5. De-energizing, grounding and start-up

5.1. General

The following sections provide instructions on how to shut-down the PCS6000 for service purposes and on how to start-up again after the work is done.

5.2. Safety information

Before you begin, read and understand the material in chapter 2, **Important safety information**, page 23 and always follow the safety rules that are described in section 2.3.2, **The 7 steps that save lives**, page 26.

⚠DANGER High voltage!

The PCS6000 is a medium voltage high power device.

- High voltage in the PCS6000 can result in serious injury or DEATH and damage to the equipment.
- Parts replacement and other work on the PCS6000 must only be carried out by qualified personnel in compliance with local regulations.

⚠CAUTION Cooling fans can start automatically!

- The water cooling system and the cooling fans can start automatically as soon as the auxiliary voltage is switched on or when the EMERGENCY OFF button is released, even if the PCS6000 is de-energized.
- Switch off the corresponding motor protection switches (see diagrams contained in the cabinet specific documentation) to shut down the cooling system.

NOTICE Risk of component damage.

PCS6000 parameters are set during commissioning of the device and must not be changed afterwards.

- Running the PCS6000 with incorrect data can result in improper operation, reduction in control accuracy and damage to equipment.

5.3. Lockout/Tagout

Service MTTR 0 - 2 h

DANGER **High voltage!**

- DO NOT access the power sections of the PCS6000 before the converter is completely disconnected and grounded.
- Before the internals of the PCS6000 are accessed for service purposes, the relevant components of the converter must be de-energized safely.
- Follow the Lockout/Tagout procedure in appendix B05.
- The Logout/Tagout procedure is to be coordinated with the site manufacturer.

5.4. Start-up after maintenance or troubleshooting

Service MTTR 0 - 2 h

1. To release the over pressure from the cooling liquid circuit or to empty the cooling liquid circuit for the replacement of the faulty component, refill the cooling system to static pressure of 1.3 to 1.7 bar.

   For instructions, see the Operation and maintenance manual of the PCS6000 water cooling system, in Appendix A06 of the Data-sheets components of the user's manual.

2. Check that the water cooling system is ready for operation.

   See the user manual for the water cooling unit.

3. Remove safety grounding equipment.

4. Visually check the appearance, cleanliness inside and outside and that no tools, grounding equipment and other objects are left in any of the units.

5. Check that the grid is energized.

6. Connect all disconnected power supplies.

7. Switch on all MCBs (mini circuit breakers).

8. Make sure the “Bat.-select” switch on the uninterrupted power supply (UPS) module is set according to electrical drawings (“3.4Ah” in CCU, “7.2Ah” in POU) (see Fig. 8–2).

9. Close all unit doors properly.

   All units containing live MV equipment are equipped with door switches and solenoid coils.

   IMPORTANT! If a door is not closed, the converter start will be prevented.

10. Check that the Key Switch is in "ON" position

Figure 5–1 Key switch

IMPORTANT! The grid isolators and the grid grounding isolator are not operated by the PCS6000 control.

11. Turn the DC-link grounding isolator in position "not grounded".

The signal lamp ISOLATOR CLOSED must be off, ISOLATOR RELEASED stays on until the GRB disconnector is closed. (Only with DC-link grounding isolator modification otherwise until DC-link is above 50VDC)

Figure 5–2 DC-link grounding isolator in position "not grounded"

12. Check the status supervision signal lamps (GRB closed, DC-link grounding isolator closed/released) located at the front of the PCS6000.

All three yellow signal lamps must be off to get the ready to start converter.(With old grounding isolator setup grounding isolator is still released)

13. If applicable, check that the grid ground switch is open and the grid isolators are closed.

14. Check that the main circuit breaker is in operating position.

15. Press the ACKNOWLEDGE ALARM or ACKNOWLEDGE TRIP function key or select the appropriate command from remote control to reset all pending alarms and trips.

    If an alarm or fault cannot be reset, the original alarm or fault cause might still be present. Ensure that the cause is removed and press the ACKNOWLEDGE ALARM or ACKNOWLEDGE TRIP function key again.

    Faults caused by defects cannot be reset with the ACKNOWLEDGE TRIP function key. Elimination of these faults requires troubleshooting by authorized service personnel.

    For more information concerning “Acknowledge of alarms” for S2S application, see the “PCS6000 Local control panel description”, 3BHS606571 E49.

16. The PCS6000 can only be started if all faults are eliminated.

The PCS6000 is now in status OFF and ready to be started via the customer's HMI system (see application specific information in Appendix A04 Operation & Interface Documents, 01 Function Description and Control Interface). The above mentioned commands can also be given from a service PC, if it is connected to the PCS6000.

For more information, see the “PCS6000 Service software manual”, 3BHS600000 E81.

If parts have been replaced, check in the list in section 7.3, **Checking procedure**, page 81 or in section 10.3, **Overview of serialized power components**, page 135 as to whether these parts have a serialization profile, ie, these parts were serialized in production.

If such a part is replaced in the field the serialization database has to be updated, ie, the new serial number must be reported to ABB by means of a warranty and failure report.

6. Troubleshooting

6.1. General

The following sections provide instructions on how to replace control components and are intended for qualified personnel who are responsible for servicing a PCS6000 drive.

6.2. Safety information

Before you begin, read and understand the material in chapter 2, **Important safety information**, page 23 and always follow the safety rules that are described in section 2.3.2, **The 7 steps that save lives**, page 26.

⚠ DANGER High voltage!

Dangerous voltage inside the PCS6000 can lead to life-threatening situations, injury of the persons involved or damage to equipment.

- When planning and carrying out maintenance work, the operating condition of the whole system should be considered.

⚠ WARNING High temperatures, risk of burns!

Rails, reactors, resistors and fuses can be hot.

⚠ CAUTION Cooling fans can start automatically!

- The water cooling system and the cooling fans can start automatically as soon as the auxiliary voltage is switched on or when the EMERGENCY OFF button is released, even if the PCS6000 is de-energized.
- Switch off the corresponding motor protection switches (see diagrams contained in the cabinet specific documentation) to shut down the cooling system.

NOTICE **Risk of component damage.**

- ABB strongly recommended to carry out all preventive maintenance work according to the maintenance schedule on time and at the stated intervals.
- Observing the maintenance schedule can prevent system malfunctions.
- ABB is not liable for defects as a result of neglecting preventive maintenance work.
- To maintain safe and reliable operation of the PCS6000, ABB recommends taking out a service contract with the local ABB service organization.
- For more information contact your local service representative.
- During the warranty period, any repair work must be carried out exclusively by trained personnel according to the ABB service and authorization concept.
- ABB recommends periodical training for the maintenance and repair personnel.

6.3. Standard procedure for troubleshooting

IMPORTANT! After a temporary blocking of IGCTs, the PCS6000 attempts to reset the fault and to restart. If the restart is successful, ie, the device does not trip again within a pre-set time, the fault will be cleared automatically.

In case of a fault proceed as follows:

1. Select the fault and alarm display of one of the following:
   - Overriding control system
   - Optional commissioning tool

   NOTICE Do NOT clear or reset the fault buffer / display and the transient recorder data at this stage!
2. Check the alarm display for the first failure (marked with “FF” in commissioning tool) and other, possibly related error messages.

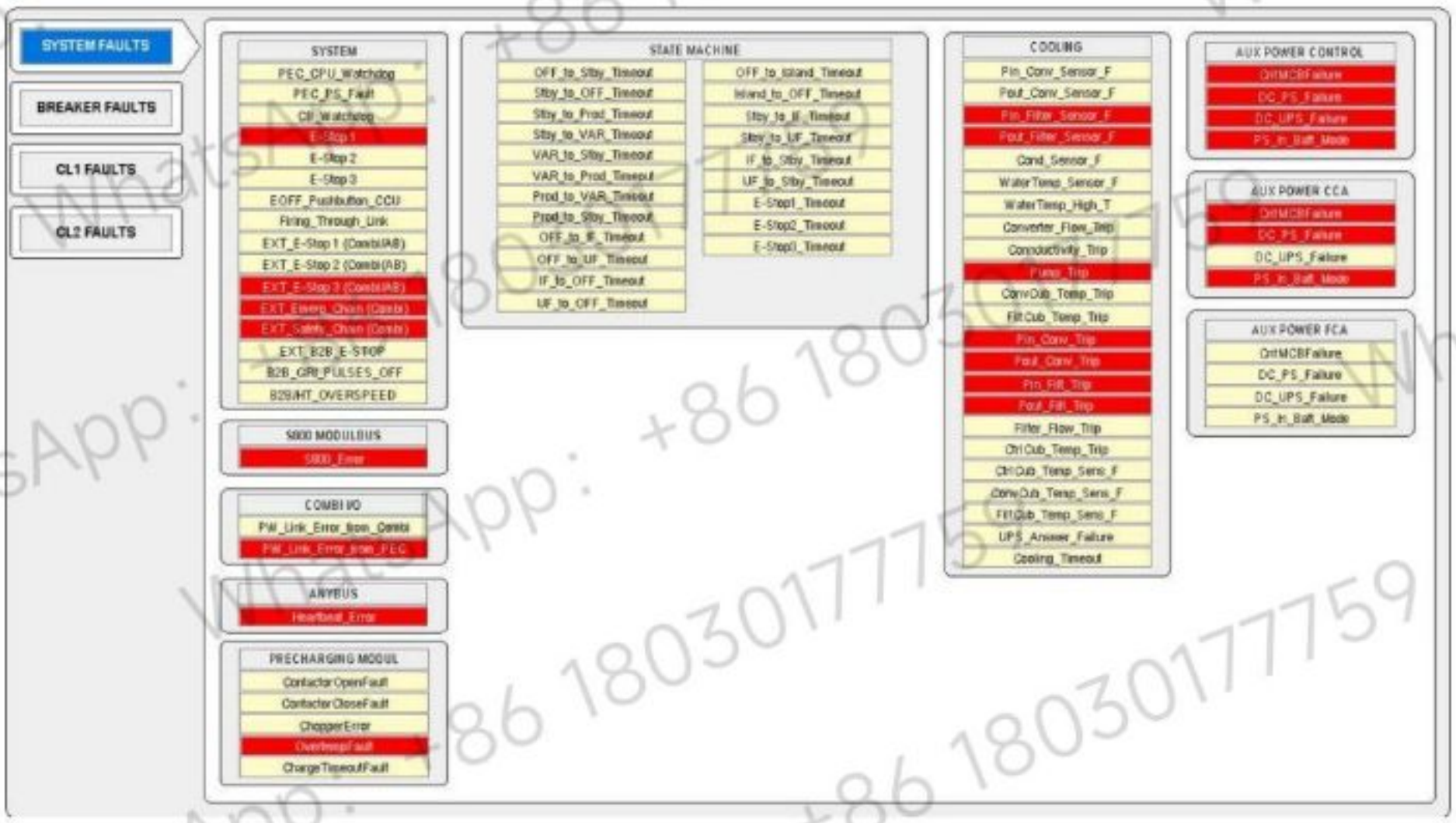


Figure 6–1 Commissioning tool (optional), error messages window

Read error messages on remote terminal

1) Try to find and rectify using Fault Handbook.
2) Check states of control equipment, power supplies, fiber-optic and communication links.
3) Check states of power equipment (converter, cooling system, switchgear, etc.)
4) Try to eliminate fault.

Fault eliminated?

Yes

No

Go to site

1) Try to find and rectify fault using Fault Handbook.
2) Check states of control equipment, power supplies, fiber-optic and communication links.
3) Check states of power equipment (converter, cooling system, switchgear, etc).
4) Repair or replace faulty component.

Fault eliminated?

Yes

No

Call ABB service

Restart

Figure 6–2 Standard procedure for troubleshooting (overview)

Proceeding from remote terminal:

1. Make sure that the transient recorder data are saved (The IPC automatically saves any new TR-Files every 10 minutes).
2. Try to find the reason for the fault: after having checked the alarm display, refer to the customer documentation, Appendix A09 - Fault handbook which provides a list of all alarm and fault messages and information on possible causes and suggestions to rectify the fault condition.
3. If necessary, analyze the transient recorder data.

   For more information, see the “PCS6000 Service software manual”, 3BHS600000 E81.
4. In the overriding control system or commissioning tool go to the window of the affected sub-system (eg, cooling system, S800).

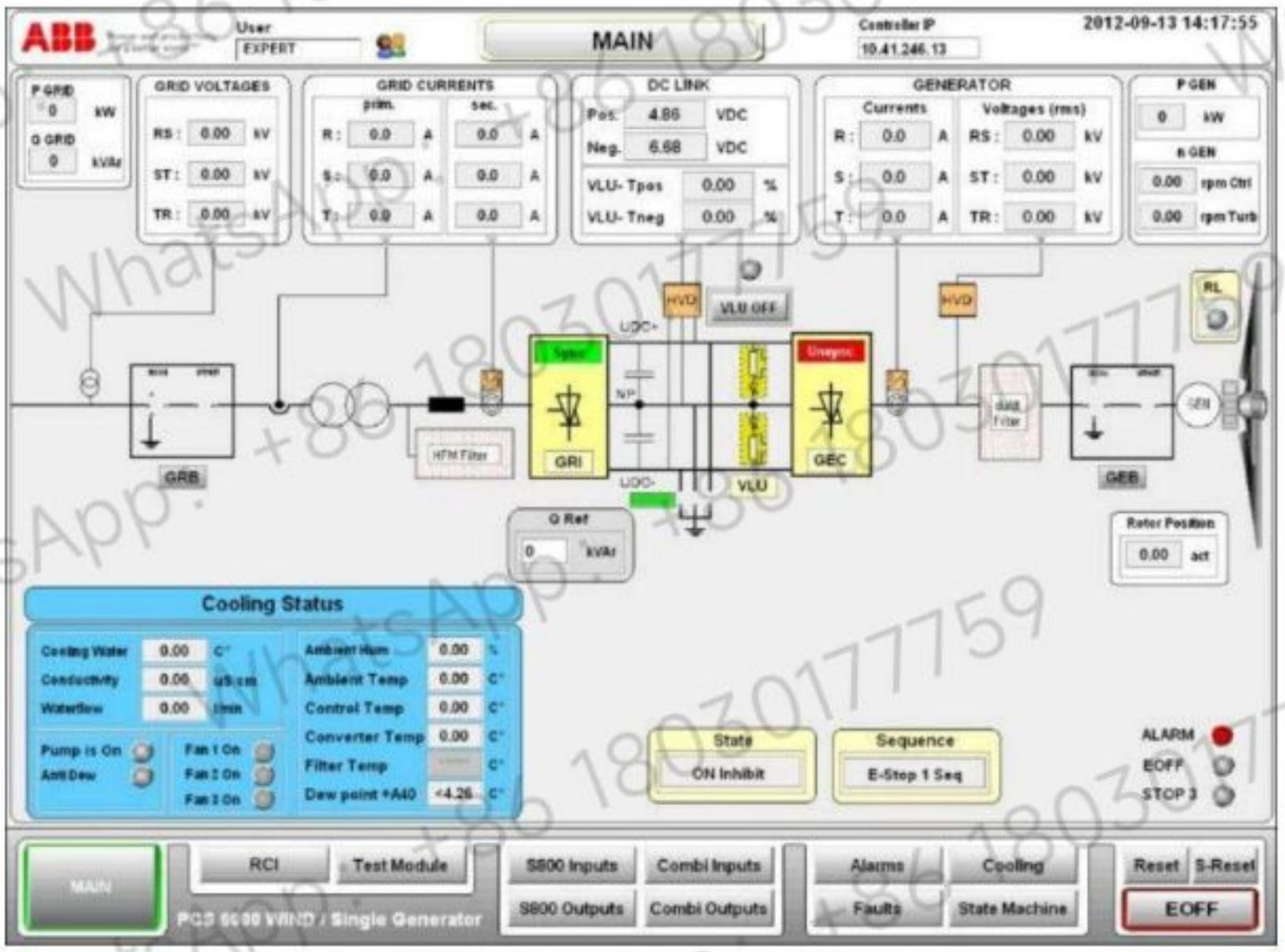


Figure 6–3 Commissioning tool (optional), typical window

5. Depending on the suggestions in the fault handbook, check the following:
   - Component states of control
   - Power equipment
   - Measured quantities, such as voltage, current, temperature, pressure and quality, statuses of switchgear.
6. If appropriate, try to restart the PCS6000 (in case of over temperature wait for cooling down first) and check if the fault occurs again.

   NOTICE DO NOT try to restart if the fault is related to converter hardware (eg, short circuits in the converter)!

Proceeding on site:

⚠ DANGER High voltage!

PCS6000 components are precision devices. Incorrect handling can result in serious injuries or DEATH and damage to the equipment.

- DO NOT access the power sections of the PCS6000 before the converter is completely de-energized and grounded.
- All repair work inside the PCS6000 must be carried out exclusively by service personnel authorized by ABB.
- Work accurately and follow exactly the instructions in this manual
- Always use the proper tools
- Recheck carefully all your actions

1. If necessary to enter the converter site for further fault finding: take an adequate set of spare parts.
2. Shut down the PCS6000 according to the "PCS6000 Lockout/tagout procedure", 3BHS600000 E22.

   NOTE – Depending on the suggestions in the fault handbook, proceed as follows.
3. Check the power and electronic components visually for the following:
   - LED indications (see chapter 7, **Checking control components**, page 81) that may indicate a component failure
   - Signs for overheated components, wires, cables or busbars
   - Equipment with traces of discoloring or sooting
   - Correct polarity of power diodes
   - Leaks
   - Proper functioning of fans, pumps etc.
   - Soiling of heat exchangers
   - Try if the fault can be located
4. Check all auxiliary power supplies.
   - If the fault is related to converter hardware check consecutively all power components (diodes, IGCTs and IPS) of each stack in the upstream and downstream converters.
   - Compare the results with neighboring stacks to find irregularities.

   For more information, see chapter 9, **Checking diodes, IGCTs and IPS**, page 115.
5. Replace the faulty component according to the instructions in chapter 10, **Replacing power and cooling components**, page 133 or according to the instructions in the specific component documentation (see customer documentation, Appendix A06 Data sheets for components).

6. If the fault could not be located, check the electronic equipment using the electrical drawings:
   - Power supplies
   - Control modules
   - Measurement devices
   - Hardwired connections
   - Fiber-optic connections
7. Replace the faulty electronic component according to the instructions in chapter 8, **Replacing control components**, page 85.
8. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70 (in case of over-temperature wait for cooling down).
9. Reset the PCS6000:
   - Faults that are related to converter hardware failures (eg, overcurrent) require a service reset after correction of the problem.
   - Faults that are related to other than converter hardware failures (eg, cooling system problems) require a normal reset after correction of the problem.

   For more information concerning “Acknowledge of alarms” for S2S application, see the “PCS6000 Local control panel description”, 3BHS606571 E49.
10. Check if the fault occurs again.

    If the reason for the failure is unclear or the problem cannot be solved, contact the ABB service representative!

    For efficient troubleshooting, have the following data available when calling the ABB service representative:
    - Serial number of converter and installation data
    - Type and serial number of each affected part
    - Date and time of occurrence
    - Grid condition (switching action, fault etc.)
    - Load conditions (steady or changing load etc.)
    - Cooling water data (temperature, pressure)
    - Any other irregular situation or operating condition (ambient temperature etc.)

7. Checking control components

7.1. General

The following sections provide instructions on checking the electronic devices of the PCS6000 and an overview on the meaning of LEDs of the main circuit boards and I/O devices.

7.2. Safety information

⚠ DANGER High voltage!

Dangerous voltage inside the PCS6000 can lead to life-threatening situations, injury of the persons involved or damage to equipment.

Before you begin, read and understand the material in chapter 2, **Important safety information**, page 23 and always follow the safety rules that are described in section 2.3.2, **The 7 steps that save lives**, page 26.

7.3. Checking procedure

1. Use the electrical drawings to locate the devices to be checked.
2. If you need to enter the power sections for additional fault finding, Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
3. Check the electronic components visually for the following:
   - LED indications (see section 7.4, **LED status indications**, page 81) that may indicate a component failure
   - Missing LED indications
   - Signs for overheated components, wires, cables or busbars
   - Equipment with traces of discoloring or sooting
4. Check all auxiliary power supplies.
5. Check all hardwired and fiber-optic connections.
6. If necessary replace a faulty component according to chapter 8, **Replacing control components**, page 85.

7.4. LED status indications

The LEDs presented in the following section can be checked easily with the auxiliary voltage switched on and without having to remove covers first. The LEDs provide information on the status of the devices and can be used for diagnostic purposes.

7.4.1. LEDs on AC 800PEC

Table 7–1 LEDs on AC 800PEC

LED number	Color	Marking	Description
LED 1	Red	F(ault)	LED off: normal state LED on: severe system fault
LED 2	Green	R(un)	LED off: FPGA not configured LED on: FPGA configured
LED 3	Green	P(ower)	LED off: power supply out of range LED on: power is on
LED 4	Green	S(upervisor)	LED off: operating condition out of range LED on: normal state
LED 5	Yellow	T(ransmission)	LED off: PowerLink not available LED flashing: PowerLink available
LED 6	Yellow	A(ctivity)	LED off: watchdog error LED flashing: normal state

7.4.2. LEDs on Combi IO

Table 7–2 LEDs on Combi IO UA D155

LED number	Color	Marking	Description
LED 1	Red	F(ault)	LED off: normal state LED on: severe system fault
LED 2	Green	R(un)	LED off: FPGA not configured LED on: FPGA configured
LED 3	Green	P(ower)	LED off: power supply out of range LED on: power is on
LED 4	Green	S(upervisor)	LED off: hardware disturbance LED on: normal state
LED 5	Yellow	T(ransmission)	LED off: PowerLink not available LED flashing: PowerLink available
LED 6	Yellow	A(ctivity)	LED off: watchdog error LED flashing: normal state

7.4.3. LEDs on PECINTM

Table 7–3 LEDs on PECINTM PC D237

LED number	Color	Marking	Description
LED 1	Red	F(ault)	LED off: normal state LED on: severe system fault
LED 2	Green	R(un)	LED off: FPGA not configured LED on: FPGA configured
LED 3	Green	P(ower)	LED off: power supply out of range LED on: power is on
LED 4	Yellow	A(ctivityr)	LED off: watchdog error LED flashing: normal state

7.4.4. LEDs on ASE2 board

Table 7–4 ASE2 board UD C920

LED number	Color	Marking	Description
LED 1	Red	F(ault)	LED off: normal state LED on: in test mode and channel 0 full scale test fault and channel 0 test offset fault – In test mode and channel 1 full scale test fault and channel 1 test offset fault – In test mode and communication test fault
LED 2	Green	R(un)	LED off: FPGA not configured LED on: FPGA configured
LED 3	Green	P(ower)	LED off: power supply out of range LED on: power on
LED 4	Green	TOF (test offset)	LED off: normal state LED flashing: in test mode and only one channel in offset test range LED on: in test mode and both channels in offset test range

Table 7–4 ASE2 board UD C920 (continued)

LED number	Color	Marking	Description
LED 5	Green	TFS (test full scale)	LED off: normal state LED flashing: in test mode and only one channel in full scale test range LED on: in test mode and both channels in full scale test range
LED 6	Green	COM(munication)	LED off: communication faulty LED on: communication OK

7.4.5. LEDs on UPS

Table 7–5 UPS/24DC/40

LED number	Color	Marking	Description
LED 1	Red	Alarm	LED off: normal state LED on: alarm state
LED 2	Yellow	Bat.-Mode Bat.-Charge	LED off: output fed from input LED on: output fed from battery LED flashing: battery charging
LED 3	Green	Power In	LED off: power supply out of range LED on: power is on

8. Replacing control components

8.1. General

The following sections provide instructions on how to replace control components and are intended for qualified personnel who are responsible for servicing a PCS6000 drive.

8.2. Safety information

Before you begin, read and understand the material in chapter 2, **Important safety information**, page 23 and always follow the safety rules that are described in section 2.3.2, **The 7 steps that save lives**, page 26.

DANGER **High voltage!**

Dangerous voltage inside the PCS6000 can lead to life-threatening situations, injury of the persons involved or damage to equipment.

- When planning and carrying out maintenance work, the operating condition of the whole system should be considered.

WARNING **High temperatures, risk of burns!**

Rails, reactors, resistors and fuses can be hot.

CAUTION **Cooling fans can start automatically!**

The water cooling system and the cooling fans may start automatically as soon as the auxiliary voltage is switched on or when the EMERGENCY OFF button is released, even if the PCS6000 is de-energized.

- Switch off the corresponding motor protection switches (see diagrams contained in the cabinet specific documentation, tab 2) to shut down the cooling system.

NOTICE **Electrostatic discharge (ESD) can damage electronic boards and components!**

- DO NOT touch printed circuit boards or other sensitive components without applying static-sensitive handling precautions!
- While working with components containing printed circuit boards, use a wrist strap which is earthed at the unit's frame.
- Whenever components need to be replaced use an antistatic mat on a table near the unit and connect the mat to the same point as the wrist strap.
- Hold a board only at the edge.
- Handle a faulty board as carefully as a new one.

IMPORTANT! It is strongly recommended to install some cover (plastic, cardboard, etc.) below the components to be removed before starting replacement work. This cover will catch dropped parts as screws, washers, screw nuts, etc.

8.3. Overview of replaceable control components

Tables 8–1, 8–2, 8–3, 8–4 and 8–5 contain electrical control components in the different units replaceable by the customer. Beside the component name, the product number and the SAP number there are 2 additional columns:

- Serialized: An “x” in this column indicates that this component was serialized in production.

  If the component was replaced in the field the serialization database should be updated, ie, the new serial number has to be reported to ABB by means of a warranty and failure report.

  For a complete list of serialized parts refer to the list of serialized assemblies and components (3BHE600000 E70).

- Special tasks in case of replacement: Indicates what must be done after replacement of the component.

8.3.1. Replaceable control components in CCU

Table 8–1 CCU control components replaceable by customer

Component name	Product number	SAP number	Serialized	Special tasks in case of replacement
AC 800PEC	PP D113 B03-20-110110	3BHE023584R204Z	x	-
AC 800PEC Combi IO	UA D155 A0111	3BHE029110R0111	x	-
S800 Bus Modem	TB820V2	3BSE013208R0001	-	Set correct address
S800 Compact MTU Connection Base	TU810V1	3BSE013230R0001	-	Set correct address
S800 Compact Connection Base	TU811	3BSE013231R0001	-	Set correct address
S800 Digital Input 48VDC	DI811	3BSE008552R0001	-	Set correct address
S800 Analog Input	AI810	3BSE008516R0001	-	Set correct address
S800 Digital Output 8 NO	DO820	3BSE008514R0001	-	Set correct address
AC/DC Converter	QUINT-PS/3AC/24DC/40	3BHE031065R0001	x	Set voltage according to electrical drawings
DC/DC Converter	QUINT-PS-24DC/24DC/10	3BHB057230P2424	x	Set voltage according to electrical drawings
UPS	QUINT-DC-UPS/24DC/40	3BHB056371P0040	x	Set time and battery dial according to electrical drawings
Battery	QUINT-BAT/24DC/3.4Ah	3BHB056372R0003	x	-
Voltage Transducer	UUD148AE01	3BHE014185R0001	x	Set jumpers according to electrical drawings

Table 8–1 CCU control components replaceable by customer (continued)

Component name	Product number	SAP number	Serialized	Special tasks in case of replacement
Current Transducer	UUD148AE02	3BHE014185R0002	x	Set jumpers according to electrical drawings
Industry PC	Compact 7M2	3BHE035578R0001	x	-

8.3.2. Replaceable control components in POU

Table 8–2 POU control components replaceable by customer

Component name	Product number	SAP number	Serialized	Special tasks in case of replacement
PECINTM	PC D237 A101	3BHE028915R0101	x	-
IPS	IPS21-24V	3BHE032593R0001	x	-
HVD	XV C770 BE102	3BHE021083R0102	x	-
VLSCD	XV C724 BE	3BHE009017R0102	x	-
ASE2B	UD C920 BE102	3BHE034863R0002	x	-
AC/DC Converter	QUINT-PS/3AC/ 24DC/40	3BHE031065R0001	x	Set voltage according to electrical drawings
DC/DC Converter	QUINT-PS-24DC/ 24DC/10	3BHB057230P2424	x	Set voltage according to electrical drawings
UPS	QUINT-DC-UPS/ 24DC/40	3BHB056371P0040	x	Set time and battery dial according to electrical drawings
Battery	QUINT-BAT/24DC/ 7.2Ah	3BHB056372R0002	x	-

8.3.3. Replaceable control components in FIU

Table 8–3 FIU control components replaceable by customer

Component name	Product number	SAP number	Serialized	Special tasks in case of replacement
AC/DC Converter	QUINT-PS/1AC/ 24DC/10	3BHE016113R0110	x	Set voltage according to electrical drawings

Table 8–3 FIU control components replaceable by customer (continued)

Component name	Product number	SAP number	Serialized	Special tasks in case of replacement
UPS	QUINT-DC-UPS/ 24DC/10	3BHB056371P0010	x	Set time dial according to electrical drawings

8.3.4. Replaceable control components in DLU

Table 8–4 DLU control components replaceable by customer

Component name	Product number	SAP number	Serialized	Special tasks in case of replacement
IPS	IPS21-24V	3BHE032593R0001	x	-
VLSCD	XV C724 BE	3BHE009017R0102	x	-

8.3.5. Replaceable control components in DRU

Table 8–5 DRU control components replaceable by customer

Component name	Product number	SAP number	Serialized	Special tasks in case of replacement
12-Pulse Firing Board	DDC779BE02	3BHE037945R0001	-	-
EAF	UF C765 AE102	3BHE003604R0102	x	-

8.5. Replacing Combi IO

Service MTTR 0 - 2 h

Figure 8–4 AC 800PEC Combi IO UA D155

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q306 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. Wait until the IPC shut-down is finished (approximately 5 min).
4. On the UPS -G302 turn the selector switch “Bat.-Select” to “Service”, then back to previous value (see Fig. 8–2) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
5. Disconnect all cables and detach the module to be replaced (see Fig. 8–3 for detachment procedure).

   NOTE – It might be useful to disconnect the lower cables after detaching the module.
6. Replace the detached module with a spare one with identical hardware configuration.
7. Reconnect all cables and power up the module by switching on MCB -Q306.
8. Check the LEDs for any possible errors according to section 7.4.2, **LEDs on Combi IO**, page 82.
9. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

   NOTE – Depending on the replaced board it might be necessary to update the software. Contact ABB Service for instructions.

8.6. Replacing S800 I/O modules

Service MTTR 0 - 2 h

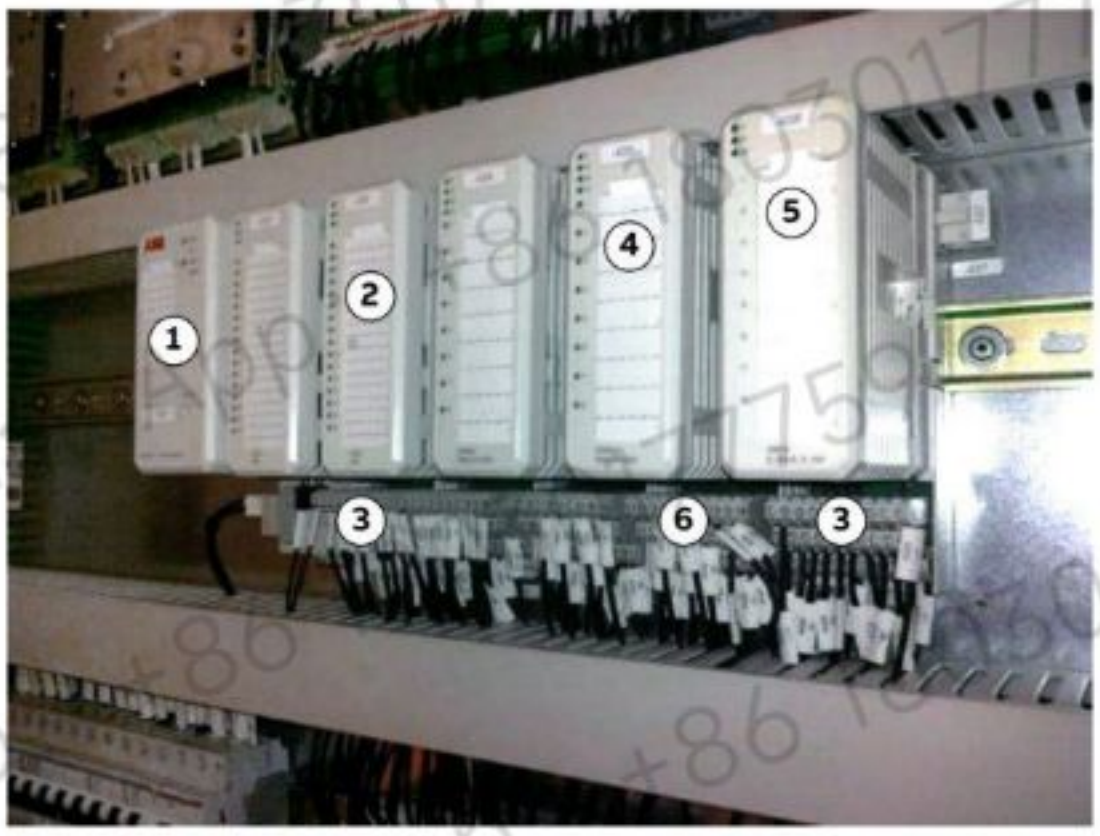


Figure 8–5 S800 assembly

1) Bus modem TB820V2	4) AI810
2) DI811	5) DO820
3) Connection base TU810V1	6) Connection base TU811

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q306 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. Wait until the IPC shut-down is finished (approximately 5 min).
4. On the UPS -G302 turn the selector switch “Bat.-Select” to “Service”, then back to previous value (see Fig. 8–2) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
5. Release the locking knob with a screwdriver on the module to be replaced (see Fig. 8–6).

8.7. Replacing voltage (AE01) and current (AE02) transducer boards

Service MTTR 0 - 2 h

⚠WARNING High voltage!

Open current loop.

- Make sure that the terminals on the current transducer side are short-circuited before disconnecting the cables to the transducer board.

Figure 8–8 Voltage and current transducer boards UUD 148 AE01/2

1) Voltage board	2) Current transducer board

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q306 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. Wait until the IPC shut-down is finished (approximately 5 min).
4. On the UPS -G302 turn the selector switch “Bat.-Select” to “Service”, then back to previous value (see Fig. 8–2) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
5. If you need to replace a current transducer board, short-circuit the terminals -X900 (current measurement inputs from customer switchgear.

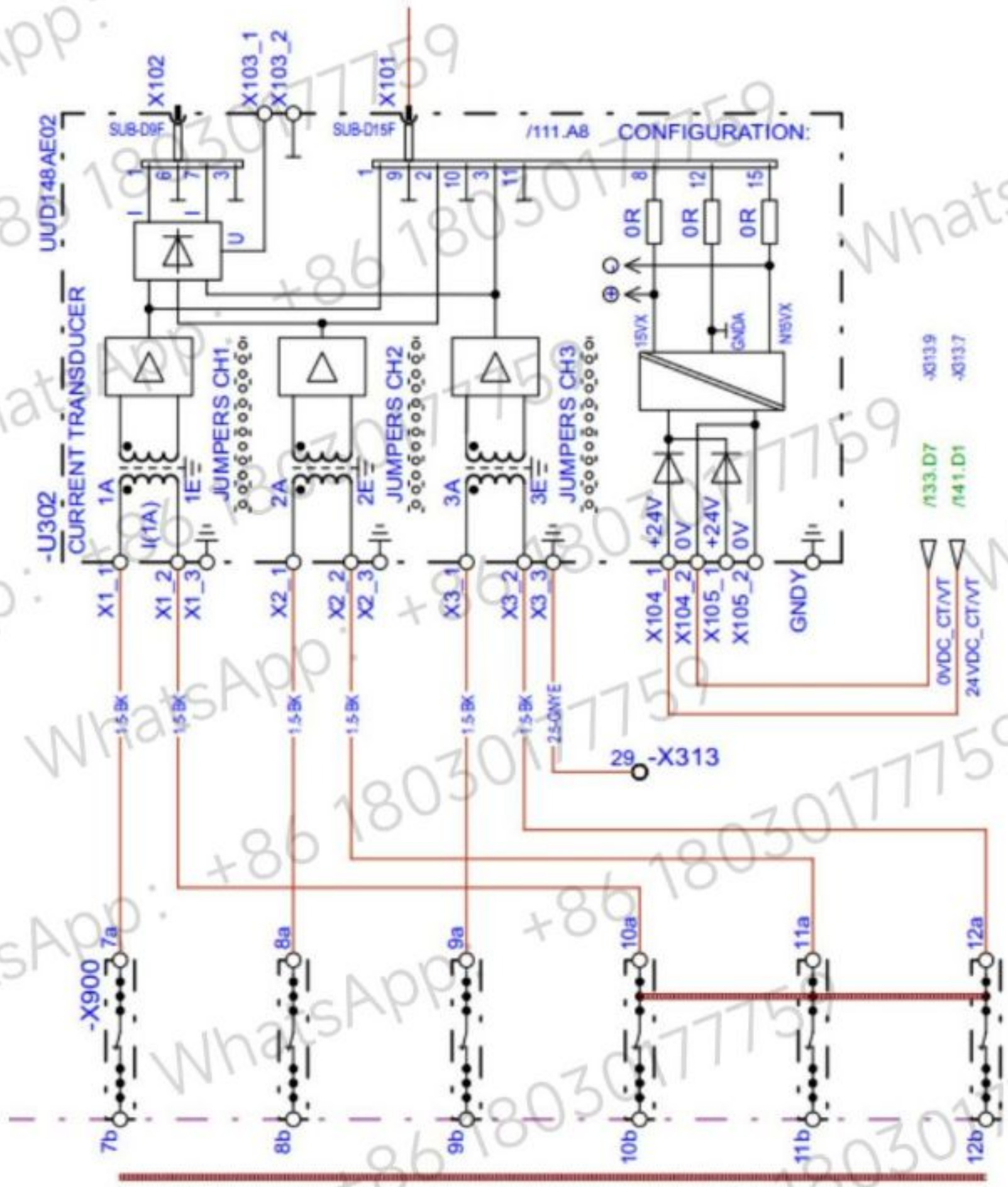


Figure 8–9 Short-circuit of current transducer

6. Disconnect all cables and detach the module to be replaced (see Fig. 8–3 for detachment procedure).
7. Replace the detached module with a spare one with identical hardware configuration; compare the jumper settings near the lower edge of the printed circuit board.
8. Reconnect all cables.
9. Remove the short-circuits from the current measurement inputs on -X900.
10. Power up the transducer board by switching on MCB -Q306.
11. Check the new module for correct functioning.
12. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.8. Replacing PECINTM

Service MTTR 2 - 4 h

Figure 8–10 PECINTM PC D237

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. On the UPS -G402 turn the selector switch “Bat.-Select” to “Service”, then back to previous value (see Fig. 8–11) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).

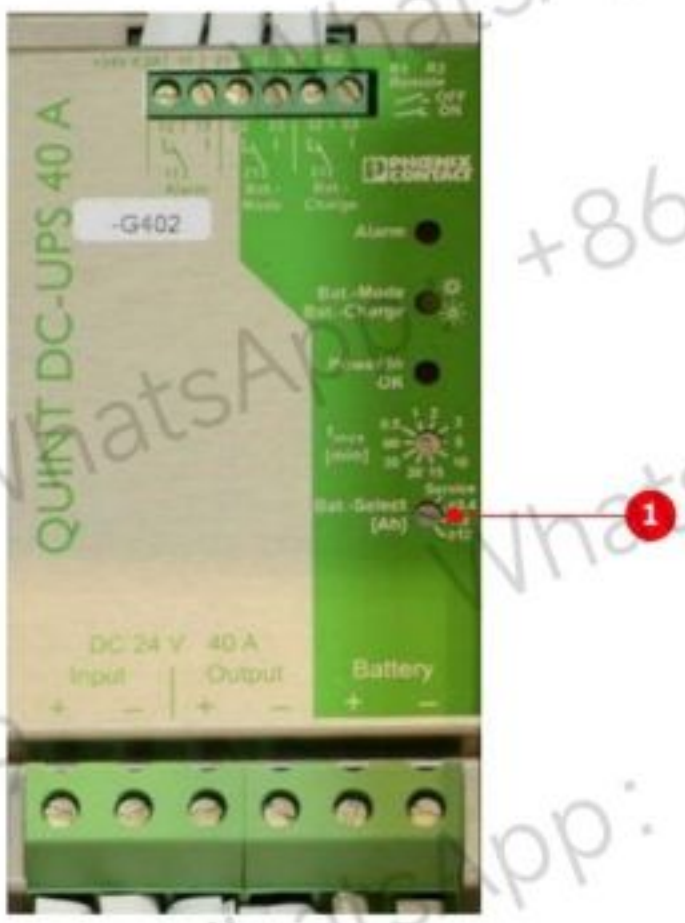


Figure 8–11 UPS -G402 selector switch “Bat.-Select”

1) Selector switch “Bat.-Select”

4. Disconnect all cables and detach the module to be replaced (see Fig. 8–3 for detachment procedure).

   IMPORTANT! Take care that all cables can be clearly identified for reconnection.

5. Replace the detached module with a spare one with identical hardware configuration.

6. Reconnect all cables.

   IMPORTANT! Make sure that all cables are connected to the correct terminals, otherwise malfunctions or component damages may occur.

7. Power up the module by switching on MCB -Q401.

8. Check the LEDs for any possible errors according to section 7.4.3, **LEDs on PECINTM**, page 83.

9. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.9. Replacing IPS

⚠CAUTION Heavy load.

The IPS module weighs approximately **6 kg** and care must be taken not to drop it.

Service MTTR 0 - 2 h

Figure 8–12 GCT power supply (IPS)

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. On the UPS -G402 turn the selector switch “Bat.-Select” to “Service”, then back to previous value (Fig. 8–11) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
4. Disconnect all plugs and unbolt the four screws.
5. Replace the detached module with a spare one.
6. Reconnect all plugs and power up the module by switching on MCB -Q401.
7. Check the new module for correct functioning according to section 9.10, **Checking IPS**, page 132.
8. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.10. Replacing HVD

Service MTTR 0 - 2 h

Figure 8–13 HVD XV C770

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. On the UPS -G402 turn the selector switch “Bat.-Select” to “Service”, then back to previous value (Fig. 8–11) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
4. Disconnect all cables and unbolt the four screws; the distancing rods remain attached to the panel wall.
5. Replace the detached board with a spare one.
6. Reconnect all cables and power up the board by switching on MCB -Q401.
7. Check the new module for correct functioning.
8. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.11. Replacing VLSCD

Service MTTR 0 - 2 h

Figure 8–14 VLSCD XV C724

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. On the UPS -G402 turn the selector switch “Bat.-Select” to “Service”, then back to previous value (Fig. 8–11) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
4. Disconnect all cables and unbolt the four mounting screws; make sure not to lose the distancing rods.
5. Replace the detached board with a spare one.
6. Reconnect all cables and power up the board by switching on MCB -Q401.
7. On the new module, measure the resistance between B2 and A1 and between B1 and A2 using an Ohm meter.

   NOTE – Please refer to the circuit diagram. Both values must in a range between 26.25 and 26.30 kΩ.
8. Apply a variable DC-voltage (0 to 15 V) between B1 and B2. Below 12.9 V the LED must be dark and above 14.0 V the LED must be alight.
9. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.12. Replacing ASE

Service MTTR 0 - 2 h

Figure 8–15 ASE2B UD C920

1. Shut down the PCS6000 according to the "PCS6000 Lockout/tagout procedure", 3BHS600000 E22.
2. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. On the UPS -G402 turn the selector switch "Bat.-Select" to "Service", then back to previous value (Fig. 8–11) to interrupt the 24 V battery supply voltage (the yellow LED "Bat.-Mode" must be dark).

   NOTE – The power supply might come from the neighboring POU.
4. Remove the cover of the ASE board enclosure.
5. Disconnect all cables and unbolt the two screws to remove the module; the isolators remain attached to the base plate on the cabinet wall.

   IMPORTANT! Take care that all cables can be clearly identified for reconnection.
6. Replace the detached module with a spare one with identical version number.
7. Reconnect all cables and fasten the cover.
8. Make sure that all cables are connected to the correct terminals, otherwise malfunctions or component damages may occur.
9. Power up the module by switching on MCB -Q401.
10. Check the LEDs for any possible errors according to section 7.4.4, **LEDs on ASE2 board**, page 83.
11. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.13. Replacing AC/DC converter

8.13.1. Replacing AC/DC converter -G301 in CCU or -G401 in POU

Service MTTR 0 - 2 h

Figure 8–16 AC/DC converter Quint-PS/3AC/24DC/40

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q306 (control cabinet, CCU) or -Q401 (POU) to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. In control cabinet, CCU wait until the IPC shut-down is finished (approximately 5 min).
4. On the UPS -G302 (CCU) or -G402 (POU) turn the selector switch “Bat.-Select” to “Service”, then back to previous value (see Fig. 8–2 or Fig. 8–11) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
5. Verify that the input cable is voltage-free.
6. Remove the reinforcement plate in front AC/DC converter.
7. POU: for -G401, remove the 48 V supply fuse -X312.9 in the CCU.
8. Disconnect all plugs and detach the module to be replaced.
9. Replace the detached module with a spare one and set the voltage dial to the same position as the old one.
10. Reconnect all plugs and power up the module by switching on MCB -Q306 (CCU) or -Q401 (POU).
11. Make sure the LED “DC OK” is lit.
12. Measure the output voltage with a multimeter and adjust the voltage dial if it's not 24 V.
13. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.14. Replacing AC/DC converter -G501 in FIU

Service MTTR 0 - 2 h

Figure 8–17 AC/DC converter Quint-PS/1P24/10

1) AC/DC converter	2) UPS

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q503 to interrupt the 1-phase 230 VAC input voltage of the AC/DC converter (24 V power supply).
3. Verify that the input cable is voltage-free.
4. Wait until UPS time (-G502) is over (or set time to very short, then back) to have the 24V supply voltage for aux contact off.
5. Remove the reinforcement plate in front AC/DC converter.
6. Disconnect all plugs and detach the module to be replaced.
7. Replace the detached module with a spare one and set the voltage dial to the same position as the old one.
8. Reconnect all plugs and power up the module by switching on MCB-Q503.
9. Make sure the LED “DC OK” is lit.
10. Measure the output voltage with a multimeter and adjust the voltage dial if it's not 24 V.
11. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.15. Replacing DC/DC converter

Service MTTR 0 - 2 h

Figure 8–18 DC/DC converter Quint-PS-24DC/24DC/10

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q306 (control cabinet, CCU) or -Q401 (POU) to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. In control cabinet, CCU wait until the IPC shut-down is finished (approximately 20 min).
4. On the UPS -G302 (CCU) or -G402 (POU) turn the selector switch “Bat.-Select” to “Service”, then back to previous value (see Fig. 8–2 or Fig. 8–11) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
5. Verify that the input cable is voltage-free.
6. Remove the reinforcement plate in front of the DC/DC converter.
7. POU: for -G404, remove the 48 V supply fuse -X312.9 in the CCU.
8. Disconnect all plugs and detach the module to be replaced.
9. Replace the detached module with a spare one and set the voltage dial to the same position as the old one.
10. Reconnect all plugs and power up the module by switching on MCB -Q306 (CCU) or -Q401 (POU).
11. Make sure the LED “DC OK” is lit.
12. Measure the output voltages with a multimeter and adjust the voltage dial if it's not 24 V and 48 V, respectively.
13. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.16. Replacing UPS

8.16.1. Replacing UPS -G302 in CCU or -G402 in POU

Service MTTR 0 - 2 h

Figure 8–19 Quint-DC-UPS/24DC/40

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q306 (control cabinet, CCU) or -Q401 (POU) to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. In control cabinet, CCU wait until the IPC shut-down is finished (approximately 5 min).
4. On the UPS -G302 (CCU) or -G402 (POU) turn the selector switch “Bat.-Select” to “Service”, then back to previous value (see Fig. 8–2 or Fig. 8–11) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
5. Verify that the input cable is voltage-free.
6. Remove the car fuses on the battery (-G303/-G403) and for -G402, remove the 48 V supply fuse -X312.9 in the CCU.
7. Remove the reinforcement plate in front of the UPS
8. Disconnect all wires and detach the module to be replaced.
9. Replace the detached module with a spare one and set the time and the “Bat.-Select” according to electrical drawings.
10. Reconnect all wires and power up the module by re-installing the removed fuses and switching on MCB -Q306 (CCU) or -Q401 (POU).
11. Check the LEDs for any possible errors according to Table 7–5 in “section 7.4.5, **LEDs on UPS**, page 84.
12. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.16.2. Replacing UPS -G502 in FIU

Service MTTR 0 - 2 h

Figure 8–20 Quint-DC-UPS/24DC/10

1) AC/DC converter	2) UPS

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q503 to interrupt the 1-phase 230 VAC input voltage of the AC/DC converter (24 V power supply).
3. Verify that the input cable is voltage-free.
4. Wait until UPS time (-G502) is over (or set time to very short, then back) to have the 24V output voltage off.
5. Disconnect all plugs and detach the module to be replaced.
6. Replace the detached module with a spare one and set the time according to electrical drawings.
7. Reconnect all plugs and power up the module by switching on MCB -Q503.
8. Check the LEDs for any possible errors according to section 7.4.5, **LEDs on UPS**, page 84.
9. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.17. Replacing batteries

8.17.1. Replacing battery -G303 in CCU

Service MTTR 0 - 2 h

IMPORTANT! Normally the PCS6000 should be shut-down for replacing the battery as described below. With special care the battery may be replaced while the PCS6000 is in operation (24 V power supply on). Then only carry out points 4 to 8.

The delivered replacement batteries are already charged. Please check the expiry date marked on the battery. DO NOT use batteries with expired date or with an expiry date shorter than the preventive exchange interval.

Figure 8–21 Battery -G303

1) Battery	3) UPS
2) Car fuses	4) Battery +/- terminals

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off MCB -Q306 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. Wait until the IPC shut-down is finished (approximately 20 min).
4. On the UPS -G302 turn the selector switch “Bat.-Select” to “Service”, then back to previous value (see Fig. 8–2) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
5. Pull out the car-fuse located on the right side of the battery.

6. Disconnect the battery connection wires from the UPS (Battery +/- terminals).
7. Loosen the mounting screws and remove the old battery.
8. Mount new battery and reconnect the battery connection wires to the UPS (Battery +/- terminals).
9. Reinsert the car-fuse.
10. Switch on MCB -Q306.
11. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.17.2. Replacing battery -G403 in POU

Service MTTR 0 - 2 h

The delivered replacement batteries are already charged.

Figure 8–22 Battery -G403

1) UPS	4) Battery
2) Battery +/- terminals	5) Car fuses
3) AC/DC converter	

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.

2. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
3. On the UPS -G402 turn the selector switch “Bat.-Select” to “Service”, then back to previous value (Fig. 8–11) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).
4. Remove the reinforcement plates in front of the battery.
5. Pull out the car-fuses located on the right side of the battery.
6. Disconnect the battery connection wires from the UPS (Battery +/- terminals).
7. Loosen the mounting screws and remove the old battery.
8. Mount new battery and reconnect the battery connection wires to the UPS (Battery +/- terminals).
9. Reinsert the car-fuses.
10. Switch on MCB -Q401.
11. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

8.17.3. Replacing battery in UPS -G502 in FIU

Service MTTR 0 - 2 h

The battery is built into the UPS -G502.

Therefore to replace the battery the whole UPS has to be replaced according to section 8.16.2, **Replacing UPS -G502 in FIU**, page 107.

8.18. Replacing fiber optic cables

Service MTTR 2 - 4 h

NOTICE **Risk of component damage.**

- Handle fiber optic cables with care.
- DO NOT touch the ends of the fibers as they are extremely sensitive to dirt. When unplugging a fiber optic cable, always hold it at the connector not at the fiber.
- Observe the mounting instructions as well as the maximum long-term tensile load and the minimum bending radius according to the manufacturer's specification.
- ABB provides kits to prepare the fiber optic cables to correct length. These kits also contain a tool to polish the fiber optic cables (see section 3.2.4, **Polishing kit for fiber optics**, page 37).

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Cut the fiber optic cables to the required length using a wire cutter or a sharp knife.

   IMPORTANT! Use the identical type of optical cable.
3. Strip the cable ends approximately 7 mm using a 16 gauge wire stripper (eg, Stripmaster type 45-092).

   NOTE – When using the duplex connector arrangement, the separated duplex cable should be stripped to roughly equal lengths on each cable end.

4. Place the connector on each end of the fiber, and slide the connector down until the fiber jacket stops it.

   IMPORTANT! The fiber should not extend more than 1.5 mm from the end of the connector.

5. (Simplex connectors) flip the top half of the connector over and snap it into the ferrule half with your fingers.

When the top half latches inside the body of the ferrule half, proper connector-to-cable attachment is achieved.

6. (Duplex connectors): place one connector on top of the other, so that the top half of each connector is over the ferrule half of the opposite connector, manually press connectors together in the center of the arrangement and then latch by pressing on the sides of each connector.

As with the simplex version, the connectors are secured when top halves latch into the ferrule halves.

7. Insert the connector fully into the polishing fixture with the trimmed fiber protruding from the bottom of the fixture.

This plastic polishing fixture can be used to polish two simplex connectors simultaneously or one duplex connector.

IMPORTANT! The four dots on the bottom of the polishing fixture are wear indicators. Replace the polishing fixture when any dot is no longer visible.

8. Place the 600 grit abrasive paper on a flat surface and press the polishing tool down on it.

9. Polish the fiber using a figure eight pattern until the connector is flush with the bottom of the polishing fixture.
10. Wipe the connector and fixture with a clean cloth or tissue then push the connector again into the polishing fixture of the polishing kit.
11. Place a 3 µm lapping film on a flat surface, place the flush connector and polishing fixture on the dull side of the 3 µm pink lapping film and continue to polish the fiber in the same figure eight pattern for approximately 25 strokes.

    The fiber end should be flat, smooth and clean (check with a magnifying glass).

    IMPORTANT! Use of the pink lapping film fine polishing step results in approximately 2 dB improvement in coupling performance of either a transmitter-receiver link or a bulkhead/splice over a 600 grit polish alone. This fine polish is comparable to the Avago Technologies factory polish.
12. Repeat this procedure for the other end of the fiber optic cable.
13. Replace the fiber optic cables with the newly assembled cables.
14. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

9. Checking diodes, IGCTs and IPS

9.1. General

The following sections provide instructions on how to check diodes, IGCTs and IPS.

9.2. Safety information

Before you begin, read and understand the material in chapter 2, **Important safety information**, page 23 and always follow the safety rules that are described in section 2.3.2, **The 7 steps that save lives**, page 26.

⚠ DANGER High voltage!

Dangerous voltage inside the PCS6000 can lead to life-threatening situations, injury of the persons involved or damage to equipment.

- When planning and carrying out maintenance work, the operating condition of the whole system should be considered.

⚠ WARNING High temperatures, risk of burns!

Rails, reactors, resistors and fuses can be hot.

⚠ CAUTION Cooling fans can start automatically!

The water cooling system and the cooling fans may start automatically as soon as the auxiliary voltage is switched on or when the EMERGENCY OFF button is released, even if the PCS6000 is de-energized.

- Switch off the corresponding motor protection switches (see diagrams contained in the cabinet specific documentation, tab 2) to shut down the cooling system.

NOTICE Electrostatic discharge (ESD) can damage electronic boards and components!

- DO NOT touch printed circuit boards or other sensitive components without applying static-sensitive handling precautions!
- While working with components containing printed circuit boards, use a wrist strap which is earthed at the unit's frame.
- Whenever components need to be replaced use an antistatic mat on a table near the unit and connect the mat to the same point as the wrist strap.
- Hold a board only at the edge.
- Handle a faulty board as carefully as a new one.

9.3. Fault Identification in triple stack (POM)

DANGER **High voltage!**

- DO NOT access the power sections of the PCS6000 before the converter is completely disconnected and grounded.

The service work described in the following chapter always has to be done after a firing through of the converter. A firing through is usually triggered by a power semiconductor (diode or IGCT) failure. The work includes:

- Test of all IGCTs / identification of faulty IGCTs
- Replacement of faulty IGCTs
- Test of all diodes / identification of faulty diodes
- Replacement of faulty diodes
- Test of replaced IGCTs / diodes

NOTE – For checking the IGCT and diodes the usage of the FADEC 3 is recommended. See section section 9, **Checking diodes, IGCTs and IPS**, page 115 and the “PCS6000 user manual”, 3BHS600000 E40.

9.4. Location of components

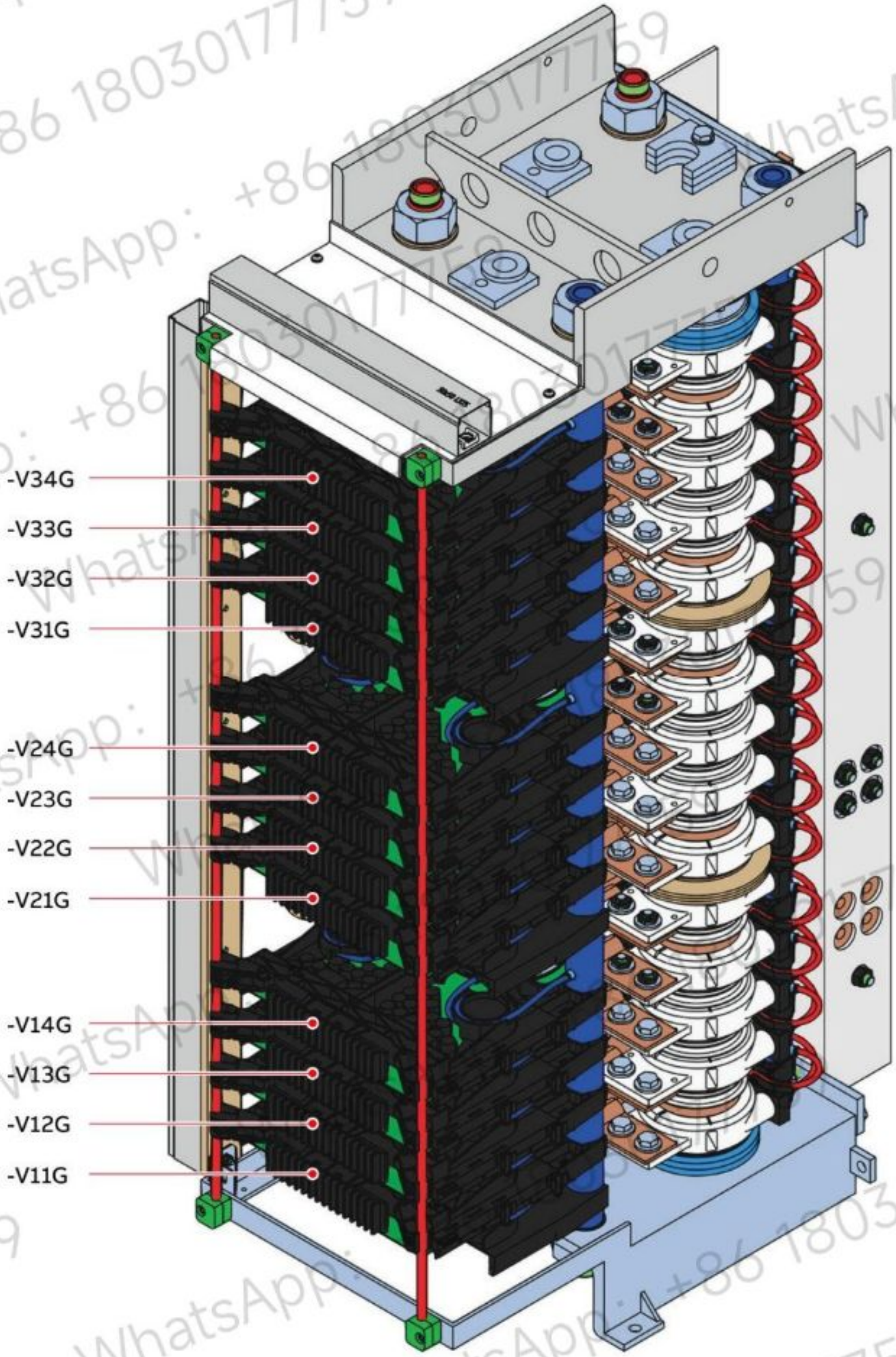


Figure 9–1 IGCT stack

9.4.1. Freewheeling diode stack

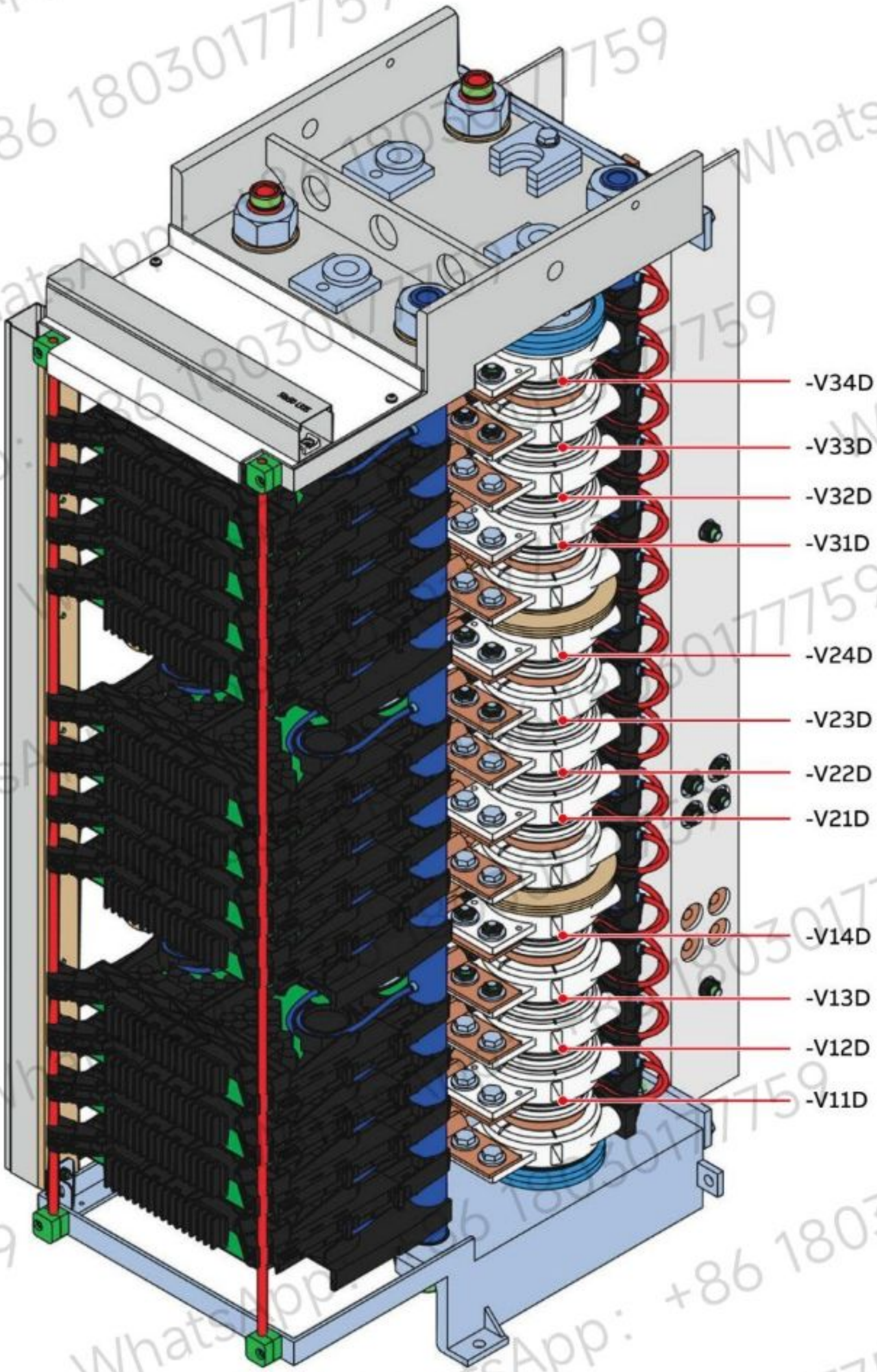


Figure 9–2 Freewheeling diode stack

9.4.2. Neutral point and clamp diode stack

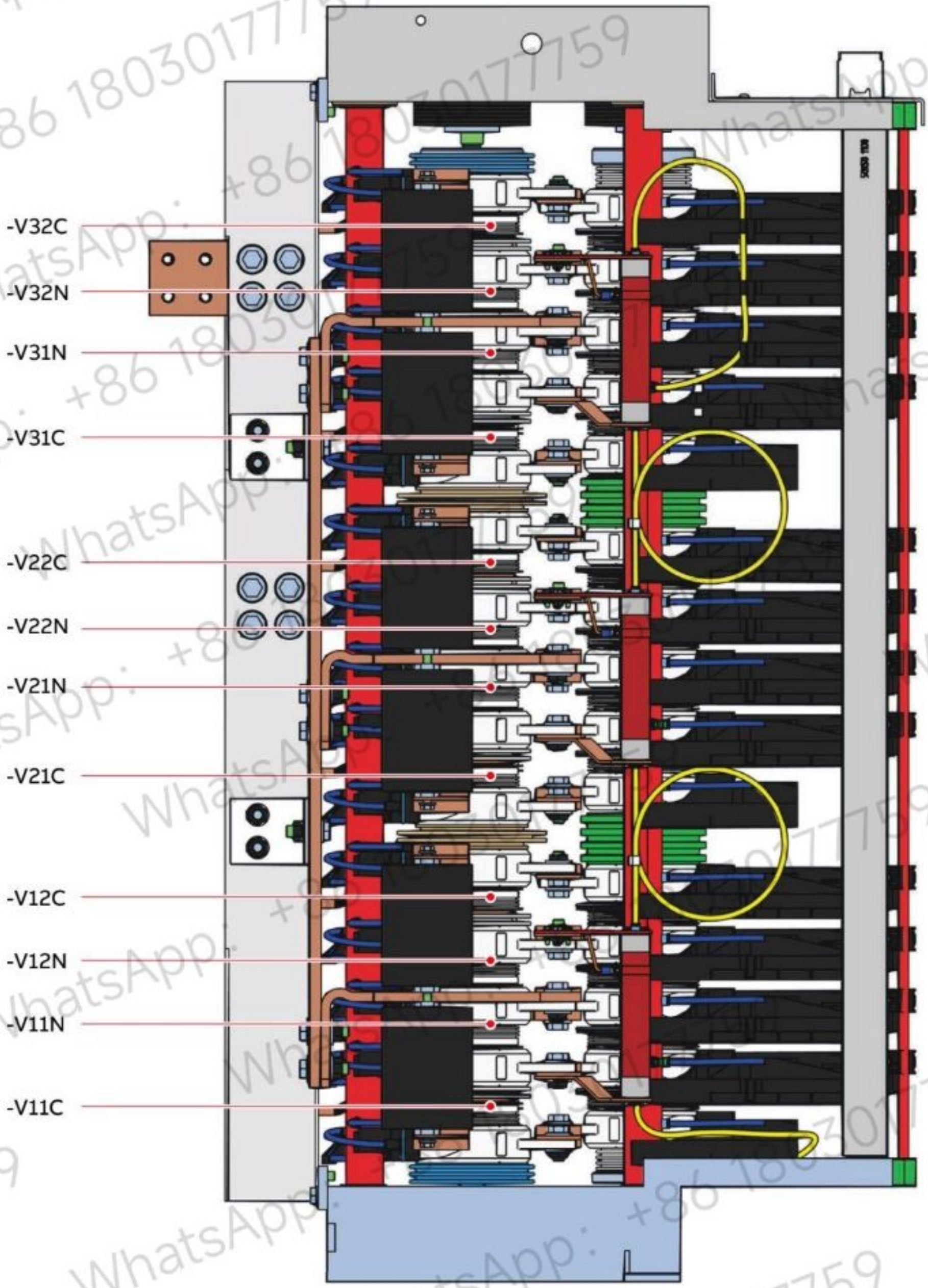


Figure 9–3 Neutral point and clamp diode stack

9.4.3. Clamp capacitors and symmetry resistors

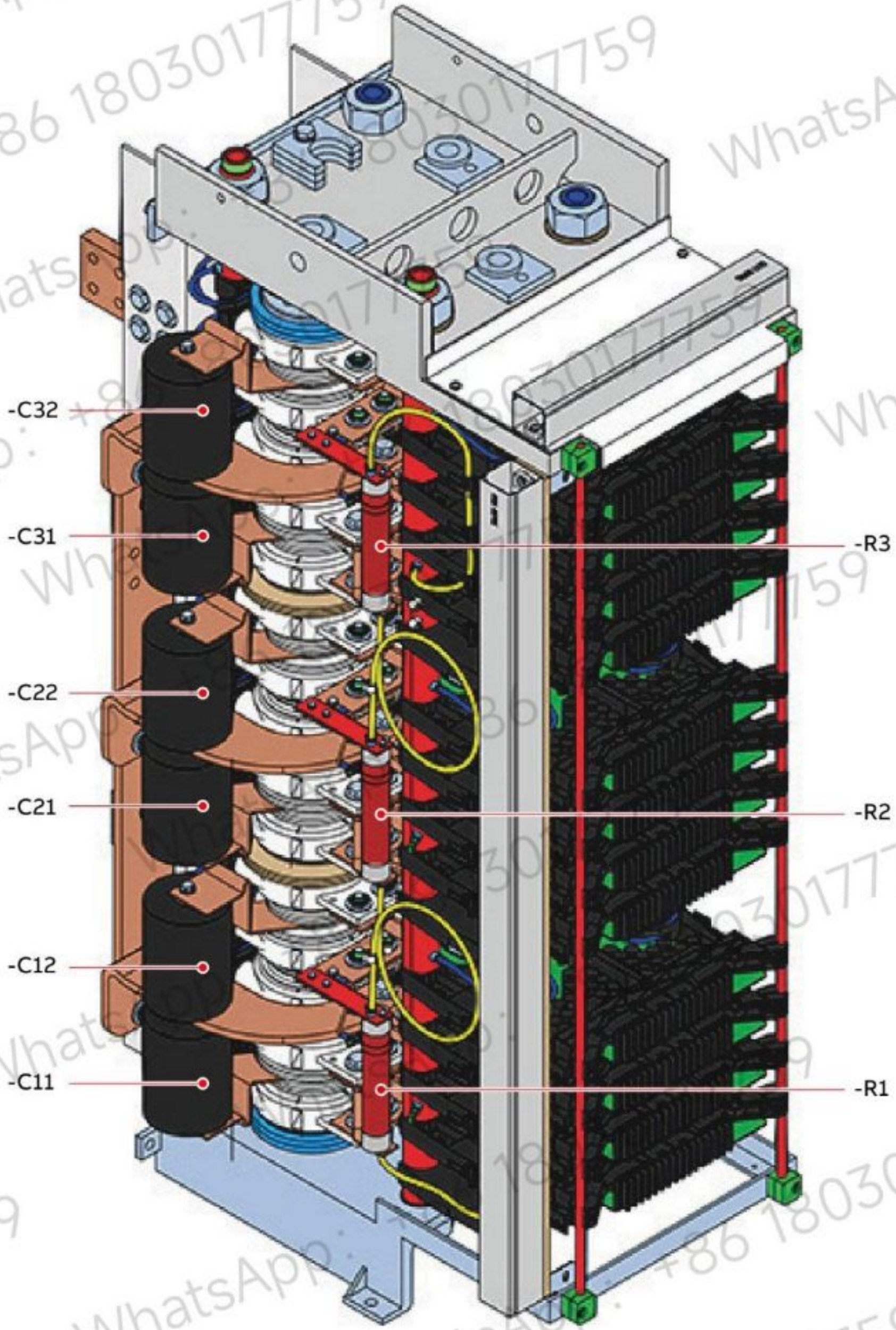


Figure 9–4 Clamp capacitors and symmetry resistors

9.5. Semiconductor checking sequence

Fig. 9–5 shows the semiconductor orientation and the following checking sequence:

1. Check LEDs of IGCTs.
2. Measure freewheeling diodes.
3. Measure neutral point and clamp diodes.
4. Measure IGCTs

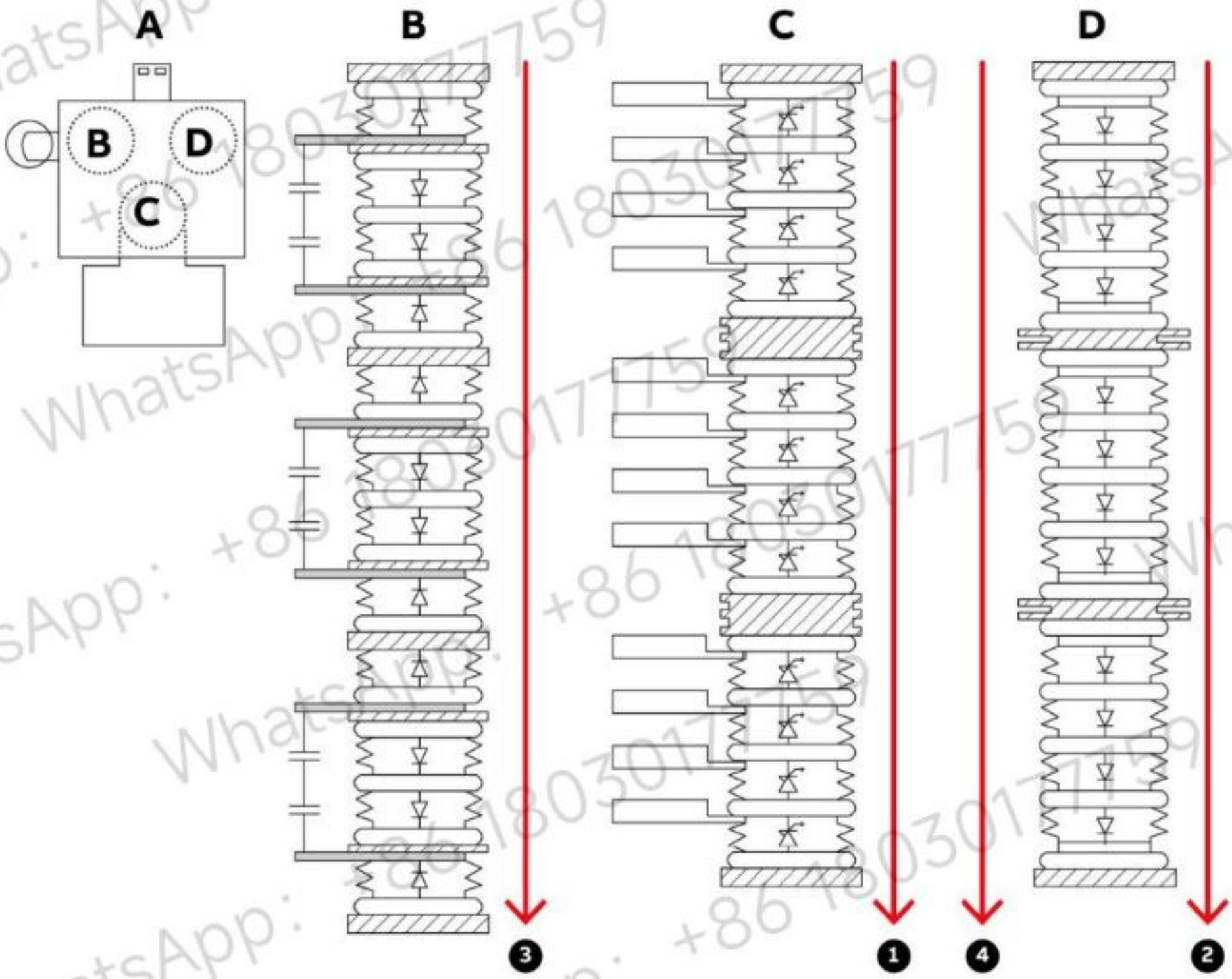


Figure 9–5 Semiconductor orientation

(A) Module top view with phase connections
(B) Neutral point and clamp diode stack
(C) IGCT stack
(D) Freewheeling diode stack

9.6. Checking IGCTs with FADEC 3

Faulty IGCTs can be found by the three LEDs mounted on the gate unit. The gate unit has to be switched on and must not receive a trigger signal. This means, before checking the LEDs, the fault must be reset.

IMPORTANT! Before resetting the alarm, "PCS6000 HMI" must be checked for any additional trips or alarms. Any trips or alarms need to be noted down before resetting

The yellow LED indicates the state of the internal voltage controller (20 VDC) and the green LED gives information about the state of the gate-cathode circuit of the IGCT. The red LED indicates a general malfunction.

1. Check the input and output voltages of the IPS in reference to electrical drawing 3BHE031194E16 (POM) and Table 9–3 using a multimeter.
2. Refer to Table 9–1 for analysis.

Table 9–1 State of gate unit (GU) and IGCT (x = irrelevant)

Red LED	Yellow LED	Green LED	State of GU and IGCT	Action to be taken
Off	Off	Off	No supply	Check IPS according to section 9.10, **Checking IPS**, page 132.
Off	On	x	Supply voltage OK	N/A
Off	x	On	Voltage controller OK	N/A.
x	Flashing	Flashing	Load (Gate-Cathode) short circuit or internal gate unit short circuit	Replace IGCT according to section 10.6.4, **Replacing IGCTs**, page 149
On	x	x	Malfunction	Replace IGCT according to section 10.6.4, **Replacing IGCTs**, page 149
Off	On	On	Internal supply OK; gate unit works correctly	Continue testing with step 3.

IMPORTANT! There is a remote possibility of the IGCT being faulty, despite the LEDs showing no error. Therefore, following tests with the FADEC 3 need to be carried out additionally. For more information, see the "FADEC 3 User manual", 3BHS537463 E72.

3. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
4. On the UPS -G402 turn the selector switch "Bat.-Select" to "Service", then back to "7.2 Ah" (Fig. 8–11 in section 8.8, **Replacing PECINTM**, page 97) to interrupt the 24 V battery supply voltage (the yellow LED "Bat.-Mode" must be dark).
5. Starting the measurement according "FADEC 3 User manual", 3BHS537463 E72.

6. Follow the test sequence according to section 9.5, **Semiconductor checking sequence**, page 121.

Figure 9–6 Correct measuring with FADEC 3

7. If red LED lights up a short circuit inside of the semiconductor is measured. The buzzer tweets twice. The IGCT needs to be replaced according to section 10.6.4, **Replacing IGCTs**, page 149.

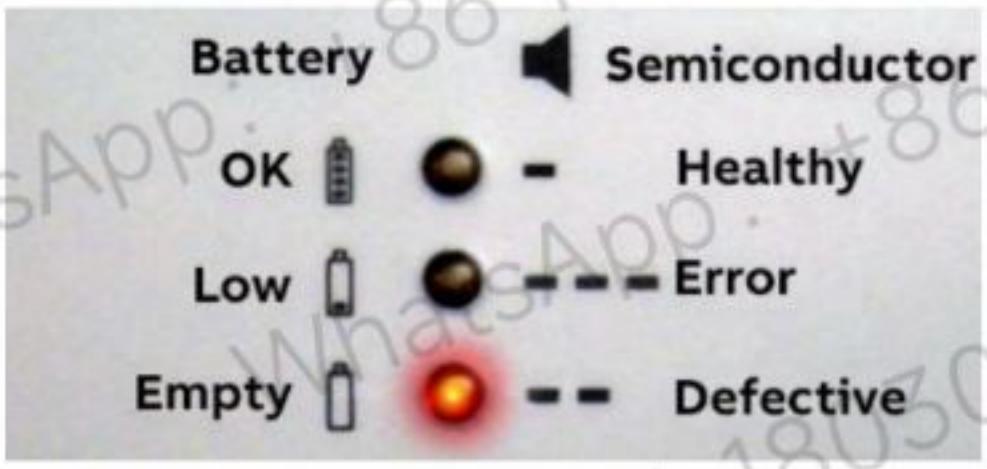


Figure 9–7 FADEC 3 Indication of defective semiconductor

9.7. Checking power diodes with FADEC 3

9.7.1. Preparation for checking power diodes

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. All semiconductor stacks are tightened.
3. All broken IGCTs have been replaced.
4. No components in the converter are removed.
5. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).

6. On the UPS -G402 turn the selector switch “Bat.-Select” to “Service”, then back to “7.2 Ah” (Fig. 8–11 in section 8.8, **Replacing PECINTM**, page 97) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).

9.7.2. Checking freewheeling diodes

1. Carry out the preparation procedure according to section 9.7.1, **Preparation for checking power diodes**, page 123.
2. Starting the measurement according to the “FADEC 3 User manual”, 3BHS537463 E72.
3. Follow the test sequence according section 9.5, **Semiconductor checking sequence**, page 121.

Figure 9–8 Correct measuring with FADEC 3

4. If red LED lights up a short circuit inside of the semiconductor is measured.

   The buzzer tweets twice. The diode needs to be replaced according to section 10.6.5.1, **Replacing freewheeling diodes**, page 153.

Figure 9–9 FADEC 3 Indication of defective semiconductor

IMPORTANT! Pay attention to the correct polarity of the diode and the probes. The plus probe must always be connected to the anode (1) of the diode and not the cathode (2).

9.7.3. Checking clamp diodes

1. Carry out the preparation procedure according to section 9.7.1, **Preparation for checking power diodes**, page 123.
2. Follow the test sequence according section 9.5, **Semiconductor checking sequence**, page 121.

Figure 9–10 Correct measuring with FADEC 3

3. If red LED lights up a short circuit inside of the semiconductor is measured. The buzzer tweets twice.

   The diode needs to be replaced according to section 10.6.5.2, **Replacing clamp diodes**, page 155.

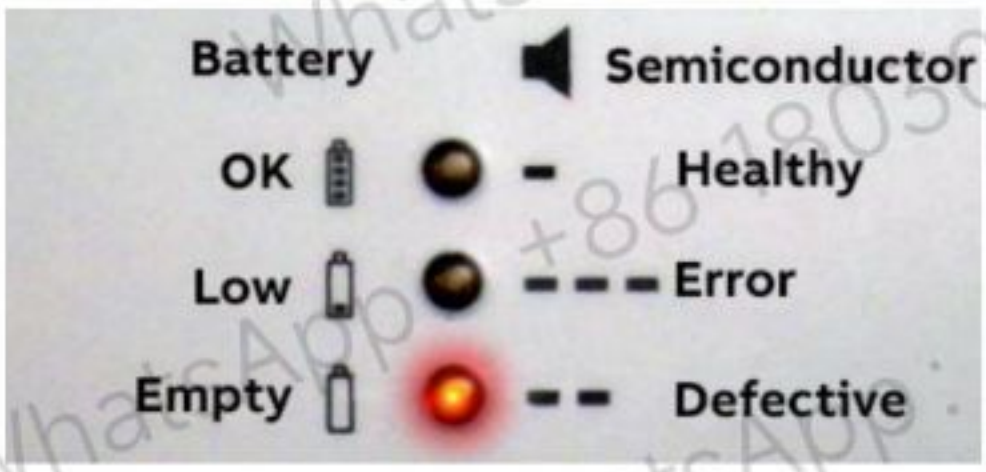
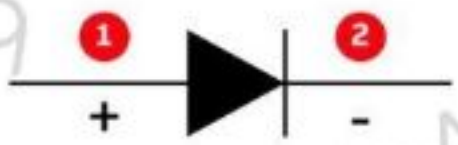


Figure 9–11 FADEC 3 Indication of defective semiconductor

IMPORTANT! Pay attention to the correct polarity of the diode and the probes. The plus probe must always be connected to the anode (1) of the diode and not the cathode (2).



9.7.4. Checking neutral point (NP) diodes

1. Carry out the preparation procedure according to section 9.7.1, **Preparation for checking power diodes**, page 123.
2. Follow the test sequence according to section 9.5, **Semiconductor checking sequence**, page 121.

Figure 9–12 Correct measuring with FADEC 3

3. If red LED lights up a short circuit inside of the semiconductor is measured. The buzzer tweets twice.

   The diode needs to be replaced according to section 10.6.5.3, **Replacing neutral point (NP) diodes**, page 157.

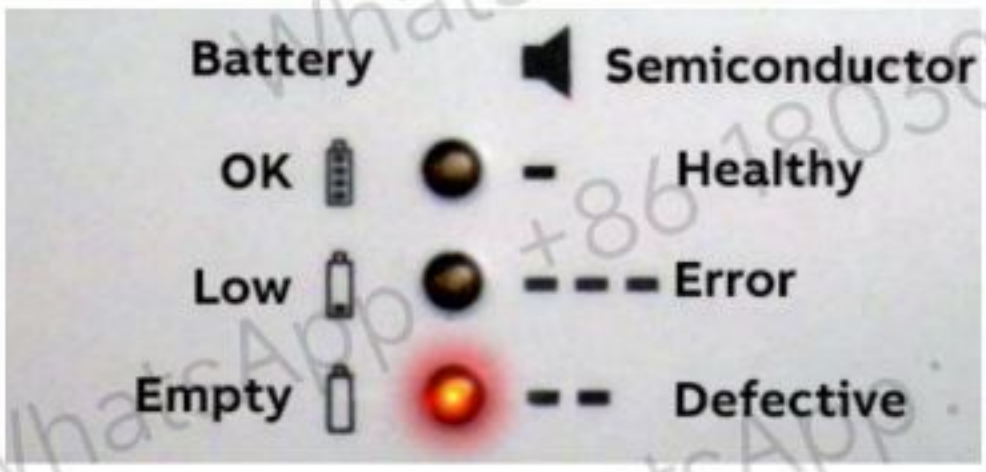
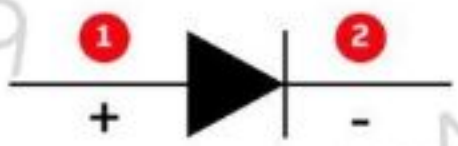


Figure 9–13 FADEC 3 Indication of defective semiconductor

IMPORTANT! Pay attention to the correct polarity of the diode and the probes. The plus probe must always be connected to the anode (1) of the diode and not the cathode (2).



9.8. Checking IGCTs with multimeter (if a FADEC 3 is unavailable)

Faulty IGCTs can be found by the three LEDs mounted on the gate unit. The gate unit has to be switched on and must not receive a trigger signal. This means, before checking the LEDs, the fault must be reset.

IMPORTANT! Before resetting the alarm, "PCS6000 HMI" has to be checked for any additional trips or alarms. Any trips or alarms need to be noted down before resetting.

The yellow LED indicates the state of the internal voltage controller (20 VDC) and the green LED gives information about the state of the gate-cathode circuit of the IGCT. The red LED indicates a general malfunction.

1. Check the input and output voltages of the IPS in reference to electrical drawing 3BHE031194E16 (POM) and Table 9–3 using a multimeter.
2. Refer to Table 9–1 for analysis.

Table 9–2 State of gate unit (GU) and IGCT

Red LED	Yellow LED	Green LED	State of GU and IGCT	Action to be taken
Off	Off	Off	No supply	Check IPS according to section 9.10, **Checking IPS**, page 132.
Off	On	-	Supply voltage OK	N/A
Off	-	On	Voltage controller OK	N/A.
-	Flashing	Flashing	Load (gate-cathode) short circuit or internal gate unit short circuit	Replace IGCT according to section 10.6.4, **Replacing IGCTs**, page 149
On	-	-	Malfunction	Replace IGCT according to section 10.6.4, **Replacing IGCTs**, page 149
Off	On	On	Internal supply OK; gate unit works correctly	Continue testing with step 3.

IMPORTANT! If a FADEC 3 is not available, the following tests need to be carried out additionally with the multimeter.

3. Switch the multimeter to the DC-voltage measuring function.

4. Measure the voltage between gate and cathode of the IGCT.

   The voltage should be around 20 V (compare with the other IGCTs).

Figure 9–14 Correct measuring between gate and cathode

5. Contact the gate from the lower side, to avoid shortening between gate and cathode with the multimeter probe

Figure 9–15 Wrong measuring between gate and cathode

6. Activate the firing using a flash light.

   After activating the firing, the voltage should be 0 V.

   IMPORTANT! Modern flashlights (mostly LED flashlights) do not emit continuously, but pulsed light. So the IGCT will be switching with the pulsed light of the flashlight. For the verification of the proper functionality a continuous firing of the IGCT is needed.

7. If the voltage value is below 20 V (or different from the other IGCTs) the IGCT needs to be replaced according to section 10.6.4, **Replacing IGCTs**, page 149.

9.9. Checking power diodes with multimeter

A multimeter is used to locate faulty diodes.

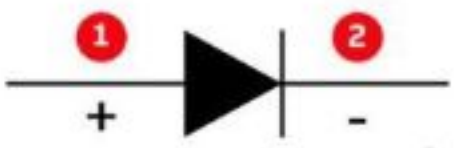
9.9.1. Preparation for checking power diodes

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. All semiconductor stacks are tightened.
3. All broken IGCTs have been replaced.
4. No components in the converter are removed.
5. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
6. On the UPS -G402 turn the selector switch “Bat.-Select” to “Service”, then back to “7.2 Ah” (Fig. 8–11 in section 8.8, **Replacing PECINTM**, page 97) to interrupt the 24 V battery supply voltage (the yellow LED “Bat.-Mode” must be dark).

9.9.2. Checking freewheeling diodes

1. Carry out the preparation procedure according to section 9.9.1, **Preparation for checking power diodes**, page 129.
2. Switch the multimeter to the diode test function.
3. Hold the two probes to the side of the coolers directly above and below the diode to be tested.

   IMPORTANT! Pay attention to the correct polarity of the diode and the probes. The plus probe must always be connected to the anode (1) of the diode and not the cathode (2).



4. The multimeter should indicate a value of ~0.22 V across each diode.

   Compare the values of all diodes in both stacks. Normally, only one diode is defective and the voltage should be lower than across all others.

   If the multimeter shows a different value, the diode needs to be replaced according to section 10.6.5.1, **Replacing freewheeling diodes**, page 153.

   IMPORTANT! Because the respective diodes of each phase are connected in parallel (Vx1N||Vx1D||Vx2D and Vx2N||Vx3D||Vx4D) a faulty clamp diode will cause the multimeter to show the other two diodes as faulty as well. If the newly installed diode is tested and shows a value below 0.22 V, check and replace the diodes connected in parallel first, before doubting the quality of the new diode. In the worst case, all three diodes have to be replaced to find the faulty one.

9.9.3. Checking clamp diodes

1. Carry out the preparation procedure according to section 9.9.1, **Preparation for checking power diodes**, page 129.
2. Remove the capacitor connections (see Fig. 9–16).

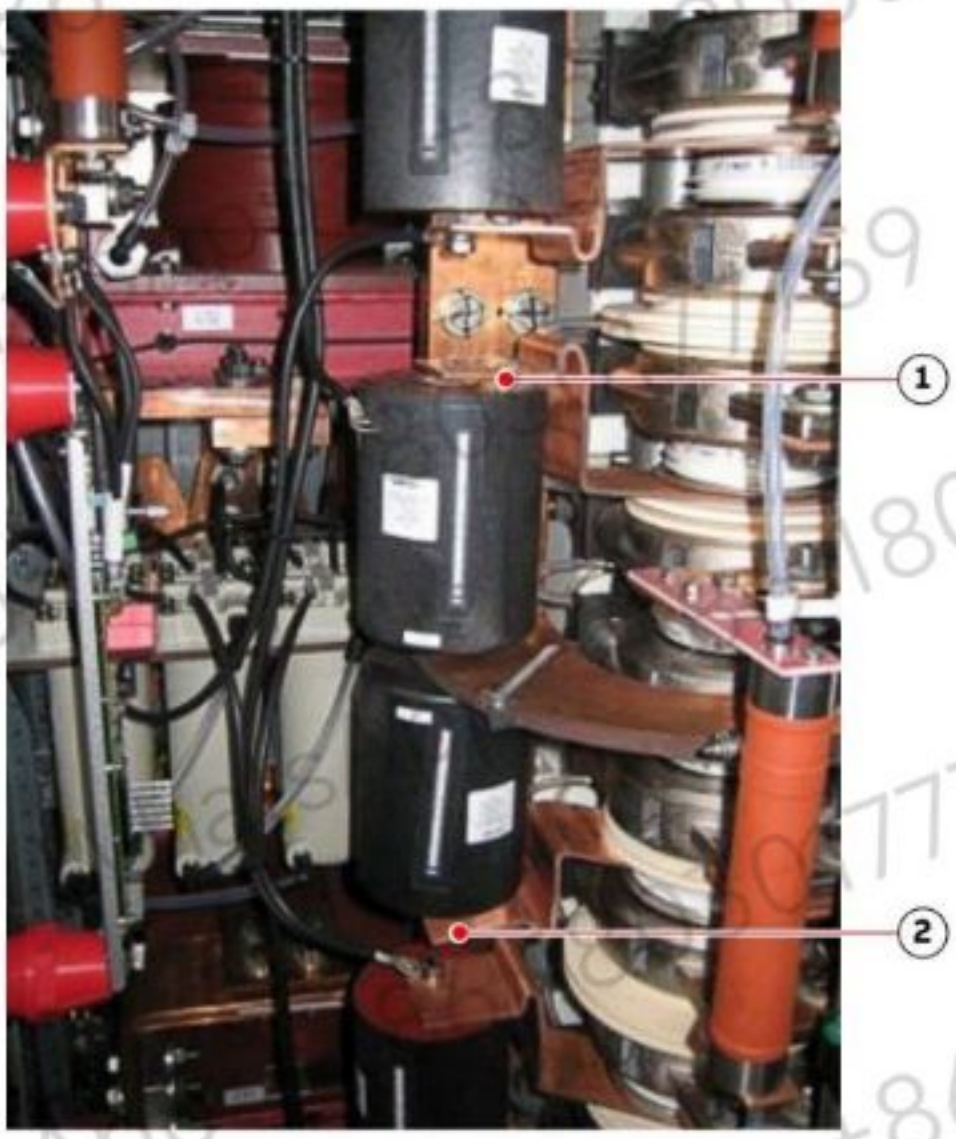


Figure 9–16 Clamp resistor connections

1) Upper connection	2) Lower connection

3. Switch the multimeter to the diode test function.
4. Hold one probe to the side of the cooler directly above (V12C, V22C, V32C) or below (V11C, V21C, V31C) (see Fig. 9–3) the diode to be tested.

   Hold the second probe to the copper bar clamped between the diode and the isolator.

   IMPORTANT! Pay attention to the correct polarity of the diode and the probes. The plus probe must always be connected to the anode (1) of the diode and not the cathode (2).

5. The multimeter should indicate a value of ~0.22 V across each diode. Compare the values of all diodes in both stacks.

   Normally, only one diode is defective and the voltage should be lower than across all others.

   If the multimeter shows a different value, the diode needs to be replaced according to section 10.6.5.2, **Replacing clamp diodes**, page 155.

6. Reconnect the capacitor wires (torque 5.5 Nm).

   IMPORTANT! Because the respective diodes of each phase are connected in parallel (V11C||V21C||V31C and V12C||V22C||V32C) a faulty clamp diode will cause the multimeter to show the other two diodes as faulty as well. If the newly installed diode is tested and shows a value below 0.22 V, check and replace the diodes connected in parallel first, before doubting the quality of the new diode. In the worst case, all three diodes have to be replaced to find the faulty one.

9.9.4. Checking neutral point (NP) diodes

1. Carry out the preparation procedure according to section 9.9.1, **Preparation for checking power diodes**, page 129.
2. Switch the multimeter to the diode test function.
3. Hold the two probes to the side of the coolers directly above and below the diode to be tested.

   IMPORTANT! Pay attention to the correct polarity of the diode and the probes. The plus probe must always be connected to the anode (1) of the diode and not the cathode (2).

4. The multimeter should indicate a value of ~0.22 V across each diode.

   Compare the values of all diodes in both stacks. Normally, only one diode is defective and the voltage should be lower than across all others.

5. If the shown value is still below 0.22 V the diode needs to be replaced according to section 10.6.5.3, **Replacing neutral point (NP) diodes**, page 157.

   IMPORTANT! Because the respective diodes of each phase are connected in parallel (Vx1N||Vx1D||Vx2D and Vx2N||Vx3D||Vx4D) a faulty clamp diode will cause the multimeter to show the other two diodes as faulty as well. If the newly installed diode is tested and shows a value below 0.22 V, check and replace the diodes connected in parallel first, before doubting the quality of the new diode. In the worst case, all three diodes have to be replaced to find the faulty one.

9.10. Checking IPS

Figure 9–17 IGCT power supply (IPS)

1. Check the input and output voltages of the IPS in reference to electrical drawing 3BHE031194E16 (POM) and Table 9–3 using a multimeter.

Table 9–3 Input and output voltages of IPS

Voltage	Minimum	Typical	Maximum	
Input voltage (X0) No. 1, 2: + / No. 3, 4: -	21.6	24	26.4	VDC
Output voltages (X1...X4)	30	37	40	VDC

2. The optical feed-back signal from the IPS to the PECINTM (OM11V1/3/5) provides information about the overall IPS state; refer to Table 9–4 for analysis.

Table 9–4 IPS analysis

Optical output	Uin (X0)	Output plugs (X1 ... X4	Action
Lit	= 24 VDC	Connected	None required
Dark	= 24 VDC	Connected	Disconnect output plugs
Dark	= 24 VDC	Disconnected	Replace IPS
Lit	= 24 VDC	Disconnected	Check gate units of IGCTs for short circuit
Dark	< 20 VDC	Connected	Disconnect output plugs
Dark	< 20 VDC	Disconnected	Check power supply

If the IPS is not OK, replace it according to section 8.9, **Replacing IPS**, page 99.

10. Replacing power and cooling components

10.1. Overview

The following sections provide instructions on how to repair defective parts and are intended for qualified personnel who are responsible for servicing a PCS6000 drive.

10.2. Safety information

Before you begin, read and understand the material in chapter 2, **Important safety information**, page 23 and always follow the safety rules that are described in section 2.3.2, **The 7 steps that save lives**, page 26.

⚠ DANGER High voltage!

Dangerous voltage inside the PCS6000 can lead to life-threatening situations, injury of the persons involved or damage to equipment.

- When planning and carrying out maintenance work, the operating condition of the whole system should be considered.

⚠ WARNING High temperatures, risk of burns!

Rails, reactors, resistors and fuses can be hot.

⚠ CAUTION Cooling fans can start automatically!

The water cooling system and the cooling fans may start automatically as soon as the auxiliary voltage is switched on or when the EMERGENCY OFF button is released, even if the PCS6000 is de-energized.

- Switch off the corresponding motor protection switches (see diagrams contained in the cabinet specific documentation, tab 2) to shut down the cooling system.

NOTICE **Risk of component damage!**

Electrostatic discharge (ESD) can damage electronic boards and components!

- DO NOT touch printed circuit boards or other sensitive components without applying static-sensitive handling precautions! (see Fig. 10–1)
- While working with components containing printed circuit boards, use a wrist strap which is earthed at the unit's frame.
- Whenever components need to be replaced use an anti-static mat on a table near the unit and connect the mat to the same point as the wrist strap.
- Hold a board only at the edge.
- Handle a faulty board as carefully as a new one
- ABB strongly recommended to install a cover (plastic, cardboard, etc.) below the components to be removed before starting replacement work. This cover will catch dropped parts as screws, washers, screw nuts, etc.

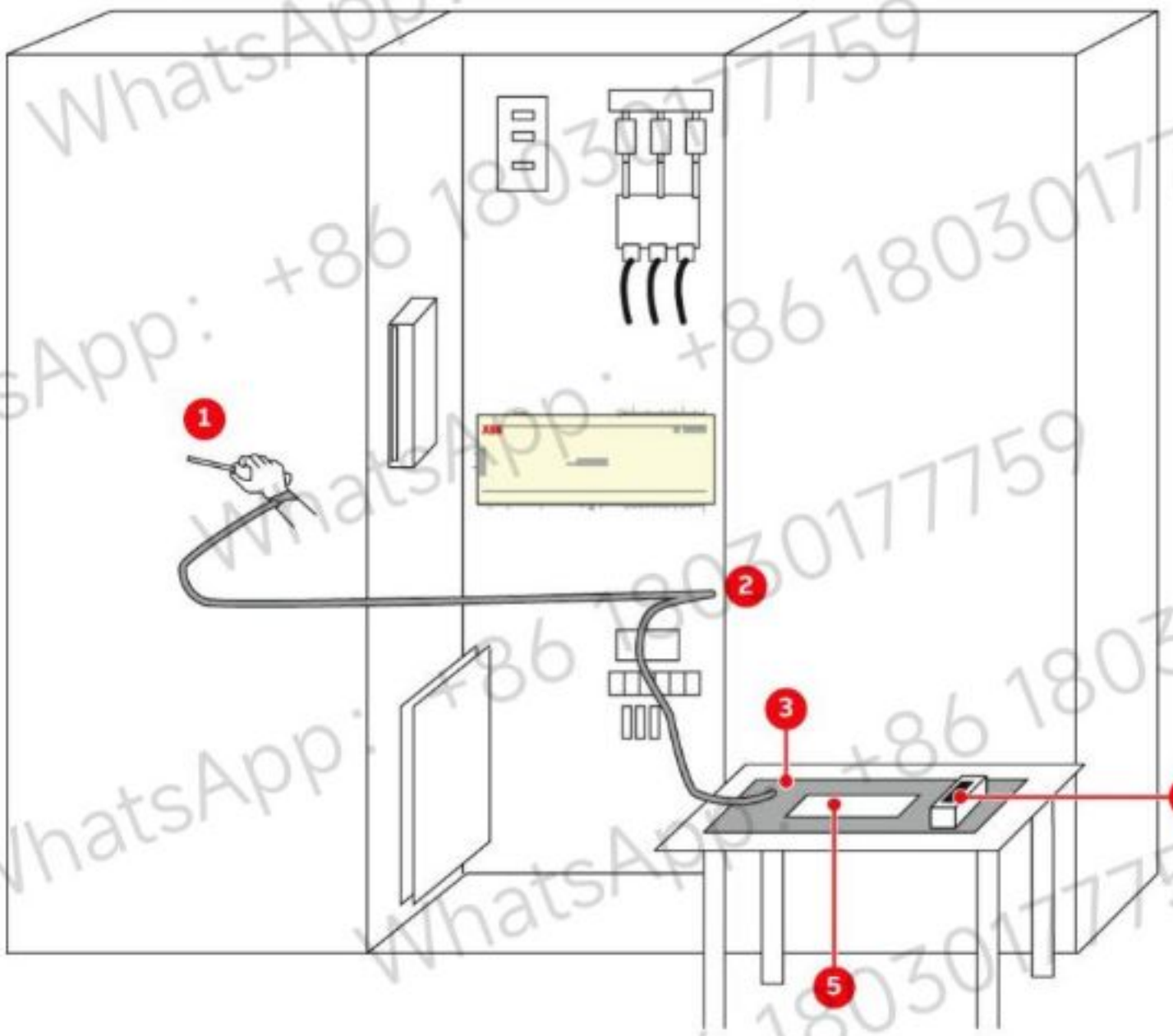


Figure 10–1 ESD precautions

1) Wrist strap
2) Earth
3) Working mat
4) Components in a box
5) Board

10.3. Overview of serialized power components

The following power components were serialized during production.

If one of these components were replaced in the field the serialization database shall be updated, ie, the new serial number has to be reported to ABB. For a complete list of serialized parts, see “Assemblies & components PCS6000 product family with serialization profile”, 3BHE600000 E70.

Table 10–1 Serialized power components

Component name	Product number	SAP number
IGCT (Low Power)	RC-IGCT 5SHX 1960L0006, 91mm GVC736	3BHB056120R0003
IGCT (Old type)	IGCT, 4500V, 91mm, 5SHY 3545L0016	3BHB020720R0002
IGCT (New generation)	IGCT, 4500V, 91mm, 5SHY 4045L0006 (One to one replacement of the 5SHY 3545L0016)	3BHB030310R0001
Reactor	Reactor 3725A, Air	3BHE035425R0001
DC-link Capacitor	DC-link Cap DCMKP 2.6kV	3BHB006617R0013
Thyristor controller	Thyristor controller 3AC 400 V 90A	3BHE031436R3090
Pre-charging transformer	3p-Tr. 30kVA 3x400V 3x4900V	3BHE019196P1330
HFM filter capacitor	HV-Cap. 3-Ph. 3.3kV, 48A	3BHB006617R0004

10.4. General directives

10.4.1. Correct tightening torques of bolted connections

IMPORTANT! The following basic rules must be observed:

1) Use a ring spanner or flat wrench to manually tighten bolted connections (up to size M10).
2) Always check M12 or higher bolted connections with a torque wrench.
3) Check the torque of a bolt nut screw connection on the nut side.
4) Avoid overlapping washers.

Unless otherwise stated in the individual procedures the tightening torques in Table 10–2 must be used for bolted connections: