ACS800

Hardware Manual
ACS800-67 (+C236) Wind Turbine Convert for Asynchronous Slip Ring Generators

ACS800-67 Manuals

HARDWARE MANUALS	Code (Chinese)	Code (English)
ACS800-67 (+C236) Wind Turbine Converters for Asynchronous Slip Ring Generators Hardware Manual	*3AXD50000173587*	*3AXD50000203802*
FIRMWARE MANUALS		
ACS800 Grid-side Control Program Firmware Manual	*3ABD0000075077*	*3AUA0000075077*
ACS800-67(LC) Doubly-fed Induction Generator Control Program Firmware Manual	*3ABD0000071689*	*3AUA0000071689*
ACS800-67 wind turbine converters System description and start-up guide	*3ABD0000095094*	*3AUA0000095094*
OPTION MANUALS		
NPBA-12 PROFIBUS adapter module installation start-up guide	*3ABD00009284R0125*	*3BFE64341588 R0125*
NCAN-02 CANopen adapter module installation start-up guide	*3ABD64254154*	*3BFE 64254154*
NTAC pulse encoder interface module installation start-up guide	*3ABD00004101R0325*	*3AFY58919730R0325*
NETA-21Remote Monitoring Tool User's Manual	*3ABD0000096939*	*3AUA0000096939*

You can find manuals and other product documents in PDF format on the Internet. See section *Document library on the Internet* on the inside of the back cover. For manuals not available in the Document library, contact your local ABB representative.

ACS800-67 (+C236) Wind Turbine Converters for Asynchronous Slip Ring Generators

Hardware Manual

3AXD50000203802 EN Rev A
EFFECTIVE: 2018-05-01

Safety instructions

Contents of this chapter

This chapter contains safety instructions which you must obey when you install and operate the converter, and do maintenance on the converter. If you ignore the safety instructions, injury, death or damage can occur to the converter, the generator or other adjoining equipment. Read the safety instructions before you work on the unit.

Use of warnings and notes

There are two types of safety instructions throughout this manual: warnings and notes. Warnings tell you about conditions which can cause injury or death, or damage to the equipment. They also tell you how to prevent the danger. Notes draw attention to a particular condition or fact, or give information on a subject. The manual uses these warning symbols:

Electricity warning tells about hazards from electricity which can cause injury or death, or damage to the equipment.

General warning tells about conditions, other than those caused by electricity, which can cause injury or death, or damage to the equipment.

Electrostatic sensitive devices warning tells you about the risk of electrostatic discharge which can cause damage to the equipment.

High temperature warning warns about hot surfaces. Some parts inside the converter cabinet remain hot for a while after the disconnection of main power.

Installation and maintenance work

These warnings are intended for all who work on the converter, generator cable or generator.

WARNING!

- Only qualified electricians are allowed to install and maintain the converter.
- Before any installation work, the stator of the generator and the supply line input of the ACS800-67 must be isolated from the supply grid. It is also highly recommended that the rotor of the generator is locked with a mechanical brake.
- The stator and the converter are not to be reconnected until the installation is complete.
- Never work on the converter, the generator cable or the generator when power is applied. After switching off the input power, always wait for 5 min to let the intermediate circuit capacitors discharge before you start working on the converter, the generator or the generator cable. Measure the voltage between terminals UDC+ and UDC- with a multimeter (impedance at least 1 Mohm) to ensure that the converter is discharged before beginning work.
- Before working in the converter power cabinet:

  Stop the fan, generator and converter. Lock the fan shaft mechanically. Switch off the main breaker, contactor of the stator circuit and the breaker of the fan transformer.

  Lock the main breaker of converter.

  Because the main breaker of converter is non-extractable, the isolation fan transformer switch needed to be isolated and locked in isolation position to ensure the safety.

  Ensure by measuring that the main circuit of the converter and incoming cable have been discharged (it takes 10 minutes after the power switch off).

  Temporary ground the main circuit.
- Apply temporary grounding before working on the unit.
- Do not work on the control cables when power is applied to the converter or to the external control circuits. Externally supplied control circuits can cause dangerous voltages to exist inside the converter even when the main power of the converter is switched off.
- Control boards of the converter unit can be at the main circuit potential. Dangerous voltages can be present between the control boards and the frame of the converter unit when the main circuit voltage is on. It is critical that the measuring instruments, such as an oscilloscope, are used with caution and safety always as a priority. The fault tracing instructions give special mention of cases in which measurements may be performed on the control boards, also indicating the measuring method to be used.

- Do not make any insulation tests without disconnecting the converter from the cabling first.
- When joining shipping splits (if any), check the cable connections at the joints before switching on the supply voltage.
- Live parts on the inside of the doors are protected against direct contact. Pay special attention when handling metallic shrouds.

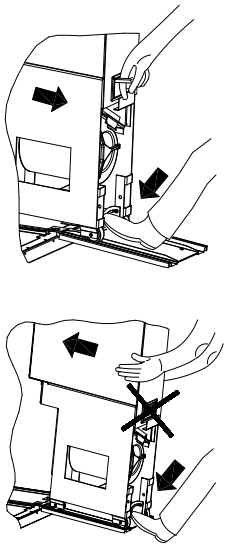
Note:

- If the main circuit of the converter unit is live, the output terminals are also live even if the converter stage is not modulating.
- The brake control terminals (UDC+, UDC-, R+ and R- terminals) are at dangerous DC voltage.
- Depending on the external wiring, dangerous voltages (115 V, 220 V or 230 V) can be present on the relay outputs of the converter system.
- The Prevention of Unexpected Start function does not remove the voltage from the main and auxiliary circuits.

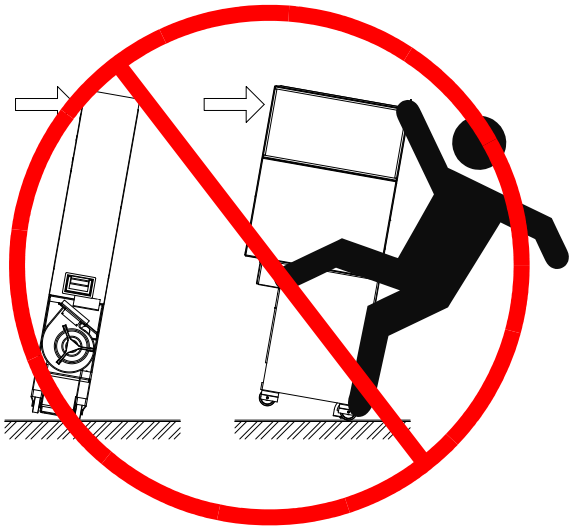
WARNING! Ignoring the following instructions can cause physical injury or death, or damage to the equipment.

- Use extreme caution when manoeuvring a converter or filter module that runs on wheels. The modules are heavy and have a high center of gravity. Make sure that the module does not topple over when you move it on the floor.

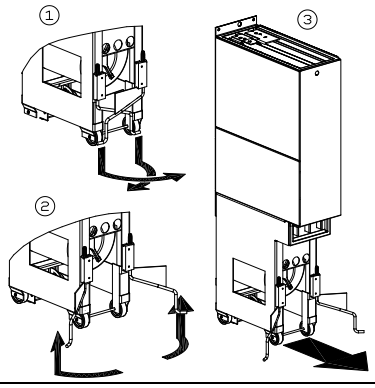
Support bottom of module



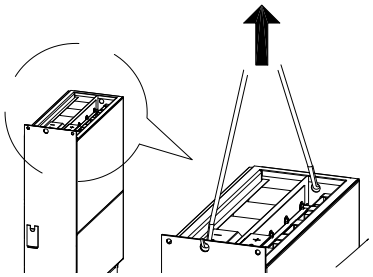
Do not tilt!



Extend the support legs of the converter module outside the cabinet!



Lift the module by the upper part only using the lifting hole(s) at the top!



- Beware of the cooling fan blades. The fans can continue to rotate for a while after the disconnection of the electrical supply.
- Beware of hot surfaces. Some parts inside the converter cabinet, such as heatsinks of power semiconductors, remain hot for a while after the disconnection of the electrical supply.
- Make sure that dust from drilling does not enter the converter when installing. Electrically conductive dust inside the unit may cause damage or lead to malfunction.

- Fastening the cabinet by riveting or welding is not recommended. However, if welding is necessary, ensure the return wire is properly connected in order not to damage the electronic equipment in the cabinet. Also ensure that welding fumes are not inhaled.
- Ensure sufficient cooling of the unit.

WARNING! Ignoring the following instructions can cause damage to the equipment.

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

Grounding

These instructions are for all personnel who are responsible for the grounding of the converter.

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

- Ground the converter, the generator and adjoining equipment to ensure personnel safety in all circumstances, and to reduce electromagnetic emission and pick-up.
- Make sure that the conductivity of the grounding conductors is sufficient. Obey the local regulations.
- In a multiple-converter installation, connect each converter separately to protective earth (PE).
- Do not install a converter equipped with an EMC (line) filter to an ungrounded power system or a high resistance-grounded (over 30 ohms) power system.

Note:

- Power cable shields are suitable for equipment grounding conductors only when adequately sized to meet safety regulations.
- As the normal leakage current of the converter is higher than 3.5 mA AC or 10 mA DC, a fixed protective earth connection is required by EN 61800-5-1, 4.3.5.5.2. The cross-section of the protective grounding conductor must be at least 10 mm^2 Cu or 16 mm^2 Al.

Fibre optic cables

WARNING! Obey these instructions. If you ignore them, equipment malfunction and damage to the fiber optic cables can occur.

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

Operation

These warnings are intended for all who plan the operation of the converter or operate the converter. Ignoring the instructions can cause physical injury or death or damage the equipment.

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

- Before adjusting the converter and putting it into service, ensure that the generator and all adjoining equipment are suitable for operation throughout the speed range provided by the converter.

- Do not operate breakers, contactors, switches or other equipment inside the cabinet when the power is applied. Electric shock may occur also in case of faulty component.
- Do not stand behind the converter when the power is applied. In the event of possible arc inside the cabinet the arc fumes and pressure exit through the backside filter.
- Keep the converter doors locked when the converter is in operation.

Note:

- When the control location is not set to Local (L not shown in the status row of the display), the stop key on the control panel will not stop the converter. To stop the converter using the control panel, press the LOC/REM key and then the stop key ⏹.

Table of contents

Mechanical installation

Planning the electrical installation

Electrical installation

Installation checklist

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Maintenance

Technical data

Further information

About this manual

Contents of this chapter

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

Compatibility

The manual is compatible with ACS800-67 (+C236) wind turbine converters.

Safety instructions

Follow all safety instructions delivered with the converter.

- Read the complete safety instructions on the first pages of this manual before you install, commission, or use the converter.
- Read task specific safety instructions before starting the task. See the section describing the task.

Reader

The reader of the manual is expected to know the standard electrical wiring practices, electronic components, and electrical schematic symbols.

Contents

The chapters of this manual are briefly described below.

Safety instructions gives safety instructions for the installation, commissioning, operation and maintenance of the converter.

Hardware description describes the converter.

Mechanical installation instructs how to move, place and mount the converter.

Planning the electrical installation provides advice on generator and cable selection, the protective functions of the converter, and cable routing.

Electrical installation describes the cabling and wiring of the converter.

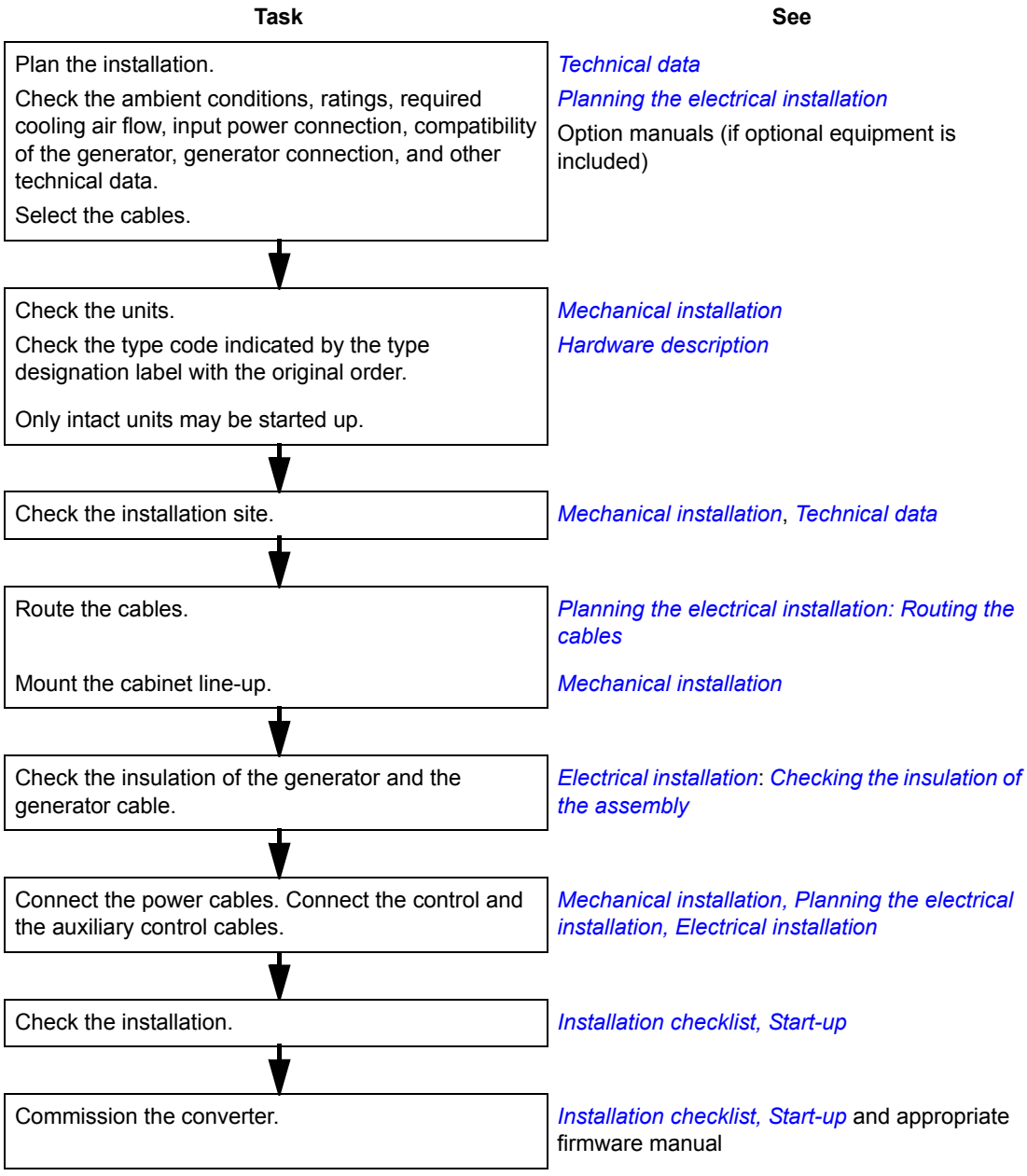
Installation checklist contains a list for checking the mechanical and electrical installation of the converter.

Start-up describes the start-up procedure of the converter.

Maintenance contains preventive maintenance instructions.

Technical data contains the technical specifications of the converter, e.g. ratings, frame sizes and technical requirements and provisions for fulfilling the requirements for CE and other markings.

Installation and commissioning flowchart



Terms and abbreviations

Term/Abbreviation	Explanation
BINT	Main Circuit Interface Board
AMC	Application and Motor Controller Board. Part of the NDCU Drive Control Unit
ZPOW	Power Supply Board
Auxiliary control cubicle (ACU)	The cubicle with auxiliary devices such as auxiliary voltage circuit breakers, control electronics, measurement boards, etc. The slide-out frame is located in the auxiliary control cubicle.
Converter	Converts electric power from one form to another.
DDCS	Distributed Drives Communication System. Communication protocol used with fibre optic link.
DTC	Direct Torque Control
EMC	Electromagnetic Compatibility
IGBT	Insulated Gate Bipolar Transistor. A voltage controlled semiconductor type widely used in converters due to their easy controllability and high switching frequency.
LCL	Inductance - capacitor - inductance filter
Grid-side converter	A converter that is connected to the electrical power network (grid) and is capable of transferring energy from the converter DC link to the grid and vice versa.
BAMU	Auxiliary Measuring Unit. Performs voltage measurement for IGBT supply unit RMIO board.
NCAN	CANopen® Adapter Module
NDCU	Drive Control Unit. Consists of a NAMC board and NIOC board built into a metal housing. NDCU-33 unit controls the rotor-side converter.
NETA	Ethernet Adapter Module
NIOC	Input/Output Board. Part of the NDCU Drive Control unit
NPBA	Profibus-DP® Adapter Module
APBU	PPCS branching unit. Module connected with RDCU/NDCU parallel.
NTAC	Pulse Encoder Interface Module
NUIM	Voltage and Current Measurement Unit
Power cabinet	Cubicle with grid and stator cable terminals, main switching and disconnecting devices, etc.
PPCS	Power Plate Communication System. Communication protocol used with optic fibre link which controls the power stage of the converter modules.
RDCO	DDCS Communication Option with optic fibre channels
RDCU	Drive Control Unit which contains an RMIO (Motor Control and I/O) board. An RDCU unit controls the grid-side converter.

Term/Abbreviation	Explanation
RFI	Radio Frequency Interference
RMIO	Motor Control and I/O Board. Part of the RDCU Drive Control Unit
Rotor-side converter	A converter that is connected to the generator rotor and controls its operation.
UPS	Uninterruptible power supply

Hardware description

Contents of this chapter

This chapter describes the construction of the converter.

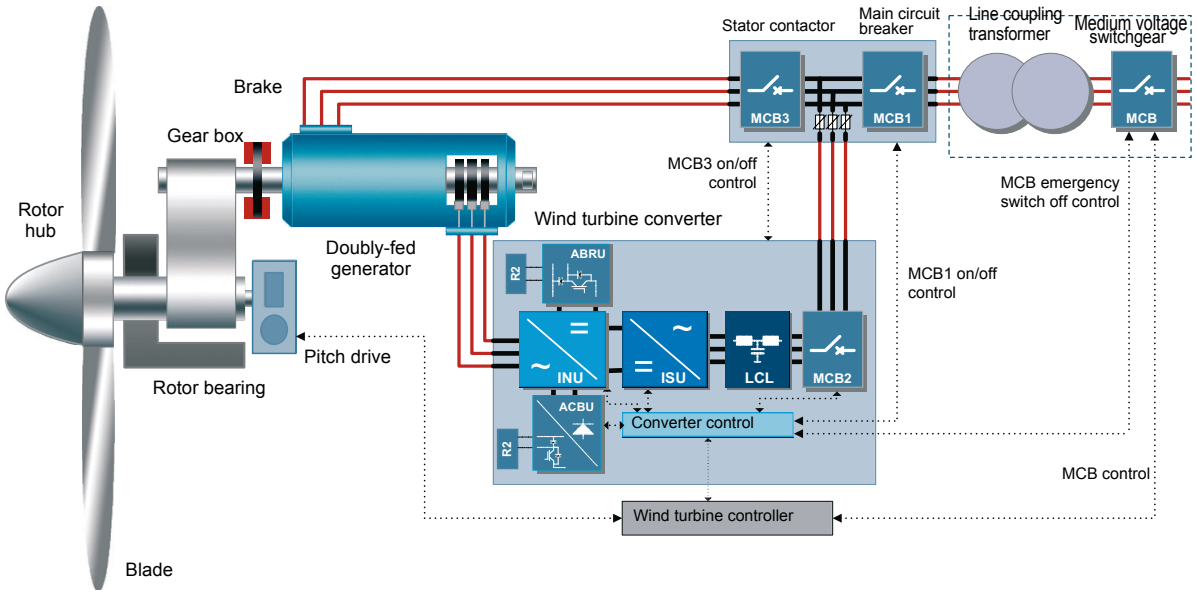
ACS800-67

ACS800-67 wind turbine converter is designed for use with induction generators with wound rotor and slip rings, such as the ABB AMK series. The converter is connected between the generator rotor and the supply network. The converter can be installed in the tower base or in the nacelle.

The speed of the rotor varies in relation to the wind speed. In order to keep the speed optimal (i.e. somewhat higher than the synchronous speed of the generator), the angle of the rotor blades is adjustable by means of a pitch drive. However, adjusting the pitch is fairly slow. To compensate for faster changes in rotor speed, the ACS800-67 quickly accelerates or decelerates the rotation speed of the field in the rotor in order to retain the optimal slip. When the wind decreases, the converter takes energy from the supply and accelerates the rotation of the rotor field so that the stator remains capable of feeding energy to the grid. Likewise, the rotation of the rotor field is decelerated at increasing wind speeds. The energy generated in the rotor above the synchronous speed can also be fed to the grid.

The converter is also used for synchronising the stator output with the grid before the actual grid connection. On disconnection, the converter adjusts the torque to zero. This also decreases the stator current to zero so that the generator can be disconnected.

The diagram below represents a typical application.



Grid-side and rotor-side converters

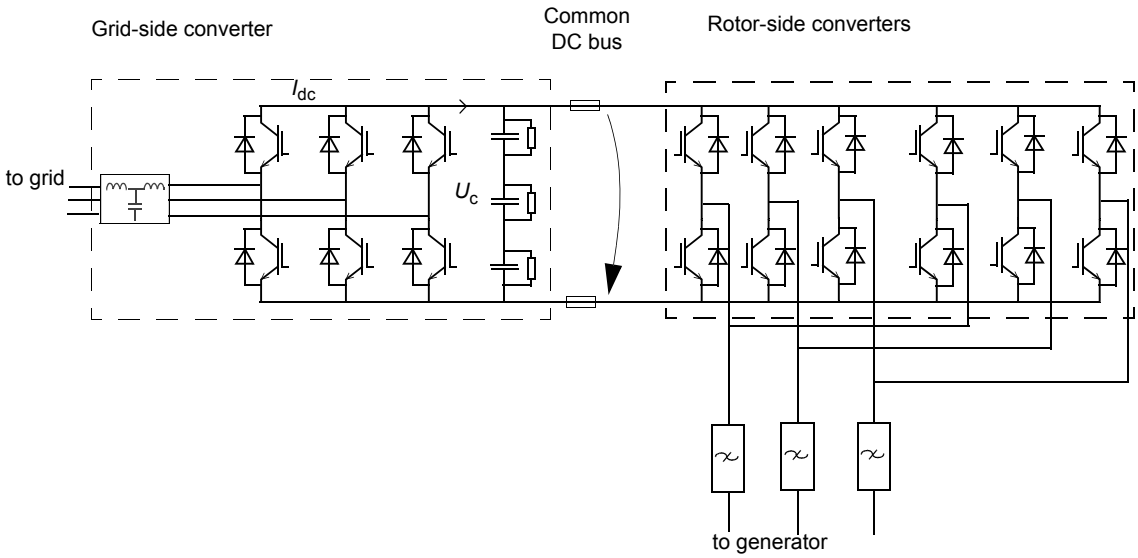
The grid-side converter is an IGBT based module equipped with AC or DC fuse and optional devices. It has an RDCU control unit with IGBT power supply control program. The grid-side converter is controlled by the rotor-side converter control unit via a fibre optic link. (The RDCU is fitted with an RDCO DDCS Communication Option module containing fibre optic terminals.)

The grid-side converter rectifies three phase AC current to direct current for the intermediate DC link of the converter. The intermediate DC link supplies the rotor-side converter. The line filter suppresses the AC voltage and current harmonics.

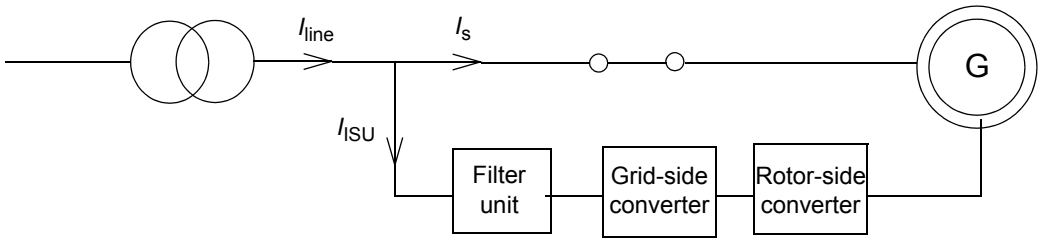
As default, the grid-side converter controls the DC link voltage to the peak value of the line-to-line voltage. The DC voltage reference can be set also higher by a parameter (see *ACS800 Grid-side Control Program Firmware Manual* [3AUA000075077 (English)]. The control of the IGBT power semiconductors is based on the Direct Torque Control (DTC) method typically used in motor control of the converter. Two line currents and DC link voltage are measured and used for the control.

The rotor-side converter consists of two IGBT based converter modules and employs the NDCU-33 control unit. The converter is equipped with Doubly-fed Induction Generator Control Program, which also controls the grid-side converter module via a fibre optic link.

The diagram below shows an example of a common DC bus converter system. In this example the converter consists of one grid-side converter, and two parallel connected rotor-side converters.

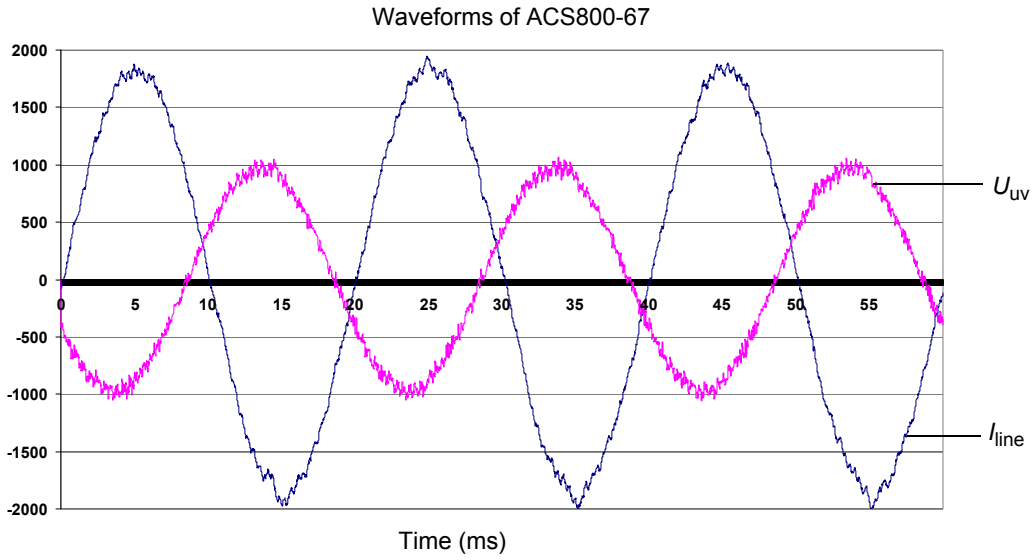


The wind turbine converter line current I_{line} consists of grid-side converter current I_{ISU} and stator current I_s.



Voltage and current waveforms

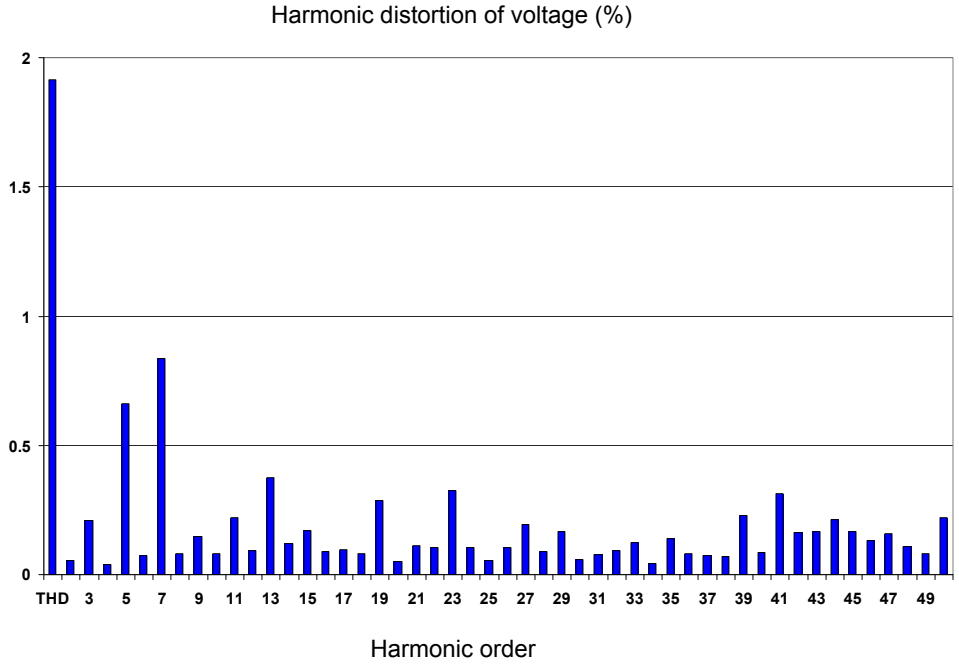
Typical line current I_{line} and line-to-line voltage U_{uv} waveforms are shown below.

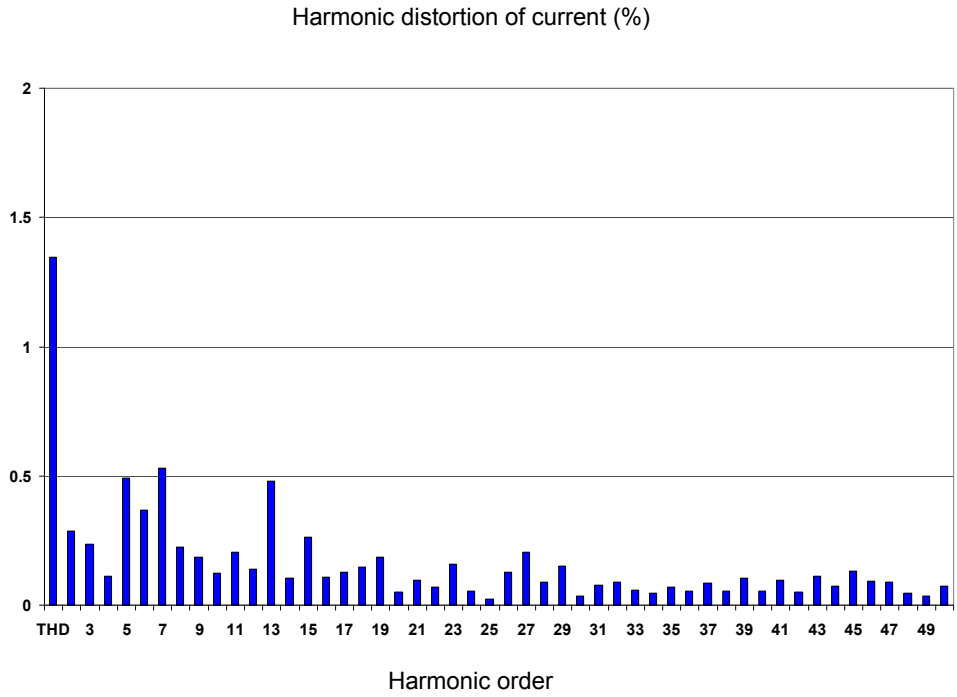


Distortion

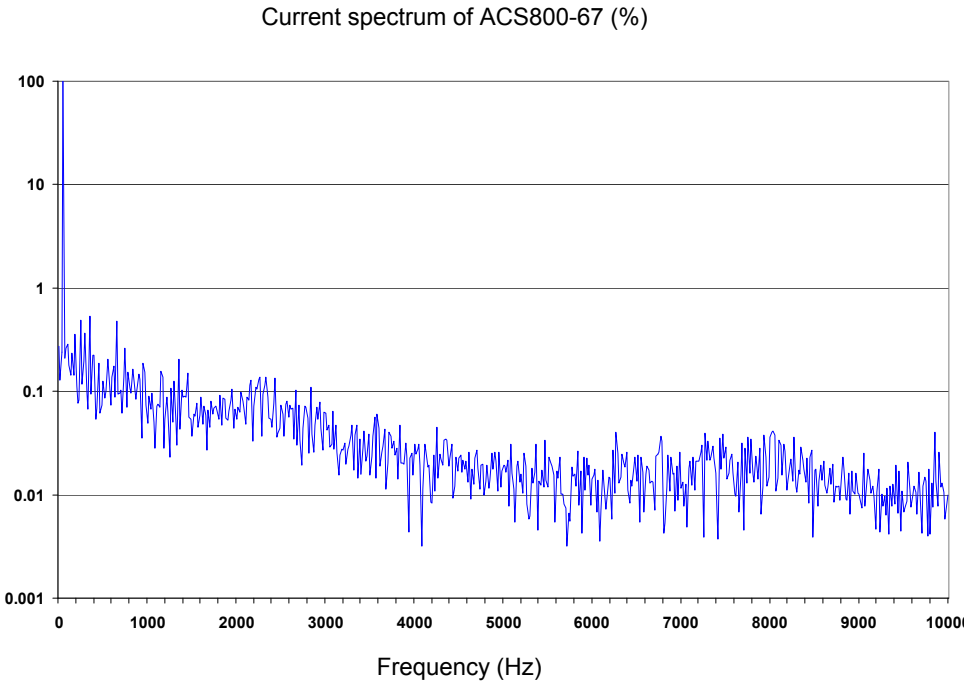
IGBT-type grid-side converter unit does not generate characteristic current/voltage harmonics like a traditional 6- or 12-pulse bridge does, because of the sinusoidal waveform of the line current.

Typical harmonic components of the voltage and current distortion are shown below. Each harmonic is presented as a percentage of the fundamental voltage. n denotes the ordinal number of the harmonic.




Harmonic distortion of current (%)
2
1.5
1
0.5
0
THD 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49
Harmonic order

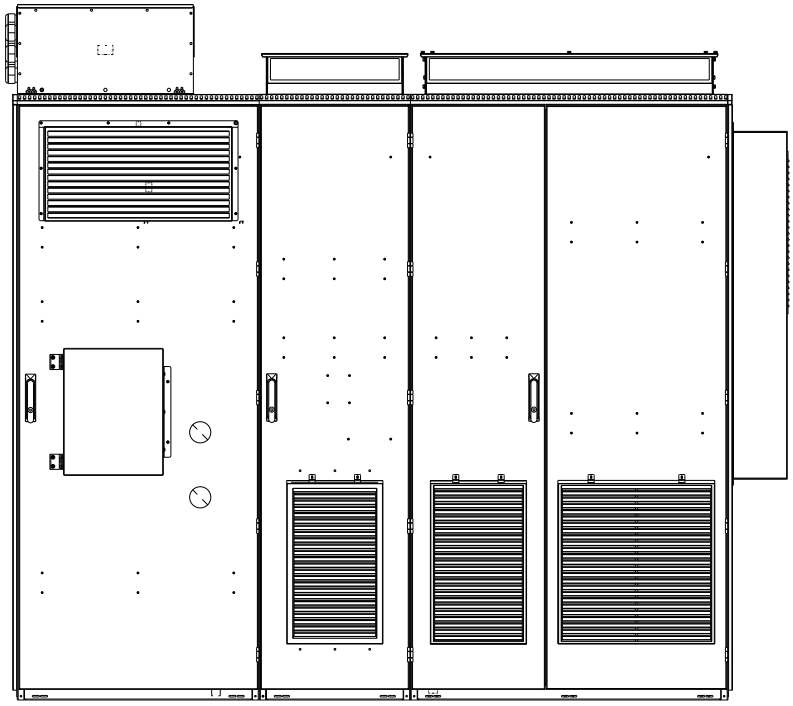
A typical spectrum of the current distortion is shown below. Each point is presented as a percentage of the fundamental current.



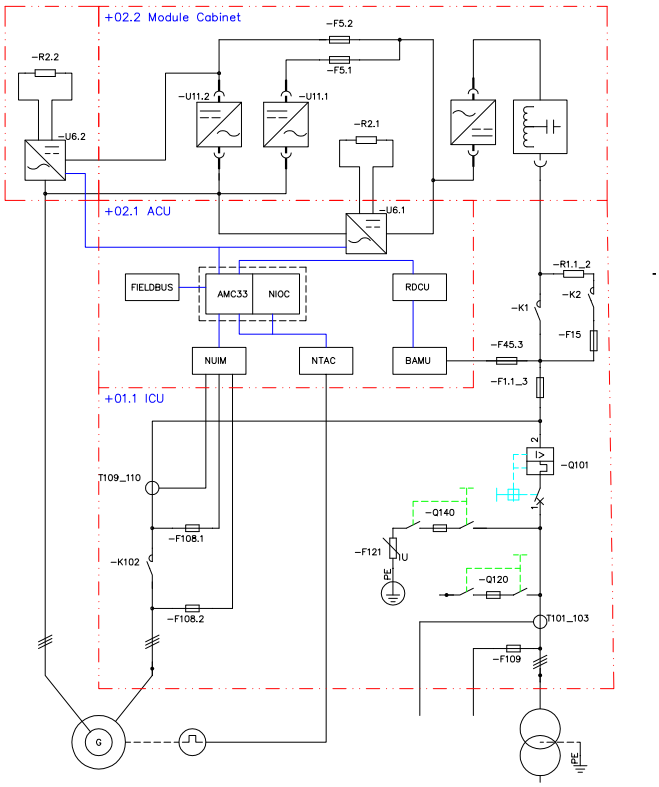
Mechanical construction

Mechanically the power cabinet is an integrated part of the ACS800-67(+C236) converter. The converter is built as one enclosed unit that can be installed either in the tower bottom end or in the nacelle.

The power cabinet is an incoming unit for the ACS800-67 wind turbine converter. The power cabinet contains main switching and disconnecting devices such as main circuit breaker and stator circuit contactor and connection terminals to the power supply network and generator stator. The power cabinet is an integral part of the converter line-up.



Single line diagram

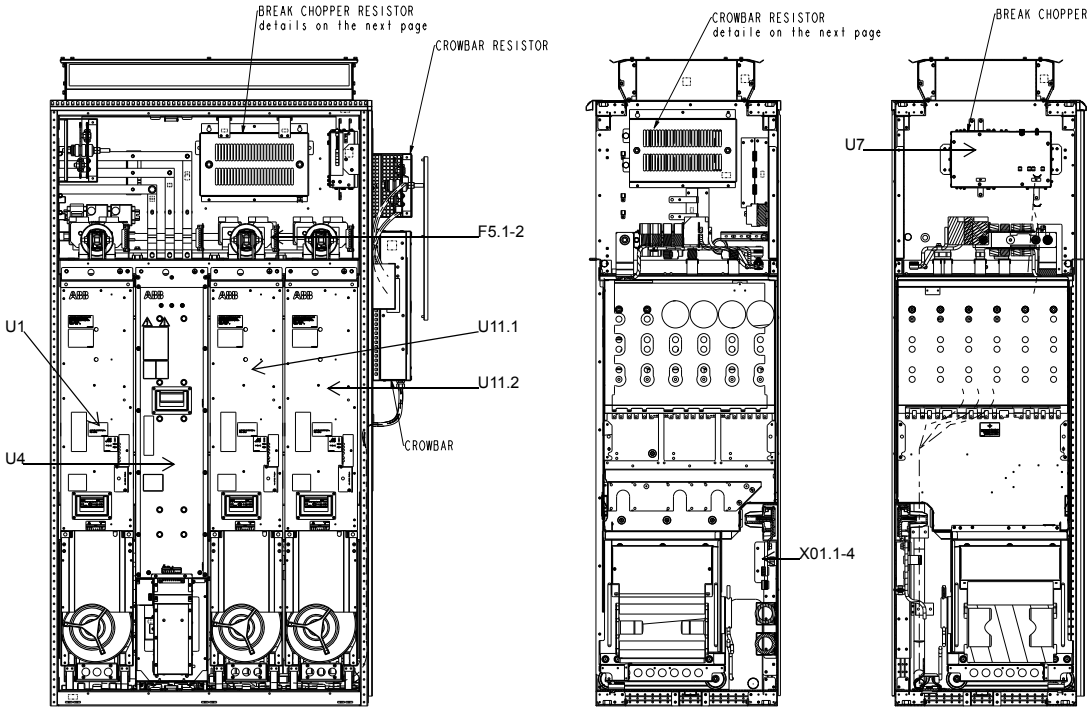


Cabinet layout

Location of main components is shown in the picture below. See the circuit diagram for their electrical connections.

编号	描述
1	Stator contactor
2	Main circuit breaker
3	Cabinet heaters
4	Grid-side (L1, L2, L3) cable lead-throughs
5	Grid-side cable connection terminals
6	Grid-side contactor and AC fuse
7	Charging circuit
8	lightning conductor
9	Stator-side (U, V, W) cable lead-throughs
10	Stator-side cable connection terminals

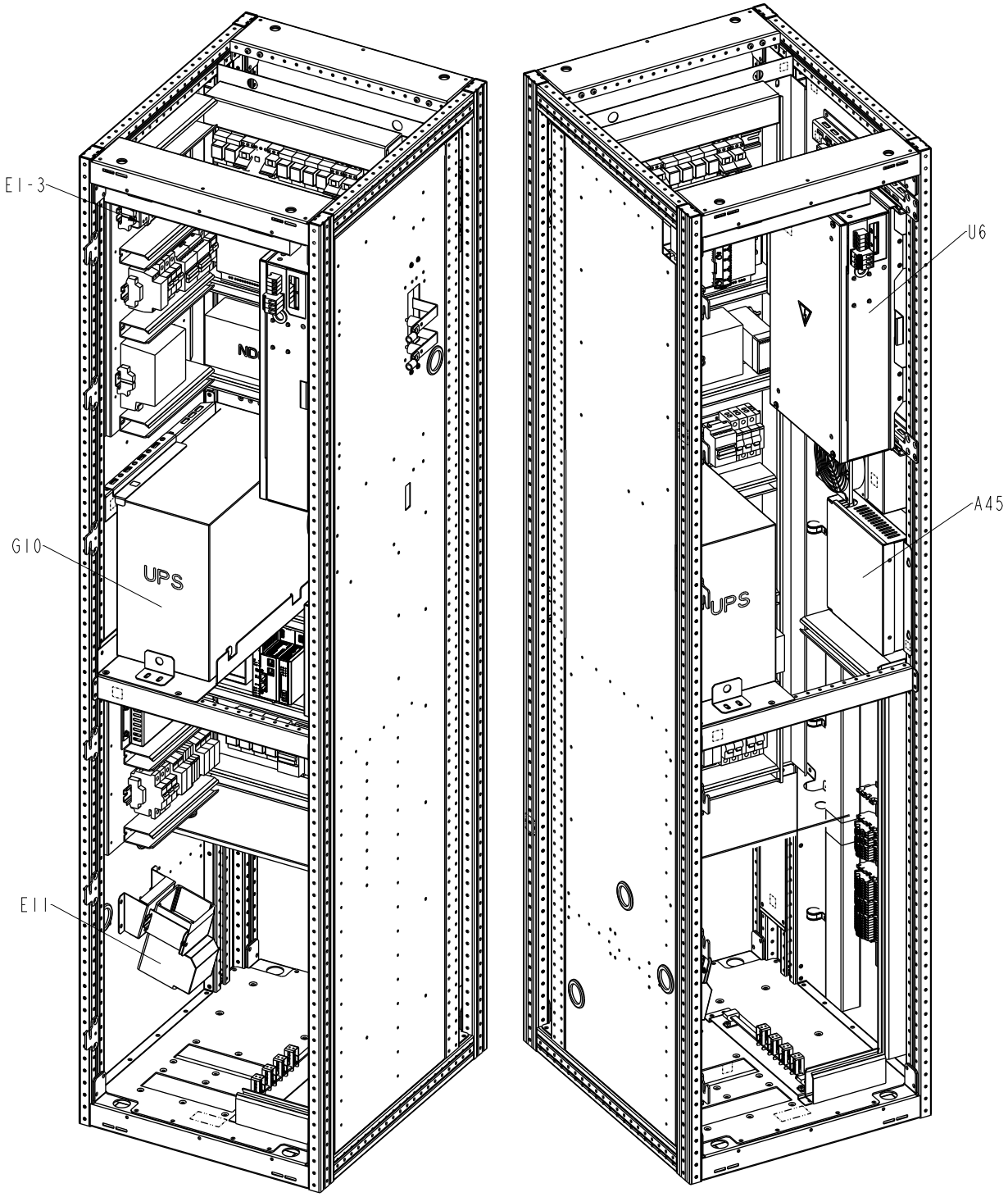
The converter is housed in a cabinet specially designed for wind turbine converters. An example layout of the converter is presented in the following drawings.



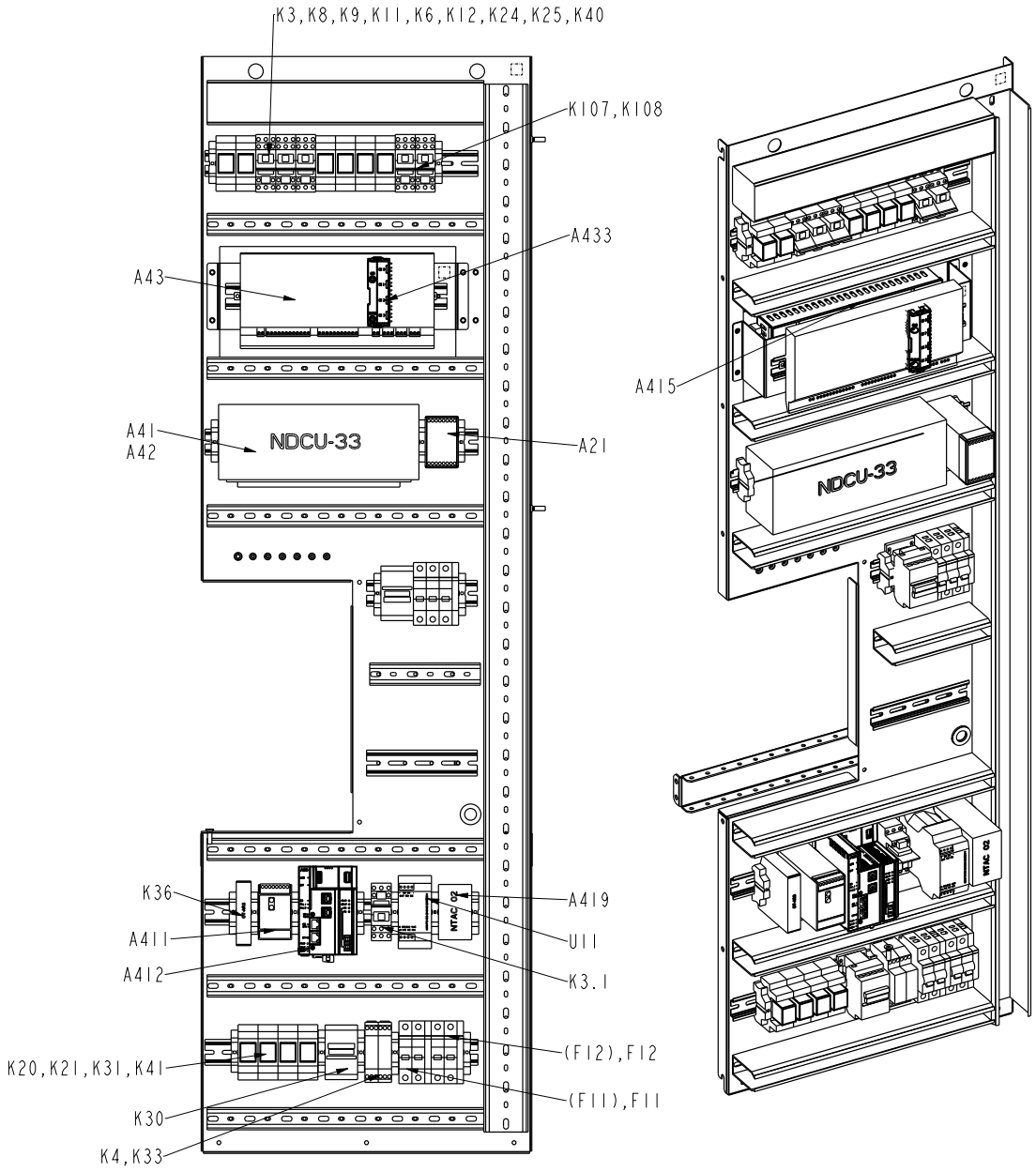
F5.1-2	Converter DC Fuse
U7	Chopper

U4	LCL filter
X01.1-4	Power contactor

U1	Grid-side converter
U11.1-2	Rotor-side converter


E1-3
G10
UPS
E11
U6
A45
UPS

Control frame



Grid supply and stator connections

Three phases of supply grid are connected to the bottom of grid supply section(L1/ L2/L3).

Control power supply for converter section and for auxiliary supply is taken from bus bars below grid air circuit breaker with double feeding cables.

Air circuit breaker Q101 is used to connect and disconnect both stator and converter to / from grid supply, stator contactor K102 is used to connect and disconnect the

generator to / from the supply grid. Before connection, the converter performs network synchronization. In fault situations where the circuit breaker trips, the converter stops and the user has to manually reconnect the breaker. See the section Breaker settings.

Generator stator connections are in power cabinet (U/V/W).

Current transformers T109.1 and T109.2 are used to measure the stator current from two phases. Measurement is made inside the control unit, which is part of converter section.

Grid-side converter supply

Supply for grid-side converter is through grid-side contactor K1 and taken from bus bars at the right top of power cabinet. Cables are routed to converter section from the AC fuses F1.1-3.

Over voltage protection

Over voltage lightning protection of the grid-side converter is implemented by one independent overvoltage protection device in each phase.The protection device is installed below the power cabinet.

Auxiliary voltage

There are 3~ 690 VAC outputs available, and 1~ 230 VAC outputs. Maximum total current from 690 VAC is 160 A.

Arc protection

The power cabinet is designed to give arc protection by placing the essential ventilation holes to the backside of the cabinet. In case of an arc in bus bars, the arc pressure and fumes leaves the cabinet from the backside thus causing minimum damages.

Functional description

Devices on the ACU cabinet are listed below.

Device	Description
K3.1	Cooling fan control of ACU cabinet.
K20	Grid MCB control. YC/YO changing, monitoring.
K21	Grid MCB status monitoring.
K24	Emergency switching-off of grid MCB, stator MCB and grid-side converter contactor.
K25	Common fault output.
K3	Grid-side converter contactor control.
K30	Stator contactor control.
K31	Stator contactor status monitoring.
K33	Switching-off monitoring of grid MCB, stator MCB and grid-side converter contactor. On-delay 2 s.
K3.3	Option for DC chopper, LCL module fan supply-off delay.
K36	Request for medium-voltage MCB switching-off in case grid MCB faults. Off-delay 1 s.
K4	Grid-side converter contactor safety function. Off-delay is 0.1 s.
K40	Safety relay ON/OFF status.
K41	Monitoring of grid-side converter contactor status.
K6	Stator cabinet and LCL overtemperature monitoring.
K7	Converter module and ACU heating control.
K8/K18	Low temperature control, start-up temperature monitoring.
K107	Grid-side MCB close status monitoring
K108	Grid-side MCB trip status monitoring
G21	Ground isolated 24V power supply
K9	Low temperature control, start-up temperature monitoring.
K11	Monitoring of power cabinet main fuses.
K12	Capacitor charging control auxiliary relay.
U10	230 V AC / 24 V DC power supply.
U11	24 V AC / ±15 V DC power supply.
F11	Circuit breaker for control circuit.
F12	Circuit breaker for heating and cooling fans.
E1	Hydrostat for humidity monitoring.
E2	Thermostat for low temperature control.
E3	Thermostat for overtemperature control.
F45.3	Protective fuse of NAMU/BAMU grid voltage measuring circuit.
A415	APBU optical fiber branching unit.
A21	Safety relay for safety functions.
A43	RDCU control unit with APBU branching unit (A415) under it.
A433	RDCO module.
A42	NDCU control unit.
A419	NTAC Pulse Encoder Interface module
A412	NETA Ethernet adapter module.
A11	NAMU/BAMU measuring unit

Device	Description
A411	NCAN module
A45	Grid-side current and voltage measuring unit
U6	CROWBAR, protection device of rotor-side
E11	Heater
G10	UPS

Control boards and optional modules

RDCU-12C

Grid-side converter is controlled by its own RDCU control unit (containing the RMIO-12C board). The RDCU is connected to the grid-side converter modules by a fiber optic link. For further information, see RDCU drive control units hardware manual [3AFE64636324 (English)].

NDCU-33CX

Rotor-side converter is controlled by its own NDCU control unit (consisting of the NIOC-02C and AMC-33 boards). The NDCU is connected to the rotor-side converter modules by a fiber optic link, distributed through APBU optical branching unit.

RDCO-02C

DDCS channel board (RDCO) is an extended module for the RMIO board. It provides optic fiber connection for PC tool, overriding controller, master-follower communication and additional I/O modules.

NTAC-02

NTAC-02 pulse encoder interface module offers an interface for a digital pulse encoder connection. A pulse encoder can be used if accurate speed or position (angle) feedback from the motor shaft is required.

NCAN-02C

NCAN-02 adapter module is an optional fieldbus adapter module. Wind turbine converter can be connected to a CANopen serial communication bus through NCAN-02 module.

NETA-21C+NEXA-21C

NETA Ethernet adapter module is an optional device for browser-based remote monitoring of the wind turbine converter via Ethernet. Multiple converters (up to 9) can be connected to the network through the DDCS branching unit (NDBU-85/95) or using a ring topology.

APBU-44C

APBU-44C PPCS branching and data logger unit is used to implement the parallel connection of multiple grid-side or rotor-side converter modules. The APBU-44C

also contains a data logger for collecting and storing real-time data from the module power stages to help fault tracing and analysis.

RAIO-01

Analog Expansion Module (RAIO) is an extended module for the RMIO board. The inlet air temperature of ACU can be read through RAIO.

Charging circuit

Resistor R1, fuses F15 and contactor K2 form a part of the charging circuit located on the slide-out frame. Charging circuit is required during the start-up procedure to avoid high in-rush current, which can be dangerous for wind turbine converter and its components. After receiving the start command, the grid-side converter closes the charging contactor which connects the intermediate DC link capacitors to the AC supply via the charging resistors. The intermediate DC link voltage rises and when it is high enough, the main contactor/breaker is closed and the charging contactor is opened. The contactors are controlled by the grid-side converter control board (RMIO) via relay outputs RO1 and RO3.

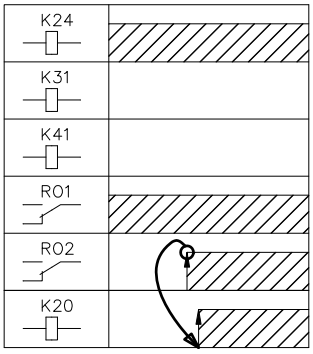
Safety functions

ACU cabinet contains special circuits for securing the start-up conditions and monitoring the shutdown process of the converter.

Start-up order is:
1) Grid air-circuit breaker (MCB1), 2) Grid-side converter contactor (MCB2), 3) Stator air-circuit breaker/ contactor (MCB3)

Shutdown order is reversed:
1) Stator air-circuit breaker/contactor (MCB3), 2) Grid-side converter contactor (MCB2), 3) Grid air-circuit breaker (MCB1)

Grid air-circuit breaker (MCB1) closing (normal run-up)

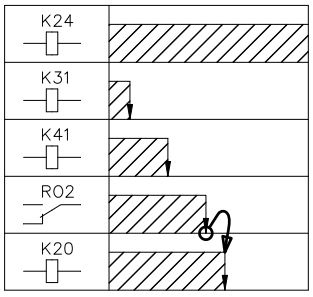


The conditions for closing grid air-circuit breaker (MCB1) are:

- No faults in the hardware monitoring circuit (K24 is closed)
- Stator air-circuit breaker/contactor is open (K31 is open)
- Grid-side converter contactor is open (K41 is open)
- No active fault in the converter (A42/X25:RO1 relay output is active)

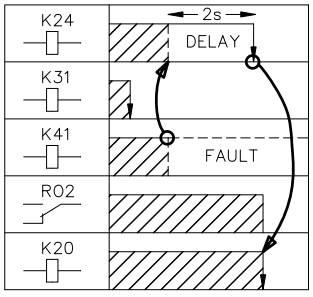
If all the conditions are fulfilled, switching on A42/X25:RO2 relay output will cause grid air-circuit breaker (MCB1) to close.

Grid air-circuit breaker (MCB1) opening (normal shutdown)



Normally, grid air-circuit breaker (MCB1) opening is handled by firmware. When the converter is running, shutting down happens in a particular order. It starts by opening the stator air-circuit breaker/ contactor (MCB3), relay K31 turns OFF. Then the converter de-energizes the grid-side converter contactor (MCB2), relay K41 turns OFF. Once both grid-side converter contactor (MCB2) and stator air-circuit breaker/contactor (MCB3) are OFF, grid air-circuit breaker (MCB1) can also be switched OFF by de-activating A42/X25:RO2 relay output.

Grid air-circuit breaker (MCB1) opening (emergency shutdown – grid-side converter contactor (MCB2) fault)

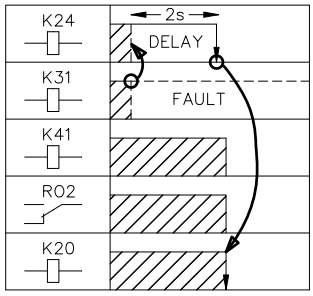


In emergency situations when the converter needs to be disconnected from the grid, the monitoring circuit of the converter shutdown process is used. Such situations happen if any of MCB devices fails during the converter shutdown:

1. Grid-side converter contactor (MCB2) FAULT

If the monitoring circuit detects that status of the grid-side converter contactor is still closed (K41 relay is ON) after the converter tried to open the contactor and 2 sec time delay has elapsed, grid air-circuit breaker (MCB1) will be forced to open by de-energizing K24 relay to disconnect the converter from the grid.

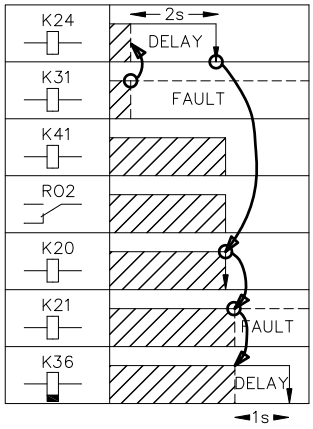
Grid air-circuit breaker (MCB1) opening (emergency shutdown – stator air-circuit breaker/contactor (MCB3) fault)



2. Stator air-circuit breaker/contactor (MCB3) FAULT

In case the stator air-circuit breaker/contactor does not obey OPEN command from the converter, the monitoring circuit will find that stator air-circuit breaker/contactor (MCB3) is still closed (K31 relay is ON) after the time delay of 2 sec. MCB1 will then be forced to open by de-energizing K24 relay to disconnect the converter from the grid.

Grid air-circuit breaker (MCB1) opening (emergency shutdown – eg, first stator air-circuit breaker/ contactor (MCB3) fault, then grid air-circuit breaker (MCB1) fault)

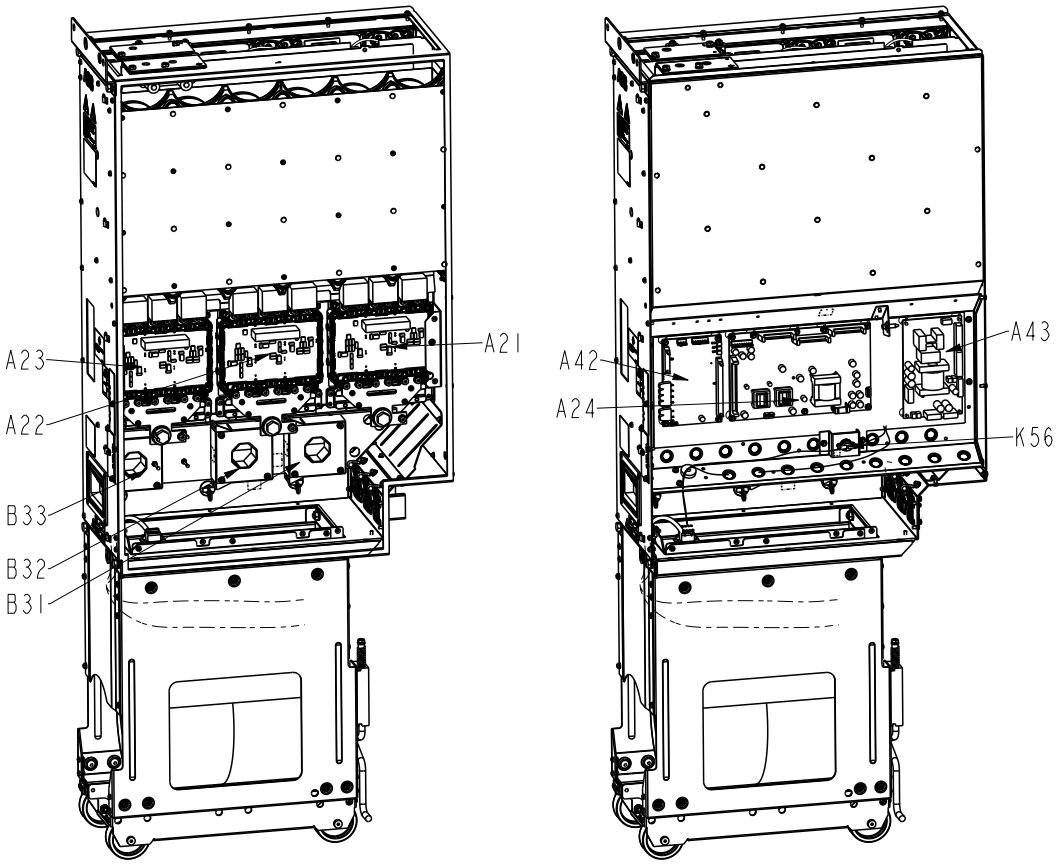


3. Grid air-circuit breaker (MCB1) FAULT

The worst case is that the grid air-circuit breaker fails to open itself. In this case the monitoring circuit will find that grid air-circuit breaker (MCB1) is closed (K21 relay is ON) despite of OPEN command (K20 relay is OFF). After 1 sec delay K36 time relay will be de-energized. The contacts of K36 can be used to control medium-voltage grid disconnecting device (X60 control cable connector).

This example diagram describes a situation when stator air-circuit breaker/contactor (MCB3) and grid air-circuit breaker (MCB1) fail one after the other.

Converter module layout is presented in the following drawing.



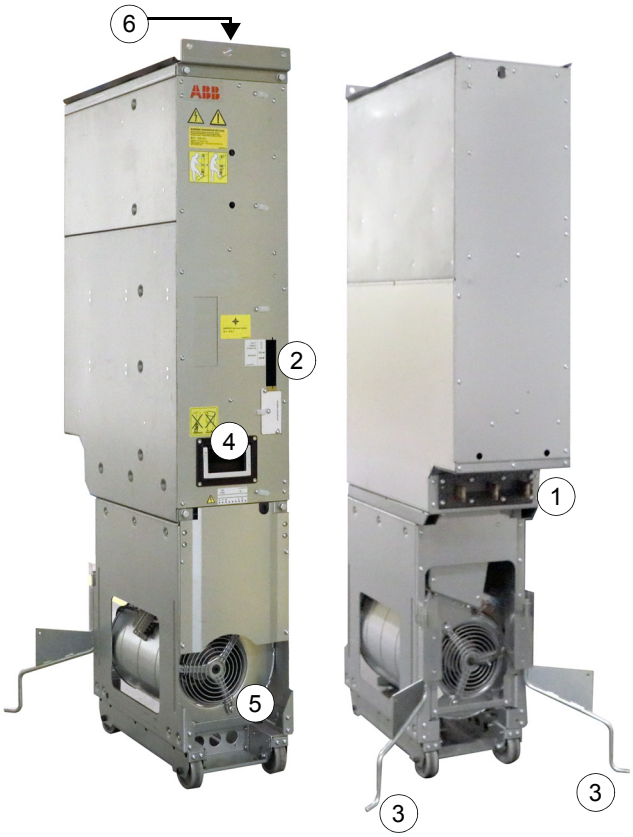
A21-23	BGAD-21C/IGBT	A42	BINT-67C	A24	BGDR-01C
B31-33	Current transducer	A43	ZPOW-7B1C	K56	Thermal Switch

Modules

The modules run on wheels, and can easily be removed from the cubicle for cable installation or service. Each module must be extracted from the cabinet for cabling and then re-inserted. The rotor/grid connection is via a quick connector at the back of the module that couples when the module is inserted into the cabinet.

Converter module

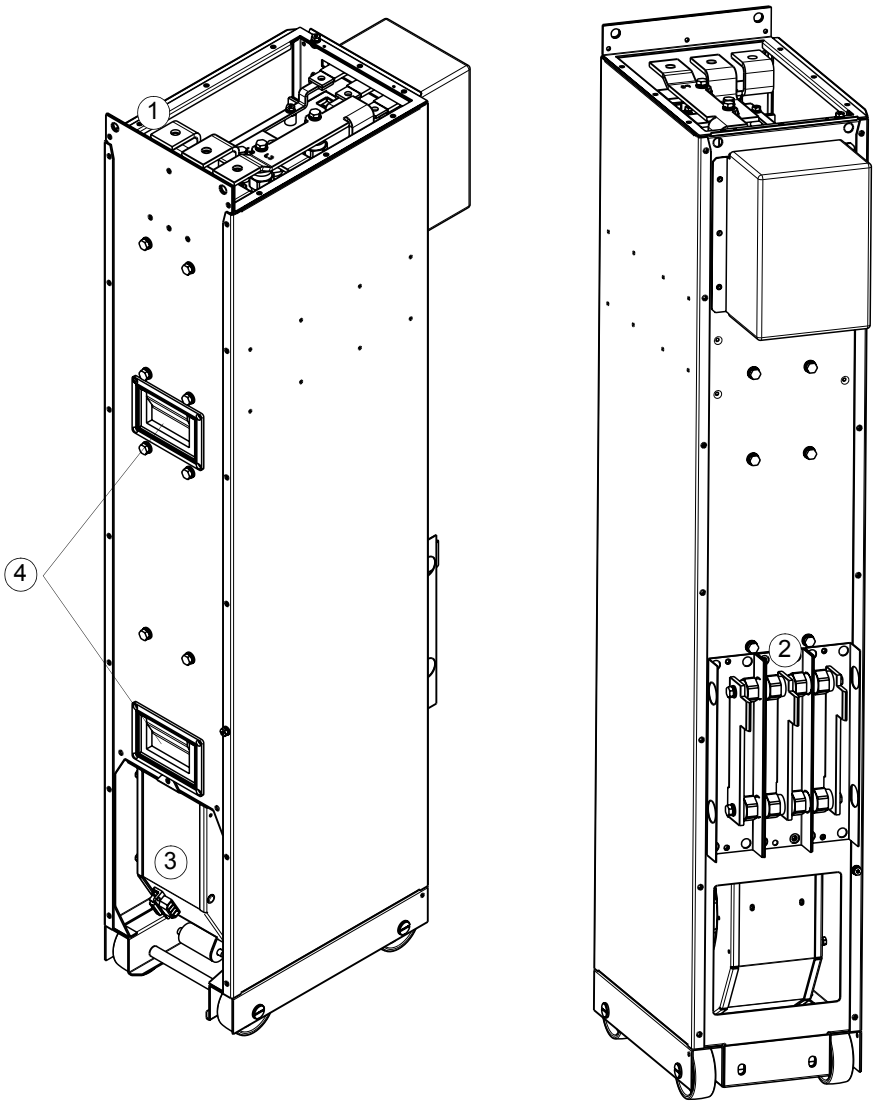
The DC input/output is located on the top front part of the converter module. The following drawing presents the converter module layout.



No.	Explanation
1	Busbars. To be aligned with the quick connector socket mounted in the cubicle. Direct connection of cables without using the quick connector is also possible.
2	Fibre optic connectors of the BINT board. Connected to the xDCU drive control unit.
3	Retractable support legs
4	Handle
5	Fan
6	DC connections

ALCL filter module

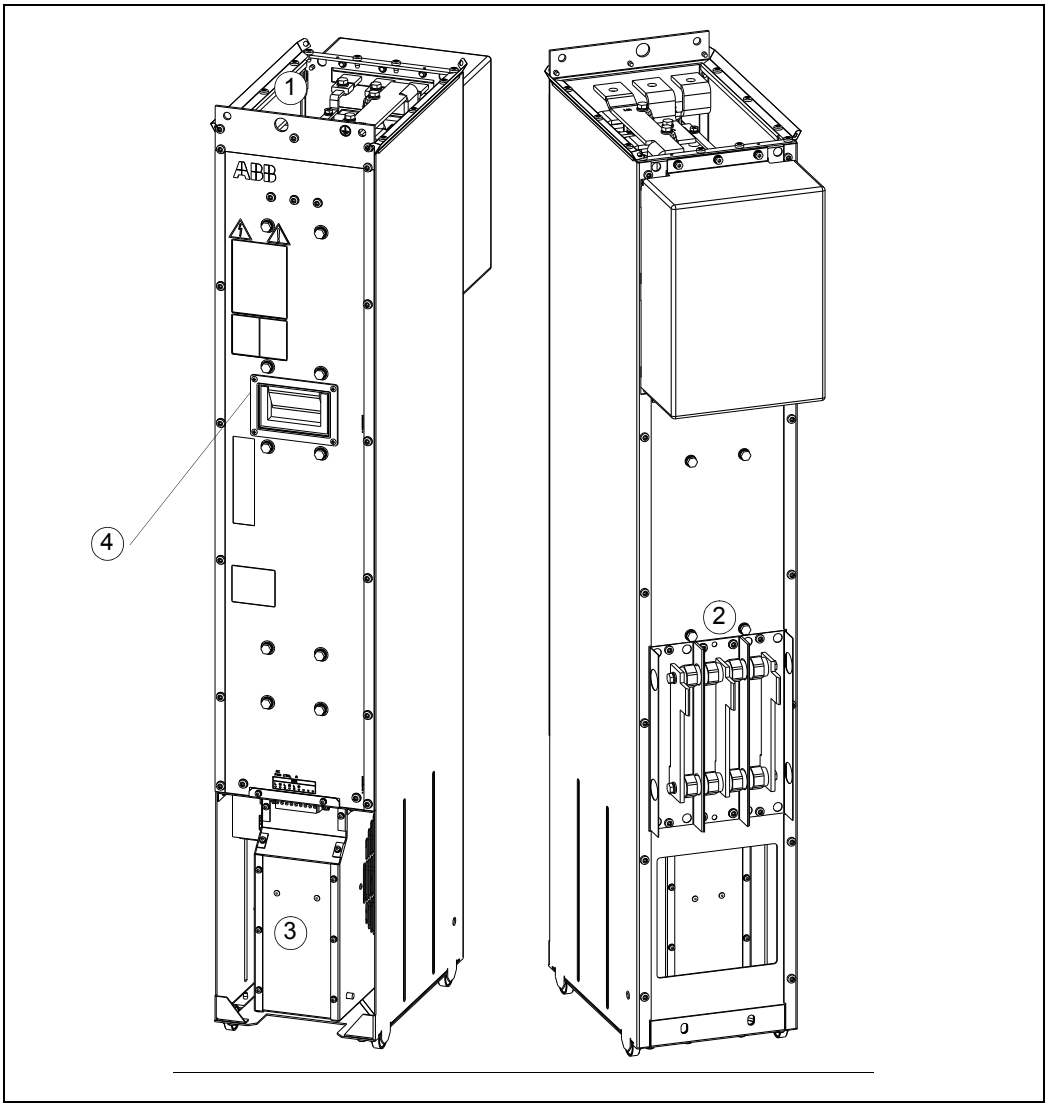
ALCL filters are used for minimising the emissions of the converter towards the grid.



Item	Explanation
1	AC input busbars
2	AC output terminals:
3	Fan
4	Handles

BLCL filter module

BLCL filters are used for minimising the emissions of the converter towards the grid.



Item	Explanation
1	AC input busbars
2	AC output terminals:
3	Fan
4	Handles

Heating and cooling

Module and the LCL filter is equipped with a fan, which runs at constant speed.

The cabinet has a heating system. See section *Cooling and heating logic.*

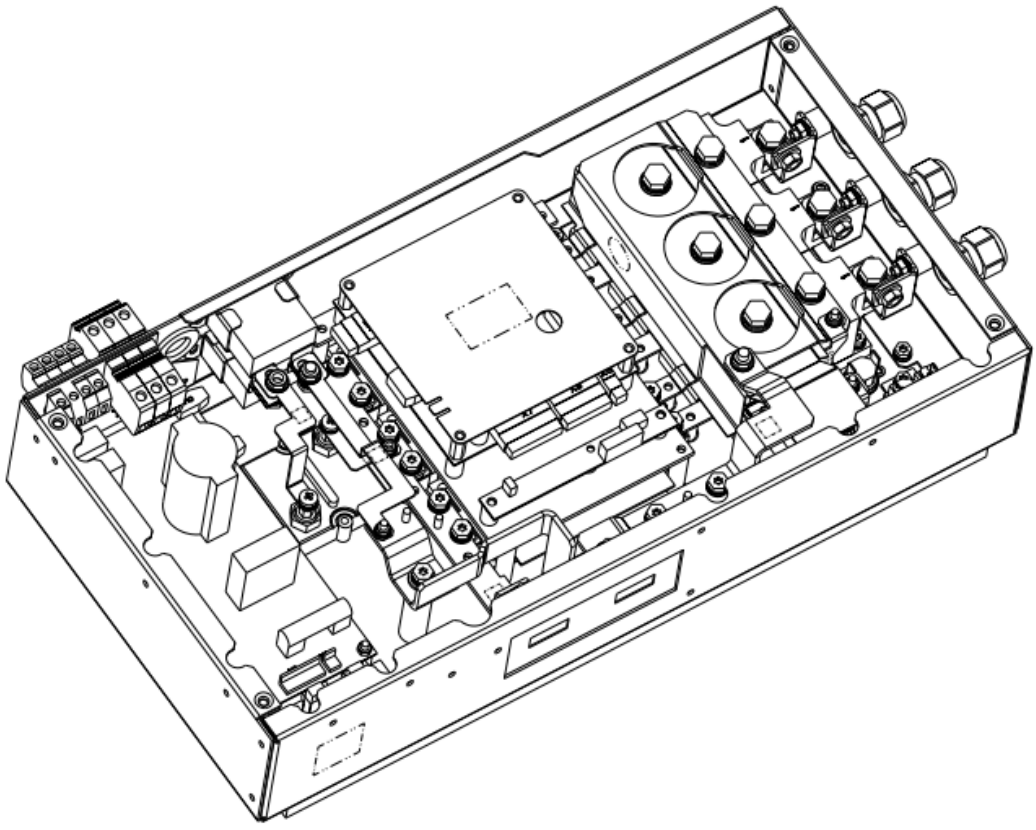
Crowbar

The crowbar circuit is used for overvoltage protection in abnormal grid conditions, e.g. loss of grid voltage or short circuit. The converter is equipped with active crowbar. The crowbar consists of the crowbar unit and a high power resistor.

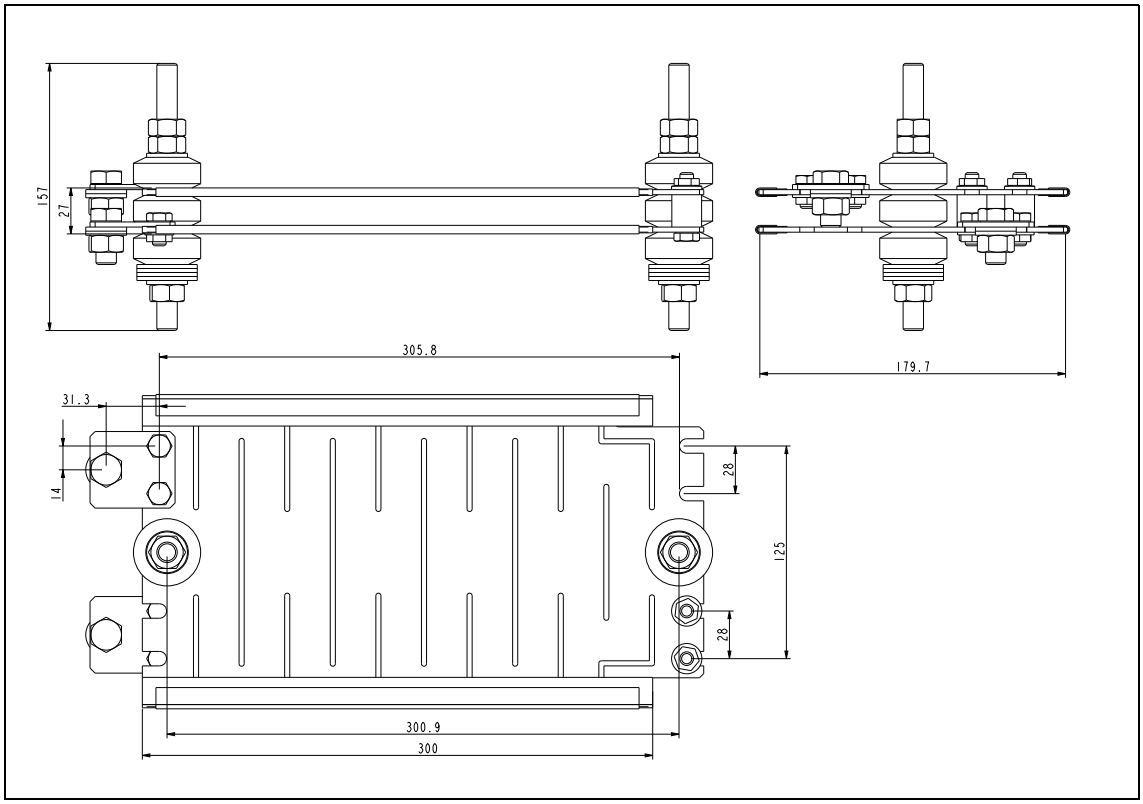
Active crowbar

Active crowbar is needed when the converter must stay connected to the grid during grid transients, i.e. the converter supports the grid by producing capacitive reactive power. The crowbar can be switched ON and OFF based on grid voltage transient influences on the rotor-side converter. This allows the converter to be connected to the grid even during very severe grid transient(s).

If the grid transient lasts longer than the predetermined time (e.g. 3 to 5 s), the converter trips on a fault.



Crowbar resistor



Du/dt filter

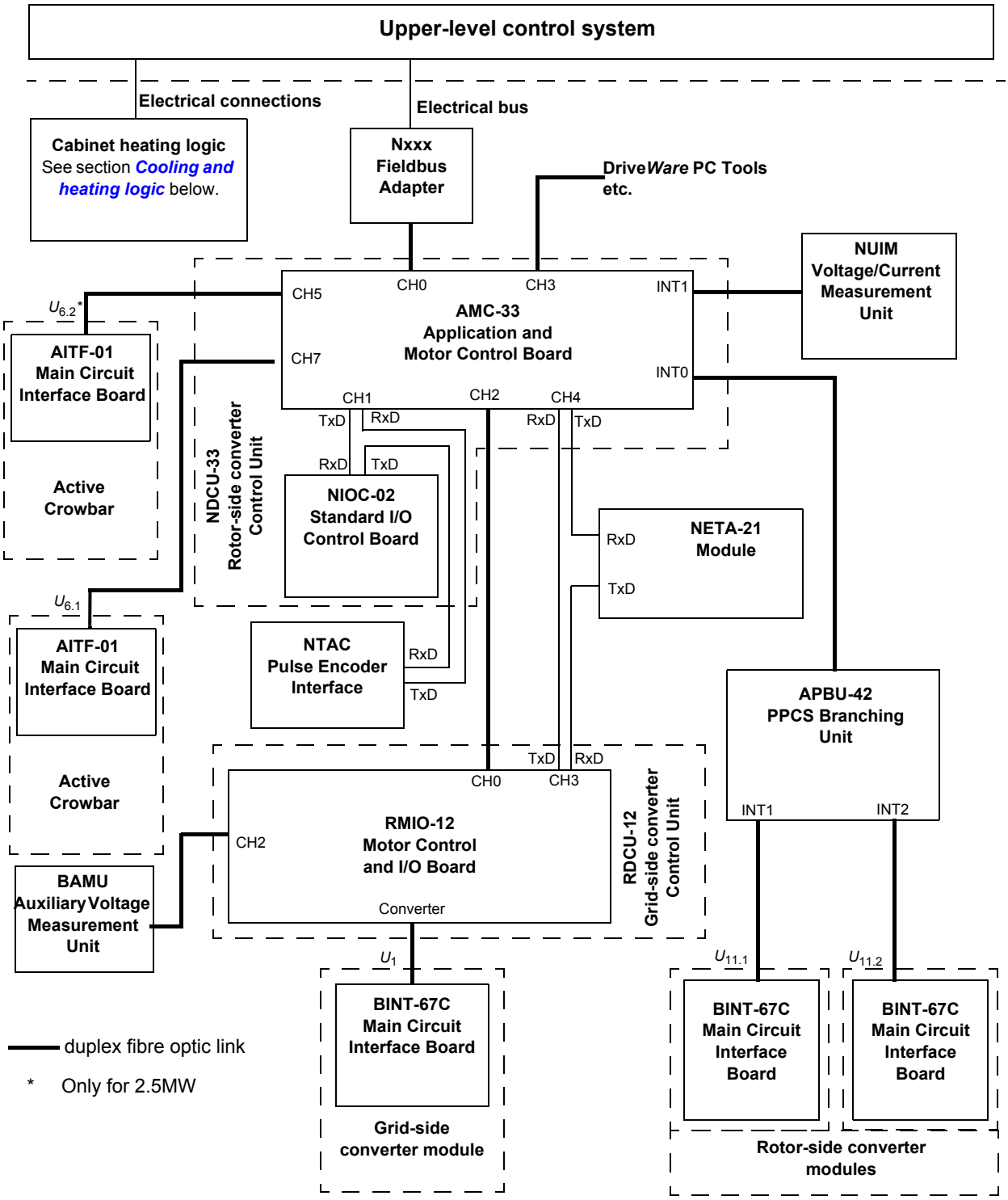
Du/dt filters suppress voltage spikes and rapid voltage changes that stress the rotor insulation. Du/dt filters are included in the rotor-side converter modules.

Control section

All the control electronics are installed in a control frame in the auxiliary control cubicle, separate from other cubicles. See sections *Cabinet layout* and *Interboard connection diagram.*

Interboard connection diagram

The diagram below shows the principal interboard optical connections of the converter. For details, see the circuit diagrams delivered with the converter.



Cooling and heating logic

The temperature and humidity must be within allowed limits in the cabinet before the converter can be powered up. The converter cabinet is equipped with a heating logic which controls the cabinet heating system, allowing the converter to start only when the operating conditions are met. When the converter is connected to the network, normal converter power losses keep the operating temperature above the required limit.

A simplified diagram of the heating logic is shown below. The auxiliary contact of the relay K18 (same as K8) and contactor K16 (in power cabinet) are connected to DI4 of A43, which is used for low-temperature warning. For more detailed information, refer to the wiring diagrams delivered with the converter.

The system has two auxiliary power inputs: one for the heating power and one for the control power. With thermostat and hygrostat default settings, power is fed through the heating foil of the power modules and the heaters of control unit, until the temperature reaches +10°C inside the control unit or +11°C inside the power modules and the humidity inside the control section drops below 80%.

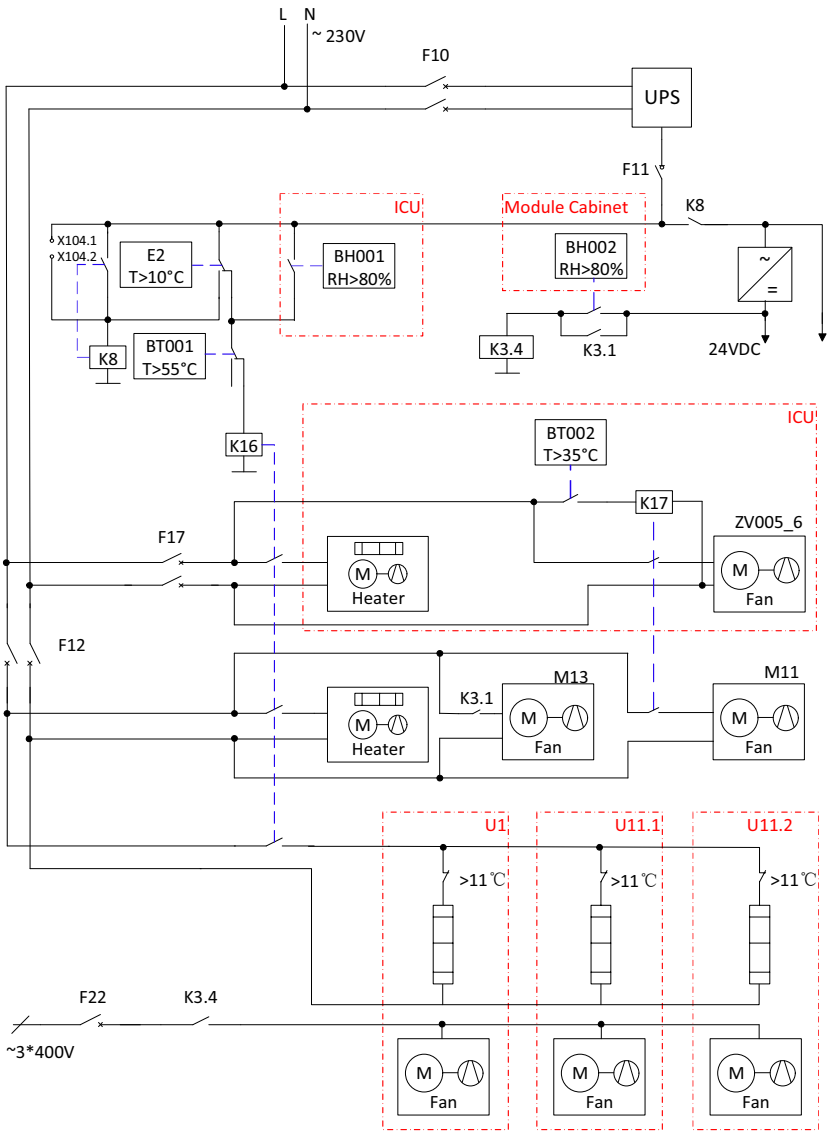
The low temperature sensor is located in ACU cabinet to prevent the circuit boards from working in a low temperature environment, and the default temperature of the sensor is +10°C.

The module is heated by heating foil, and the power is large. The temperature inside the module can reach the required temperature firstly during the cold start. At the same time, a high temperature switch is connected to the power supply circuit of the heating circuit to prevent the temperature from being too high.

ICU cabinet and module cabinet are more sensitive to humidity, therefore, the humidity sensors are set in ICU and module cabinet respectively. Because there is only a heating foil inside the module cabinet, the module fan will be stared when the humidity is higher than the setting value, which helps to prevent the condensation. The heater will be started when the humidity is too high. In order to avoid high temperature in the ACU cabinet, when the temperature is higher than the setting value of the temperature sensor, the heating circuit will be disconnected even if the humidity is not reduced to the setting value.

When the heating is completed, relay K8 closes and auxiliary power is connected to the control boards. After the control boards are booted (lasts about 1 minute), the converter is ready to start.

When the temperature in the ICU cabinet exceeds the setting value of the temperature sensor, the fan in the ICU cabinet will be started. The fan used for Crowbar cooling in the ACU cabinet starts with the start of the converter, and the cooling fan in the cabinet starts when the temperature is higher than the setting value of the temperature sensor. The module fan starts when the converter starts.


L
N
~ 230V
F10
UPS
F11
K8
ICU
Module Cabinet
X104.1
X104.2
E2
T>10°C
BH001
RH>80%
BH002
RH>80%
~
=
K8
BT001
T>55°C
K3.4
K3.1
24VDC
K16
ICU
BT002
T>35°C
K17
ZV005_6
F17
M
Heater
M
Fan
F12
M13
K3.1
M11
U1
U11.1
U11.2
>11℃
>11℃
>11℃
F22
K3.4
~3*400V

Type code

The cabinet has a type designation label attached, containing e.g. the type code of the unit (ACS800-67-0570/1210-7). The type code contains information on the specifications and configuration of the unit.

- The first 21 digits form the basic code. It describes the basic construction of the unit. 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 main selections are described below. For more information, contact your local ABB representative.

Basic code

Digit no.	Name/Description	Alternatives	Description
1…6	Product series	ACS800	
8…9	Construction	67	Cabinet mounted wind turbine converter
11…19	Size	0570/1210	Grid-side converter kVA rating / Rotor-side converter kVA rating
21	Voltage rating	7	Nominal voltage: 690 V.

Mechanical installation

Contents of this chapter

This chapter describes the mechanical installation procedure of the converter.

General

See chapter *Technical data* for allowable operating conditions and requirements for free space around the unit.

The unit should be installed in an upright vertical position.

The floor that the unit is installed on should be of non-flammable material, as smooth as possible, and strong enough to support the weight of the unit. The floor flatness must be checked with a spirit level before the installation of the cabinets into their final position. The maximum allowed deviation from the surface level is 2 mm (0.08 in.) in every 1 metre. The installation site should be levelled, if necessary, as the cabinet is not equipped with adjustable feet.

The wall behind the unit should be of non-flammable material.

The converter can be installed on elevated floor and over a cable duct. The integrity of the supporting structure must be checked before the converter is placed in such a position.

Provide the converter with the amount of fresh **cooling air** given in *Technical data*.

Sufficient clearance must be left in front of and behind the converter to enable installation, cooling air flow and maintenance.

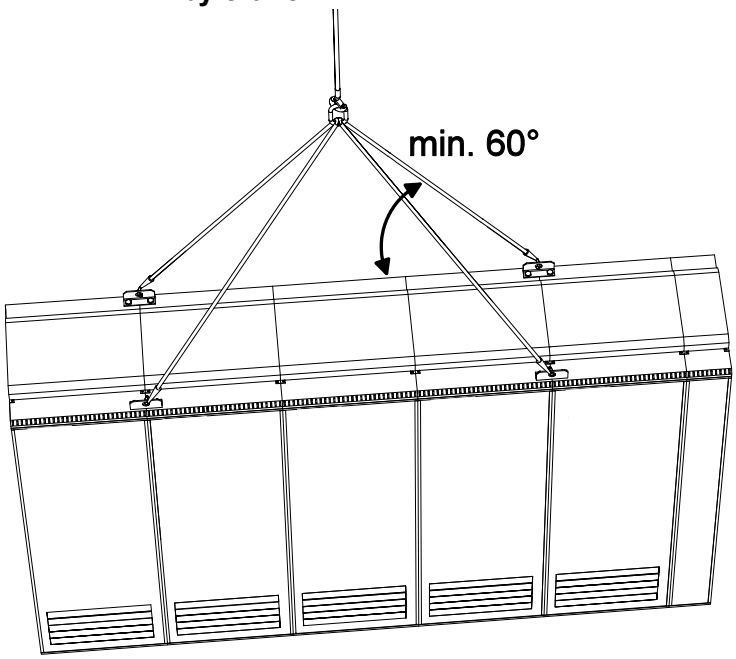
Required tools

The tools required for moving the unit to its final position, fastening it to the floor and tightening the connections are listed below.

- crane, fork-lift or pallet truck (check load capacity!); iron bar, jack and rollers
- Pozidrive and Torx (2.5–6 mm) screwdrivers for the tightening of the frame screws.
- torque wrench
- set of wrenches or sockets.

Moving the unit

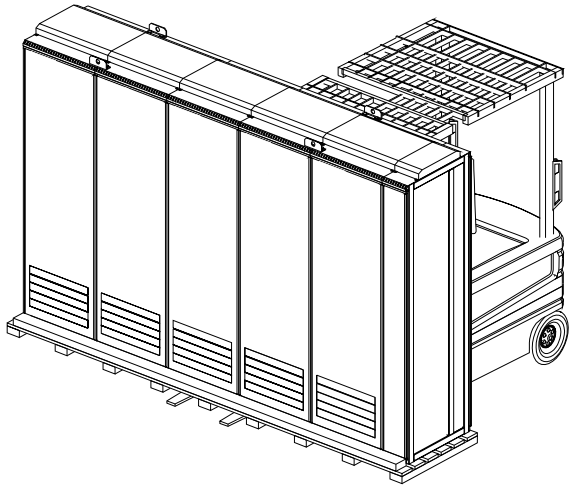
…by crane



Use the steel lifting lugs attached to the top of the cabinet. Insert the lifting ropes or slings into the holes of the lifting lugs.

The lifting lugs can be removed (not mandatory) once the cabinet is in its final position. **If the lifting lugs are removed, the bolts must be refastened to retain the degree of protection of the cabinet.**

…by fork-lift or pallet truck

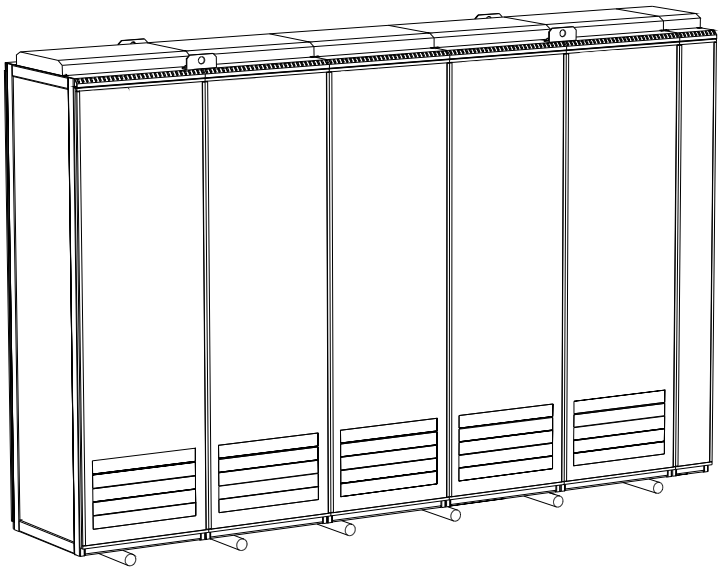


The centre of gravity may be quite high. Be therefore careful when transporting the unit. Tilting the cabinets must be avoided.

The units are to be moved only in the upright position.

If using a pallet truck, check its load capacity before attempting to move the unit.

…on rollers

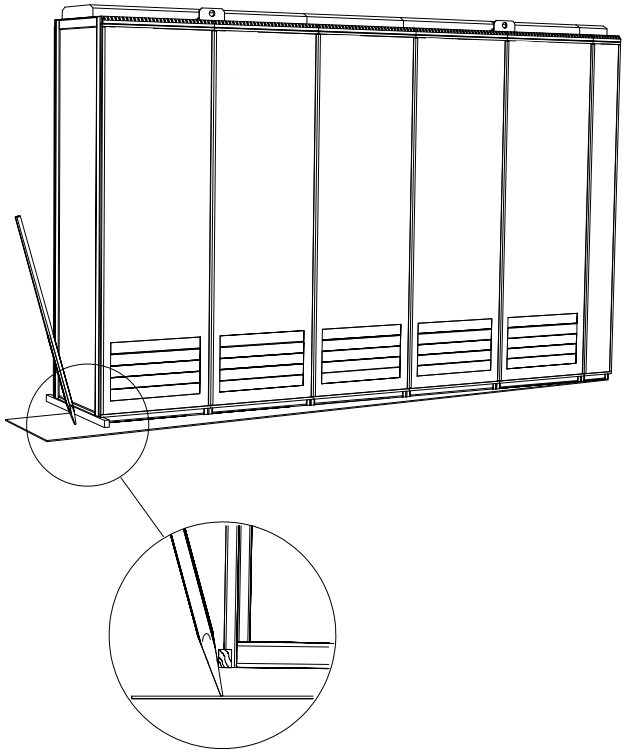


Remove the wooden bottom frame which is part of the shipment.

Lay the unit on the rollers and move it carefully until close to its final location.

Remove the rollers by lifting the unit with a crane, fork-lift, pallet truck or jack as described above.

Final placement of the unit



The cabinet can be moved into its final position with an iron bar and a wooden piece at the bottom edge of the cabinet. Care is to be taken to properly place the wooden piece so as not to damage the cabinet frame.

Before installation

Delivery check

The converter delivery contains:

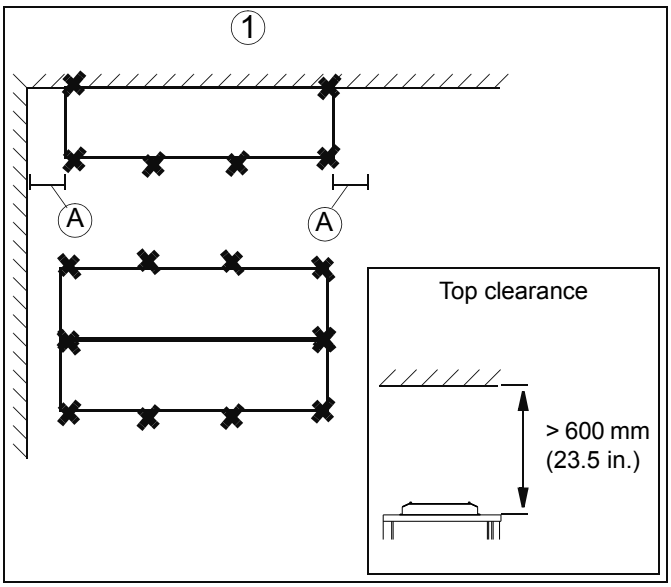
- converter cabinet
- optional modules (if ordered) installed into the control frame at the factory
- ramp for extracting modules from the cabinet
- hardware manual
- appropriate firmware manuals and guides
- optional module manuals
- delivery specific circuit diagrams
- delivery specific dimensional drawings
- delivery documents.

Check that there are no signs of damage. Before attempting installation and operation, check the information on the type designation label of the converter to verify that the unit is of the correct type. The label includes an IEC rating, a type code and a serial number, which allow individual recognition of each unit.

The type designation label is located on the cabinet door.

Each converter module is also labelled.

Installation procedure



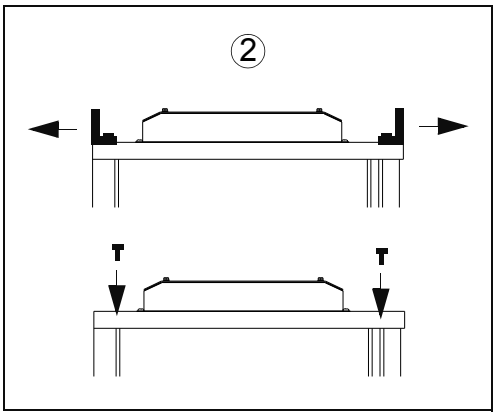
(1) The cabinet can be installed with its back against a wall. Fasten the unit (or first shipping split) to the floor with fastening clamps or through the holes inside the cabinet. For the location of the fastening holes, see delivery specific dimensional drawings.

Note: A clearance of 600 mm (23.5 in.) minimum above the basic roof level of the cabinet (see inset on left) is required for cooling.

(A) **Note:** Leave some space at the left-hand and right-hand sides of the line-up (A) to allow the doors to open sufficiently.

Note: Any height adjustment must be done before fastening the units or shipping splits together. Height adjustment can be done by using metal shims between the bottom frame and floor.

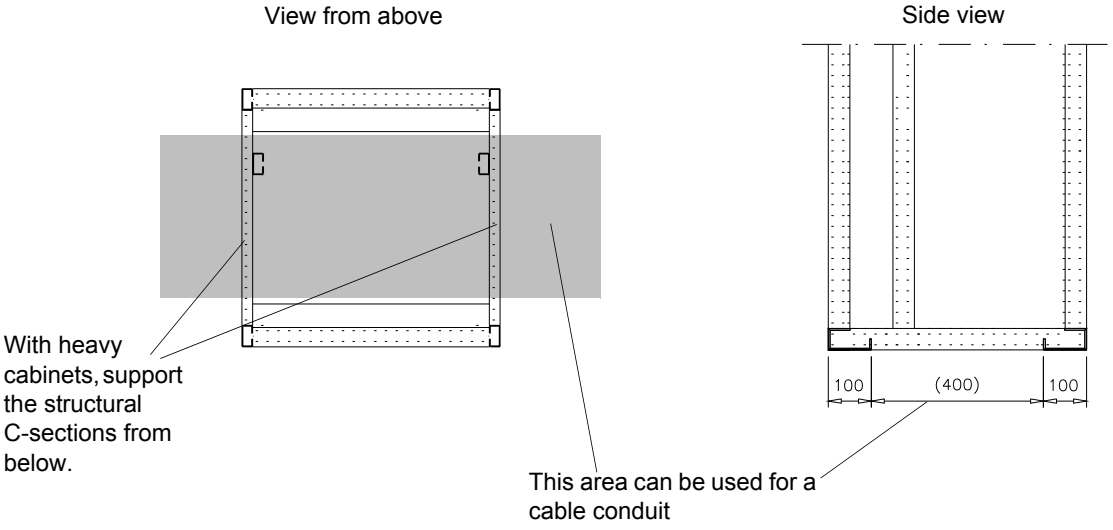
(2) Remove the lifting bars (if present). Use the original bolts to block any unused holes.

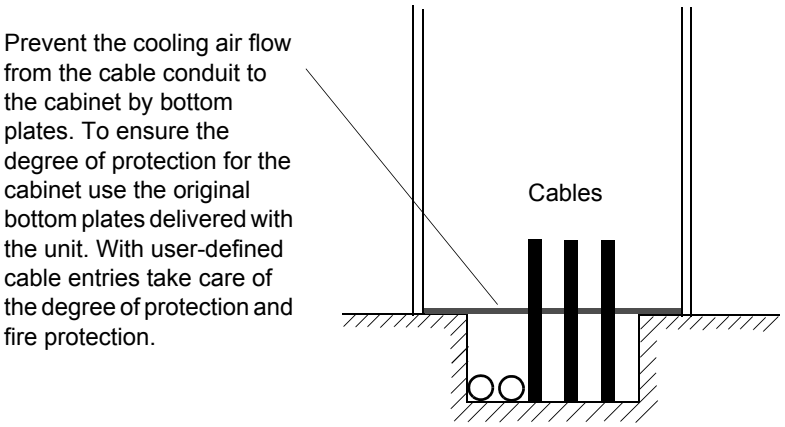


Miscellaneous

Cable conduit in the floor below the cabinet

A cable conduit can be constructed below the 400 mm (15.7 in.) wide middle part of the cabinet. The cabinet weight lies on the two 100 mm (3.9 in.) wide transverse sections which the floor must carry.





Electric welding

It is not recommended to fasten the cabinet by welding. However, if welding is necessary, follow the instructions below.

Cabinets without flat bars at the base

- Connect the return conductor of the welding equipment to the cabinet frame at the bottom within 0.5 metres of the welding point.

Cabinets with flat bars at the base

- 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 onto the floor within 0.5 metres 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 to 200 micrometres; on the flat bars the coating is approximately 20 micrometres. Ensure that the welding fumes are not inhaled.

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.

Checking the compatibility of the generator

See chapter *Technical data* for the converter ratings and the generator connection data.

Protecting the generator winding and bearings

The output of the converter comprises – regardless of output frequency – of pulses of approximately 1.35 times the mains network voltage with a very short rise time. This is the case with all converters employing IGBT converter technology.

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

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

The stress on generator insulation is reduced by using du/dt filters. Du/dt filters also reduce bearing currents.

To avoid damage to generator bearings, insulated N-end (non-driven end) bearings and output filters from ABB must be used. In addition, the cables must be selected and installed according to the instructions given in this manual. These types of filters are included in the ACS800-67 converter as default:

- du/dt limitation (protects generator insulation system and reduces bearing currents).

Grid connection

Disconnecting device (disconnecting means)

The converter must be equipped with a hand operated input disconnecting device (disconnecting means) which isolates the converter and the generator from the supply grid. A switch fuse disconnector is available as option.

The disconnecting device does not, however, isolate the input busbars from the supply grid. Therefore during installation and maintenance work on the converter, the input cables and busbars must be isolated from the supply with a disconnector at the distribution board or at the supplying transformer.

EU

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

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

Thermal overload and short circuit protection

Protection against short circuit in stator cable

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

Protection against short circuit inside the power cabinet

There are no additional short circuit protection devices besides the air breaker in stator circuit and the disconnectors in line converter and auxiliary supply circuits. There shall be a disconnector before the supplying transformer that meets the requirement stated in the chapter *Grid connection* above.

Protection against short circuit in generator rotor cable

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

Protection against short circuit inside the cabinet

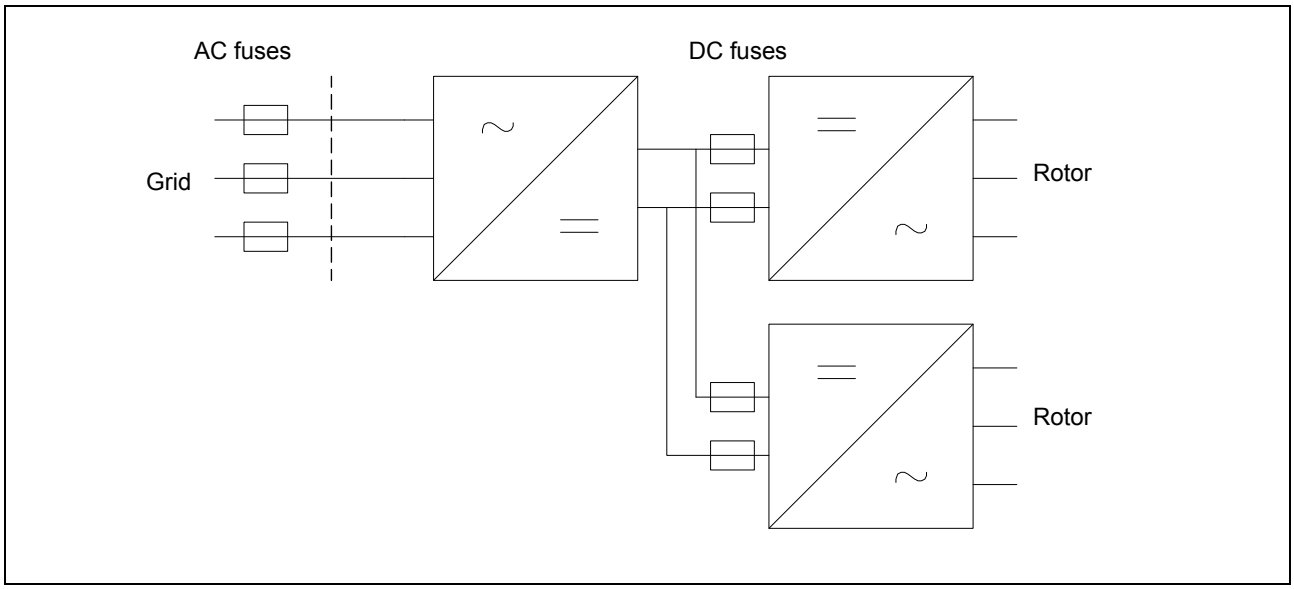
Equip the converter with main fuses listed in chapter *Technical data*. The fuses restrict converter damage and prevent damage to adjoining equipment in case of a short circuit inside the converter. **Check that the operating time of the fuse is below 0.5 seconds.** The operating time depends on the fuse type (gG or aR), supply network impedance and the cross-sectional area, material and length of the

cable. In case the 0.5 seconds operating time is exceeded with gG fuses, ultrarapid (aR) fuses will in most cases reduce the operating time to an acceptable level.

WARNING! Circuit breakers are not capable of providing sufficient protection because they are inherently slower than fuses. Always use fuses with circuit breakers.

DC fuses

The converter employs fuses in the DC link between the grid-side and rotor-side converter modules. See chapter *Technical data* for fuse ratings.



Ground fault protection

All units are equipped with an internal earth fault protective function to protect the converter against earth faults in the converter, generator and generator cable. (This is not a personal safety or a fire protection feature.) Earth fault protective functions can be disabled; refer to the appropriate *Firmware Manual*.

Emergency stop devices

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

An emergency stop function is available for stopping and switching off the whole converter.

Restarting after an emergency stop

After an emergency stop, the emergency stop button must be released and a reset performed before the main contactor (or air circuit breaker and stator contactor) can be closed and the converter started.

Selecting the power cables

This section contains the general cable selection rules. For a list of recommended cables, see chapter *Technical data*.

Note: The converter configuration may require multiple cabling. See section *Stator side connection procedure* in chapter *Electrical installation.*

General rules

Dimension the cables **according to local regulations**:

- The cable must be able to carry the converter load current. See chapter *Technical data* for the rated currents.
- The cable must be rated for at least 70°C (140°F) maximum permissible temperature of conductor in continuous use.
- The cable must withstand the short circuit current given in chapter *Technical data*.
- The inductance and impedance of the PE conductor/cable (grounding wire) must be rated according to permissible touch voltage appearing under fault conditions (so that the fault point voltage will not rise excessively when a ground fault occurs).
- 600 VAC cable is accepted for up to 500 VAC. For 690 VAC rated equipment, the rated voltage between the conductors of the cable should be minimum 1 kV.

The rated voltage of the supply line cables should be U_0/U = 0.6/1 kV for 690 VAC rated equipment. (U_0 = rated voltage between the conductor and the earth, U = rated voltage between the conductors.)

A four conductor system is allowed for input cabling, but shielded symmetrical cable is recommended. To operate as a protective conductor, the shield conductivity must be at least 50% of the conductivity of the phase lead. 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 rotor cable and its PE pigtail should be kept as short as possible in order to reduce electromagnetic emission as well as capacitive current.

Power cable busbars

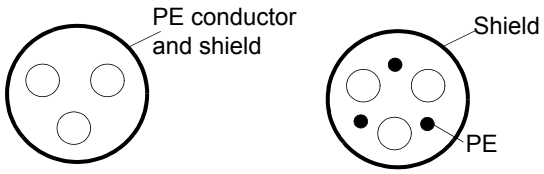
If necessary, the same screw can be used for connecting two cable lugs (on both sides of the busbar). Cable lugs with one or two holes can be used. Always use a torque wrench for tightening the busbar connections.

Alternative power cable types

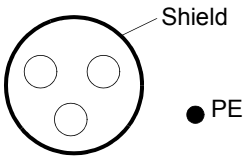
Power cable types that can be used with the converter are represented below.

Recommended

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

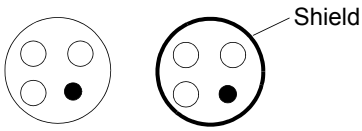


A separate PE conductor is required if the conductivity of the cable shield is <50% of the conductivity of the phase conductor.



A four conductor system: three phase conductors and a protective conductor.

Can be used for rotor cables (not recommended)

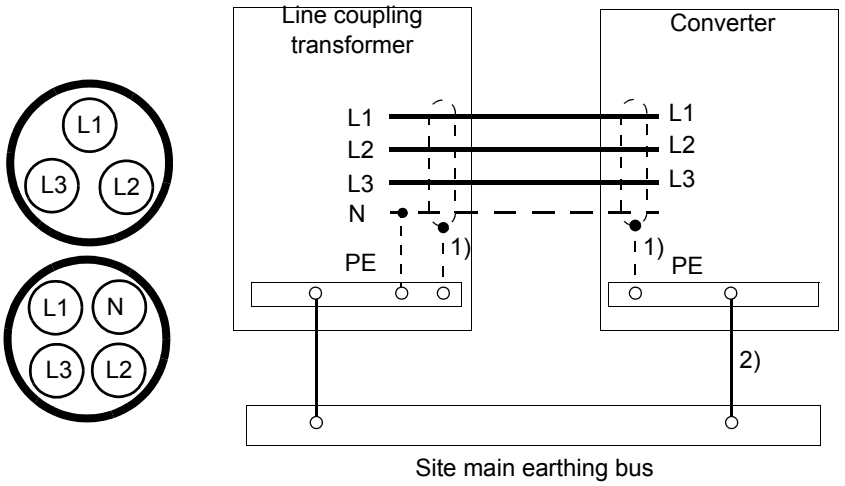


Not allowed for rotor cables with phase conductor cross section larger than 10 mm^2 (rotors > 30 kW).

Note: The N conductor is not normally used with ACS800-67 converters although it is visible in the following diagrams.

Supply line cable connection for low power supply

A low current (< 300 A) single cable connection is represented below.



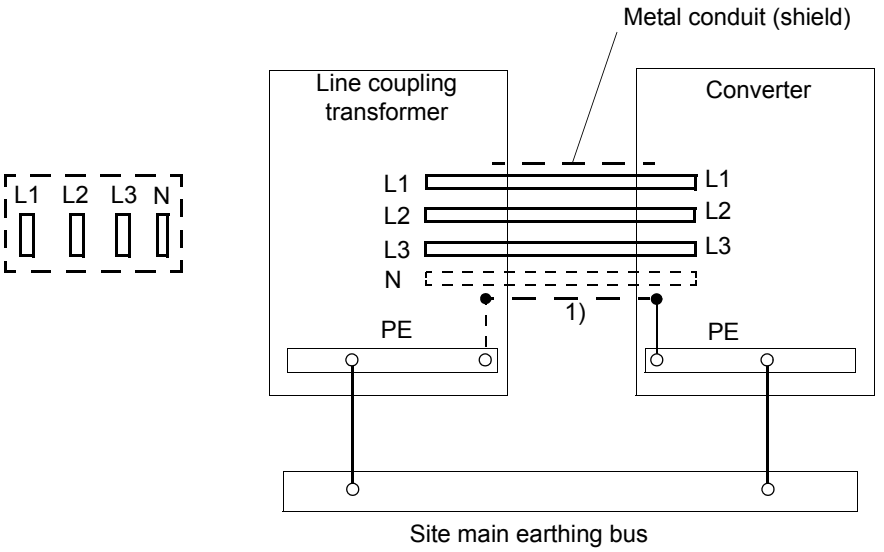
1) As short as possible for low inductance

2) Not used if the supply cable screen operates as a protective conductor.

Supply line cable connection for high power supply

Busbar connection

A high current (> 300 A) busbar connection is represented below.

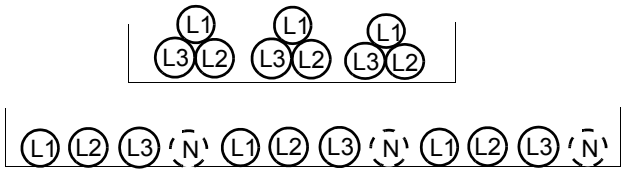


1) Connect the metal conduit of the busbar system (or the metal of the bus duct) to PE at either one end or both ends.

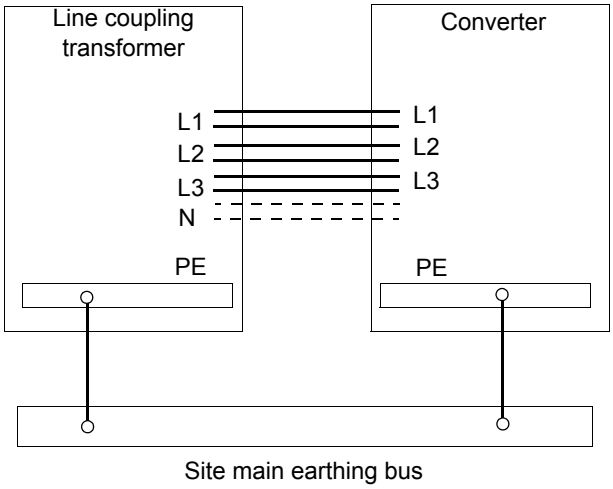
Note*:* Paint should be removed to allow a good connection to the cabinet frames throughout the whole perimeter of the metal conduit (or a bus duct). The metal conduit (or the bus duct metal) should be electrically continuous throughout its complete length.

Cable bus system

The connection of a high current (> 300 A) cable bus system that consists of several cables is represented below. In this system, less conductor material is needed due to better cooling of separate conductors.



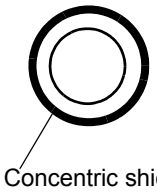
It is recommended to arrange the cables as shown – alongside each other – to achieve a current distribution as accurate as possible. Gaps between cables are required for cooling.

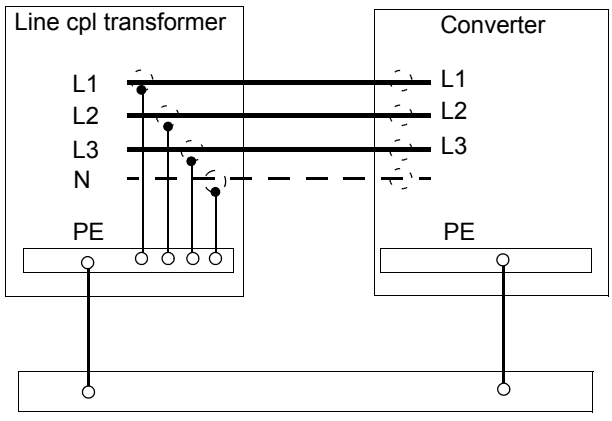


Note: Current derating of the cables is required when installing the cables in a cable tray. This derating factor must be taken into account as per the local electrical safety code.

Single core cables with concentric protective shields

When single core cables equipped with concentric protective shields (metal) are used, the phase current will induce voltage to the cable shield. If the shields are connected to each other at both ends of the cable, current will flow in the cable shield. In order to prevent this and to ensure personal safety, the cable shield must be connected only to PE at the transformer side and insulated on the converter side. The connection is represented below.

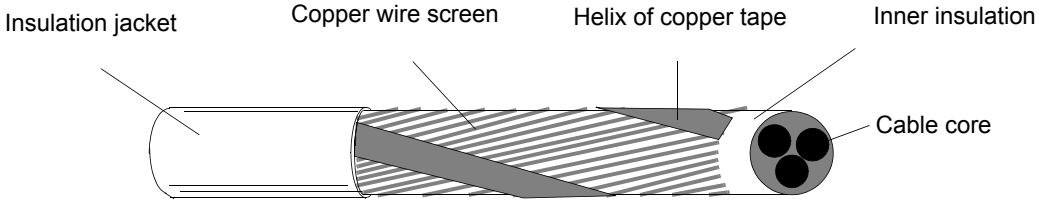


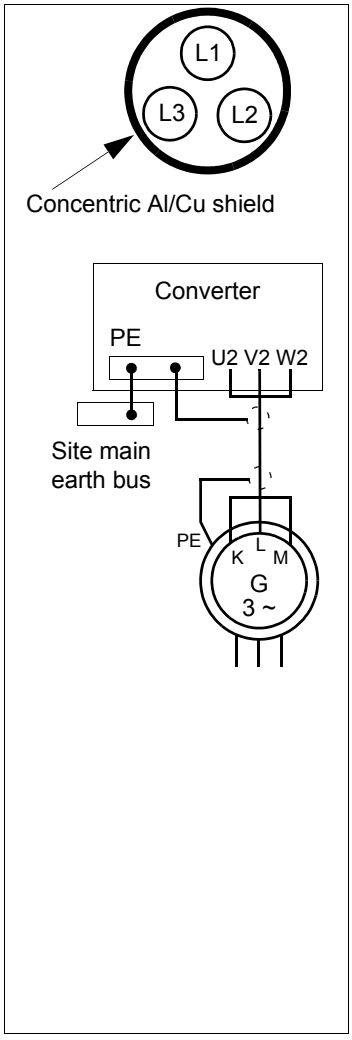


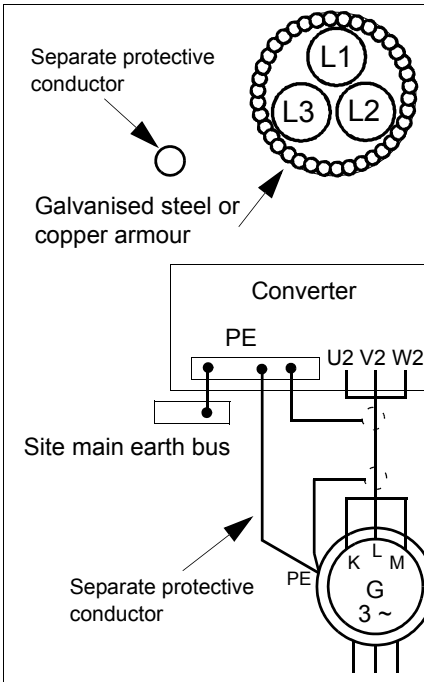
Rotor cable connection

Rotor cable connections for different cable types are represented below. For minimum radio frequency interference (RFI) at the generator end, earth the cable screen 360 degrees at the lead through or earth the cable by twisting the screen (flattened width ≥ 1/5 × length).

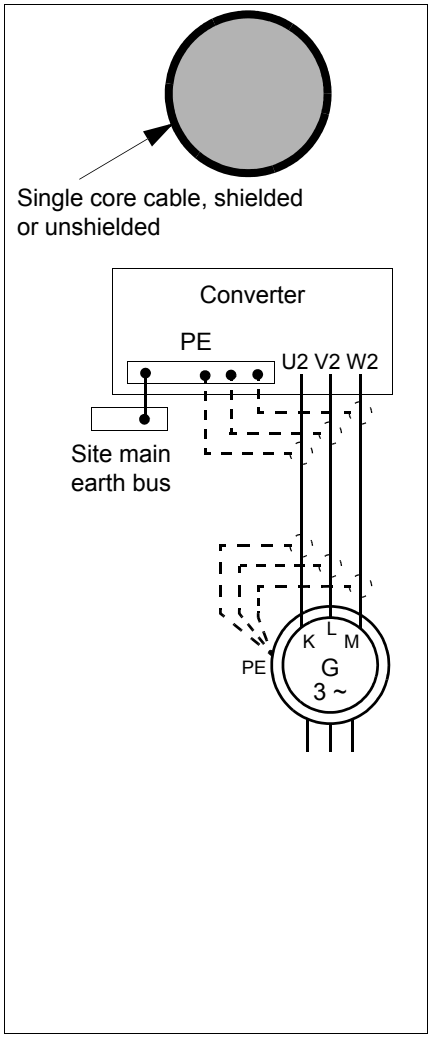
To effectively suppress radiated and conducted radio frequency emissions, the shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminium shield. The minimum requirement of the motor cable shield of the converter is shown below.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







A separate PE conductor system is used only if local safety regulations do not allow earthing of the converter and the generator merely through the cable screen. This solution increases bearing currents compared to symmetrical shielded cable, thus causing extra wear.



Conduit

Where conduits must be coupled together, bridge the joint 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 input power, generator, brake resistors, and control wiring. When conduit is employed, type MC continuous corrugated aluminium armor cable or shielded cable is not required. A dedicated ground cable is always required. Do not run generator wiring from more than one converter in the same conduit.

Armored cable / shielded power cable

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

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

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

Power factor compensation capacitors

Do not connect power factor compensation capacitors or surge absorbers to the generator cables (between the converter and the generator). They are not designed to be used with converters, and will degrade generator control accuracy. They can cause permanent damage to the converter or themselves due to the rapid changes in the converter output voltage.

If there are power factor compensation capacitors in parallel with the three phase input of the converter, ensure that the capacitors and the converter are not charged simultaneously to avoid voltage surges which might damage the unit.

Equipment connected to the rotor cable

Installation of safety switches, contactors, connection boxes, etc.

To minimize the emission level when safety switches, contactors, connection boxes or similar equipment are installed in the rotor cable (i.e. between the converter and the rotor):

- EU: Install the equipment in a metal enclosure with 360 degrees grounding for the shields of both the incoming and outgoing cables, or in another way connect the shields of the cables together.

Bypass connection

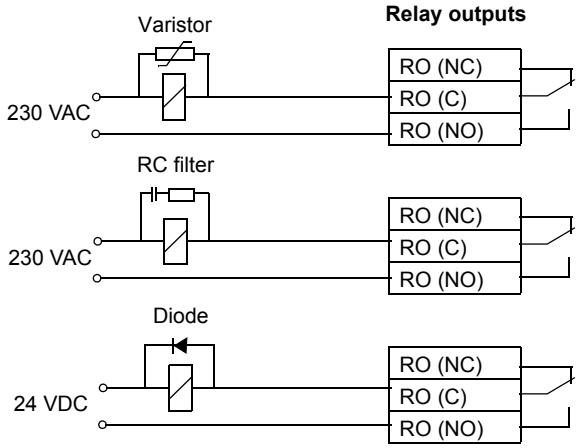
WARNING! Never connect the supply power to the converter output terminals U2, V2 and W2. If frequent bypassing is required, employ mechanically connected switches or contactors. Mains (line) voltage applied to the output can result in permanent damage to the unit.

Relay output contacts and inductive loads

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

The relay contacts of the RMIO board are protected with varistors 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.



Auxiliary voltage cables

The auxiliary voltage (115, 230 V, etc.) cables must be rated for the required voltage and current. Wire types H07V-U and H07V-R as specified by CENELEC HD 21 S2 Part 3 are highly recommended. A separate PE wire must be provided.

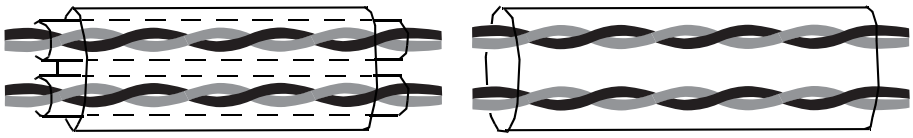
Selecting the control cables

All control cables must be shielded.

As a general rule, the control signal cable shield should be earthed directly in the ACS800-67. The other end of the shield should be left unconnected or earthed indirectly via a high frequency, high voltage capacitor of a few nanofarads (e.g. 3.3 nF / 3000 V). The screen can also be earthed 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 analogue signals. This type of cable is recommended for the pulse encoder signals also. Employ one individually shielded pair for each signal. Do not use common return for different analogue signals.

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



a
Double shielded twisted multipair cable

b
Single shielded twisted multipair cable

Run analogue 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 that the relay controlled signals be run as twisted pairs.

Never mix 24 VDC and 115/230 VAC signals in the same cable.

Relay cable

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

Coaxial cable (for use with Advant Controllers AC 80 / AC 800M)

- 75 ohm
- RG59, diameter 7 mm or RG11, diameter 11 mm
- Maximum cable length: 300 m (1000 ft)

Connection of a generator temperature sensor to the converter I/O

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

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

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

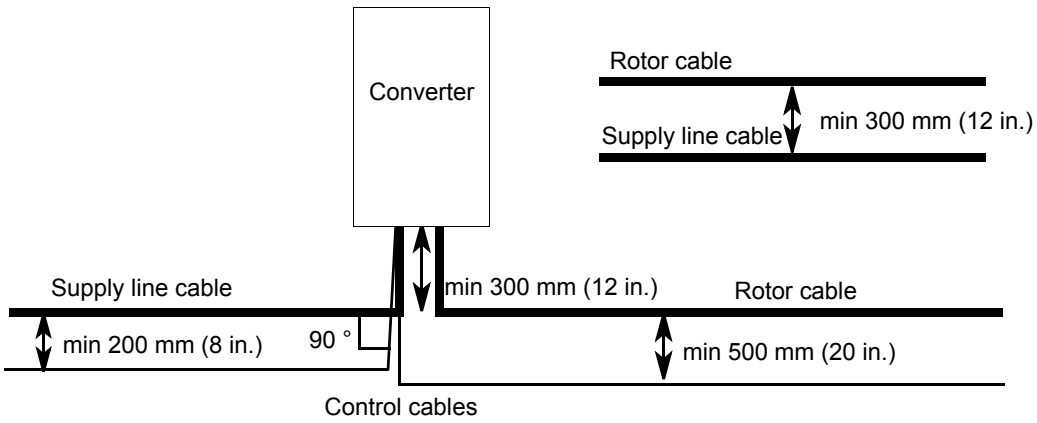
Routing the cables

Route the rotor cable away from other cable routes. Rotor cables of several converters can be run in parallel installed next to each other. It is recommended that the rotor cable, supply line cable and control cables be installed on separate trays. Avoid long parallel runs of rotor cables with other cables in order to decrease electromagnetic interference caused by the rapid changes in the rotor voltage.

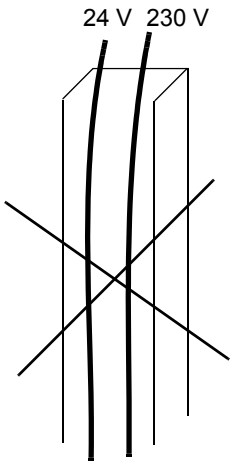
Where control cables must cross supply line and rotor cables, make sure they are arranged at an angle as near to 90 degrees as possible. Do not run extra cables through the converter.

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

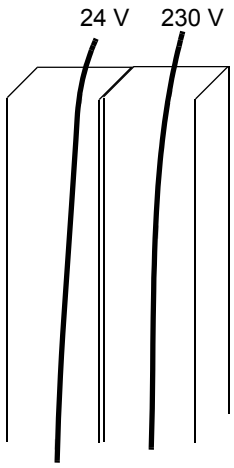
A diagram of the cable routing is shown below.



Control cable ducts



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



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

Electrical installation

Contents of this chapter

This chapter describes the electrical installation procedure of the ACS800-67.

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

WARNING! During the installation procedure, the converter modules and the LCL filter module have to be temporarily extracted from the cabinet. The modules are heavy, and have a high centre of gravity. Be careful when manoeuvring the modules. In order to minimise the danger of toppling over, keep the support legs of the converter modules extended whenever manoeuvring outside the cabinet.

Checking the insulation of the assembly

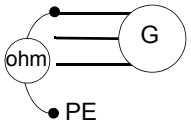
Every converter has been tested for insulation between the main circuit and the chassis (2500 V rms 50 Hz for 1 second) at the factory.

When checking the insulation of the assembly, proceed in the following manner.

WARNING! Check the insulation before connecting the converter to the power supply network. Make sure that the converter is disconnected from the grid.

Rotor cable

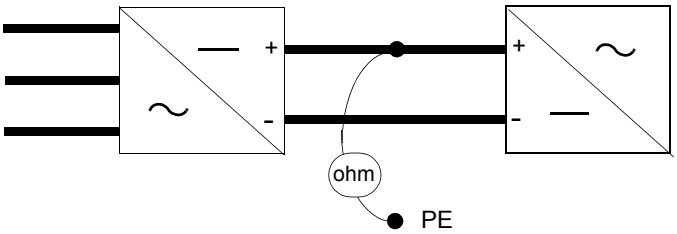
- Check that all rotor cables are disconnected from the converter output terminals.
- Measure the insulation resistances of the rotor cable and the rotor between each phase and the protective earth by using a measuring voltage of 1 kV DC. The insulation resistance must be higher than 1 Mohm.



R ≥ 1 Mohm

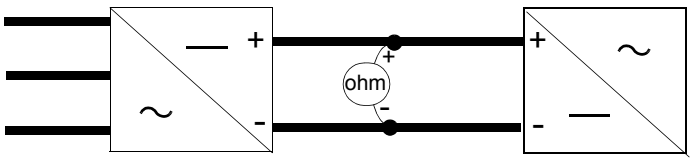
DC busbars

- Measure the resistance between each DC busbar and protective earth with a multimeter.



R ≥ 100 kΩ

- Measure the resistance between the DC busbars with a multimeter.

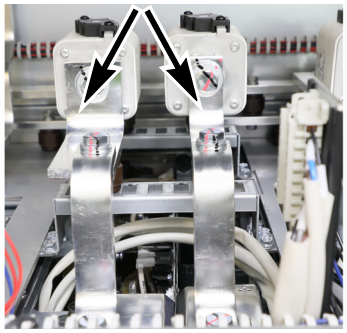


R = ∞ or rises gradually, depending on multimeter type

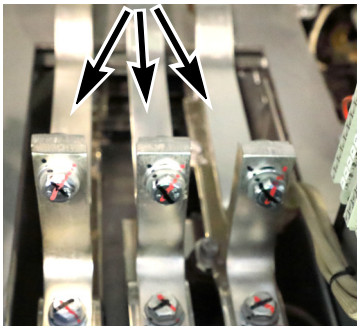
DC and AC busbars

- Short circuit the L-shaped DC busbars of the converter modules.
- Short circuit the L-shaped AC busbars of the LCL filter module.

DC busbars



AC busbars

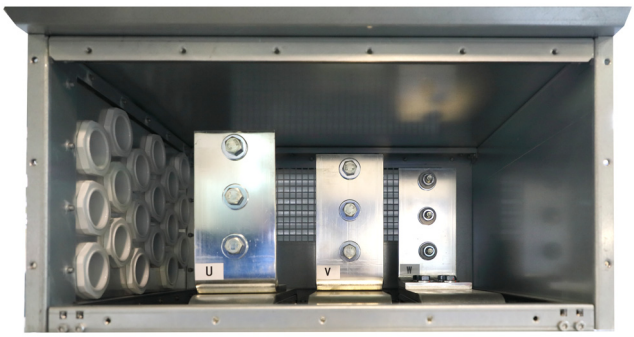


- Measure the insulation resistances between the DC busbars and the converter frame and between the AC busbars and the converter frame by using a measuring voltage of 1 kV DC. The insulation resistance must be higher than 1 Mohm.

Stator side connection procedure

The stator connections are located in the stator section of the power cabinet.

- Read and repeat the steps in *Safety instructions*.
- Open the stator section door of the power cabinet.
- Remove the protective covers from lower part of the cabinet.
- Lead the cables through gland into the cabinet.
- Cut the cables to suitable length
- Strip the cables
- Crimp the cable lugs.
- Connect the stator cables to stator terminals U, V and W. See the figures below. See the chapter *Technical data*.

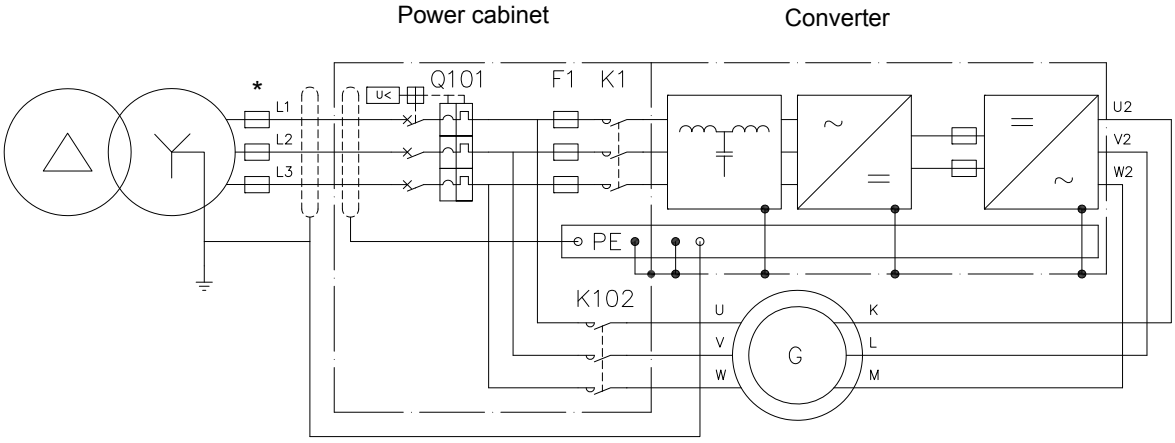


Grid and rotor connections

Connection diagram

The diagram presents an example of the main connection diagram.

*The switch fuse disconnector is not always included in the delivery!



Grid supply connection

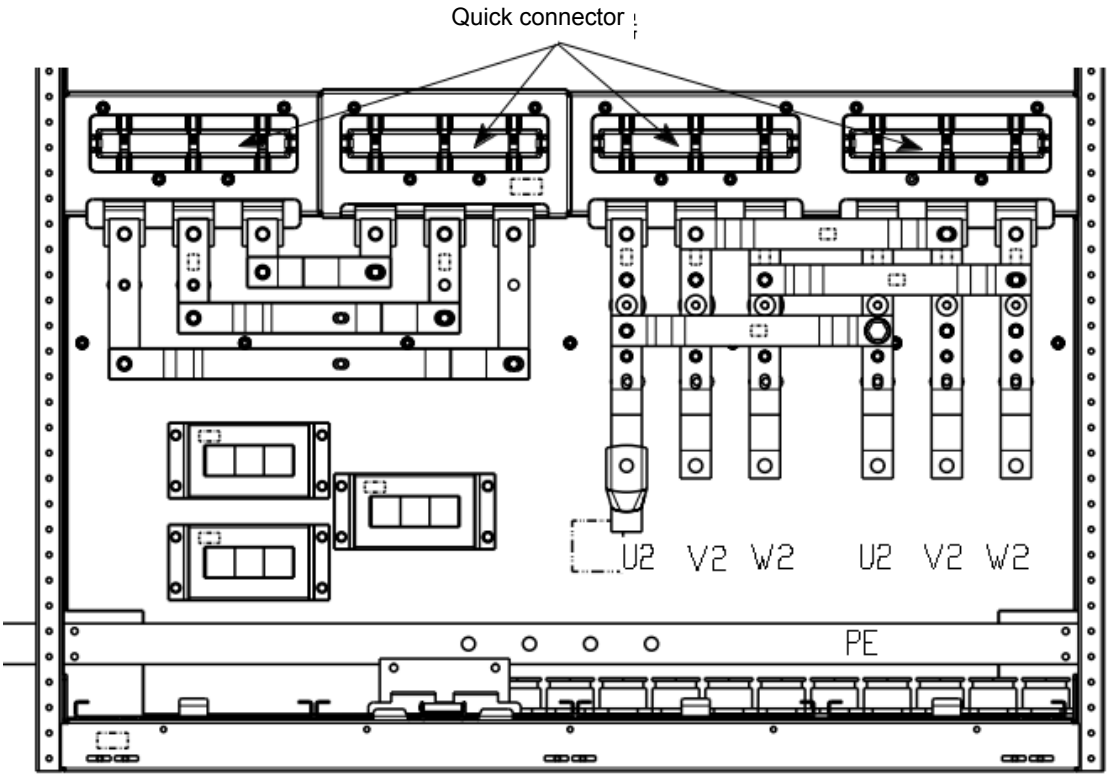
- Remove the protective cover. Connect the grid cables to grid terminals L1, L2 and L3. See the chapter *Technical data*.

- Tighten the cable lead-through grommets and seal them properly.
- Assemble the cooling fan and protective covers. Close the door.

The recommended cable types are given in the chapter *Planning the electrical installation*.

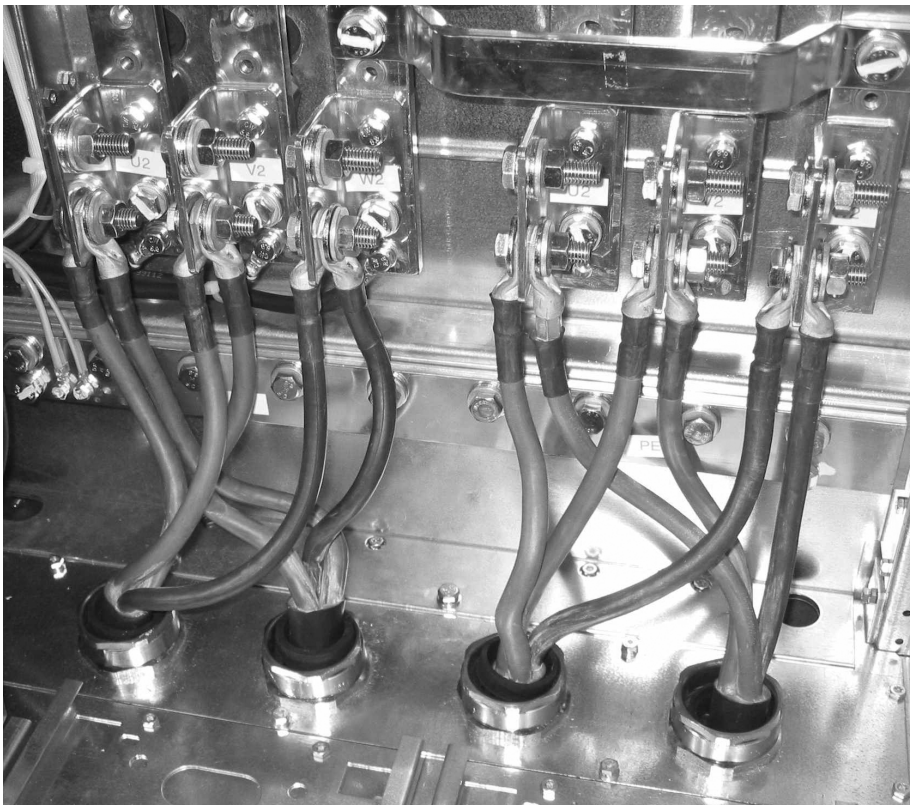
The rotor connections are located behind the power modules. The following figure shows the connectors inside the cabinet.

Protective earth cable may be connected to PE busbar under any free bolt. Note that marked bolts are mounting bolts of the PE busbar and are not for connecting the PE cables.

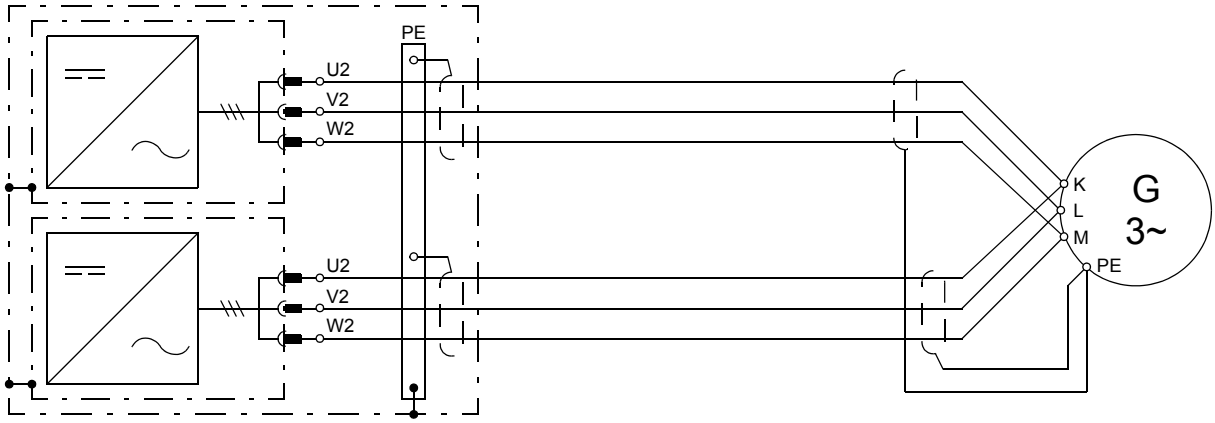


U2, V2, W2 = Output busbars

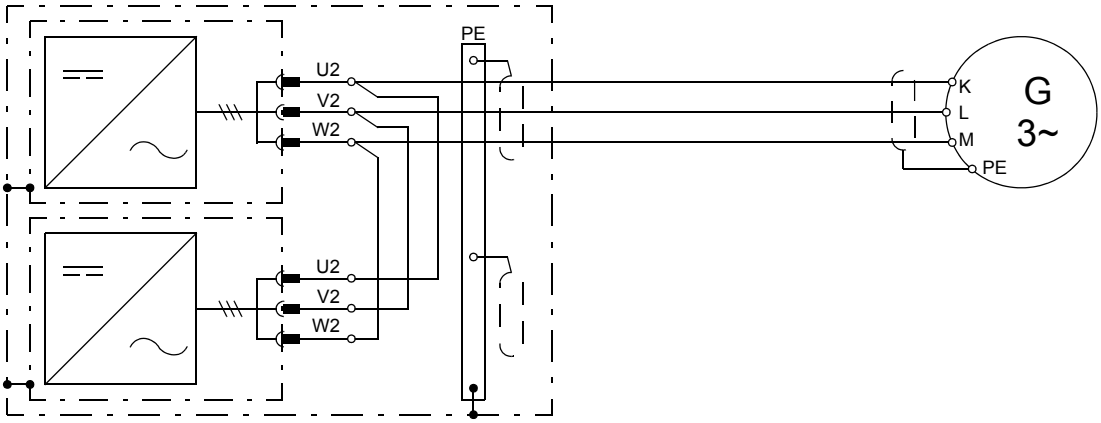
Rotor cabling example



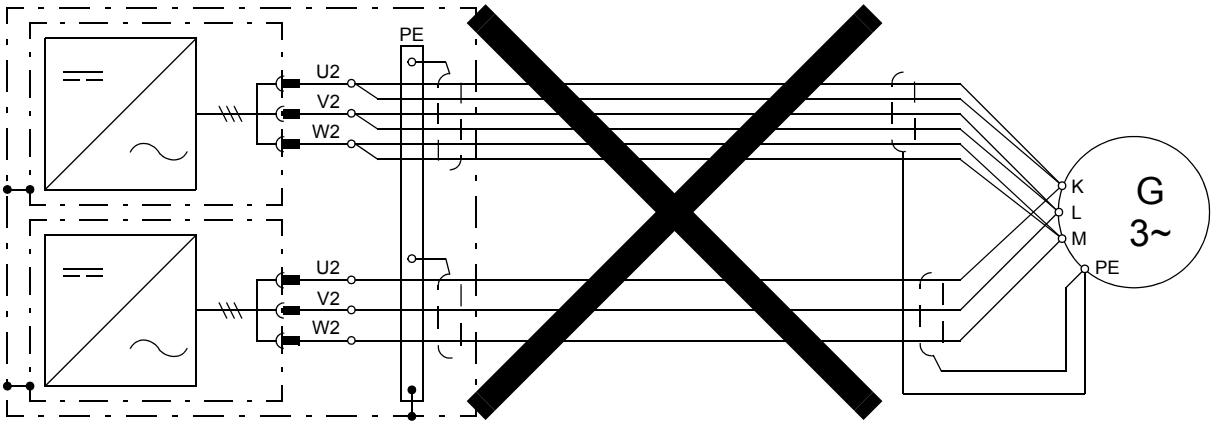
All rotor-side converter modules (two are shown below) are to be connected in parallel. It is recommended that the cabling from all rotor-side converter modules to the rotor is physically identical considering cable type, cross-sectional area, and length. Jumpering the output cables from one rotor-side converter to another (and then to the rotor) is also possible, but not recommended.



Rotor-side converter modules



Rotor-side converter modules

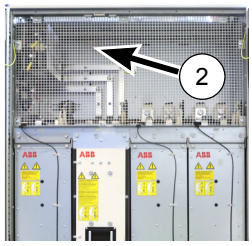


Rotor-side converter modules

The recommended cable types are given in chapter *Planning the electrical installation*.

Connection procedure

WARNING! Use extreme caution when manoeuvring a converter or filter module that runs on wheels. The modules are heavy and have a high centre of gravity. They topple over easily if handled carelessly.



Extract each module from the cabinet as follows:

(1) Open the cabinet doors.

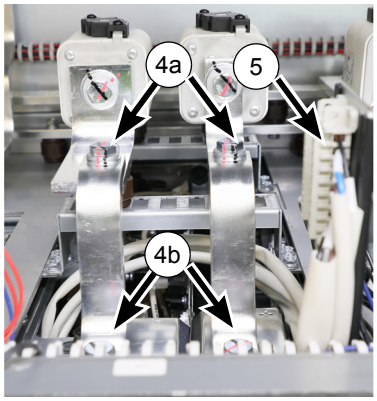
(2) Remove the shroud covering the upper part of the cabinet.

Converter modules:

(3) Open the transparent cover on the front of the converter module and disconnect the fibre optic cables. Move the cables aside.

(4) Disconnect the L-shaped DC busbars on top of the converter module: Loosen the two upper screws (4a), but leave them in place. Remove the two lower screws (4b).

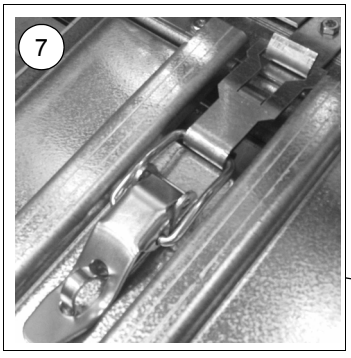
(5) Disconnect the socket terminal block next to the DC busbars.

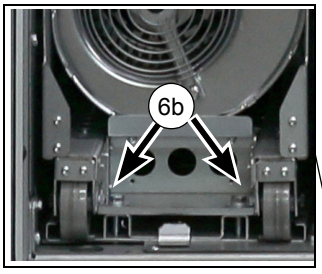


(6) Remove the two module fastening screws (6a) at the top. At the base of the module, loosen the two fastening screws (6b).

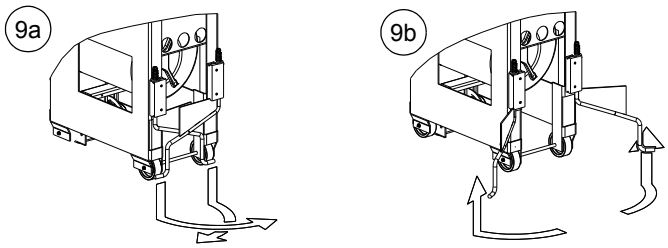
(7) Latch the module ramp to the hook at the base of the cabinet.

(8) Pull the module carefully out of the cabinet along the ramp. Make sure the wires do not catch.





(9) Extend the support legs of the module. Keep the legs extended until the module is about to be inserted back into the cabinet.



LCL filter module:

(10) Disconnect the L-shaped AC busbars on top of the filter module: Loosen the three upper screws (10a), but leave them in place. Remove the three lower screws (10b).

(11) Disconnect the socket terminal block next to the AC busbars.

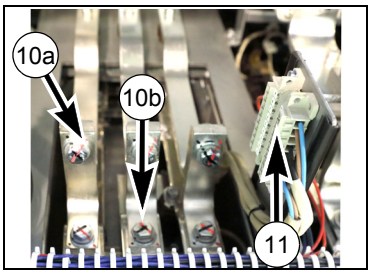
(12) Remove the two module fastening screws at the top.

(13) Remove the fan: Disconnect the fan wiring plug (13a). Remove the locking screw (13b). Pull the fan out along its sliding rails (13c).

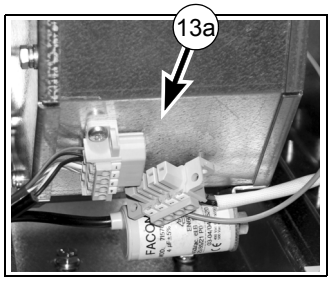
(14) At the base of the module, remove the four fastening screws.

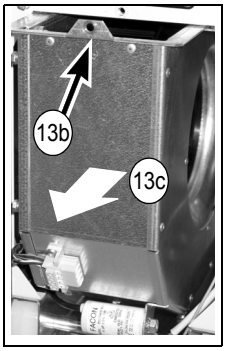
(15) Latch the module ramp to the hook at the base of the cabinet.

(16) Pull the module carefully out of the cabinet along the ramp.

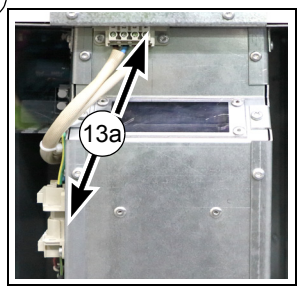


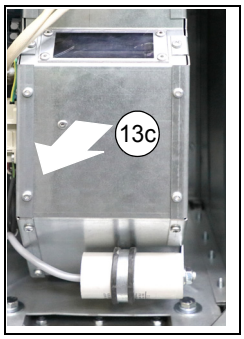
ALCL

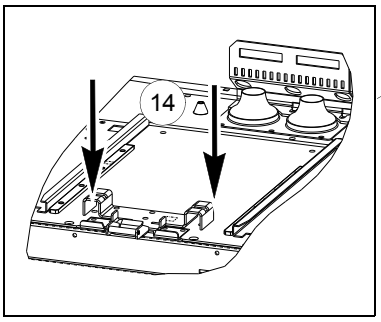


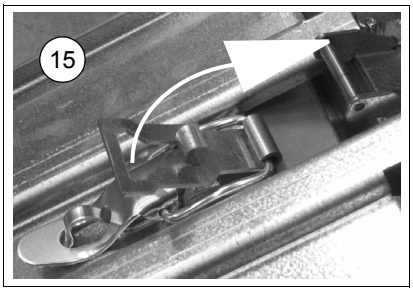


BLCL









Lead the cables into the cabinet.

Cut the cables to suitable length.
Strip the cables and conductors.
Twist the cable screens into bundles and connect to cabinet PE (ground) busbar.
Connect any separate ground conductors/cables to cabinet PE (ground) busbar.
Connect the phase conductors to the output (U2, V2, W2) and input (L1, L2, L3) terminals. See section *Cable terminals* in chapter *Technical data.*
Insert each module into the cabinet as follows: (1) Move the module close to the ramp. With converter modules, retract the support legs of the module. (2) Push the module back into the cabinet. (3) Refasten the module fixing screws at the top. Reconnect the busbars and the cables (socket terminal block, fibre optic cables). (4) Remove the pull-out ramp. (5) With converter modules, flip the module fastening bracket into the down position and tighten the screws. With LCL filter module, fix the four fastening screws at the bottom of the filter module and reconnect the fan. (6) Replace the shroud covering the upper part of the cabinet. (7) Close the doors. (8) At the generator, connect the cables according to instructions from the generator manufacturer. Pay special attention to the phase order.

Control connections

The cabinet installed unit is controlled using the local control devices mounted in the control frame. See sections *Cabinet layout* and *Interboard connection diagram* in chapter *Hardware description*. No additional control connections are needed. However, it is possible to:

- halt the unit by an external emergency stop button (if the unit is equipped with a local emergency stop button, external buttons can be connected in series)
- read fault indications through a relay output
- communicate with the unit through a serial communication interface.

See the circuit diagrams delivered with the converter for the default control connections and the connection terminals.

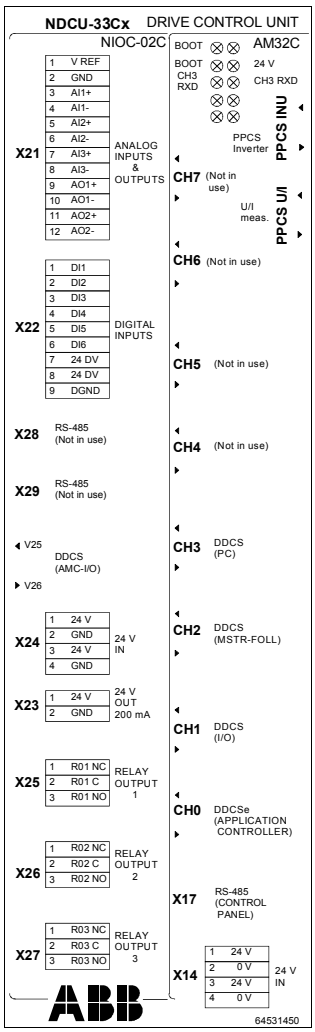
Connection procedure

- Lead the cables into the cabinet below the control unit. Wherever possible, use the existing cable trunking in the cabinet. Use sleeving wherever the cables are laid against sharp edges. Leave some slack in the cable (at the hinge) to allow the control unit to extend fully. Tie the cables to the braces to provide strain relief.
- Cut the cables to suitable length. Strip the cables and conductors.
- Twist the cable shields into bundles and connect them to the ground terminal nearest to the terminal block. Keep the unshielded portion of the cables as short as possible.
- Connect the conductors to appropriate terminals (see the circuit diagrams delivered with the unit).

Control unit NDCU-33Cx/RDCU-12C

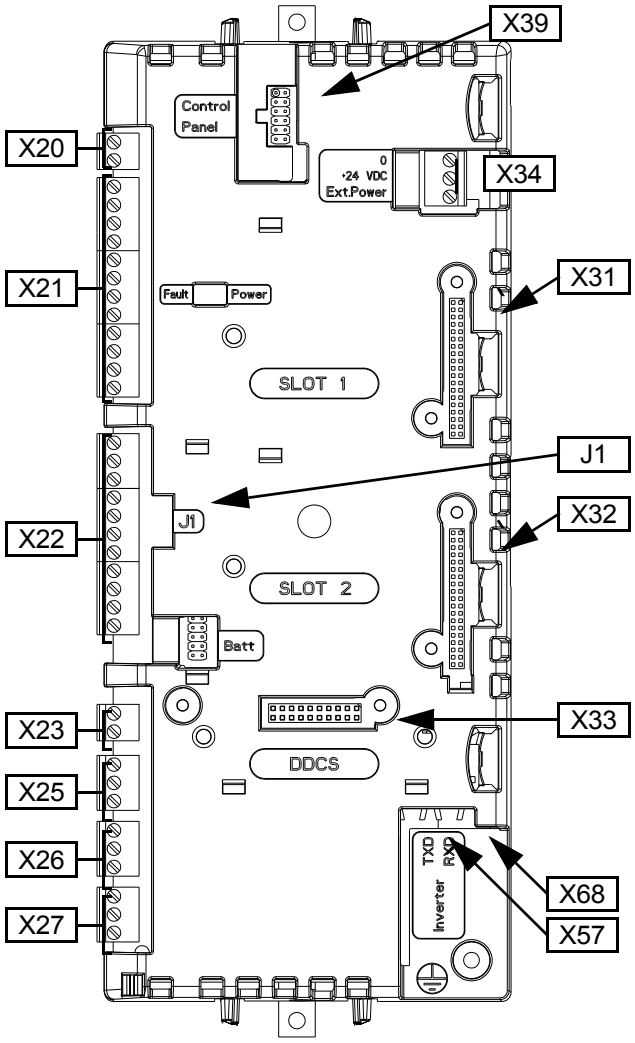
The connectors of the rotor-side converter control unit NDCU-33Cx (consisting of the NIOC-02C and AM33C boards) and the grid-side converter control unit RDCU-12C (containing the RMIO-12C board) are presented below. For further information on the RDCU control unit, see *RDCU-02(C) Drive Control Unit Hardware Manual* [3AFE64636324 [English)].

NDCU-33Cx



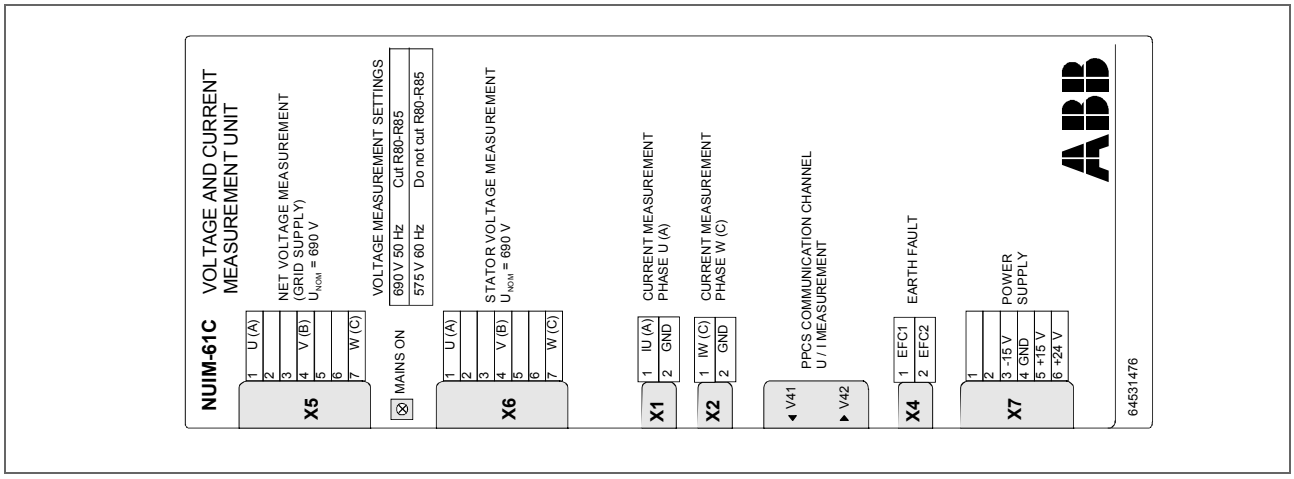
RDCU-12C

X20	1	VREF
	2	GND
X21	1	VREF
	2	GND
	3	AI1+
	4	AI1-
	5	AI2+
	6	AI2-
	7	AI3+
	8	AI3-
	9	AO1+
	10	AO1-
	11	AO2+
	12	AO2-
X22	1	DI1
	2	DI2
	3	DI3
	4	DI4
	5	DI5
	6	DI6
	7	+24V
	8	+24V
	9	DGND
	10	DGND
	11	DIIL
X23	1	+24 V
	2	GND
X25	1	RO1
	2	RO1
	3	RO1
X26	1	RO2
	2	RO2
	3	RO2
X27	1	RO3
	2	RO3
	3	RO3



Voltage and Current Measurement Unit NUIM-61C

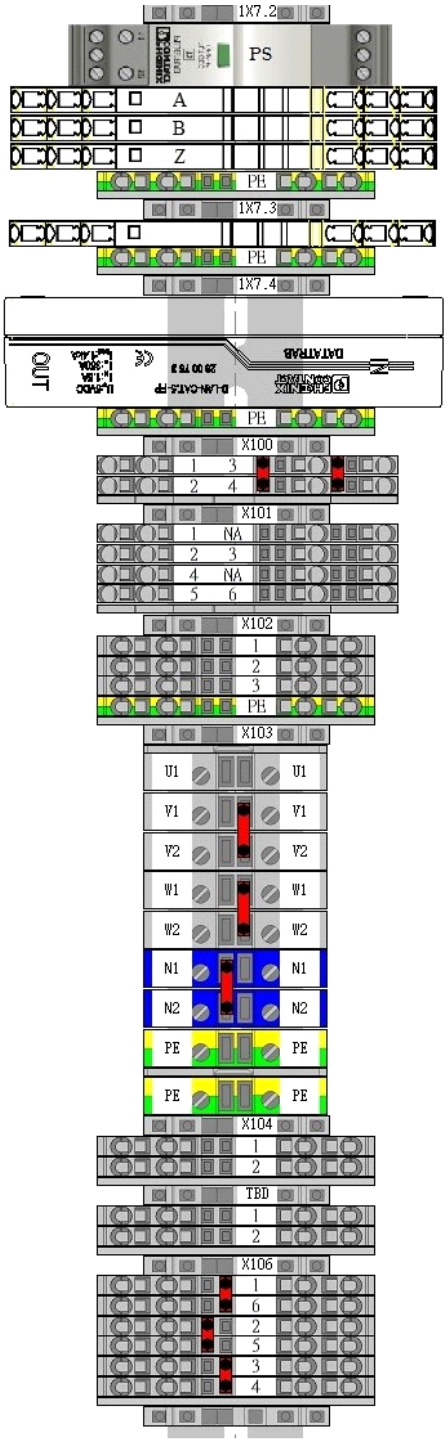
The connectors of the Voltage and Current Measurement Unit NUIM-61C are presented below. See *ACS800-67(LC) Doubly-fed Induction Generator Control Program Firmware Manual* [3AUA0000071689 (English)] for more information.



Signal connection between auxiliary power supply and main control system of the fan

Terminal block

The connecting terminal block between auxiliary power supply and the main control system of the fan are located in the lower part of the right side of the control cabinet. The following diagram shows the diagram for the terminal block.



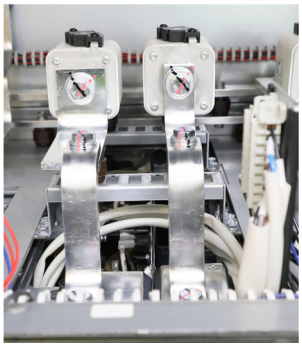
	Terminal No.	Signal	Description
1X7.2	PS:1	Encoder signal	Encoder+24V
	PS:2		Encoder+24V Earth
	Z:1		Encoder Z+
	Z:2		Encoder Z-
	A:1		Encoder A+
	A:2		Encoder A-
	B:1		Encoder B+
	B:2		Encoder B-
	PE		Connecting shield
1X7.3	1	Fieldbus interface	CANOPEN:H
	2		CANOPEN:L
	3		CANOPEN:GND
	PE		PE(Shield)
1X7.3	--	Ethernet interface	Net port
1X100	1,2	Reset signal	Reset button
	3,4	Emergency stop signal	Emergency stop button
X101	1,2,3	Breaking superior circuit breaker request	Constant open or closed point
	4,5,6	Converter fault signal	Constant open or closed point
X102	1	Power grid voltage phase A	A
	2	Power grid voltage phase B	B
	3	Power grid voltage phase C	C
	PE	PE	PE
X103	U	Auxiliary power supply	L1
	V		L2
	W		L3
	N		N
	PE		PE
X104	Reserve	Reserve for	
X106	1	A-phase current detection	A-(S1)
	6		A+(S2)
	2	B-phase current detection	B-(S1)
	5		B+(S2)
	3	C-phase current detection	C-(S1)
	4		C+(S2)

Installation checklist

Checklist

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

	MECHANICAL INSTALLATION: Check that…
☐	there is sufficient free space around the unit. See chapter *Technical data*: *Free space requirements*.
☐	the operating conditions are allowed. See chapter *Technical data: IEC ratings* and *Ambient conditions*.
☐	the unit is properly fastened on a non-flammable base. See chapter *Mechanical installation.*
☐	the cooling air flows freely.
☐	if the lifting lugs are removed, the bolts are refastened to retain the degree of protection of the cabinet.
	ELECTRICAL INSTALLATION: Check that… See chapter *Electrical installation: Planning the electrical installation.*
☐	the rotor and the driven equipment are ready for start.
☐	the converter is grounded properly.
☐	the supply (input power) voltage matches the nominal input voltage of the converter.
☐	the supply (input power) connection at L1, L2 and L3 and their tightening torques are OK.
☐	appropriate supply (input power) fuses and disconnector are installed.
☐	the rotor connections at U2, V2 and W2 and their tightening torques are OK.
☐	the rotor cable is routed away from other cables.
☐	settings of the voltage transformer are OK.
☐	the stator connections are OK, and the stator cables are routed away from other cables.
☐	any unused conductive sleeves at cable entries are tied up with cable ties.
☐	there are no power factor compensation capacitors in the rotor or stator cable.
☐	the external control connections inside the converter are OK.
☐	current and voltage measurement (connected to NUIM board) connections are OK.
☐	NTAC Pulse Encoder Interface Module cable connections (including phasing) are OK. See *NTAC/NDIO/NAIO I/O Modules Installation and Start-up Guide* [3AFY58919730 (English)].
☐	there are no tools, foreign objects or dust from drilling on top of the modules, inside the modules or inside the cabinet.
☐	there is no foreign matter near or underneath the cabinet as the cooling fans might draw that into the cabinet.
☐	if there is a cable conduit below the cabinet, air flow from the conduit is prevented by plates around the cable entries.

☐	there is no condensed humidity or ice anywhere on or inside the unit. If condensed humidity or ice is detected, use external heaters for evaporation.
☐	the L-shaped DC busbar connections (of the converter modules) and their tightening torques are OK.
☐	there is enough space between the two lower screws and bolts of the L-shaped DC busbars (of the converter modules) and the module frame. Use a mirror to check this. The air gap must be > 13 mm. 
☐	the X50 terminal connectors of the modules are in place and their connections are OK.
☐	fibre optic cables are undamaged and their connections are OK (i.e. transmitters are connected to receivers and vice versa): - Blue cable is connected to the dark grey connector of the control unit. - Black cable is connected to the light grey connector of the control unit
☐	the insulation resistances are OK. See chapter *Electrical installation:* *Checking the insulation of the assembly.*
☐	the emergency stop cable connections are OK.
☐	if other external cables are used, both ends of the cables are connected and the cables do not cause any damage or danger when the power is switched on.
☐	all shrouds and covers are in place.

Start-up

Contents of this chapter

This chapter describes the start-up procedure of the converter. The installation of the converter system must be checked before start-up. See chapter *Installation checklist.*

Start-up procedure

	Action	Additional information
	**WARNING!** The work described in this chapter must only be carried out by a qualified electrician. The *Safety instructions* on the first pages of this manual must be followed. Negligence of the safety instructions can cause injury or death. **WARNING!** Ensure that the disconnector of the supply transformer is locked out, i.e. no voltage is, or can be, connected to the converter system inadvertently. Check also by measuring that there is no voltage connected. Ensure that the stator of the generator is isolated from the supply. It is also highly recommended to close the mechanical brake of the generator.	
Basic checks with no voltage connected		
☐	Open the power cabinet door and remove the protection covers to check visually that there are no extra or loose material whatsoever inside the cabinet. Also check that there is no condensed moisture on the power cabinet surfaces, including bus bars, terminal and other components.	
☐	Check that the Roxtec cable lead-throughs and other cable lead-through grommets are tightened and sealed properly.	
☐	Check the current trip limits of the circuit breakers (preset at the factory). *General rule* Ensure the selectivity condition is fulfilled i.e. the breaker trips at a lower current than the protection device of the supplying network, and that the limit is high enough not to cause unnecessary trips during the intermediate DC circuit load peak at start. *Long term current limit* As a rule of thumb, this should be set to the rated AC current of the module. *Peak current limit* As a rule of thumb, this should be set to a value 2-3 times the rated AC current of the module.	Optional device. See the circuit diagrams delivered with the converter.
☐	Check the settings of the relays and breakers/switches of the auxiliary circuits.	Optional devices. See the circuit diagrams delivered with the converter.
☐	Check the power cabinet default setting for temperature sensor is 10°C and for humidity sensor 85% RH.	
☐	Disconnect any unfinished or unchecked 230/115 VAC cables that lead from the terminal blocks to the outside of the equipment.	
☐	Check the means of stopping the machinery. Can the rotation of the driven machine be stopped if necessary? Check the mechanical brakes.	

	Action	Additional information
☐	Write down the following data on the converter system for later use. Note down any deviations from delivery documents. • Generator, pulse encoder and cooling fan rating plate data • Maximum and minimum speeds • Speed scaling factor, gear ratio, etc. • Acceleration and deceleration times • Inertia compensation	
☐	Check that circuit breakers and protection switches in the cooling fan supply circuit are closed.	See the circuit diagrams delivered with the converter.
☐	Locate the PPCS branching unit (APBU-xx). Enable memory backup battery by setting actuator 6 of switch S3 to ON. (Only with parallel connected rotor-side modules.)	By default, memory backup is switched off to save the battery.
☐	Measure the insulation resistance of the 690 V system to the ground. It shall be more than 10 M .	
☐	Measure the insulation resistance of the stator connection to the ground. It shall be more than 10 M .	
Connecting voltage to grid terminals and auxiliary circuit		
	**WARNING!** When voltage is connected to the grid terminals, voltage may also be connected to the auxiliary circuits of the converter. **WARNING!** Never remove or insert the DC fuses of the converter's DC link when the main contactor is closed (DC busbar is live). Make sure that it is safe to apply voltage. Ensure that • nobody is working on the unit or circuits that are wired from outside into the cabinets • cabinet doors are closed.	
☐	Open all the breakers, switches and other protection devices and leave them open. Close the doors.	
☐	Connect the grid voltage by closing the supply grid breaker. Observe any abnormalities.	
☐	Close the auxiliary voltage disconnector Q120 and observe any abnormalities.	
☐	Open the supply grid disconnector. Open the auxiliary voltage disconnector Q120 and open the cabinet door.	
☐	Disconnect the auxiliary voltage cables that lead from the terminal blocks to the outside of the equipment and have not yet been checked. Also disconnect any uncompleted wiring.	
☐	Disconnect the communication link between the converter system and any overriding system.	See the circuit diagrams delivered with the converter.
☐	Make sure the main contactor / air circuit breaker cannot be switched on inadvertently by remote control.	
☐	Be ready to trip the main breaker of the supply transformer in case something abnormal occurs.	
☐	Close the main breaker of the supply transformer.	The input terminals of the converter system are now energised.
☐	Close the auxiliary circuit On/Off switch.	The auxiliary voltage circuit is now energised.
Starting the grid-side converter		

	Action	Additional information
☐	If the converter is equipped with an input fuse cubicle (optional), close the fuse switches.	Optional devices. See the circuit diagrams delivered with the converter.
☐	Close the grid-side converter (rectifier) switch disconnector.	On units with line contactors, the grid-side converter charges the contactor control capacitors (3 s at first start). The grid-side converter performs a fault status check.
☐	Close the contactor and start the grid-side converter.	See appropriate *Firmware manual*.
Control program set-up		
☐	Follow the instructions in the appropriate *Firmware Manual* to start-up the converter and to set the converter parameters.	
On-load checks		
☐	Check that the cooling fans of the grid-side and rotor-side converter modules rotate freely in the right direction.	The fan rotates noiselessly in the direction the arrow on the fan cover points to (clockwise).
☐	Check that the LCL filter module fan rotates freely clockwise.	The fan runs noiselessly.
☐	Check the correct operation of the emergency stop circuits from each operating location.	

Maintenance

Contents of this chapter

This chapter contains a table of maintenance intervals, maintenance instructions, and the descriptions of LEDs.

Safety instructions

Only a qualified electrician is allowed to perform the maintenance.

Before starting work inside the converter system,

- isolate the generator stator and the input of the ACS800-67 from the grid. It is also highly recommended that the rotor of the generator is locked with a mechanical brake
- switch off any voltages connected to the I/O terminals
- wait for 5 minutes to let the intermediate circuit capacitors discharge
- open the cabinet doors
- ensure there is no dangerous voltage present by measuring the voltage of the input terminals and the intermediate circuit terminals.

Maintenance intervals

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

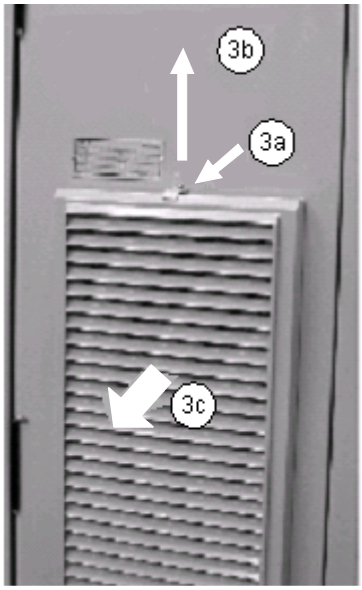
Interval	Maintenance action	Instruction
3 months after commissioning and every 3 years thereafter	Tighten and clean the power connections.	
	Checking the intactness of device surface in cabinet	Visual inspection
Every 6 to 12 months (depending on ambient and use condition)	Heatsink temperature check and cleaning	See section *Heatsinks*.
6 months after commissioning and every 2 years thereafter	Checking the tightness of the connections at the terminal strip	
Every year	Air filter replacement	See section *Checking and replacing the air filters.*
Every 3 years	Power connections check and cleaning	See section *Power connections*.
Every 9 years	Cooling fan change	See section *Cooling fans*.
Every 6 years	APBU branching unit - Memory backup battery renewal (Only with parallel connected rotor-side modules.)	Locate the APBU unit. Switch off the power to the unit. Remove cover. Replace battery with a new CR 2032 battery.
Follow circuit breaker maintenance program	Main circuit breaker maintenance	Follow the latest standards
Follow contactor maintenance program	Contactor maintenance	See contactor related manuals
Every 3 years	Replace UPS battery	
The modules are stored more than one year	Reform the DC capacitor of module	See ACS880-104WIND manual.

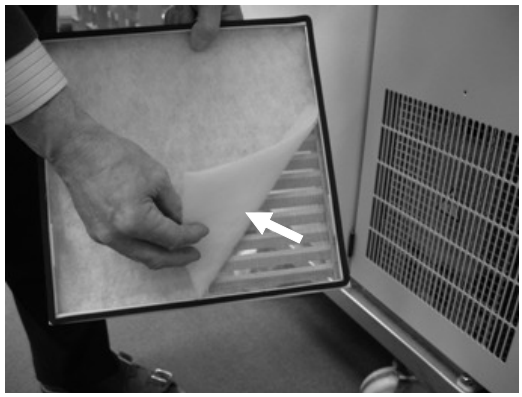
Checking and replacing the air filters

Door filter

- Read and repeat the steps in *Safety instructions* above.
- Open the stator section door.
- Check the air filter and replace if necessary (see the chapter *Technical data* for the correct filter types).

Access the door filter by removing the fastener at the top of the grille (3a), lifting the grille (3b) and pulling it away from the door (3c).

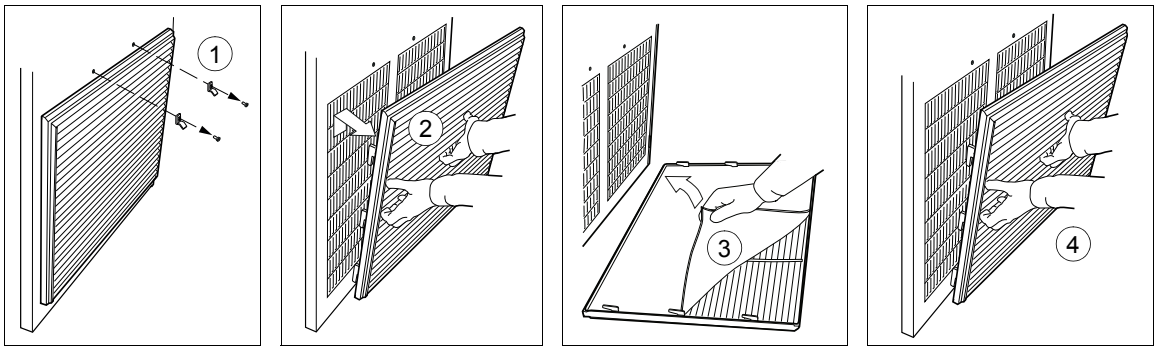




- Check the cleanliness of the cabinet. Clean the interior of the cabinet if necessary using a soft brush and a vacuum cleaner.
- Close the door.

Rear ventilation filters

- Read and repeat the steps in *Safety instructions* above.
- Remove the fasteners at the top of the grating.
- Lift the grating and pull it away from the cabinet.
- Replace the air filter mat.
- Install the grating in reverse order.



Power connections

WARNING! Use extreme caution when manoeuvring a converter or filter module that runs on wheels. The modules are heavy and have a high centre of gravity. They topple over easily if handled carelessly.

1. Read and repeat the steps in *Safety instructions* above.
2. Open the cabinet doors.
3. Extract one module from the cabinet as described in section *Connection procedure* in chapter *Electrical installation*.
4. Check the tightness of the cable connections at the quick connector. Use the tightening torque table in chapter *Technical data*.
5. Clean all contact surfaces of the quick connector and apply a layer of suitable joint compound (e.g. Isoflex® Topas NB 52 from Klüber Lubrication) onto them.
6. Re-insert the module.
7. Repeat steps 3 to 6 for all remaining modules.

Cooling fans

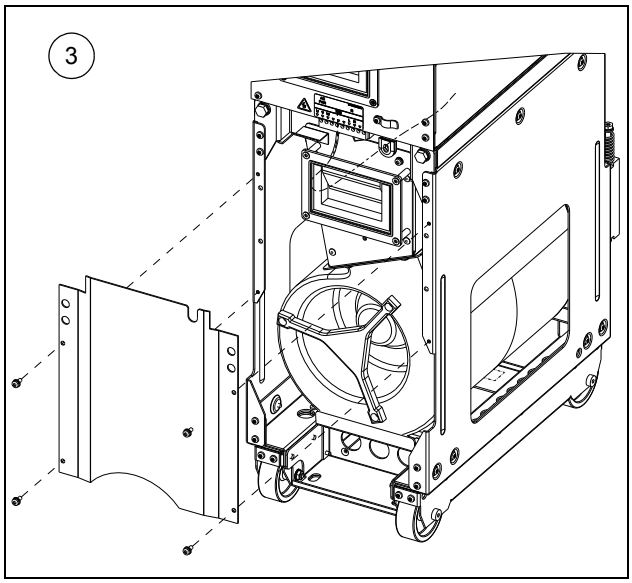
The cooling fan lifespan depends on the running time of the fan, ambient temperature and dust concentration. Each module has its own cooling fan. Replacements are available from ABB. Do not use other than ABB specified spare parts.

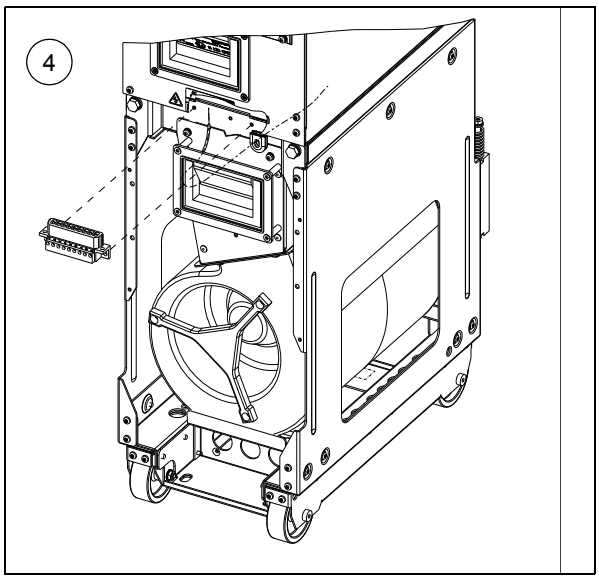
The control program keeps track of the running time of the cooling fan of the grid-side converter modules. See appropriate *Firmware Manual* for the actual signal which indicates the running time.

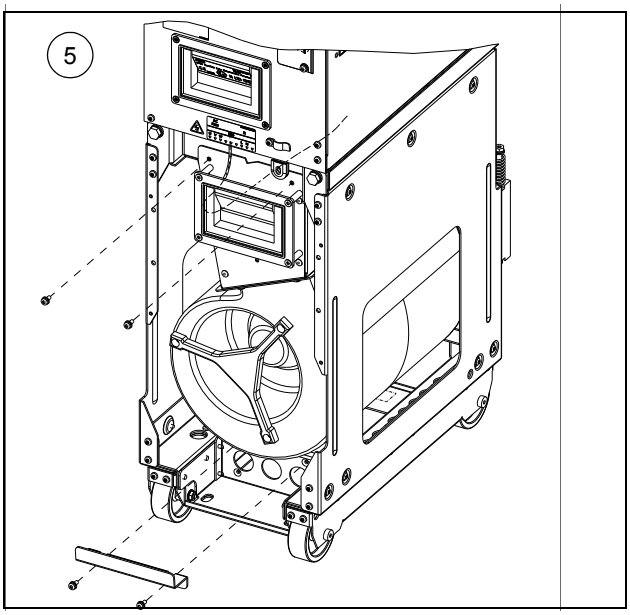
Fan failure can be predicted from increased noise from fan bearings and gradual rise in the heatsink temperature in spite of heatsink cleaning. Fan replacement is recommended once these symptoms appear.

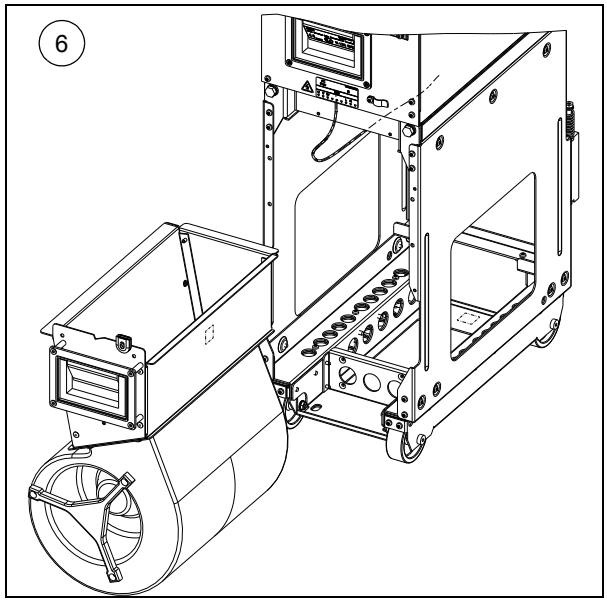
Converter module fan replacement

1. Read and repeat the steps in *Safety instructions* above.
2. Open the cabinet doors.
3. Remove the front shroud.
4. Remove tightening screws, and disconnect the fan wiring plug.
5. Remove the fan tightening screws and fan shroud.
6. Pull the fan out along its sliding rails.
7. Install a new fan in reverse order.







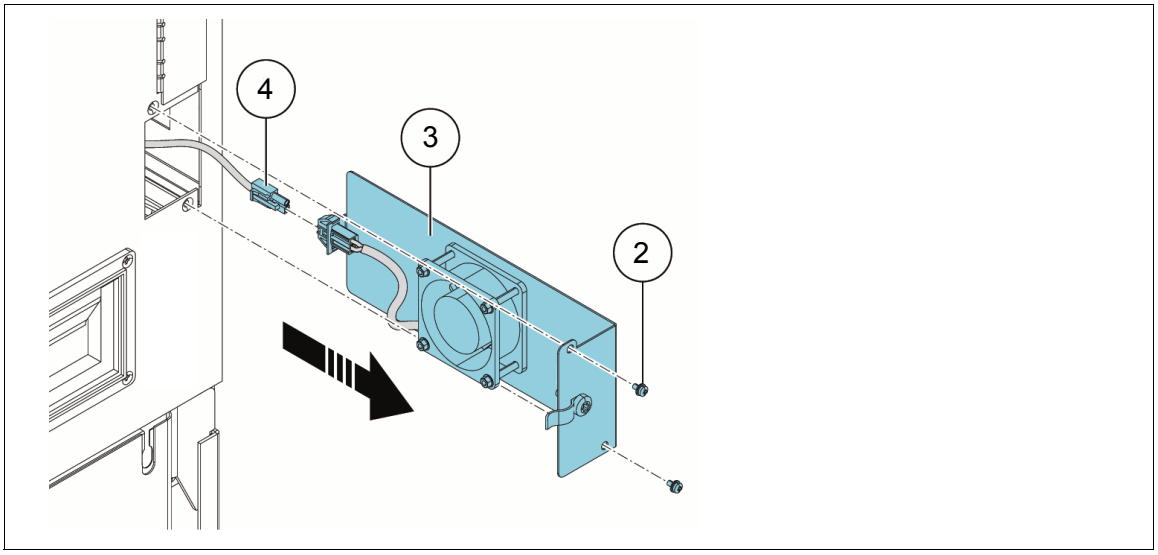


Frame R8i – Circuit board compartment fan

The R8i module is equipped with a fan blowing air through the circuit board compartment. The fan is accessible from the front of the module.

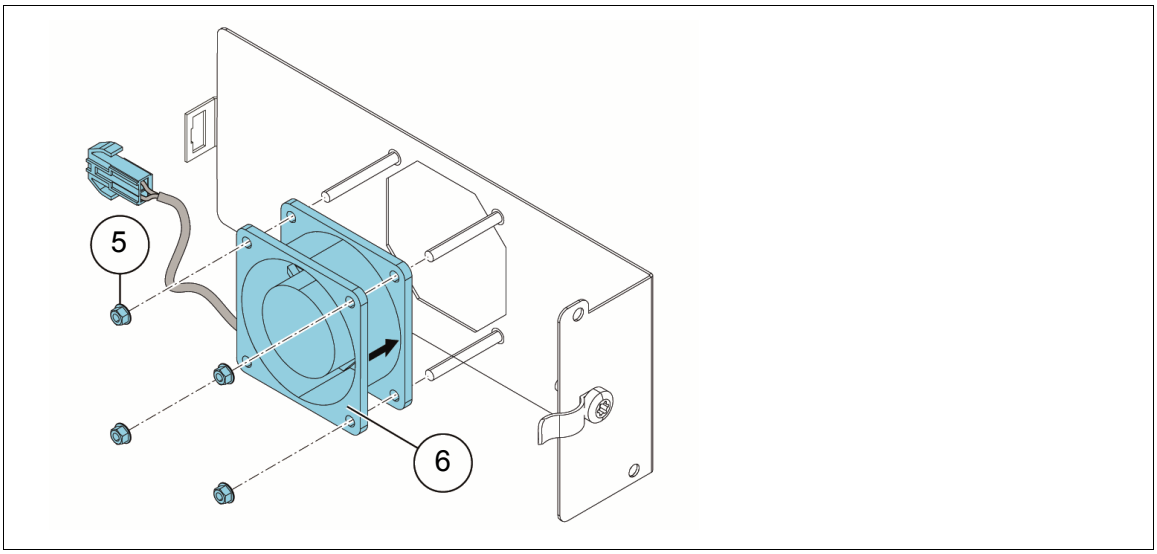
WARNING! Repeat the steps described in section *Safety instructions*. The complete safety instructions are given in *Safety instructions for ACS800-67 (+C236) Wind Turbine Converters for Asynchronous Slip Ring Generators Hardware Manual* (3AXD50000203802 [English]). Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Open the door of the module cubicle.
2. Remove the two M4×12 (T20) screws which lock the fan holder.
3. Pull the fan holder out of the module.
4. Disconnect the fan cable.



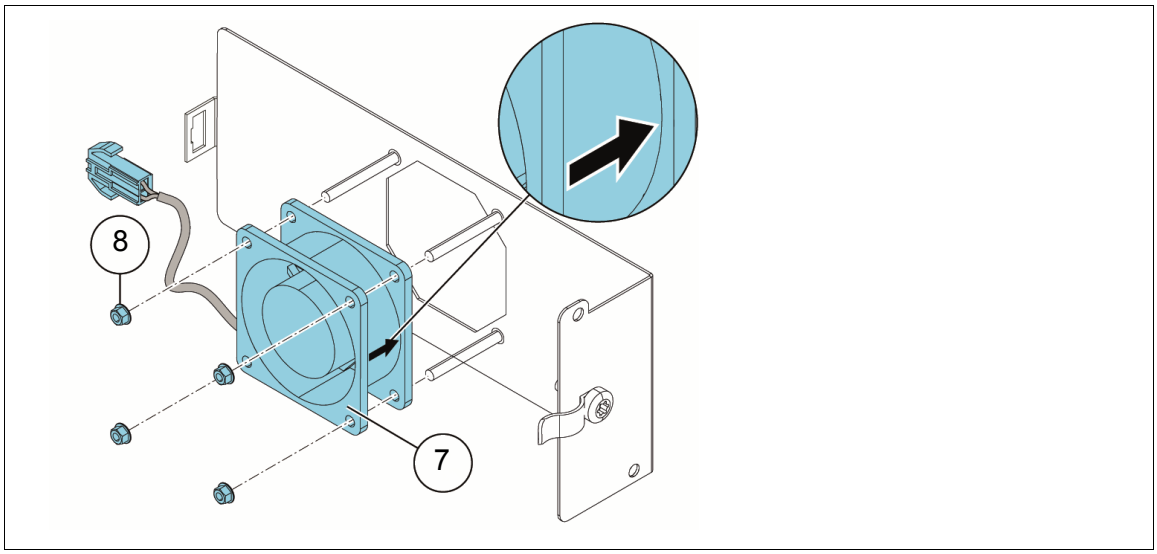
5. Remove the four M3 (5.5 mm) nuts which hold the fan.

6. Remove the fan from the fan holder.



7. Put the fan onto the threaded studs on the fan holder with the airflow direction arrow pointing towards the fan holder.

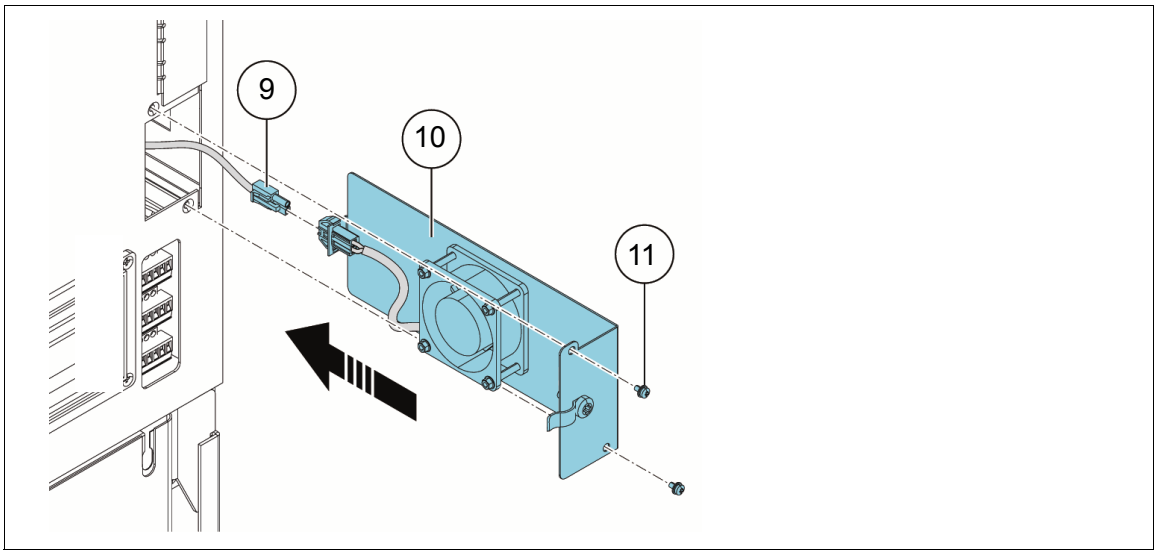
8. Install and tighten the four nuts removed earlier.



9. Connect the fan cable.

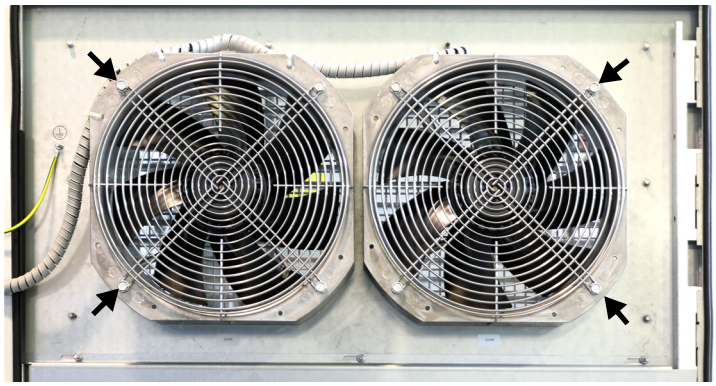
10. Align and push the fan holder into the module.

11. Install and tighten the two M4×12 (T20) screws.



Power cabinet cooling fan replacement

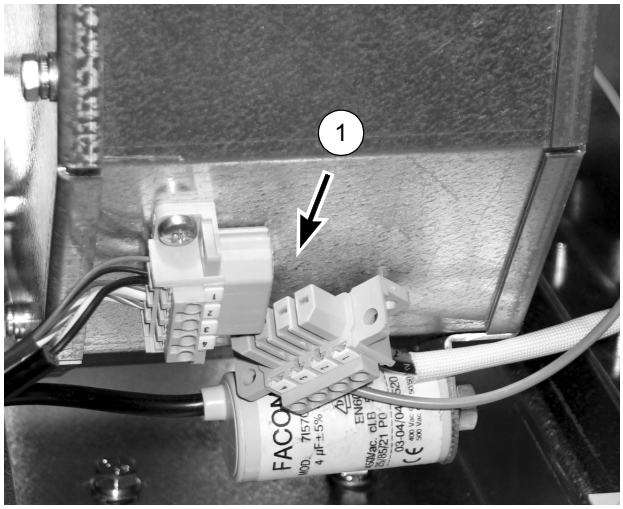
1. Read and repeat the steps in *Safety instructions* above.
2. Open the cabinet doors of stator part.
3. Disconnect the fan wiring plug.
4. Remove four screws.
5. Pull the fan out.
6. Check the cleanliness of the cabinet. Clean the interior of the cabinet if necessary using a soft brush and a vacuum cleaner.
7. Install a new fan in reverse order.

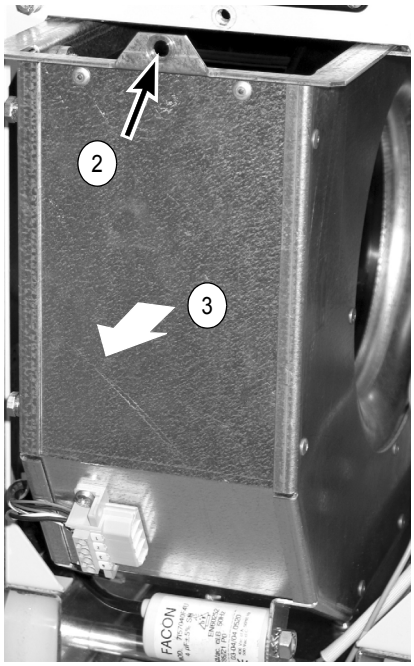


ALCL filter fan replacement

1. Read and repeat the steps in *Safety instructions* above.
2. Open the cabinet doors.
3. Disconnect the fan wiring plug (1).

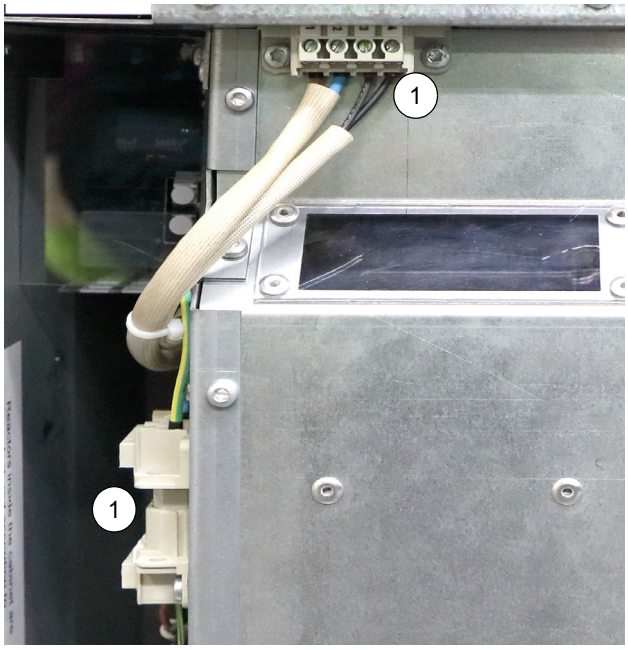
4. Remove the locking screw (2).
5. Pull the fan out along its sliding rails (3).
6. Install a new fan in reverse order.

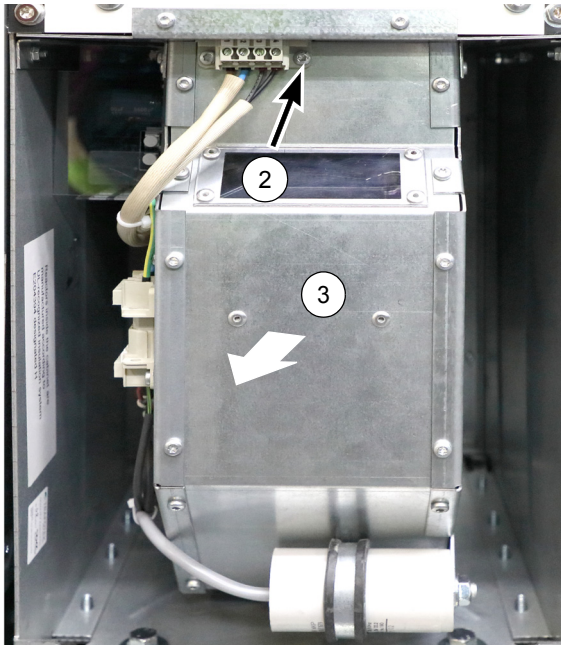




BLCL filter fan replacement

1. Read and repeat the steps in *Safety instructions* above.
2. Open the cabinet doors.
3. Disconnect the fan wiring plug (1).
4. Remove the locking screw (2).
5. Pull the fan out along its sliding rails (3).
6. Install a new fan in reverse order.





Heating heater replacement

1. Read and repeat the steps in *Safety instructions* above.

2. Heating heater shall be changed as one unit. No attempt shall be made to disassemble the heater.

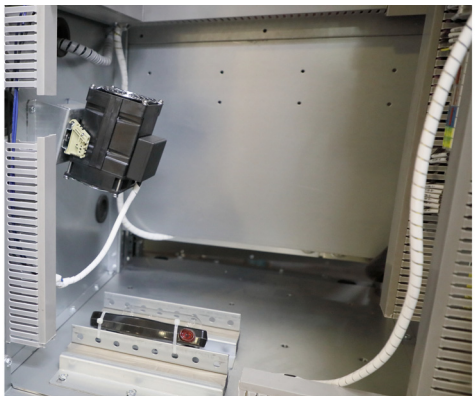
3. Open the power cabinet doors.

4. Below is an example of heater replacement. Remove the lower protective cover from stator section. Locate the heaters ZV001 and ZV002.

5. Loosen the screws securing the bracket.

6. Withdraw the heater unit from the bracket, and disconnect the power cable of connection terminals.

7. Install a new heater unit in reverse order.



Heatsinks

The heatsink fins of the power modules pick up dust from the cooling air. The module runs into overtemperature warnings and faults if the heatsinks are not clean. In a “normal” environment (not especially dusty nor clean) the heatsinks should be checked annually, in a dusty environment more often.

Whenever necessary, clean the heatsinks as follows:

1. Remove the cooling fan (see section *Cooling fans*).
2. Blow dry clean compressed air from bottom to top and simultaneously use a vacuum cleaner at the air outlet to trap the dust. **Note:** Prevent the dust from entering adjoining equipment.
3. Refit the cooling fan.

Capacitors

The lifespan depends on the operating time of the converter, loading and ambient temperature. Capacitor life can be prolonged by lowering the ambient temperature.

It is not possible to predict capacitor failure. Capacitor failure is usually followed by damage to the unit and an input cable fuse failure, or a fault trip. Contact ABB if capacitor failure is suspected.

Capacitor replacement

Contact an ABB service representative.

Other maintenance actions

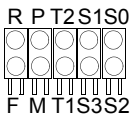
Power module replacement

To replace converter modules, follow the instructions on module removal and refitting given in section *Connection procedure* in chapter *Electrical installation*.

LEDs

This table describes the LEDs.

Location	LED	When LED is lit
RMIO-12		
V30	Red	Converter in fault state
V22	Green	The 5 V power supply on the board is OK.
BINT-67		
V1	Red	Fault
V2	Yellow/Green	STO/enable
AITF-01C*		
V203	Green	The 5 V power supply on the board is OK.
V309	Green	Converter operation is enabled.
V310	Red	Prevention of unexpected start is ON.
V311	Green	The 24 V power supply for the gate drivers is OK.

ZPOW-7B1C			
	V16	Green	The 24 V output voltage is ON.
AMC-33**			
	F	Red	Internal fault: LED is on during program boot.
	R	Green	Not in use with the current software version
	M	Green	RESET signal is ON.
	P	Green	Auxiliary voltage is OK.
	T1...T2	Yellow	DDCC channels CH0 (T1) and CH3 (T2) are receiving data.
	S0	Yellow (blinking)	Application program is running.
	S1	Yellow	Not in use with the current software version
APBU-44			
	V18 A (upper)	Green	The 3.3 V power supply voltage is OK.
	V18 B (lower)	Green	Backup battery voltage is OK. LED does not indicate missing battery or the OFF state of the battery ON/OFF switch in APBU board revision D or earlier.
	V19 A (upper)	Yellow	Master channel (CNTL) is sending data.
	V19 B (lower)	Yellow	Master channel (CNTL) is receiving data.

* Located on the active crowbar unit ACBU.

**Located on the NDCU-33 unit.

Technical data

Contents of this chapter

This chapter contains the technical specifications of the converter, e.g. ratings, frame sizes and technical requirements, and provisions for fulfilling the requirements for CE and other markings.

Converter and filter module types

The ACS800-67 wind turbine converter types are listed in the following table.

ACS800-67	Grid-side converter		Rotor-side converter		LCL filter
	Type	Frame size	Type	Frame size	Type
2200	ACS880-104WIND-0420A-7	R8i	ACS880-104WIND-0820A-7+E205	2xR8i	ALCL-15-7
2500	ACS880-104WIND-0520A-7	R8i	ACS880-104WIND-1010A-7+E205	2xR8i	BLCL-15-7

IEC ratings

The IEC ratings for the ACS800-67 with 50 Hz and 60 Hz supplies are given below. The symbols are described below the table.

Grid-side converter IEC ratings

Grid-side ACS800-104WIND	Frame size	Nominal ratings						Overload	Heat dissipation
		$I_{cont.max}$ A (AC)	$I_{cont.max}$ A (DC)	I_{max} A (AC)	I_{max} A (DC)	S_N kVA	P_N kW (DC)	I_{OI} A (AC)	P_{loss} kW
Three-phase supply voltage: 690 V									
-0420-7	R8i	380	461	570	691	454	450	418	13.4*
-0520-7	R8i	470	570	705	855	562	556	517	15.3**

* Including an ALCL-15-7 LCL filter.

* *Including a BLCL-15-7 LCL filter.

Rotor-side converter IEC ratings

Rotor-side ACS800-104WIND	Frame size	Frame size					Overload	Heat dissipation
		$I_{cont.max}$ A (AC)	$I_{cont.max}$ A (DC)	I_{max} A (AC)	I_{max} A (DC)	S_N kVA	I_{OI} A (AC)	P_{loss} kW
Three-phase supply voltage: 690 V								
-0820A-7+E205	2×R8i	820	923	1230	1384	980	902	12.0
-1010A-7+E205	2×R8i	1010	1136	1520	1710	1207	1111	14.6

Symbols

Nominal ratings

$I_{cont.max}$ Continuous rms output current. No overloadability at 40°C.

I_{max} Maximum output current. Allowable for 10 seconds at start, otherwise as long as allowed by converter temperature.

Typical ratings for no overload use

$P_{cont.max}$ Typical converter output power.

Typical ratings for light overload use (10% overloadability)

I_{2N} Continuous rms current. 10% overload is allowed for 1 minute every 5 minutes.

P_N Typical converter output power.

Typical ratings for heavy duty use (50% overloadability)

I_{2hd} Continuous rms current. 50% overload is allowed for 1 minute every 5 minutes.

P_{hd} Typical converter output power.

Derating

The load capacity (current and power) decreases if the installation site altitude exceeds 2000 metres (6600 ft), or if the ambient temperature exceeds 45°C (113°F).

Temperature derating

In the temperature range +45°C (+113°F) to +50°C (+122°F), the rated output current is decreased by 2% 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 50°C (+122°F), the derating factor is 100% - 1 $\frac{\%}{°C}$ · 10°C = 90% or 0.90. The output current is then 0.90 × I_{2N} or 0.90 × I_{2hd}.

Note: $I_{cont.max}$ rating is not allowed above 45°C (113°F).

Altitude derating

At altitudes from 2000 to 4000 m (6600 to 13123 ft) above sea level, the derating is 1% for every 100 m (328 ft). For a more accurate derating, use the DriveSize PC tool. If the installation site is higher than 2000 m (6600 ft) above sea level, please contact your local ABB representative or office for further information.

Dimensions, noise, cooling characteristics of the modules

Unit	Frame size	Height mm	Width mm	Depth mm	Weight kg	Noise level dBA	Air flow m^3/h
Grid-side converter	R8i	1397	240	590.5	118	72	1280
Rotor-side converter	2×R8i	2×1397	2×240	590.5	300	74	2560
LCL filter	BLCL-15-7	1355	240	504.9	217.5	-	400
LCL filter	ALCL-15-7	1397	240	199	180	-	400

See also delivery specific dimensional drawings.

AC fuses

The converter is equipped with AC fuses. Suitable Bussmann types are listed below. Equivalent fuses from other manufacturers can also be used.

ACS800-67…	AC Fuses (aR)					
	I_N A	U_N V	Qty	Type	Fuse size	ABB code
U_N = 690 V						
2200	500	690	3	170M6458	Size3	3ABD00036577
2500	630	690	3	170M6460	Size3	3AXD50000147489

DC fuses

The DC fuses (manufactured by Bussmann) used in the ACS800-67 are listed below. Any blown fuses must be replaced with an identical type. U_N and I_N are the nominal voltage and current of the fuse.

Rotor-side converter DC fuses

ACS800-67…	DC Fuses (aR)					
	I_N A	U_N V	Qty	Type	Fuse size	ABB code
U_N = 690 V (690 V)						
2200	800	1200	4	170M6546		3AFE68736005
2500	1000	1100	4	170M6548		3AFE63916749

Power consumption of auxiliary devices

		型号	U_n V DC	U_n V AC	P W
Boards	PCB, Relay, Contactor		24		204
Heater	E11, ZV001	XA142		230	1483
Module fan	(U1, U11.1-2)	D2D160-CE02-11		400	2274
ACU cooling fan	M11	W2E200-HH38-06		230	67
ICU cooling fan	ZV005-006	W2E250-HL06-21		230	165×2
LCL cooling fan	(U6)	R2E225-PD-12			135

Breaker settings

It is important that the grid supply breaker is typically set as indicated in the table below as all the components are dimensioned according to the limit. The breaker setting for all units has been set at the factory. There is no need to adjust the settings except when replacing breaker.

Breaker	Type	Type	I_n (A)	I_{trip} (A)	Time
Q101	ACS800-67-0460/ 0980-7	E2.2B	2500	L = 0.9 In S = 1 In I = 3 In	t (L)= 3S t (S)= 0.1S
	ACS800-67-0570/ 1210-7	E4.2N	3200	L = 0.9 In S = 1 In I = 3 In	t (L)= 3S t (S)= 0.1S

1.The network frequency setting must be selected according to local network frequency, 50/60Hz.

2. Breaker I_{trip}(A) and time are default values in the table above, but the actual values may be different according to specific projects. Please refer to the delivered dimension drawing.

Stator contactor settings

There is one stator contactor in the right power cabinet which is used to connect/ disconnect stator to/from grid supply.

Contactor	Converter type	Type
K102	ACS800-67 2200	AF2050
	ACS800-67 2500	AF2650

Grid-side contactor settings

Contactor	Converter type	Type
K1	ACS800-67 2200	AF305
	ACS800-67 2500	AF400

Cable terminals

DC input and generator cable terminal sizes and tightening torques are given below. The terminals must be suitable for tin-plated busbars.

Cable terminals	Screw size	Tightening torque
DC terminals	M12 Max. intrusion into module: 20 mm (0.8 in.)	50 N·m (37 lbf·ft)
Grid, stator and rotor terminals	M12	70 N·m (52 lbf·ft)

Input power cable connection

Voltage (U_1) 690 VAC 3-phase ±10%
Frequency 47 to 63 Hz

Rotor connection

Voltage (U_2) 0 to U_1, 3-phase symmetrical, U_{max} 750 V
Frequency 0 to 100 Hz
Current See section *IEC ratings*.

Switching frequency 2 kHz (average)

Efficiency

Approximately 97% at nominal power level

Cooling and noise

Method Internal fans, air flow direction: from bottom to top.

Filter material

Inlets	Luftfilter airTex G150 Stainless steel net yarn
Outlet	Stainless steel net yarn

Free space around the unit See section *Free space requirements*.
Cooling air flow See section *IEC ratings*.
Noise ≤ 80dBA

Degrees of protection

IP42

Ambient conditions

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

	Operation installed for stationary use	**Storage** in the protective package	**Transportation** in the protective package
Installation site altitude	0 to 4000 m (13123 ft) above sea level [above 2000 m (3281 ft), see section *Derating*]	-	-
Air temperature	-30 to +50°C (-22 to 122°F). **Note:** In low temperatures, the cabinet must be warmed up before start-up. See also section *Derating*.	-40 to +70°C (-40 to +158°F)	-40 to +70°C (-40 to +158°F)
Relative humidity	5 to 95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.		
Contamination levels (IEC 60721-3-3, IEC 60721-3-2, IEC 60721-3-1)	No conductive dust allowed.		
	Boards without coating: Chemical gases: Class 3C1 Solid particles: Class 3S2 **Boards with coating:** Chemical gases: Class 3C2 Solid particles: Class 3S2	**Boards without coating:** Chemical gases: Class 1C2 Solid particles: Class 1S3 **Boards with coating:** Chemical gases: Class 1C2 Solid particles: Class 1S3	**Boards without coating:** Chemical gases: Class 2C2 Solid particles: Class 2S2 **Boards with coating:** Chemical gases: Class 2C2 Solid particles: Class 2S2
Atmospheric pressure	70 to 106 kPa 0.7 to 1.05 atmospheres	70 to 106 kPa 0.7 to 1.05 atmospheres	60 to 106 kPa 0.6 to 1.05 atmospheres
Vibration (IEC 60068-2)	Max. 0.075mm (0.003 in.) (2 ~ 57 Hz), Max. 10 m/s^2 (33 ft/s^2) (57 ~ 150 Hz) sinusoidal	Max. 0.075mm (0.003 in.) (2 ~ 57 Hz), Max. 10 m/s^2 (33 ft/s^2) (57 ~ 150 Hz) sinusoidal	Max. 3.5 mm (0.14 in.) (2 ~ 9 Hz), Max. 15 m/s^2 (49 ft/s^2) (9 ~ 200 Hz) sinusoidal
Shock (IEC 60068-2-27)	Not allowed	Max. 100 m/s^2 (330 ft./s^2), 11 ms	Max. 100 m/s^2 (330 ft./s^2), 11 ms
Free fall	Not allowed	100 mm (4 in.) for weight over 100 kg (220 lb)	100 mm (4 in.) for weight over 100 kg (220 lb)

Materials

Cabinet	Hot-dip zinc-coated sheet steel with polyester thermosetting powder coating on visible surfaces.
Busbars	Tin-plated
Fire safety of materials (IEC 60332-1)	Insulating materials and non-metallic items mostly self-extinctive
Packaging	Frame: Wood or plywood. Plastic wrapping: PE-LD. Bands: PP or steel.
Disposal	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 film 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.
Air filter (inlet)	Luftfilter airTex G150

Free space requirements

Front: Make sure there is enough room for the doors to open fully. Allow for room for module extraction and insertion.
Rear: 500 mm (20 in.) from the rear air outlet. Make sure that there is enough room for rear air outlet maintenance.
Left/Right: None; however, there should be enough room for the leftmost and/or rightmost cabinet doors to open fully.
Top: 600 mm (23.5 in.) above the basic roof level of the cabinet.

Compliance with the Machinery Directive

The wind turbine converter complies with the European Union Machinery Directive requirements for a partly completed machinery. The declaration of incorporation is available from ABB.

Further information

Product and service inquiries

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

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

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