ABB wind turbine converters

Hardware manual

ABRU-0x DC choppers (+D150) and resistors (+D151) for ACS800-67LC/-77LC/-87LC wind turbine converters

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List of related manuals

ACS800-67LC manuals	Code (English)
ACS800-67LC wind turbine converters hardware manual	*3AUA0000058400*
ACS800-67LC wind turbine converters system description and start-up guide	*3AUA0000059432*
ACS800-67(LC) doubly-fed induction generator control program firmware manual	*3AUA0000071689*
ACS800 grid-side control program firmware manual	*3AUA0000075077*

ACS800-77LC manuals	
ACS800-77LC wind turbine drives hardware manual	*3AFE68802172*
ACS800-77LC wind turbine converters (back-to-back) hardware manual	*3AUA0000023485*
ACS800-77LC wind turbine drives system description and start-up guide	*3AFE68802237*
ACS800-77LC wind turbine drives (back-to-back) system description and start-up guide	*3AUA0000040012*
ACS800-77LC/87LC induction and PM generator control programs firmware manual	*3AUA0000081707*
Configuration and control program for wind turbine applications firmware manual	*3AFE68859549*
ACS800 grid-side control program firmware manual	*3AUA0000075077*

ACS800-87LC manuals	
ACS800-87LC wind turbine converters hardware manual	*3AUA0000060416*
ACS800-87LC wind turbine converters system description and start-up guide	*3AUA0000060417*
ACS800-77LC/87LC induction and PM generator control programs firmware manual	*3AUA0000081707*
ACS800 grid-side control program firmware manual	*3AUA0000075077*

Option manuals	
ABRU-0x DC choppers (+D150) and resistors (+D151) for ACS800-67LC/-77LC/-87LC wind turbine converters hardware manual	*3AUA0000076494*
ICU800-67LC incoming units (+C108/+C109) hardware manual	*3AUA0000071553*
Manuals for fieldbus adapters, etc.	

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.

Hardware manual

ABRU-0x DC choppers (+D150) and resistors (+D151) for ACS800-67LC/-77LC/-87LC wind turbine converters

3AUA0000076494 Rev B
EN
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6. Fault tracing

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8. Technical data

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Further information

1

Introduction to the manual

What this chapter contains

This chapter contains general information on the manual, eg, the intended audience and contents of the manual.

Applicability

The manual is compatible with optional DC (brake) chopper used in ACS800-67LC, ACS800-77LC and ACS800-87LC wind turbine converters. Chopper type is ABRU-0x. ABRU-0x DC chopper is also called *brake chopper*.

Safety instructions

For the complete safety instructions, see the hardware manual delivered with the wind turbine converter.

Target audience

This manual is intended for people who plan the installation, install, commission, use and service the DC (brake) chopper. Read the manual before working on the DC (brake) chopper. The reader of the manual is expected to know the standard electrical wiring practices, electronic components, and electrical schematic symbols.

Purpose of the manual

This manual helps in planning the installation, installing, commissioning, using and maintaining the DC (brake) chopper.

Contents of the manual

The chapters of this manual are briefly described below.

Operation principle and hardware description describes the operation and hardware of the ABRU-0x.

Planning the installation provides advice on resistor and cable selection, the protective functions, and cable routing.

Installation describes the cabling and wiring of the ABRU-0x.

Start-up describes how ABRU-0x is started up.

Fault tracing describes the warning and fault messages related to the ABRU-0x.

Maintenance contains maintenance instructions.

Technical data contains the technical specifications of the ABRU-0x, eg, ratings.

Circuit diagrams contains circuit diagrams of the ABRU-0x and its control connections.

Related documents

See *List of related manuals* inside of the front cover.

Terms and abbreviations

For the complete list of terms and abbreviation, see the hardware manual of the converter.

Term/Abbreviation	Explanation
ABRU	DC (brake) chopper type used in ABB wind turbine converters
ABRC	DC (brake) chopper control board used in ABRU
Brake chopper	See *DC chopper.*
Brake resistor	See *DC resistor.*
Converter	Converts direct current and voltage to alternating current and voltage, or vice versa.
Cubicle	One section of a cabinet-installed converter. A cubicle is typically behind a door of its own.
DC chopper	Conducts the surplus energy from the intermediate circuit of the converter to the DC (brake) resistor when necessary. The chopper operates when the DC link voltage exceeds certain maximum limit.
DC link	DC circuit between rectifier and INU
DC link capacitors	Energy storage which stabilizes the intermediate circuit DC voltage.
DC resistor	Dissipates the converter surplus energy conducted by the DC (brake) chopper to heat. Essential part of the chopper circuit. See *DC chopper*.
DDCS	Distributed drives communication system; a protocol used in optical fiber communication
EMC	Electromagnetic compatibility
Generator-side converter	The converter that is connected to the generator and controls its operation. The generator-side converter is also called INU (see *INU*). Generator-side converter is used in ACS800-77LC and ACS800-87LC wind turbine converters.
Grid-side converter	A converter that is connected to the power supply network (grid) and is capable of transferring energy from the converter DC link to the grid and vice versa. The grid-side converter is also called ISU (see *ISU*). Grid-side converter is used in ACS800-67LC, ACS800-77LC and ACS800-87LC wind turbine converters.
IGBT	Insulated gate bipolar transistor
ISU	IGBT supply unit. IGBT supply modules under control of one control board, and related components.
INU	Inverter unit. Inverter module(s) under control of one control board, and related components. One INU typically controls one generator.
Intermediate circuit	See *DC link*.
PLC	Programmable logic controller
RFI	Radio-frequency interference
RMIO	Motor control and I/O board. The RMIO is a versatile control board and an IO interface the use of which is determined by the control program loaded onto the board. The RMIO is widely used in the ACS800 product series, eg. for controlling converter modules, supply units, cooling units, etc.
Rotor-side converter	A converter that is connected to the generator rotor and controls its operation. The rotor-side converter is also called INU (see *INU*). Rotor-side converter is used in ACS800-67LC wind turbine converters.
Wind turbine converter	A converter for controlling AC generators in wind turbine applications.

2

Operation principle and hardware description

What this chapter contains

This chapter describes the operation, hardware and type designation of the DC chopper.

Operation principle

A wind turbine converter can be equipped with a DC chopper and DC resistor to add some short-term and temporary load reserve to the system. The reserve can keep the converter operational over a rapid malfunction such as a power grid break.

The DC resistor is connected to the DC chopper and together they form the temporary load reserve. The DC chopper monitors the voltage level in the DC link of the converter. When the voltage exceeds the operation limit of the chopper which means overvoltage in the DC link, the chopper connects the DC resistor to the DC link and conveys the excess energy to it. The resistor dissipates the excess energy, and the DC voltage level decreases to the normal operating level without fault trip of the converter, considering that the heat dissipation capacity of the resistor-chopper combination is sufficient.

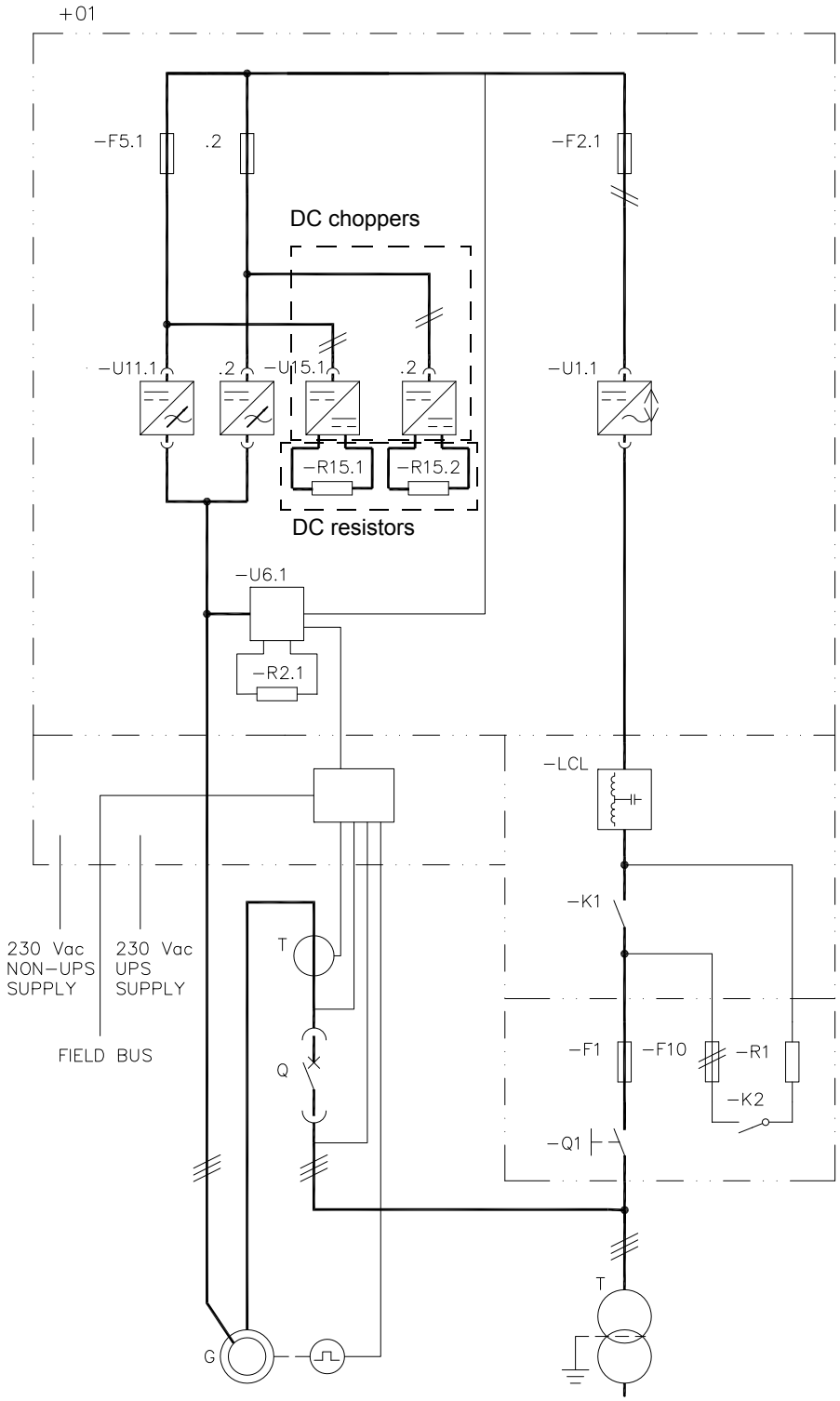
An ABRU-0x DC chopper unit includes an ABRC-65 control board and IGBT switches. In case of ACS800-77LC and ACS800-87LC converters, the customer needs to dimension and acquire an external DC resistor and its cabling separately. In case of ACS800-67LC, the factory-installed DC resistor can be included in the wind turbine converter delivery (option +D151). Each ABRU unit must be connected to a separate DC resistor.

The DC chopper is equipped with fuses as standard. The fuses protect the resistor and resistor cable in a short-circuit situation.

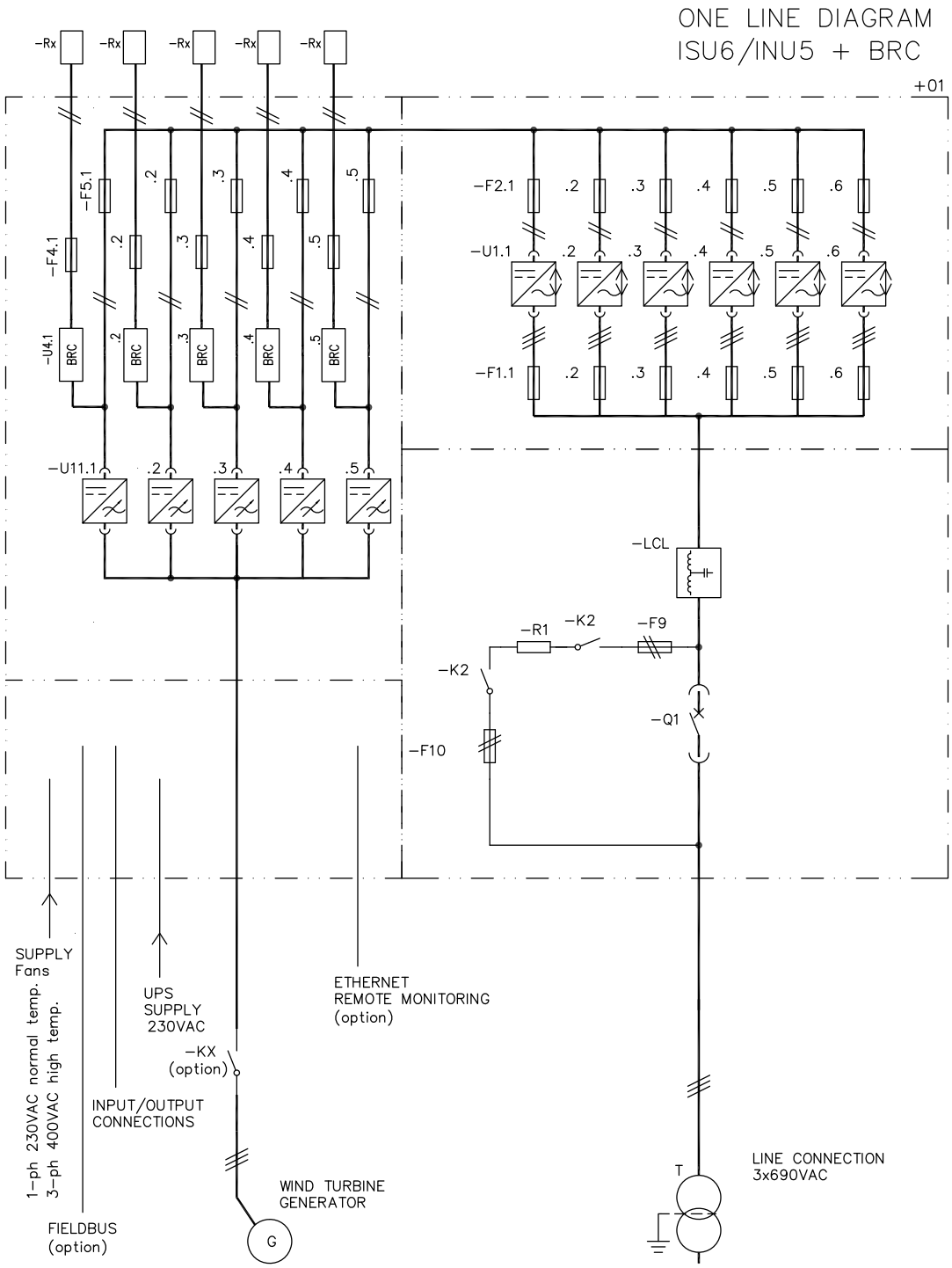
Circuit diagrams

The diagrams below show the main circuit diagrams of the wind turbine converter with DC chopper.

ACS800-67LC



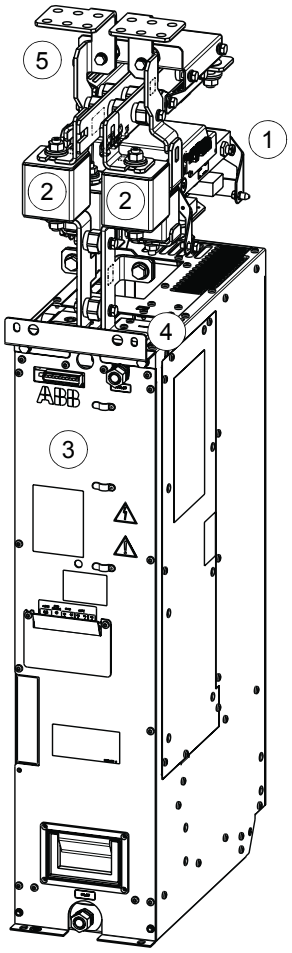
ACS800-77LC and ACS800-87LC



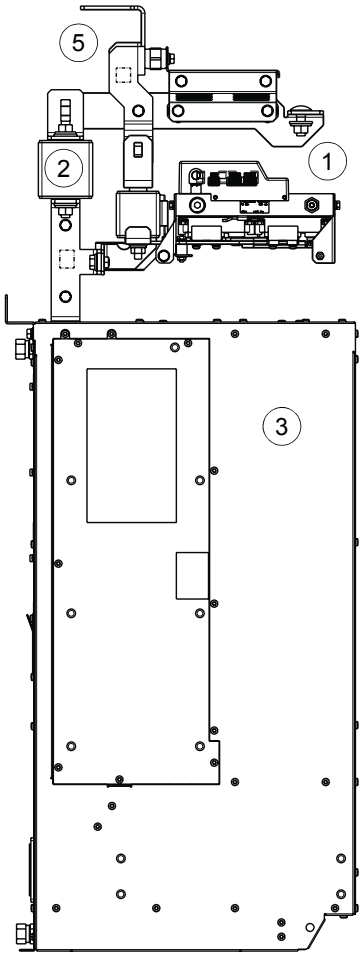
Overview

DC chopper is located on top of each rotor-side (ACS800-67LC) or generator-side (ACS800-77LC and ACS800-87LC) converter module. The converter module with the DC chopper assembly in case of ACS800-87LC wind turbine converter is shown below.

View from front



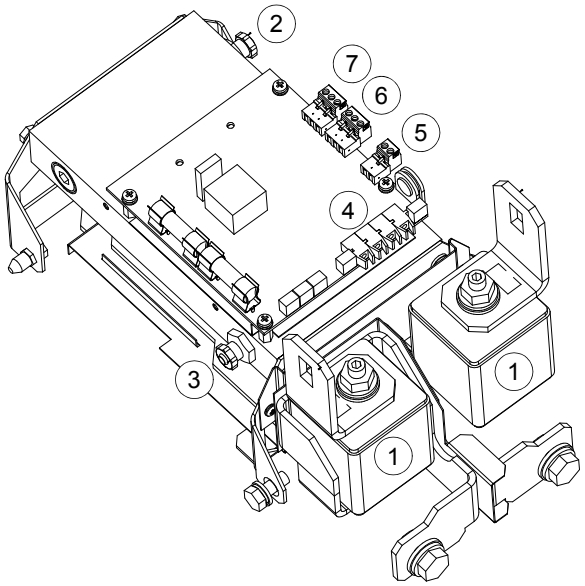
View from side



No.	Description
1	DC chopper including chopper DC fuses, related busbars and mounting supports (on top of the converter module)
2	Converter module DC fuses [F5]
3	Converter module [U11]
4	Converter module DC busbars
5	Busbar assembly for the DC resistor connection

Component placement

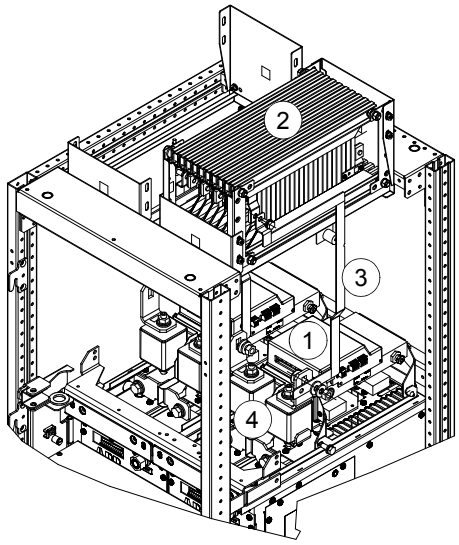
Component placement of the DC chopper is presented below. DC resistor is not included in the picture, it is connected to busbar assembly above the DC chopper. In the delivery containing DC chopper, the connections in the picture below are ready-made at the factory. For the circuit diagrams, see chapter *Circuit diagrams*.



No.	Description
1	Fuses
2	Coolant inlet connection
3	Coolant outlet connection
4	Fibre optic connectors: V1and V2 (master/follower), V3 and V4 (DDCS)
5	Connector X1: Digital input for the supervision of the resistor thermal switch as default
6	Connector X2: Relay output for the alarm indication as default
7	Connector X3: Relay output for the chopper fault indication. Connected to a digital input on the RMIO board of the grid-side converter as default.

DC chopper with DC resistor (options +D150 and +D151)

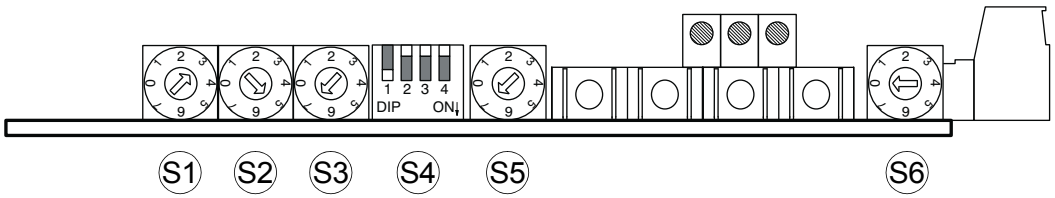
Layout of the DC chopper with DC resistor in ACS800-67LC wind turbine converter is shown below.



No.	Description
1	DC chopper
2	DC resistor
3	Busbar
4	Converter module fuses

Settings

The DC chopper control modes and functions are selected and parameters are set with ABRC-65 control board switches S1…S6.



Switches are described below.

- S1: Together with S2, S1 sets ratio p_{MAX} between the actual maximum load (power) of the resistor circuit during the operation and the nominal power rating of the DC resistor. Default setting is 3. See section *Setting switches S1, S2 and S3* below.
- S2: Together with S1, S2 sets ratio p_{MAX} between the actual maximum load (power) of the resistor circuit during the operation and the nominal power rating of the DC resistor. Default setting is 5. See section *Setting switches S1, S2 and S3* below.
- S3: Sets thermal time constant of DC resistor. Default setting is 7. See section *Setting switches S1, S2 and S3* below.
- S4: Selects mode and function of the DC chopper. See section *Setting switch S4* below.
- S5: Selects nominal grid voltage (U_N). Default setting is 7 (690 V AC). See section *Setting switch S5* below.
- S6: Sets node address for DDCS communication. In each ABRU unit, switch S6 must be set to a different position (0…7) in all parallel DC choppers connected to same fibre optic link.

Setting switches S1, S2 and S3

Example: DC voltage during the operation of the chopper is U_{DC} = 1120 V. Maximum allowed peak power of the chopper P_{MAX} = 500 kW, and duration of the duty cycle needed is 3 s (ie, maximum short-time heat dissipation capacity of the resistor must be E_{MAX} = 1500 kWs) and DC resistor resistance R_{BR} = 2.2 Ω, and DC resistor nominal power P_N = 4.46 kW.

$$p_{MAX} = \frac{U_{DC}^2}{R_{BR} \cdot P_N} = \frac{(1120\ \text{V})^2}{2.2\ \Omega \cdot 4.46 \cdot 10^3\ \text{W}} = 128$$

DC resistor thermal time constant τ can now be obtained:

$$\tau = p_{MAX} \cdot \frac{R_{BR} \cdot E_{MAX}}{U_{DC}^2} = 128 \cdot \frac{2.2\ \Omega \cdot 1500 \cdot 10^3\ \text{Ws}}{1120\ \text{V}} = 336\ \text{s}$$

Calculated p_{MAX} = 128 is set by selecting the corresponding values from the following table: S1 = 3 and S2 = 5.

S1	S2	p_{MAX}	S1	S2	p_{MAX}	S1	S2	p_{MAX}	S1	S2	p_{MAX}
0	0	0.891	0	2	5.657	0	4	35.92	0	6	228.1
1	0	1.000	1	2	6.350	1	4	40.32	1	6	256.0
2	0	1.122	2	2	7.127	2	4	45.25	2	6	287.4
3	0	1.260	3	2	8.000	3	4	50.80	3	6	322.5
4	0	1.414	4	2	8.980	4	4	57.02	4	6	362.0
5	0	1.587	5	2	10.08	5	4	64.00	5	6	406.4
6	0	1.782	6	2	11.31	6	4	71.84	6	6	456.1
7	0	2.000	7	2	12.70	7	4	80.63	7	6	512.0
0	1	2.245	0	3	14.25	0	5	90.51	0	7	574.7
1	1	2.520	1	3	16.00	1	5	101.6	1	7	645.1
2	1	2.828	2	3	17.96	2	5	114.0	2	7	724.1
3	1	3.175	3	3	20.16	3	5	128.0	3	7	812.7
4	1	3.564	4	3	22.63	4	5	143.7	4	7	912.3
5	1	4.000	5	3	25.40	5	5	161.3	5	7	1024
6	1	4.490	6	3	28.51	6	5	181.0	6	7	1149
7	1	5.040	7	3	32.00	7	5	203.2	7	7	1290

Calculated thermal time constant τ is set by selecting S3 = 7 from the following table.

S3	τ [s]
0	2.62
1	5.24
2	10.5
3	21.0
4	41.9
5	83.9
6	168
7	336

Setting switch S4

The following table lists the selections of switch S4. Default settings are marked with *.

Dip no.	Function	Setting (switch position)
1	ON - OFF control mode	ON (down) *
2	X2 is used as alarm output	OFF (up) *
	X2 is used in fan control	ON (down)
3	PWM frequency 2 kHz	OFF (up) *
	PWM frequency 1 kHz	ON (down)
4	Master	OFF (up) *
	Follower	ON (down)

The operation mode is selected with dip 1 of switch S4. The normal operation mode is ON - OFF mode which should be the selection typically. In the ON - OFF control mode, the IGBT is switched on when the intermediate circuit DC voltage exceeds the upper voltage limit. The IGBT keeps switching until the intermediate circuit DC voltage drops below the lower voltage limit.

The following table lists the DC chopper voltage limits in the ON - OFF mode.

Maximum DC voltage	Voltage limits	
	Lower limit	Upper limit
1.1 · 1.41 · U_N	1.19 · 1.35 · U_N	1.21 · 1.35 · U_N
1073 V	1108 V	1127 V

U_N is the nominal grid AC voltage.

To obtain sufficient power, up to eight ABRU units (each with a separate DC resistor) can be connected in parallel to the same intermediate circuit. If the ON - OFF control mode is selected, one ABRC-65 control board acts as a master and measures the intermediate circuit DC voltage. When several ABRC-65 boards are used, one ABRC-65 is defined as the master and the others as followers. The master ABRC-65 sends the IGBT control signal via an optical DDCS link to the follower ABRC-65 boards.

Setting switch S5

The following table lists S5 selections.

Switch S5 position	Nominal grid AC voltage [V]
6	525 / 550 / 575 / 600
7	660 / 690

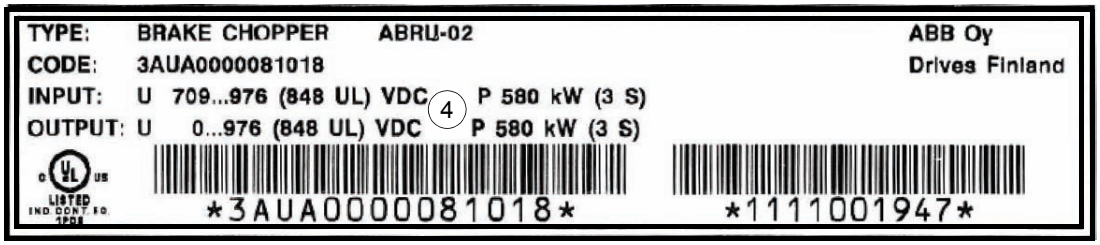
Type designation label

The type designation label includes the ratings, valid markings, type code and a serial number of the unit. A type designation label containing the serial number of whole converter and the complete type code is attached to the converter. Each converter module is also individually labelled.

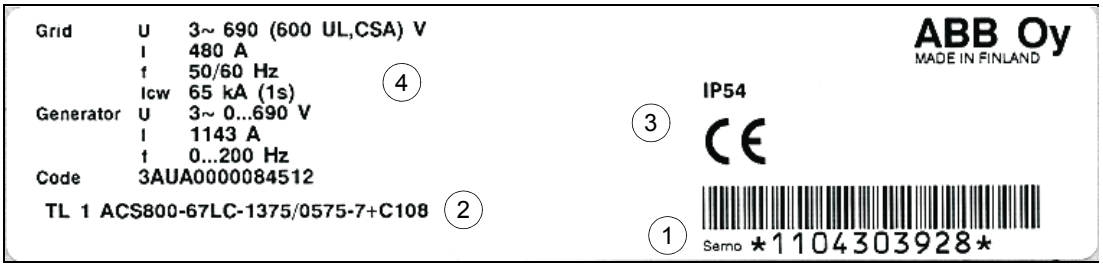
Example labels of DC chopper and a converter with DC chopper option code are shown below.

No.	Description
1	Serial number. The first digit of the serial number refers to the manufacturing plant. The next four digits refer to the unit's manufacturing year and week, respectively. The remaining digits complete the serial number so that there are no two units with the same number.
2	Type code
3	Valid markings
4	Ratings of the unit

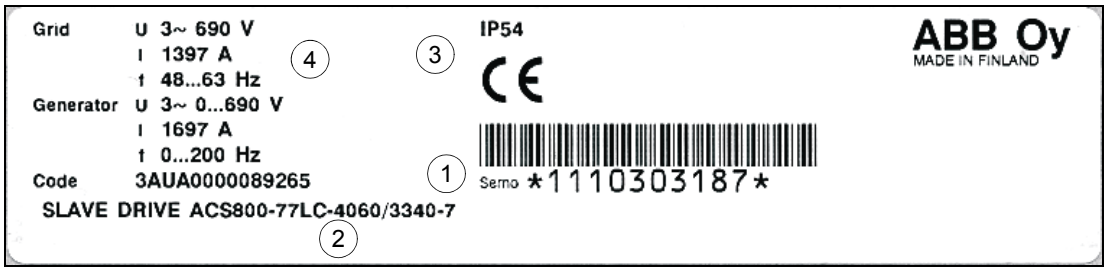
DC chopper



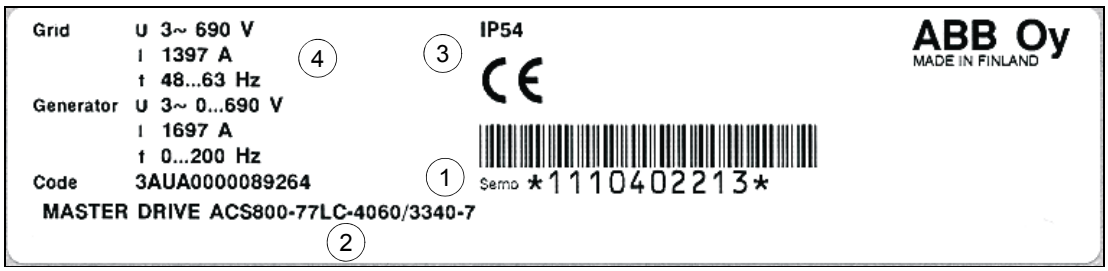
ACS800-67LC



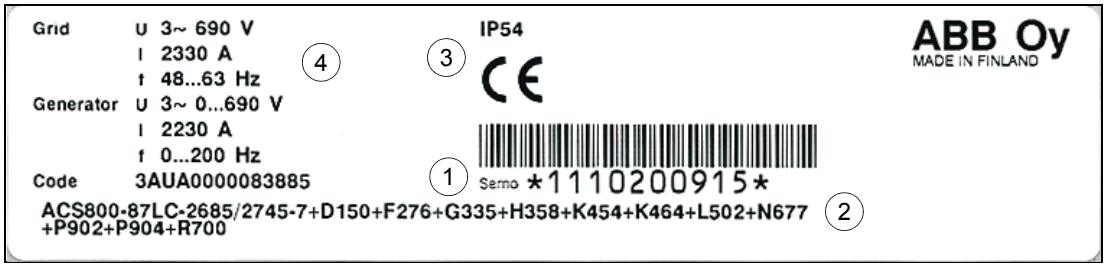
ACS800-77LC, slave drive



ACS800-77LC, master drive



ACS800-87LC



Type designation key

The type designation key contains information on the specifications and configuration of the unit. The type designation is printed on the type designation label attached to each wind turbine converter.

- The first 23 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 option codes related to DC chopper are described below. For all option codes available, see the hardware manual of the converter.

ACS800-67LC

Ride through options	
+D150	DC chopper for each rotor-side converter module
+D151	DC resistor (1500kJ) for each DC chopper

ACS800-77LC

Ride through options	
+D150+F276	Grid fault ride-through with DC chopper

ACS800-87LC

Line control options	
+D150+F276	Ride-through with energy absorber

3

Planning the installation

What this chapter contains

This chapter contains information about selecting and planning the installation of DC resistors for those deliveries which do not include them as factory-installed (no option +D151). For the deliveries with the factory-installed DC choppers and resistors (with options +D150 and +D151), the design of the whole chopper circuit including the resistors has been done by ABB.

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 drive may experience problems that the warranty does not cover.

Protecting the DC chopper and resistor cable against thermal overload

The DC chopper protects itself and the resistor cables against thermal overload when the cables are dimensioned according to the nominal current of the chopper. Ensure that the rating of the resistor cable meets/exceeds the nominal current of the chopper.

Protecting the system in short-circuit situations

The converter module DC fuses detect also the chopper short-circuits and restrict the damages. The resistor and resistor cables are protected by the chopper DC fuses. Therefore resistor cable short-circuit protection is handled by them as long as the cable is dimensioned properly according to the chopper current. When customer-installed resistor and resistor cable are used (converter with no option +D151), ensure that the rating of the resistor cable meets/exceeds the actual resistor load current.

Mechanical installation

For the installation of the DC resistors, follow the instructions provided by the resistor manufacturer.

Selecting the location for the DC resistor (no option +D151)

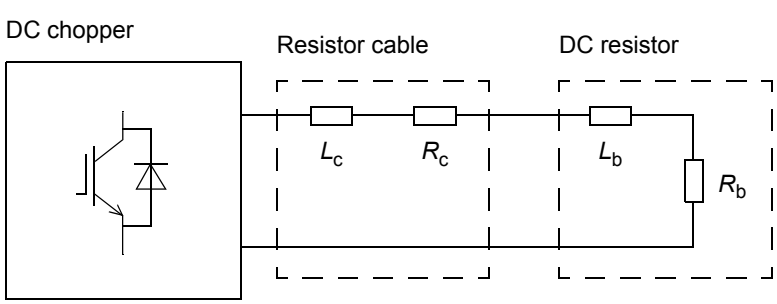
- Arrange sufficient cooling and mechanical protection (eg, shrouds) for the resistor assembly.
- Do not install the resistor near flammable materials.
- Note the maximum cable length allowed (see the calculations and instructions later in this chapter).

Resistor sizing

Typical DC resistor cable sizes

Max. nominal current of the fuse (A)	Conductor size Al (mm^2)	Conductor size Cu (mm^2)
25	2.5	1.5
35	-	2.5
50	6	-
63	10	6
80	16	10
125	25	16
160	35	25
200	50	35
250	70 (95)	50
315	120	70
400	150	95
500	185	120
630	240	150
800	300	185
1000	400	240

Resistor circuit consists of resistor cable and DC resistor. The diagram below presents the electrical characteristics of the DC chopper circuit.



L_c	resistor cable inductance
R_c	resistor cable resistance
L_b	DC resistor inductance
R_b	DC resistor resistance

1. Size the resistor according to the actual load cycle (power and energy). Use the equation below.

$$R = \frac{U_{DC}^2}{P_{load}}$$

R	resistor resistance
U_{DC}	DC link voltage over the resistor. 1.18 × 1.35 × U_N
U_N	Nominal AC voltage of the power supply (690 V AC)
P_{load}	Maximum power of the actual load cycle. If you do not know the actual load cycle, use the chopper maximum power. See chapter *Technical data*.

2. Ensure that the calculated resistance value is within the allowed minimum and maximum values defined for the chopper circuit. See chapter *Technical data*.
3. Select a resistor with power rating that exceeds P_{load} maximum power rating.
4. Ensure that the resistor withstands the energy pulse during the load cycle. If you do not know the load cycle, use the maximum short-term energy given for the chopper. See chapter *Technical data*.
5. Ensure that the resistor inductance value is less than 2 µH.

Selecting and routing the DC resistor cables

Customer must select the resistor cable for the chopper circuit when there are no factory-installed resistors (converter with option +D150 but no option +D151).

- First size the cable to withstand the maximum power of the chopper. See section *Current and voltage rating of the resistor cable* below.
- Then ensure that the maximum inductance of the chopper circuit will not be exceeded with the selected cable and resistor. See section *Checking the chopper circuit inductance and resistance* below.

Current and voltage rating of the resistor cable

1. Define the voltage rating of the cable as follows. (It must exceed the DC voltage during the operation of the chopper.):

$U_{cable} > 1.18 \times 1.35 \times U_N$,

where U_N is the nominal AC voltage of the power supply (690 V AC).

2. Define the current rating of the cable as follows:

$$I_{cable} = \frac{P_{max}}{U_{DC}}$$

P_{max}	Maximum power of the chopper. See chapter *Technical data*.
U_{DC}	DC link voltage over the resistor. 1.18 × 1.35 × U_N

3. Define the maximum cable length.

$$l = \frac{L_{max} - L_b}{2 \cdot L_{nom}}$$

l	cable length
L_{max}	Chopper maximum inductance. See chapter *Technical data*.
L_b	DC resistor inductance. See the resistor specification.
L_{nom}	conductor nominal inductance per meter

If cable length calculation gives too short cable, use larger cable or parallel connections to improve the conductivity (and decrease the inductance). If two same kinds of cables are connected parallel, inductance and resistance theoretically halves. With two cables connected parallel, the cable length is multiplied with factor 1.7. That is because two separate cables are not identical in practice.

$l_{parallel} = 1.7 \cdot l$

$l_{parallel}$	maximum cable length with parallel connected cables
1.7	parallel cable length multiply factor
l	maximum cable length with one same cable type

For total values, calculate the total resistance of the chopper circuit and then the total inductance. Then compare the values to the chopper limit values.

Cable resistance is calculated as follows:

$R_c = l \cdot R_{nom} \cdot 2$

R_c	cable resistance
l	cable length
R_{nom}	cable nominal resistance per meter

If two cables are connected parallel, the cable resistance is half of single cable resistance.

Total resistance can be calculated as follows:

$R_{total} = R_c + R_b$

R_{total}	chopper circuit total resistance
R_c	cable resistance
R_b	DC resistor resistance

Checking the chopper circuit inductance and resistance

1. Calculate single cable inductance as follows:

$L_c = l \cdot L_{nom} \cdot 2$

If two cables are connected parallel, the cable inductance is single cable inductance multiplied with factor 0.59.

$L_{c,\ parallel} = 0.59 \cdot L_c$

2. Calculate total inductance of the chopper circuit as follows:

$L_{total} = L_c + L_b$

L_{total}	chopper circuit total inductance
L_c	cable inductance
L_b	DC resistor inductance

3. Compare calculated values to the values given in chapter *Technical data*. If resistance is lower than minimum, the DC resistors are wrongly dimensioned.
4. Compare chopper circuit inductance to the values given in chapter *Technical data*. If inductance is higher than maximum inductance in the table, use larger cable or use parallel cables. Also if the inductance of the DC resistors is quite high (>2 µH), use resistors with lower inductance.

EMC compliance of the complete installation

Note: ABB cannot verify that the EMC requirements are fulfilled with external user-defined DC resistors and cabling. The EMC compliance of the complete installation must be considered by the user.

Minimizing electromagnetic interference

Follow these rules in order to minimise electromagnetic interference caused by the rapid current changes in the cables:

The resistor cable must be completely shielded, either by cable shield or metallic enclosure. Unshielded single-core cable can only be used if routed inside a cabinet that efficiently suppresses the radiated RFI emissions.

The cables should be installed away from other cable routes.

Long parallel runs with other cables should be avoided. The minimum parallel cabling separation distance should be 0.3 metres.

The cables should cross at right angles.

Maximum cable length

The maximum length of the resistor cable is 300 m. However, keep the cable as short as possible in order to minimise the EMC emissions and stress on chopper IGBTs. The longer the cable the higher the EMC emissions. The longer the cable the higher the inductive load and voltage peaks over the IGBT semiconductors of the DC chopper.

4

Installation

What this chapter contains

This chapter contains general instructions on installing the user-defined resistor. For the deliveries with the factory-installed DC choppers and resistors (options +D150 and +D151), customer does not need to do any installation work.

Checking the insulation of the assembly

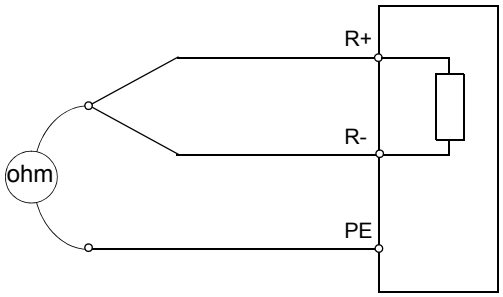
Mechanical installation of the resistor assembly

Follow the instructions given by the resistor manufacturer. Consider the instructions given in chapter *Planning the installation*.

WARNING! Read and follow the safety instructions in the converter hardware manual. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

- Check that the resistor cable is connected to the resistor and disconnected from the converter output terminals R+ and R-. At the converter end, connect the R+ and R- conductors of the resistor cable together.

- Measure the insulation resistance between the combined conductors and the PE conductor by using a measuring voltage of 1 kV DC. The insulation resistance must be higher than 1 Mohm.

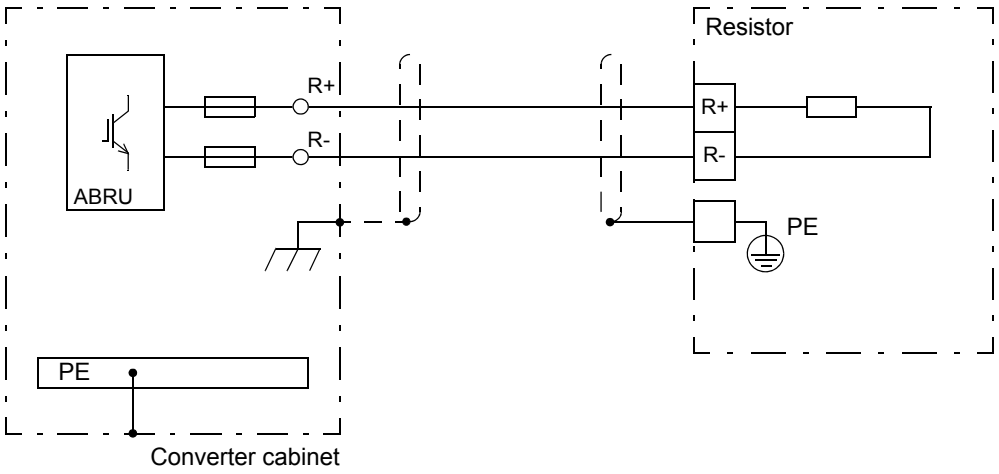


Options +D150 and +D151

Every converter equipped with integrated DC resistor is tested for insulation between the main circuit and the chassis at the factory (2700 V rms 50 Hz for 1 second). Do not make any voltage tolerance or insulation resistance tests.

Installing the DC resistor

Connection diagram



Connection procedure

1. Lead the resistor cable in through the roof of the cubicle.
2. Seal the lead-through properly to resume the degree of protection (IP54).
3. Connect the conductors to R+ and R- terminals.
4. Twist the cable shield to a bundle and connect it to frame of the cabinet.

For the location of the DC chopper busbars, see section *Terminal and lead-through data for the resistor cable* on page *46*.

5

Start-up

What this chapter contains

This chapter describes the start-up of the DC chopper.

Start-up checklist

Safety	
	**WARNING!** The safety instructions must be followed during the start-up procedure. See the safety instructions in the hardware manual of the converter.
☐	Only qualified electricians are allowed to start-up the DC chopper.
☐	Ensure that the coolant flows freely through the chopper cooling element.
☐	Lock the generator shaft mechanically to ensure that the generator rotor can not rotate during the commissioning.
Installation	
Check and ensure that:	
☐	Units with no option +D151: The DC resistors have been connected to appropriate terminals (R+, R- and PE), and the terminals have been tightened (pull conductors to check).

Settings

☐ Make the settings on the ABRC-65 board. See section *Settings* on page *19*. Example settings with factory-installed DC resistor (option +D151):

	Master	**Slave$_1$**	**Slave$_n$**
S1	3	3	3
S2	5	5	5
S3	7	7	7
S4:1	ON	ON	ON
S4:2	OFF	OFF	OFF
S4:3	OFF	OFF	OFF
S4:4	OFF	ON	ON
S5	7	7	7
S6	0	1	n

6

Fault tracing

What this chapter contains

This chapter contains information about warnings and faults related to DC chopper.

Warning and fault messages

The tables below present the warning and fault message of the grid-side converter control program related to monitoring of the DC chopper.

Warning	Cause	What to do
DI1 (9088) (09.12 SUPPLY ALARM WORD bit 2)	Fault in eg, DC chopper unit. Overloading, short-circuit, fuse failure etc. can cause this warning. This supervision is valid only when converter is in RDY_RUN state (i.e. 08.01 Main Status Word bit 1 = 1).	Check acknowledge circuit connected to digital input DI1 of the grid-side converter. Check the DC chopper unit. Replace it if necessary.

Fault text	Cause	What to do
DI1 (9081) (09.11 SUPPLY FAULT WORD bit 5)	Fault in eg, DC chopper unit. Overloading, short-circuit, fuse failure etc. can cause this fault. This supervision is valid only when converter is in RDY_RUN state (i.e. 08.01 Main Status Word bit 1 = 1).	Check acknowledge circuit connection to digital input DI1 of the grid-side converter. Check the DC chopper unit. Replace it if necessary.

Relative heat energy accumulated in DC resistors

The ABRC-65 control board calculates the actual relative heat (0% … 100%) accumulated in a DC resistor. The calculation is based on a thermal model with a single time constant. When the function is on, heat accumulates in the resistor. When the function is off, heat dissipates and the DC resistor cools down. When the actual relative heat value is 100%, the DC resistor has reached its maximum temperature rise. The value is calculated based on the resistor parameters.

The actual relative heat is read from the DC chopper register to the RMIO board of the grid-side converter and transferred further to the RMIO board of the generator-side converter (signal BU ENERGY ACT). When several DC chopper units are in use, the highest of the values is selected as the signal value. Finally, the value is transferred to PLC via fieldbus.

Fault relay output (X3)

The ABRC-65 control board contains a fault memory whose state is available as fault relay output X3. Output X3 is connected to a digital input on the RMIO board of the grid-side converter.

The fault memory is set when a short-circuit fault (in an IGBT, DC resistor or cable), a blown/missing fuse or a thermal fault (overload, overtemperature) is detected. The chopper function is stopped immediately except for thermal faults after which the delay is 1 s.

Diagnostics of the DDCS interface

Each connected ABRU unit has its separate communication link status word. There is also a common status word for all connected ABRU units. If five consecutive communication errors occur between the RMIO board of the grid-side converter and the ABRC board, a fault/alarm state is generated in a fault/alarm word of the grid-side converter.

7

Maintenance

What this chapter contains

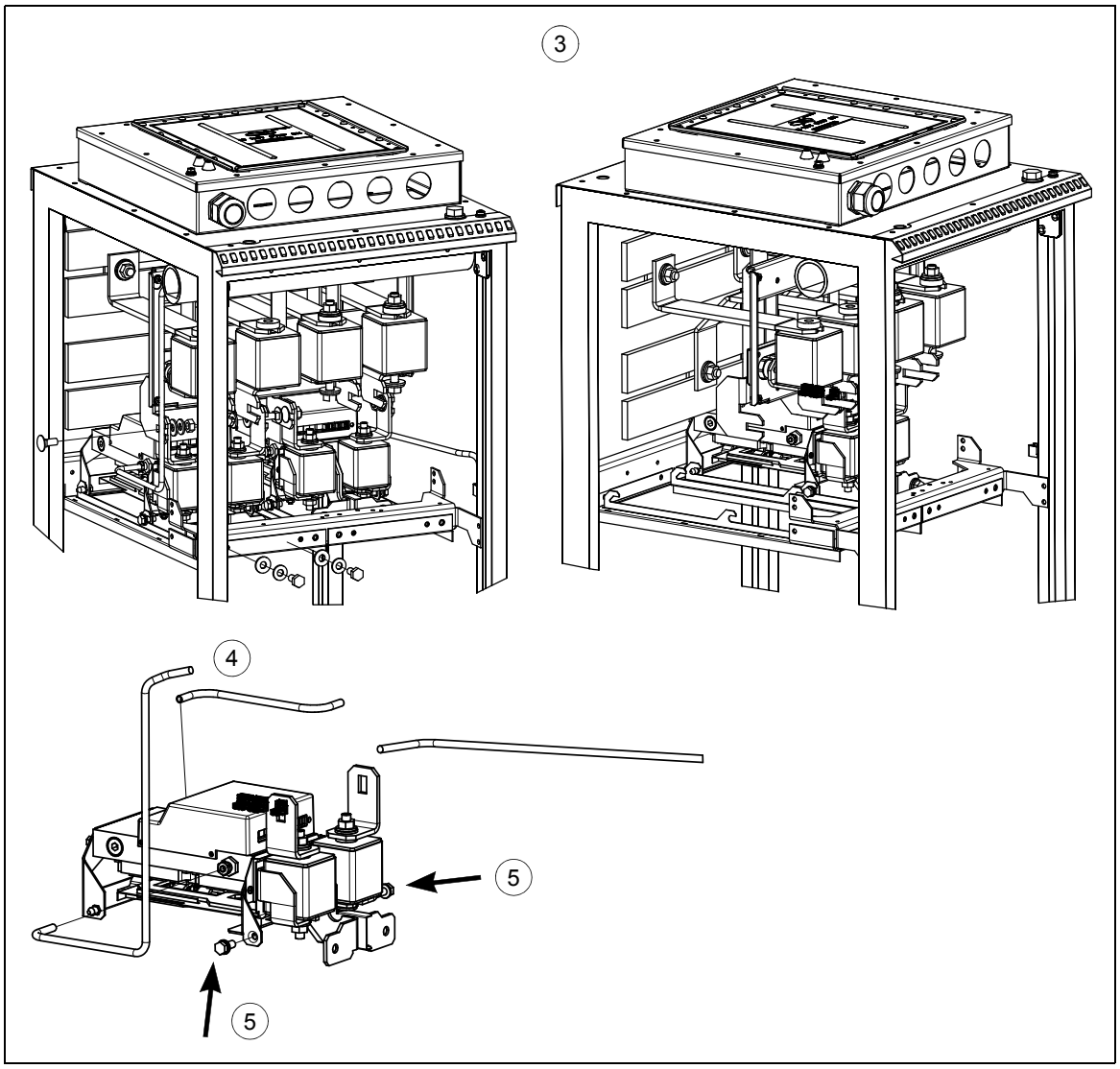
This chapter contains maintenance instructions.

Replacing the DC chopper

ACS800-67LC

WARNING! Read and follow the safety instructions in the converter hardware manual. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

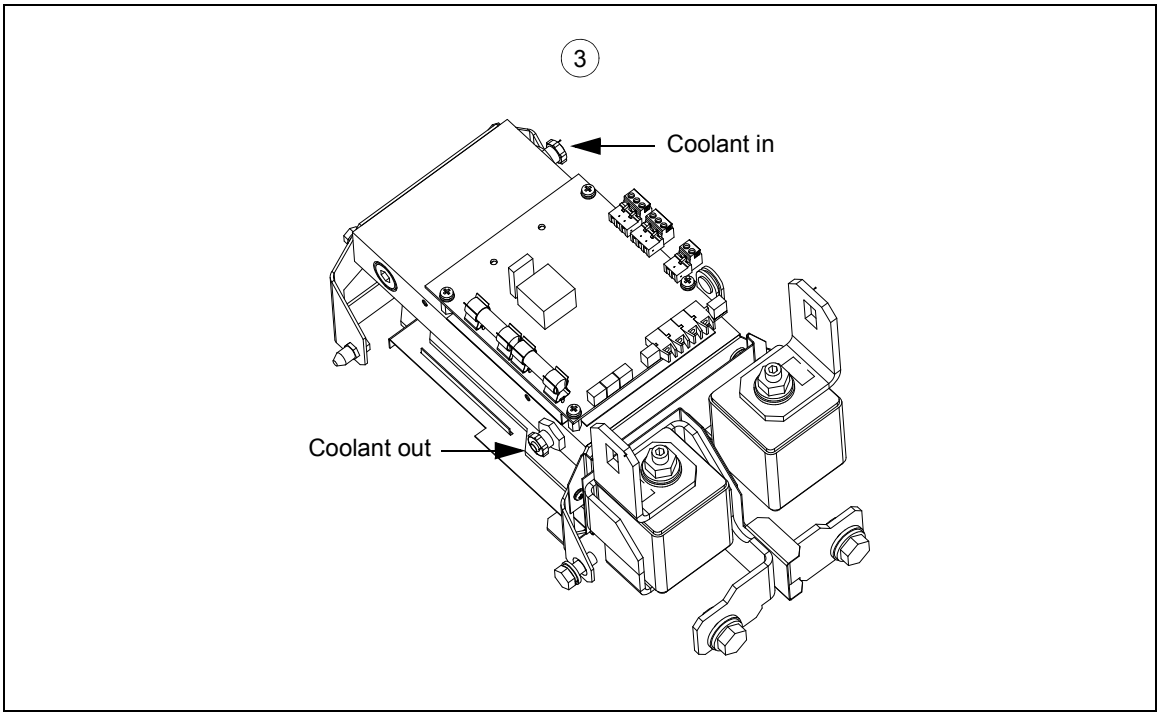
1. Ensure that the converter is disconnected from the power supply network and all other precautions described in the converter hardware manual have been taken into consideration.
2. Open the door and remove the shroud in front of the DC chopper.
3. Remove the four busbar screws of the DC chopper.
4. Remove two coolant pipes of the DC chopper.
5. Remove the two screws in the corners of the DC chopper.
6. Remove the connections (X1…X3, V1…V4) of the ABRC control board (see chapter *Circuit diagrams*). Pull the DC chopper unit out.
7. Install a new DC chopper in reverse order.

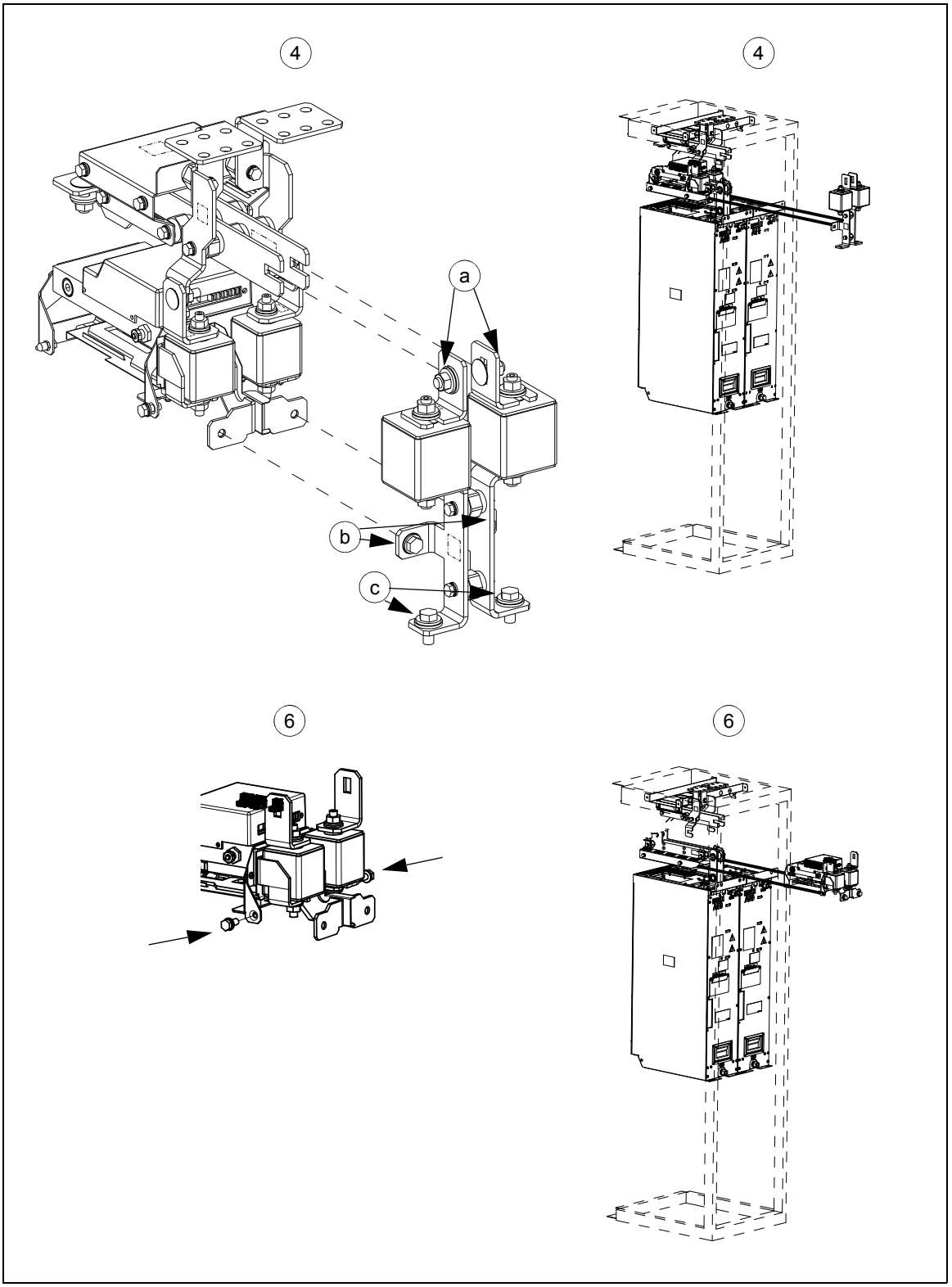


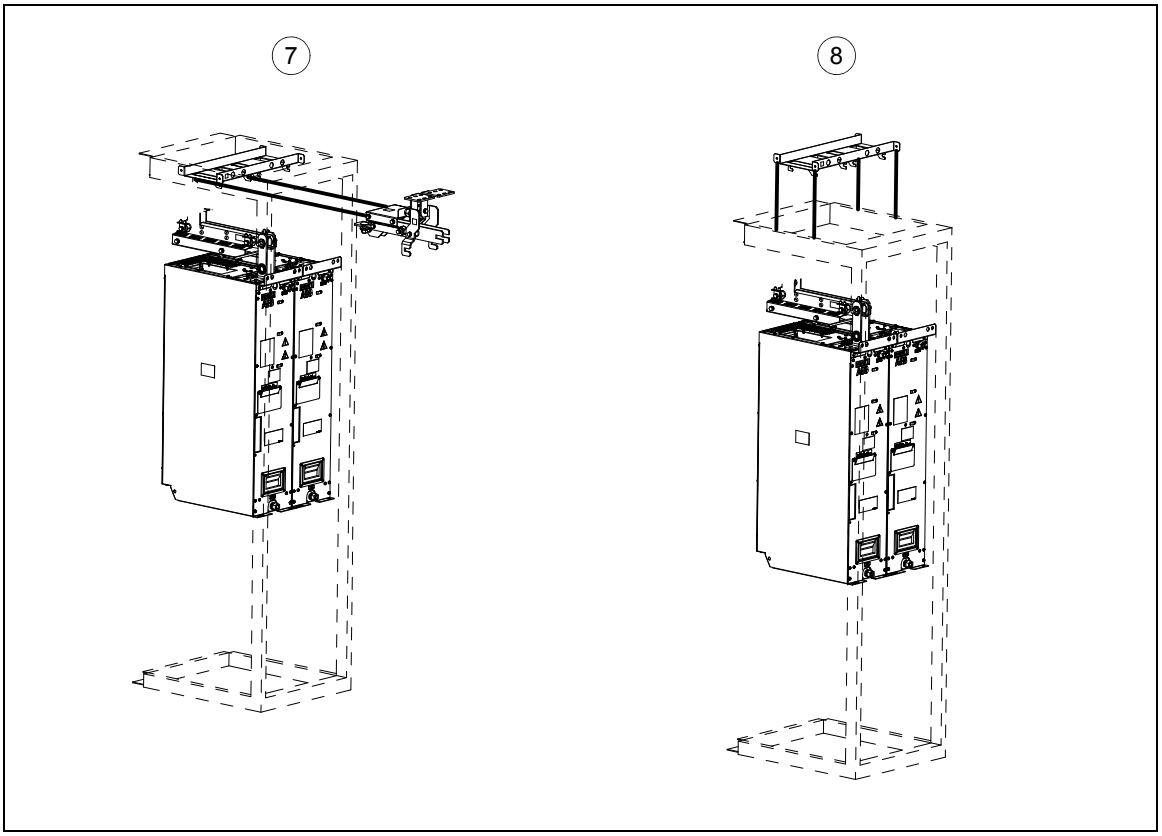
ACS800-77LC and ACS800-87LC

WARNING! Read and follow the safety instructions in the converter hardware manual. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Ensure that the converter is disconnected from the power supply network and all other precautions described in the converter hardware manual have been taken into consideration.
2. Open the door and remove the shroud in front of the DC chopper.
3. Remove the coolant piping of the DC chopper.
4. Remove the DC fuses of the converter module:
   - Loosen the two bolts (a).
   - Open the two bolts (b).
   - Open the two bolts (c).
   - Pull out the DC fuse unit.
5. Remove the connections (X1…X3, V1…V4) of the ABRC control board (see chapter *Circuit diagrams*).
6. Remove the two screws in the corners of the DC chopper and pull the DC chopper unit out.
7. Remove the DC busbars of the DC chopper with two screws.
8. Remove the assembly plate of the DC chopper with four screws.
9. Install a new DC chopper in reverse order.




4
4
a
b
c
6
6

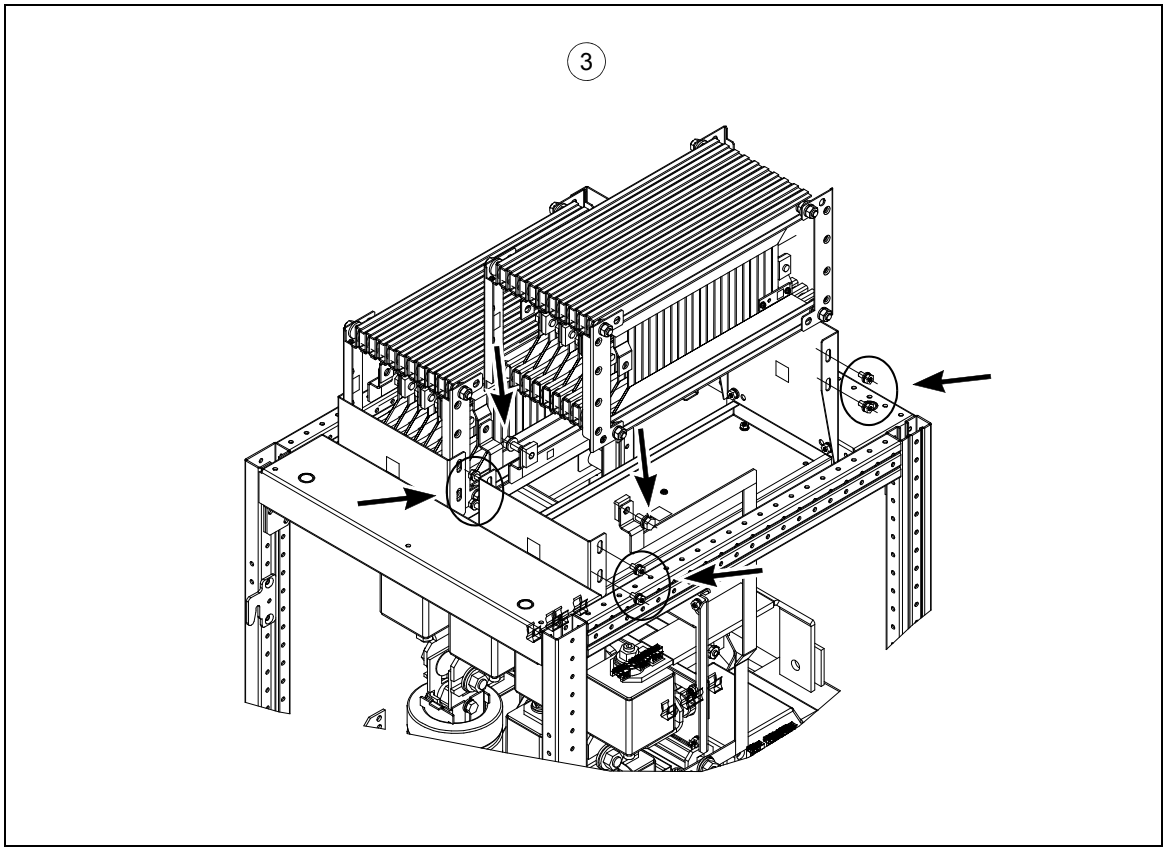

7
8

Replacing the DC resistor (option +D151)

Replacement of the DC resistor in ACS800-67LC wind turbine converter is shown below.

WARNING! Read and follow the safety instructions in the converter hardware manual. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Ensure that the converter is disconnected from the power supply network and all other precautions described in the converter hardware manual have been taken into consideration.
2. Open the door and remove the shroud and roof in front of the DC resistor.
3. Remove the two screws in the ends of the busbars. Remove the eight screws in the corners of the DC chopper.
4. Install a new DC resistor in reverse order.



Replacing the fuses of the DC chopper

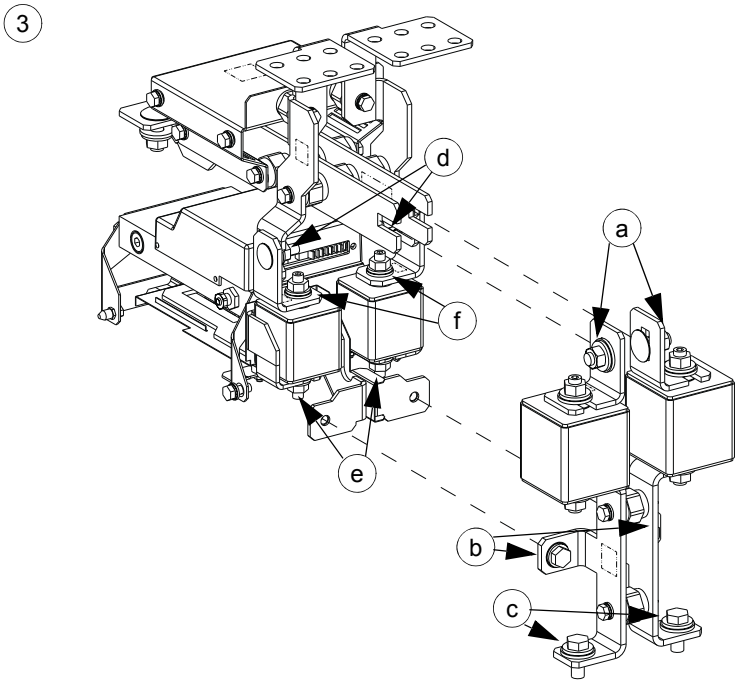
WARNING! Read and follow the safety instructions in the converter hardware manual. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Ensure that the converter is disconnected from the power supply network and all other precautions described in the converter hardware manual have been taken into consideration.
2. Open the door and remove the shroud in front of the DC chopper.
3. The DC choppers have two DC fuses each. To change the fuses, first remove the DC fuse unit (ACS800-77LC and ACS800-87LC only) of the converter module:
   - Loosen the two bolts (a).
   - Open the two bolts (b).
   - Open the two bolts (c).
   - Pull out the DC fuse unit.

   Change the fuses:
   - Loosen the two nuts (d).
   - Loosen the two nuts (e).
   - Pull out the fuses with the upper fixing busbar.
   - Loosen the two nuts (f), and open and remove screw sets.
   - Fasten the new fuses to the upper busbar.
   - Fasten the fuses and busbar in its place.
   - Fasten all bolts and screws removed in previous steps in reverse order.

   The tightening torque for the M12 set screws is 5 N·m.

   The tightening torque for the M12 nuts is 50 N·m.



8

Technical data

What this chapter contains

This chapter contains technical data of the DC chopper.

Ratings

DC chopper (690 V AC)	Power (kW) Max. peak*	Resistance (ohm)		Maximum inductance (µH)
		Minimum	Maximum*	
ABRU	625	2.0	2.4	30.0

Maximum short-term energy is 1500 kWs per generator-side/rotor-side converter module.

Ratings in the type designation label of ABRU-02

	Voltage	Power
Input	709…976 (848 UL) V DC	max. 580 kW (3 s)
Output	0…976 (848 UL) V DC	max. 580 kW (3 s)

Fuses

DC chopper type	Fuse type (Bussmann)	Qty
ABRU-01	170M5952	2

DC chopper type	Fuse type (Bussmann)	Fuse type (Mersen)	Qty
ABRU-02	170M5388	PC72UD13C250TF	2

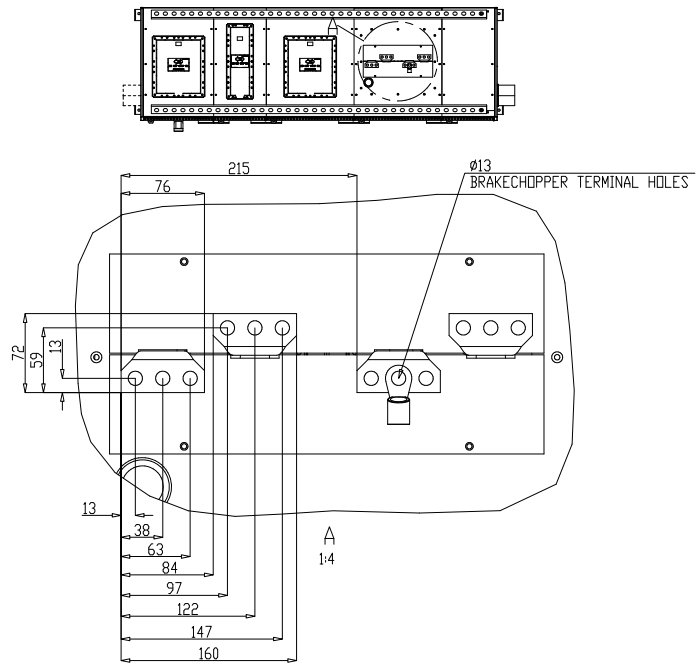
DC chopper control board type	Fuse type (Mersen)	Fuse type (Littelfuse)	Qty
ABRC-65	W330000	KLKD001	2

Terminal and lead-through data for the resistor cable

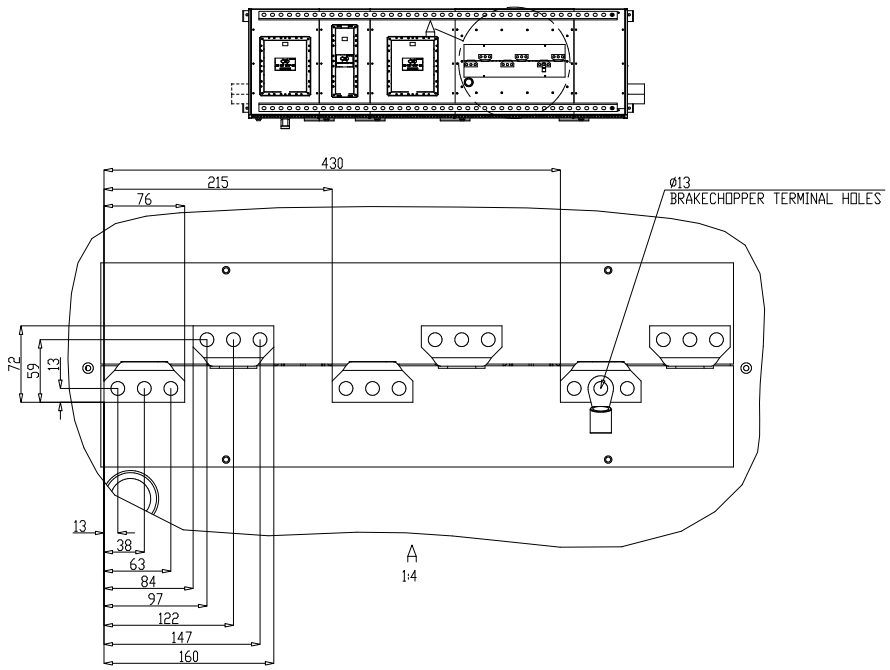
DC chopper cables are connected to the busbars from above. The location of the DC chopper busbars is shown in the pictures below.

ACS800-67LC

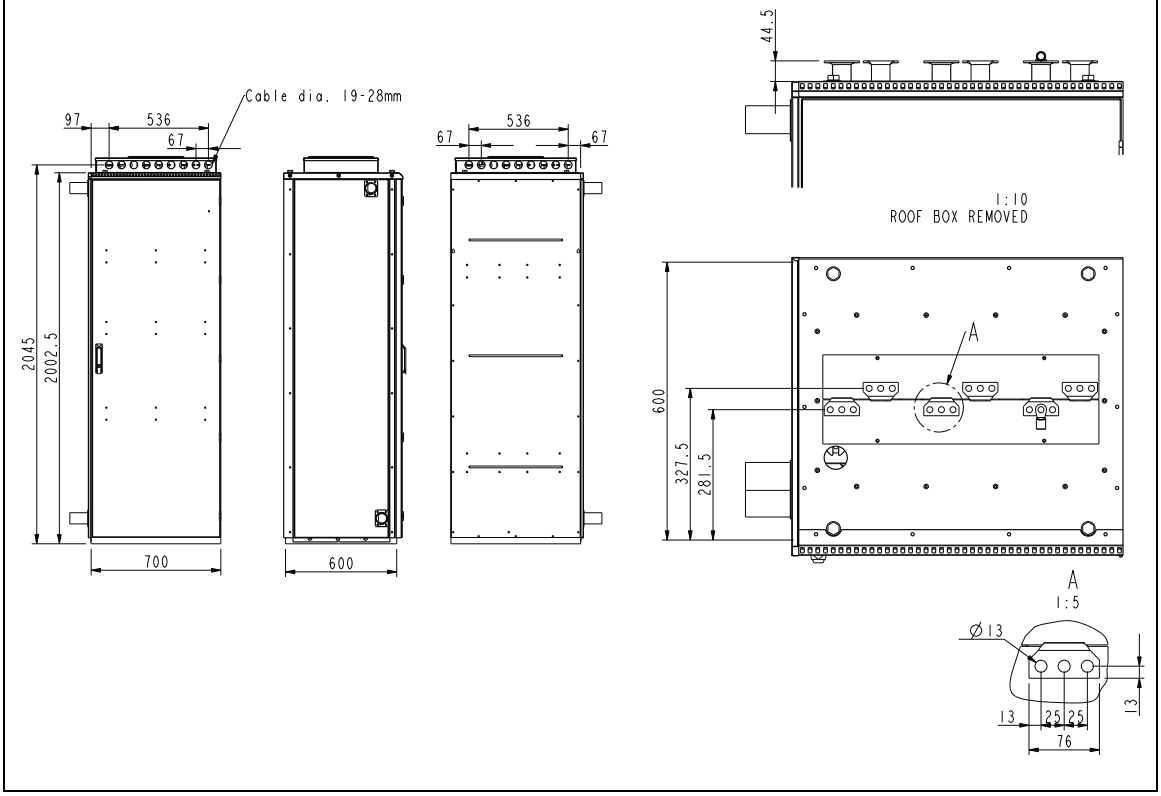
500 mm wide rotor-side converter module cubicle



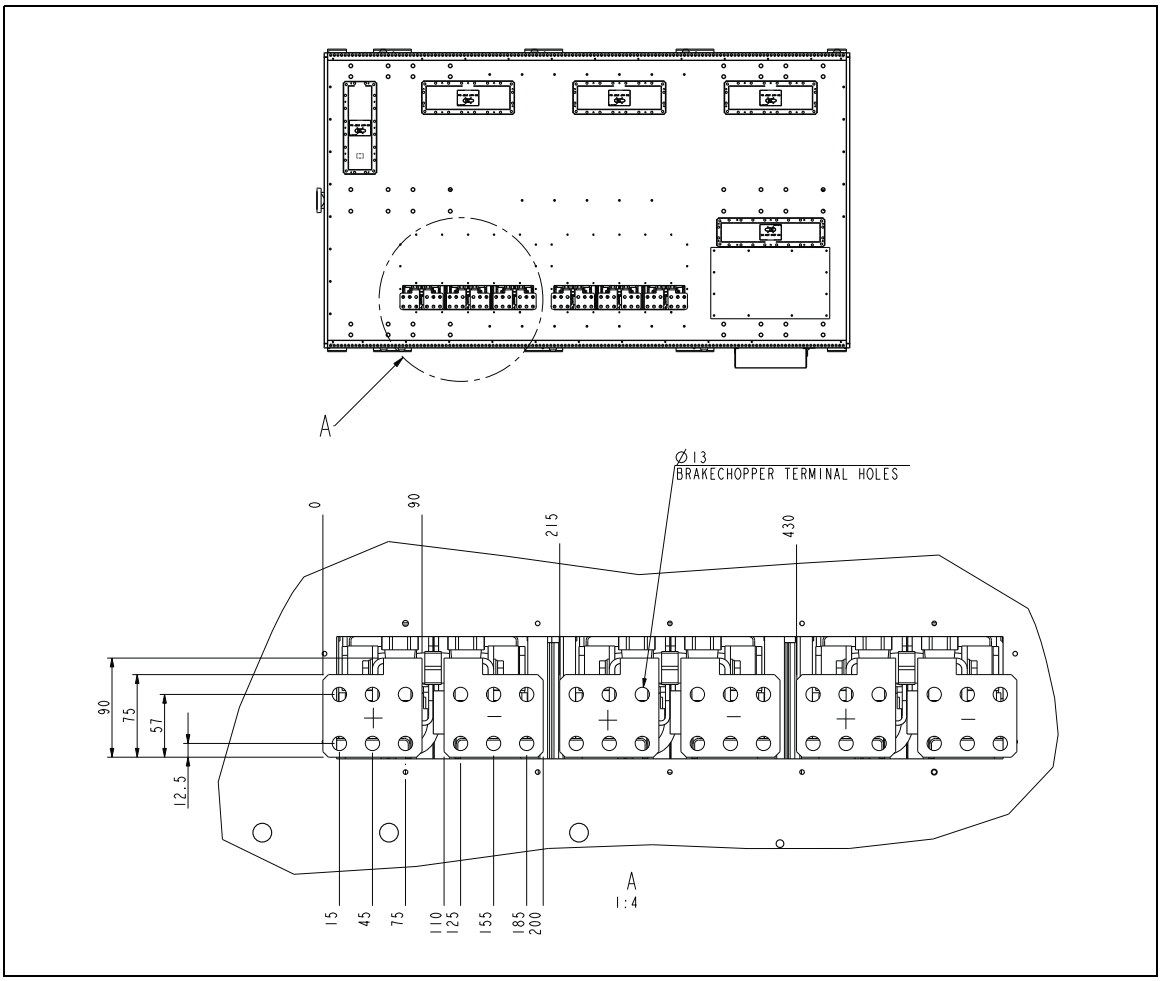
700 mm wide rotor-side converter module cubicle



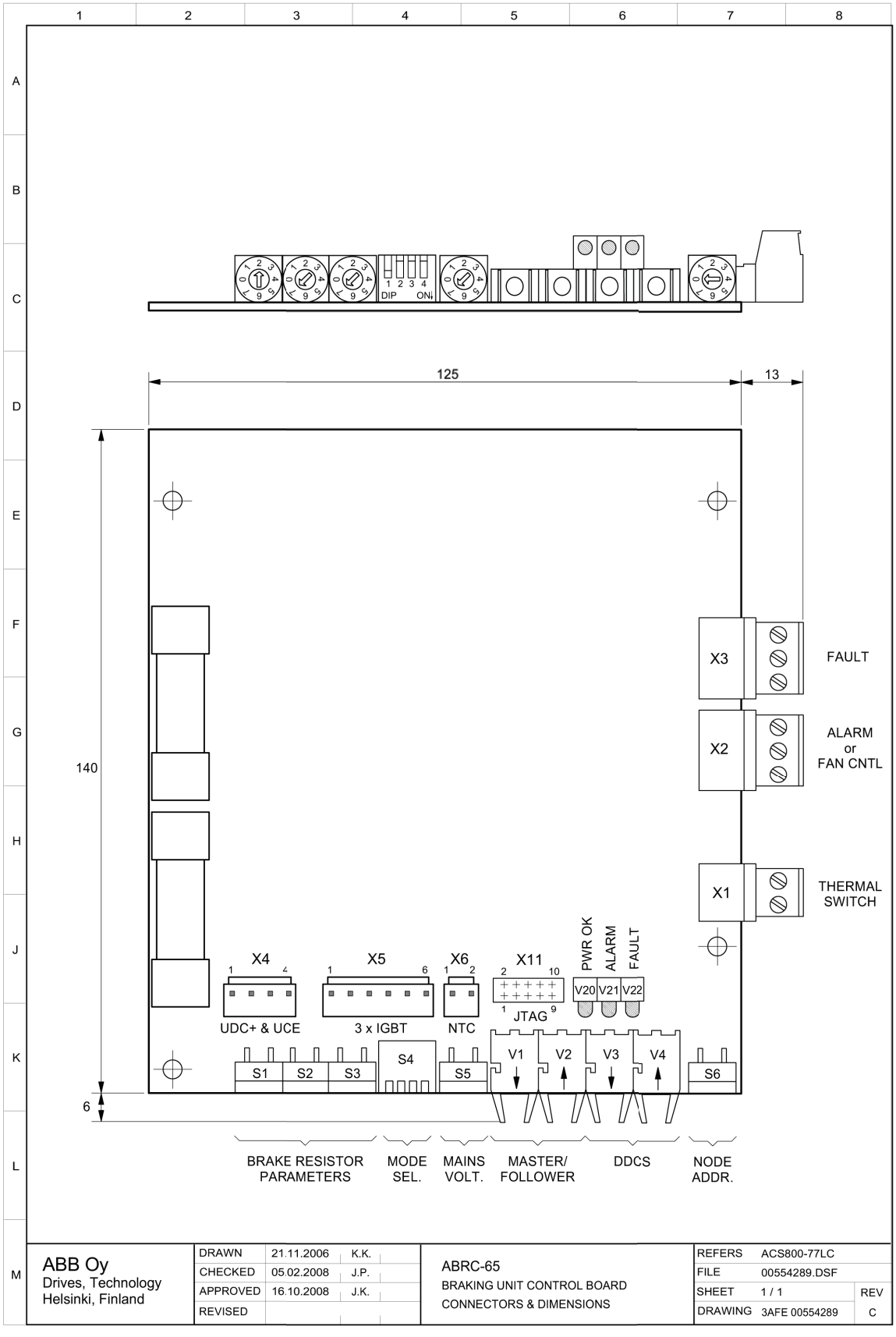
ACS800-77LC



ACS800-87LC


A
Ø13
BRAKECHOPPER TERMINAL HOLES
0
90
215
430
90
75
57
12.5
15
45
75
110
125
155
185
200
A
1:4

Connectors and dimensions of the ABRC control board



Degree of protection

The complete cabinet installation is protected to IP54 as standard.

Applicable standards

See the converter hardware manual.

CE marking

A CE mark is attached to the converter to verify that the unit follows the provisions of the European Low Voltage and EMC Directives. For further information, see the converter hardware manual.

UL marking

The converter is cULus listed industrial control panel. The approvals are valid with rated voltages up to 600 V AC. The markings are attached to the converter when option +C129 (cULus) is selected. For further information and UL checklist, see the converter hardware manual.

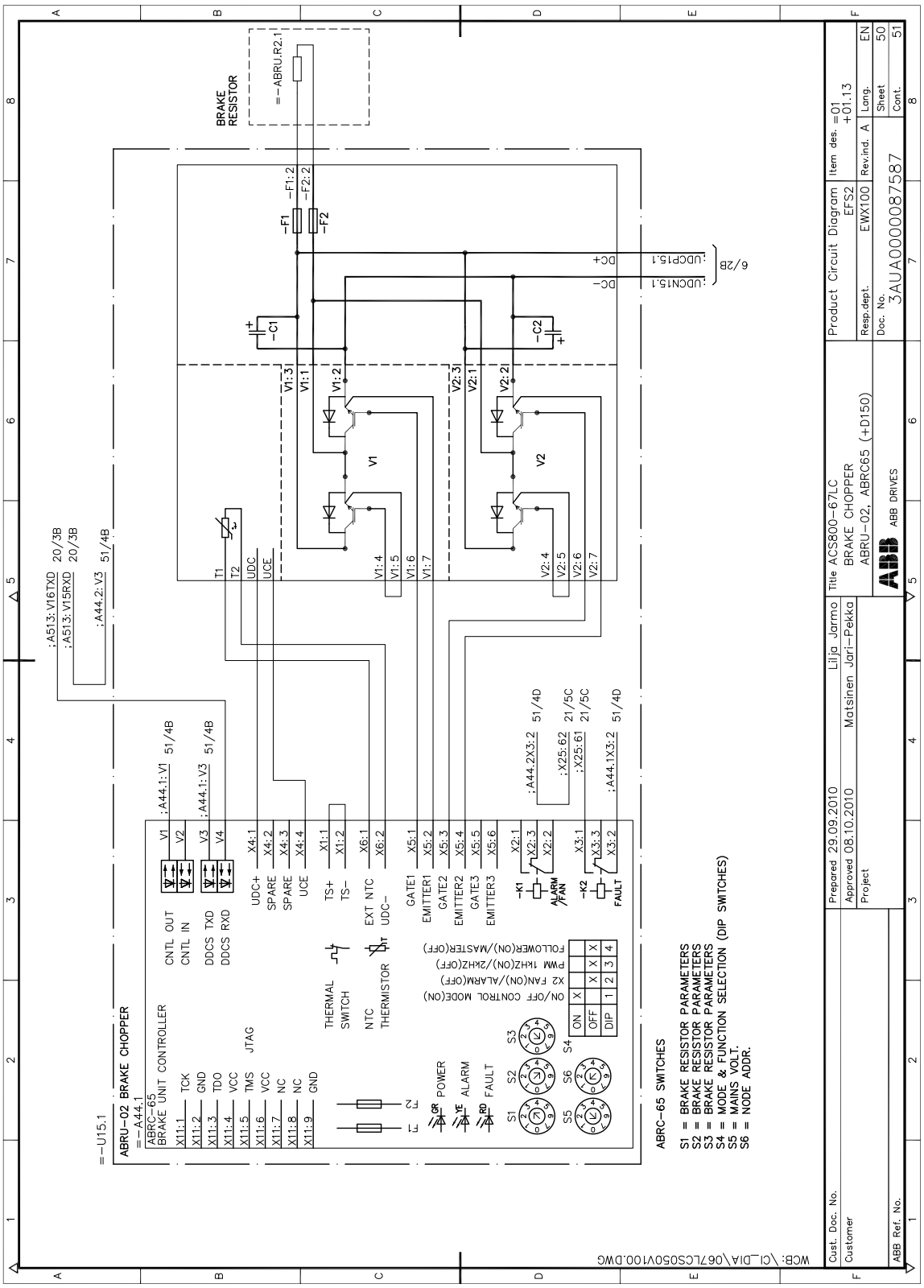
9

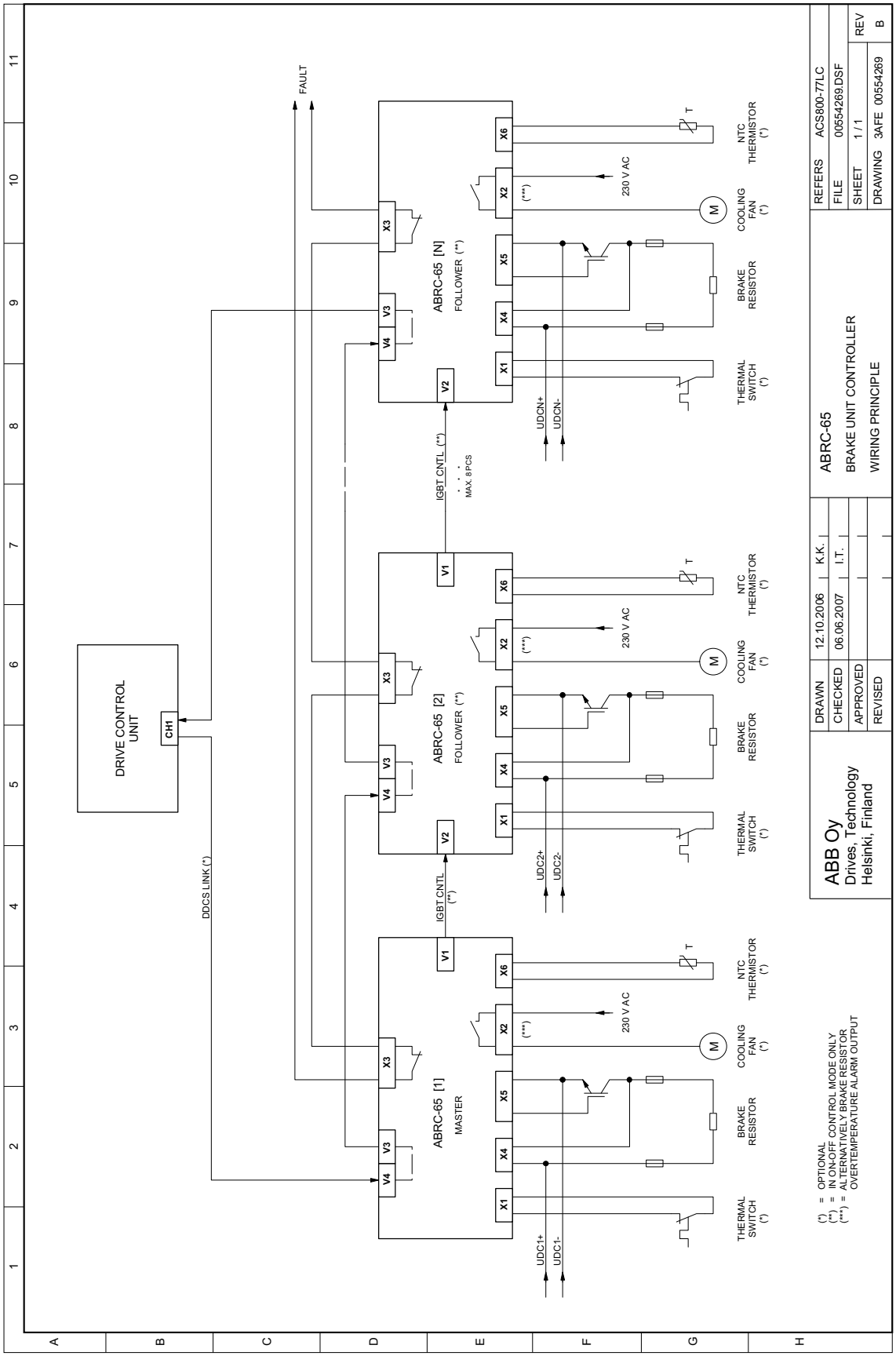
Circuit diagrams

What this chapter contains

This chapter contains example circuit diagrams of the DC chopper and its control connections. The example diagrams help in understanding the internal connections and operation of the DC chopper.

WARNING! These example diagrams are not intended for wiring or diagnostic purposes as they most probably differ from a customised DC chopper. The customer specific diagrams are attached to the delivery of a cabinet-installed unit.


ABRU-02 BRAKE CHOPPER
=-A44.1
ABRC-65
BRAKE UNIT CONTROLLER
=-U15.1
BRAKE RESISTOR
=-ABRU.R2.1
-F1
-F2
-C1
-C2
V1
V2
T1
T2
UDC
UCE
DC+
DC-
ABRC-65 SWITCHES
S1 = BRAKE RESISTOR PARAMETERS
S2 = BRAKE RESISTOR PARAMETERS
S3 = BRAKE RESISTOR PARAMETERS
S4 = MODE & FUNCTION SELECTION (DIP SWITCHES)
S5 = MAINS VOLT.
S6 = NODE ADDR.
Prepared 29.09.2010 Lilja Jarmo
Approved 08.10.2010 Matsinen Jari-Pekka
Project
Title ACS800-67LC
BRAKE CHOPPER
ABRU-02, ABRC65 (+D150)
Product Circuit Diagram
EFS2
Item des. =01
+01.13
Resp.dept. EWX100
Rev.ind. A
Lang. EN
Doc. No. 3AUA0000087587
Sheet 50
Cont. 51
Cust. Doc. No.
Customer
ABB Ref. No.
WCB:\CI_DIA\067LCS050V100.DWG


DRIVE CONTROL UNIT
CH1
DDCS LINK (*)
FAULT
ABRC-65 [1]
MASTER
ABRC-65 [2]
FOLLOWER (**)
ABRC-65 [N]
FOLLOWER (**)
IGBT CNTL (**)
IGBT CNTL (**)
MAX. 8 PCS
V1
V2
V3
V4
X1
X2
X3
X4
X5
X6
UDC1+
UDC1-
UDC2+
UDC2-
UDCN+
UDCN-
THERMAL SWITCH (*)
BRAKE RESISTOR
COOLING FAN (*)
230 V AC
(***)
NTC THERMISTOR (*)
T
M
(*) = OPTIONAL
(**) = IN ON-OFF CONTROL MODE ONLY
(***) = ALTERNATIVELY BRAKE RESISTOR OVERTEMPERATURE ALARM OUTPUT
ABB Oy
Drives, Technology
Helsinki, Finland
DRAWN 12.10.2006 K.K.
CHECKED 06.06.2007 I.T.
APPROVED
REVISED
ABRC-65
BRAKE UNIT CONTROLLER
WIRING PRINCIPLE
REFERS ACS800-77LC
FILE 00554269.DSF
SHEET 1 / 1
REV
DRAWING 3AFE 00554269 B

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/drives and selecting *Sales, Support and Service network*.

Product training

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

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