SYSTEM DRIVES

PCS6000

Service manual

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1. About this manual

1.1. Equipment covered by this manual

This manual covers the standard PCS6000 equipment and provides generic information. The manual does not claim to cover all variations and details of the equipment, nor to consider all eventualities that may arise during installation, commissioning, operation and maintenance of the equipment.

If the equipment is adapted to specific customer needs or applications, and if handling, installation, and operation of the equipment are affected by these modifications, specific information is provided in the appropriate documentation (eg, layout drawings, wiring diagrams, technical data, and engineering notes) in the appendices.

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

1.2. Overview

This manual covers the standard PCS6000 equipment and provides information for service work. The manual contains information from product family 1 and 2. If necessary, the differences are pointed out. It is for trained personnel according to the ABB service and authorization concept. The manual does not claim to cover all variations and details of the equipment, nor to consider all eventualities that may arise during service of the equipment. The described units, modules or components need not always be present in the converter layout.

Each person involved in the service must have read and fully understood the corresponding chapters in this PCS6000 service manual.

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

1.3. Contents of this manual

– Chapter 2, **Important safety information**, page 23 explains the various safety instruction levels and provides general instructions on safety, which need to be strictly observed.

– Chapter 3, **Service tools**, page 31 introduces the special tools used for service work as described in this document.

– Chapter 4, **Preventive maintenance**, page 47 contains an overview about periodically required preventive maintenance tasks to ensure reliable operation.

– Chapter 5, **De-energizing, grounding and start-up**, page 69 provides instructions on how to shut-down the PCS6000 for service purposes and on how to start-up again after the work is done.

– Chapter 6, **Troubleshooting**, page 73 provides instructions on how to proceed when encountering a problem with the PCS6000.

– Chapter 7, **Checking control components**, page 81 provides 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.

– Chapter 8, **Replacing control components**, page 85 provides instructions on how to replace defective control components.

– Chapter 9, **Checking diodes, IGCTs and IPS**, page 115 provides instructions on how to check power semiconductors and IPS.

– Chapter 10, **Replacing power and cooling components**, page 133 provides instructions on how to repair defective parts.

ABB is constantly striving for the best product and service offerings for our customers. Therefore ABB appreciates your valuable feedback or suggestions for improvements of PCS6000 products.

1.4. Related documents

Table 1–1 Product-specific documentation

Title	Document number
Service training and authorization concept	3BHS393721 E01
PCS6000 user manual	3BHS600000 E40
PCS6000 Local control panel description(1)	3BHS606571 E49
FADEC 3 User manual	3BHS537463 E72
PCS6000 Fault handbook	3BHS846120 E90
PCS6000 Preventive maintenance schedule	3BHS600000 E88
PCS6000 Service software manual	3BHS600000 E81
PCS6000 Preconditions for commissioning	3BHS600000 E83
PCS6000 Preventive maintenance report	3BHS600000 E84(2)
PCS6000 Commissioning test instruction	3BHS600000 E85
PCS6000 Commissioning test report	3BHS600000 E86
PCS6000 Quality checklist for commissioning	3BHS600000 E87
PCS6000 Pilot commissioning report PF: review	3BHS600000 E89
PCS6000 Lockout/tagout procedure(2)	3BHS600000 E22
PCS6000 product family WCU30 - WCU82 water cooling unit operating and maintenance manual	3BHS317637 E40
PCS6000: WCU81A IEC water cooling unit, operations and maintenance manual	3BHE054718 E40
Assemblies & components PCS6000 product family with serialization profile	3BHE600000 E70
Permission for working and permit to work for test work at test stations	3BHS817511 E30

(1) Only shore to ship application

(2) This document is only a template. The report for your drive will have a different number.

Table 1–2 Standards

Standard	Title
ANSI Z535.6	American national standard for product safety information in product manuals, instructions, and other collateral materials
ISO 7010	2011 (E) - Graphical symbols - Safety colours and safety signs - Registered safety signs
ISO 3864-2	2004 (E) - Graphical symbols – Safety colours and safety signs – Part 2: Design principles for product safety labels
EN 50110	European standard code for electrical work safety

1.5. Target groups and required qualification

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

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

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

1.5.1. Handling

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

1.5.2. Mechanical installation

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

1.5.3. Electrical installation

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

1.5.4. Operation

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

1.5.5. Maintenance

The personnel include all persons who:

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

1.6. User's responsibilities

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

1.7. Intended use of the equipment

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

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

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

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

1.8. Document conventions

The document uses the following font formats and symbols. See also section 2.1, **Safety messages and safety signs in this document**, page 23.

Font formats

Convention	Description
1.	Sequential procedural steps in a task
•	Non-sequential procedural steps in a task
▶	Instructions on how to avoid a safety hazard
1)	Figure callout under an image or a numbered list
–	Items in a list
(1)	Refers to a figure callout in text that is near an image with figure callouts, eg, “Remove cover (1) and…” This convention is also used for numbering equations
Italic text	Identifies software parameters, eg, *16.02 PARAMETER LOCK*.
Bold text	Depending on the context, indicates a safety hazard, the text that you type, a software or physical **button**, or a **link** to another part of the document
Underlined text	Identifies a hyperlink
`Courier font`	Identifies software file names and file paths
Option	Identifies optional procedural steps and devices.
Cursor	Represents blinking text on a screen

Symbols

Symbol	Description
	These pictograms refer to the subject matter of the text.
	See section 2.1.2, **Safety signs**, page 23.

2. Important safety information

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

2.1. Safety messages and safety signs in this document

This document uses ANSI Z535.6 signal words, ISO 7010 safety signs, and ISO 3864-2 colors to highlight safety-related information.

2.1.1. Safety messages

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

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

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

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

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

NOTICE Is used to address practices not related to physical injury, but which can result in equipment damage.

2.1.2. Safety signs

Sign	Description	Sign	Description
	Refer to the instruction manual.		Automatic start-up warning
	Hazardous voltage warning		Corrosive substance warning
	Hot surface warning		Electrostatic discharge susceptibility

2.2. Product safety labels

Product safety labels on the equipment alert you to the hazards that can occur when you work on or operate the equipment.

– Always follow the instructions on the labels to avoid the hazard

– Keep the labels in a perfectly legible condition

For the location of the labels, see the label placement document for the drive.

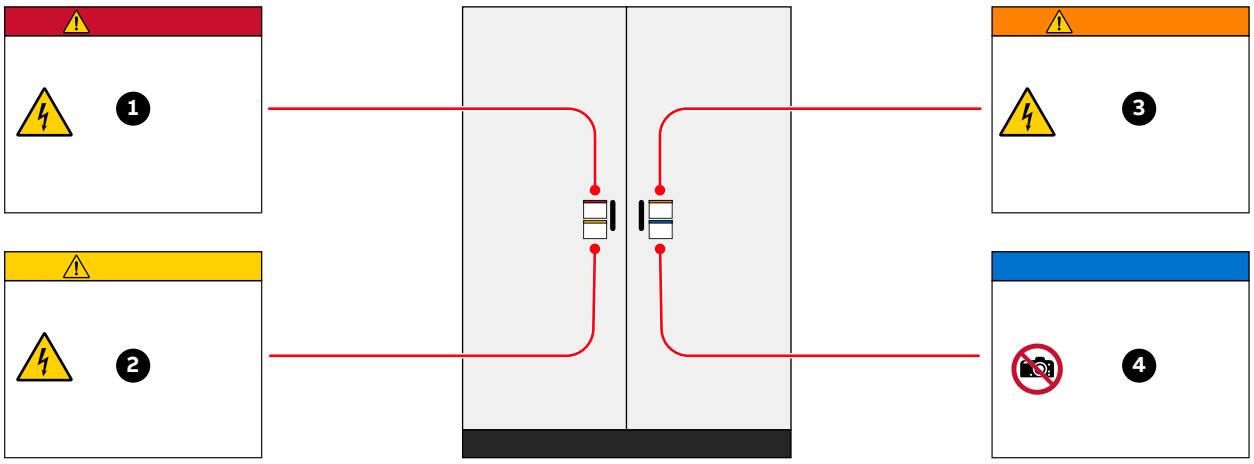


Figure 2–1 Product warning label examples (label placement depends on the drive)

1) Danger label	3) Caution label
2) Warning label	4) Notice label

2.3. Electrical safety

The following electrical safety instructions are based on EN 50110.

2.3.1. General safety instructions

1) Minimize hazards.

2) Before energizing the drive:

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

3) Before working on the drive:

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

4) Before working simultaneously on the drive and on other drive system equipment:

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

5) In case of fire in the drive room:

- Observe the established rules and regulations for fire safety
- Only allow firefighters with the appropriate PPE to enter the drive room

2.3.2. The 7 steps that save lives

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

1) **Prepare for the work: do an on-site risk assessment or job hazard analysis that considers the limits of approach for shock and arc-flash.**
   - Be in possession of a clear work order to execute the work.
   - When required, the access or work permit is to be obtained by a person who is authorized for the specific electrical system.
   - Engage the person responsible for electrical equipment or system to review single-line diagrams, schematics, switching plans, etc.
   - Ensure the competence of workers.
   - Check for proper tools for the job.
   - Determine and select the proper arc-rated Personal Protective Equipment (PPE).
   - Decide of the appropriate work methods and initiate the Permit To Work (PTW) process.
2) **Clearly identify the work location and equipment.**
   - Use your senses (sight, hearing and smell) to identify problem areas.
   - Define the work area via barriers and barricading and label equipment.
   - Avoid distractions such as talking or texting on the phone.
3) **Disconnect all sources of supply and secure against reconnection by applying Lockout/Tagout.**
   - If ABB is responsible for switching and it cannot be done remotely, then the person performing the switching must be properly trained and wearing the proper PPE identified in step 1.
   - The Person in Charge of Work (PICW) must ensure that switching is performed in the proper manner by witnessing it from a safe distance if present on site or by engaging the person responsible for switching to identify all isolation points.
   - Apply Lockout/Tagout (LOTO) to the energy isolation device and if multiple energy isolation devices are involved, then Group LOTO must be implemented with the PICW serving as the Group LOTO Leader.
4) **Verify the absence of operating voltage: always test before you touch!**

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

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

5) Carry out earthing and short-circuiting.

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

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

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

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

7) Complete the permit to work and "Walk the Permit".

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

2.4. Possible residual risks

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

1) **Electric power equipment generates electro-magnetic fields which can cause a hazard to people with metal implants and / or a pacemaker.**
2) **Drive system components can move unintentionally when being commissioned, operated, or serviced due to:**
   - Operation of the equipment outside the scope of the specifications
   - Incorrectly assembled or installed equipment
   - Incorrectly connected cables
   - External influence on, or damage of the equipment
   - Incorrect parameter settings
   - Software errors
   - Faulty hardware
3) **Hazardous touch voltages can be present on drive system components, which can be caused by:**
   - Operation of the equipment outside the scope of the specifications
   - External influence on, or damage of the equipment
   - Induced voltages by external equipment
   - Condensation on equipment components, or pollution
   - Faulty hardware
4) **High temperatures, noise, particles, or gases can be emitted from drive system components caused by:**
   - Operation of the equipment outside the scope of the specifications
   - External influence on or damage of the equipment
   - Incorrect parameter settings
   - Software errors
   - Faulty hardware
5) **Hazardous substances can be emitted from drive system components caused by:**
   - Incorrect disposal of components
6) **Control cabinet door: danger of slight injuries, eg, foot crushing as the door of the control cabinet is not fixed to the cabinet when the locks are open.**
   - Support the door with your hand when opening the locks.
   - Weight per door: approximately < 20 kg.
7) **Generator disconnector: risk of excessive arcing due to undetected arc.**

- Risk of injuries from particles, contamination, electric shock, hearing damage, burns, explosion due to hardware failure, operation beyond specified limits, unauthorized access
- No access to converter room or platform is allowed when the turbine is idling with open generator disconnectors or a 2CL converter is running in constricted operation
- Turbine idling speed shall be limited to a maximum of 30% of rated speed
- 2CL converter must not be operated in constricted mode, except in case of converter defect that requires disconnecting the defective drive train
- Operation time in constricted mode and idling with open disconnector must be reduced as far as possible

3. Service tools

The following sections describe the special tools that are required for carrying out service on a PCS6000 drive.

3.1. Overview

The following tables indicate all converter service tools required for service work on the PCS6000 with their ABB order number (SAP number).

3.1.1. Converter service tools

Table 3–1 Converter service tool list

Designation	Order number
Converter service toolbox	3BHB008753R0002
Grounding kit	3BHE039277R0001
Tube cutter	3BHE001055R0041
Polishing kit for fiber optics	HFBR4593

Further service tools and instruments, eg, multimeter, oscilloscope etc. are required, but cannot be ordered from ABB.

3.1.2. Commissioning tools

Table 3–2 Commissioning tool list

Designation	Order number
RCI box XU D194	3BHE018137R0001
PCS6000 HMI	3BHE003298R0111
Filling kit for PCS6000 water cooling	3BHE023603R0001
Filling kit extension tube	3BHE012850P0016

3.1.3. Replacement tools

Table 3–3 Replacement tool list

Designation	Order number
Reactor replacement kit FIU	3BHE039651R0001
Base beam lifting jack	3BHE039648R0001
Chain-block (minimum 50 kg)	3BHB032083R0001
Pump maintenance table kit WCU	3BHE039649R0001
Generator breaker / grid breaker replacement kit	3BHE040630R0001

3.2. Converter service tools

It is recommended to have the converter service tools (according to Table 3–2) available on each converter site.

3.2.1. Converter service toolbox

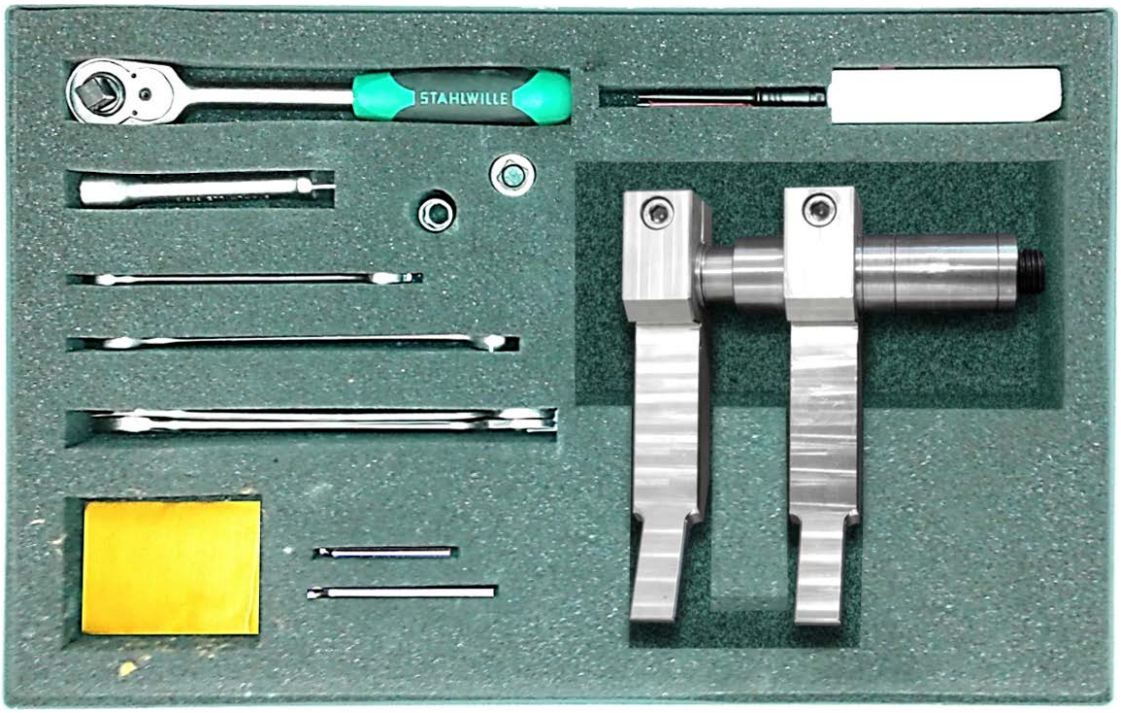


Figure 3–1 Converter service toolbox

- Weight: 4 kg
- Length: 600 mm
- Width: 400 mm
- Height: 111 mm

The converter service toolbox contains the tools listed in Table . These tools are required for replacing components in the POU (IGCTs, diodes, capacitors and resistors).

Table 3–4 Converter service toolbox content (3BHB008753R0002)

Designation	Order number
hex-key, 5 mm	NB 307950P0513
hex-key, 3 mm	NB 307950P0511
6HEX PIN INSERT 1/2” 12 mm	WMN 400007P0212
Double fork key C 21x23	WM 420039P0023
Extension 1/2”-130	GMN 744036P0028
RATCHET 1/2Z	GMN 744036P0043
Spreader tool	3BHE041414R0001

Table 3–4 Converter service toolbox content (3BHB008753R0002) (continued)

Designation	Order number
Spreader jaw 1	3BHE041418R0001
Spreader jaw 2	3BHE041429R0001
Main pipe	3BHE041430R0001
Secondary pipe	3BHE041431R0001
Hex socked set screw M24x50	3BHL001192P0001
SCR-CYL-ISO4762-AM10X40-A2-70	NB 315840P0259
SSW-ISO4026-M8X25-A2-21H	GMN 323232P6211
Double fork key C 12X13	WM 420039P0005
DG-key C18x20	3BHE009970R0001
6HEX PIN INSERT 1/2” 8 mm	WMN 400007P1208
View briefcase A4	Q 101130P0021
Assembling jig	HEFA415052
FADEC 3 - Semiconductor inspection tool	3BHE043725R0001
Hexagon key 8 (32x112) with ball head	3BHE055664R0002
Hexagon key 4 (22x80) with ball head	3BHE055664R0001
Screwdriver P-B 135 5	3BHE055712R0001

The spreading tool (see Fig. 3–2) is used to release the stacks containing semiconductors to allow replacement of semiconductors. See also section 10.6.3, **Using the spreading tool**, page 145.

Figure 3–2 Spreading tool (part of converter service toolbox)

The stabilizer plate (see Fig. 3–3) is used to stabilize the stacks containing semiconductors during replacement. See section 10.7.2, **Releasing the stacks**, page 179.

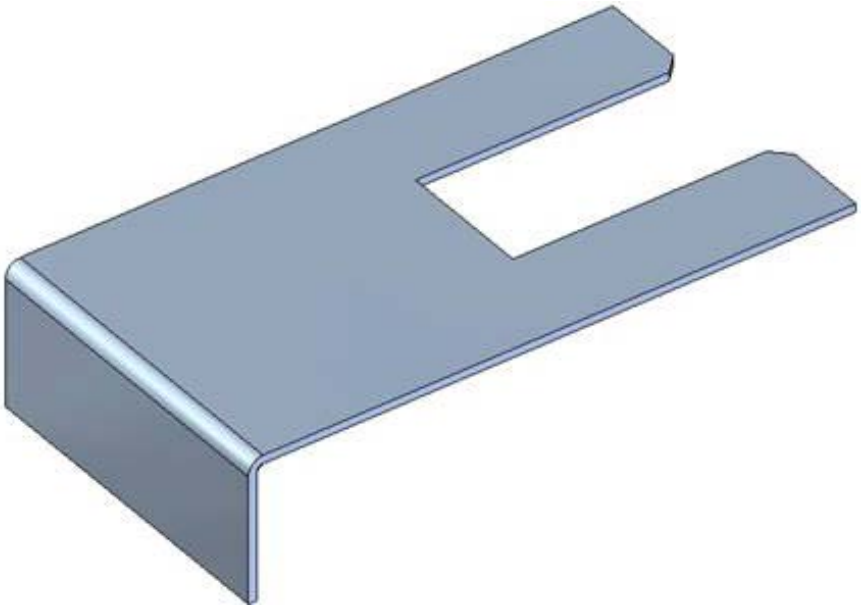


Figure 3–3 Stabilizer plate (part of converter service toolbox)

The FADEC 3 is a test device to find defective semiconductor in the stack. See chapter 9, **Checking diodes, IGCTs and IPS**, page 115 and the “PCS6000 user manual”, 3BHS600000 E40.

Figure 3–4 Semiconductor test device FADEC 3

3.2.2. Grounding kit

Figure 3–5 Grounding kit

- Weight: 15 kg
- Length: 1000 mm
- Width: 300 mm
- Height: 300 mm

The grounding kit comprises the grounding device with four ground connectors (made of 95 mm^2 stranded copper wire with three 1 m long ends for phase connection and a 2 m long end for PE connection), a connection pole and a bag.

The grounding kit is used to ground the converter before any service or maintenance work on the converter is done.

3.2.3. Tube cutter

Figure 3–6 Tube cutter

- Weight: approximately 200 g
- Length: approximately 100 mm
- Width: approximately 100 mm
- Height: approximately 20 mm

The tube cutter is used to adjust the length of the water cooling tubes in the converter. The tool can cut tube diameters between 2 and 12 mm.

Instruction to connect tubes to Legris adapters

1. Cut the tube plane with the cutter. If the tube was already assembled, cut off the groove that was caused by the lock washer.
2. Insert the tube into the Legris adapter as far as it will go.
3. Make sure that there is no mechanical stress on the tube, especially not from sideways.

3.2.4. Polishing kit for fiber optics

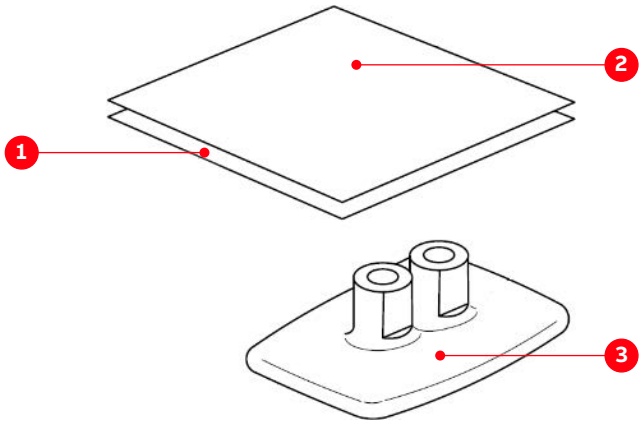


Figure 3–7 Polishing kit for fiber optics (used with all connection types)

1) 3 µm lapping film	3) Polishing fixture
2) 600 grit abrasive paper	

The polishing kit for fiber optics is used to prepare and polish plastic fiber optical cables from Avago. These fiber optic cables are used in the converter for the control system.

3.3. Commissioning tools

The commissioning tools (according to Table 3–2) are intended for com-missioning of the PCS6000, but they are also used for service tasks.

3.3.1. RCI-Box XU D194

Figure 3–8 RCI-Box XU D194 with power cables and fiber optic cables

- Weight: approximately 2 kg
- Length: 275 mm
- Width: 136 mm
- Height: 101 mm
- Input: 24V DC

The RCI-Box (Remote Control Interface) XU D194 is used to transfer digital measurement signals from the main controller to an oscilloscope. This allows to monitor internal measurement signals in real-time without having to install any probes in the converter.

The digital internal signals are converted to analog signals and sent to the oscilloscope by the RCI-Box. The signals to be monitored can be freely selected in the PCS6000 HMI. A maximum of 8 channels can be monitored simultaneously with one RCI.Box.

3.3.2. PCS6000 HMI

The PCS6000 HMI is used for monitoring/controlling of the converter during commissioning and service. It will be installed locally on the IPC (Industrial PC) in the converter. Access is obtained remotely using the remote desktop protocol.

- Functionality of the PCS6000 HMI:
- Single line diagrams of converter status
- Main operational status values
- Alarm / fault viewer
- View / operate inputs and outputs signals
- Overview and control of converter state
- Usage of RCI-Box
- Online measurement data monitoring (option)

User interface (main screen) of the PCS6000 HMI:

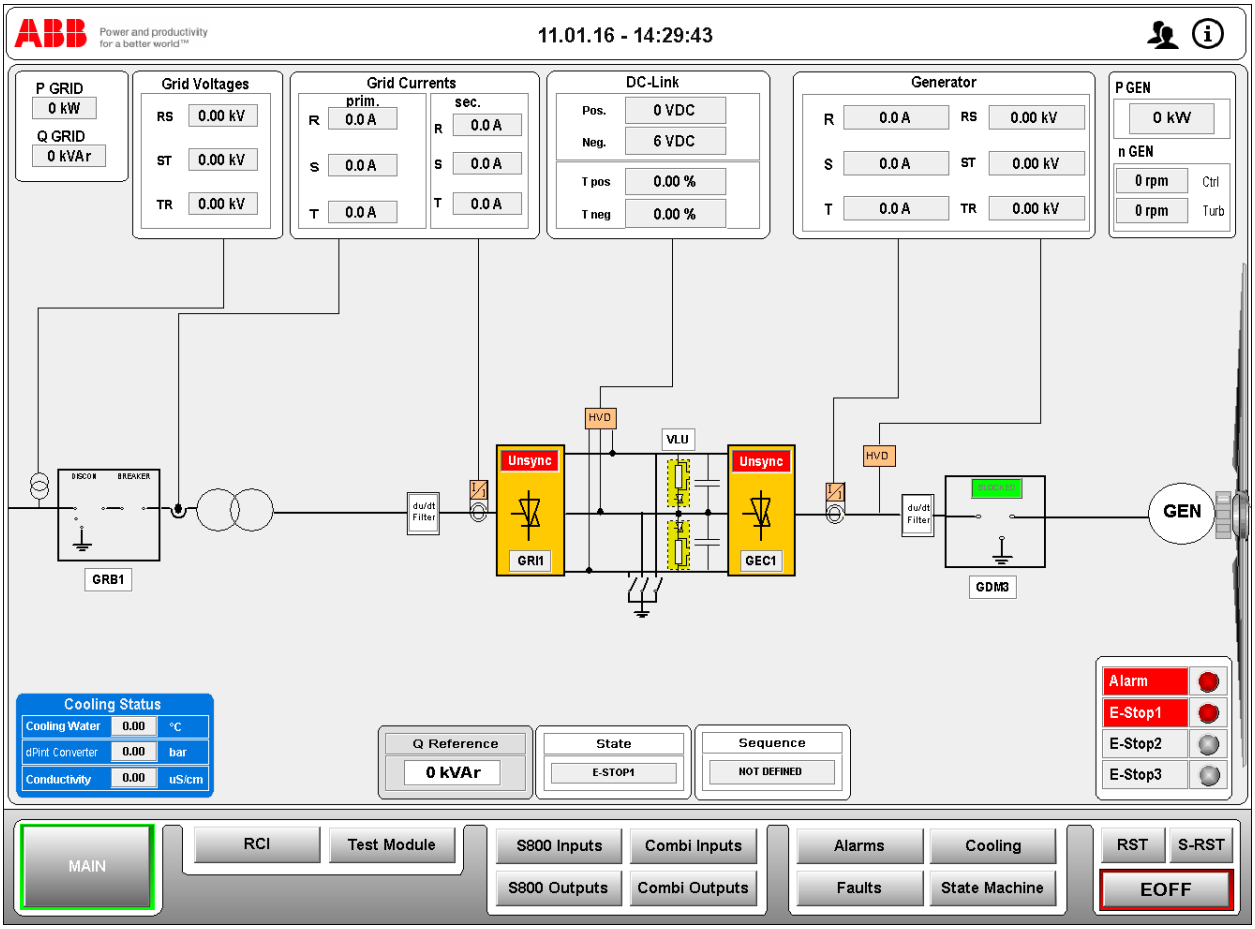


Figure 3–9 User interface of the PCS6000 HMI

3.3.3. Filling kit for PCS6000 water cooling

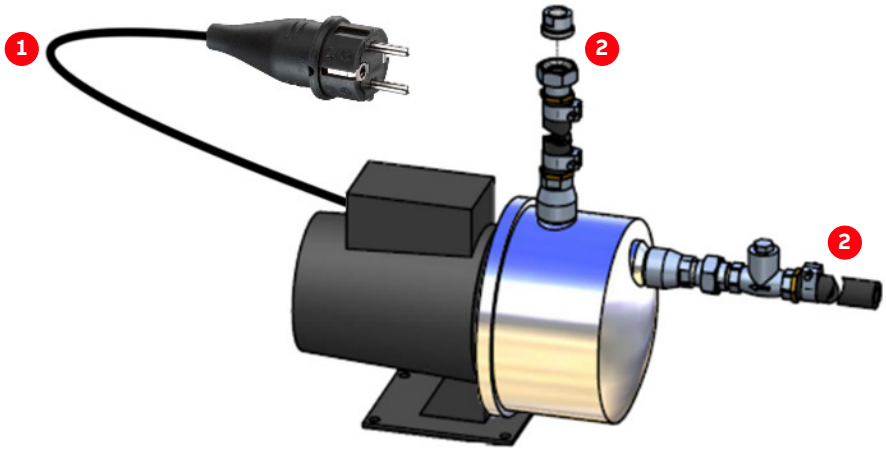


Figure 3–10 Filling kit for PCS6000 water cooling

1) 1.5 m with connector type “F”	2) 1/2” or 1”

- Weight: approximately 10 kg
- Length: 400 mm
- Width: 300 mm
- Height: 300 mm
- Power: 850 W
- Input: 1x 220 - 240 V AC 50Hz

The filling kit for PCS6000 water cooling is used to fill the water cooling system with cooling liquid. It consists of a pump with one hose to connect to the converter (with connection) and one to the water source.

The standard length of the tube between pump and converter is 2 meters.

The use of the filling kit for PCS6000 water cooling is described in the Operation and maintenance manual of the PCS6000 water cooling system (provided in Appendix A06, Data sheets components of the user manual).

3.3.4. Filling kit extension tube

Figure 3–11 Filling kit extension tube

– Weight: 0.25 kg/m

– Outer diameter: 22 mm

If the tube of the filling kit for PCS6000 water cooling is not sufficient, ie, if the distance between the converter and the water source is bigger than 2 meters, an extension tube is available.

The length of the extension tube can be selected (maximum 25 meters).

3.4. Replacement tools

The replacement tools (according to Table 3-3) are required very seldom and therefore it is suggested to bring them on site only when required.

3.4.1. Reactor replacement kit

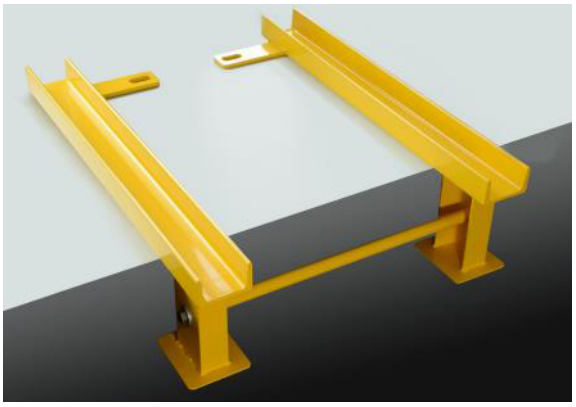


Figure 3–12 Reactor replacement kit

– Weight: approximately 6 kg

– Length: 700 mm

– Width: 570 mm

– Height: 206.5 mm

The reactor replacement kit can be installed at the lower beam of the cabinet to pull out the filter reactor on its slides. Two M10 ring bolts (not shown in Fig. 3–12) are also part of the reactor replacement kit.

The use of the reactor replacement kit is shown in Fig. 10–99.

3.4.2. Base beam lifting jack

Figure 3–13 Base beam lifting jack (3BHE039648R0001)

– Weight: approximately 1 kg
– Length: 100 mm
– Width: 75 mm
– Height: 125 mm

The base beam lifting jack can be hooked into the top frame of the converter cabinet, eg, to hang up a chain-block. The structure of the converter can carry a maximum 250 kg load on the lifting jack in any top frame mounting position.

The use of the base beam lifting jack is shown in Fig. 10–80 “Use of chain-block to lift out pump” on page 231.

3.4.3. Chain-block

Figure 3–14 Chain-block

- Weight: 2.4 kg
- Length: 84 mm
- Width: 88 mm
- Height: 217 mm

The chain-block is used to remove heavy parts as transformers, reactors or pumps from the cabinet. It has to be used together with a base beam lifting jack (see section 3.4.2, **Base beam lifting jack**, page 42).

The use of the chain-block is shown for example in Fig. 10–80.

3.4.4. Pump maintenance table kit (Only for Swedewater WCU)

Figure 3–15 Pump maintenance table kit

– Weight: approximately 8 kg
– Length: 729.5 mm
– Width: 280 mm
– Height: 1047.5 mm

The Swedewater WCU pump maintenance table kit consists of a support table plate and two pairs of legs (long for the upper pump and short for the lower pump).

The use of the pump maintenance table is shown for example in Fig. 10–79 “Pump maintenance table with long legs (for upper pump)” on page 231.

Please note that the pump maintenance table kit can only be used with converters delivered after 1st January 2013. For converters delivered before that date this table can only be used partly (if the corresponding mounting holes are available).

3.4.5. Generator breaker replacement kit

Figure 3–16 Generator breaker replacement kit

- Weight: 33.7 kg
- Trolley length: 800 mm
- Trolley width: 600 mm
- Trolley height: 1000 mm (foldable)
- Rail length: 800 mm

The generator breaker replacement kit consists of a trolley and two trolley track beams. With the trolley the generator breaker can be pulled out of the cabinet. The trolley can also be used for transportation of material.

The use of the generator breaker replacement kit is shown for example in Fig. 10–125.

4. Preventive maintenance

4.1. General

The following sections provide an overview about periodically required preventive maintenance tasks to ensure reliable operation. The instructions are based on many years of experience and recommendations from sub-suppliers.

4.2. 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.
- Low voltage remains on the auxiliary energy distributor of the converter control system after the PCS6000 has been switched off.
- External auxiliary and control voltages (eg, of measuring circuits) can also remain even if the internal auxiliary power supply has been switched off.
- Before working on these circuits, verify that the corresponding external voltage sources have been switched off and secured according to the safety rules.

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.

4.3. General directives

NOTICE

- 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.
- The executed repair work must be documented.
- The specified maintenance intervals according to the “PCS6000 Preventive maintenance schedule”, 3BHS600000 E88 and ambient conditions must be complied with and documented.
- ABB recommends periodical training for the maintenance and repair personnel.

4.3.1. Preventive Maintenance Report

The maintenance has to be done according to the following chapters and reported in the “PCS6000 Preventive maintenance schedule”, 3BHS600000 E88 In the report all changed components, deviations, modifications or service activities must be documented.

The completed report is to be sent to the Service organization of both, the customer and ABB.

4.4. Preventive maintenance schedule

Carry out all maintenance tasks on time and at the stated intervals according to the applicable service instructions and the “PCS6000 Preventive maintenance schedule”, 3BHS600000 E88.

4.4.1. Preventive maintenance tasks

The following sections describe how the different maintenance tasks listed in the preventive maintenance schedule must be carried out.

4.4.2. Inspection

Periodical inspections are required to:

– Recognize aging of components and replacement of components not pre-defined in maintenance schedule

– Avoid failures due to wear and tear on components connections caused by the operating stress factors, eg, vibration

Inspections cover mainly checking of power connections and visual checking:

– Dust built-up inside the converter room and inside the converter

– Signs for overheated components, wires, cables or busbars
  - Electronic components with unusual brown or black spots
  - Copper busbars with a bluish discoloration have been overheated

– Corrosion on circuit boards, connectors or busbars

– Appropriate fastening of plugs, cables, wires and their connections

Procedure:

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Check the components listed in Table 4–1. While doing so, pay particular attention to deformations or discolorations, eg, due to thermal stress.
3. After completing all work, restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

Table 4–1 Visual inspection

Components	Check for
Converter surroundings	– Contamination – Dust accumulation – Cracks in the concrete/rock
Overall system (all components)	– Signs – Safety labels – Contamination – Dust accumulation, effects of static charges – Damage to the surface treatment – Traces of moisture
Electronic devices, electronic circuit boards	– Condition – Deformations – Discolorations – Scorch marks – Plugs inserted and secured
Reactors, resistors, capacitors, transformers	– Condition – Deformations – Discolorations – Scorch marks
Fans	– Mechanical damage – Fan function – No noise or vibrations
Cables, cable ducts, fiber-optic connections	– Mechanical damage – Isolation damage – Scorch marks – Fit of screw joints – Fit of cable lugs – Condition of the screw connections (visual inspection of the tightening torque markings, see Fig. 4–1) – Fiber-optic connections not bent
Ground connections	– Fit of screw joints – Yellow/green markings (completeness)

Table 4–1 Visual inspection (continued)

Components	Check for
Copper busbars	– Corrosion – Deformations – Discolorations – Thermal marks – Scorch marks – Condition of the screw connections (visual inspection of the tightening torque markings, see Fig. 4–1)
Water cooling system, pumps	– Condition of the cooling water lines, valves, seals and couplings – Traces of water leakage – Vibration noises (pumps) – Water temperature and pressure in the system and in the expansion vessel

4.4.2.1. Checking semiconductor stack tightness

Effort 0 - 2 h

It is recommended to check periodically the tightness of the semiconductor stack. This can be done as described undersection 10.6.7, **Tightening the stacks**, page 166.

4.4.2.2. Checking bolt connections

Effort 0 - 2 h

1. If not already done for other inspection purposes, shut-down the PCS6000 according to “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Check tightness of power conductor bolt connections:
   - Make visual checks of the torque markings on the bolts (Fig. 4–1).
   - If the torque markings on a screw are out of alignment, check torque of screw connection. The required torque is listed in Table 10–2 in section 10.4.1, **Correct tightening torques of bolted connections**, page 135.
   - If a connection is loose, tighten the bolt using a torque wrench, then check also the torque of all other connections (the probability is high that if one connection is loose also other connections are loose).
   - Torque markings of bolts that have been released and/or re-tightened must be cleaned and newly applied.

     NOTICE The capacitors bushing will be damaged when excessive force is applied. DO NOT exceed the maximum tightening torque when tightening the capacitor terminals. For the appropriate tightening torque of all screws and especially for the screws of the capacitors refer to section 10.4.1, **Correct tightening torques of bolted connections**, page 135.

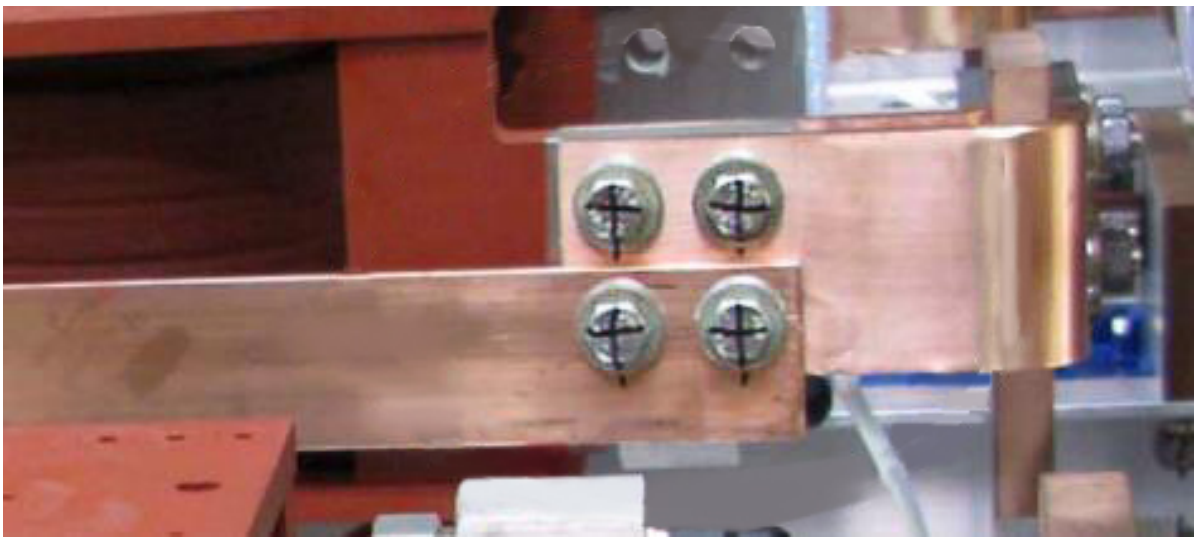


Figure 4–1 Bolt connections, checking the tightening torque markings

After completing all work - if no further inspections have to be performed - restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.3. Cleaning

Effort 2 - 4 h

NOTICE **Risk of component damage!**

The PCS6000 contains components which are sensitive to electrostatic discharge. Electrostatic-sensitive precautions must be applied and suitable tools must be used when cleaning boards and assemblies:

- Clean with special care using anti-static brushes and a vacuum cleaner.
- Dirt and dust on the electrical components can cause malfunctions and component failures!
- DO NOT use compressed air to clean the control system cabinets or converter under any circumstances.
- Dirt can be spread uncontrollably this way, which could lead to the corresponding malfunctions.
- DO NOT use alcohol or solvents when cleaning inside the cabinets or any electrical components.

Cleaning is necessary if dirt or dust accumulation (also called fouling) occurs within the converter. This could lead to thermally activated accelerated aging, which can be prevented by periodically cleaning.

Procedure:

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Clean the room carefully with a vacuum cleaner. In the area around the converter, use a soft nozzle tube in order not to damage any components.
3. If necessary, clean the components with a dry cloth.
4. Clean all air inlets and outlets of the cabinets.
5. Clean the air inlets and outlets on all door and roof fans.
6. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.4. Replacing components

Effort 2 - 4 h

Replacement means exchange of components as part of the maintenance schedule or as a consequence of performed visual inspection or performance checks.

The procedures to replace components are described in chapter 7, **Checking control components**, page 81 or in chapter 10, **Replacing power and cooling components**, page 133. The corresponding sections are depicted in the following table.

For replacement tasks without a description of the replacement procedure in this service manual, always shut-down the PCS6000 according to “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22 Switch off the corresponding MCB (see electrical diagram) before replacing the component. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

Table 4–2 Replacement procedures

Unit	Component	Replacement procedure
CCU	Quint battery	See section 8.17.1, **Replacing battery -G303 in CCU**, page 108.
	Fan with heater 	Disconnect the cables from the fan with heater -E301, unscrew and replace it.
CCU	Door air filter mats 	Unclip filter mat holder and replace filter mat with original ABB filter mat.
DLU	Door air filter mats 	Unclip filter mat holder and replace filter mat with original ABB filter mat.
	Roof fan and roof fan filter mats	See section 10.14.2, **Replacing roof fan and air filter mats**, page 269.

Table 4–2 Replacement procedures (continued)

Unit	Component	Replacement procedure
VFU	Door air filter mats 	Unclip filter mat holder and replace filter mat with original ABB filter mat.
	Roof fan and roof fan filter mats	See section 10.14.2, **Replacing roof fan and air filter mats**, page 269.
DRU	Door air filter mats 	Unclip filter mat holder and replace filter mat with original ABB filter mat.
	Door fan with heater	See section 10.14.1, **Replacing door fan with heater**, page 268.
	Roof fan and roof fan filter mats	See section 10.14.2, **Replacing roof fan and air filter mats**, page 269.
FIU	Door air filter mats 	Unclip filter mat holder and replace filter mat with original ABB filter mat.
	UPS (with battery)	See section 8.17.3, **Replacing battery in UPS -G502 in FIU**, page 110.
	Roof fan and roof fan filter mats	See section 10.14.2, **Replacing roof fan and air filter mats**, page 269.
POU	Door air filter mats 	Unclip filter mat holder and replace filter mat with original ABB filter mat.
	Quint battery	See section 8.17.2, **Replacing battery -G403 in POU**, page 109.
	Door fan with heater	See section 10.14.1, **Replacing door fan with heater**, page 268.
	Roof fan and roof fan filter mats	See section 10.14.2, **Replacing roof fan and air filter mats**, page 269.

Table 4–2 Replacement procedures (continued)

Unit	Component	Replacement procedure
WCU (Swedewater)	Door air filter mats 	Unclip filter mat holder and replace filter mat with original ABB filter mat.
	Pump slip ring sealing	See section 10.10.8, **Replacing pump slip ring sealing**, page 232.
	Pump motor bearings	See section 10.10.7, **Replacing pump**, page 228.
	Water filter	See section 10.10.6, **Replacing the water filter**, page 227.
WCU (Armatec)	Door air filter mats 	Unclip filter mat holder and replace filter mat with original ABB filter mat.
	Pump slip ring sealing	See section 10.11, **Replacing components in WCU (ARMATEC)**, page 240.
	Pump motor bearings	See section 10.11, **Replacing components in WCU (ARMATEC)**, page 240.
	Water filter	See section 10.11, **Replacing components in WCU (ARMATEC)**, page 240.

4.4.5. DC-link performance check

Effort 0 - 2 h

The DC-link charging for performance check is performed via the test module of the converter HMI.

IMPORTANT! The measurement results are compared to the nominal values in the “PCS6000 Preventive maintenance report”, 3BHS600000 E84.

The deviation of the measured values from the nominal values is grouped in 3 categories:

– **OK:** The measurement result is in the expected range.

– **Monitor:** The measurement result is near the limit.

  The respective component is still OK, but it makes sense to compare previous and future measurements to monitor a trend, as well as to compare similar measurements taken with the same instrument.

– **Action:** The respective component might be faulty and should be replaced.

Procedure:

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Close all doors.
3. Open DC-link grounding switch.
4. Charge the DC link up to +/-500V.
5. Record the discharging time from +/-500 to +/-200V.
6. Record the discharge time in the Preventive Maintenance Report.
7. If the converter is a 2CL system, repeat the test with the second conversation line.
8. After completing all work, restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.6. DC-link component check

Effort 4 - 8 h

The DC-link component check has to be done as described below, if the procedure in section 4.4.5, **DC-link performance check**, page 56 shows a deviation from the nominal value more than 10%.

IMPORTANT! A standard multimeter with capacitance measuring function (up to 10 mF) is required to perform these measurements.

The measurement results are compared to the nominal values in the Preventive Maintenance Report. The deviation of the measured values from the nominal values is grouped in 3 categories:

– **OK:** The measurement result is in the expected range.

– **Monitor:** The measurement result is near the limit.

  The respective component is still OK, but it makes sense to compare previous and future measurements to monitor a trend, as well as to compare similar measurements taken with the same instrument.

– **Action:** The respective component might be faulty and should be replaced.

Procedure:

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Double check that the DC-link is grounded (ground switch).

3. Remove reinforcement plates and the ASM10 (Auxiliary Supply Module).

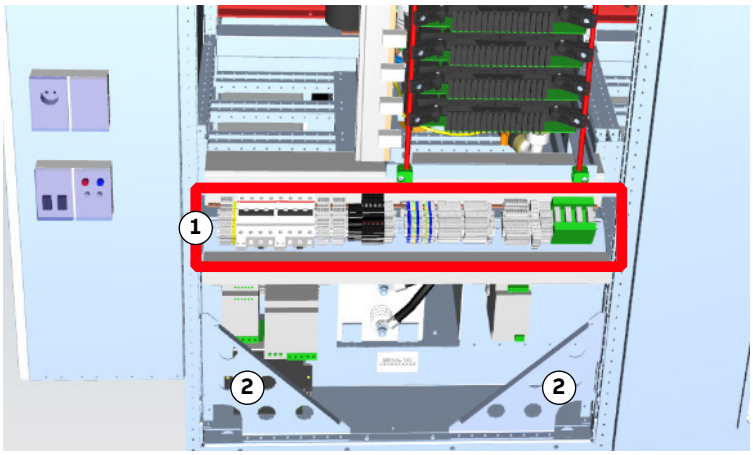
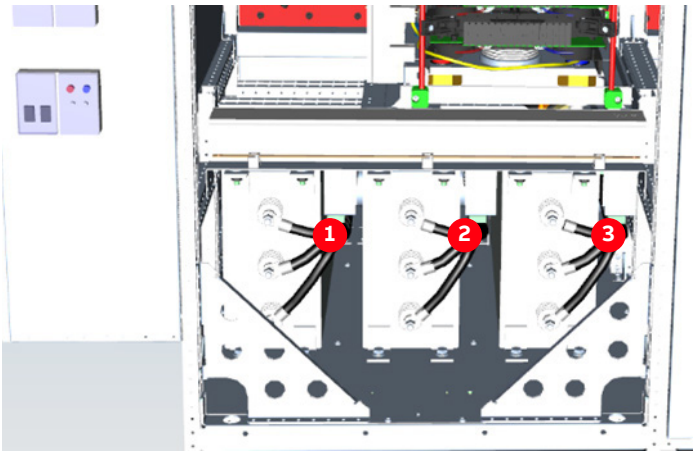


Figure 4–2 ASM10

1) ASM	2) Reinforcement plate

4. Disconnect the three sets of measurement the wires (1, 2 and 3) which connect the DC-link capacitors (C701…C703) to the converter.



5. Record the serial number of each capacitor in the Preventive Maintenance Report.

6. Measure the capacitance of Grid side Power Module Capacitors (see electrical circuit diagram POMxx).

7. Measure the capacitance of Generator side Power Module Capacitors (see electrical circuit diagram POMxx).

8. Reconnect the wires/busbars from the converter with the marked tightening torque (see separate sticker on the capacitor) to the capacitors.

NOTE – If the tightening torque is not specified on the capacitor, use tightening torque defined under section 10.4.1, **Correct tightening torques of bolted connections**, page 135.

9. After completing all work, restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.7. Filter components performance check

Effort 2 - 4 h

IMPORTANT! A standard multimeter with capacitance measuring function (up to 10 mF) is required to perform these measurements.

The measurement results are compared to the nominal values in the Preventive Maintenance Report. The deviation of the measured values from the nominal values is grouped in 3 categories:

– **OK:** The measurement result is in the expected range.

– **Monitor:** The measurement result is near the limit.

  The respective component is still OK, but it makes sense to compare previous and future measurements to monitor a trend, as well as to compare similar measurements taken with the same instrument.

– **Action:** The respective component might be faulty and should be replaced.

The filter components performance check comprises the following 3 parts:

– Grid side filter components performance check (see section 4.4.7.1, **Grid side filter components performance check**, page 59)

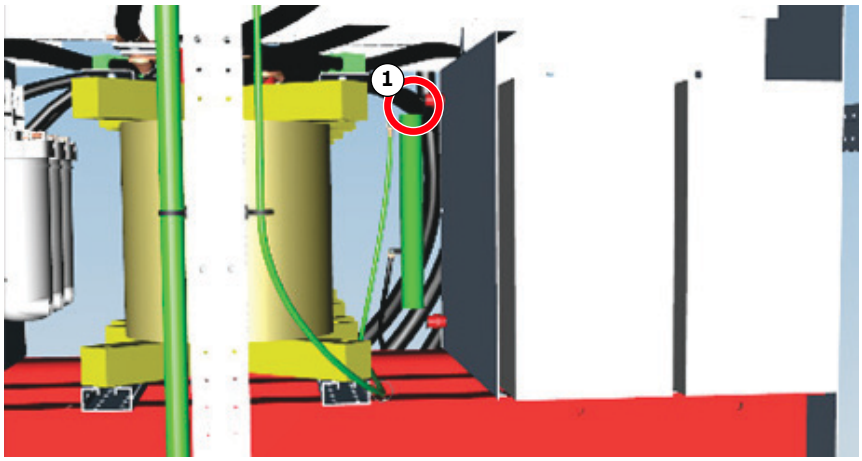
– Neutral point performance check (see section 4.4.7.2, **Neutral point performance check**, page 61)

– dv/dt filter components performance check (see section 4.4.7.3, **dv/dt filter components performance check**, page 61)

4.4.7.1. Grid side filter components performance check

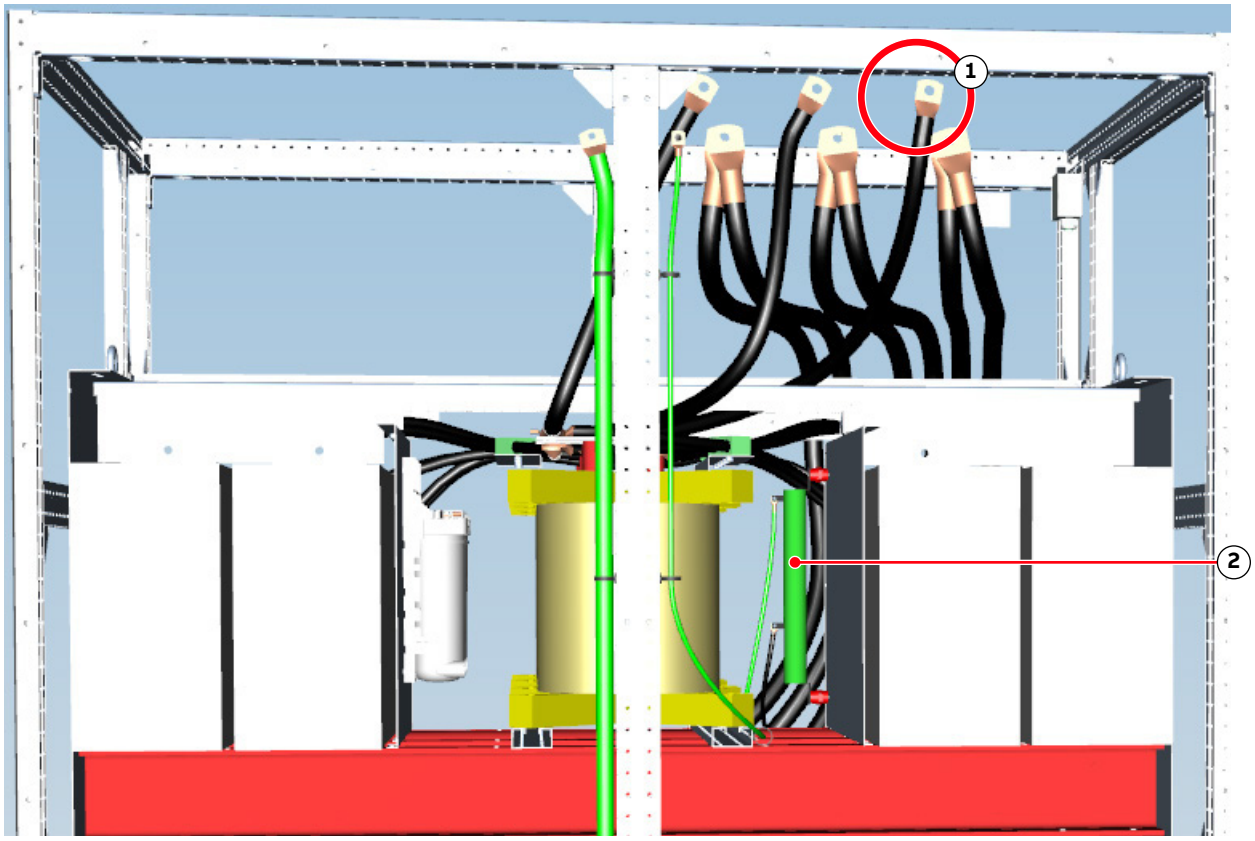
1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Double check that the DC-link is grounded (ground switch) and the grid side is grounded (grounding kit).
3. Disconnect the PE wire to -R544:2 in cabinet +A12. (see electrical circuit diagram HFMxx).

4. Measure the resistance of -R544 between -R544:2 (the disconnected pin) and -R544:1.



1) Measure the resistance

5. Measure the capacitance between -X541/2:3 and -X541/2:4 (12 capacitors parallel, when grid side grounded).



1) -X541/2:3
2) -X541/2:4

6. Reconnect the removed connection.

7. After completing all work, restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.7.2. Neutral point performance check

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Double check that the DC-link is grounded (ground switch).
3. Disconnect the wire from:
   - +A23-R461 pin2
   - +A23-R462_1 pin1
   - +A23-R463 pin 1

   See electrical circuit diagram NCM10
4. Measure the capacitance of -C461 between -C461:1 and Ground.
5. Measure the resistance of -R461 between -R461:1 and -R461:2.
6. Measure the resistance of -R462 (over both two resistances) between -R462_1:1 and Ground.
7. Measure the resistance of -R463 between -R463:1 and -R463:2.
8. Measure the resistance of -R463 between -R464:1 and -R464:2
9. Reconnect the removed connections.
10. After completing all work, restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.7.3. dv/dt filter components performance check

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Double check that the DC-link is grounded (ground switch) and the generator side is grounded.
3. Measure the resistance of -R581 and -R582 (connected in series) in cabinet +A11 between -R581:2 and -R582:1.
4. Measure the resistance of -R583 and -R584 (connected in series) in cabinet +A11 between -R583:2 and -R584:1.
5. Measure the resistance of -R585 and -R586 (connected in series) in cabinet +A11 between -R585:2 and -R586:1.
6. (see electrical circuit diagram VFMxx)
7. Measure the capacitance between -C581:2 in cabinet +A11 and Ground (7 capacitors parallel when generator side grounded).
8. Measure the resistance between -C581:2 in cabinet +A11 and Ground. The measurement is passed when Rmeasured rises to OL (OverLoad).
9. After completing all work, restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.8. Functionality and security procedure

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Visually check the cable connections to the grid breaker (GRB).
3. Check the properly fixation of the contact block of the Local Emergency Button +A40.
4. Check whether the maintenance of the GRB has been done according to the manufacturer's specifications.

   IMPORTANT! All the points of the following tests have to be confirmed by ticking the corresponding check boxes in the Preventive Maintenance Report.
5. Perform the “Local Emergency Button test” according to the procedure given in the Preventive Maintenance Report.

   During this test the different paths of the GRB open command will be checked. Each path (-X910:5, -X910:8, -X910:9, -X910:11) is tested with the other paths disconnected. For each test case, the GRB must open when the Local Emergency Button +A40 is pressed.
6. Perform the “Door interlocking test” according to the procedure given in the Preventive Maintenance Report.

   During this test the proper function of all door interlocks will be checked.
7. Perform the “Grounding isolator interlocking test” according to the procedure given in the Preventive Maintenance Report.

   WARNING! For the grounding isolator interlocking test, the GRB disconnector must be in test position!

   - During this test the interlocking function between GRB and DC-link grounding isolator has to be confirmed, ie, the GRB cannot be closed unless the DC-link grounding switch is open and locked; and the DC-link cannot be grounded if the GRB Disconnector is closed or simulated to be “closed” via the HMI button.
   - If the locking supervision contact is not used, the interlocking has to be confirmed as follows: The GRB cannot be closed if the DC-link grounding isolator is closed, whereas the DC-link grounding isolator cannot be closed if the GRB is closed.
8. Perform the “Safety interface to upper level control test” according to the procedure given in the Preventive Maintenance Report.

   During this test the safety interface communication from the WTC (Wind Turbine Control) to the converter and from the converter to the WTC will be checked.
9. Perform the “UPS Supply Check” according to the procedure given in the Preventive Maintenance Report.

   This test procedure is used to verify the proper functionality of the Uninterruptible Power Supply (UPS).
10. After completing all work, restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.9. GRB opening time verification

Effort 0 - 2 h

The response time of the Grid Breaker (GRB) has to be checked according to the manufacturer's specifications (responsibility of customer).

For the ABB converter, the GRB opening time has to be less than the specified limit in the Preventive Maintenance Report.

4.4.10. Insulation Measurement 1CL

Effort 2 - 4 h

The insulation resistance of the converter components must be measured to verify their ability to withstand voltage stress. The results of the measurements must be noted in the Preventive Maintenance Report.

IMPORTANT! A high voltage insulation tester with a test voltage of 2500 VDC (eg, METRISO 5000) is required to perform the insulation measurements. The water conductivity must be lower than 0.5 µs/cm during the insulation measurements.

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Visually check that the LEM current transducer cables do not touch the medium voltage busbars.
3. Shorten the following points:
   - AC grid Side: phases U,V,W
   - AC generator side: phases U,V,W
   - DC-link+ N -: X801, X803, X805 (inside DLU)
   - Filter Capacitors: C541-C544, C461, C581 - C587
   - Braking Resistor: X801-X802, X804-X805 (inside DLU)
4. Disconnect the following components:
   - Ground Connection HFM: R544.2
   - Ground Connection NCM: C461.2
   - Ground Connection VFM: C587.2
   - Pre-charger PCM: Remove fuses F421-F423 and ground PCM
   - HVD-board: -U706, remove link to PECINTM (sub-d connector)
5. Open the following switches:
   - GEB / GDM: Open disconnector and ground generator
   - Earth Isolator: Q801

6. Apply a test voltage of 2500 VDC between the shortened phases and ground as shown in Fig. 4–3 for at least 1 minute.

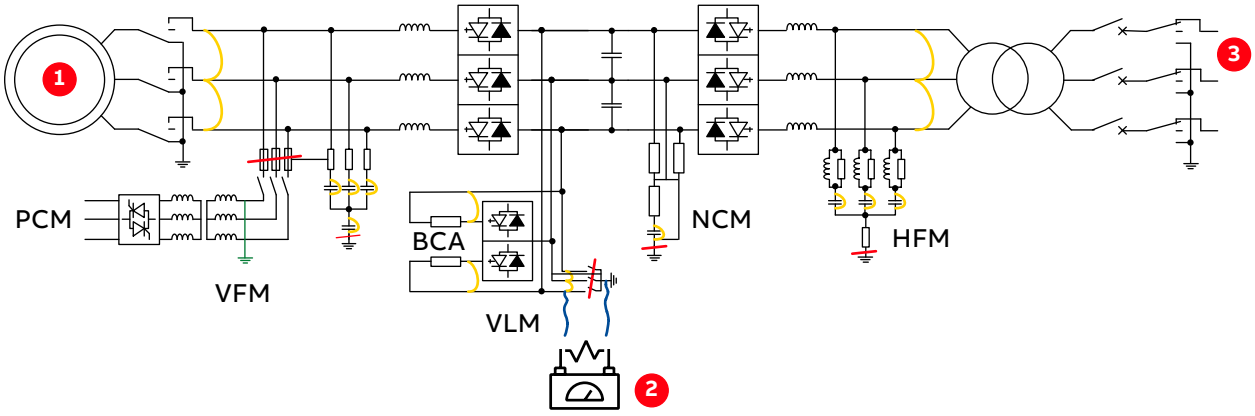


Figure 4–3 Insulation measurements PCS6000 Converter 1CL with PCM

1) Generator
2) Insulation test device
3) Wind park grid

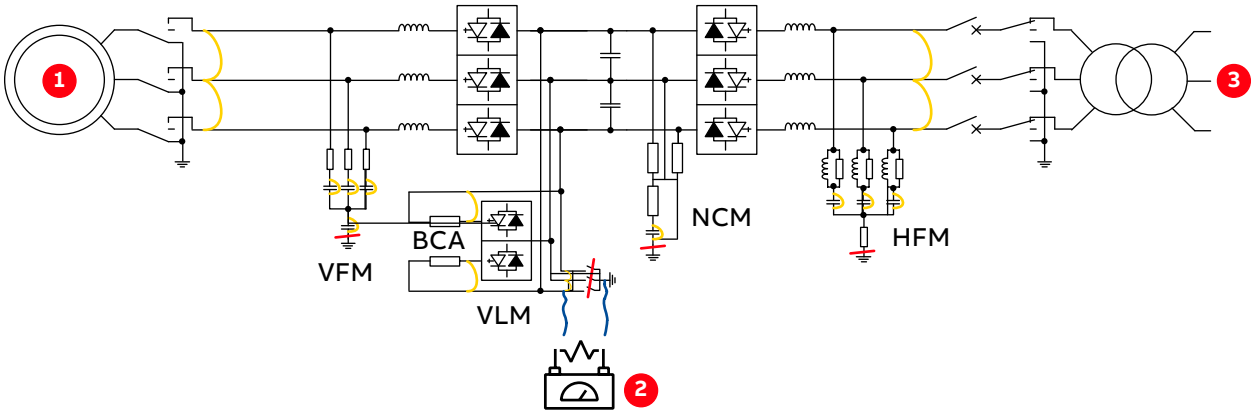


Figure 4–4 Insulation measurements PCS6000 Converter 1CL without PCM

1) Generator
2) Insulation test device
3) Wind park grid

7. Verify that the measured circuit is discharged

8. Close the ground switch

9. Reconnect all components

10. Remove all temporary bridges

11. After completing all work, restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.11. Insulation Measurement 2CL

Effort 2 - 4 h

The insulation resistance of the converter components must be measured to verify their ability to withstand voltage stress. The results of the measurements must be noted in the Preventive Maintenance Report.

IMPORTANT! A high voltage insulation tester with a test voltage of 2500 VDC (eg, METRISO 5000) is required to perform the insulation measurements. The water conductivity must be lower than 0.5 µs/cm during the insulation measurements.

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Visually check that the LEM current transducer cables do not touch the medium voltage busbars.
3. Shorten the following points:
   - AC grid Side of each CL: phases U,V,W
   - AC generator of each CL: phases U,V,W
   - DC-link+ N - of each CL: X801, X803, X805
   - DC-link between CL1 and CL2: X801
   - Filter Capacitors of each CL: C461, C581 - C587
   - Braking Resistor of each CL: X801-X802, X804-X805
4. Disconnect the following components:
   - Ground Connection NCM: C461.2
   - Ground Connection VFM74: C587.1
   - Ground Connection VFM73: C584.1
   - Pre-charger PCM of each CL: Remove fuses F421-F423 and ground PCM
   - HVD-board: -U706, remove link to PECINTM (sub-d connector)
5. Open the following switches:
   - GDM of each CL: open disconnector and ground generator and transformer
   - Earth Isolator of each CL: Q801

6. Apply a test voltage of 2500 VDC between the shortened phases and ground as shown in Fig. 4–5 for at least 1 min.

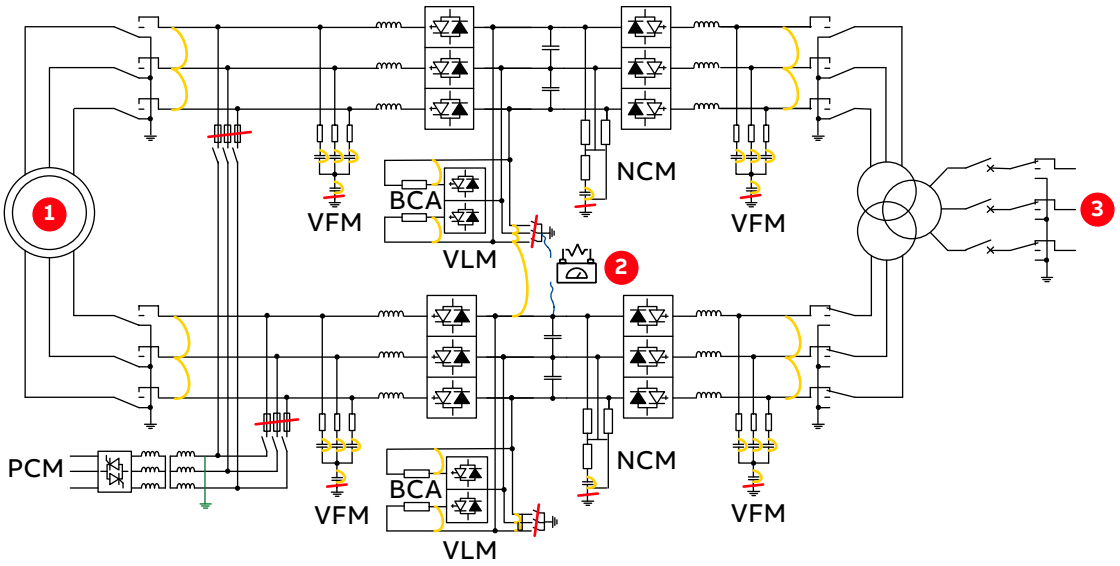


Figure 4–5 Insulation measurements PCS6000 Converter 2CL

1) Generator	3) Wind park grid
2) Insulation test device	

7. Verify that the measured circuit is discharged.
8. Close the ground switch.
9. Reconnect all components.
10. Remove all temporary bridges
11. After completing all work, restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.12. GDM performance check

Effort 0 - 2 h

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Double check that the DC-link is grounded (ground switch).
3. Visual inspection insulators active parts.
4. Control bolt fixations and connections.
5. Greasing shaft and chain motor drive.
6. Check the motor drive.
7. Operation functioning test (Open, Closed, Earth).
8. Record the switching time in the Preventive Maintenance Report.

9. After completing all work, restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

4.4.13. Braking resistor performance check

Effort 0 - 2 h

The braking resistor check has be done as described below.

IMPORTANT! A standard multimeter with resistor measuring function (~1…5 Ω) is required to perform these measurements.

The measurement results are compared to the nominal values in the Preventive Maintenance Report. The deviation of the measured values from the nominal values is grouped in 3 categories:

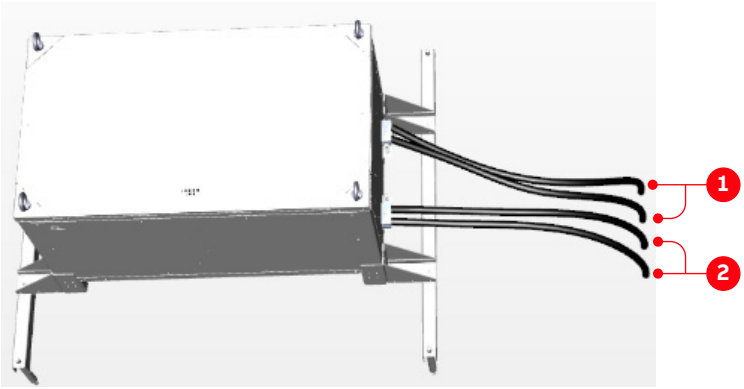
– **OK:** The measurement result is in the expected range.

– **Monitor:** The measurement result is near the limit.

  The respective component is still OK, but it makes sense to compare previous and future measurements to monitor a trend, as well as to compare similar measurements taken with the same instrument.

– **Action:** The respective component might be faulty and should be replaced.

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Double check that the DC-link is grounded (ground switch).
3. Disconnect the BRU cables on converter side
4. Record the serial number of each braking resistor in the Preventive Maintenance Report.
5. Measure the resistance of the two resistor halves (RDC+ to NP and RDC- to NP) and record the values in the Preventive Maintenance Report.



1) R_{DC}+ to NP

2) R_{DC}- to NP

6. Reconnect the wires/busbars from the converter with the marked tightening torque.

   If the tightening torque is not specified use tightening torque defined in section 10.4.1, **Correct tightening torques of bolted connections**, page 135.

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

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)

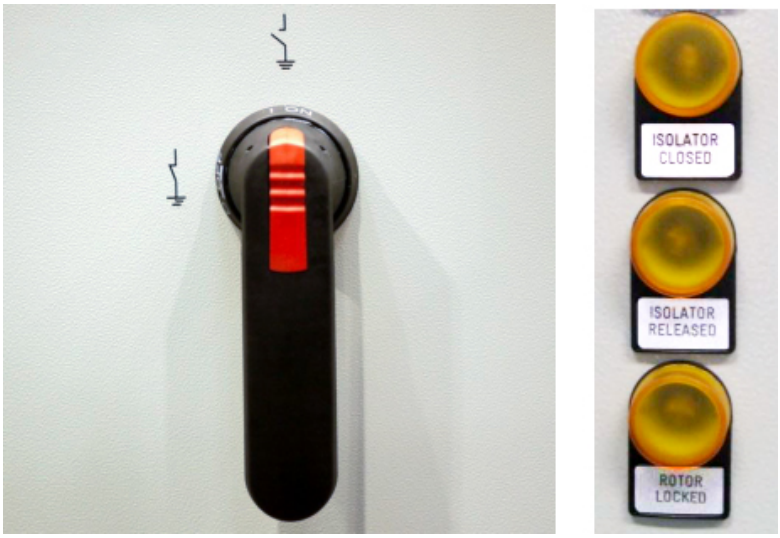


Figure 5–2 DC-link grounding isolator in position “not grounded”

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.

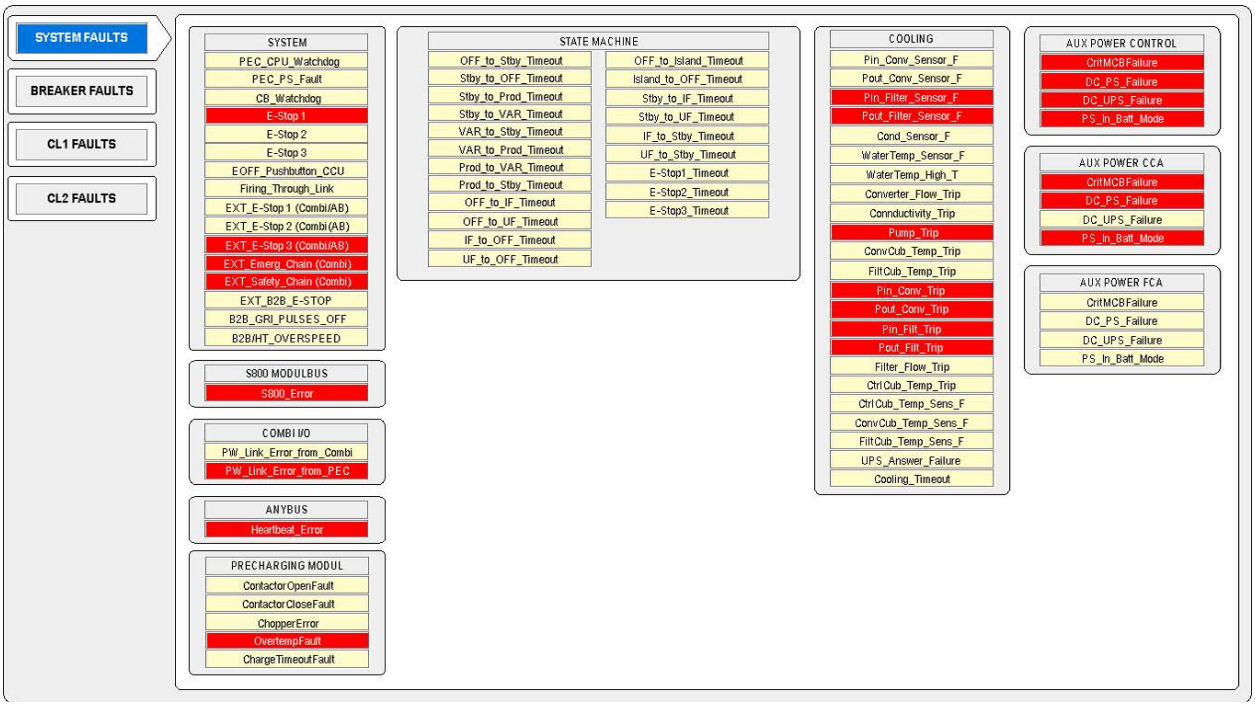


Figure 6–1 Commissioning tool (optional), error messages window

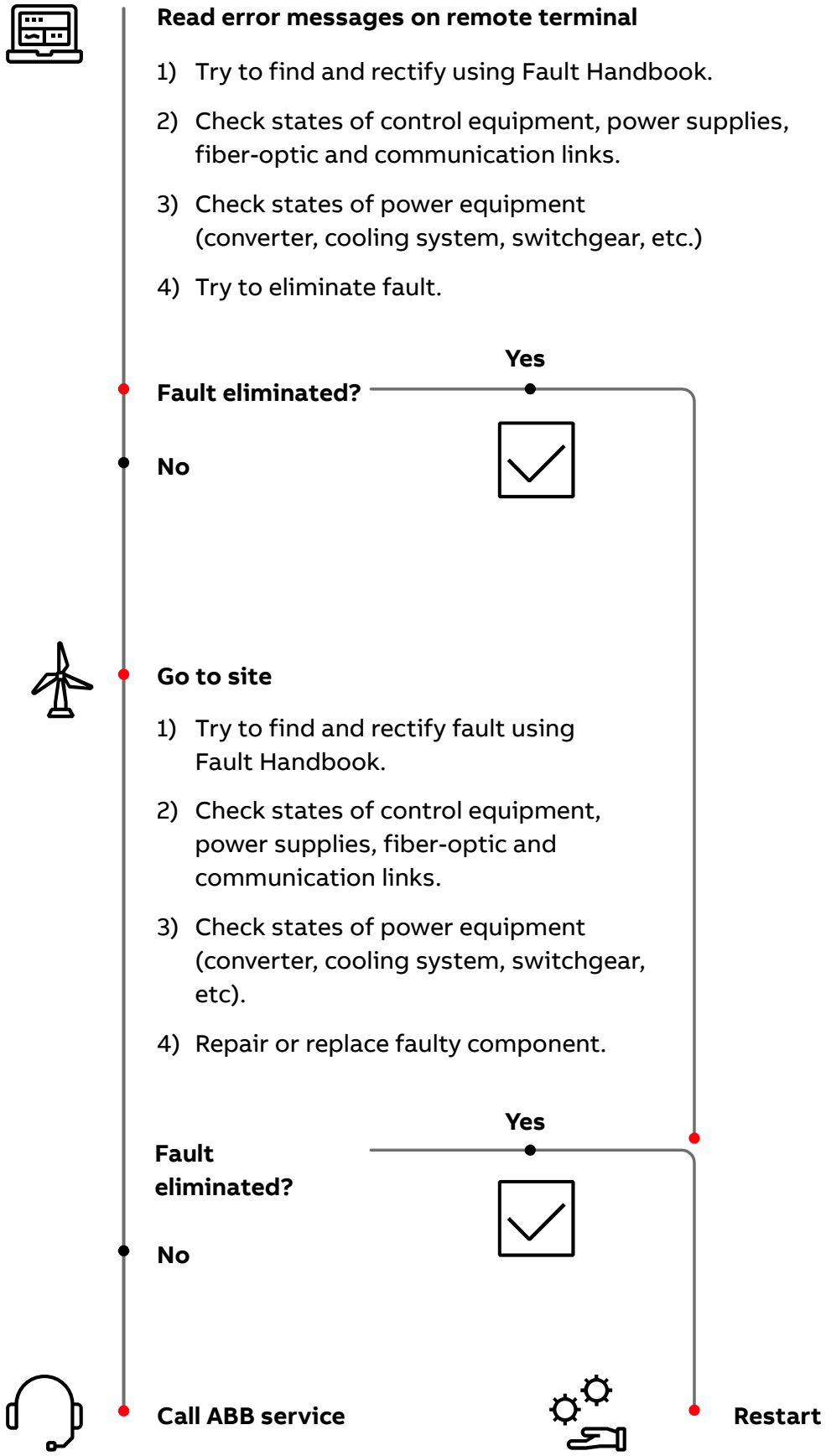


Figure 6–2 Standard procedure for troubleshooting (overview)

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).

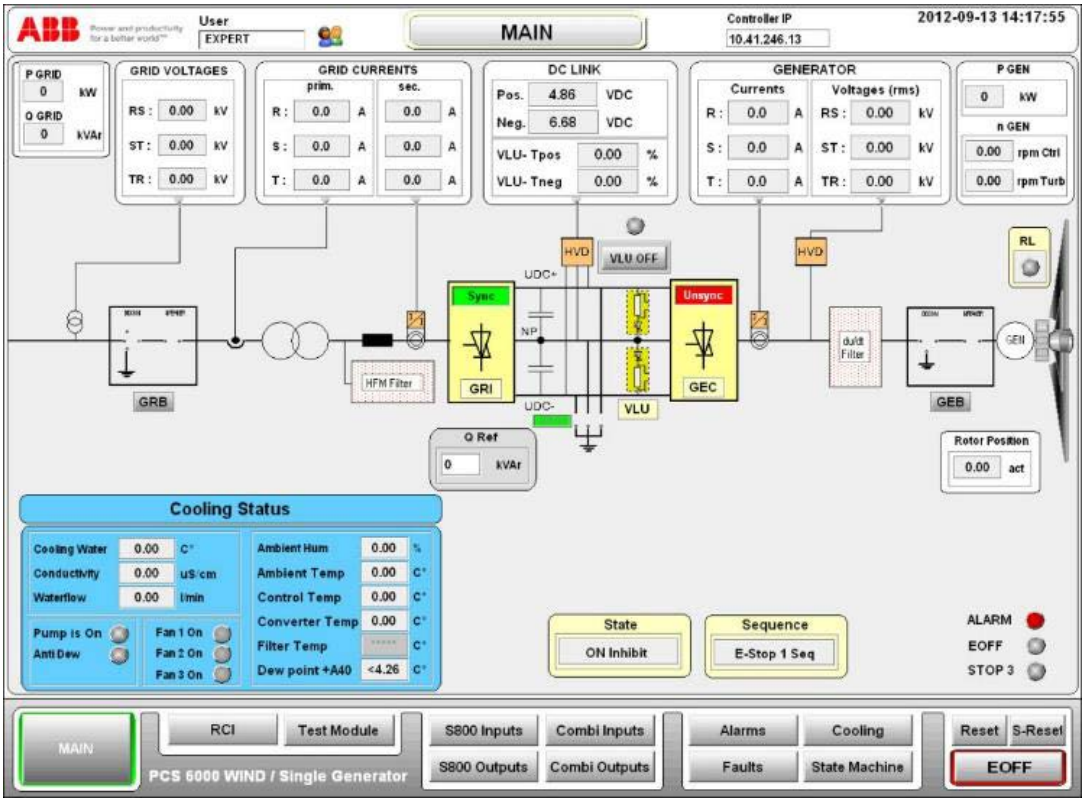


Figure 6–3 Commissioning tool (optional), typical window

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	-

8.4. Replacing AC 800PEC

Service MTTR 0 - 2 h

Figure 8–1 AC 800PEC

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 minutes).
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).

Figure 8–2 UPS -G302 selector switch “Bat.-Select”

1) Selector switch “Bat.-Select”

5. Disconnect all cables and detach the module to be replaced (see Fig. 8–3) and take care that all cables can be clearly identified for reconnection.

6. Unscrew the two screws (see 1 in Fig. 8–3).
7. Push the device up against the spring mechanism (see 2, circled Fig. 8–3).
8. Tilt the device forward and remove it from the DIN rail (see 3 in Fig. 8–3).

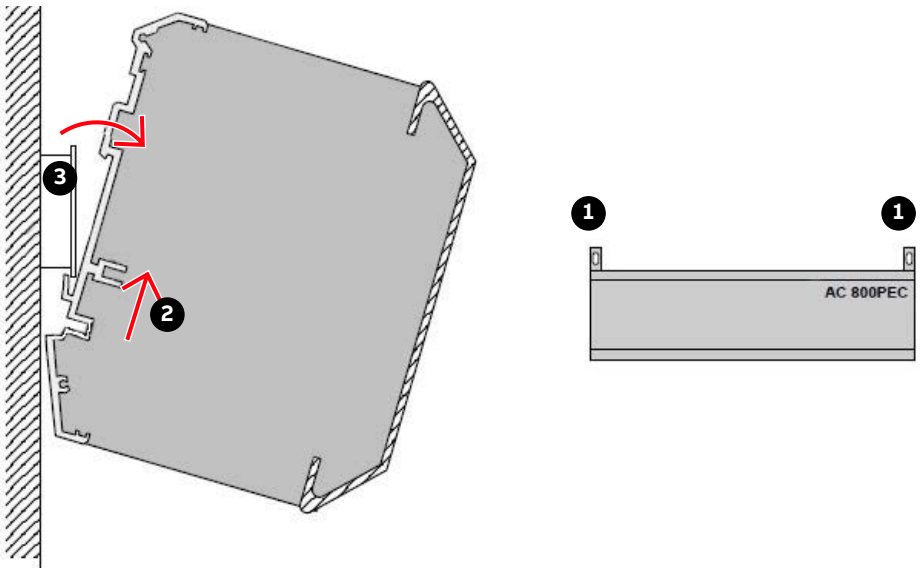


Figure 8–3 Removing a AC 800PEC module

1) Screw	3) DIN rail
2) Spring mechanism	

9. Replace the detached module with a spare one with identical hardware configuration and identical software.
10. Check the identification code on the nameplate which must be identical.

    For more information, see the AC 800 PEC Hardware Guide, Chapter 6 - Guidelines for Configuration and Ordering, page 123.
11. Reconnect all cables.

    IMPORTANT! Make sure that all cables/optical fibers are connected to the correct terminals, otherwise malfunctions or component damages might occur.
12. Power up the module by switching on MCB -Q306.

    NOTE – Depending on the replaced board it can be necessary to update the software. Contact ABB Service for further instructions.
13. Check the LEDs for any possible errors according to section 7.4.1, **LEDs on AC 800PEC**, page 82.
14. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

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

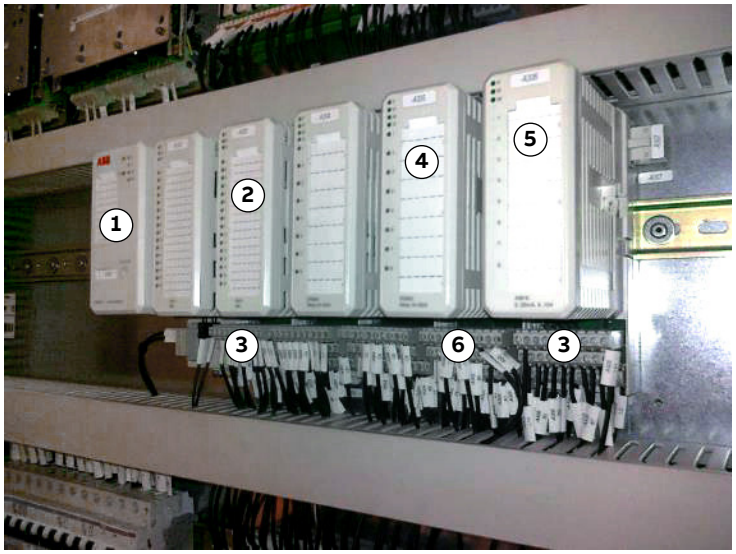


Figure 8–5 S800 assembly

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).

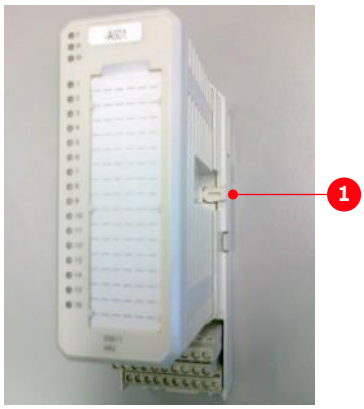


Figure 8–6 S800 I/O module

1)	Locking knob

6. Remove the module from its base.
7. Replace the module with a spare one, adjusting the address dials to match the base (see 1 in Fig. 8–7).

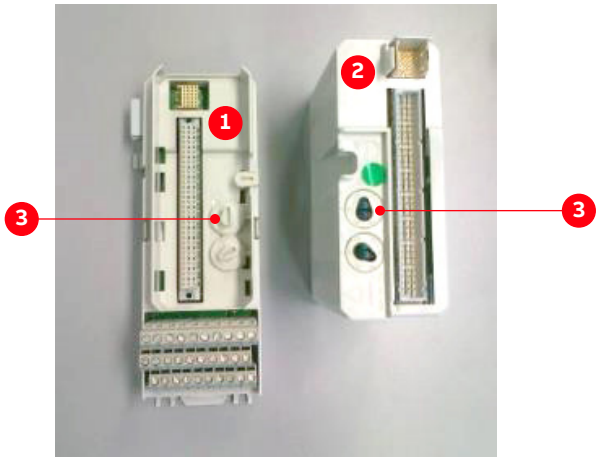


Figure 8–7 S800 I/O module address

1)	Base	3)	Address dials
2)	I/O module		

8. Engage the locking knob (see Fig. 8–6).
9. Switch on MCB -Q306.
10. Check the new module for correct functioning.
11. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

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.

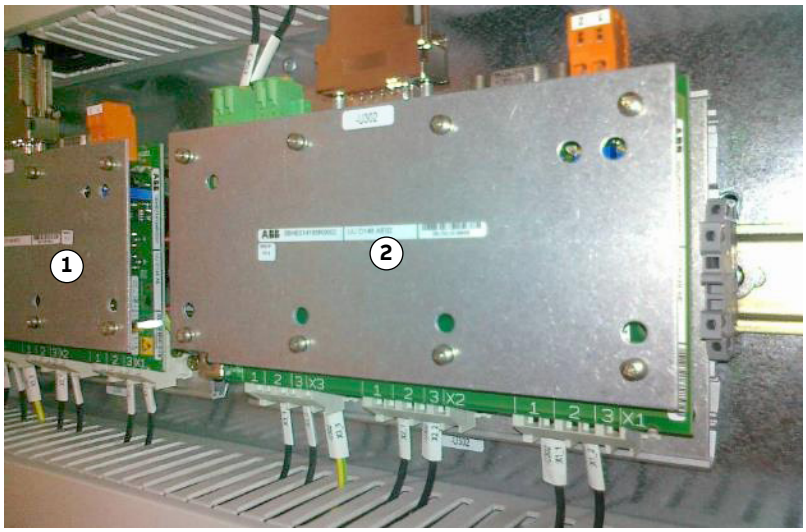


Figure 8–8 Voltage and current transducer boards UUD 148 AE01/2

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.

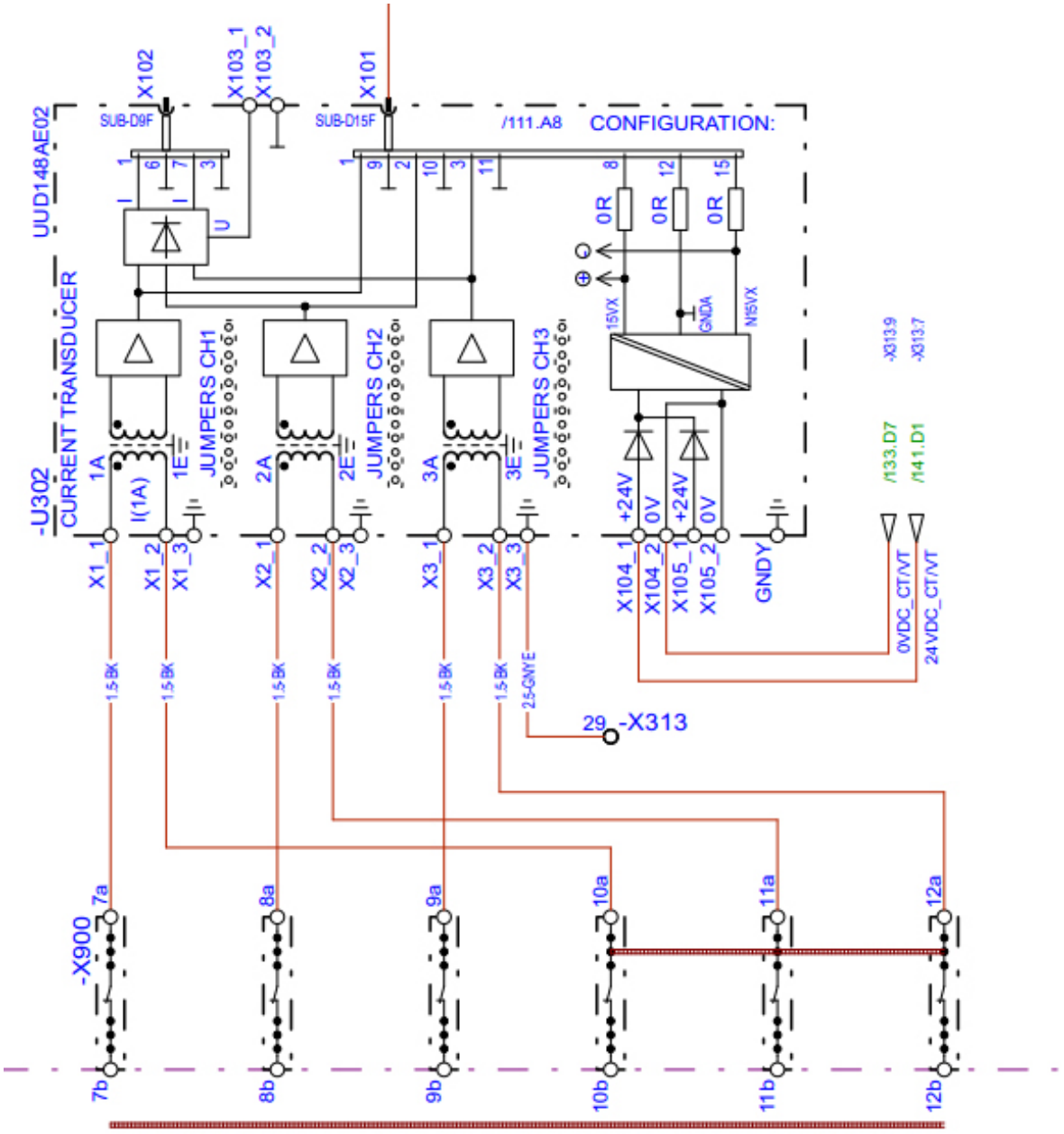


Figure 8–9 Short-circuit of current transducer

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

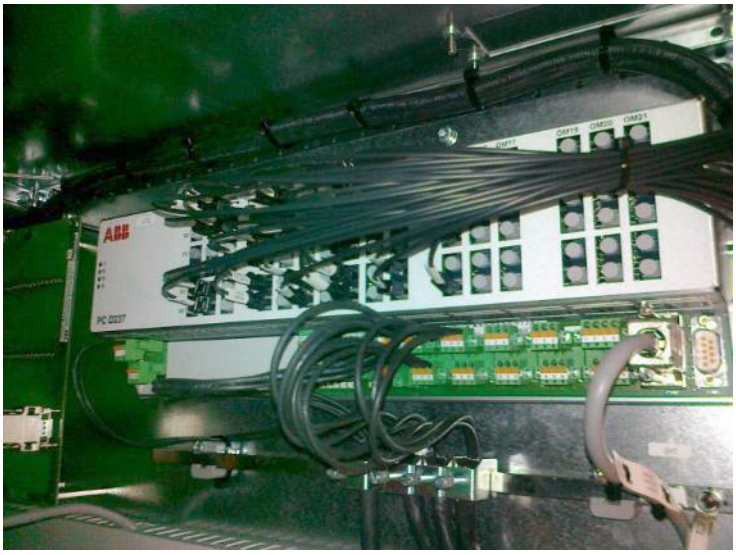


Figure 8–10 PECINTM PC D237

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).

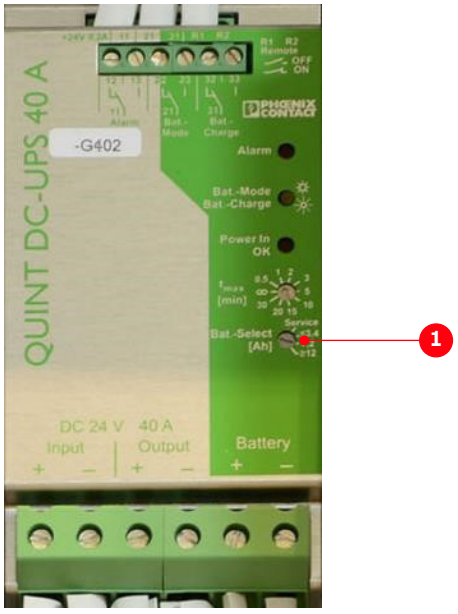


Figure 8–11 UPS -G402 selector switch “Bat.-Select”

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

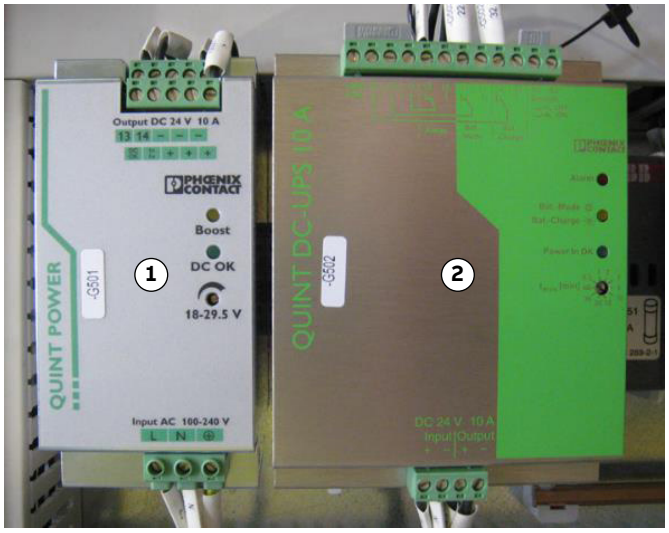


Figure 8–17 AC/DC converter Quint-PS/1P24/10

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

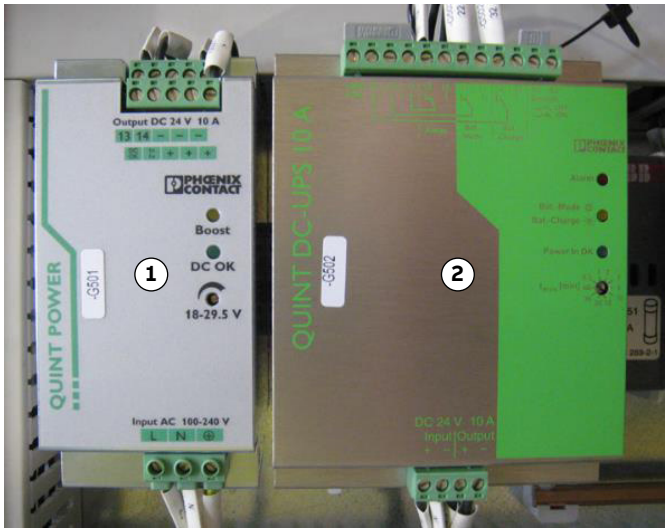


Figure 8–20 Quint-DC-UPS/24DC/10

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.

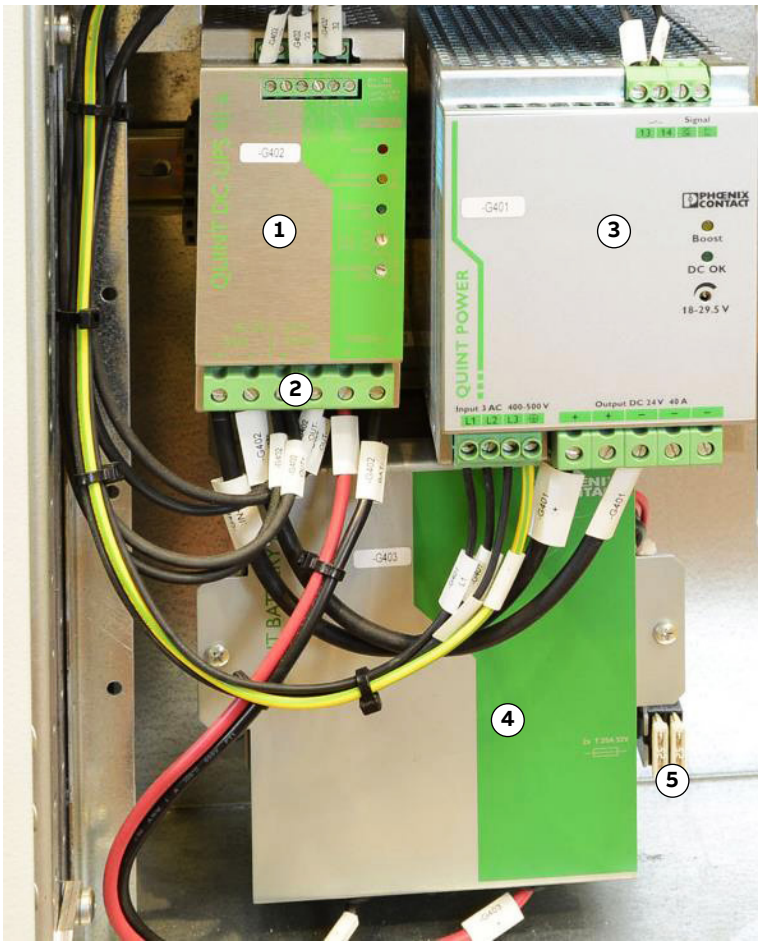


Figure 8–22 Battery -G403

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).

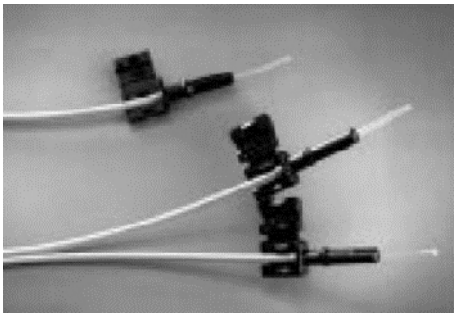
   NOTE – When using the duplex connector arrangement, the separated duplex cable should be stripped to roughly equal lengths on each cable end.

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.

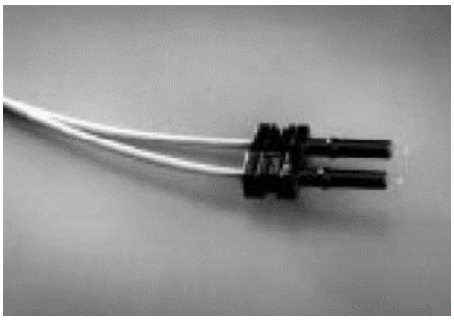
5. (Simplex connectors) flip the top half of the connector over and snap it into the ferrule half with your fingers.

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



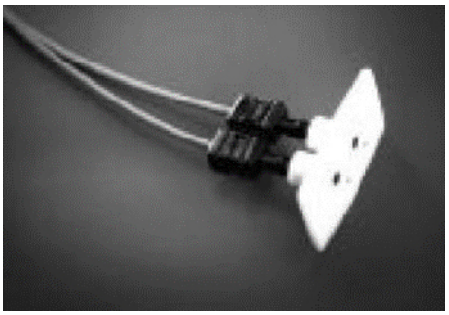
6. (Duplex connectors): place one connector on top of the other, so that the top half of each connector is over the ferrule half of the opposite connector, manually press connectors together in the center of the arrangement and then latch by pressing on the sides of each connector.

   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

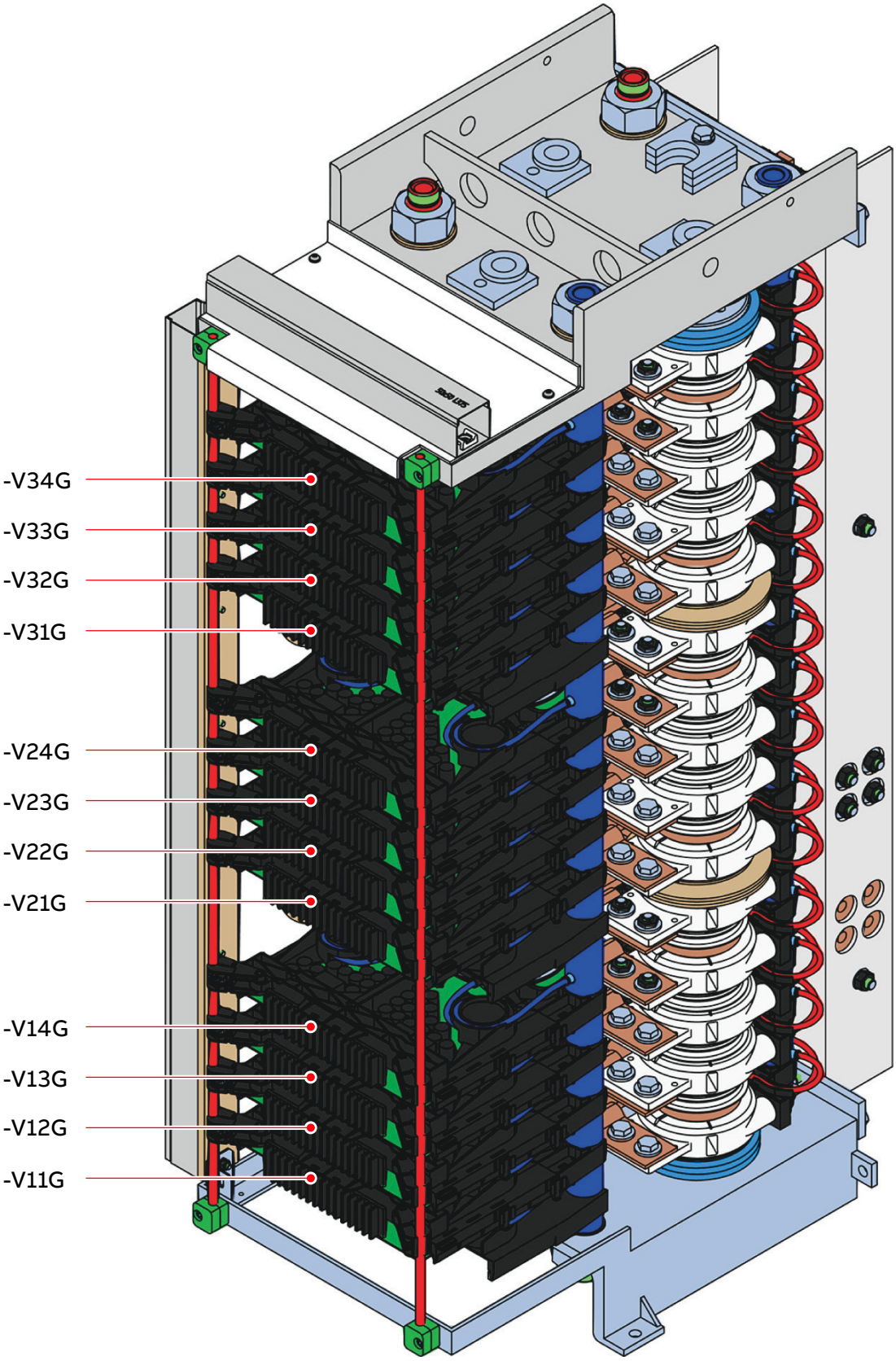


Figure 9–1 IGCT stack

9.4.1. Freewheeling diode stack

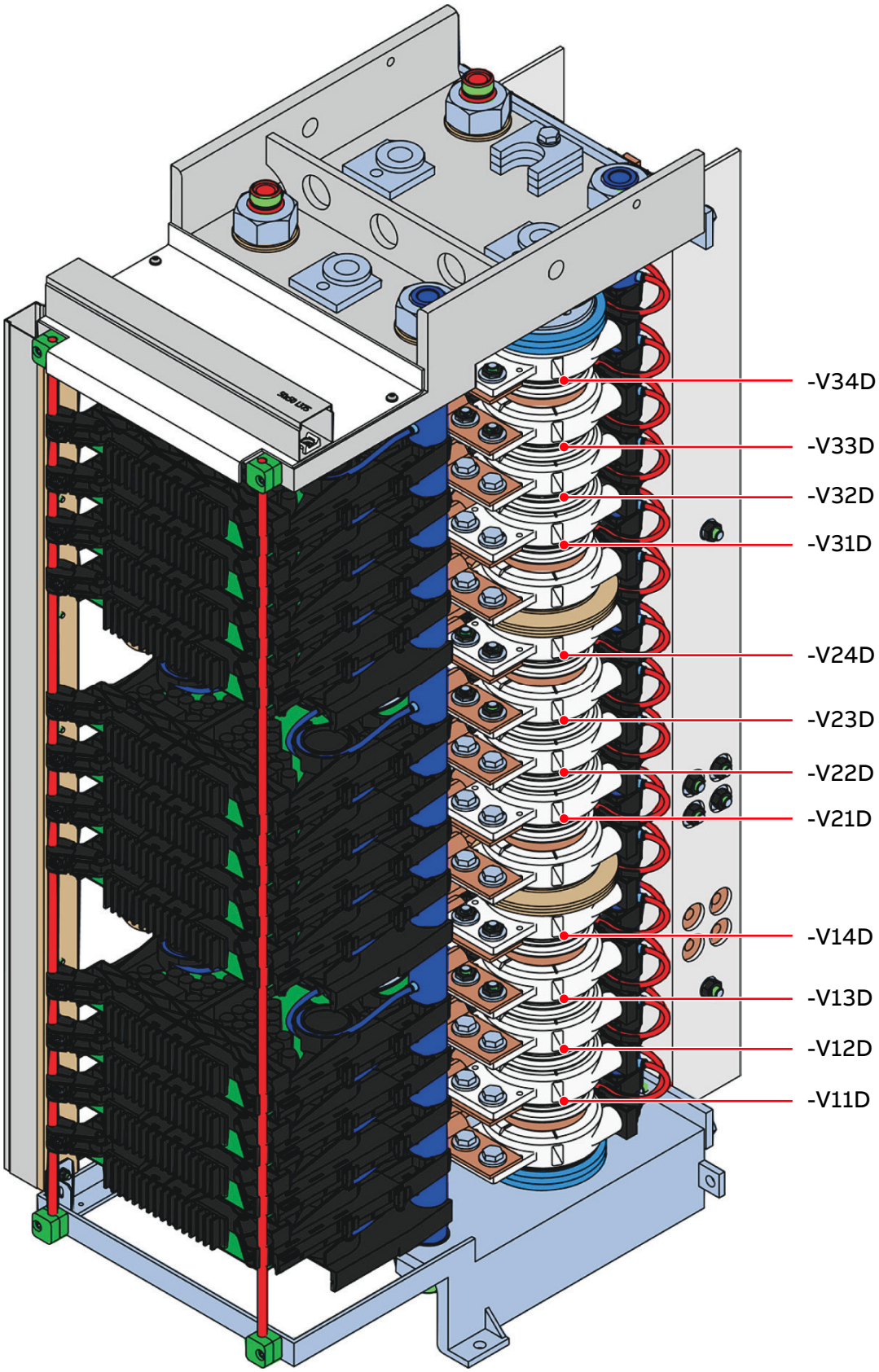


Figure 9–2 Freewheeling diode stack

9.4.2. Neutral point and clamp diode stack

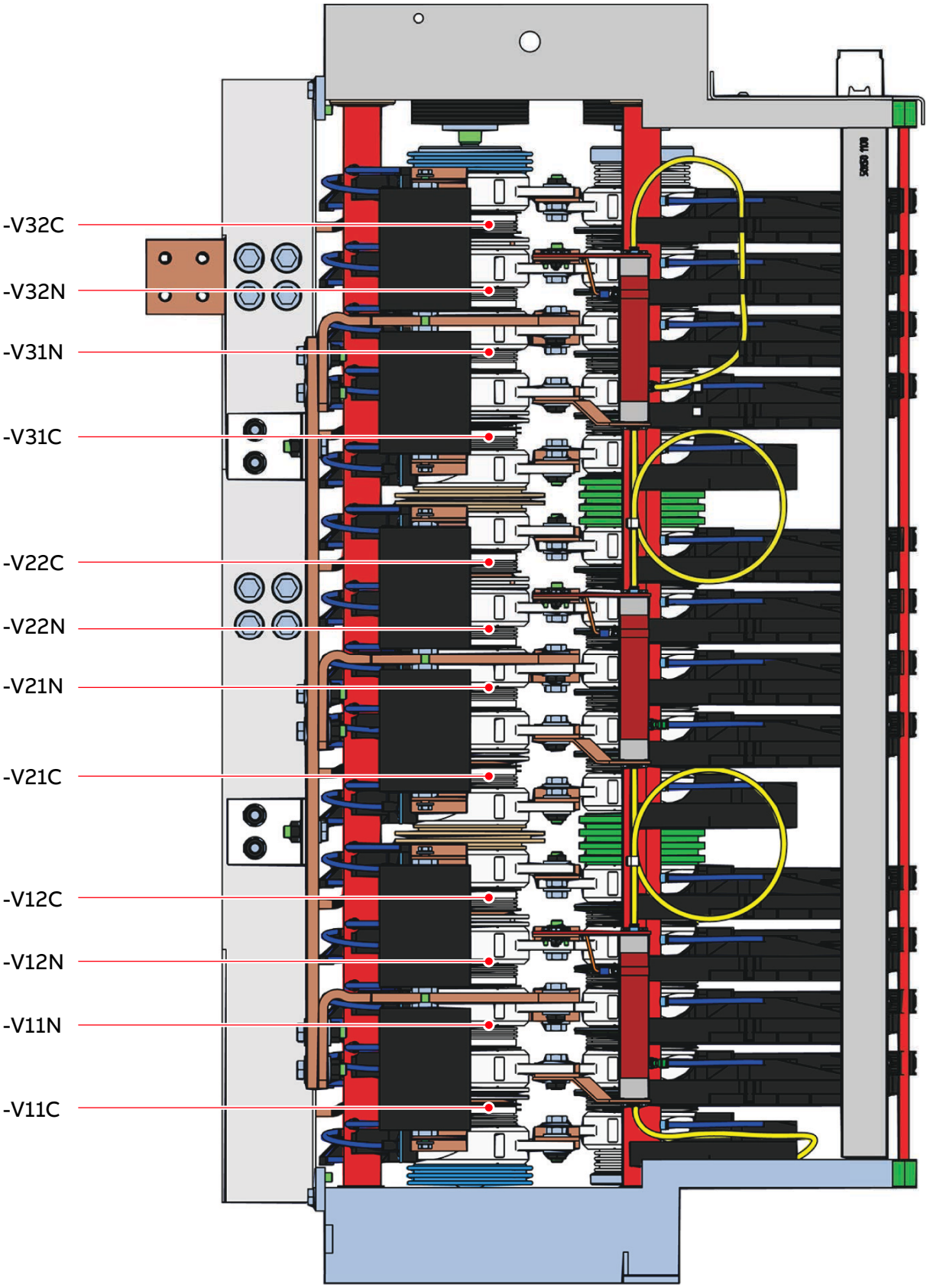


Figure 9–3 Neutral point and clamp diode stack

9.4.3. Clamp capacitors and symmetry resistors

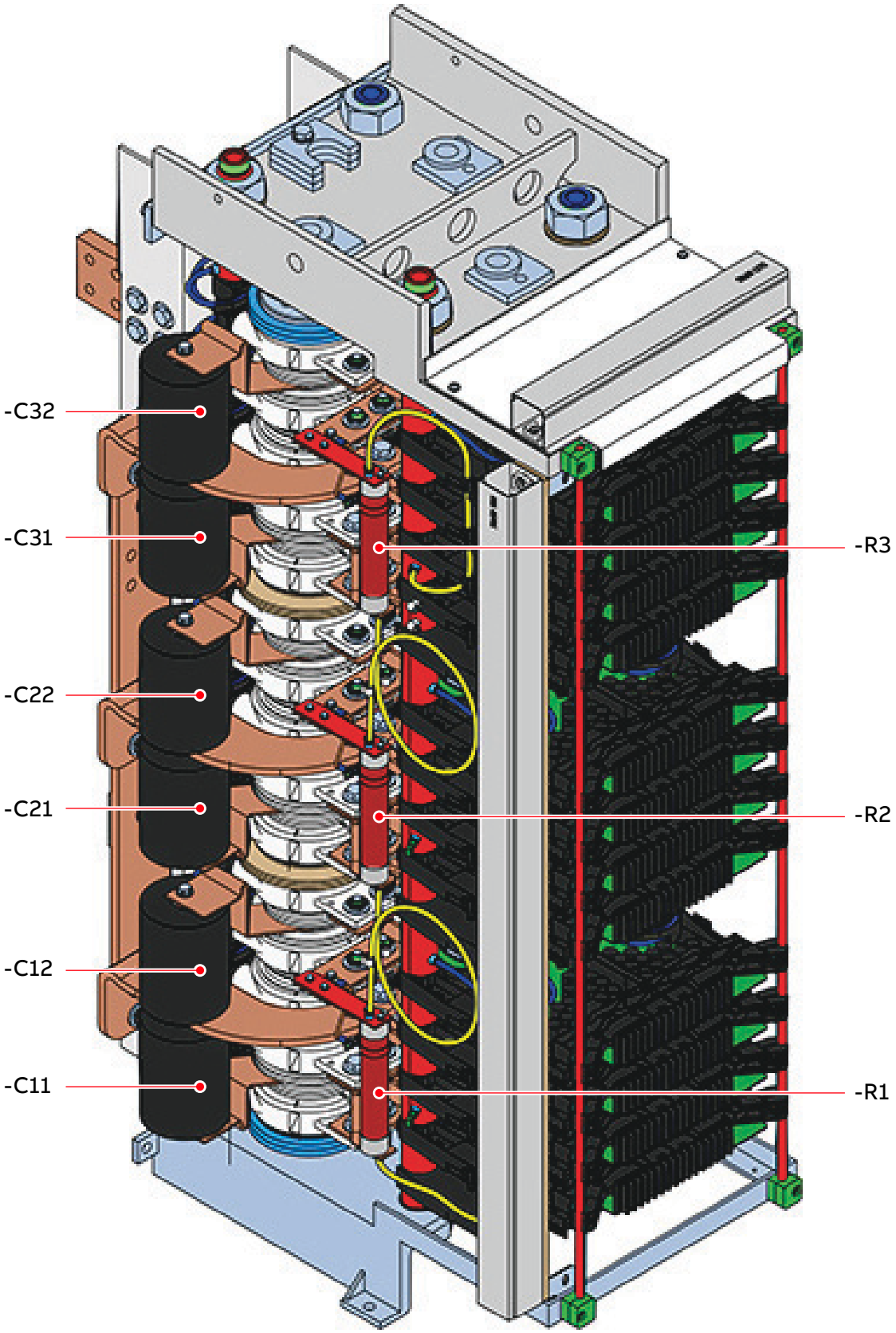


Figure 9–4 Clamp capacitors and symmetry resistors

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

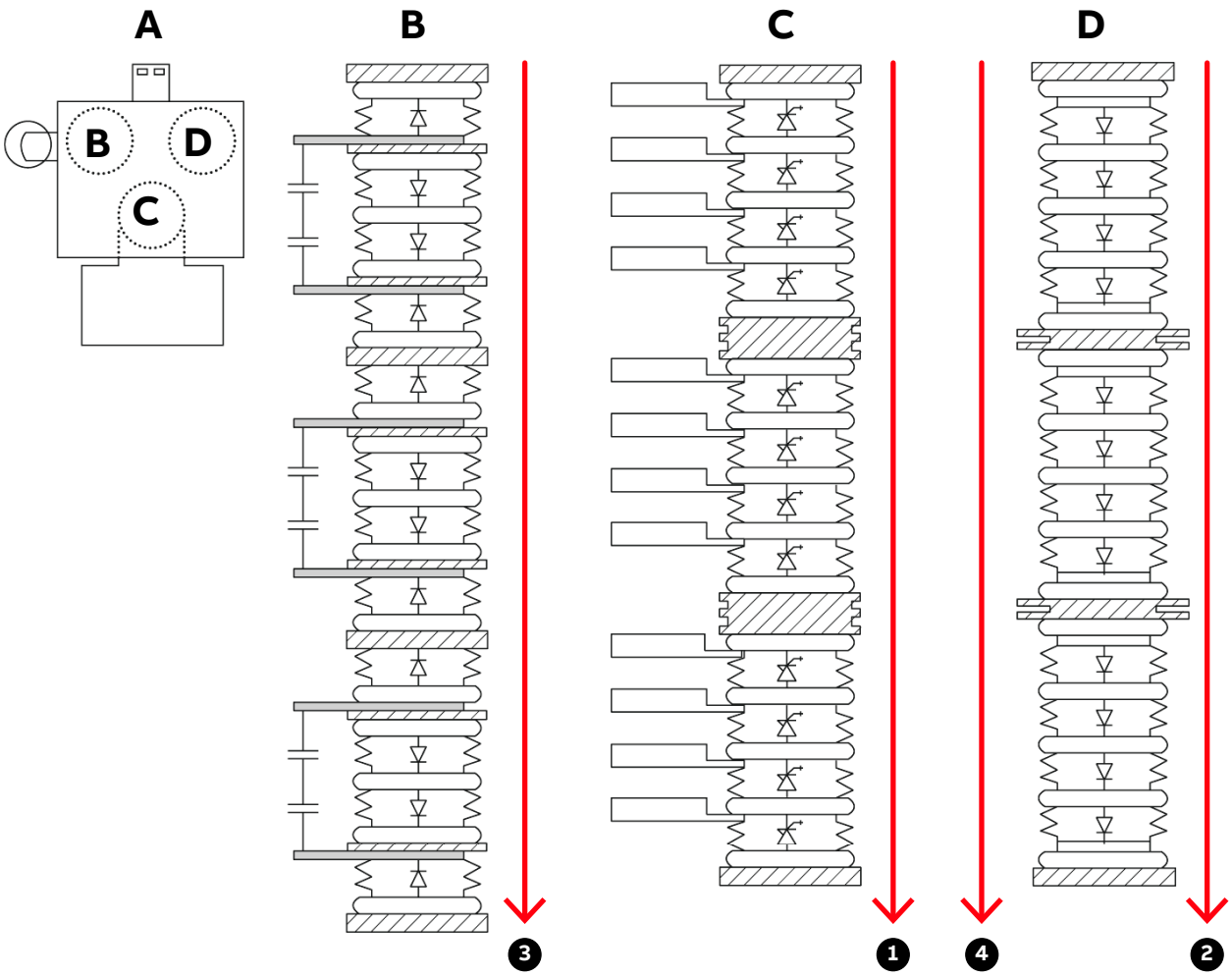


Figure 9–5 Semiconductor orientation

(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.

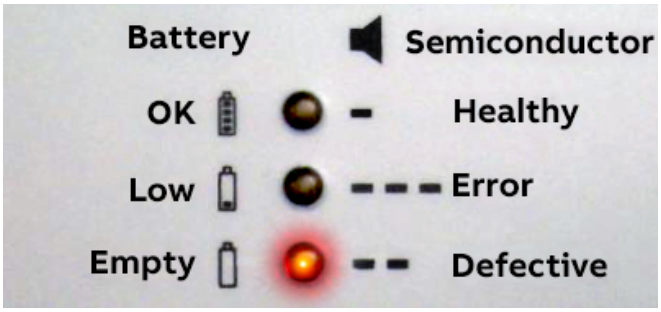


Figure 9–7 FADEC 3 Indication of defective semiconductor

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.

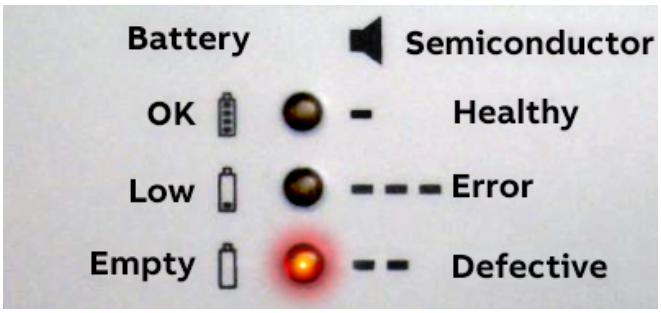
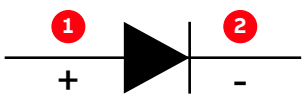


Figure 9–9 FADEC 3 Indication of defective semiconductor

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.

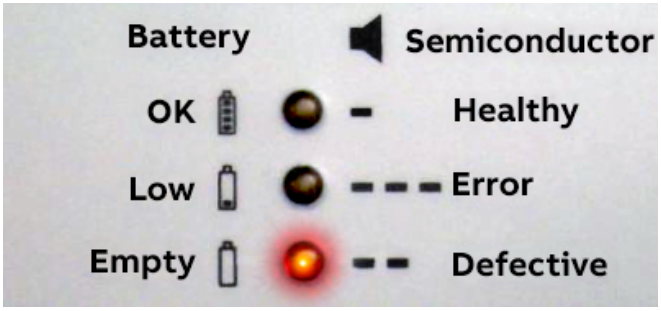
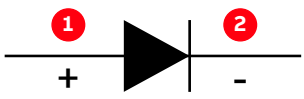


Figure 9–11 FADEC 3 Indication of defective semiconductor

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.

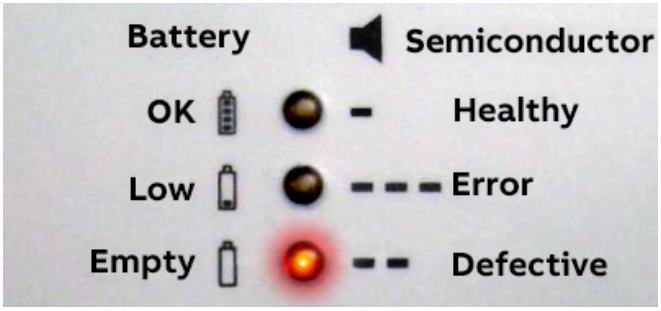
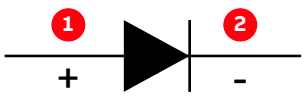


Figure 9–13 FADEC 3 Indication of defective semiconductor

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).

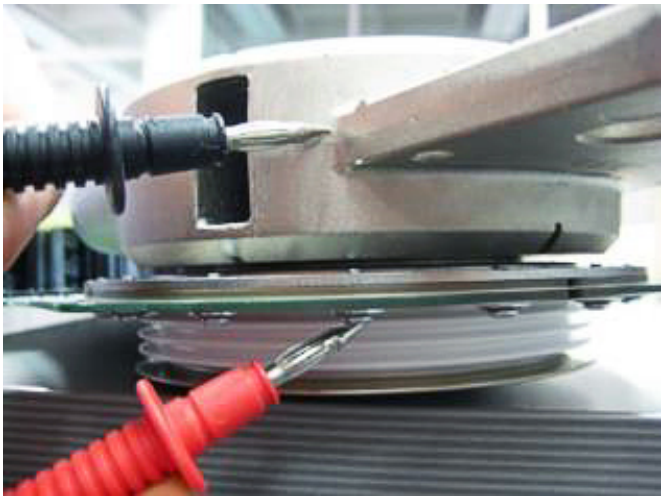


Figure 9–14 Correct measuring between gate and cathode

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

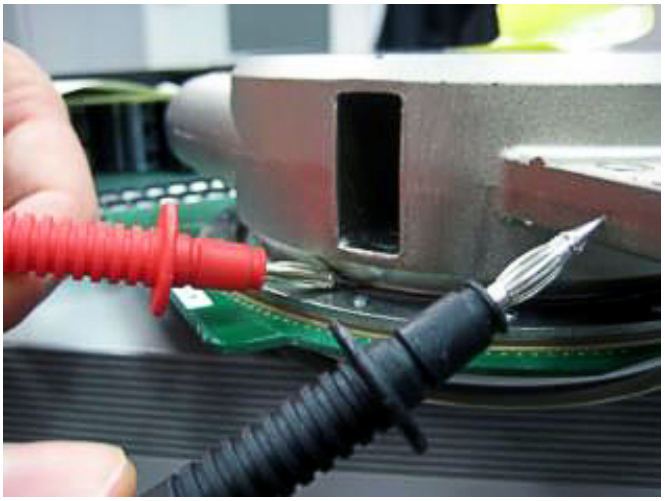


Figure 9–15 Wrong measuring between gate and cathode

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.

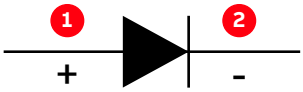
9.9.1. Preparation for checking power diodes

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).

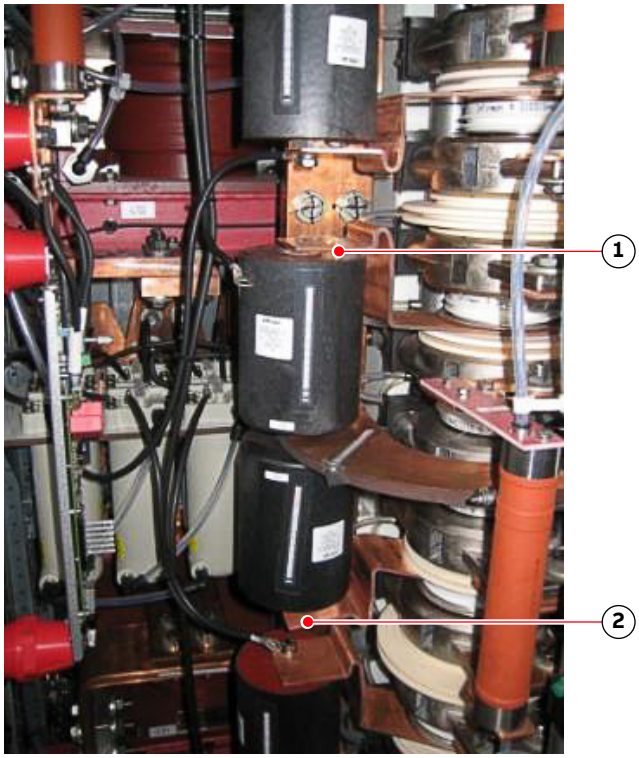


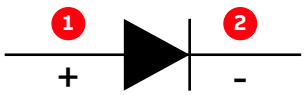
Figure 9–16 Clamp resistor connections

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.

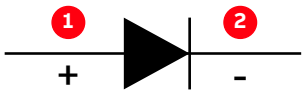
6. Reconnect the capacitor wires (torque 5.5 Nm).

   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.

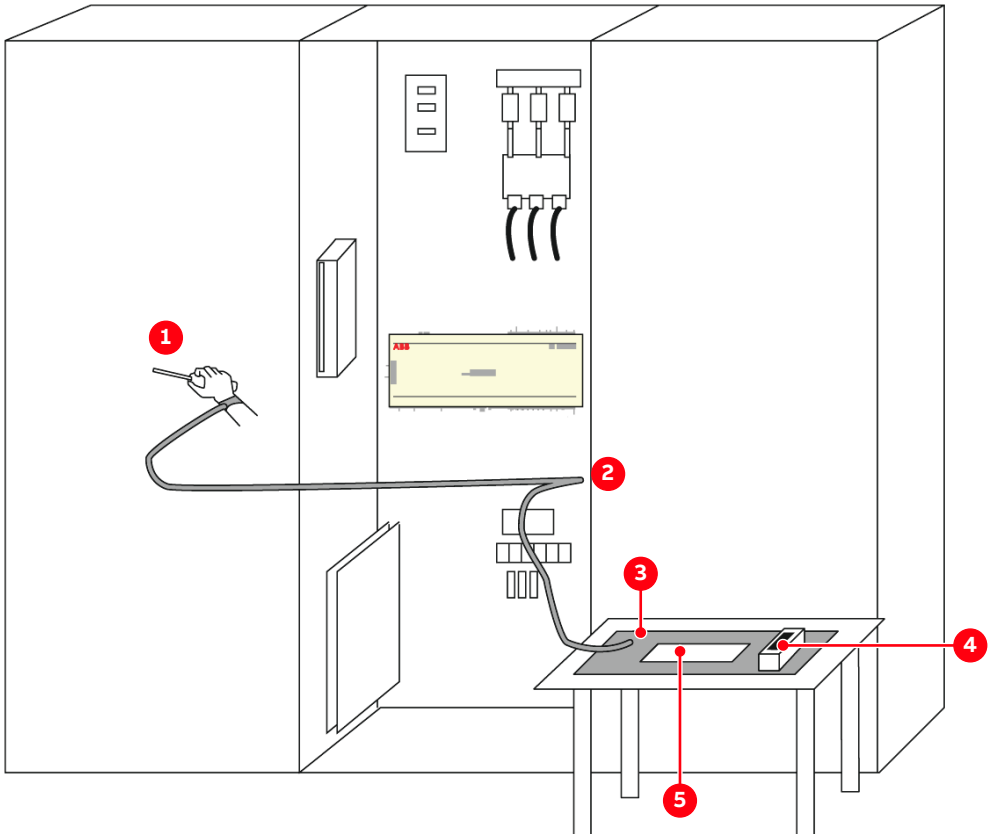


Figure 10–1 ESD precautions

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:

Table 10–2 Standard tightening torques for bolted connections

Bolt size	Torque
M4	2 Nm
M5	3 Nm
M6	5.5 Nm
M8	15 Nm
M10	30 Nm
M12	Busbar connections: 40 Nm Other connections: 60 Nm
M16	120 Nm

10.4.1.1. Capacitors

Tightening torques for capacitors are given in the relevant data sheets or are indicated on the capacitor housings. If not indicated otherwise, the following maximum torques apply:

– **Filter capacitors:** 10 Nm for mechanical connections and 1.2 Nm for electrical connections

– **Intermediate circuit capacitors:** 10 Nm for mechanical and electrical connections

10.4.2. Training for maintenance and repair personnel

NOTICE **Risk of component damage.**

- During the warranty period, any repair work must be carried out exclusively by ABB service personnel.
- ABB recommends periodical training for the maintenance and repair personnel.

10.4.2.1. Service training

Maintenance and service training courses are offered by ABB on request. Customer staff having successfully attended such courses, will be certified to do maintenance and repair work on the PCS6000 after the warranty period.

For more information contact your ABB service representative.

10.4.3. List of PCS6000 components > 25 kg

⚠CAUTION **Heavy objects!**

- Use lifting aids and proper lifting technique, when lifting and moving the components that are listed in Table 10–3.

Table 10–3 contains all possible components that weigh > 25 kg, which contains the complete PCS6000 product family.

Table 10–3 List of components > 25kg of PCS6000 product family

Material	Name of material	Weight (kg)	Dimensions (mm)
3BHE034815R0001	BRM Braking Resistor Module 3R0 Widap	74.00	1000 x 330 x 236
3BHE034908R0001	BRU50 Braking Resistor Unit	200.00	1150 x 400 x 1025
3BHE046614R0001	BRU51 Braking Resistor Unit	235.00	1156 x 790 x 731
3BHE045278R0001	BRU55 Braking Resistor Unit	260.00	1500 x 1190 x 872
3BHE046412R0001	BRU56 Braking Resistor Unit	238.00	1504 x 1190 x 935
3BHE034909R0001	BRU70 Braking Resistor Unit	400.00	1200 x 650 x 1025
3BHE046363R0001	BRU70 Braking Resistor Unit Gen01	340.00	1300 x 650 x 1081
3BHE038360R0001	BRU71 Braking Resistor Unit	400.00	1200 x 650 x 1025
3BHE044919R0001	BRU80 Braking Resistor Unit	500.00	1050 x 650 x 1169
3BHE035425R0001	Reactor 0.005mH, 3725A, air	25.00	370 x 320 x 220
3BHL000733P0108	Reactor 0.69mH, 928A, core	782.00	110 x 53 x 73
3BHE008528R0001	Filter Capacitor 3X 36uF 2.3 kV AC	72.00	340 x 190 x 779
3BHE034911R0001	FRM70 Filter Reactor Module	900.00	880 x 646 x 1170
3BHE034913R0001	GBM30 Generator/Grid Breaker Module	160.00	720 x 390 x 704
3BHE034914R0001	GBM50 Generator/Grid Breaker Module	120.00	704 x 526 x 730
3BHE041013R0001	GBM80 Generator Breaker Module	210.00	550 x 650 x 850
3BHE044922R0001	GDM80 Generator/Grid Disconnector Module	55.00	752 x 476 x 425
3BHB006617R0004	HV-Capacitor 3-Phase 3x80µF, 3.3kV, 48A	44.00	345 x 175 x 560
3BHE031197R0001	PES PEB 3PH 3kV PCD I01 -A01	360.00	570 x 742 x 1367
3BHE034555R0001	PES PEB 3PH 3kV PCD I02 -A01	300.00	570 x 742 x 1367
3BHE019196P1330	Precharging Trans. 30 kVA, 400 V, Yny0	115.00	400 x 156 x 450
3BHE038551R0001	Pump WCU30, 300 l/min 3x400V 50Hz 5.5kW	77.00	218 x 498 x 300
3BHE043674R0001	Pump WCU80, 565min/l 3x400V, 50Hz, 11kW	90.00	218 x 498 x 300
3BHE037940R0001	Pump with Motor 525l/min 3AC400V 7.5kW	146.00	218 x 498 x 300
3BHE034919R0001	VLM30 Voltage Limiting Module	50.00	512 x 528 x 440
3BHE034262R0001	VLM70 Voltage Limiting Module	60.00	528 x 513 x 440

Table 10–3 List of components > 25kg of PCS6000 product family (continued)

Material	Name of material	Weight (kg)	Dimensions (mm)
3BHE045468R0001	Wilo Pump (Helix) 520l/min 3AC400V 7.5kW	84.00	320 x 296 x 1177
3BHE045481R0001	Wilo Pump (Helix) 580l/min 3AC400V 9.0kW	146.00	320 x 296 x 1177
3BHE048994R0001	Wilo Pump (Helix) V2204/3-2/16/V/K/460-6DC-Link	137.00	320 x 296 x 1177
3BHB006617R0013	Cap. DCMKP 2.6kV/2x1.5mF	49.00	345 x 175 x 690
3BHB006617R0014	DC-Link Cap. DCMKP 3.15kV/2x1.01mF	49.00	345 x 175 x 690

10.5. Preparation of cooling liquid circuit before replacing components

⚠ CAUTION Hot liquid!

Cooling liquid temperature can exceed 50°C!

- Pay attention to the direction of the vent hose and make sure that escaping cooling liquid does not cause injury to persons or damage to the components.
- Leakage of cooling liquid into the converter needs to be avoided, especially glycol causes severe pollution of the converter.

10.5.1. Releasing the over pressure from the cooling liquid circuit

Replacement of certain components connected to the cooling liquid circuit requires releasing the over pressure from the cooling liquid circuit.

1. Switch off cooling pump and secure against restarting.
2. Place a catching tray under the valve V82 in such a way that escaping cooling liquid when releasing pressure does not spill into the converter.

   IMPORTANT! The catching tray must be capable of catching approximately 5 liters of liquid.
3. Close valve V51.
4. Isolate all parts of the cooling circuit which do not need to be released (V30/V31 for the Filter, V56 for the expansion vessel or, if applicable, valves in the external cooling circuit.
5. Open valve V82.
6. Close valve V82 again if no further cooling liquid escapes.
7. Remove the catching tray from the converter cabinet.

8. Wipe up any remnants of leaked cooling liquid.

10.5.2. Emptying the cooling liquid circuit

Replacement of certain components connected to the cooling liquid circuit requires emptying the cooling liquid circuit.

1. Cut off the external cooling circuits to/from external heat exchanger and to/from the filter unit if they need not be emptied (external valves and valves V30 / V31 and V56).
2. Release the over pressure of the cooling system as described in section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138.
3. Place a catching tray under the drain valve V82 to collect the escaping cooling liquid when opening the valves.

   IMPORTANT! The volume of the cooling liquid can be more than 250 L.
4. Open valve V82 to drain the cooling liquid. Ensure that V51 is open.
5. Open the venting valve in the FCA.
6. Close valve V82 again if the cooling liquid circuit is empty.
7. Remove the catching tray from the converter cabinet.
8. Wipe up any remnants of leaked cooling liquid.

10.6. Replacing components in POU

After faulty semiconductors have been identified, they have to be ex-changed according to the procedures below.

Converter service tools from the toolbox (3BHB008753R0001) for standard converters are required to carry out these procedures eg, a spreading tool and a stabilizer plate (see chapter 3, **Service tools**, page 31).

To ensure sufficient cooling, each stack is clamped with a specified clamping force. To exchange semiconductors, the clamping force must be released.

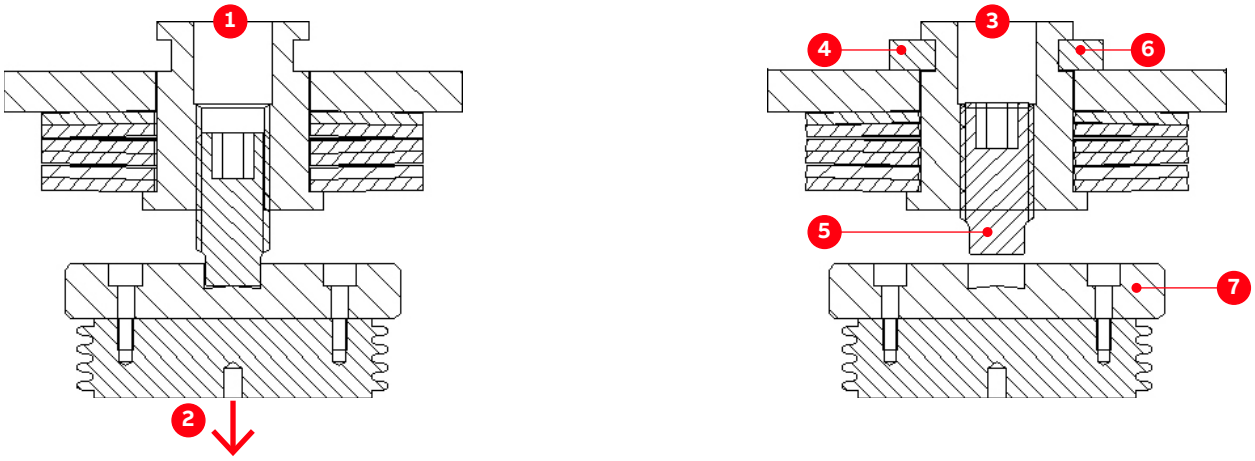


Figure 10–2 Clamping components

1) Stack clamped	5) Clamping screw
2) Force	6) Pressure loading gauge
3) Stack released	7) Pressure plate
4) Tension	

10.6.1. General procedure to replace power semiconductors

NOTICE **Risk of component damage.**

- All stacks containing semiconductors must be released before using the spreading tool.

1. Discharge the DC-link, earth all power connections at the foreseen positions and check the converter for residual voltage before doing any other work on the converter.
2. Check the computer screen in “PCS6000 HMI” to find out which phase module has initiated the failure.
3. Check all IGCTs according to section 9.8, **Checking IGCTs with multimeter (if a FADEC 3 is unavailable)**, page 127.
4. Replace faulty IGCTs according to section 10.6.4, **Replacing IGCTs**, page 149.
5. Check all power diodes according to section 9.9, **Checking power diodes with multimeter**, page 129.
6. Replace faulty diodes according to section 10.6.5, **Replacing power diodes**, page 153.
7. After the replacement of the faulty diodes recheck all diodes in the corresponding module.

   IMPORTANT! More than one semiconductor in the module may be faulty due to secondary failures after a short circuit in one phase module.

10.6.2. Releasing the stacks

1. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
2. 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).

   NOTE – No IGCTs in the stack are powered anymore; all LEDs are dark.

   Verify that all power supply cables to the IGCTs are voltage-free.

   NOTICE The power supply to the IGCTs must be switched off before releasing the stack! Otherwise the IGCTs could be damaged.

   IMPORTANT! Towards the back on top of each triple stack module you will find three U-shaped pressure loading gauges in their storage place (mounted with screw, use 19 mm wrench to loosen).
3. Take the three pressure loading gauges from their storage places and insert them completely under the tension jacks of the three stacks (see Fig. 10–3).

   NOTICE The pressure loading gauges must be inserted completely before the stack can be released (see Fig. 10–4). Otherwise the tension jacks can break.

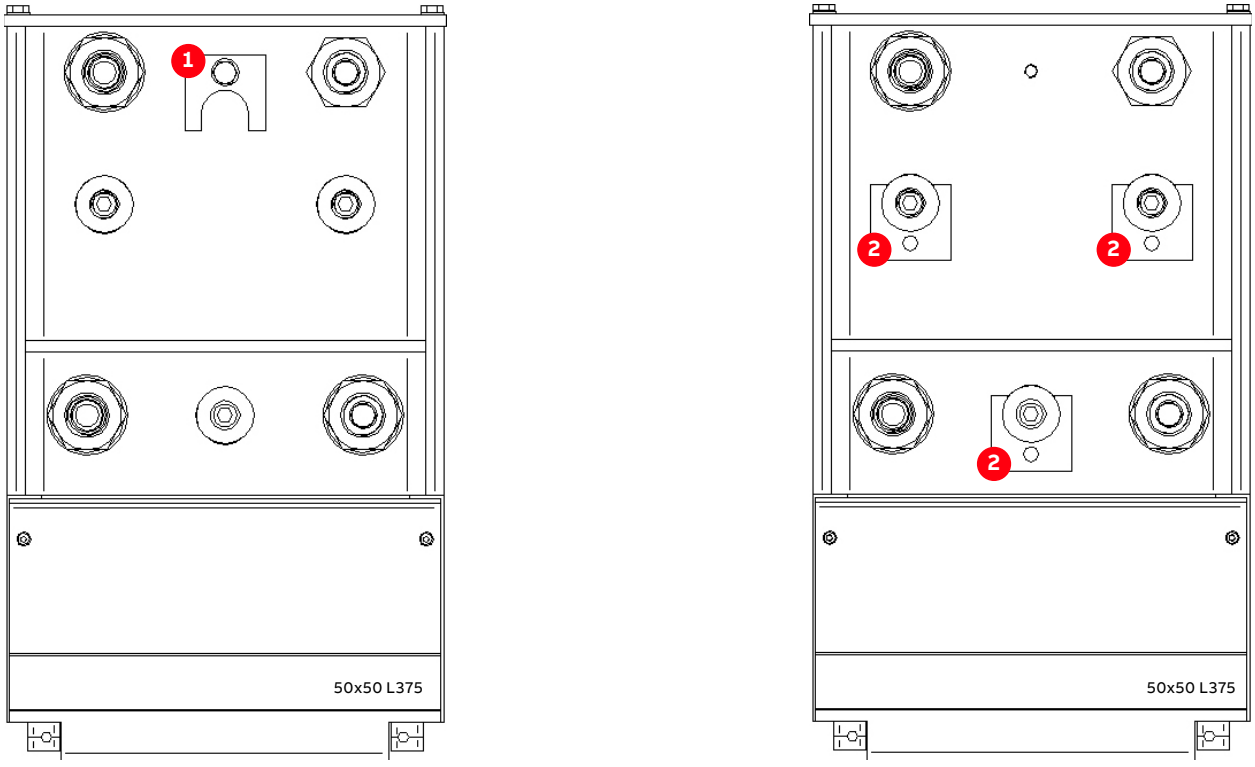


Figure 10–3 Pressure loading gauges

1) Pressure loading gauge in storage place	2) Pressure loading gauges placed under tension jacks

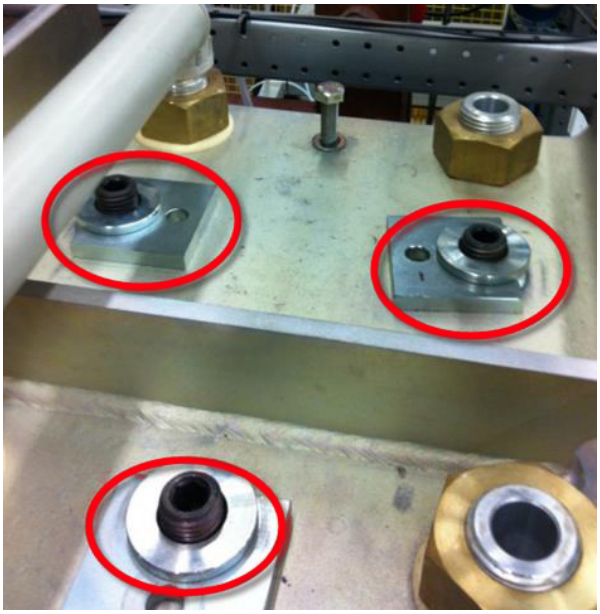


Figure 10–4 Pressure loading gauges inserted

4. Loosen all 24 fixation screws of the gate unit fixations (see Fig. 10–5) using a 5 mm Allen wrench to make sure that the gate unit fixation can move freely in vertical direction.

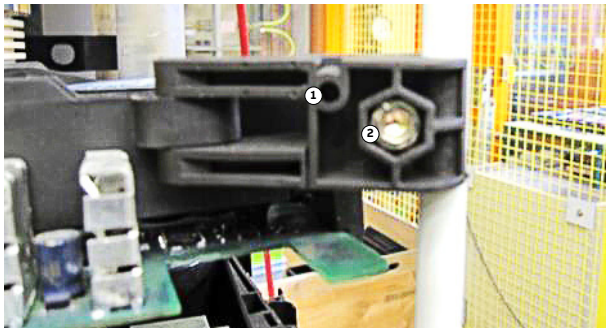


Figure 10–5 Gate unit fixation

1) Gate unit fixation	2) Fixation screw

5. Release all three stacks in the order given in Fig. 10–6 by loosening the clamping screws counter-clockwise using the socket wrench with 12 mm Allen socket.

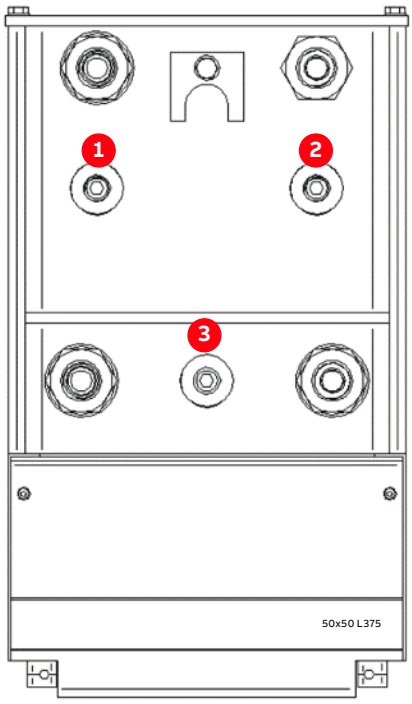


Figure 10–6 Order of loosening the clamping screws

NOTICE Stack misalignment can damage the semiconductors. Release the stacks in the following sequence:

1)Neutral point and clamp diode stack

2)Freewheeling diode stack

3)IGCT stack

The clamping screws must be unbolted until they reach above the pressure plate (see Fig. 10–2).

6. Enter a stabilizer plate in the bottom of the stack where a semiconductor needs to be exchanged as shown in Fig. 10–7.

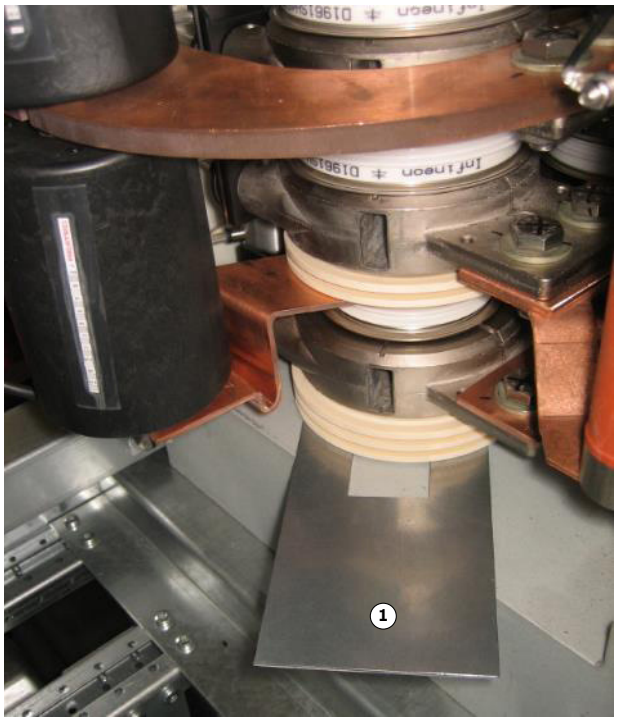


Figure 10–7 Stabilizer plate insertion

1) Stabilizer

10.6.3. Using the spreading tool

NOTICE **Risk of component damage.**

Stack misalignment due to the incorrect use of the spreading tool can damage the semiconductors.

- Only use the spreading tool on released stacks.
- Always support the spreading tool with your hand (arrow in Fig. 10–8).
- Always insert the spreading tool horizontally into a stack. DO NOT attempt to insert the tool from any other angle.

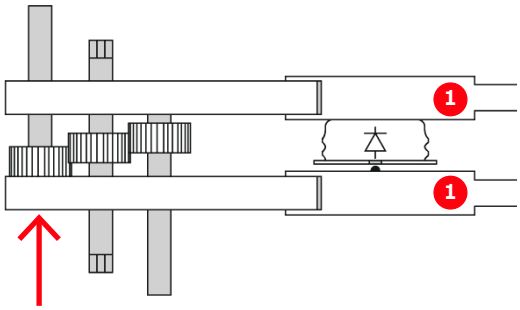


Figure 10–8 Manual support during spreading tool insertion

Procedure:

1. Insert the spreading tool completely into the slots of the coolers (heat sink) above and below the faulty semiconductor as shown in Fig. 10–9.

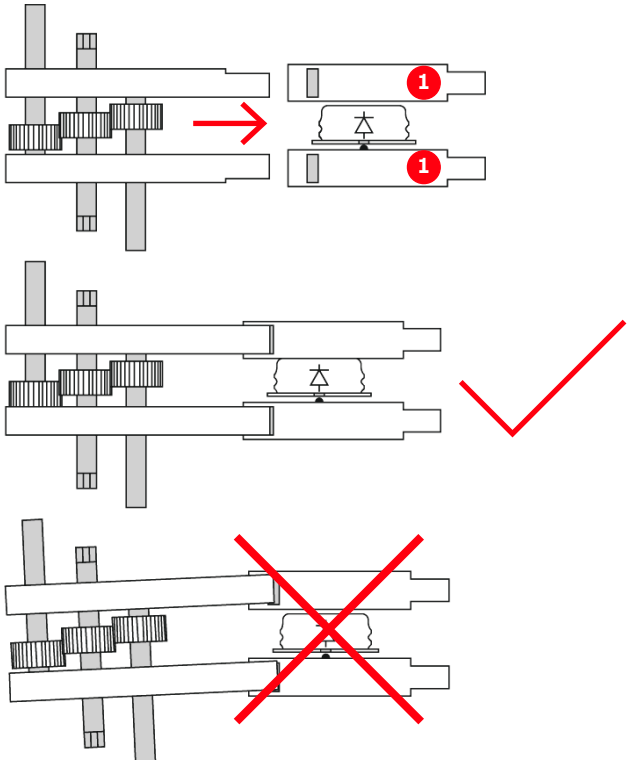


Figure 10–9 Spreading tool insertion

1) Heat sink

2. Expand the spreading tool by turning the middle rod with a 13 mm wrench to lift off the top heat sink so that the semiconductor can be removed (see Fig. 10–10).

NOTICE Excessive lifting might cause damage to the stack! DO NOT separate the two heat sinks more than necessary to remove the semiconductor.

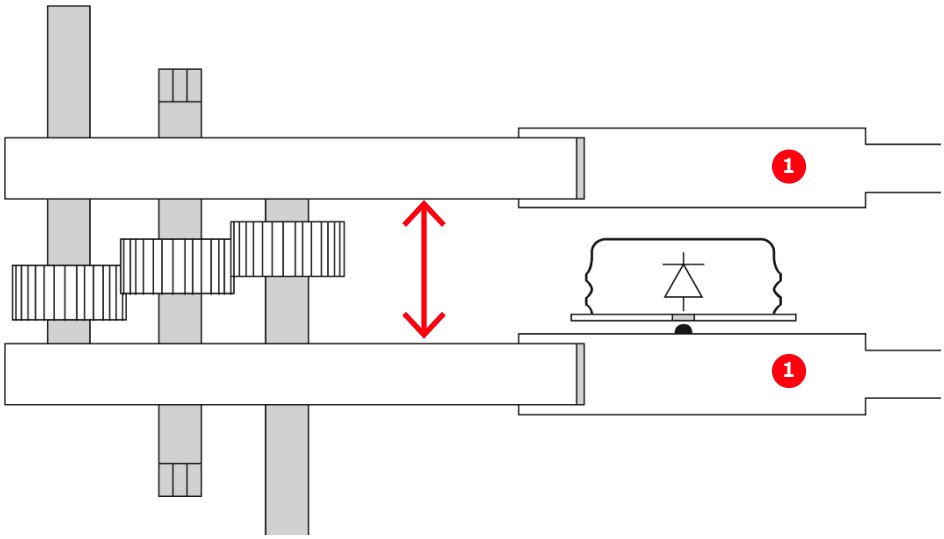


Figure 10–10 Spreading tool expansion

1) Heat sink

– For replacing the neutral point diodes the spreading tool must be applied over three heat sinks (see Fig. 10–11).

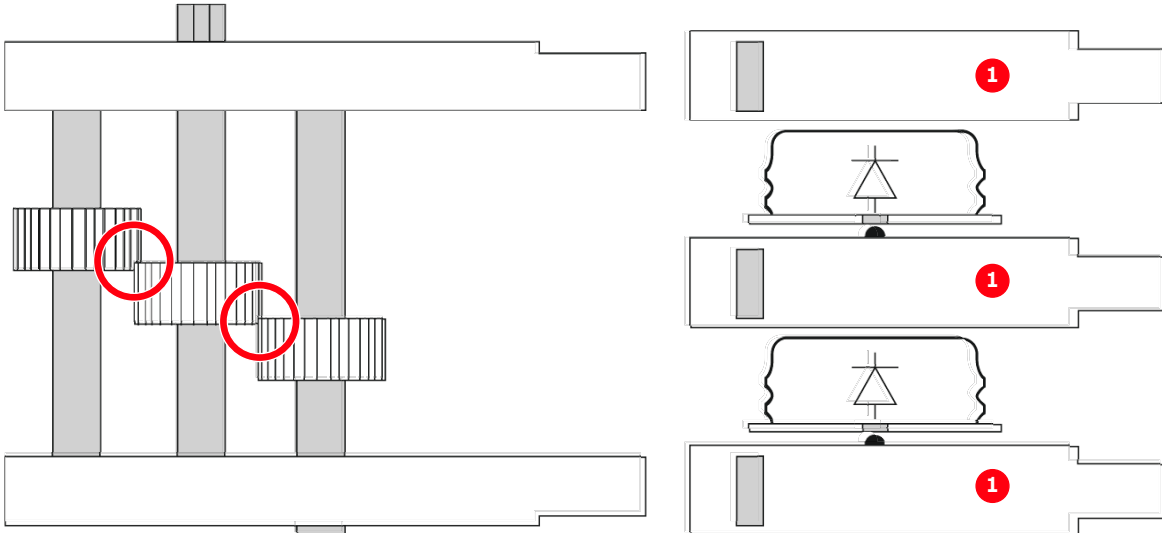


Figure 10–11 Spreading tool applied over three heat sinks

IMPORTANT! The spreading tool must not be spread too far; the gear wheels must grip into each other at least 3 mm.

Fig. 10–12 shows an example of the use of the spreading tool, inserted in the IGCT stack. Turning the wrench clockwise would open the stack.

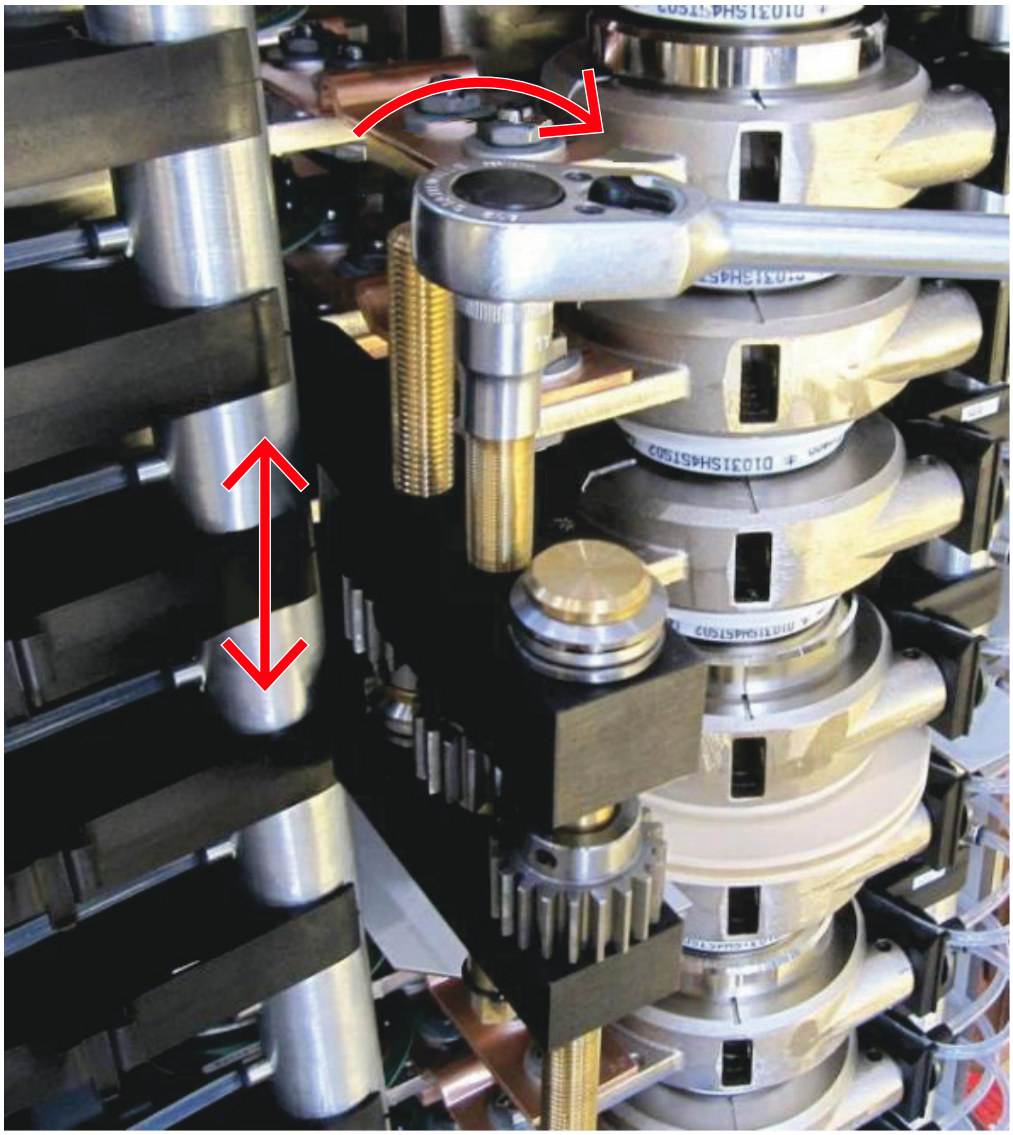


Figure 10–12 Spreading tool use example

10.6.4. Replacing IGCTs

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1. Release the stacks according to section 10.6.2, **Releasing the stacks**, page 141.
2. Disconnect the fiber optic and power supply cables of the faulty IGCT as well as the one directly above it.

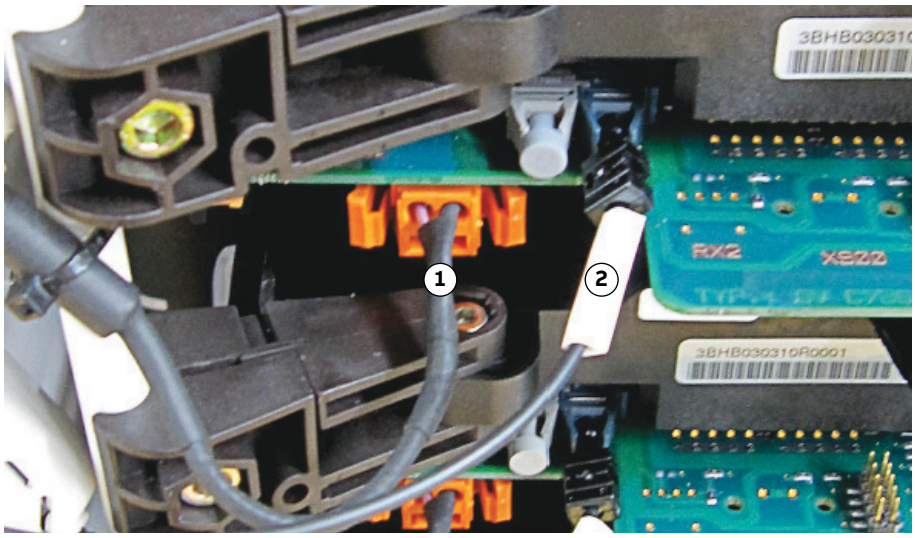

Figure 10–13 Disconnecting cables from IGCT

1) Power supply cable	2) Fiber optic cable

3. Remove both gate unit fixations (left and right) of the faulty IGCT completely by loosening the mounting screws with a 3 mm Allen wrench.
   IMPORTANT! Do not drop the nut from the bottom side.

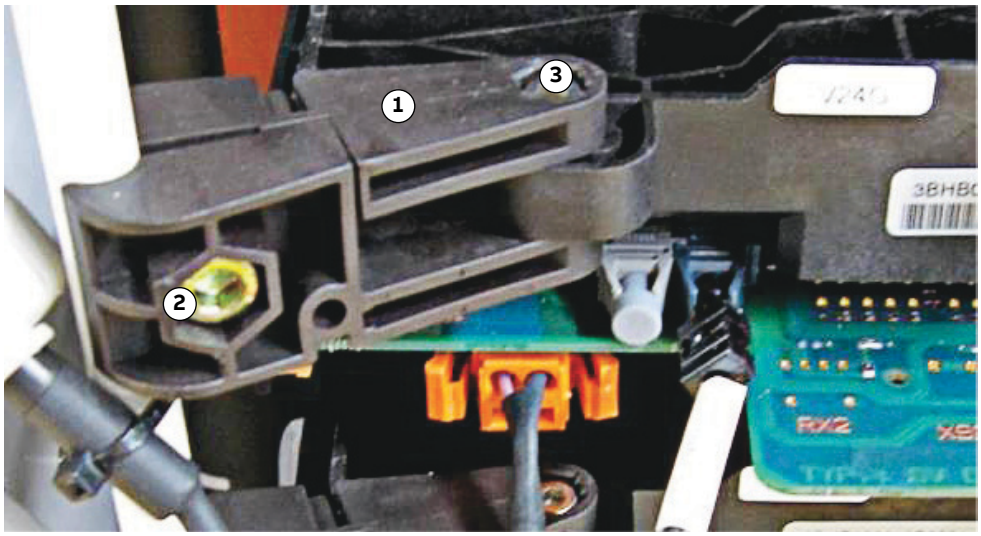

Figure 10–14 Removing the gate unit fixations of the IGCT

1) Gate unit fixation	3) Mounting screw
2) Fixation screw (has been loosened prior to releasing stacks)	

4. Insert the spreading tool completely into the slots of the heat sinks above and below the faulty IGCT and expand it according to section 10.6.3, **Using the spreading tool**, page 145.
5. Extract the IGCT.

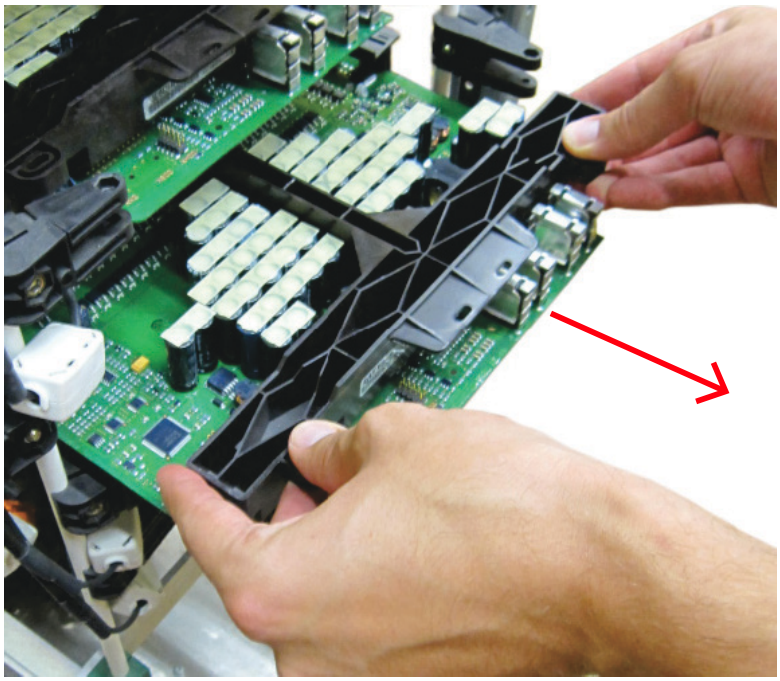

Figure 10–15 Extracting the IGCT

NOTICE Hold the IGCT at the black plastic frame and support from underneath as shown in Fig. 10–16.Avoid touching the gate drive board or semiconductor.

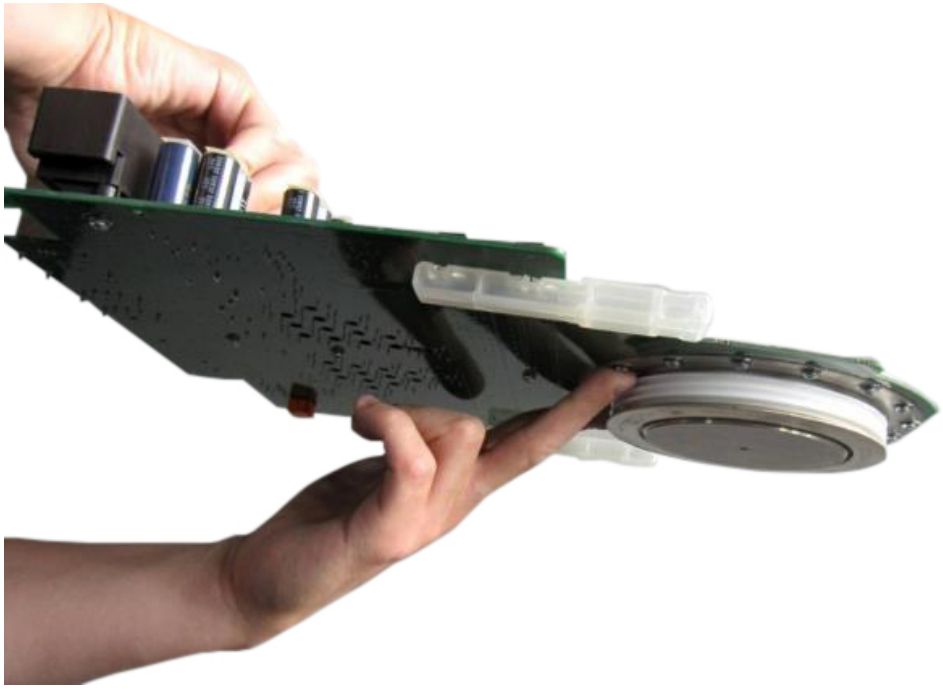

Figure 10–16 Correct handling of IGCT

6. Insert the new IGCT carefully in the guiding rail until it is snapped into position by the positioning and stop device.

NOTICE Incorrect insertion of the IGCT can damage the IGCT and misalign the stack. When the IGCT is correctly inserted it can be heard and felt when it snaps into position.

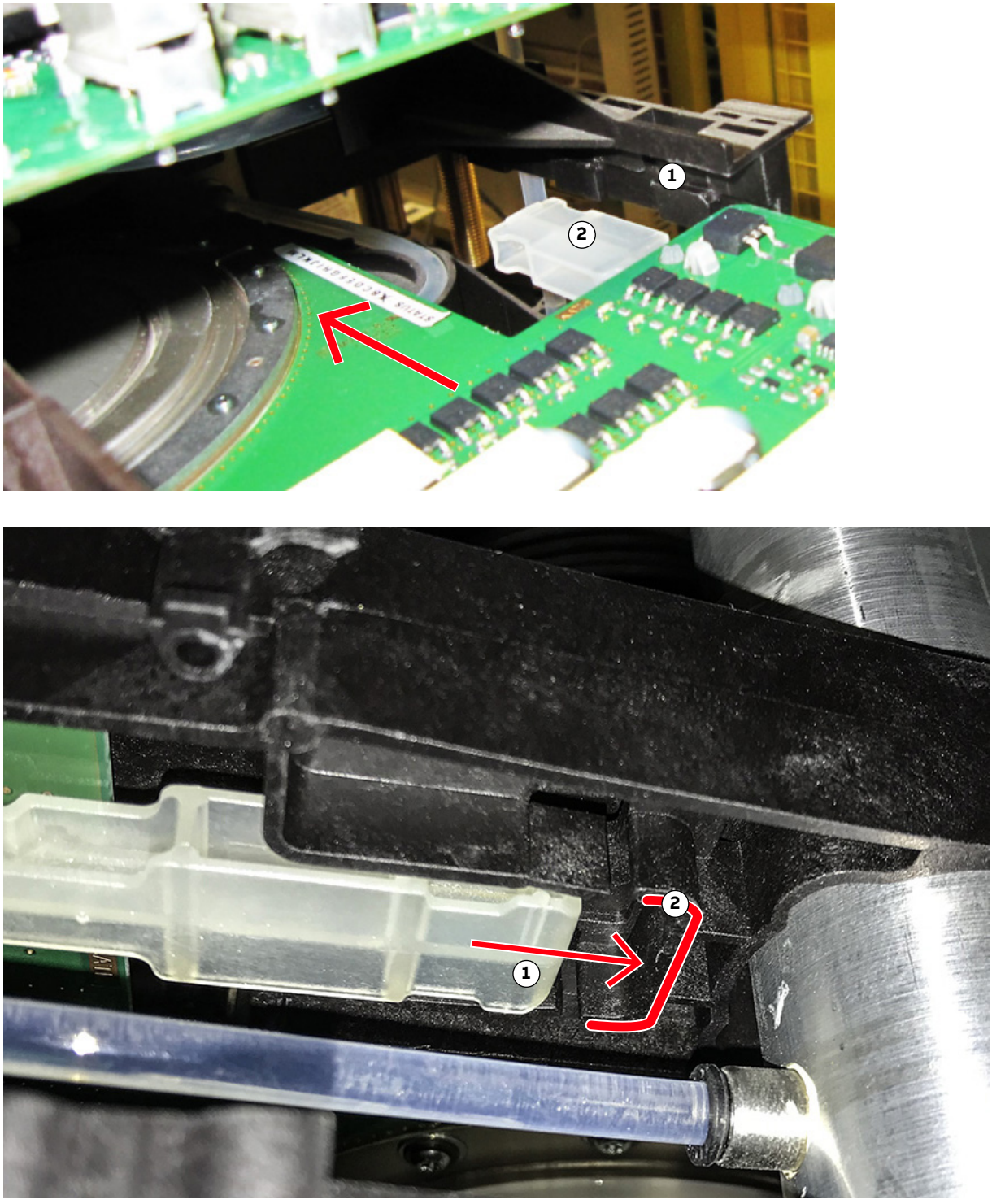

Figure 10–17 Inserting the IGCT

1) Guiding rail	2) Positioning and stop device

7. In case the new IGCT is not fitted with positioning and stop devices remove them from the faulty IGCT and use them on the new one (see Fig. 10–18).

CAUTION! DO NOT use any grease or any electrical joint compound.

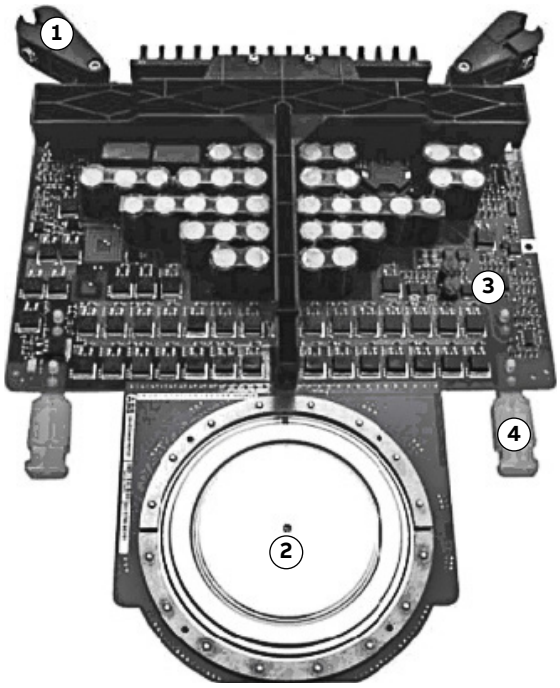

Figure 10–18 IGCT components

1) Gate unit fixation	3) Gate drive
2) Semiconductor	4) Positioning and stop device

8. Clean the contact surfaces of the IGCT with a fluff-free cloth.

- Clean heavily polluted surfaces with a cleansing agent (eg, pure alcohol). The surfaces must be free from dust, fat and oil.
- Make sure not to scratch the surface.

9. Lower the stack and remove the spreading tool.

10. Remove the stabilizer plate.

11. Remount the gate unit fixations to the new IGCT without tightening the clamping screws (see Fig. 10–14).

12. Reconnect the fiber optic and the power supply cables (see Fig. 10–13).

13. Check the stack alignment according to section 10.6.6, **Checking stacks alignment**, page 159.

14. Tighten the stacks according to section 10.6.7, **Tightening the stacks**, page 166.

15. Re-check the IGCTs as described in section 9.8, **Checking IGCTs with multimeter (if a FADEC 3 is unavailable)**, page 127.

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

10.6.5. Replacing power diodes

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10.6.5.1. Replacing freewheeling diodes

⚠ CAUTION

- Always verify the polarity with the corresponding wiring diagram.
- DO NOT use any grease or any electrical joint compound.
- Pay attention to the correct polarity when inserting the new diode.

1. Release the stacks according to section 10.6.2, **Releasing the stacks**, page 141.
2. Insert the spreading tool completely into the slots of the coolers above and below the faulty diode and expand it according to section 10.6.3, **Using the spreading tool**, page 145.
3. Replace the faulty diode with a new one.
4. Clean the diode contact surfaces with a fluff-free cloth.

– Clean heavily polluted surfaces with a cleansing agent (eg, pure alcohol). The surfaces must be free from dust, fat and oil.

– Make sure not to scratch the surface.

5. Use the centering ball on the lower heat sink (see Fig. 10–19) to position the diode.

   The diode snaps in place when it has been centered correctly.

   NOTICE Failure to center the diode correctly can damage the diode and cause stack misalignment.

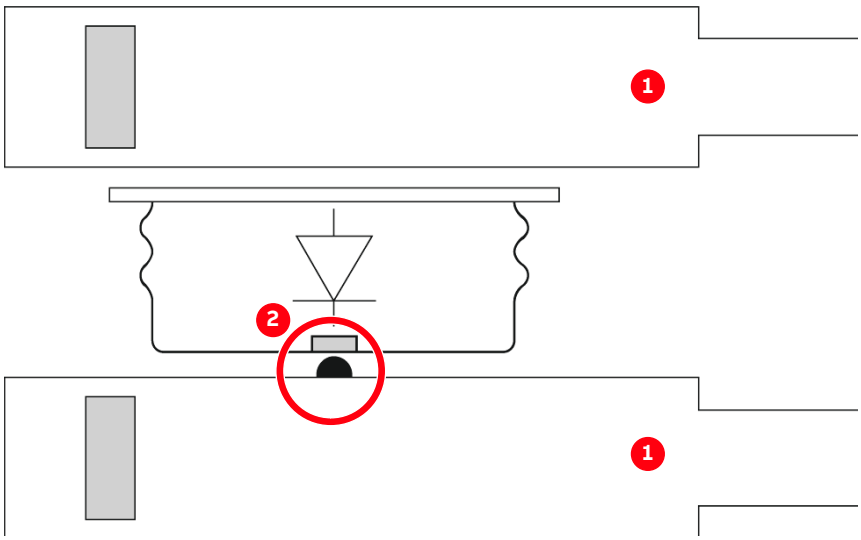


Figure 10–19 Centering freewheeling and neutral point diodes

1) Heat sink	2) Centering ball

6. Rotate the diode so that you can easily see the serial number (see Fig. 10–20).

Figure 10–20 Diode marking

7. Remove the spreading tool.

8. Check the stack alignment according to section 10.6.6, **Checking stacks alignment**, page 159.

9. Remove the stabilizer plate.

10. Tighten the stacks according to section 10.6.7, **Tightening the stacks**, page 166.

11. Re-check the diodes according to section 9.9.2, **Checking freewheeling diodes**, page 129.

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

10.6.5.2. Replacing clamp diodes

The position of the clamp diodes is at the top and bottom of each phase stack (see Fig. 10–21).

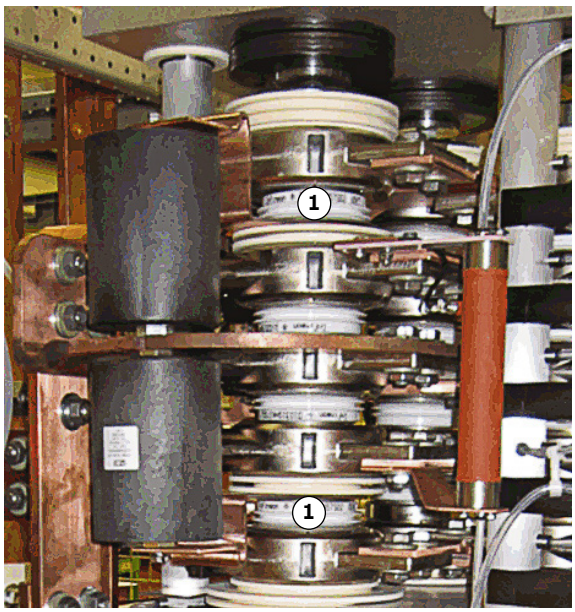


Figure 10–21 Clamp diodes

1) Clamp diode

⚠ CAUTION

- Always verify the polarity with the corresponding wiring diagram before inserting the new diode.
- DO NOT use any grease or any electrical joint compound.

NOTICE Risk of component damage!

Failure to center the diode correctly can result in stack misalignment and damage to the diode.

Procedure:

1. Release the stacks according to section 10.6.2, **Releasing the stacks**, page 141.
2. Insert the spreading tool completely into the slots of the coolers above and below the faulty diode and expand it according to section 10.6.3, **Using the spreading tool**, page 145.
3. For a smooth replacement, position the replacement diode next to the faulty one.

   IMPORTANT! The lower clamp diode is centered with a centering ball on the lower heat sink. The copper bar and the isolator is then centered on the diode. Great care must be taken not to lose the upper centering ball of the copper bar and the isolator while removing or replacing the diode. Ideally, get assistance of another person.
4. Remove the faulty diode and immediately insert the replacement diode.

5. Clean the diode contact surfaces with a fluff-free cloth.
   - Clean heavily polluted surfaces with a cleansing agent (eg, pure alcohol). The surfaces must be free from dust, fat and oil.
   - Make sure not to scratch the surface.
6. Use the centering ball to position the diode.
   - Upper clamp diode: centering ball is below the diode
   - Lower clamp diode: centering ball above and below the diode

   The diode snaps in place when it has been centered correctly.

   NOTICE Failure to center the diode correctly can damage the diode and cause stack misalignment.

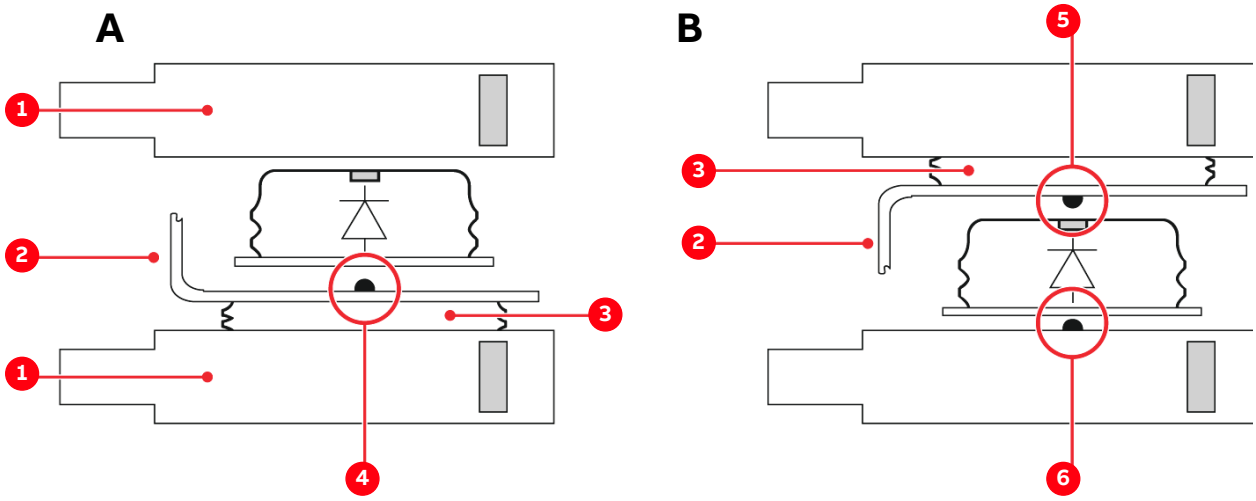


Figure 10–22 Centering upper (A) and lower (B) clamp diodes

1) Heat sink	4) Centering ball
2) Copper bar	5) Upper centering ball
3) Isolator	6) Lower centering ball

7. Rotate the diode so that you can easily see the serial number (see Fig. 10–20).
8. Remove the spreading tool.
9. Remove the stabilizer plate.
10. Check the stack alignment according to section 10.6.6, **Checking stacks alignment**, page 159.
11. Tighten the stacks according to section 10.6.7, **Tightening the stacks**, page 166.
12. Re-check the diodes according to section 9.9.3, **Checking clamp diodes**, page 130.
13. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.6.5.3. Replacing neutral point (NP) diodes

The NP diodes are located above and below the copper busbar (see Fig. 10–23).

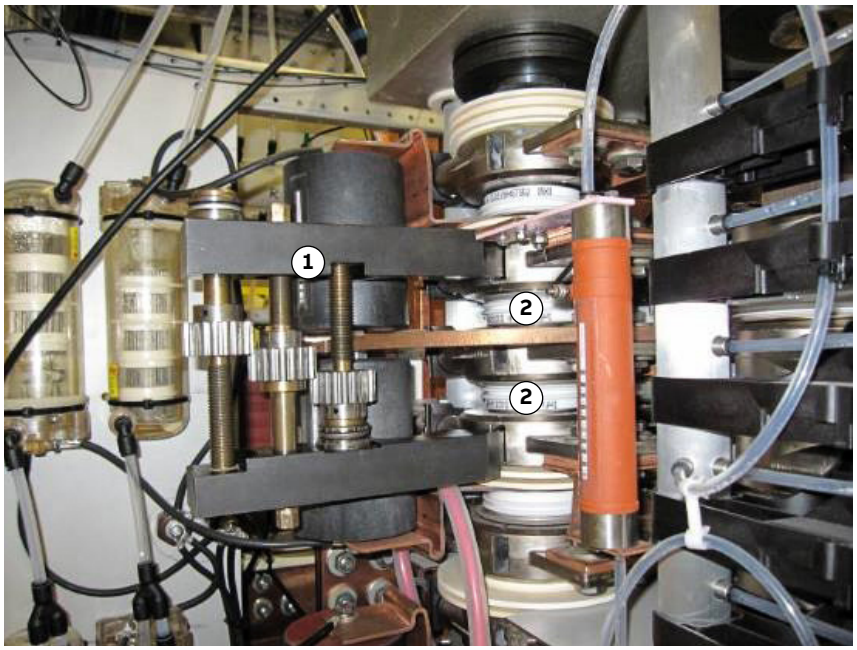


Figure 10–23 NP diodes

1) Spreading tool	2) NP diode

⚠CAUTION Hazardous Voltage!

- Always verify the polarity with the corresponding wiring diagram.
- DO NOT use any grease or any electrical joint compound.
- Pay attention to the correct polarity when inserting the new diode.

Procedure:

1. Release the stacks according to section 10.6.2, **Releasing the stacks**, page 141.
2. Insert the spreading tool into the slots above and below both NP diodes as illustrated in Fig. 10–23.

   Two diodes are in-between the spreading tool.

   IMPORTANT! The spreading tool must not be spread too far; the gear wheels have to grip into each other
3. Expand the spreading tool according to section 10.6.3, **Using the spreading tool**, page 145.
4. Replace the faulty diode with a new one.
5. Clean the diode contact surfaces with a fluff-free cloth.

– Clean heavily polluted surfaces with a cleansing agent (eg, pure alcohol). The surfaces must be free from dust, fat and oil.

– Make sure not to scratch the surface.

6. Use the centering ball on the lower heat sink (see Fig. 10–24) to position the diode.

   The diode snaps in place when it has been centered correctly.

   IMPORTANT! Failure to center the diode correctly can damage the diode and cause stack misalignment.

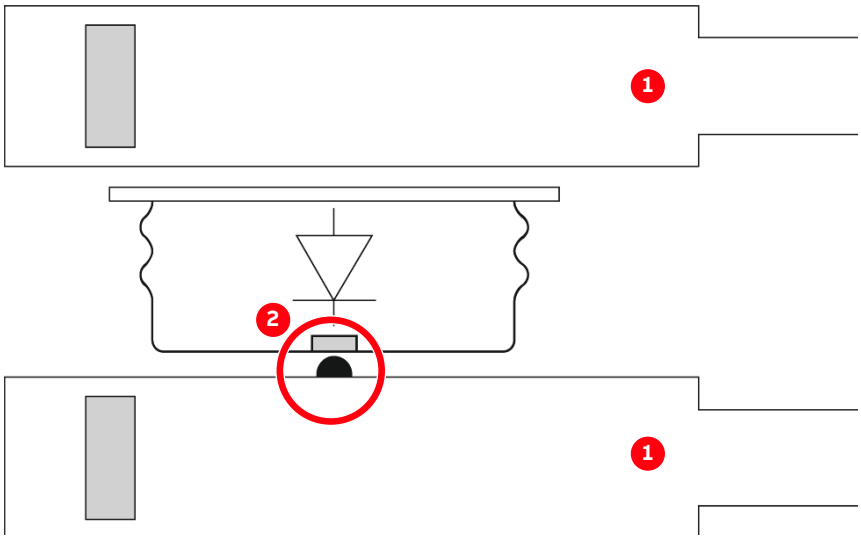


Figure 10–24 Centering freewheeling and neutral point diodes

1) Heat sink	2) Centering ball

7. Remove the spreading tool.
8. Remove the stabilizer plate.
9. Check the stack alignment according to section 10.6.6, **Checking stacks alignment**, page 159.
10. Tighten the stacks according to section 10.6.7, **Tightening the stacks**, page 166.
11. Re-check the diodes according to section 9.9.4, **Checking neutral point (NP) diodes**, page 131.
12. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.6.6. Checking stacks alignment

A stack is aligned when all stack elements, ie, isolators, heat sinks, semiconductors and intermediate pieces, are aligned to one another from bottom to top. In other words, correct alignment is not determined by perpendicularity.

> **NOTICE** **Risk of component damage!**
>
> Tightening a misaligned stack (IGCT, freewheeling diode, clamping / neutral point diode) can damage the semiconductor pole pieces, which can cause semiconductor failure during operation.
>
> - Always check the diode alignment and correct it if necessary BEFORE you tighten a diode in the stack.
> - Only align a stack AFTER the stacks pressure has been released. See section 10.6.2, **Releasing the stacks**, page 141.

Tools

Stack alignment requires the following tools:

– Converter service tools from the toolbox 3BHB008753R0001

– 1 meter long, straight and rigid object with a flat surface (eg, spirit level or wooden slat)

10.6.6.1. Aligning an IGCT stack

An IGCT stack is aligned when all IGCTs have been correctly inserted, ie, the positioning and stop device (1) of each IGCT has been fully inserted into the guiding rails (2).

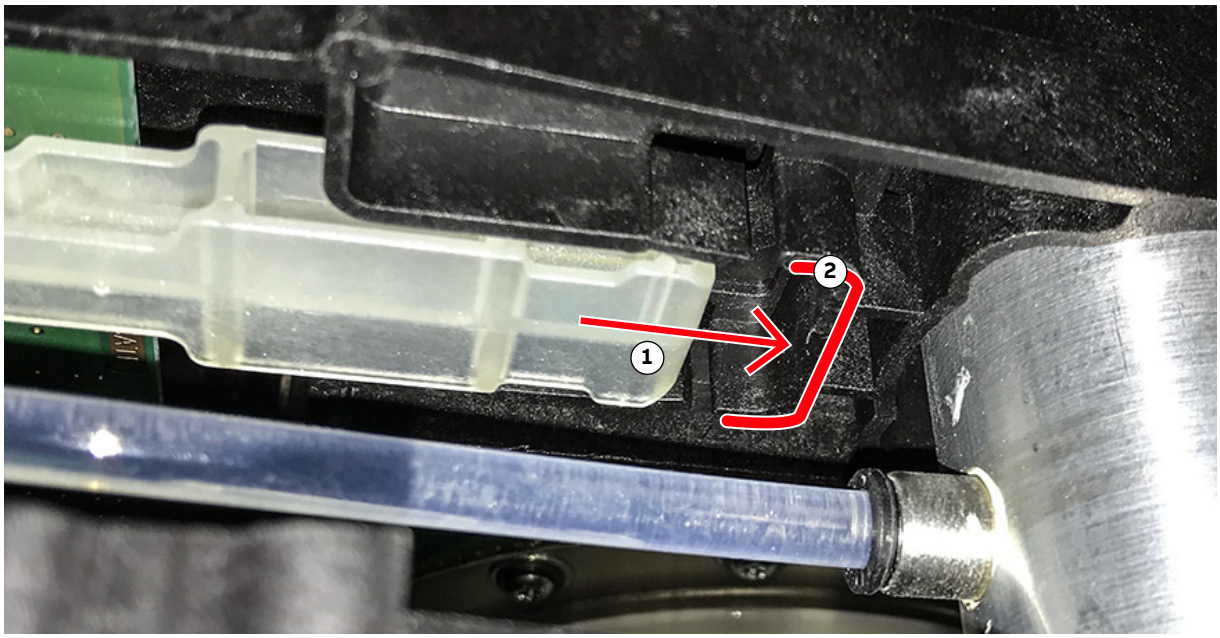


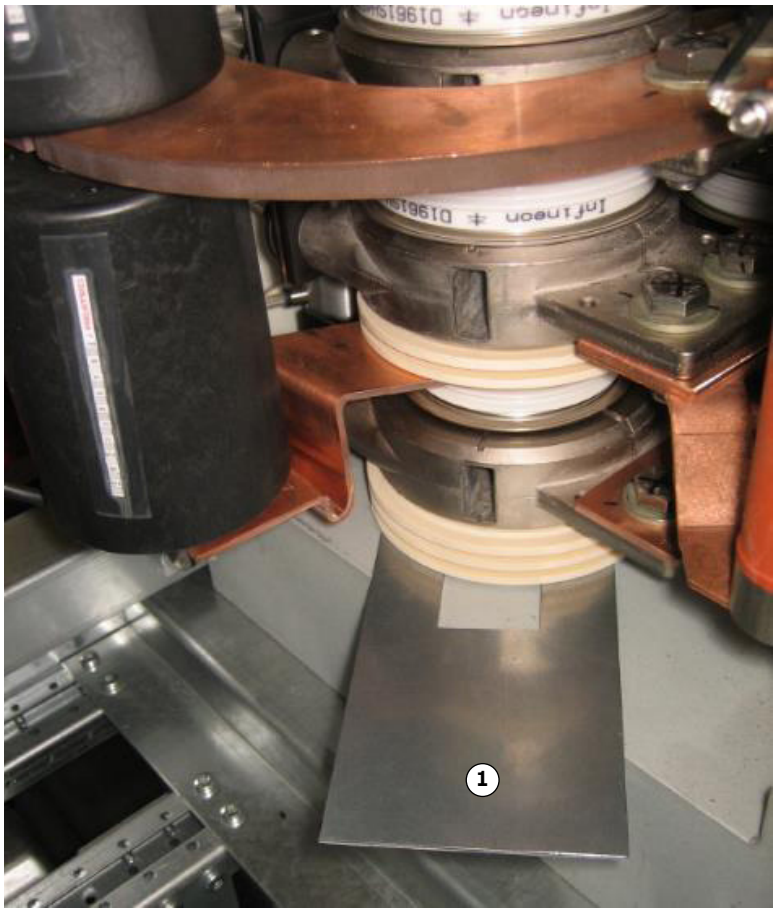
Figure 10–25 Example of positioning and stop device not fully inserted yet

1) Positioning and stop device	2) Guiding rails

IMPORTANT! If an IGCT has not been inserted correctly, use the following procedure:

Procedure:

1. Slide a stabilizer plate (1) under the IGCT stack.



2. Insert the spreading tool completely into the slots of the heat sinks above and below the faulty IGCT and expand it according to section 10.6.3, **Using the spreading tool**, page 145.
3. Push the IGCT further in until the positioning and stop device of the IGCT snaps into place.
4. Visually confirm that the positioning and stop device has reached the end position up against the guiding rails.
5. Lower the stack and remove the spreading tool.
6. Remove the stabilizer plate.

10.6.6.2. Diode stack (freewheeling / neutral point and clamping)

A diode stack is aligned when all of the heat sinks are visually aligned with each another from the bottom isolator to the top isolator.

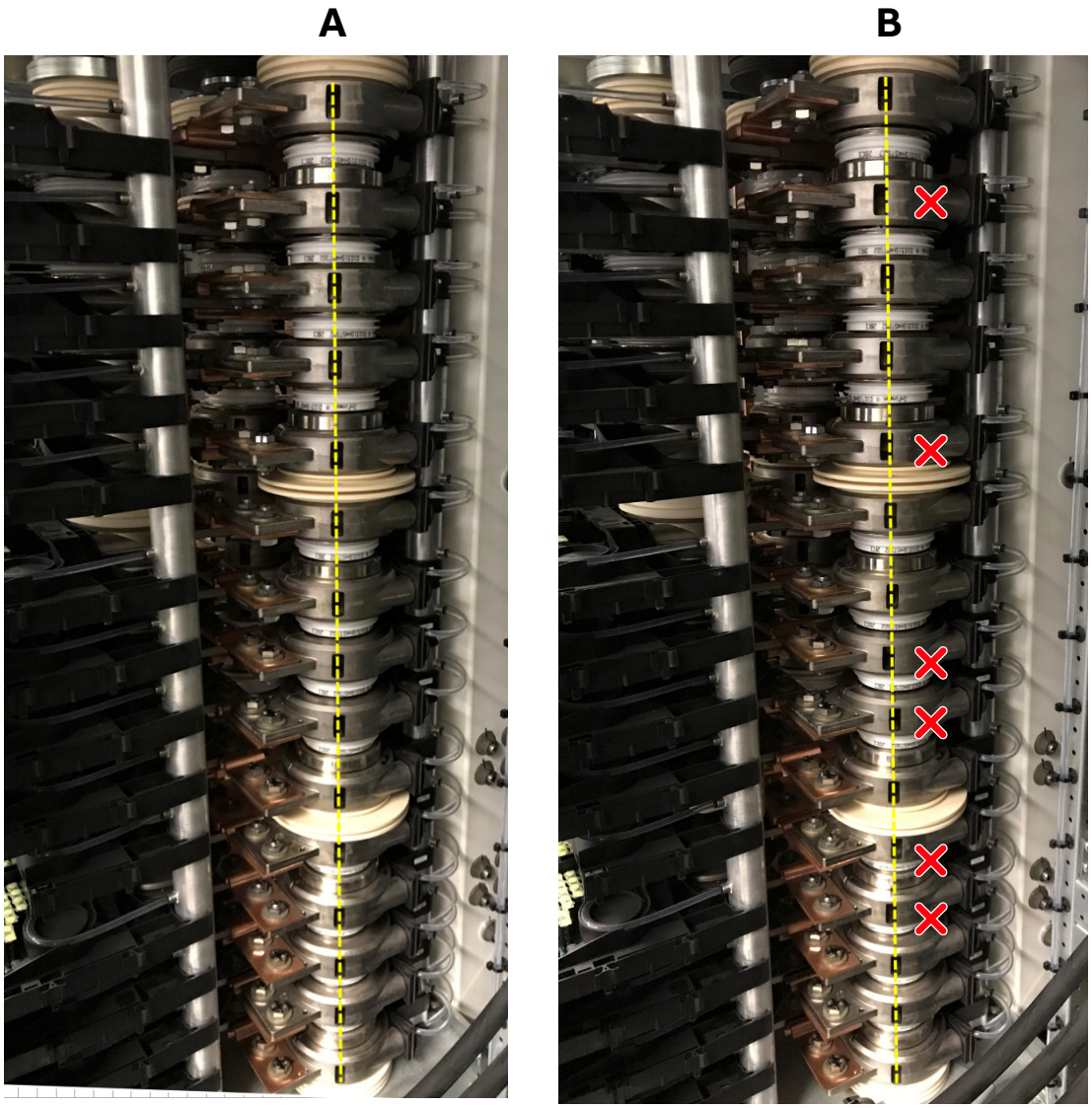


Figure 10–26 Freewheeling diode stack with aligned heat sinks (A) and misaligned heat sinks (B).

Checking vertical alignment

1. Align a 1-meter long spirit level (or wooden slat) vertically with the centers of the bottom and top isolators in the stack and then place against the following components:
   - Freewheeling diode stack: heat sinks.
   - Neutral point and clamping diode stacks: clamping capacitor busbars.
2. Visually check the vertical alignment of the heat sink slots.

   If the slots are not aligned, you need to realign the stack.

Realigning the stack

The following procedure aligns the heat sinks horizontally from the bottom to the top of the stack.

1. On the misaligned heat sinks, loosen the flexible busbar on the heat sink side by removing the M12 bolts with two 19 mm wrenches.

   IMPORTANT! Carefully note the direction of bolts assembly, which is not always the same on each heat sink. If you drop a washer, bolt or nut into the power module or cubicle, remove it immediately.

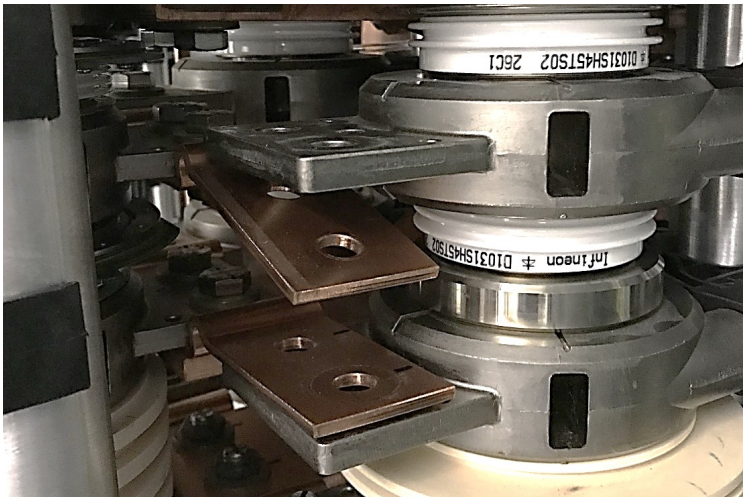


Figure 10–27 Heat sink with loosened flexible bus bar.

2. Ensure that isolator at the bottom of the stack is centered by the centering pin to the frame.

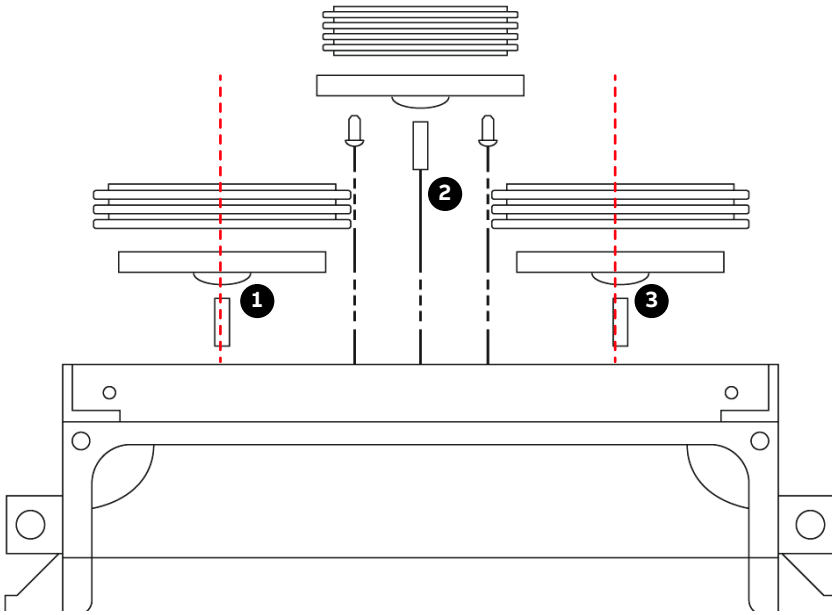


Figure 10–28 Power module assembly (back view)

1) Freewheeling diode stack, bottom disk and centering pin
2) IGCT stack, bottom disk and centering pins
3) Neutral point stack, bottom disk and centering pin

3. Center the heat sink immediately above the bottom isolator with the center of the bottom isolator.

   NOTE – The bottom isolator does not have a centering pin for the heat sink.

4. From bottom to top, gently move each misaligned heat sink back into position by hand.

   NOTE – If you cannot move the heat sink, use the spreader tool to spread open the heat sinks above and below the heat sink and then try again.

   NOTICE Applying too much force when you move the heat sink can scratch the semiconductor surface.

Figure 10–29 Heat sink moved back into position.

5. Visually verify the alignment of the stack.

6. If the stack is correctly aligned, tighten the stacks according to section 10.6.7, **Tightening the stacks**, page 166.

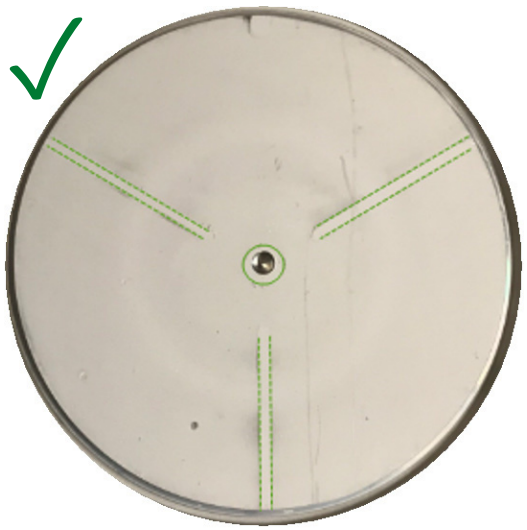
7. Insert the M12 bolts that you removed from the flexible busbars (see step 1).

   IMPORTANT! The direction of the bolt assembly is not the same on all heat sinks. Refer to the notes that you made in step 1 for the correction orientation. If you drop a washer, bolt or nut into the power module or cubicle, remove it immediately.

8. Tighten the M12 bolts with two 19 mm wrenches to the heat sinks according to section 10.4.1, **Correct tightening torques of bolted connections**, page 135.

10.6.6.3. Effects of stack misalignment on semiconductors pole pieces

Below are different possible signs of stack misalignment (marked X), visible on semiconductors pole pieces. If repetitive semiconductor failures happen in a stack where similar observations as marked X are made, the necessity of replacing of all semiconductors in the stack should be evaluated with ABB technical support.



- **Observation:** All imprints of the above heat sink are centered on the pole piece of the semiconductor.
- Heat sink and semiconductors are well aligned.

X

- **Observation:** Imprints from above heat sink are not centered on the IGCT pole piece.
- **Possible cause:** IGCT not fully inserted before the stack was tighten.

X

- **Observation:** Several imprints from above heat sink are not centered on the pole piece.
- **Possible cause:** Severe and repetitive misalignment of the above heat sink or missing centering ball.

X

- **Observation:** Imprint of centering ball on the diode pole piece.
- **Possible cause:** Diode not snapped into centering ball before stack tightening.

X

- **Observation:** Missing imprints from the heat sink on the semiconductor pole piece or non-homogeneous imprints to the touch
- **Possible cause:** Semiconductor tighten inside an already misaligned stack (pressure distribution not nominal).

X

- **Observation:** Missing imprints from the heat sink on the semiconductor pole piece or non-homogeneous imprints to the touch
- **Possible cause:** Semiconductor tighten inside an already misaligned stack (pressure distribution not nominal).

10.6.7. Tightening the stacks

IMPORTANT! The order in which the stacks are tightened (see Fig. 10–30) must be adhered to:

1) IGCT stack
2) Freewheeling diode stack
3) Neutral point and clamp diode stack

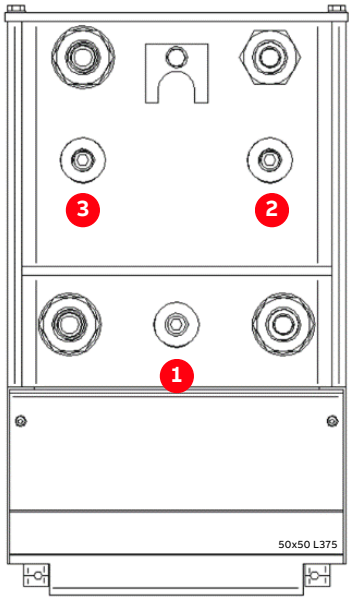


Figure 10–30 Order of tightening the clamping screws

1. Tighten all three stacks in the order given in Fig. 10–30 by tightening the clamping screw (see Fig. 10–31).

   NOTICE The pressure plate can be damaged and a misalignment of a stack can occur if the clamping screw is not correctly inserted in the pressure plate.

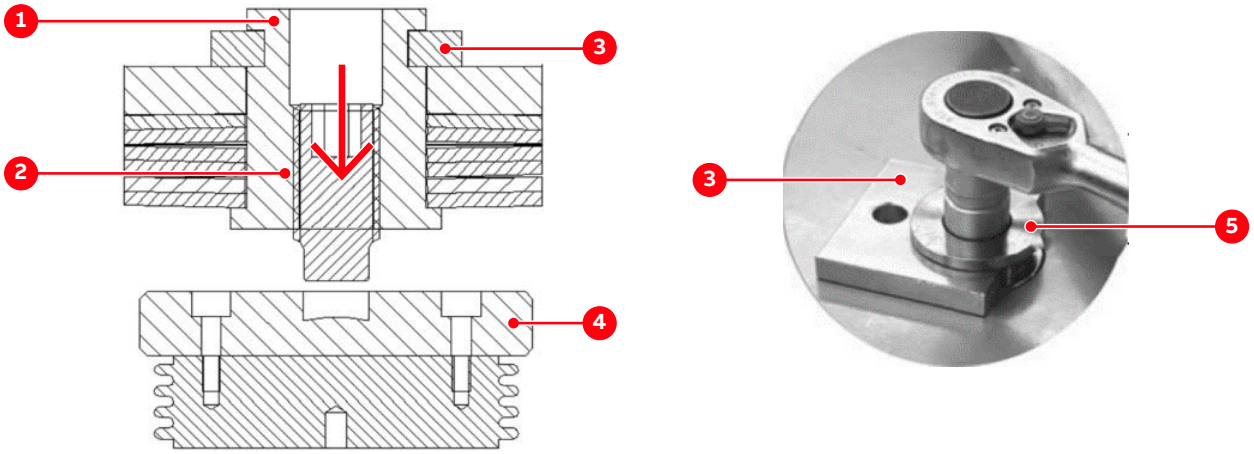


Figure 10–31 Tightening the clamping screw

1) Tension jack	4) Pressure plate
2) Clamping screw	5) Tension jack
3) Pressure loading gauge	

2. Tighten the clamping screw until the pressure loading gauge is just released and the surfaces are even, then remove the pressure loading gauge (see Fig. 10–32).

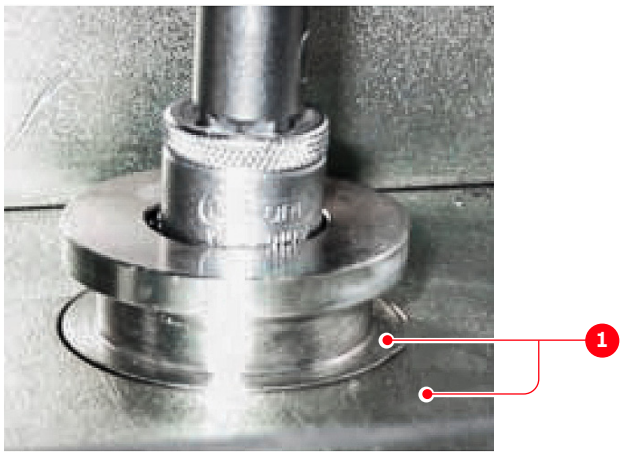


Figure 10–32 Adjusting clamp pressure of stack

1) These surfaces must be even

3. Fasten the pressure loading gauges in their storage place with the M12 fastening screw and washer using a 19 mm wrench.

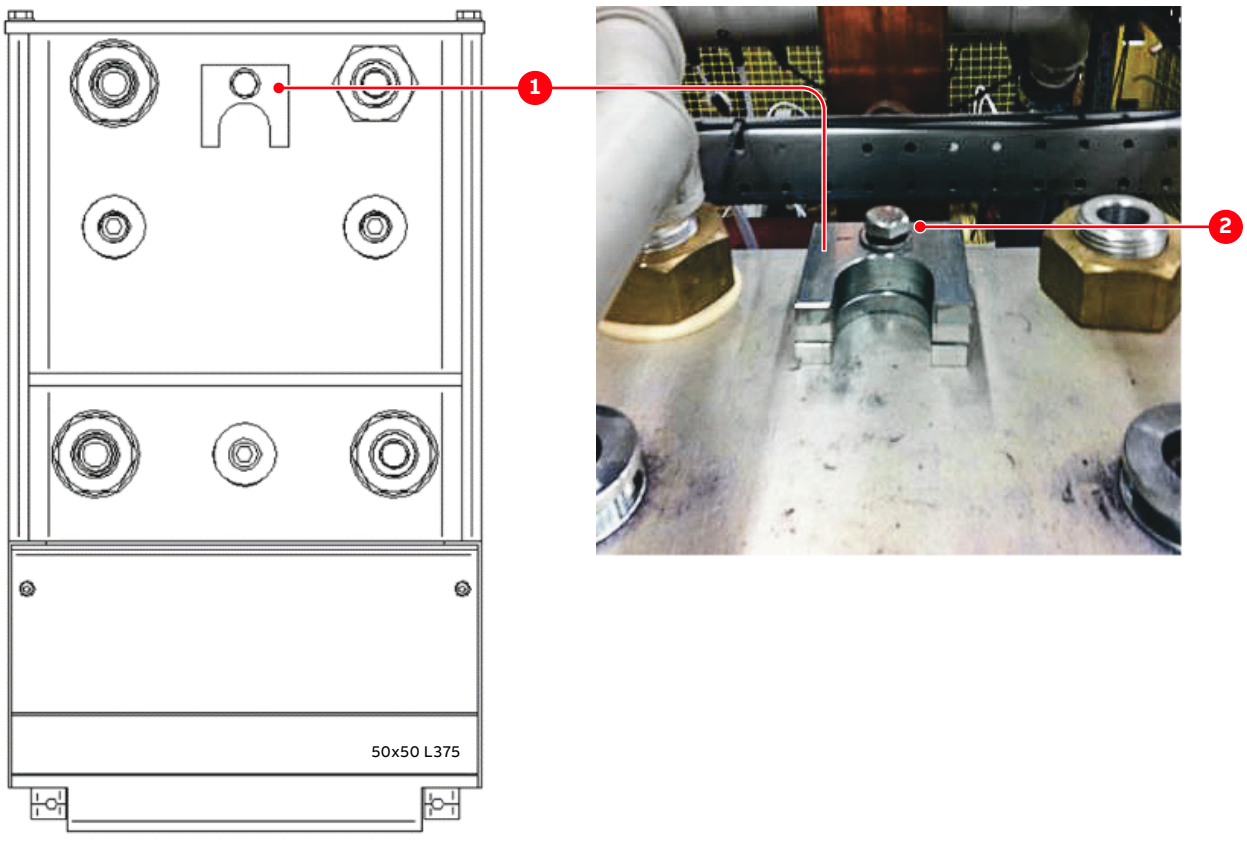


Figure 10–33 Pressure loading gauges storage place

1) Pressure loading gauges in storage location 2) M12 fastening screw and washer

4. Tighten the 24 fixation screws of the IGCT gate unit fixations using a 5 mm Allen wrench.

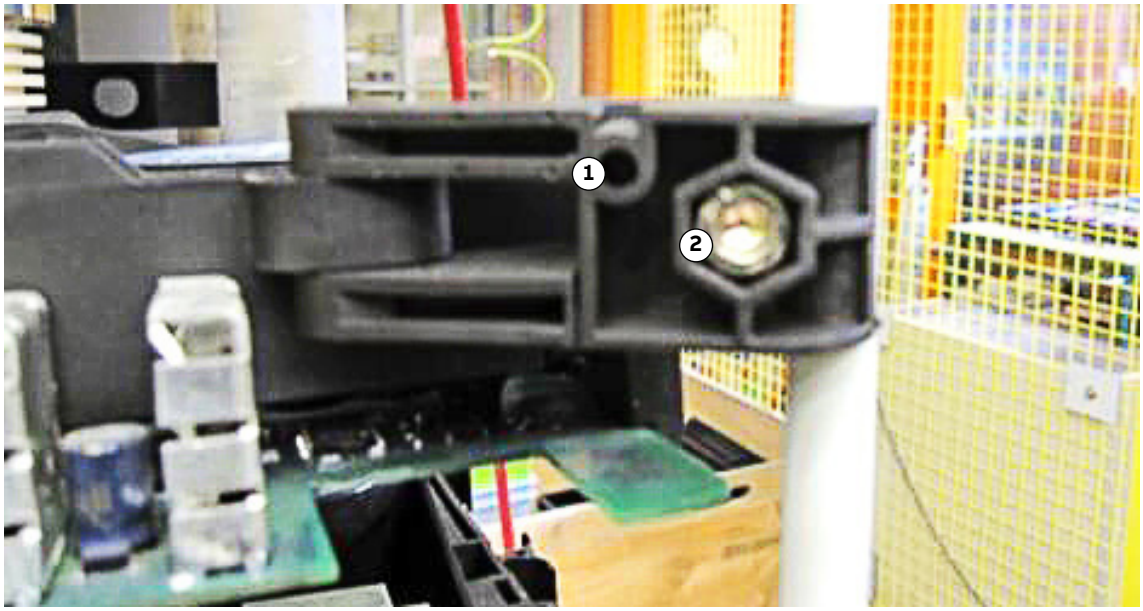


Figure 10–34 Gate unit fixation

1) Gate unit fixation	2) Fixation screw

10.6.8. Replacing clamp capacitor

Service MTTR 0 - 2 h

Figure 10–35 Clamp capacitors

1. Unbolt the upper and lower copper bar from the capacitor.

   NOTICE DO NOT exert any torque onto the capacitors. During loosening as well as fastening, the capacitor connections need to be held in place with a 23 mm flat wrench (contained in converter service toolbox).

2. Use flat wrench from ABB toolbox to access the capacitor nut and loosen the capacitor(s).

   WARNING! Discharge the capacitor before touching! Make sure the replacement capacitor is not pre-charged.

3. Replace the faulty capacitor with a new one of the same type and the same capacitance.

4. Bolt the capacitors to the copper bars.

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

10.6.9. Replacing symmetry resistor

Service MTTR 0 - 2 h

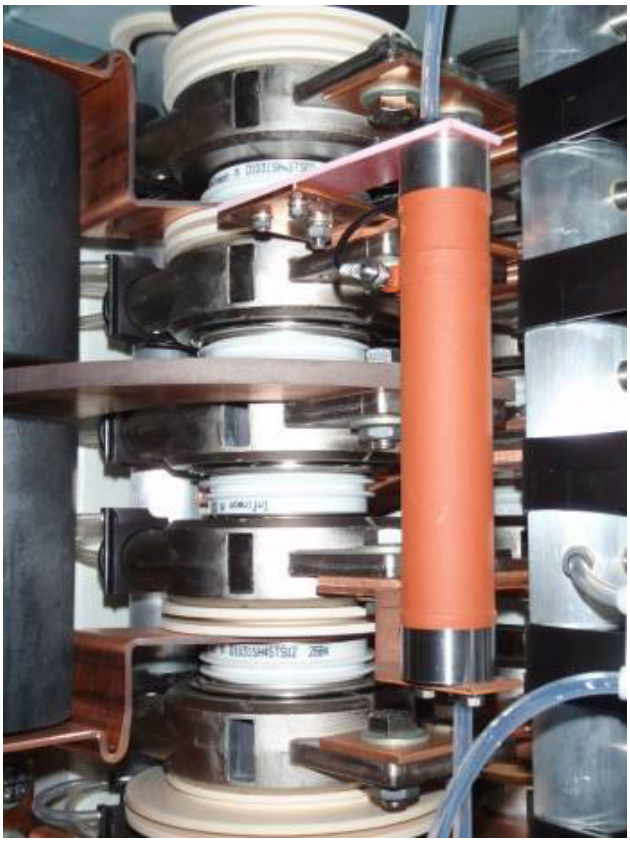


Figure 10–36 Symmetry resistor

Preparation:

1. Release the over pressure of the cooling system according to section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138.
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 “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).
4. Place a catching tray in such a way that leaking cooling liquid from the faulty resistor does not spill into the converter.

   NOTICE Leakage of cooling liquid into the converter needs to be avoided, especially glycol, which causes severe pollution of the converter.

Replacement:

1. Remove hoses from the resistor and direct the leaking water into the catching tray and close the leaks with Legris plugs.
2. Unbolt the faulty resistor.
3. Mount the new resistor.

   NOTICE Excessive bending of the hoses must be avoided.
4. Attach hoses; make sure they are inserted completely.

   For instructions on how to connect the cooling tubes, see section 3.2.3, **Tube cutter**, page 36.
5. Check that no hose is touching busbars or other voltage carrying parts.
6. Remove catching tray and all tools from the converter cabinet.
7. Wipe up any remnants of leaked cooling liquid.
8. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.6.10. Replacing clamp resistor

Service MTTR 4 - 8 h

There are two versions of clamp resistors existing: an older version with 2 big resistors and a newer version with 6 small resistors (see Fig. 10–37). The replacement procedure is similar for both versions.

Figure 10–37 Clamp resistor

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty the water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139 (recommended since access to the hoses is quite difficult).

   It is also possible to release only the over pressure of the cooling system as described in section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138 and then to close the leaks immediately with Legris plugs.
3. Switch off the auxiliary power supply in the respective unit(s).
4. Disconnect all cables (mark the cables before disconnecting).
5. Unbolt the Allen-key screws.
6. Replace the resistor.

   NOTE – To do this, the lower 6-pack must be taken out completely, it is not possible to remove one single resistor.
7. Reconnect all plugs.

   For instructions to connect the cooling tubes, see section 3.2.3, **Tube cutter**, page 36.

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

10.6.11. Replacing clamp reactor

Service MTTR 2 - 4 h

1. Shut-down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Release the over pressure of the cooling system according to section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138.
3. Switch off the auxiliary power supply in the respective unit(s).
4. Remove the clamp capacitor including the neutral point busbar (see Fig. 10–38).
5. Disconnect the Legris input and output from clamp reactor and clamp resistor and close the leaks with Legris plugs.

Figure 10–38 Clamp reactor

6. Remove the clamp resistor according to section 10.6.10, **Replacing clamp resistor**, page 172.
7. Disconnect the busbars to the reactor.
8. Remove the reactor by unbolting the two M6 screws in the front and the 4 Torx screws in the back.

   CAUTION! The reactor weights approximately 25 kg. Use lifting aids and proper lifting technique when lifting and moving.
9. Replace the reactor and install all parts again.

10. Reconnect all plugs. For instructions to connect the cooling tubes, see section 3.2.3, **Tube cutter**, page 36.

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

10.6.12. Replacing LEM current transducer

Service MTTR 0 - 2 h

Figure 10–39 LEM current transducers

1) Two upper busbar bolts	3) Two lower busbar bolts
2) Four LEM mounting screws	

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Disconnect all cables from LEM current transducer.
3. Unbolt the 2 lower M12 busbar bolts.
4. Remove the 4 LEM mounting screws.
5. Unbolt the 2 upper M12 busbar bolts.
6. Replace the LEM current transducer.
7. Bolt the cooper bars again (40 Nm).
8. Reconnect all cables. Make sure no wire was interchanged, compare to the remaining LEM current transducers.
9. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.6.13. Replacing DC capacitor

Service MTTR 2 - 4 h

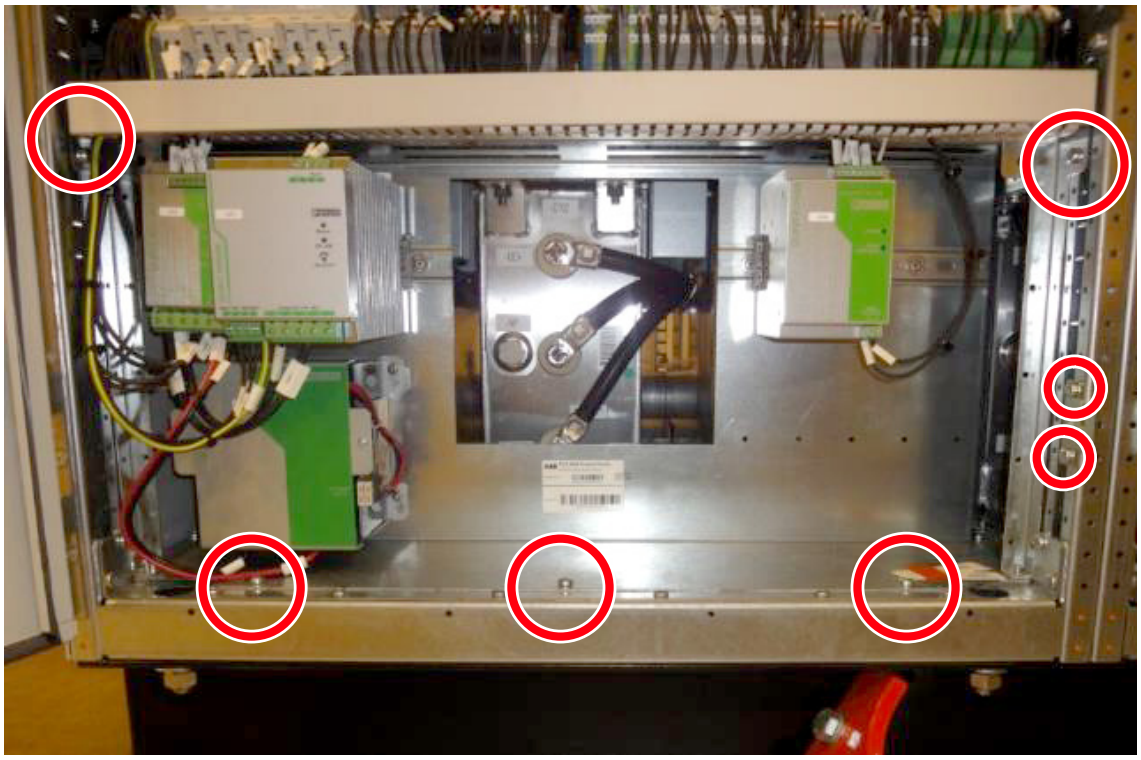


Figure 10–40 Mounting screws of ASM in front of DC capacitor

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Disconnect all system cables from ASM.
3. Remove ASM by unbolting the 5 Torx screws and the door fixation plate screws (see arrows in Fig. 10–40).

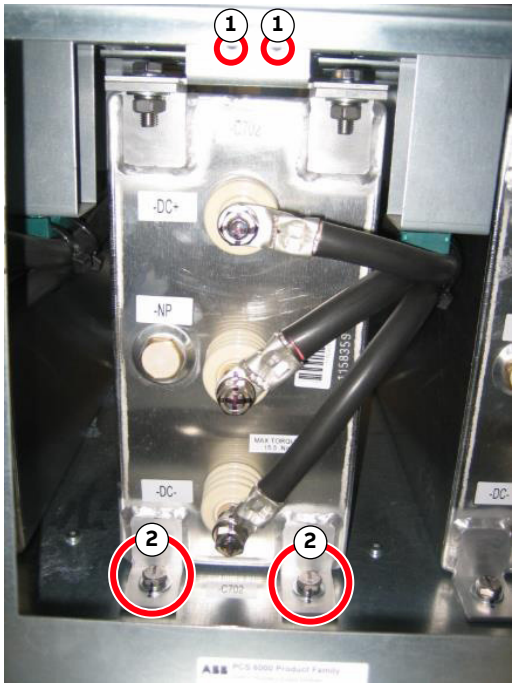


Figure 10–41 DC capacitor

1) Torx screw	2) Hexagonal screw

4. Mark the cables with DC+, NP and DC- and then disconnect them.

   CAUTION! The capacitor weights approximately 50 kg. Single person lift could cause injury. Use assistance when lifting and moving.

5. Remove the capacitor by releasing the hexagonal screws at bottom and the Torx screws on top (see Fig. 10–41).

6. Assembly the metal plate from the old capacitor to the new.

7. Replace the DC capacitor.

   NOTICE During loosening as well as fastening, the capacitor connections need to be held in place with a 19 mm spanner. For maximum tightening torques refer to section 10.4.1, **Correct tightening torques of bolted connections**, page 135.

8. Reconnect the cable.

9. Install the ASM again.

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

10.7. Replacing components in DRU

Converter service tools from the toolbox (3BHB008753R0001) for standard converters are required to carry out these procedures eg, a spreading tool (see chapter 3, **Service tools**, page 31).

A pressure loading spanner is attached to the bottom of the DRU frame.

There are two types of spreader tools available. Type 2 is the preferred tool when working on the diode stack of the LSU (see Fig. 10–42).

10.7.1. General

Service MTTR 2 - 4 h

After faulty semiconductors have been identified, they have to be exchanged according to the procedures below.

⚠CAUTION

- All stacks containing semiconductors must be released before using the spreading tool.

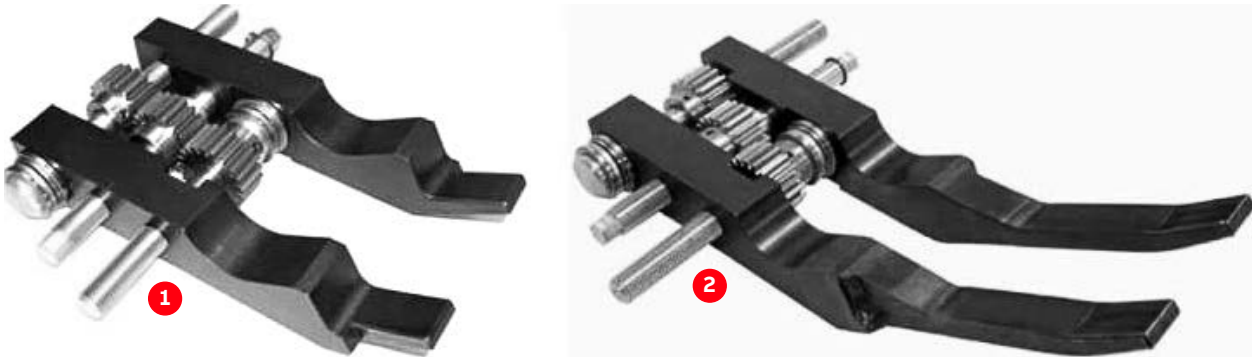


Figure 10–42 Spreader tools

1) Type 1 spreader tool	2) Type 2 spreader tool

To ensure sufficient cooling, each stack is clamped with a specified clamping force. To exchange semiconductors, the clamping force must be released.

10.7.2. Releasing the stacks

IMPORTANT! The clamping pressure of the stack must be released when diodes or thyristors of the rectifier are replaced. Do not release the pressure all at once, as otherwise all semiconductors in the stack will become mis-aligned. They must then be re-centered in a time consuming procedure. The misalignment results from the flexible busbar connectors at the rear of the stack. They are connected to the coolers and push them to the front, resulting in misalignment of the semiconductors. It is therefore essential that the instructions below are followed.

Procedure:

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Insert the clamp pressure loading spanner (see B in Fig. 10–43).
3. Insert the spreader tool (type 2, see Fig. 10–42) into the openings of the coolers above and below the diode or thyristor which is to be replaced (see Fig. 10–43).

   NOTICE DO NOT use the extensions available for type 1 of the spreader tool. The extensions cause the cooler above the faulty semiconductor to be pushed down by the flexible connectors at the rear of the stack, thus clamping the semiconductor. When replacing a semiconductor which is next to a pulse transformer, pay attention to the transformer leads. The wires can be easily caught in the gears of the spreader tool.

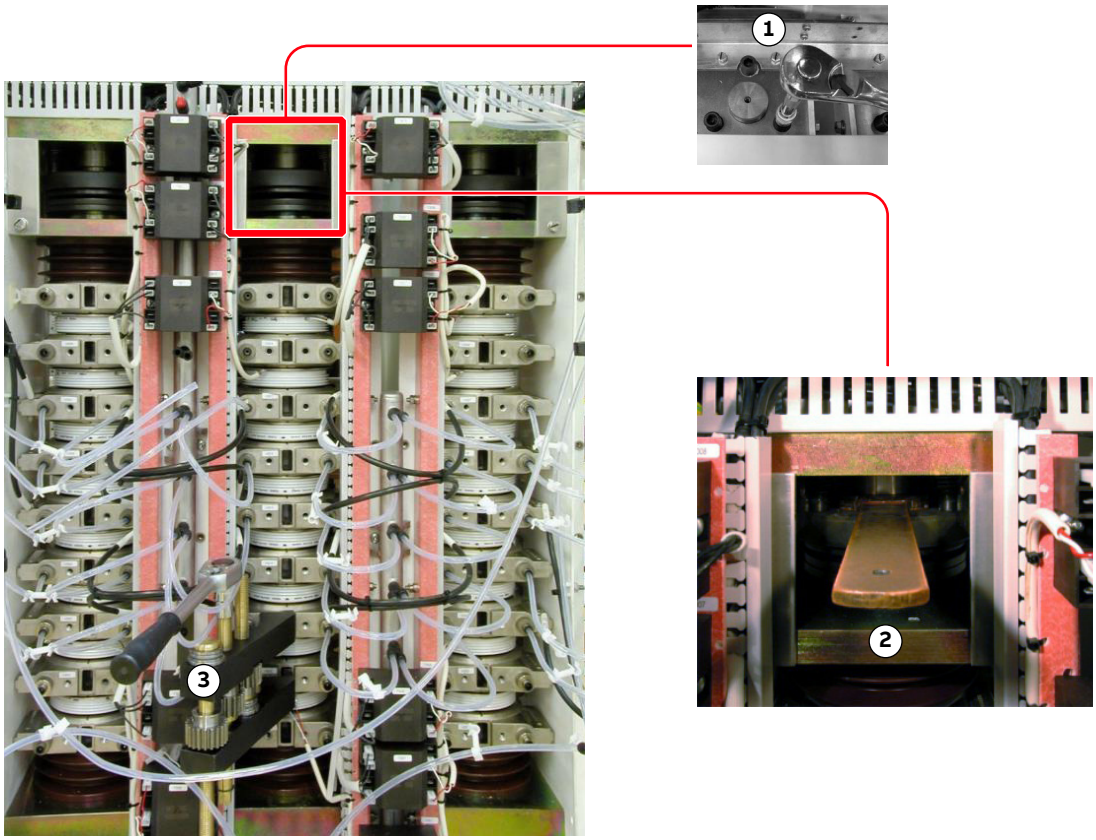


Figure 10–43 Applying spreader tool

1) Pressure loading spanner	3) Spreader tool
2) Pressure adjusting bolts	

4. Alternately release the clamping pressure and then spread the spreader tool to maintain the pressure in the stack above the semiconductor to be changed.

   Proceeding in this manner prevents the semiconductors from becoming misaligned.

5. Remove the semiconductor as soon as the clearance above the semiconductor is big enough.

6. Prepare the new semiconductor for reassembly.

   Check the contact surfaces of the new diode for any dirt. If necessary, clean the contact surfaces with an appropriate solvent (eg, alcohol). Using a fluff-free cloth wipe the surfaces paying attention not to scratch the surfaces.

   IMPORTANT! DO NOT use any grease or any electrical joint compound.

7. Insert the new semiconductor into the stack and center it.

   NOTICE Pay attention to the correct polarity. Always verify the polarity with the corresponding wiring diagram.

8. Alternately close the gap between the new semiconductor and the cooler and increase the pressure in the stack until the pressure adjustment spanner can be removed.

9. Reconnect any disconnected wires.

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

10.7.3. Centering misaligned stacks

In case a stack becomes misaligned, the coolers can be pushed back into place and the semiconductors can be centered using a fixture as illustrated in Fig. 10–44 Rearranging misaligned stacks.

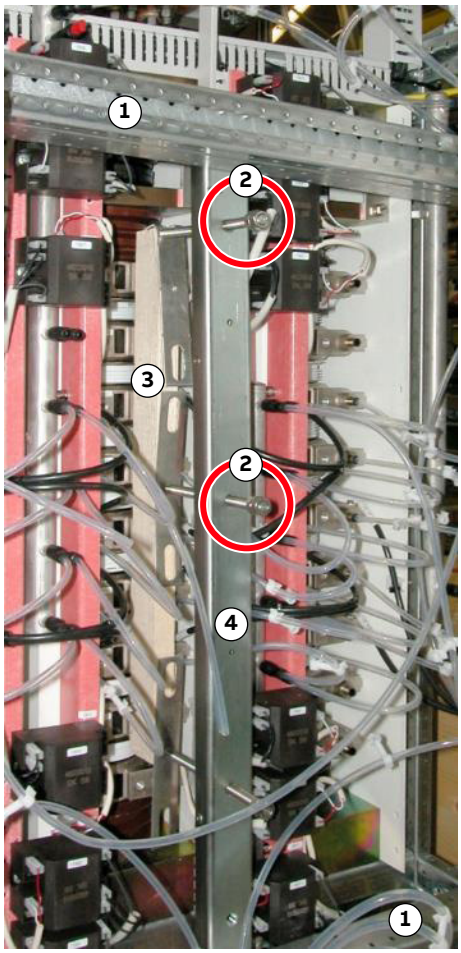


Figure 10–44 Rearranging misaligned stacks

1) Horizontal bar	3) Wooden bar
2) Adjustment bolt	4) Vertical bar

The two horizontal bars are fixed to the frame of the cabinet. By means of the adjustment bolts, the wooden bar is pushed against the coolers thus pushing the coolers back into place and holding them there. The semi-conductors can be centered one by one starting at the bottom of the stack. The spreader tool is used to create the clearance for moving the semiconductors into place. Since the space is very narrow it is recommended to use a piece of wire shaped into a half moon to move the semi-conductors.

10.8. Replacing components in DLU

10.8.1. Replacing grounding isolator

Service MTTR 0 - 2 h

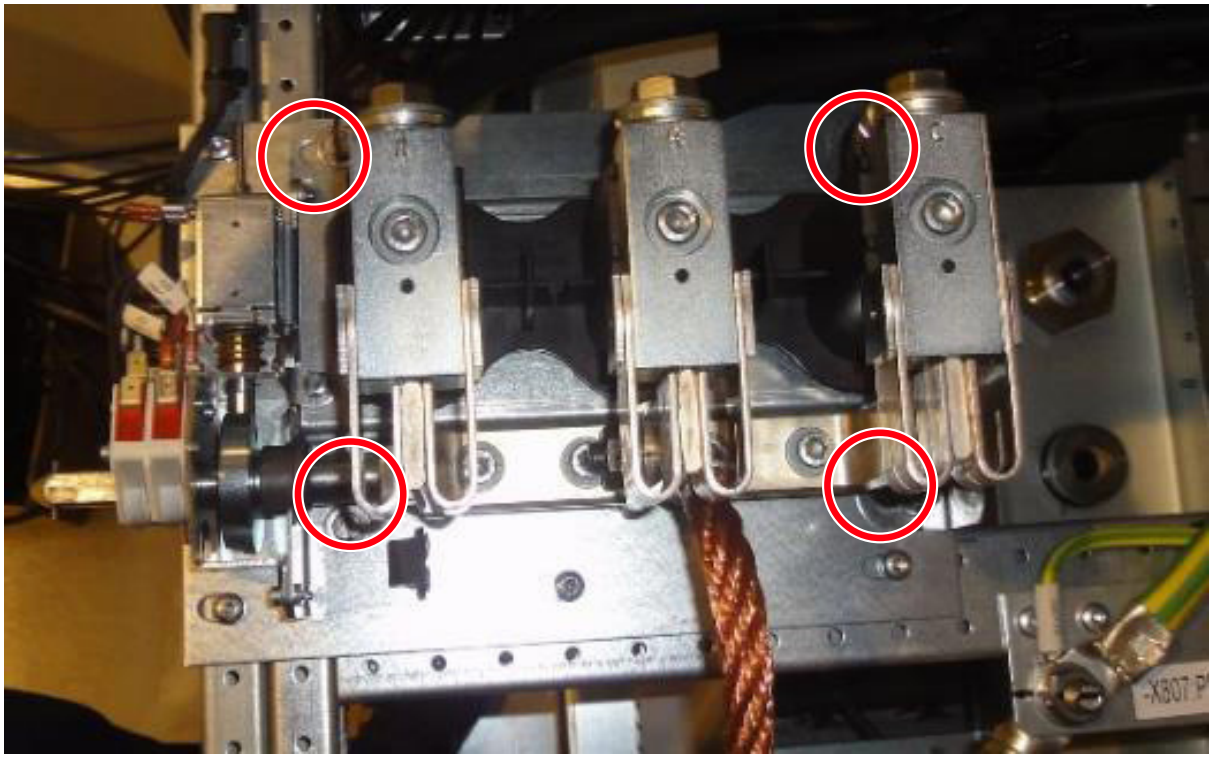


Figure 10–45 Earth isolator mounting screws

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Before remove the grounding isolation install an additional grounding kit to ground the DC-link.
3. Disconnect all electrical cables.
4. Unbolt the 4 screws (see Fig. 10–45).
5. Replace the earth connector (weight approximately 10 kg).
6. Remove the additional grounding kit
7. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.8.2. Replacing resistor -R462_1, -R462_2

Service MTTR 0 - 2 h

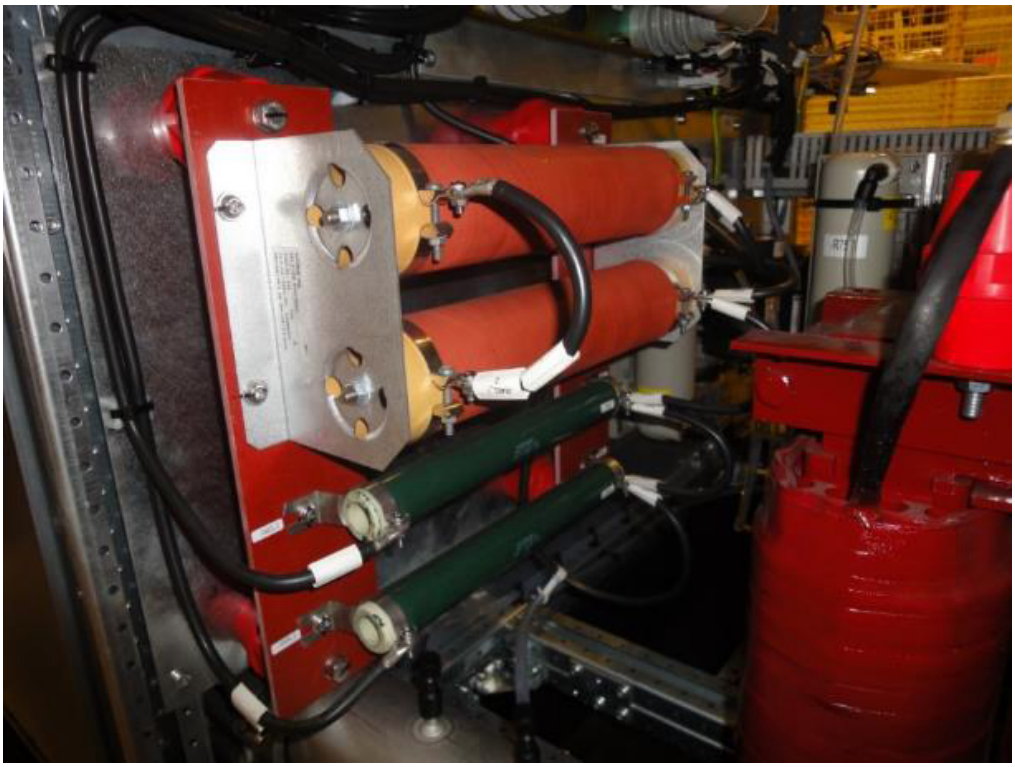


Figure 10–46 Resistor -R462_1, -R462_2

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Disconnect all electrical cables.
3. Unbolt the Torx screws for the resistor, which have to be replaced.
4. Replace the faulty resistor.
5. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.8.3. Replacing resistor -R751 to -R754 or capacitor -C751 to -C752

Service MTTR 2 - 4 h

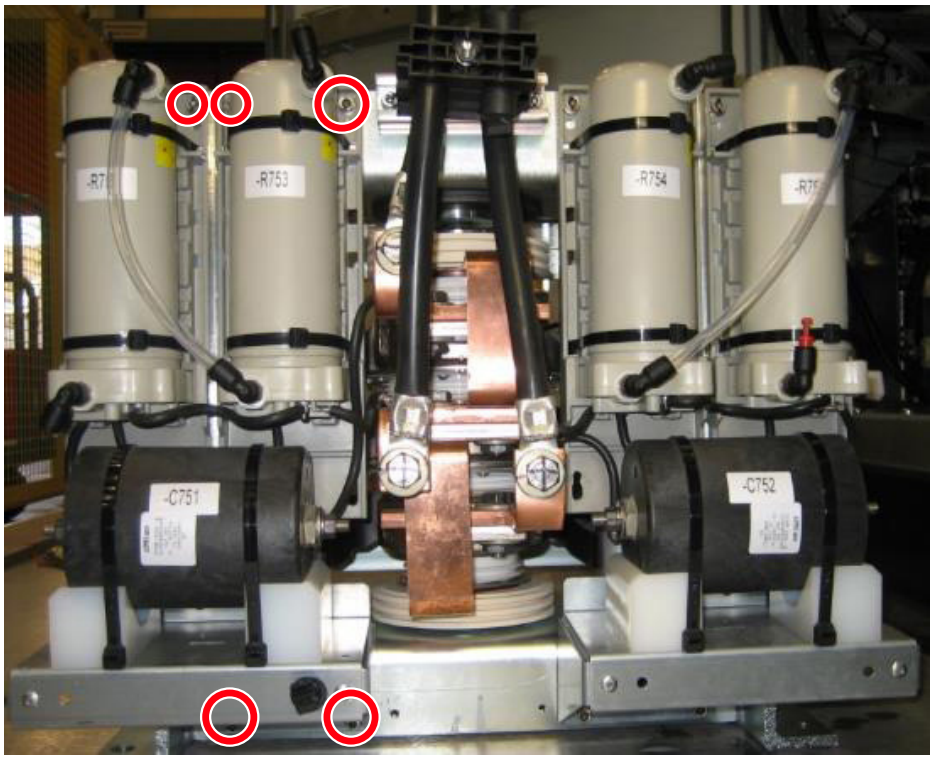


Figure 10–47 Rear view of VLM

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Release the over pressure of the cooling system according to section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138.
3. Place a catching tray in such a way that leaking cooling liquid from the faulty resistor-assembly does not spill into the converter.

   NOTICE Leakage of cooling liquid into the converter needs to be avoided; especially glycol causes severe pollution of the converter.
4. Remove hoses from the resistor, direct the leaking water into the catching tray and close the leaks with Legris plugs.
5. Unbolt the cable to the capacitor.
6. Unbolt the 5 Allen-key screws (3 above and 2 below) from the relevant resistor-assembly (see Fig. 10–47).
7. Unbolt the cable between the resistor and the copper bar.
8. Remove the whole resistor-assembly and replace the faulty component.
9. Install the resistor-assembly again and reconnect all cables and hoses.
10. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.8.4. Replacing resistor -R461

Service MTTR 0 - 2 h

Figure 10–48 Resistor -R461

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Release the over pressure of the cooling system according to section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138.
3. Place a catching tray in such a way that leaking cooling liquid from the faulty resistor does not spill into the converter.

   NOTICE Leakage of cooling liquid into the converter needs to be avoided; especially glycol causes severe pollution of the converter.
4. Remove hoses from the resistor, direct the leaking water into the catching tray and close the leak with a Legris plug.
5. Disconnect the electrical connection.
6. Replace the resistor.
7. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.8.5. Replacing capacitor -C461

Service MTTR 0 - 2 h

Figure 10–49 Capacitor -C461

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

   NOTICE DO NOT exert any torque onto the capacitor! During loosening as well as fastening, the capacitor connections need to be held in place with a 23 mm flat wrench (contained in converter service toolbox). For maximum tightening torques refer to section 10.4.1, **Correct tightening torques of bolted connections**, page 135.
3. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.8.6. Replacing IGCTs and diodes

Service MTTR 0 - 2 h

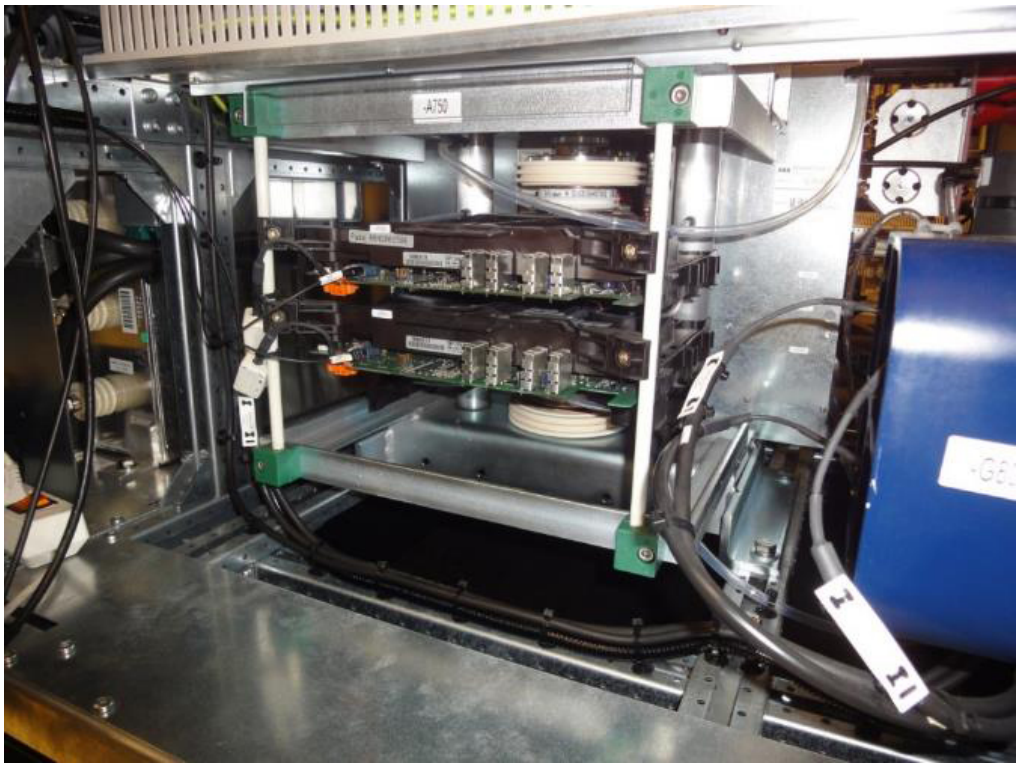


Figure 10–50 VLM

The procedure for replacing the semiconductors in the VLM is similar but not exactly the same as the procedure described in section 10.6, **Replacing components in POU**, page 139. In the VLM there is only one stack instead of three, but the figures shown in section 10.6, **Replacing components in POU**, page 139 apply in principle.

1. Switch off MCB -Q401 to interrupt the 3AC 400 V input voltages of the AC/DC converter (24 V power supply).
2. 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).
3. Take the pressure loading gauge from its storage place and insert it completely under the tension jack of the stack.

   NOTICE The pressure loading gauge must be inserted completely before the stack can be released. Otherwise the tension jack can break.
4. If an IGCT is to be changed loosen all 4 fixation screws of the gate unit fixations using a 5 mm Allen wrench to make sure that the gate unit fixation can move freely in vertical direction.
5. Release the stack by loosening the clamping screw counter-clockwise using the socket wrench with 12 mm Allen socket.
6. Enter a stabilizer plate in the bottom of the stack.

7. Insert the spreading tool as described in section 10.6.3, **Using the spreading tool**, page 145.

   IMPORTANT! If the lower diode of the VLM has to be replaced the use of the spreading tool is not possible. A second person must lift and hold the upper components while the diode is exchanged

8. Replace an IGCT similar as described in section section 10.6.4, **Replacing IGCTs**, page 149 (steps 2 to 10) or replace a diode similar as described in section section 10.6.5.2, **Replacing clamp diodes**, page 155 (steps 2 to 8).

9. Re-check replaced IGCTs as described in section 9.8, **Checking IGCTs with multimeter (if a FADEC 3 is unavailable)**, page 127 and re-check replaced diodes according to section 9.9.3, **Checking clamp diodes**, page 130.

10. Tighten the stack by tightening the clamping screw.

    Make sure that the clamping screw enters correctly into the pressure plate (special attention has to be payed to this since the insulation plate is not in a fixed position). Otherwise the pressure plate could be damaged.

11. Tighten the clamping screw until the pressure loading gauge is just released and the surfaces are even, then remove the pressure loading gauge.

12. Fasten the pressure loading gauge in its storage place with the M12 fastening screw and washer using a 19 mm wrench.

13. f an IGCT has been changed, tighten all 4 fixation screws of the IGCT gate unit fixations using a 5 mm Allen wrench.

10.8.7. Replacing VLM

Service MTTR 2 - 4 h

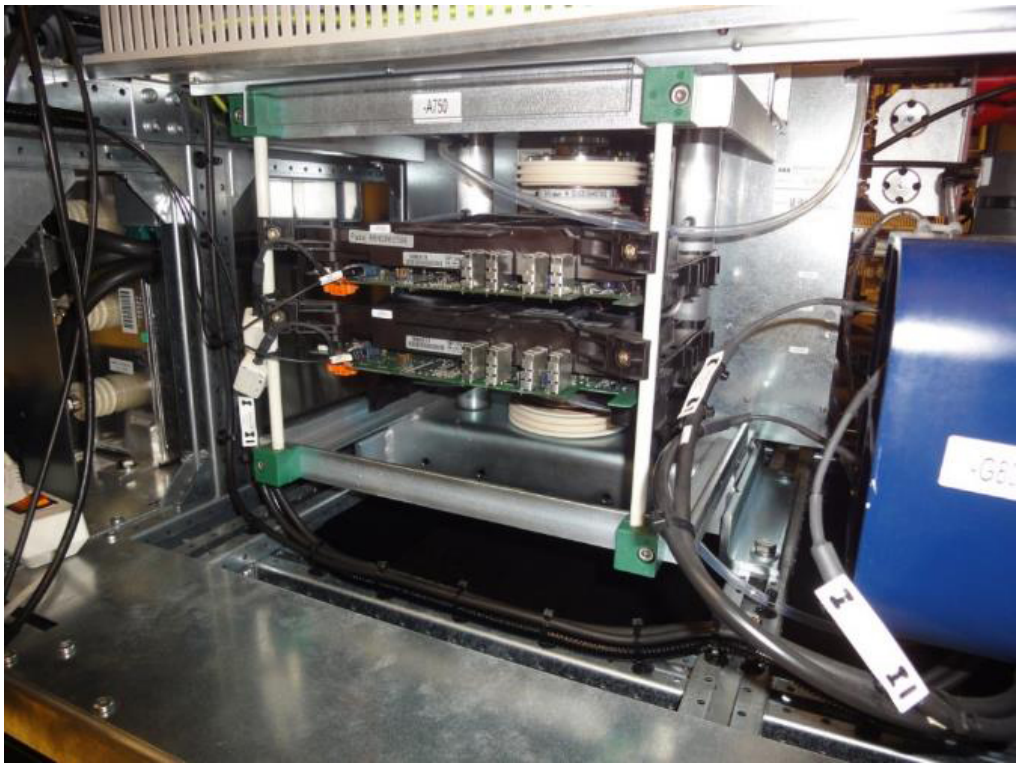


Figure 10–51 VLM

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Release the over pressure of the cooling system according to section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138.
3. Remove cable trunk across the cabinet.
4. Disconnect power cable -X802, -X803, -X804 at patch panel.
5. Place a catching tray in such a way that leaking cooling liquid from the water hoses does not spill into the converter.
6. Disconnect 6 water hoses, direct the leaking water into the catching tray and close the leak with a Legris plug.
7. Disconnect the electrical connection in front of the VLM between the POU and IPS.

   CAUTION! The VLM weights approximately 60 kg. Single person lift could cause injury. Use assistance when lifting and moving.
8. Unbolt the VLM with the four screws (see Fig. 10–51) from the frame.
9. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.8.8. Replacing pre-charging transformer

Service MTTR 2 - 4 h

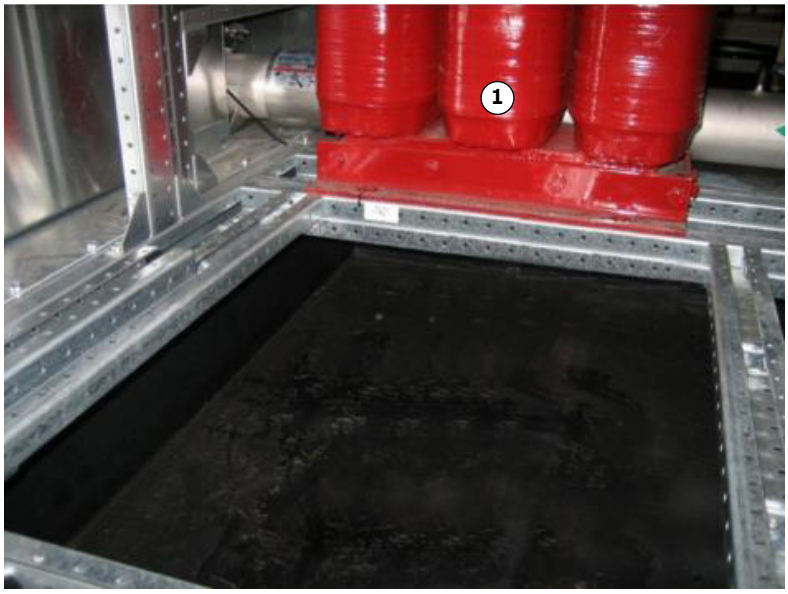


Figure 10–52 Precharging transformer (VLM removed)

1) Pre-charging transformer

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Release the over pressure of the cooling system according to section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138.
3. If access from the back side is possible, remove the back wall of the cabinet.

   If this access is not possible, release the over pressure of the cooling system according to section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138 and remove VLM according to section 10.8.7, **Replacing VLM**, page 189 to gain access.
4. Disconnect all electrical connections.
5. Open the 4 M10 bolts and remove the transformer. If access from the back side is possible lift the transformer out from behind, otherwise use the chain block to lift the transformer to the front of the cabinet (see Fig. 10–52).
6. Rebuild the DLU in reverse order.
7. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.8.9. Replacing dv/dt filter reactor in DLU

Service MTTR 4 - 8 h

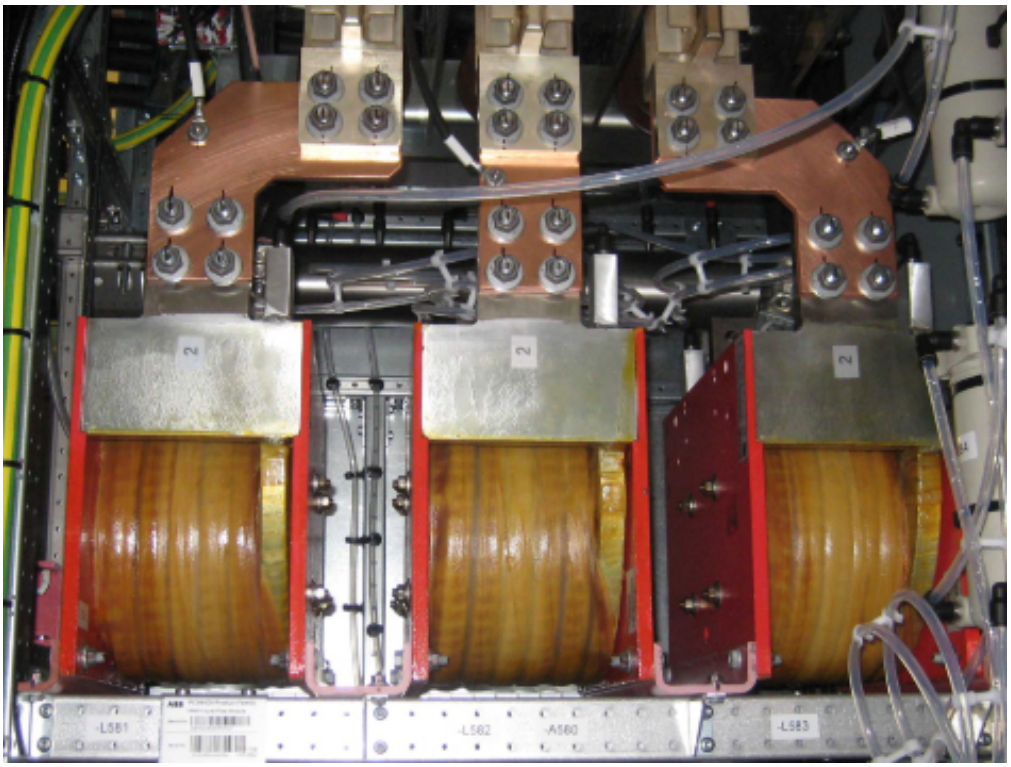


Figure 10–53 dv/dt filter reactor

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Disconnect water pipes, busbars and cables.

   CAUTION! The reactor weighs approximately 25 kg. Use lifting aids and proper lifting technique when lifting and moving.

4. Unbolt the 4 mounting bolts from the U-shaped profiles on the faulty reactor (see Fig. 10–54).

Figure 10–54 dv/dt filter reactor mounting bolts (different VFM variants)

NOTE – 2 bolts in front and 2 bolts on back of the reactor.

5. Replace the faulty dv/dt filter reactor.
6. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.8.10. Replacing dv/dt filter resistor in DLU

Service MTTR 4 - 8 h

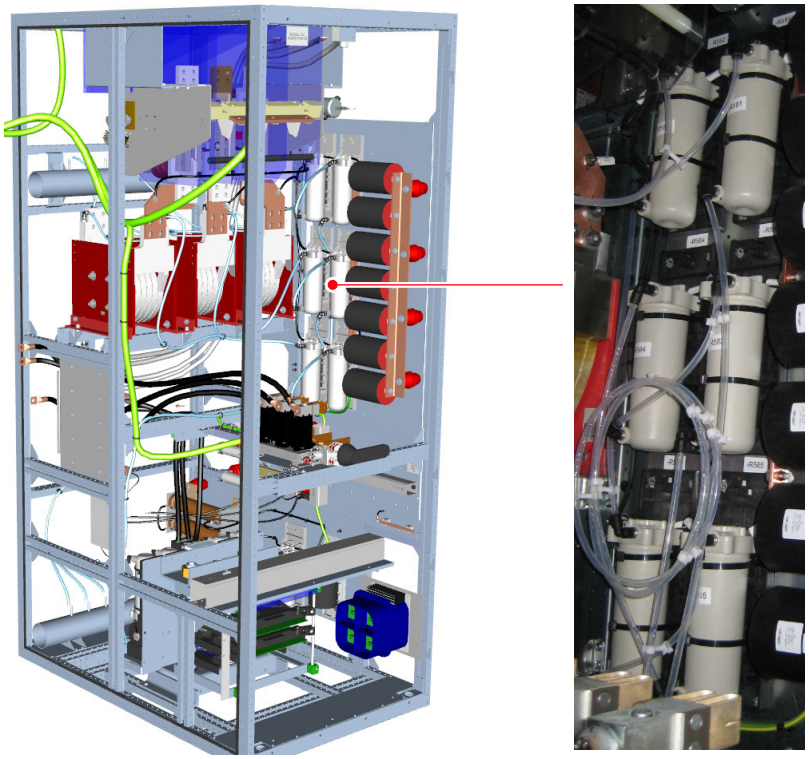


Figure 10–55 dv/dt filter resistors

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Remove the transparent plastic cover in front of the capacitor bank by loosening the mounting screws.
3. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
4. Disconnect water pipes and cables.
5. Remove the cable ties.
6. Replace the dv/dt filter resistor.
7. Reconnect water pipes and cables.
8. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.8.11. Replacing dv/dt filter capacitor in DLU

Service MTTR 0 - 2 h

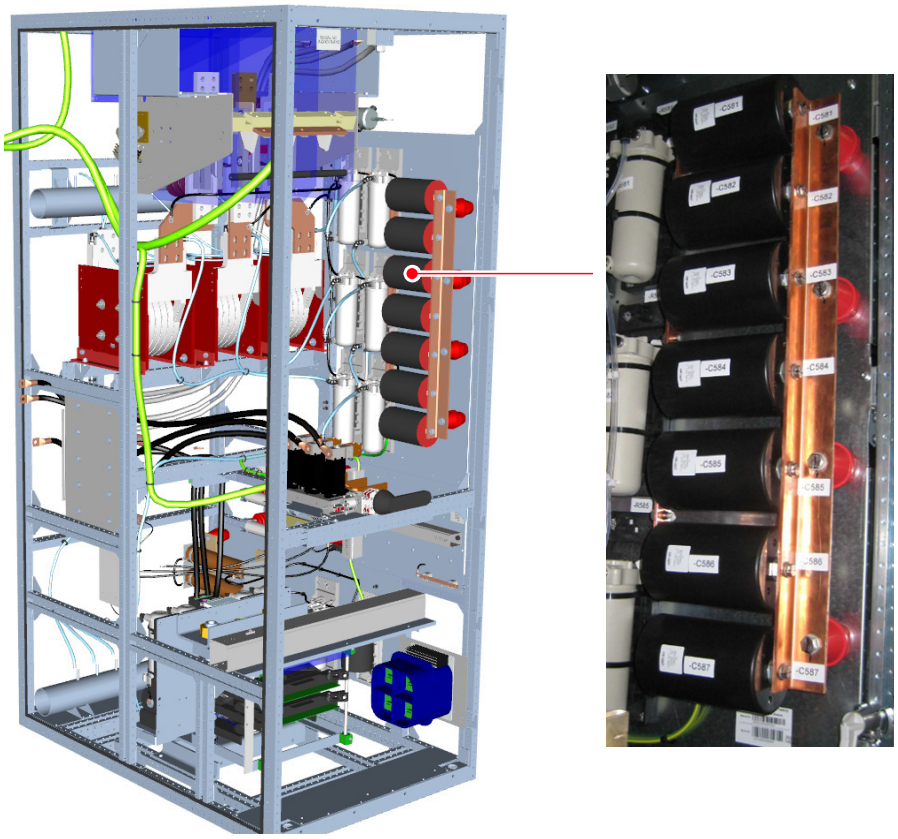


Figure 10–56 dv/dt filter capacitors

1. Shutdown the PCS6000 according to “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Remove the transparent plastic cover in front of the capacitor bank by loosening the mounting screws.
3. Disconnect cables.
4. Replace dv/dt filter capacitor.

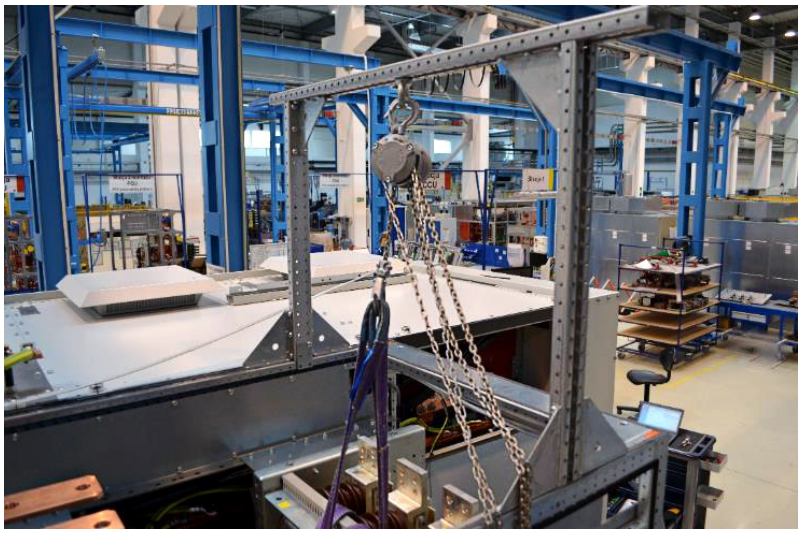
   Do not exert any torque onto the capacitors. During loosening as well as fastening, the capacitor connections need to be held in place with a 23 mm flat wrench (contained in converter service toolbox).

   NOTE – For maximum tightening torques refer to section 10.4.1, **Correct tightening torques of bolted connections**, page 135.
5. Reconnect cables.
6. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

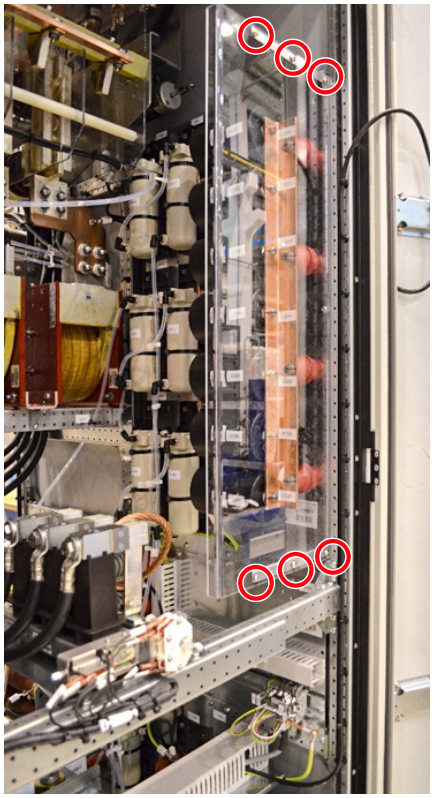
10.8.12. Replacing grid/generator disconnector module in DLU

Service MTTR 4 - 8 h

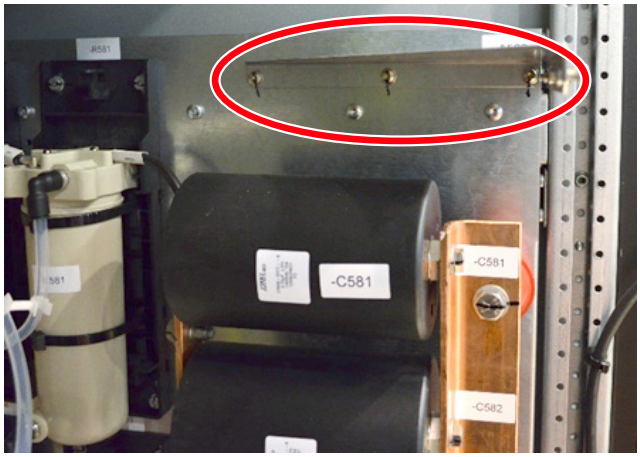
IMPORTANT! For replacing of the GDM a suitable ladder and two persons are required. A fixing point for the chain-block above the GDM is also needed to lift out the GDM. If a fixing point in the surrounding infrastructure is not available, a framework that is similar to the one in the following image is required.



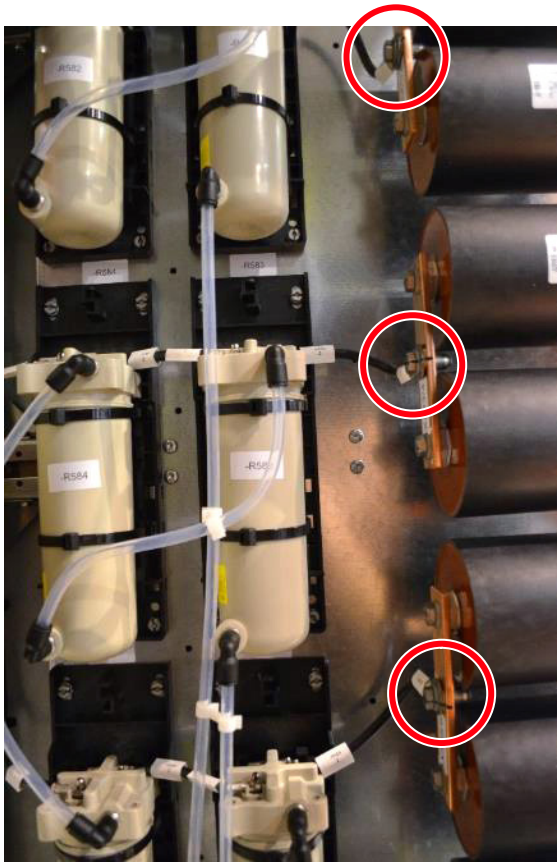
1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Disconnect all electrical cables.
3. Remove the transparent plastic cover in front of the capacitor bank by loosening the mounting screws.



4. Remove the upper aluminum bracket above the capacitors.



5. Loosen the electrical connection between the resistors and capacitor.

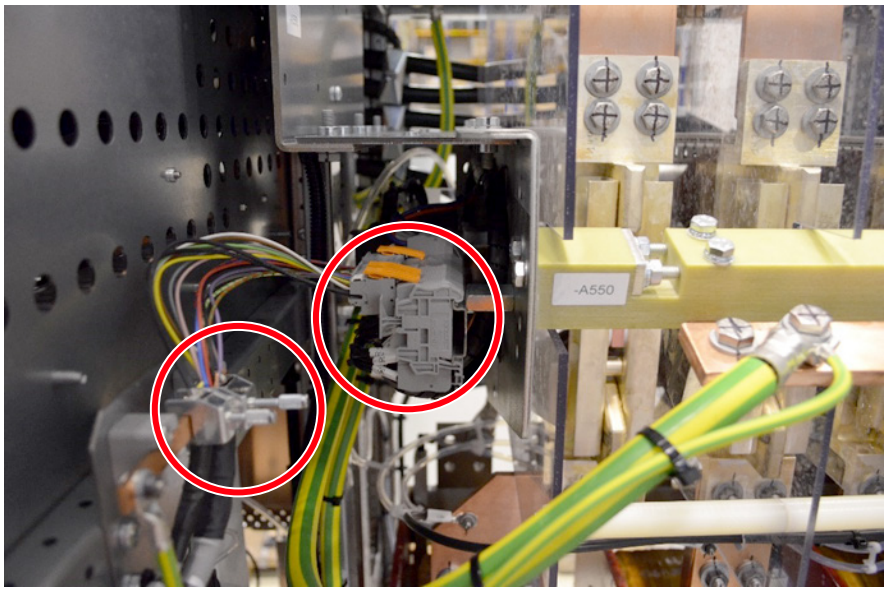


6. Disassemble the capacitor bank by loosening the screws on the right side of the capacitor bank.

   CAUTION! The capacitor bank weighs approximately **30 kg**.

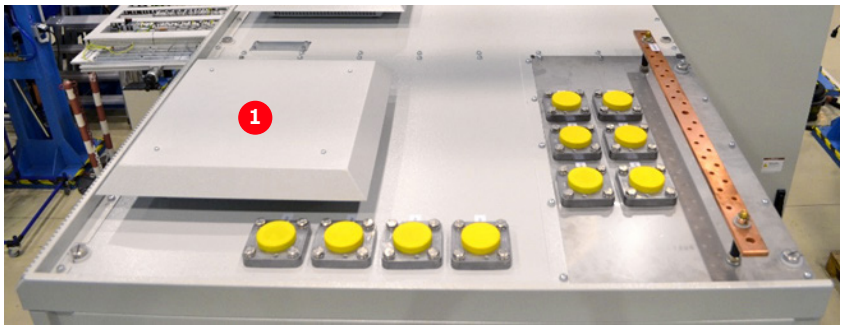
7. Remove the HV cables on the right side of the converter which are connected to the Pfisterer plugs.

8. Disconnect the power supply of the roof fan.
9. Remove the LV power supply of the GDM and unscrew the earth connection on the left side.

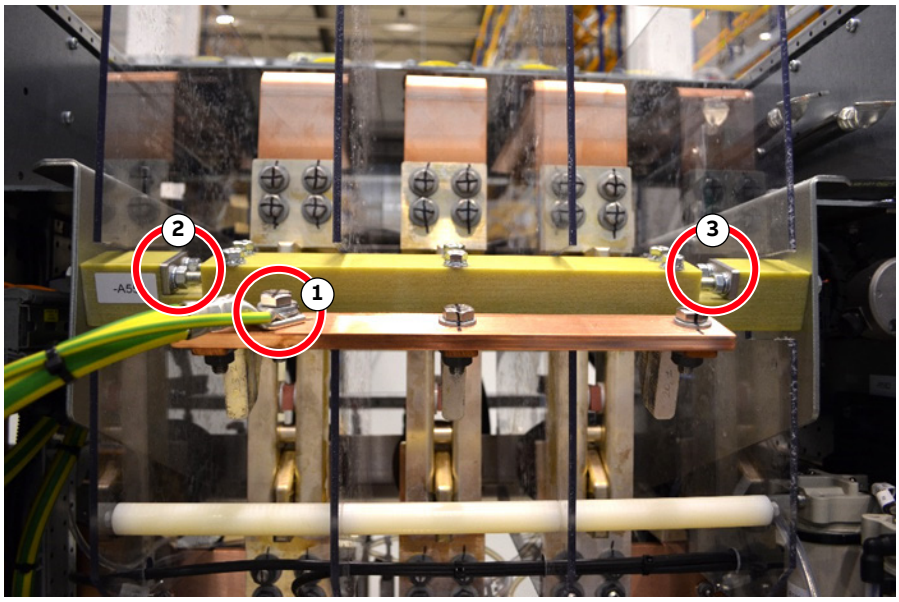


10. Unscrew the roof above the roof fan (1).

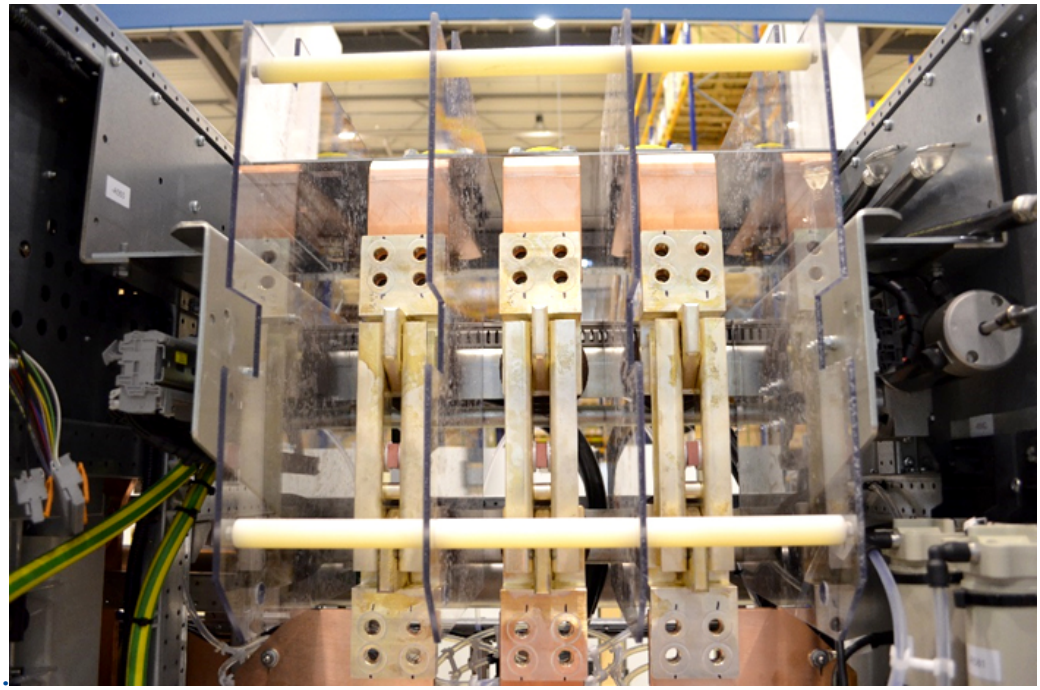
NOTICE Be careful while lifting the roof with the fan.



11. Disconnect the ground (1) in front of the GDM and remove the insulated bar by loosening the mounting screws on the left (2) and the right (3) side of the GDM.



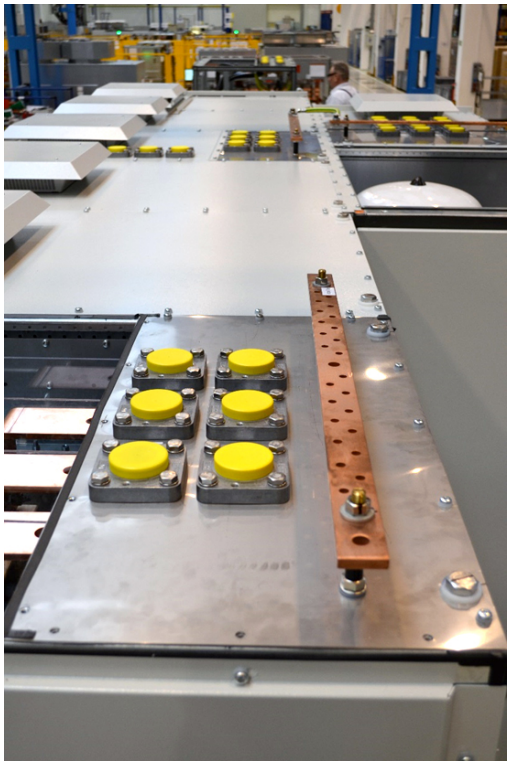
12. Disconnect the copper bars below (to the filter reactor) and above (to Pfisterer plugs) the GDM



13. Disconnect the cables between the dv/dt filter and the main copper bars (on busbar side).

14. Disconnect the ground cable positioned in the left corner at the back of the DLU.

15. Unscrew the roof part above the GDM.

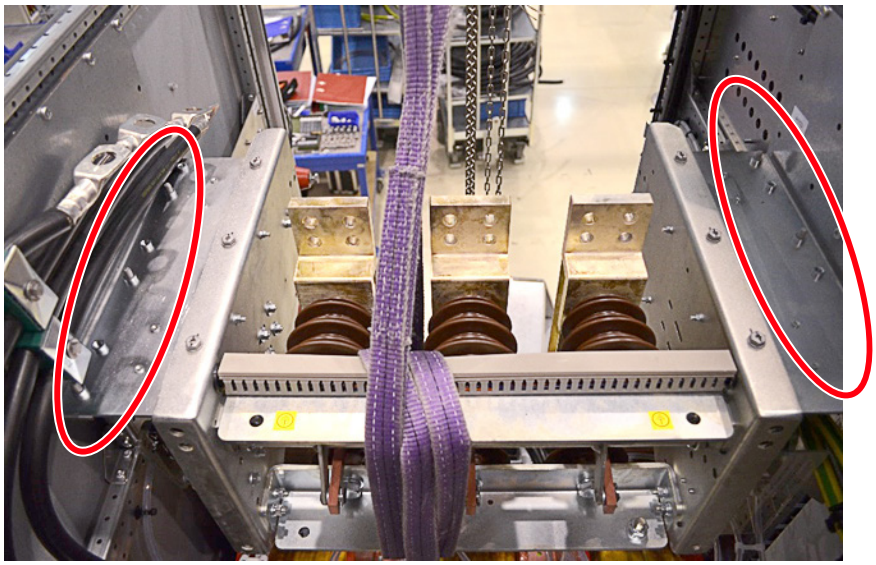


16. Remove the Plexiglas cover of the GDM.

17. Install a framework and the chain-block above the cabinet next to the door and connect the chain-block to the GDM.

NOTICE Ensure that the position of the tension belt matches with the center of gravity so that the GDM can be craned straight up and down.

18. Remove the mounting screws on both sides of the GDM.



19. Lift the GDM some millimeters and remove the left aluminum plate.

20. Crane the GDM carefully through the door.

NOTICE ABB recommends that two people lift the GDM. Be careful that it doesn't hit the water cooled resistors. Also be careful with the relays on the left side of the GDM.

21. Replace the GDM.

22. Rebuild the DLU in reverse orders

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

10.9. Replacing components in VFU

10.9.1. Replacing grid/generator disconnector module (GDM1) at the front of the VFU

Service MTTR 4 - 8 h

Requirements

- 2 people
- Ladder
- Fixing point for the chain block above the GDM

  If the surrounding infrastructure does not have a fixing point, use a framework that is similar to Fig. 10–57.

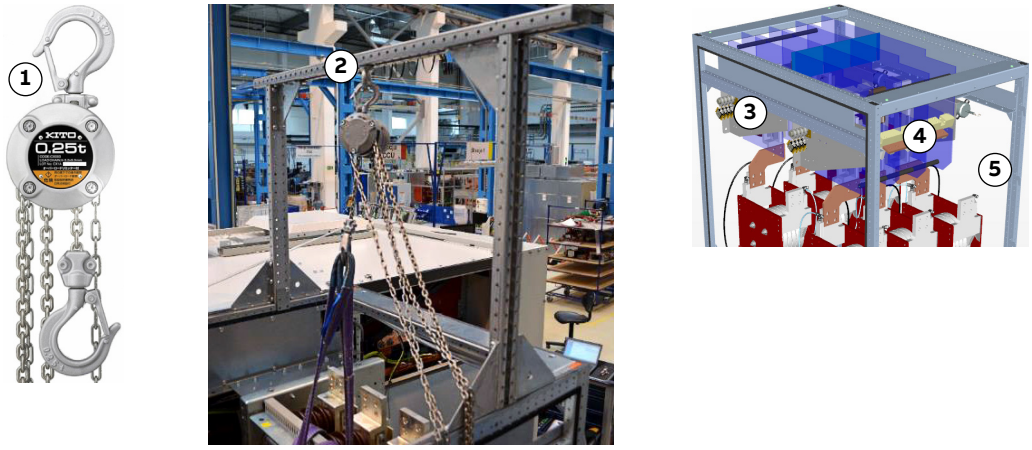
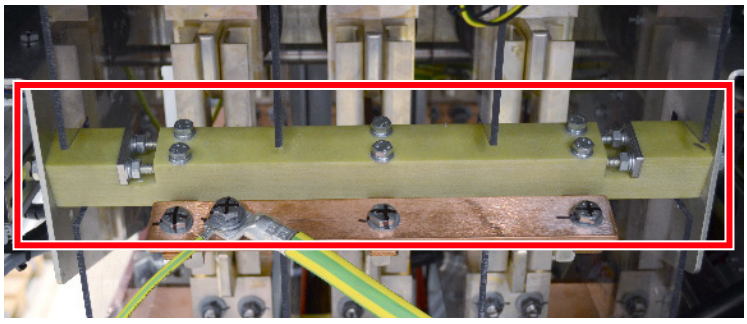


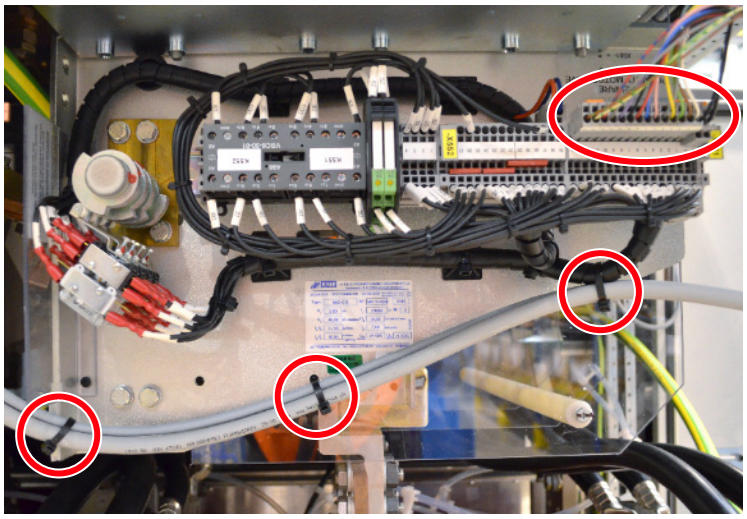
Figure 10–57 Framework for chain-block

1) Chain block	4) GDM1
2) Framework for chain block	5) Front door location
3) GDM2	

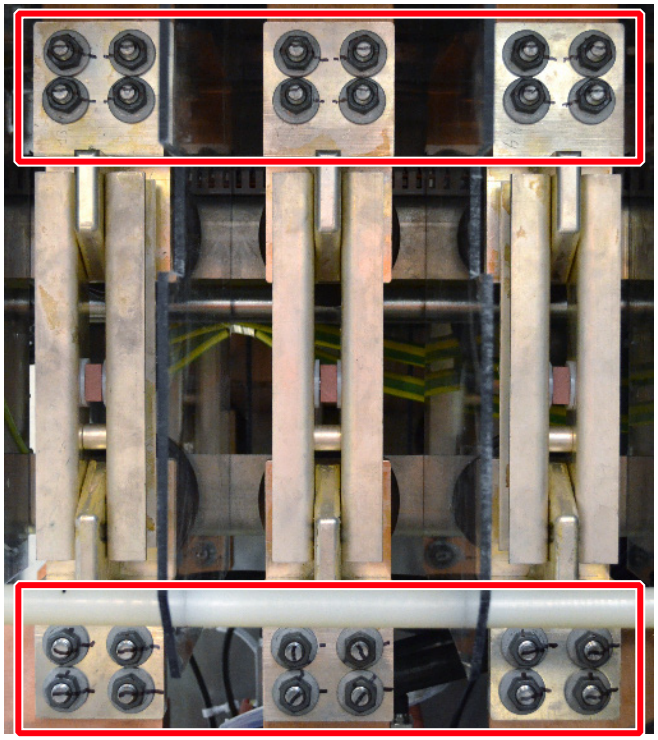
1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Remove grounding cables shown in the figure below.
3. Remove the insulated bar in front of the GDM1 by loosening the four mounting bolts positioned on the left and right side of the GDM1 aluminum frame.



4. Remove the three cable ties and the system and LV system cable positioned at the side of the GDM1.

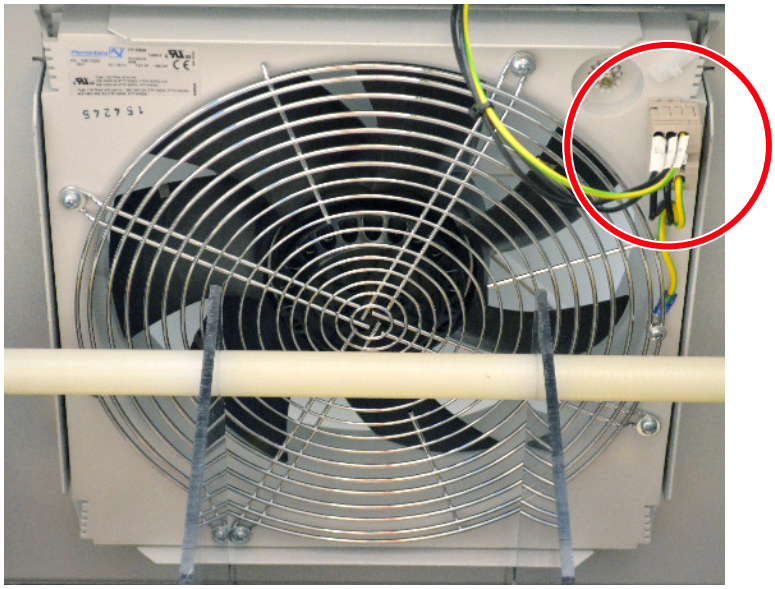


5. Remove the screws which connect the GDM1 to the copper bars.



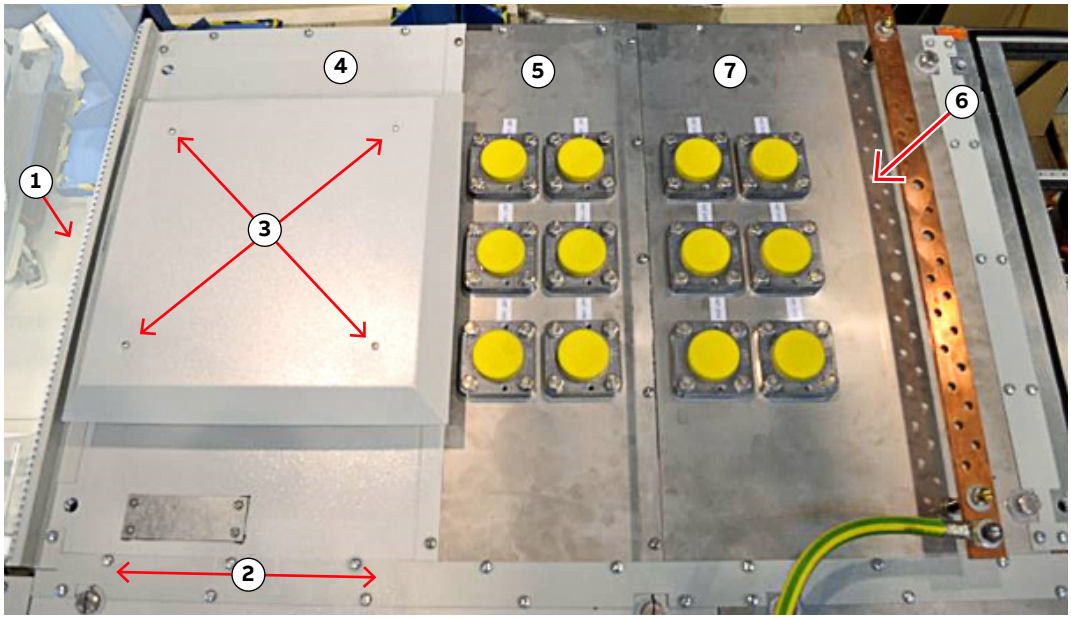
6. Remove the HV-cables on the dv/dt reactors and position them in a way that the GDM1 can be pulled out easily.

7. Remove the voltage supply cable from the roof fan.



8. Loosen the roof cover of the converter.

The numbers in the following picture shows the working sequence.



9. Remove the front frame cover.

10. Loosen the screws of the overlapping cover (between VFU and DLU/POU).

11. Remove the screws of the roof fan and remove the cover plate.

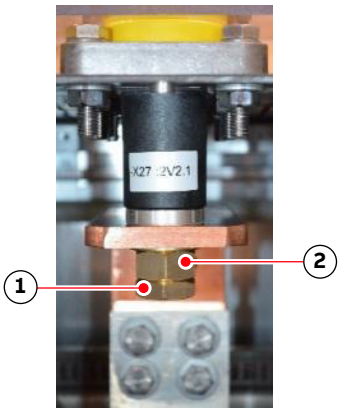
12. Remove the screws of the cover under the roof fan before lifting the roof segment.

NOTICE While removing this roof segment, do not pull on the roof fan itself.

13. Remove the screws and afterwards the cover plate above GDM1

14. Unscrew the overlapping plate between VFU and WCU.

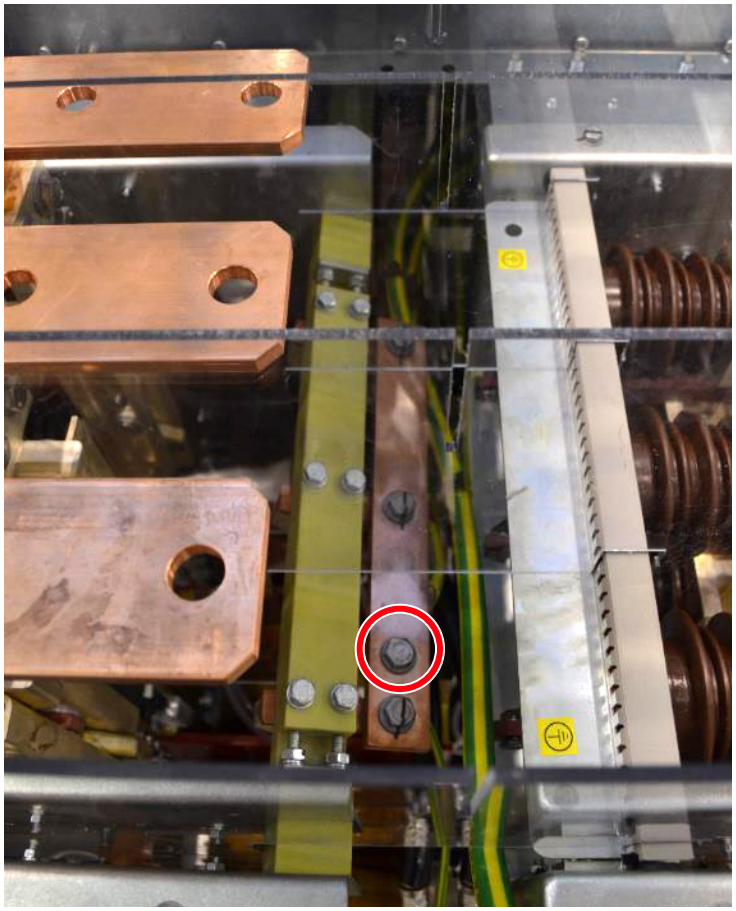
15. Before removing the cover above GDM2, unscrew nuts 1 and 2 of the six Pfisterer plugs between GDM2 and remove the plugs.



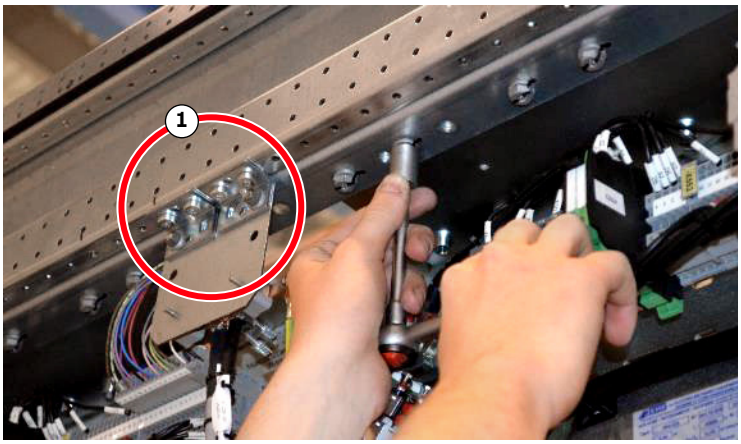
16. Remove the two grounding cable mounted under and above the roof cover of GMD2.

17. Remove the roof cover above GDM2.

18. Remove grounding cables on the copper bar between GDM1 and GDM2 as well as the insulated bar by loosening the mounting bolts.



19. Remove the side wall of VFU and loosen the mounting screws of GDM1 and remove the aluminum plate on the left side of the GMD1 mounted on the frame.



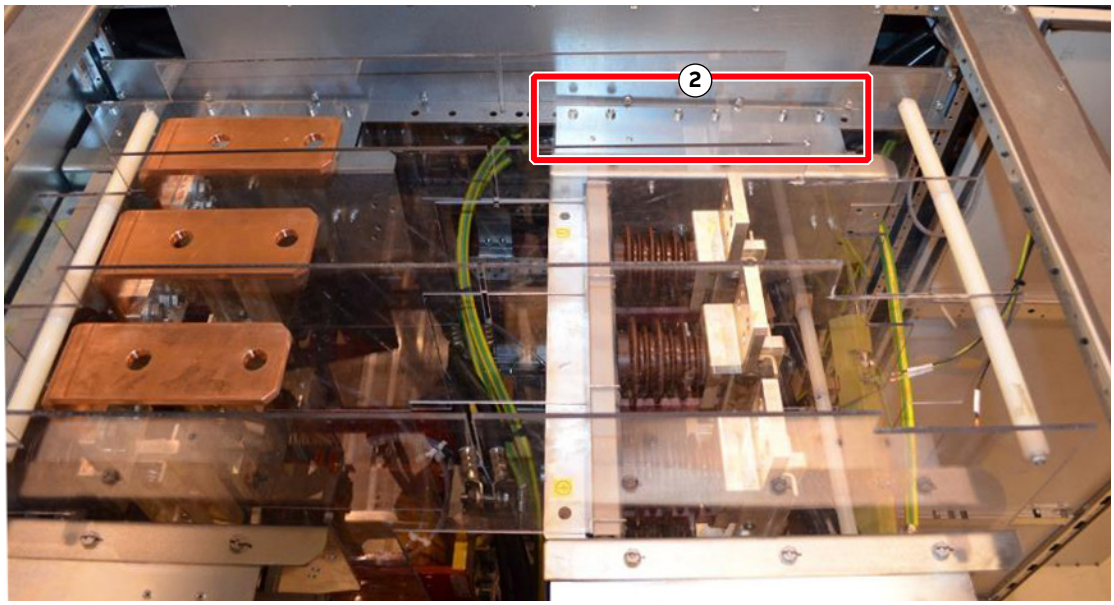


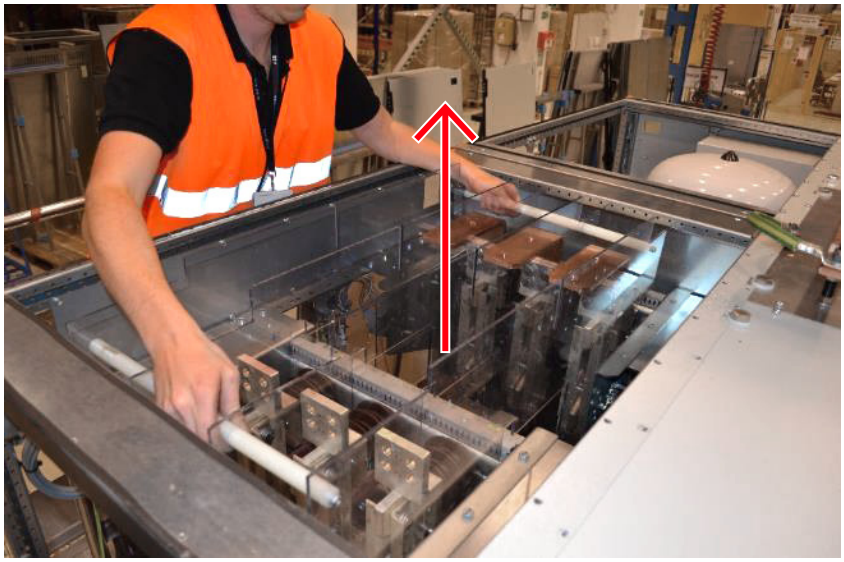
Figure 10–58 GDM1 mounting screws and aluminum plate

1) Mounting screws	2) Aluminum plate

20. Remove the grounding cable from the Insulated bar which is located between GDM1 and GDM2.

21. Pull the GMD1 with the Plexiglas housing to the front.

22. Remove the Plexiglas housing.



23. Install the framework and the chain block above the GMD1.

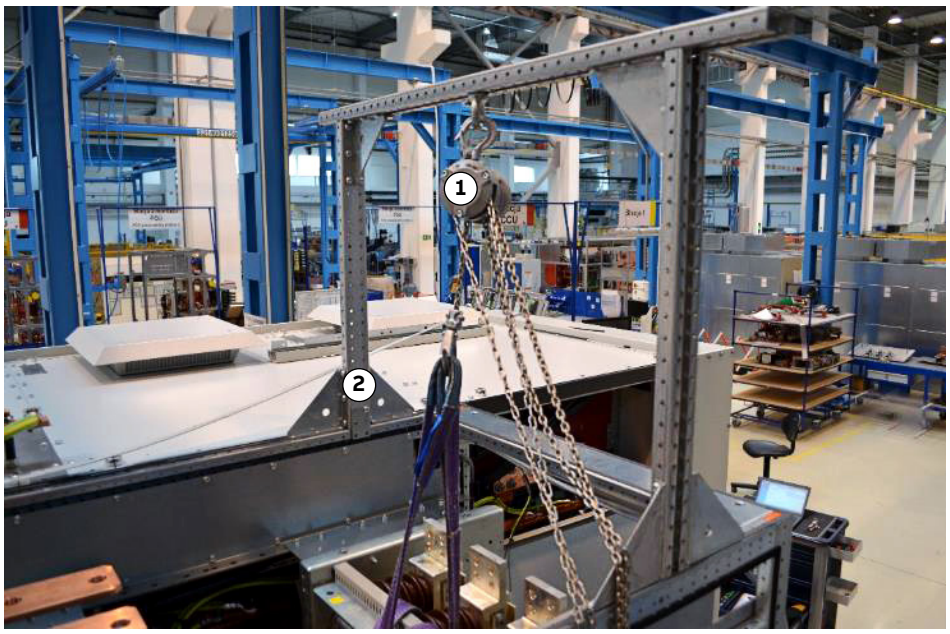
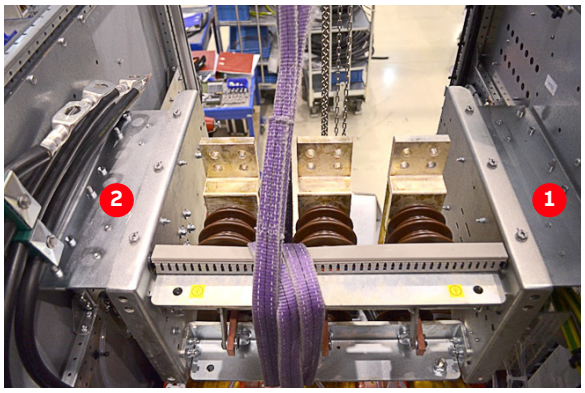


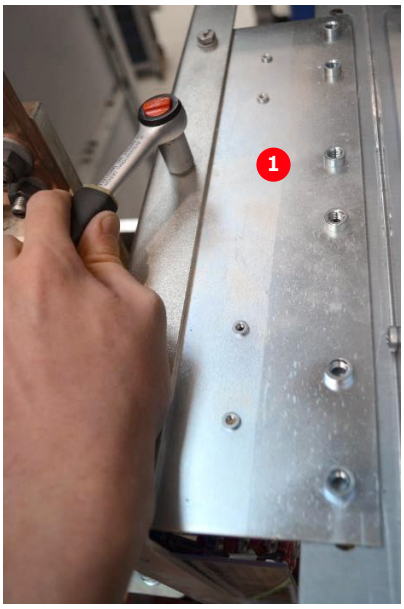
Figure 10–59 GDM1 with framework for chain block

1) Chain block	2) Framework

24. Remove the aluminum plate (1) on the right side of the GDM1.

25. Remove the aluminum plate (2) on the left side of the GDM1.





26. Lower the GDM1 out of position.

CAUTION! Two people are required, one to operate the chain block and one to move the GDM1.

27. Replace the GDM1.

28. Rebuild the DLU in reverse order.

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

10.9.2. Replacing grid/generator disconnector module (GDM2) at the back of the VFU

Service MTTR 4 - 8 h

Requirements

– Before replacing the GDM2 (at the back) the GDM1 at the front must be removed.

  See section 10.9.1, **Replacing grid/generator disconnector module (GDM1) at the front of the VFU**, page 203.

– 2 people

– Ladder

– Fixing point for the chain block above the GDM

  If the surrounding infrastructure does not have a fixing point, use a framework that is similar to Fig. 10–60.

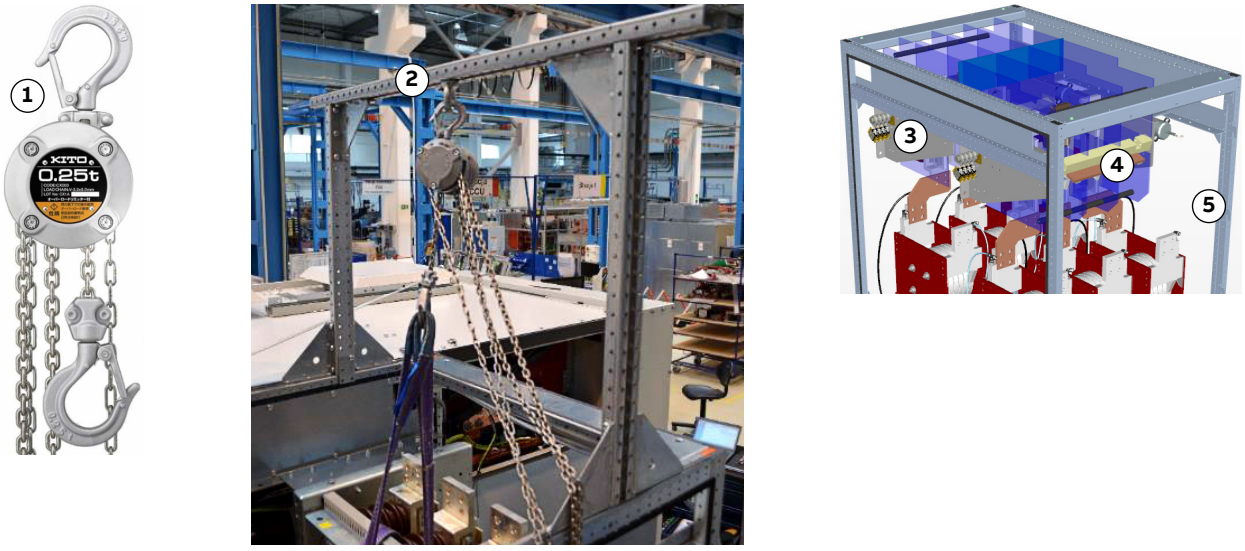
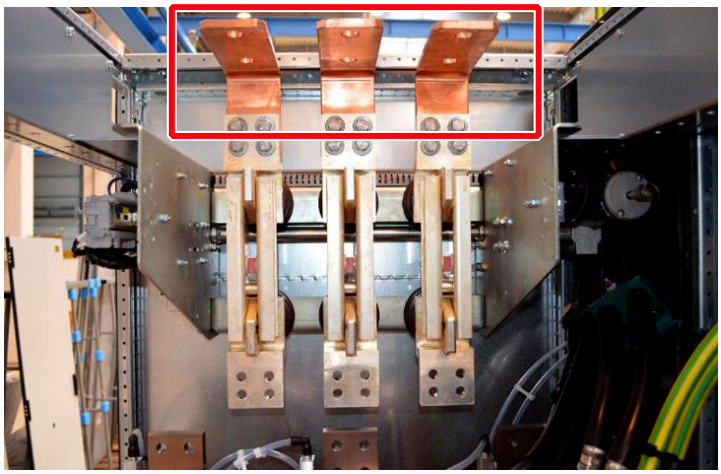


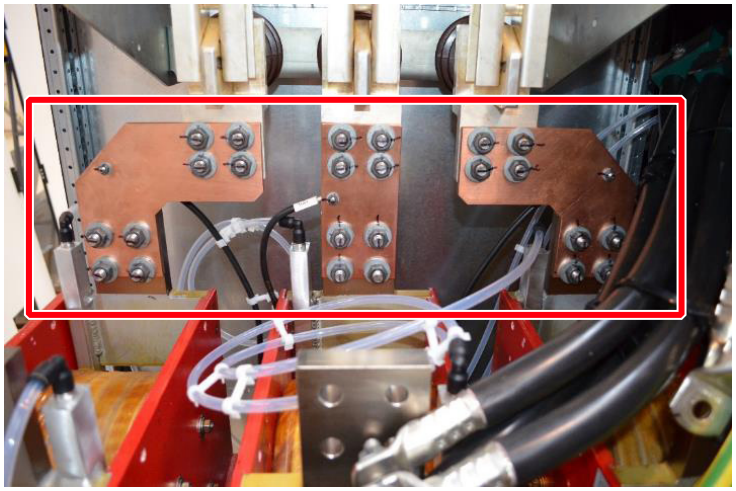
Figure 10–60 Framework for chain-block

1) Chain block	4) GDM1
2) Framework for chain block	5) Front door location
3) GDM2	

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Follow the procedure of section 10.9.1, **Replacing grid/generator disconnector module (GDM1) at the front of the VFU**, page 203.

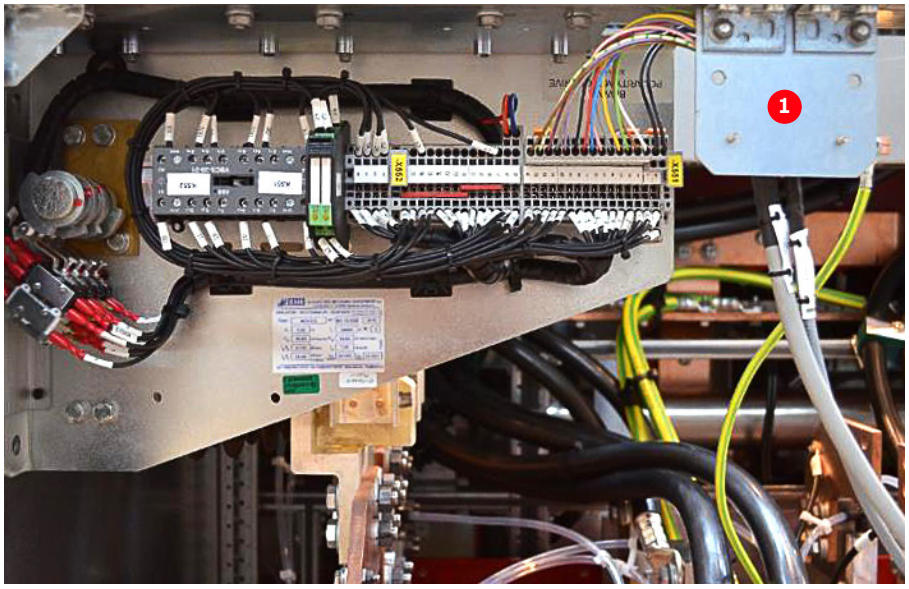
3. Remove the copper plates above (Pfisterer connector) and below (dv/dt reactor) of GMD1.



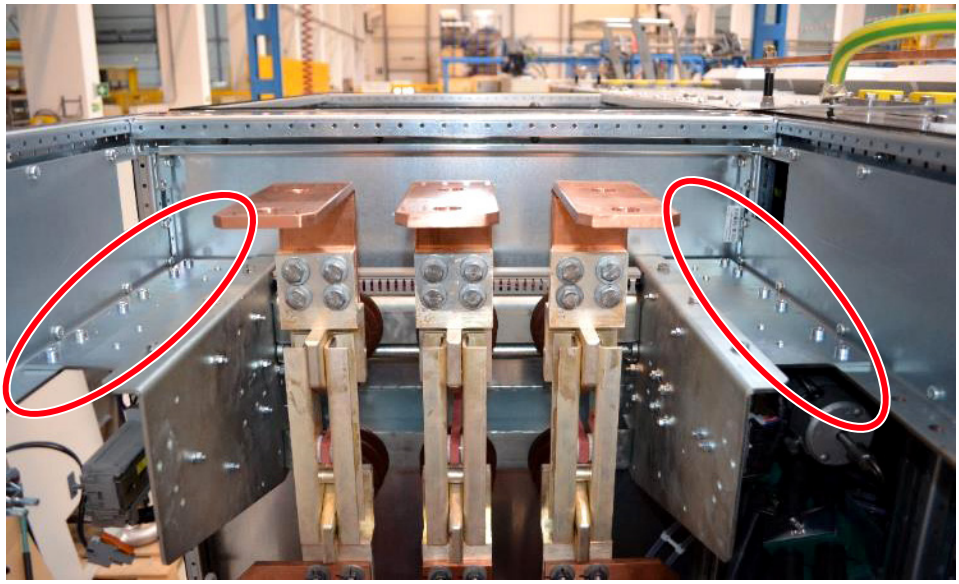


4. Remove the HV cables and position them in a way that the GDM can easily be pulled out and open the green cable holder on the left side.

5. Remove the LV and system cable on the left side of the GDM2 as well as the aluminum plate.



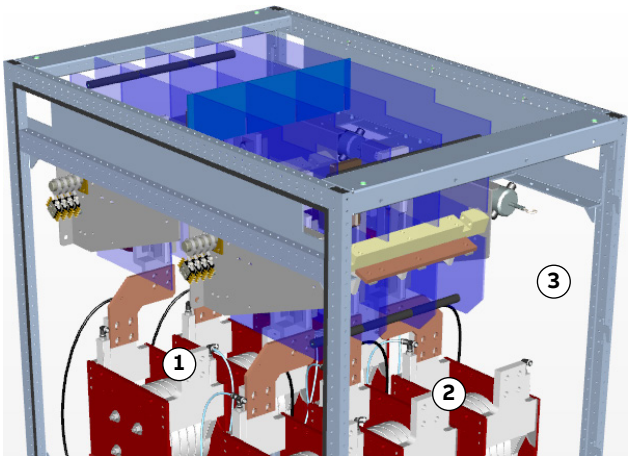
6. Remove the mounting screws of GDM2 and pull the GDM2 to the front of the cabinet.



7. Lift the GDM2 down as described in section 10.9.1, **Replacing grid/generator disconnector module (GDM1) at the front of the VFU**, page 203.
8. Replace the GDM2.
9. Rebuild the VFU in reverse order.
10. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.9.3. Replacing dv/dt filter reactor at the front of the VFU (VFM1)

Service MTTR 4 - 8 h



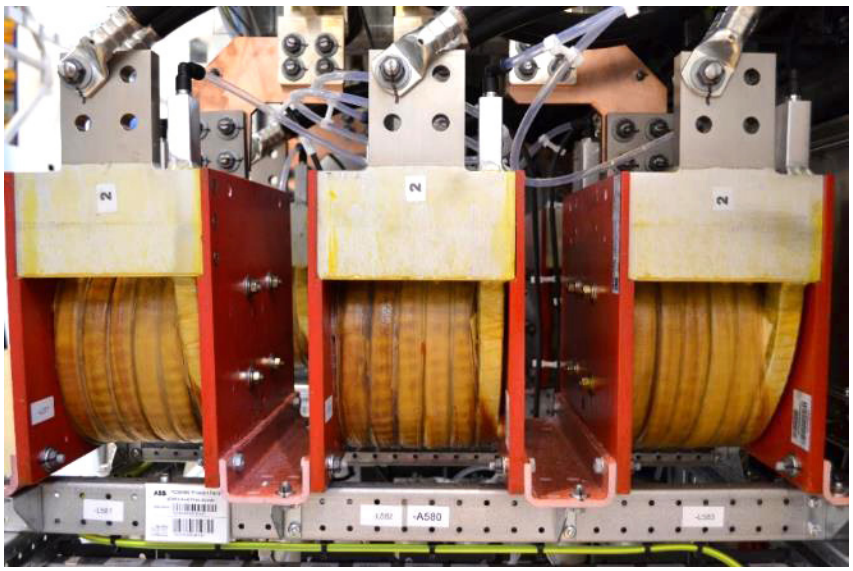


Figure 10–61 dv/dt filter reactor

1) VFM2	3) Front (door location)
2) VFM1	

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Disconnect water pipes, copper busbars and power cables.

   CAUTION! The reactor weights approximately 25 kg. Use lifting aids and proper lifting technique when lifting and moving.

4. Unbolt the 4 mounting screws from the U-shaped profiles on the faulty reactor (see Fig. 10–62).

   2 screws in front and 2 screws on back of the reactor. When the screws are loosen, the reactor can be replaced.

Figure 10–62 dv/dt filter reactor mounting screws (different VFM variants)

5. Replace the faulty dv/dt filter reactor.

6. Fasten the mounting screws.

7. Reconnect the water pipes, copper busbar and the power cable.

   DANGER! Be aware of the correct mounting torque, when reconnecting the copper bars and power cables (See section 10.4.1, **Correct tightening torques of bolted connections**, page 135). It also has to be ensured that the washer rest flat on the copper busbars.

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

10.9.4. Replacing dv/dt filter reactor at the back of the VFU (VFM2)

Service MTTR 4 - 8 h

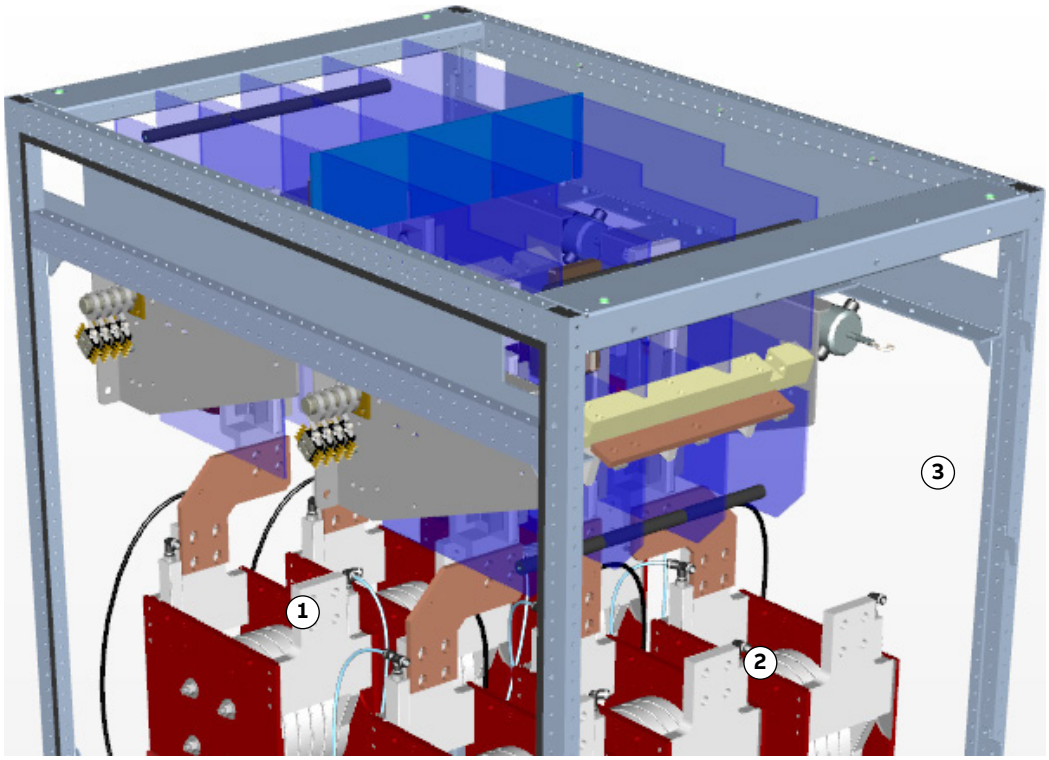


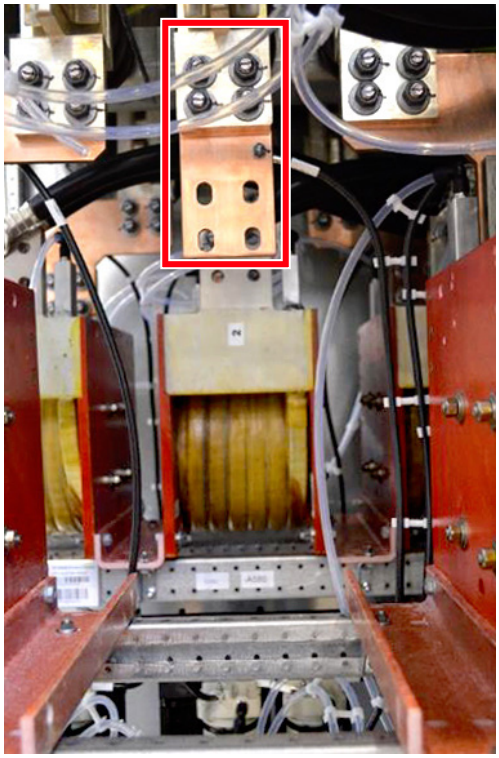
Figure 10–63 Position of VFM

1) VFM2	3) Front (door location)
2) VFM1	

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Remove the filter reactor in front of the faulty reactor (see section 10.9.3, **Replacing dv/dt filter reactor at the front of the VFU (VFM1)**, page 213).

   CAUTION! The reactor weights approximately 25 kg. Use lifting aids and proper lifting technique when lifting and moving.

4. Remove the copper plate of the front reactor.



5. Disconnect water pipes, busbar and power cable.

6. Unbolt the 4 mounting screws from the U-shaped profiles on the faulty reactor (see Fig. 10–54).
Note: 2 screws in front and 2 screws on back of the reactor.

7. Replace the faulty dv/dt filter reactor.

8. Reconnect pipes, busbars and power cables.

9. Reassemble the dv/dt filter in the front.

10.9.5. Replacing dv/dt filter resistor in VFU

Service MTTR 0 - 2 h

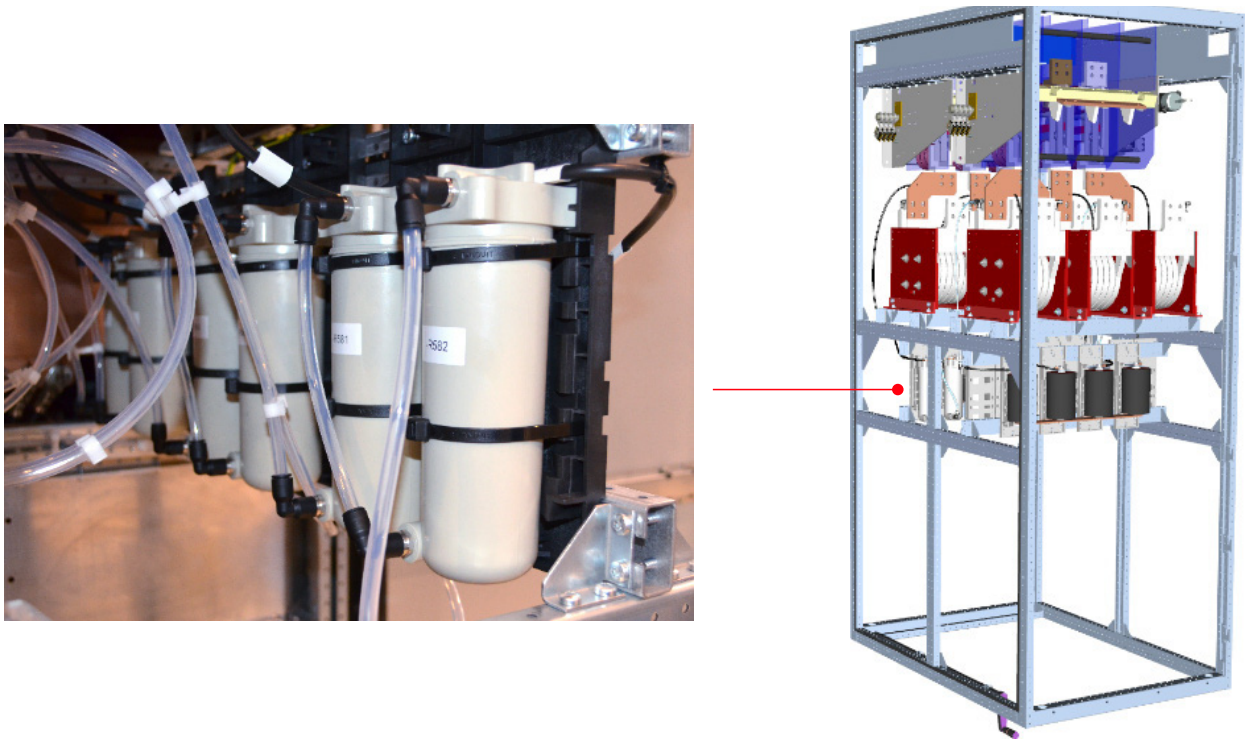


Figure 10–64 dv/dt filter resistors

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Remove the Plexiglas cover in front of the capacitor bank by loosening the mounting screws.
4. Disconnect water pipes and cables.

5. Remove the mounting screws of the backplane.

Figure 10–65 Position of mounting screws dv/dt filter resistors

6. Remove the cable ties.
7. Replace the dv/dt filter resistor.
8. Add new cable ties.
9. Mount the resistor together with its backplane.
10. Reconnect water pipes and cables.
11. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.9.6. Replacing dv/dt filter capacitor in VFU

Service MTTR 0 - 2 h

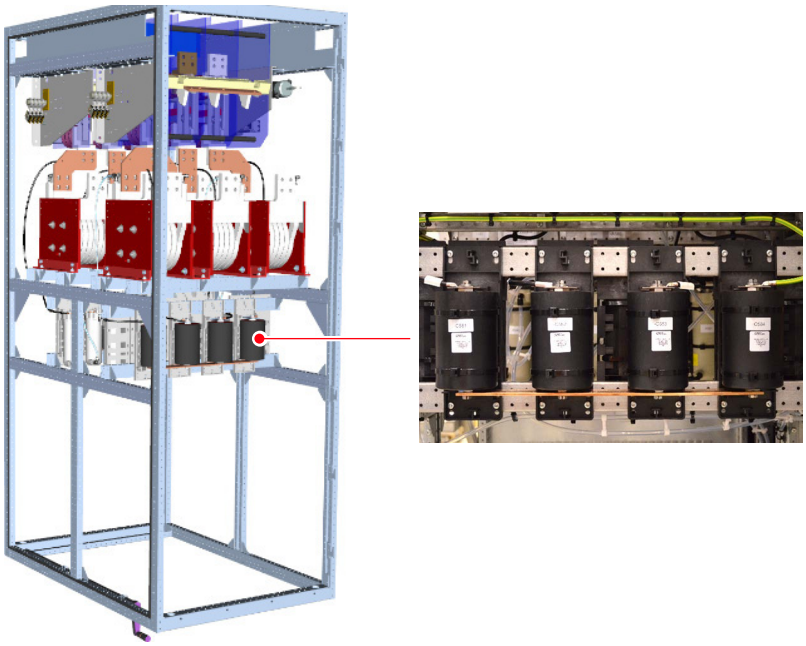


Figure 10–66 dv/dt filter capacitors

1. Shut-down the PCS6000 according to “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Remove the Plexiglas in front of the capacitor bank by loosening the mounting screws.
3. Disconnect cables.
4. Replace dv/dt filter capacitor.

   NOTICE DO NOT exert any torque onto the capacitors. During loosening as well as fastening, the capacitor connections need to be held in place with a 23 mm flat wrench (contained in converter service toolbox). For maximum tightening torques refer to section 10.4.1, **Correct tightening torques of bolted connections**, page 135.
5. Reconnect cables.
6. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.10. Replacing components in WCU (Swedewater)

10.10.1. Replacing or cleaning conductivity meter

Service MTTR 4 - 8 h

Figure 10–67 Conductivity meter

1) Coupling ring

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Disconnect the electrical connection.

4. Turn coupling ring below the meter clockwise (looking from top) to open.

Figure 10–68 Conductivity meter

5. Replace the conductivity meter.
6. Tighten coupling ring below the meter in anti-clockwise direction.
7. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.10.2. Replacing inlet water temperature meter

Service MTTR 0 - 2 h

Figure 10–69 Temperature meter

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

   IMPORTANT! Pocket type sensor, water circuit has not been touched.

2. Remove 2 radial screws.
3. Replace measuring head and check that the sensor wires are covered with heat conducting paste.
4. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.10.3. Replacing pressure gauge and pressure transmitter

Service MTTR 0 - 2 h

Figure 10–70 Pressure gauge and transmitter

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Close valve V91 for B5501 or V92 for B5502 and B5530.
3. Replace the faulty component.

   Use a sealing paste (Loctite 278 or similar product) and apply according to the manufacturer's technical information.
4. Open the valve again.
5. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.10.4. Replacing deionizer flow meter

Service MTTR 0 - 2 h

Figure 10–71 Deionizer flow meter

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Release the over pressure of the cooling system as described in section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138 or, if necessary, empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Close valve V59.
4. Replace the deionizer flow meter.
5. Open valve V59 again.
6. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.
7. Adjust the flow valve to a flow indication of approximately 8 l/min

10.10.5. Replacing the ion exchange vessel

Service MTTR 0 - 2 h

⚠CAUTION Corrosive substance!

Contact may result in irritation. For more information, see Safety Data Sheet 8-1000-193.

- Avoid skin and eye contact with the deionizer resin!
- Wear protective clothing, including rubber gloves and safety goggles

Figure 10–72 Ion exchange vessel (right side: old version)

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Close flow meter FI10 before and valve V59 after the ion exchange vessel.
3. Open first valve V55 and then V71 to release pressure.

   CAUTION! Pay attention to the direction of the vent hole and make sure that escaping water does not cause injury to persons or damage to the motor or other components. Water temperature can be up to **50°C**.

4. Close valve V55 and V71 again.

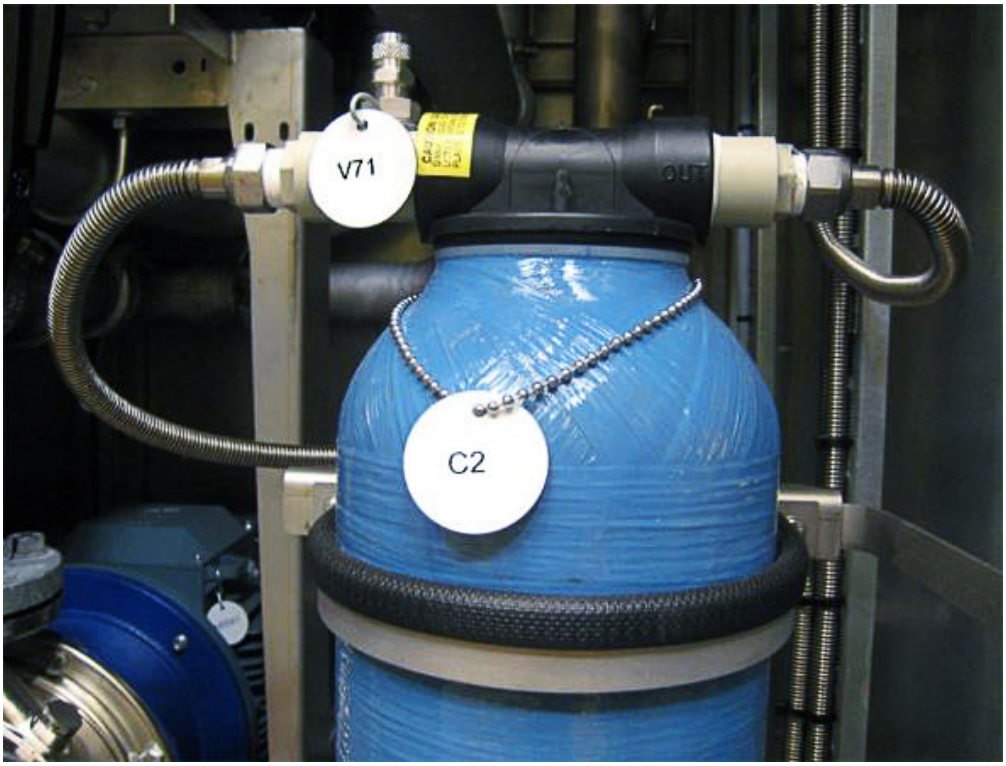


Figure 10–73 Ion exchange vessel

5. Remove the two clamps to dismount the vessel.

   CAUTION! The ion exchanger vessel weights approximately 20 kg.

6. Hold the vessel distributor head in place and turn the vessel to unbolt it from the distribution head.
7. Switch over the vessel distributor head with the hose couplings to the new vessel.
8. Check the correct length (minimum bending force at the Legris fitting) of plastic tubes (in old versions). If they are not long enough replace tubes and Legris.
9. Remount the vessel and re-position the clamps.
10. Open carefully flow meter FI10 before the ion exchange vessel.
11. De-aerate through valve V71 and close when water starts to trickle out.
12. Open valve V59.
13. Run pump for approximately 30 minutes to flush loosen resin into the (old) water filter.
14. Replace the water filter according section 10.10.6, **Replacing the water filter**, page 227.

10.10.6. Replacing the water filter

Service MTTR 0 - 2 h

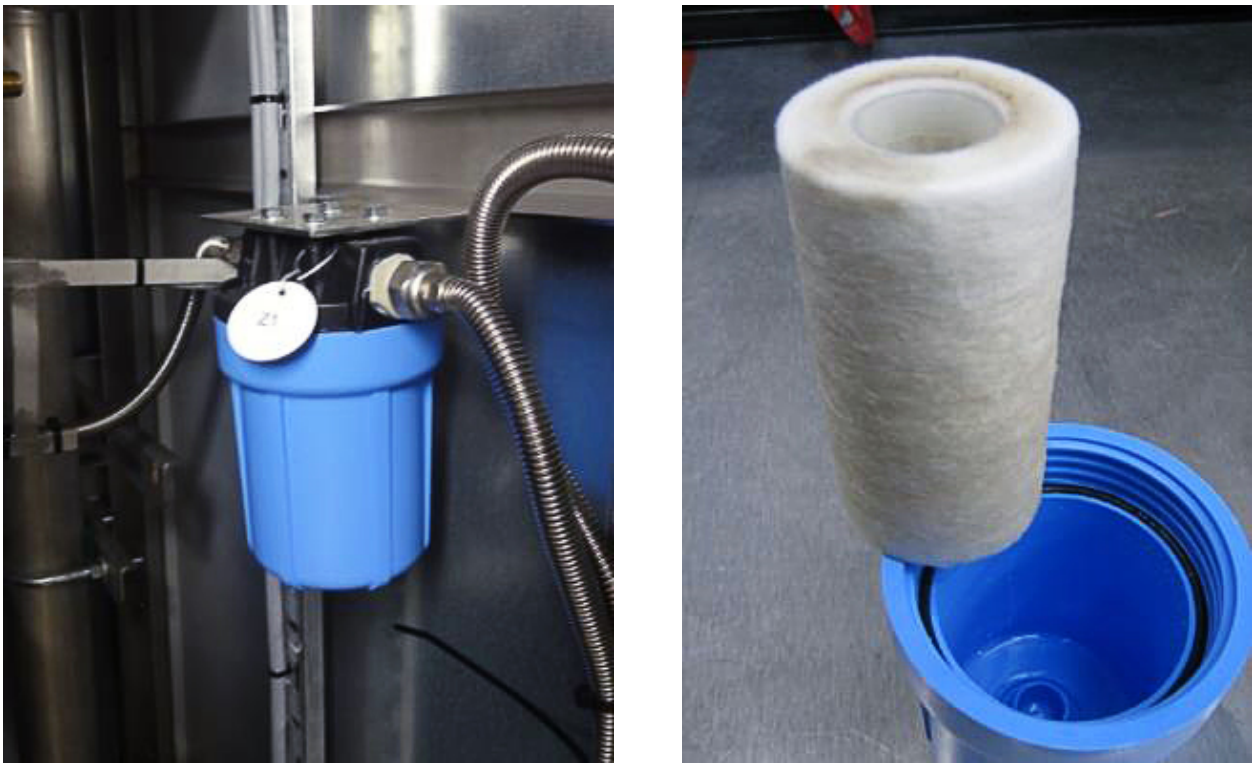


Figure 10–74 Water filter

The water filter has a limited life length. It is recommended to replace the water filter when the deionizer vessel is serviced or changed. Should the flow indicated on flow meter FI10 go down, a change of the water filter is due.

If you have replaced the resin vessel it is possible to flush any new resin out of the vessel. Therefore, first run the pump for 30 minutes with the new vessel before replacing the old filter.

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Close flow meter FI10 and valve V59.
3. Release the over pressure of the cooling system as described in section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138.
4. Unbolt bottom of housing. Remove large O-ring and set aside.

   NOTE – Although it should be possible to unbolt the filter housing by hand, oil filter pliers can be helpful.
5. Discard used water filter. Rinse out bottom of housing.
6. Wipe clean O-ring of old lubricant.
7. Lubricate O-ring with clean petroleum jelly (Vaseline) or silicone lubricant.
8. Place O-ring back into groove and smooth into place with finger.

9. Insert new water filter over standpipe in bottom of housing.

   NOTICE Water filters with tapered ends need to be specifically installed with the tapered end towards the threads of the housing.

10. Screw bottom of housing onto cap and hand tighten.

    NOTICE DO NOT over-tighten. Make sure cap standpipe slips into water filter.

11. Turn on water supply (flow meter FI10) slowly to fill the cooling system with water.

12. Open valve V59.

13. Check for leaks before leaving installation.

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

10.10.7. Replacing pump

Service MTTR 2 - 4 h

Converter service tools are required to carry out this work:

– Pump maintenance table kit WCU (3BHE039649R0001)

– Base beam lifting jack (3BHE039648R0001)

– Chain-block minimum 150 kg (3BHB032083R0001)

See also chapter 3, **Service tools**, page 31.

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

2. Open MCB -Q601 or -Q602 on the WCU electrical control box.

3. Release the over pressure of the cooling system as described in section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138.

4. Close valve V1 or V2 to isolate pump from the water circuit (the other pump side is isolated by the non return valve V3 or V4).

5. Place a catching tray under the draining bolt of the pump in such a way that escaping cooling liquid when opening the draining bolt does not spill into the converter.

   IMPORTANT! The catching tray should be capable to catch approximately 5 liters.

6. Open draining bolt and deaeration valve V73/72 to drain the pump.

7. Disconnect pump electrically.

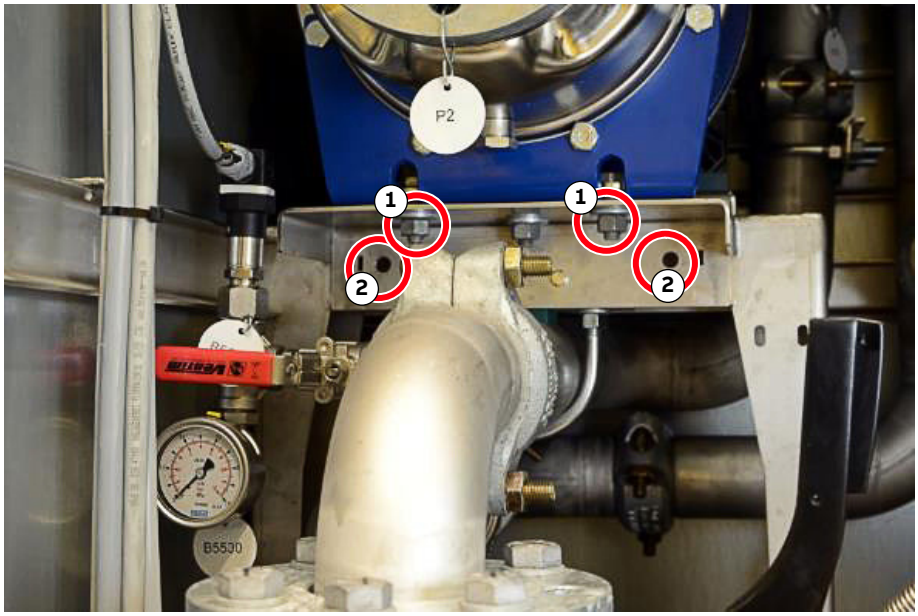


Figure 10–75 Pump support

1) Support bolt	2) Mounting hole for maintenance table

8. Remove the 3 support bolts (see Fig. 10–75).

9. Loosen both flanges of the pump and remove bolts.

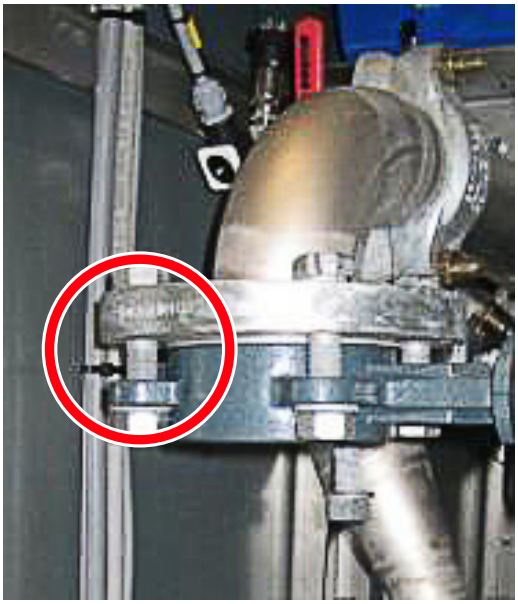


Figure 10–76 Pump flange

1) Pump flange bolt

10. Use the bolts from the pump flange to fix valve V1 before removing the connecting pipe (see Fig. 10–76).

The connecting pipe can be turned out of the way using the turn flanges (see Fig. 10–77).

Figure 10–77 Connecting pipes turned aside

11. Use the bolts from the pump flange to fix valve V1 before removing the connecting pipe (see Fig. 10–76).

12. If no 10 mm mounting holes (see Fig. 10–75) are available (converters delivered before January 1, 2013), the pump maintenance table can only be used after drilling these holes according to the drilling plan shown in Fig. 10–78.

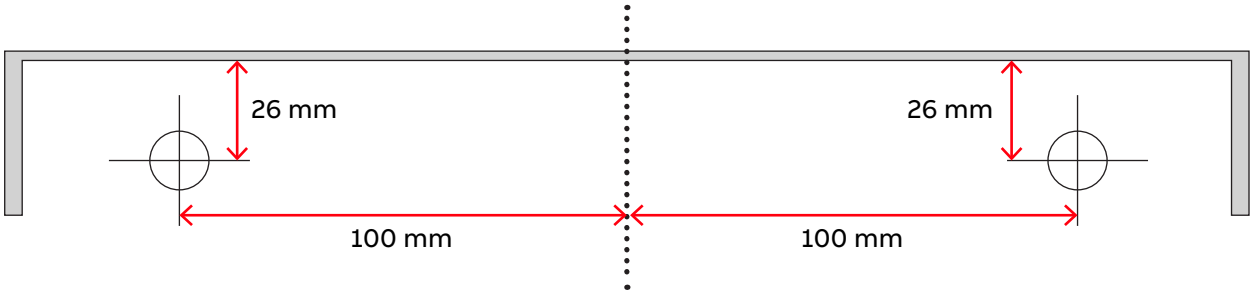


Figure 10–78 Drilling plan

13. Install pump maintenance table (see Fig. 10–79) with long legs (for upper pump) or with short legs (for lower pump).

Figure 10–79 Pump maintenance table with long legs (for upper pump)

14. Pull pump to front into suitable working or lifting position.

CAUTION! The pump with motor weights approximately 125 kg. Single person lift could cause injury. Use lifting aids and assistance when lifting and moving.

15. For work on the pump maintenance table fix motor with M12 bolt to the table.

16. For removing the pump install base beam lifting jack into MNS profile.

17. Lift pump out of the cabinet.

Figure 10–80 Use of chain-block to lift out pump

18. Replace pump and fit all back in opposite order.

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

10.10.8. Replacing pump slip ring sealing

Service MTTR 0 - 2 h

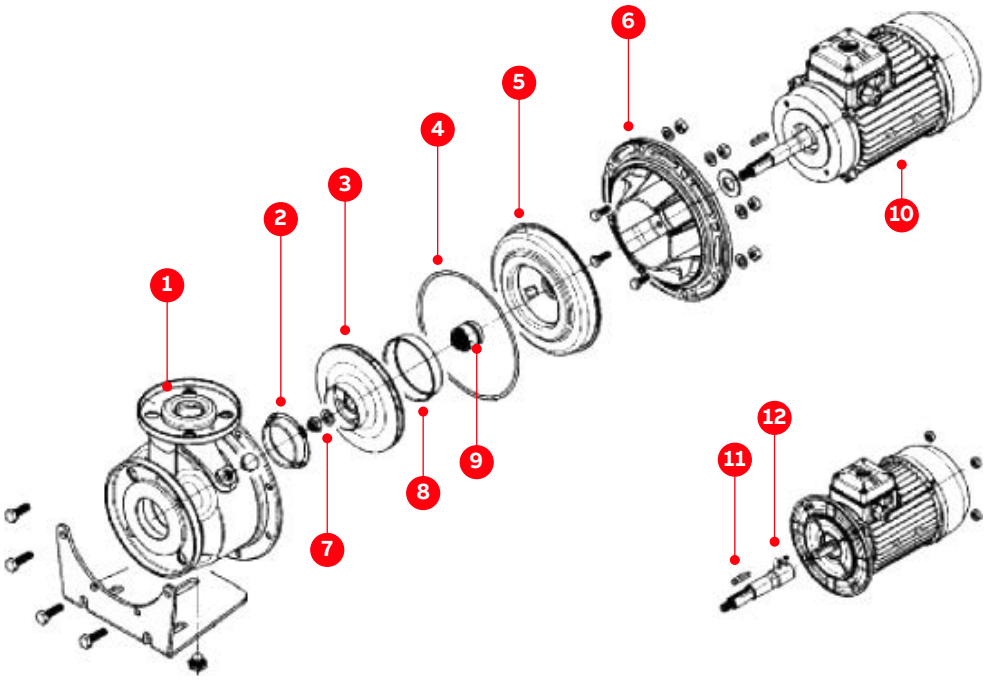


Figure 10–81 Pump components (Swedewater)

1) Pump body	7) Impeller fastening nut and washer
2) Wear ring	8) Counter-wear ring
3) Impeller	9) Mechanical seal
4) O-ring	10) Complete motor
5) Seal-holding disk	11) Tab
6) Adapter	12) Coupling

1. Follow instruction in section 10.10.7, **Replacing pump**, page 228 (steps 1 to 10).
2. Open pump case (see Fig. 10–82).

Figure 10–82 Opening pump case

3. Remove pump wheel with impact wrenches.

4. Remove key out of keyway.

Figure 10–83 Pump shaft

5. Remove spring and sealing.
6. Replace sealing.

Figure 10–84 Pump sealing

7. Rotate pump by hand to ensure correct centering.
8. Fit all back in opposite order.
9. Pump wheel torque is 45 Nm.
10. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.10.9. Replacing the 3-way valve

Service MTTR 4 - 8 h

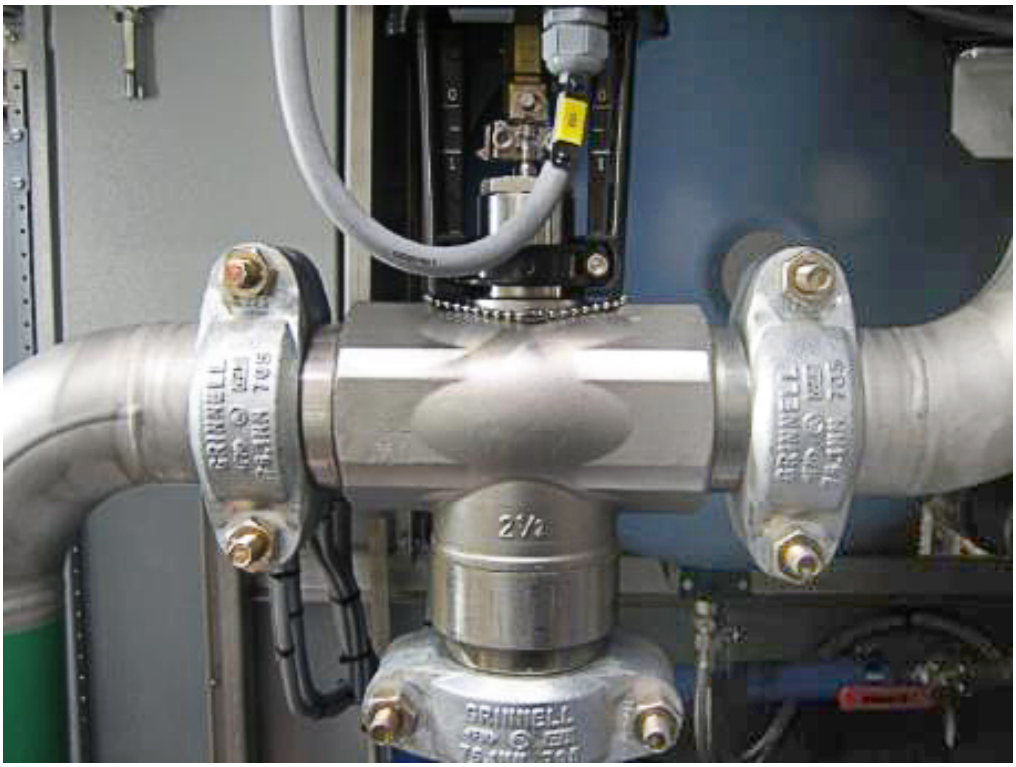


Figure 10–85 3-way valve

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Remove side wall of the WCU cabinet.
4. Remove pulling clutch.
5. Loosen the actuator and move it out of the way.
6. Open all 3 “Grinnell” flanges.
7. Replace valve and fit all back in opposite order.
8. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.10.10. Replacing expansion vessel

Service MTTR 0 - 2 h

Figure 10–86 Expansion vessel

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off 24 V DC auxiliary power.
3. Release the over pressure of the cooling system as described in section 10.5.1, **Releasing the over pressure from the cooling liquid circuit**, page 138.
4. Close valve V56 (the key for the padlock is inside the electrical control box).
5. Unbolt the 4 mounting screws of the electrical control box and temporarily strap the electrical control box to the WCU frame without removing the cables (see Fig. 10–86).

   CAUTION! The expansion vessel weights approximately 24 kg. Use lifting aids and proper lifting technique when lifting and moving.
6. Disconnect the coolant hose.

7. Unbolt the 2 mounting screws on the lower side of the expansion vessel.

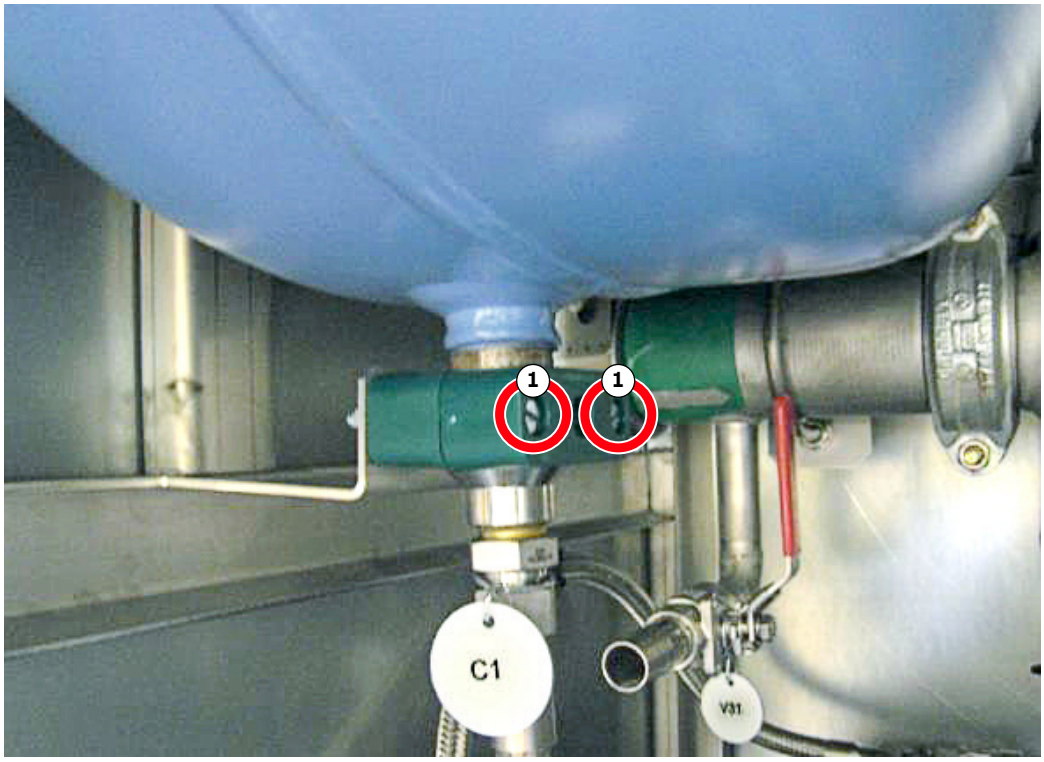


Figure 10–87 Expansion vessel

1) Mounting screw

8. Unhook the expansion vessel from the upper mounting, remove it and then install the new expansion vessel and connect the coolant hose.

Use a sealing paste (Loctite 278 or similar product) and apply according to the manufacturer's technical information.

9. Equalize the air pressure to zero by pressing the car tube valve on the vessel.

10. Open valve V56 and secure against closing with padlock.

11. Switch on 24 V DC auxiliary power.

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

10.10.11. Replacing automatic deaeration valve

Service MTTR 0 - 2 h

Figure 10–88 Automatic deaeration valve

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Close valve V51.
3. Replace the automatic deaeration valve.

   NOTE – If required, remove the WCU back wall or unbolt the 4 mounting screws of the electrical control box and temporarily strap the electrical control box to the WCU frame without removing the cables (see Fig. 10–86).
4. Open valve V51.
5. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.10.12. Replacing (checking) ball valve ¾”

Service MTTR 0 - 2 h

> **NOTICE** **Risk of component damage.**
>
> A leaking valve might be fixed by following the steps below. However, if it's still dripping after tightening, then the whole valve should be replaced.

1. Remove the crank with a 14 size spanner.

Figure 10–89 Ball valve ¾”

1) Mounting nut

2. Tight the gland with a 14 size spanner with approximately 20 Nm.

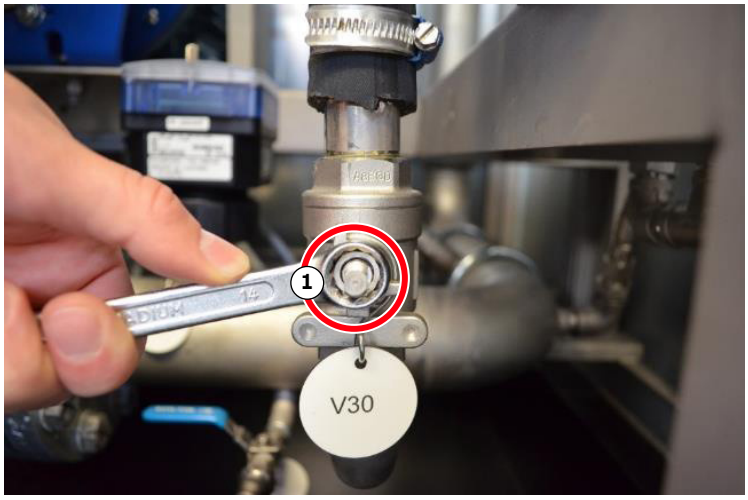


Figure 10–90 Gland from the Ball valve ¾”

1) Gland

10.10.13. Replacing (checking) ball valve ½”

Service MTTR 0 - 2 h

NOTICE **Risk of component damage.**

A leaking valve might be fixed by following the steps below. However, if it's still dripping after tightening, then the whole valve should be replaced.

1. Turn the crank approximately 10 times ON and OFF.

Figure 10–91 Ball valve ½”

10.11. Replacing components in WCU (ARMATEC)

⚠WARNING High voltage!

- Before the internals of the PCS6000 are accessed for service purposes, the relevant components of the converter must be de-energized safely.

Service MTTR

MTTR (hours)	Service
4 - 8	Replacing a pump
0 - 2	Replacing the vessel
0 - 2	Replacing the cartridge
0 - 2	Replacing valve K5541
0 - 2	Replacing the expansion vessel C1
0 - 2	Replacing conductivity sensor B5503
0 - 2	Replacing pressure sensor B5501
0 - 2	Replacing pressure sensor B5502
0 - 2	Replacing flow indicator FI10

IMPORTANT! For all work on the WCU, whether maintenance or troubleshooting, see the relevant documents of the manufacturer. For ARMATEC Water Cooling Units use please the ARMATEC WCU Service Instruction (appendix B06).

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22
2. If necessary, empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. The replacement of WCU components is described in WCU service documentation (appendix B06).
4. Filling and draining of the cooling system according to “PCS6000 user manual”, 3BHS600000 E40.
5. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.12. Replacing components in FIU

The FIU with FCM is the previous generation. From 2015 onward, the FIU is assembled with the FIM.

Figure 10–92 FIU with FCM (left) and with FIM (right)

1) FIU with FCM	2) FIU with FIM

10.12.1. Replacing HFM filter reactor

Service MTTR 0 - 2 h

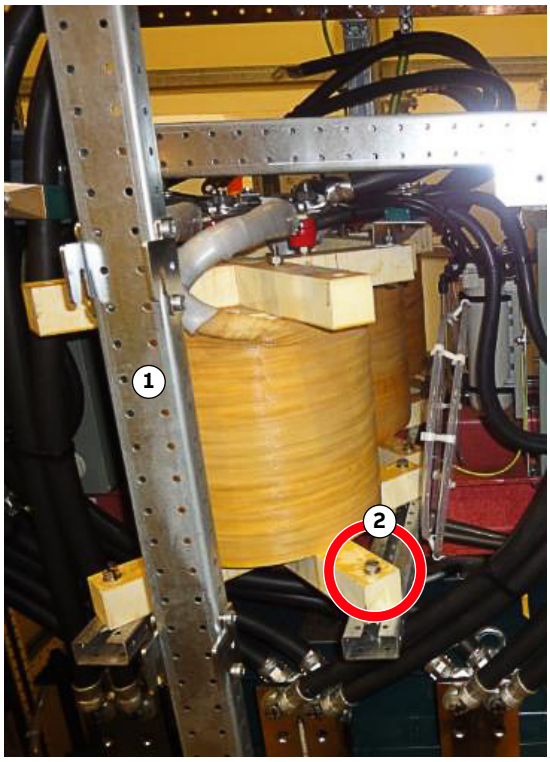


Figure 10–93 HFM filter reactor

1) Middle beam	2) Mounting screw

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Disconnect all necessary electrical connections.
3. Remove middle beam.

   CAUTION! The reactor weights approximately **44 kg**. Use lifting aids and proper lifting technique when lifting and moving.
4. Mark the reactor's position and unbolt the 4 mounting screws on the lower supports of the reactor and remove it.
5. Replace the new reactor in the same position (marks), fix the mounting screws and connect all cables.
6. Install the middle beam as it was before.
7. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.12.2. Replacing HFM filter capacitor

Service MTTR 2 - 4 h

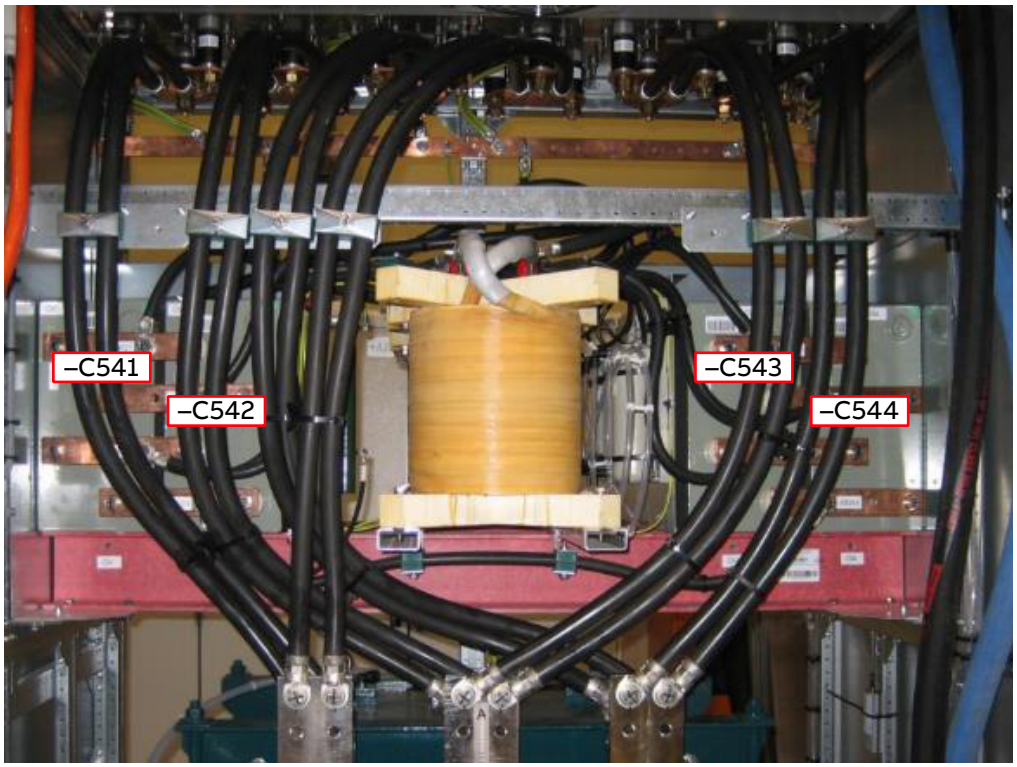


Figure 10–94 HFM filter capacitor

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. For -C541, first remove -C542. Likewise, for -C544 first remove -C543.
3. For -C541 and -C542. If applicable, remove the FCM.

4. Open first the cable duct from the FCM (the cables stay connected) and remove the FCM with part of the frame (see Fig. 10–95).

   The FIM in converters without an FCM do not need to be removed.

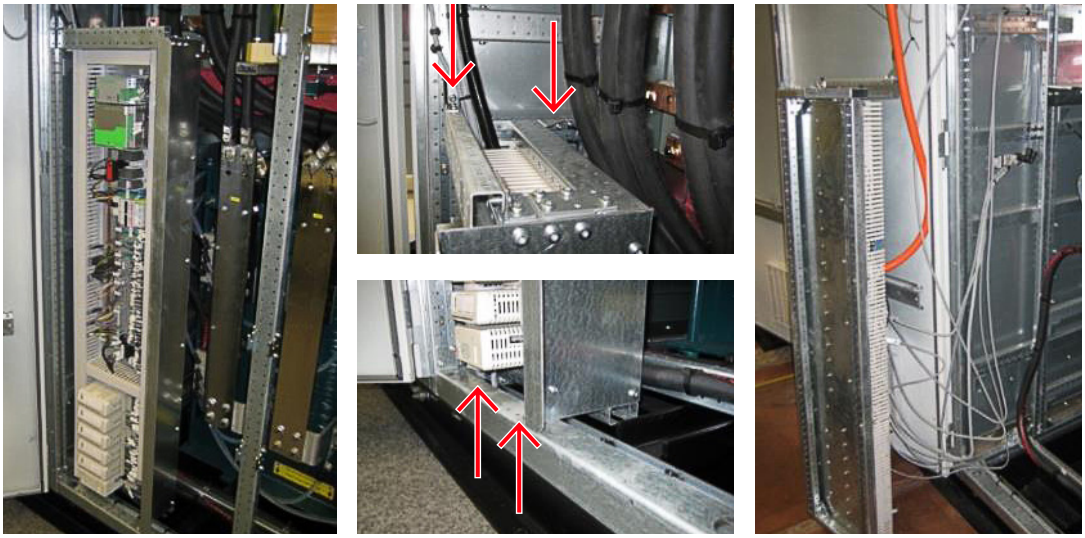


Figure 10–95 FCM removal (circles show bolt locations)

5. Disconnect all necessary electrical connections.

   CAUTION! The capacitor weights approximately 41 kg. Single person lift could cause injury. Use assistance when lifting and moving.

6. Remove the plate top of the capacitors.

Figure 10–96 Top and bottom views of capacitor

7. Unbolt the capacitor (bottom long bolts and top short bolts).

8. Remove power cables and beam in front of the capacitor.
9. Pull the capacitor out, until the bottom flange is on top of the front beam and then put a wooden beam (circa 50 × 25 × 400mm) under the capacitor and fix it with a cable tie to the two rear beams (see Fig. 10–96) to support the capacitor while taking out or putting back in.
10. To lift the capacitor out, install the ring bolt from the top plate to the capacitor and use the base beam lifting jack.

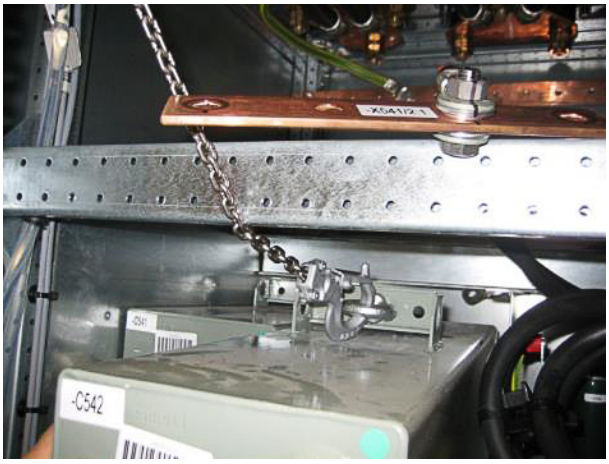


Figure 10–97 Lifting out capacitor

11. Lift the new capacitor with the chain block and shift it back into its destined position.

    For maximum tightening torques refer to section 10.4.1, **Correct tightening torques of bolted connections**, page 135.
12. Rebuild the filter unit by reconnecting all electrical connections and assembly all components at original position.
13. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.12.3. Replacing HFM filter resistor

Service MTTR 4 - 8 h

Figure 10–98 HFM filter resistor

1. Shutdown the PCS6000 according to “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Disconnect cooling hoses and cables from the resistor.
4. Remove the 4 mounting screws of the base plate and remove the resistor with base plate.
5. Install new resistor with base plate and reconnect cooling hoses and cables.
6. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.12.4. Replacing filter reactor

Service MTTR 4 - 8 h

> **⚠CAUTION Heavy object!**
>
> The reactor weights approximately **760 kg**.
>
> – Use lifting aids and assistance when lifting and moving.

Converter service tools are required to carry out this work:

– Reactor replacement kit FIU (3BHE039651R0001)

– Chain-block minimum 150 kg (3BHB032083R0001)

See chapter 3, **Service tools**, page 31.

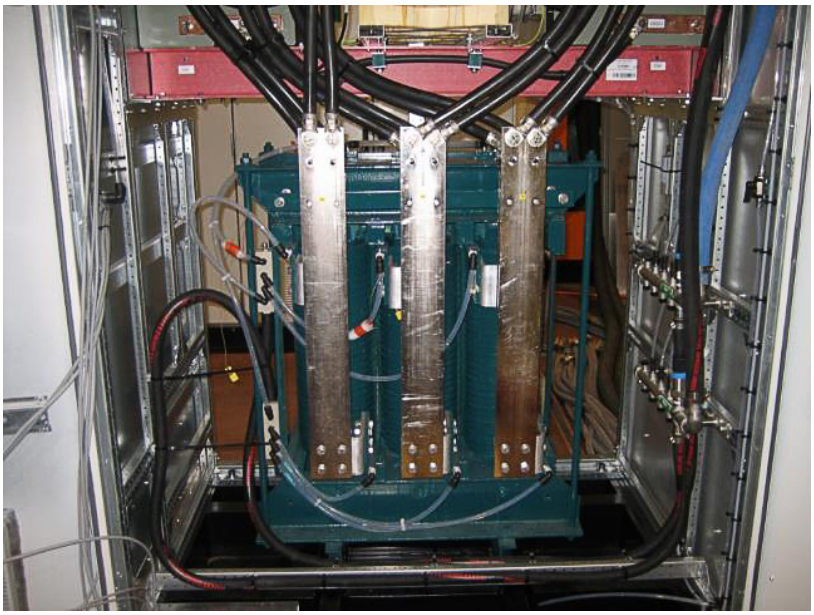


Figure 10–99 Filter reactor

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139circuit.
3. Remove middle beam of the cabinet.
4. If applicable, remove the FCM (see section 10.12.2, **Replacing HFM filter capacitor**, page 243, Fig. 10–81), unbolt all cables (including ground connection in the back of the reactor), hoses and screws.

   NOTE – In converters with FIM instead of FCM the FIM can remain installed.
5. Remove bottom front beam of the cabinet.
6. Remove the water connection to the filter reactor including the beam.
7. Install reactor replacement kit for replacement of the reactor.

8. Hook on back lower beam and on connection bar.

   If eye bolts are provided: mount eye bolts into the threaded holes on front beam and use eye bolts for fixing.

9. Loosen reactor bolts, grease slides, pull out of the cabinet with chain block.

10. The filter reactor is now outside the cabinet, use a crane to move it.

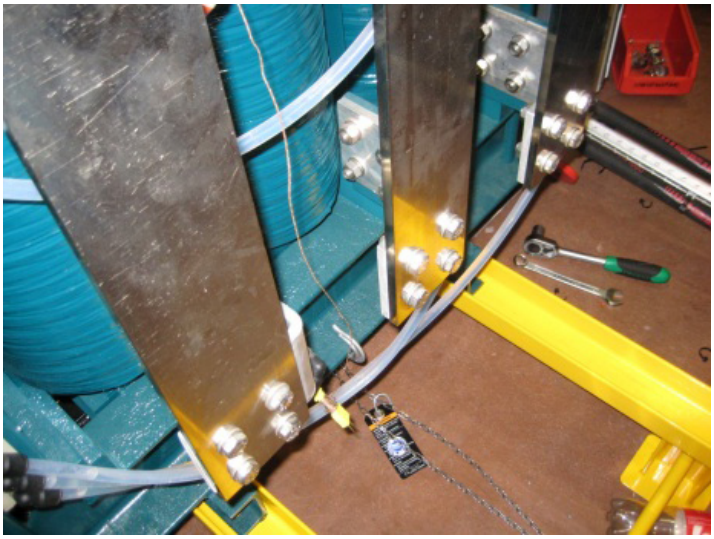


Figure 10–100 Removed filter reactor

11. When the new reactor is on the slides, use the chain block to pull it back into the cabinet.

12. Reinstall all mechanical and electrical components in reverse order.

    IMPORTANT! DO NOT forget the ground connection in the back.

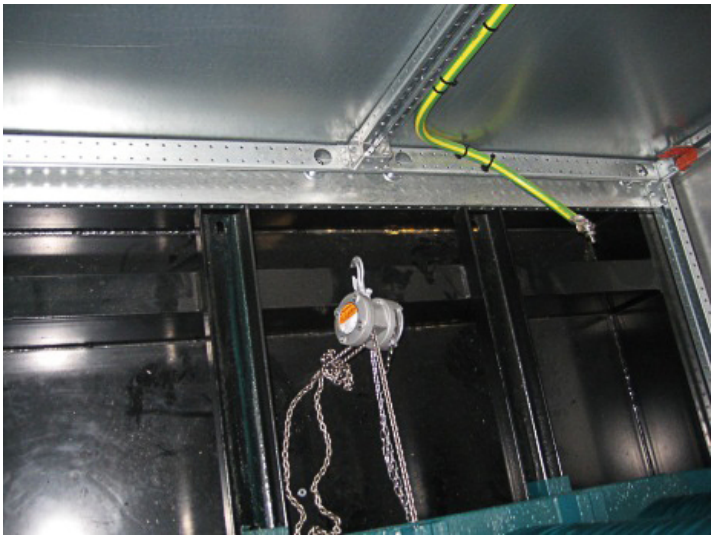


Figure 10–101 Ground connection

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

10.12.5. Replacing pressure transmitter

Service MTTR 4 - 8 h

Figure 10–102 Pressure transmitter

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Disconnect all Legris adapters and hoses from the stainless steel water distribution (use a catching tray to catch the remaining cooling liquid).
4. Heat up the connection thread (below the transmitter) up to approximately 250 °C with a hand-held hot air blower until the Loctite 620 sealing mellows and unbolt the pressure transmitter from the stainless steel water distribution.
5. Clean any remaining Loctite from the thread and let it dry completely.
6. Install new pressure transmitter. The new part must be sealed again with “Loctite 620” or a similar product.
7. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.13. Replacing components in GBU

10.13.1. Replacing generator breaker (GEB) / grid breaker (GRI)

Service MTTR 4 - 8 h

> **⚠CAUTION Heavy object!**
>
> The generator breaker weights approximately **160 kg**.
>
> ▸ Use lifting aids and assistance when lifting and moving.

Tools

Converter service tools are required to carry out this work:

– GEB replacement trolley GBU50/70 (3BHE040630R0001) (see chapter 3, **Service tools**, page 31).

Procedure:

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Isolate and earth the power cable connection to the GEB/GRI.
3. Discharge GEB/GRI spring.
4. Remove the arc protection cover on the GEB/GRI cabinet.

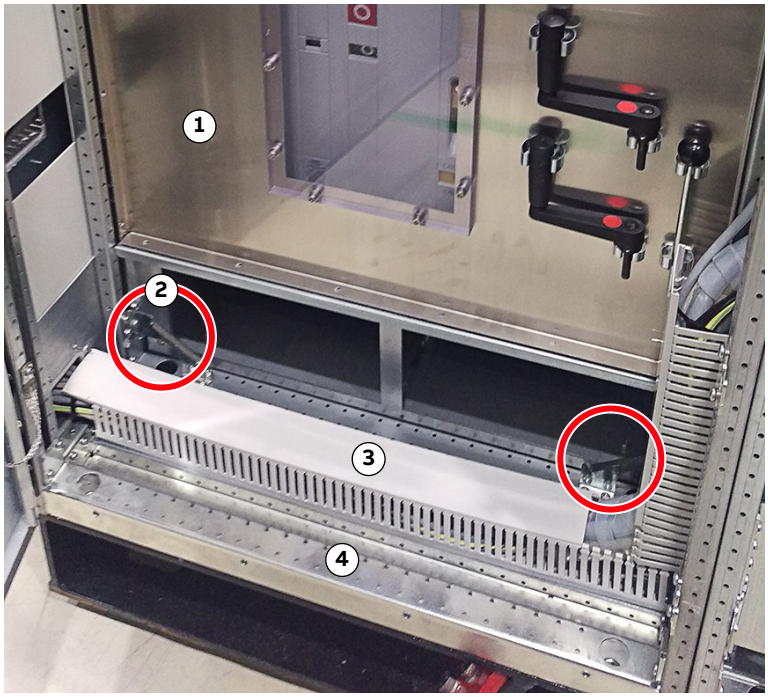


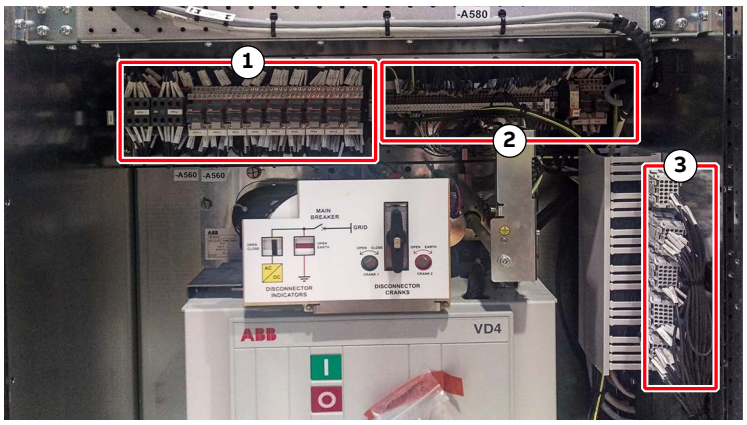
Figure 10–103 GBU

1) Arc protection cover	3) Cable duct
2) Corner brace	4) Lower front beam

5. Unplug the 230 V supply (-X561 L2, N2, PE).
6. Discharge the breaker spring by opening and closing the GEB/GRI.
7. Disconnect all control plugs from the GEB/GRI.

   IMPORTANT! Access to the breaker connections is either possible from the back side after removing the back wall (if accessible) or from below after removing the drawer (only on new design).

Figure 10–104 Generator breaker (GEB)



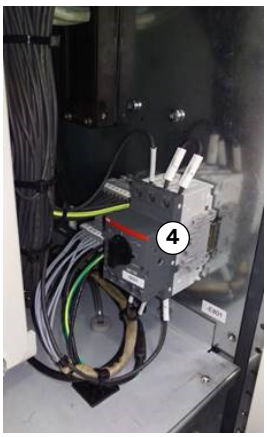


Figure 10–105 Grid breaker (GRI)

1) DMC3	3) GRI plug breaker
2) -X561 rail	4) External rail -X561, fan MCB and temperature monitoring

8. Unbolt the 4 drawer mounting screws, 2 on each side (there is only one fan drawer on new design).

Figure 10–106 Drawer mounting screws

9. Remove the corner braces.

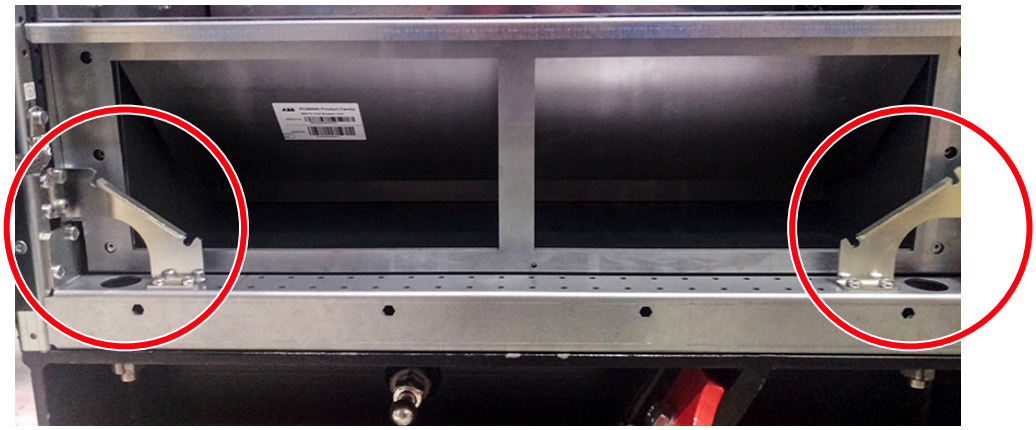


Figure 10–107 Corner braces

10. If present, remove the push button locking device.

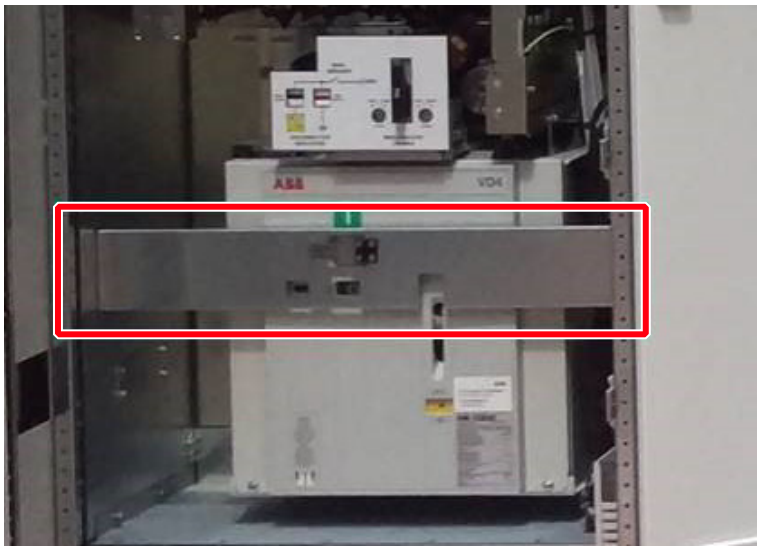


Figure 10–108 GBM push button locking device

11. Unbolt the lower front beam mounting screws (one on each side) to allow the fan drawer to be pulled out.

Figure 10–109 Lower front beam mounting screws

12. Disconnect the signal cables from the differential pressure measurement device, which is on top of the fan drawer.

Figure 10–110 Differential pressure measurement device

13. Pull out and remove the fan drawer below the GEB.

Figure 10–111 Fan drawer below the GEB

14. If access from the back side is possible, remove the back wall of the cabinet, if not, access to the GEB main power cable is possible underneath the GEB.

If available, use a cushion to protect your head from the edges.

Figure 10–112 Protection cushion

15. Disconnect the power cables on the 3 lower bus bar connections at the breaker.

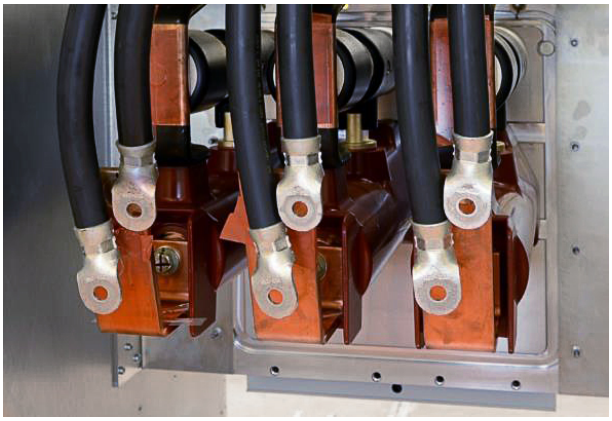


Figure 10–113 Breaker's lower power cable connections

16. Disconnect the copper angle with the power cables at the upper connection at the breaker.

Figure 10–114 Breaker's upper power cable connection

17. Disconnect the protection earth cable on the back of the GEB base plate.

NOTE – For better accessibility, you might need to remove the DMC3 / -X561 rail plate.

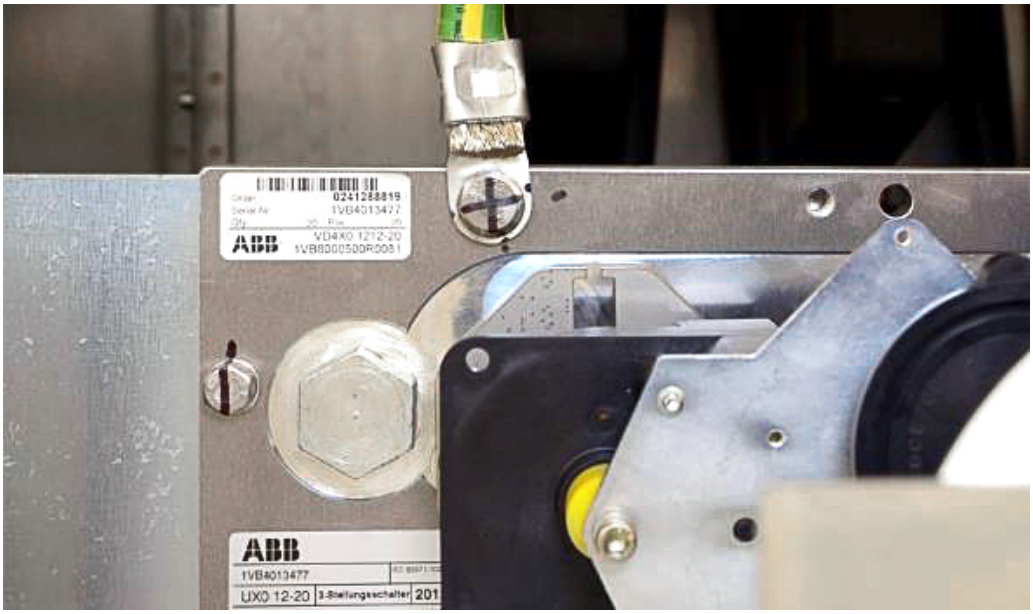


Figure 10–115 Breaker's protecting earth connection

18. Remove the fiber optic cable from the copper bar.

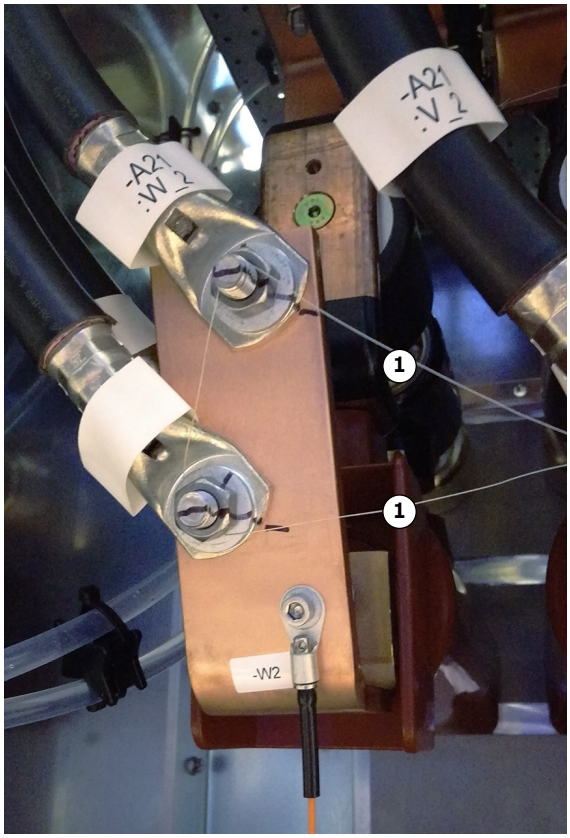


Figure 10–116 Fiber optic cable

19. Remove the front cover of the breaker by loosening two M8 bolts on the bottom.

Figure 10–117 Breaker's protecting earth connection

20. Install the two trolley track beam on the cabinet bottom and support the track beam outside of the cabinet securely (height ~210 mm).

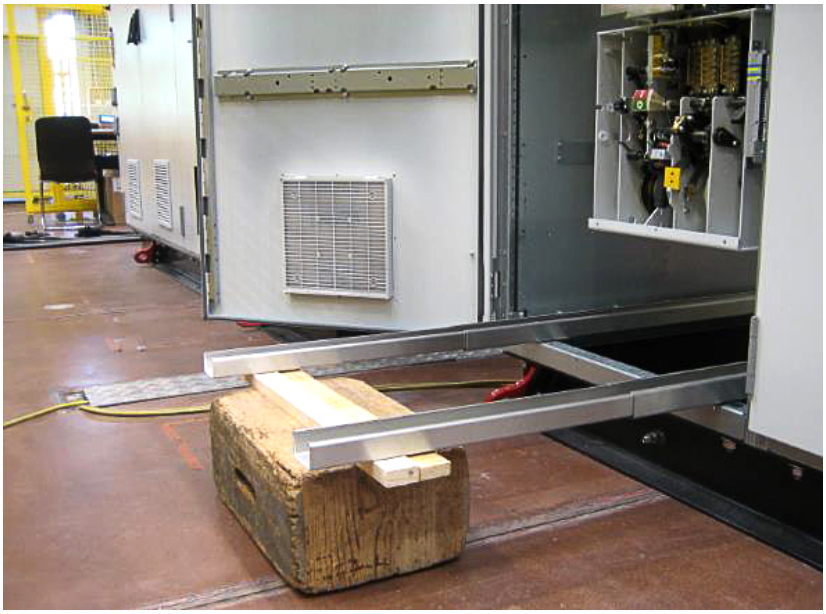


Figure 10–118 Trolley track beams

21. If available on site, the Reactor Replacement Kit can be used for this purpose.

Figure 10–119 Support by reactor replacement kit

22. Pull the beams only as far, as they are still supported by the base beam of the cabinet.

Figure 10–120 Trolley track beams (top view)

23. Loosen the two wing nuts under the trolley and leave at least 25 mm space for adjusting the lever.

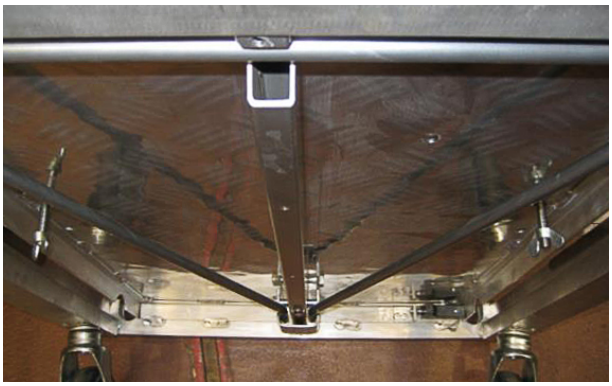


Figure 10–121 Trolley with loose wing nuts

24. Insert the trolley into the cabinet and adjust the lever to fit GEB.

First use the two M8 bolts to fix the GEB to the lever.

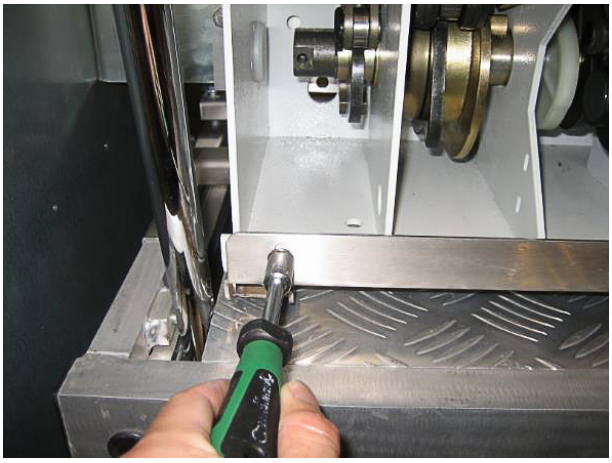


Figure 10–122 Fixing the GEB to the lever

25. Raise the lever by tightening the four M12 lifting bolts smoothly.

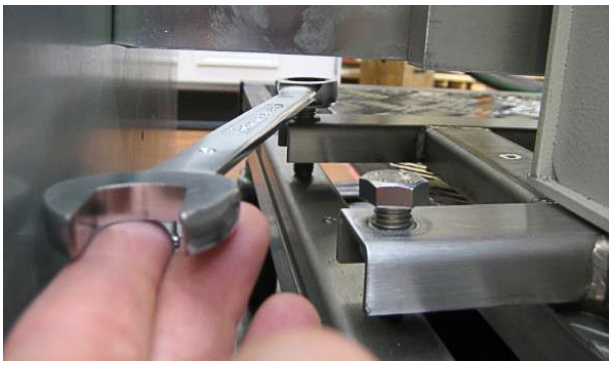


Figure 10–123 Rising the lever

26. Loosen the eight M8 mounting screws and adjust the lever, until all screws can easily be turned out by hand.

Figure 10–124 Unbolting the GEB

27. Pull the GEB out of the cabinet (take special care for the cooling hoses above the GEB!).

The GEB can then be lifted by crane (with or without the trolley).

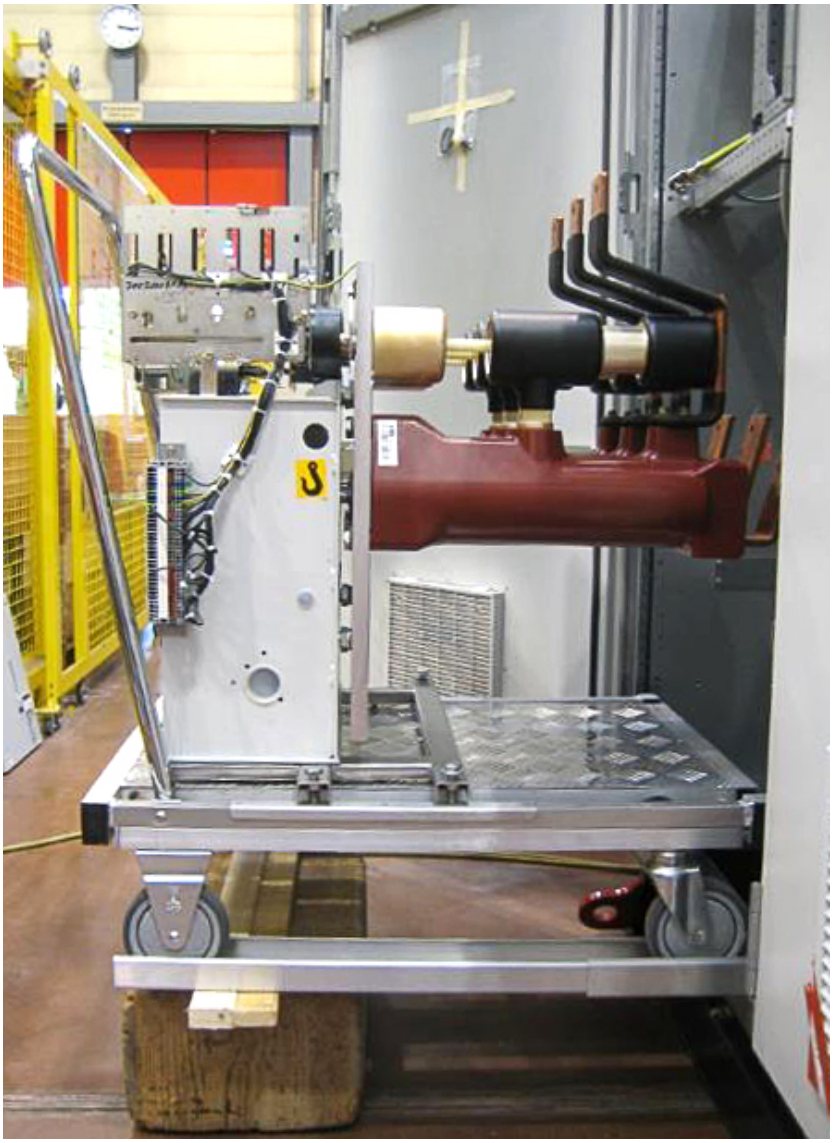


Figure 10–125 GEB pulled out of the cabinet

28. Mount the new breaker in reverse order.

IMPORTANT! The explosion protection flap of the fan drawer must be open and held by the retention spring after the drawer has been reinserted.

If the explosion protection flap is closed, open it as follows:

– Insert a small item, eg, an Allen key into the hole at the bottom of the drawer (see Fig. 10–126) and push the retaining spring down (see Fig. 10–127) so that the flap can be pushed back until it engages at the back end of the retaining spring (see Fig. 10–128).

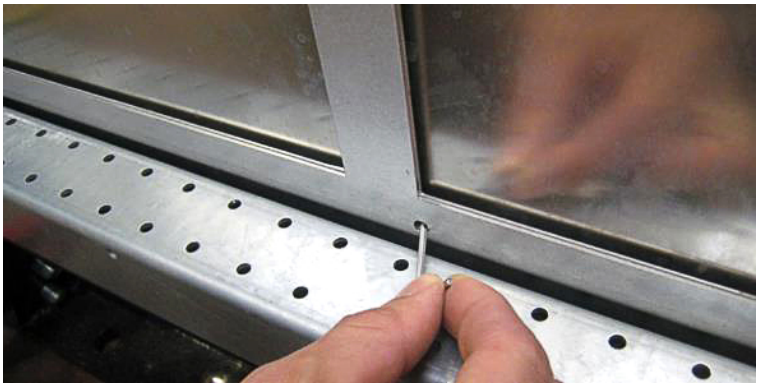


Figure 10–126 Releasing the retaining spring (flap closed)

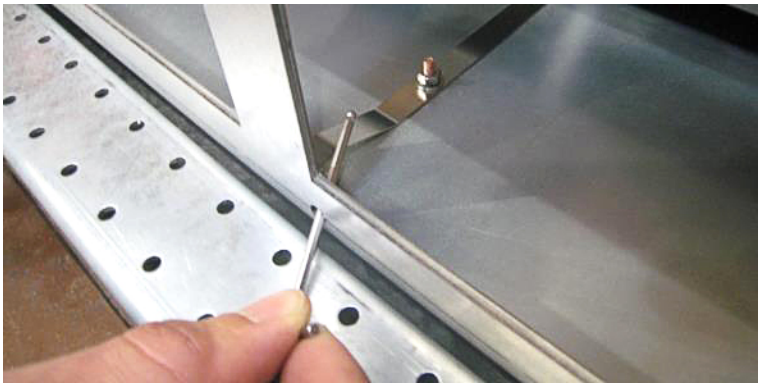


Figure 10–127 Releasing the retaining spring (flap open)

Figure 10–128 Flap open and engaged

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

10.13.2. Replacing dv/dt filter reactor in GBU

Service MTTR 4 - 8 h

⚠CAUTION Heavy object!

The reactor weights approximately **25 kg**.

- Use lifting aids and proper lifting technique when lifting and moving.

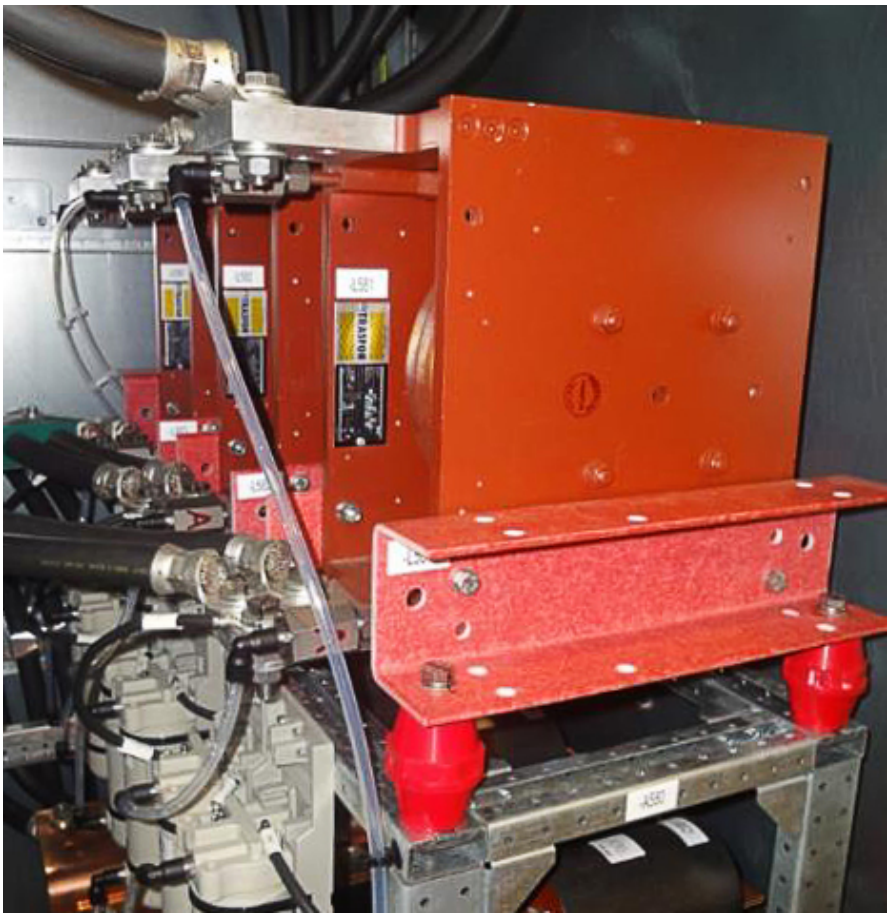


Figure 10–129 dv/dt filter reactor

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Disconnect water pipes, busbars and cables.

4. Put two wooden support beams of approximately 60 mm height under the dv/dt filter reactor

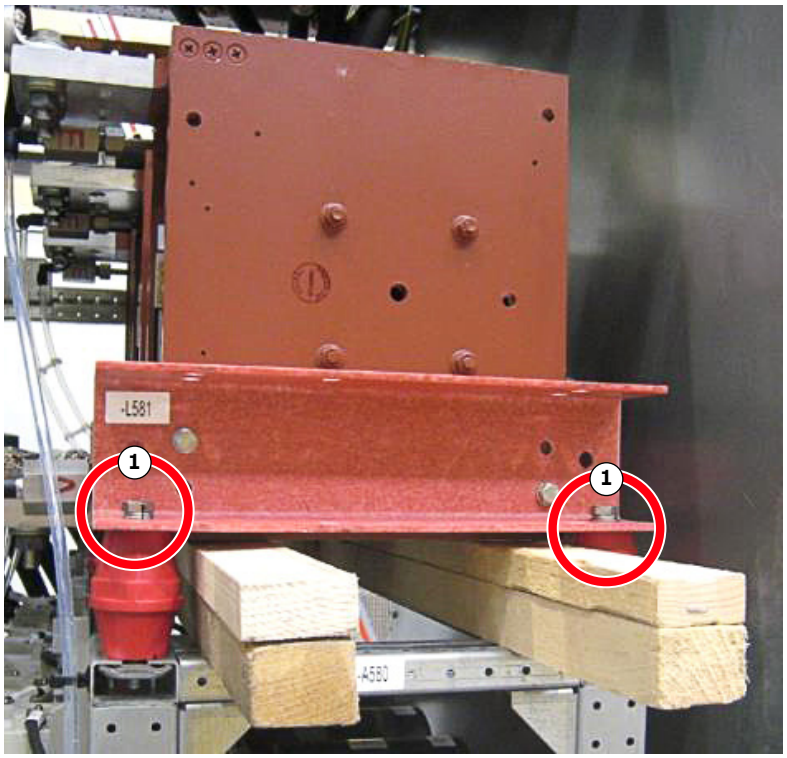


Figure 10–130 dv/dt filter reactor mounting bolts

1)	Mounting bolt

5. Unbolt the 4 mounting bolts from the U-shaped profiles on the faulty reactor (see Fig. 10–130).

   NOTE – 2 screws in front and 2 screws on back of the reactor.

6. Replace the faulty dv/dt filter reactor.

7. Remove the wooden beams.

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

10.13.3. Replacing dv/dt filter resistor in GBU

Service MTTR 4 - 8 h

Figure 10–131 dv/dt filter resistors

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Empty water circuit of the cooling system according to section 10.5.2, **Emptying the cooling liquid circuit**, page 139.
3. Disconnect water pipes and cables.
4. Remove the cable ties.
5. Replace the dv/dt filter resistor.
6. Reconnect water pipes and cables.
7. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.13.4. Replacing dv/dt filter capacitor in GBU

Service MTTR 0 - 2 h

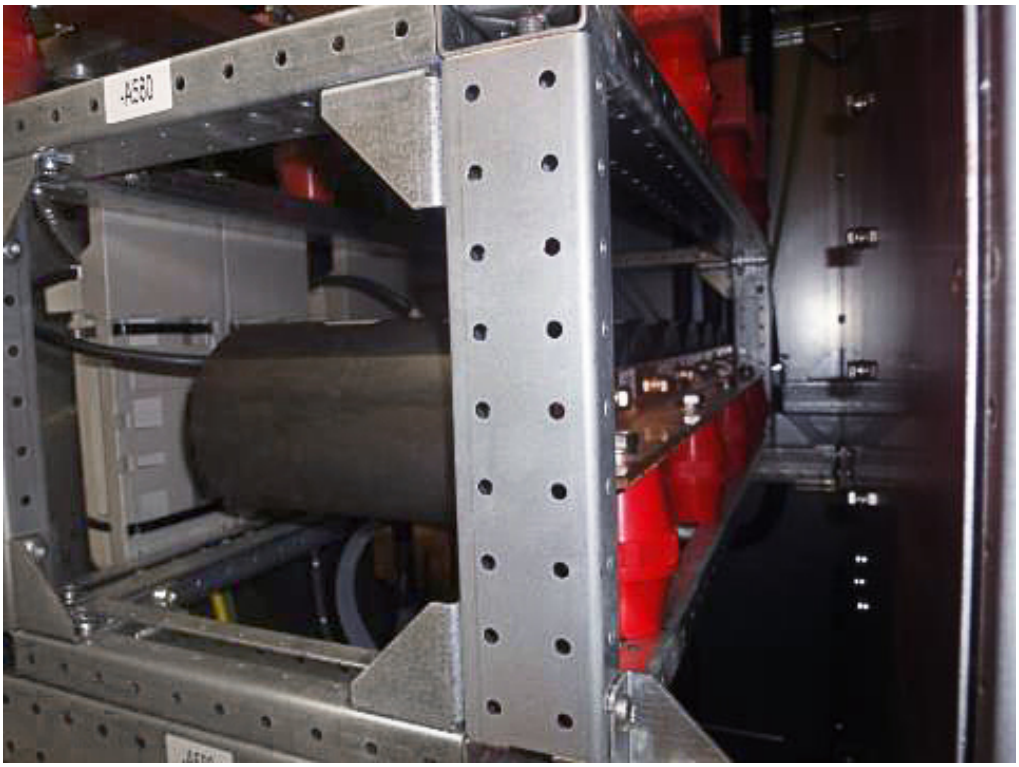


Figure 10–132 dv/dt filter capacitors

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Disconnect cables.
3. Replace dv/dt filter capacitor.

   NOTICE DO NOT exert any torque onto the capacitors! During loosening as well as fastening, the capacitor connections need to be held in place with a 23 mm flat wrench (contained in converter service toolbox). For maximum tightening torques refer to section 10.4.1, **Correct tightening torques of bolted connections**, page 135.
4. Reconnect cables.
5. Restart the PCS6000 according to section 5.4, **Start-up after maintenance or troubleshooting**, page 70.

10.13.5. Replacing fan of GBU fan drawer

Service MTTR 0 - 2 h

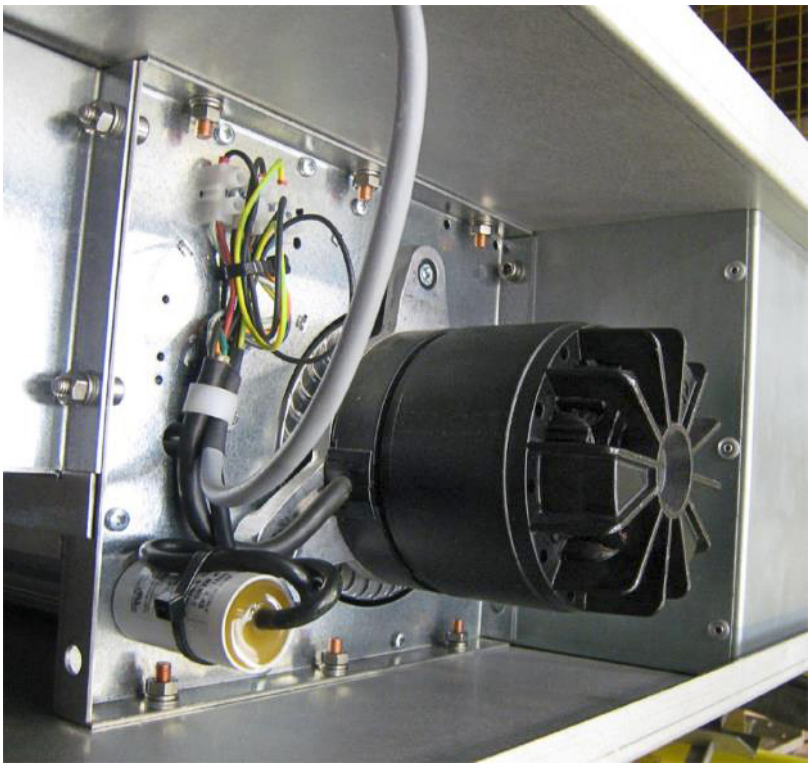


Figure 10–133 Fan of GBU fan drawer

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Disconnect the fan power supply plugs from the generator breaker (GEB).
3. Unbolt the 4 drawer mounting screws, 2 on each side (there is only a fan drawer on new design).

Figure 10–134 Drawer mounting screws

4. Unbolt the lower front beam mounting screws (one on each side) to allow the fan drawer to be pulled out.

Figure 10–135 Lower front beam mounting screws

5. Pull out and remove the fan drawer below the GEB.

Figure 10–136 Fan drawer below the GEB

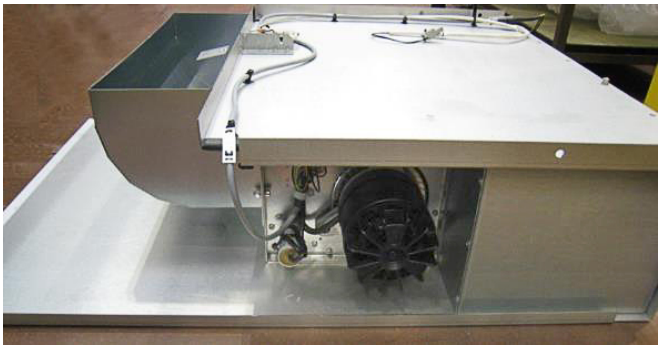


Figure 10–137 Fan drawer removed.

6. Unbolt all drawer metal plates until the fan can be removed.
7. Replace fan.
8. Reassemble in reverse order.

   IMPORTANT! The explosion protection flap of the fan drawer must be open and held by the retention spring after the drawer has been reinserted.

9. If the explosion protection flap is closed:

- Insert a small item, eg, an Allen key into the hole at the bottom of the drawer.

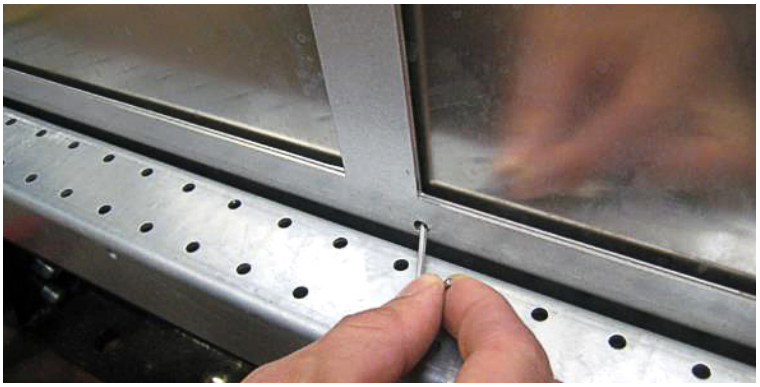


Figure 10–138 Releasing the retaining spring (flap closed)

- Push the retaining spring down (see Fig. 10–127) so that the flap can be pushed back until it engages at the back end of the retaining spring (see Fig. 10–128).

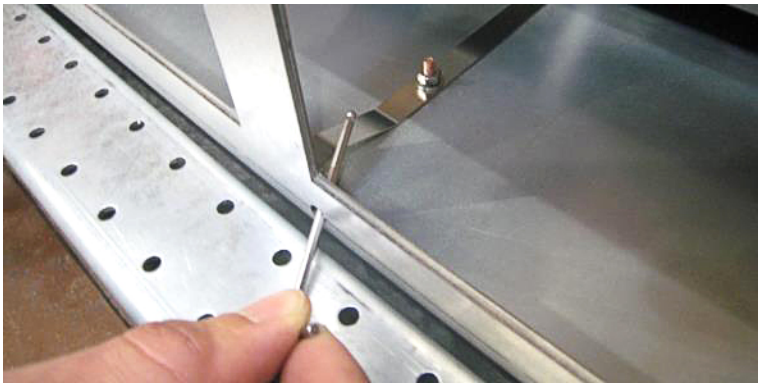


Figure 10–139 Releasing the retaining spring (flap open)

Figure 10–140 Flap open and engaged

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

10.14. Replacing fans in miscellaneous units

10.14.1. Replacing door fan with heater

Service MTTR 0 - 2 h

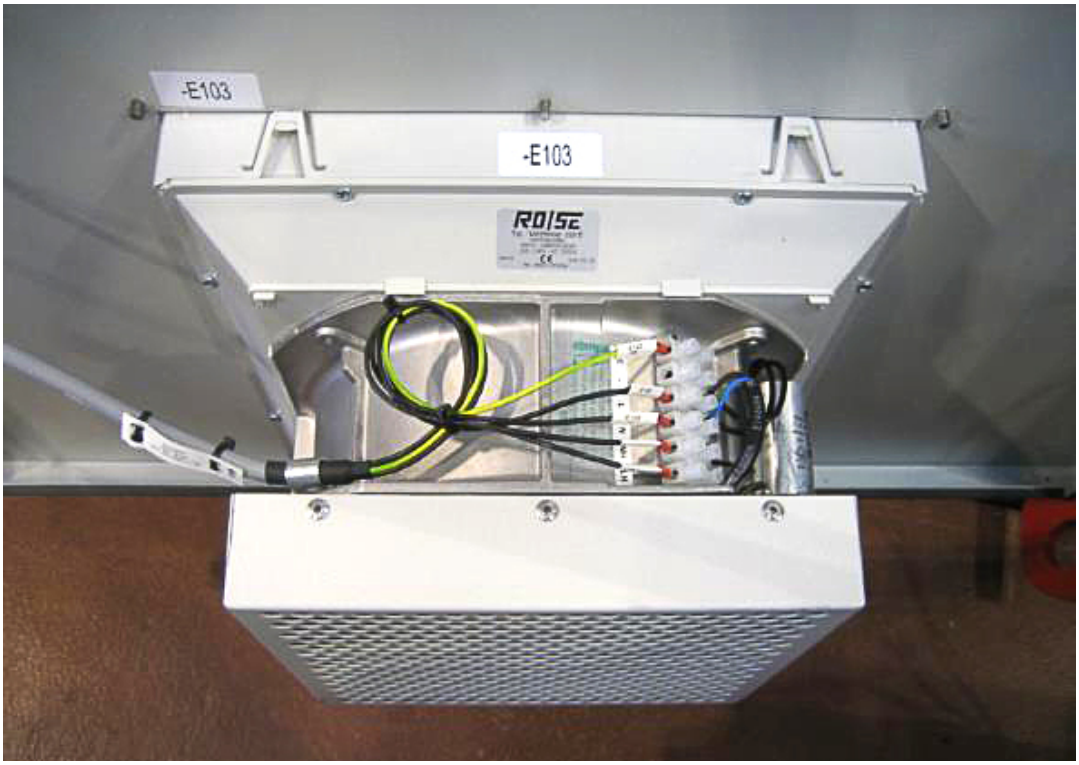


Figure 10–141 Door fan with heater

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off corresponding MCB (see electrical circuit diagram) to interrupt the 3AC 400 V fan supply voltages.
3. Disconnect the cables from the fan.
4. Remove the filter frame from the front of the door.
5. Unscrew the fan unit and replace it by a new one.
6. Reconnect the cables to the fan.

10.14.2. Replacing roof fan and air filter mats

Service MTTR 0 - 2 h

Figure 10–142 Roof fan

Replacing the roof fan

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off corresponding MCB (see electrical circuit diagram) to interrupt the 3AC 400 V fan supply voltages.
3. Disconnect the cables from the fan.
4. Press in the plastic clip on the corner of the fan and move it out of the top of the cabinet.
5. Replace the fan unit by a new one.
6. Reconnect the cables to the fan.

Replacing the roof fan filter

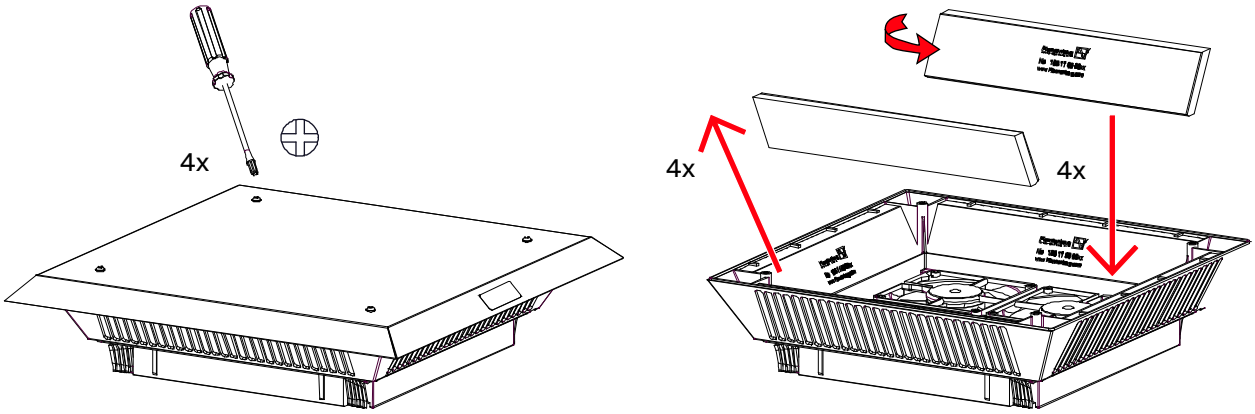


Figure 10–143 Filter fan replacement

1. Shut down the PCS6000 according to the “PCS6000 Lockout/tagout procedure”, 3BHS600000 E22.
2. Switch off corresponding MCB (see electrical circuit diagram) to interrupt the 3AC 400 V fan supply voltages.
3. Unscrew top cover.
4. Replace the 4 filter mats.

   NOTICE Make sure that the filter is installed in the correct position.
5. Reassemble the top cover.

ABB Switzerland Ltd.
Bruggerstrasse 66
CH-5400 Baden
Switzerland

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