolant types is a risk for cooling system corrosion.

**Materials**

Materials used in the internal cooling circuit are:

- stainless steel AISI 316L (UNS 31603)
- heavy gauge aluminum
- plastic materials such as PA, PEX and PTFE
  
  **Note:** PVC hoses are not suitable for use with antifreeze.

- rubber gasket NBR (nitrile rubber).

Use only these materials in the external cooling circuit, too.

**WARNING!** When connecting external piping to the internal cooling circuit, use only materials that are specified above. Copper and brass must not be used under any circumstances. Even minor dissolution of copper can cause copper precipitation on aluminum and subsequent galvanic corrosion. The liquid cooling system may not contain any zinc (for example, galvanized pipes) at all since zinc would react with the inhibitor.
Cooling and heating
Further information

Product and service inquiries
Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to abb.com/searchchannels.

Product training
For information on ABB product training, navigate to new.abb.com/service/training.

Providing feedback on ABB Drives manuals
Your comments on our manuals are welcome. Navigate to new.abb.com/drives/manuals-feedback-form.