10.6.4. Replacing IGCTs

Service MTTR 0 - 2 h

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.

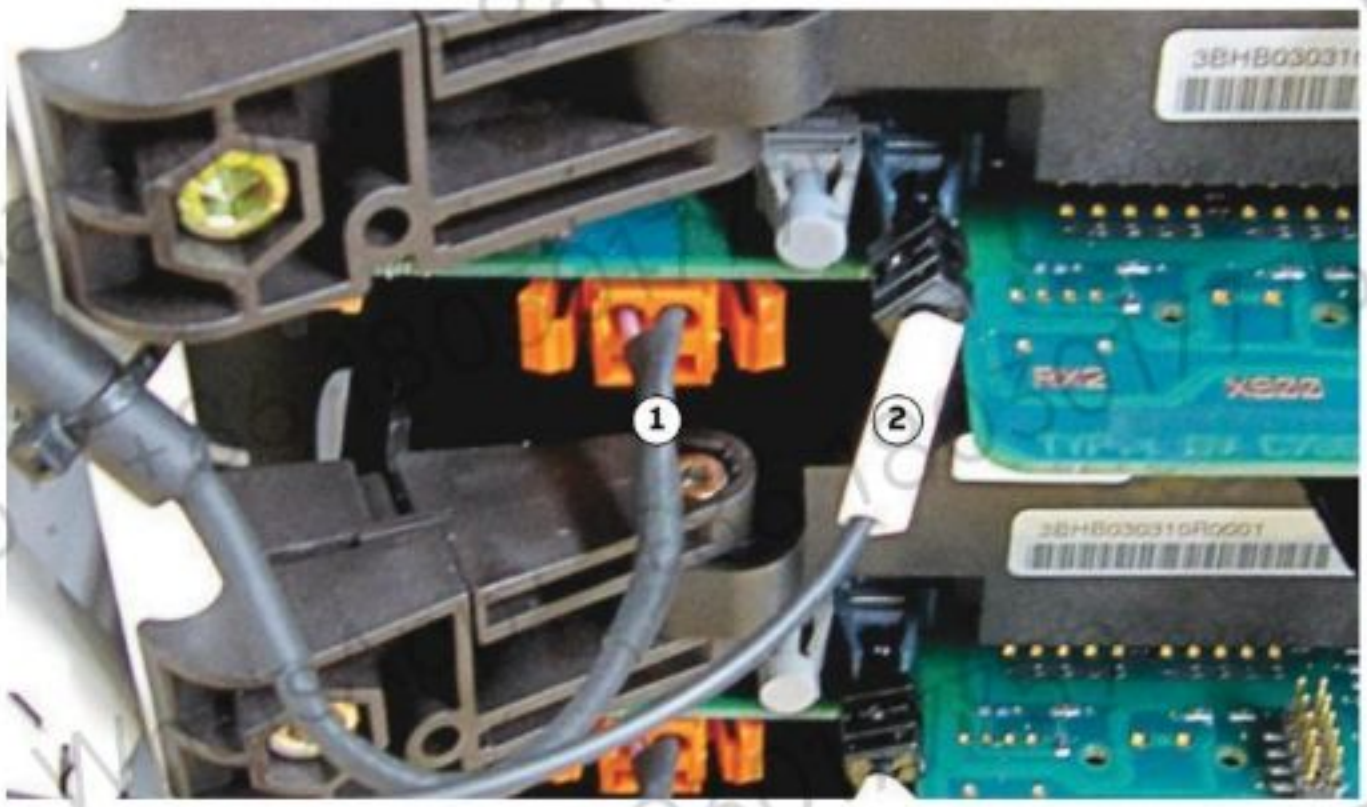

Figure 10–13 Disconnecting cables from IGCT

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.

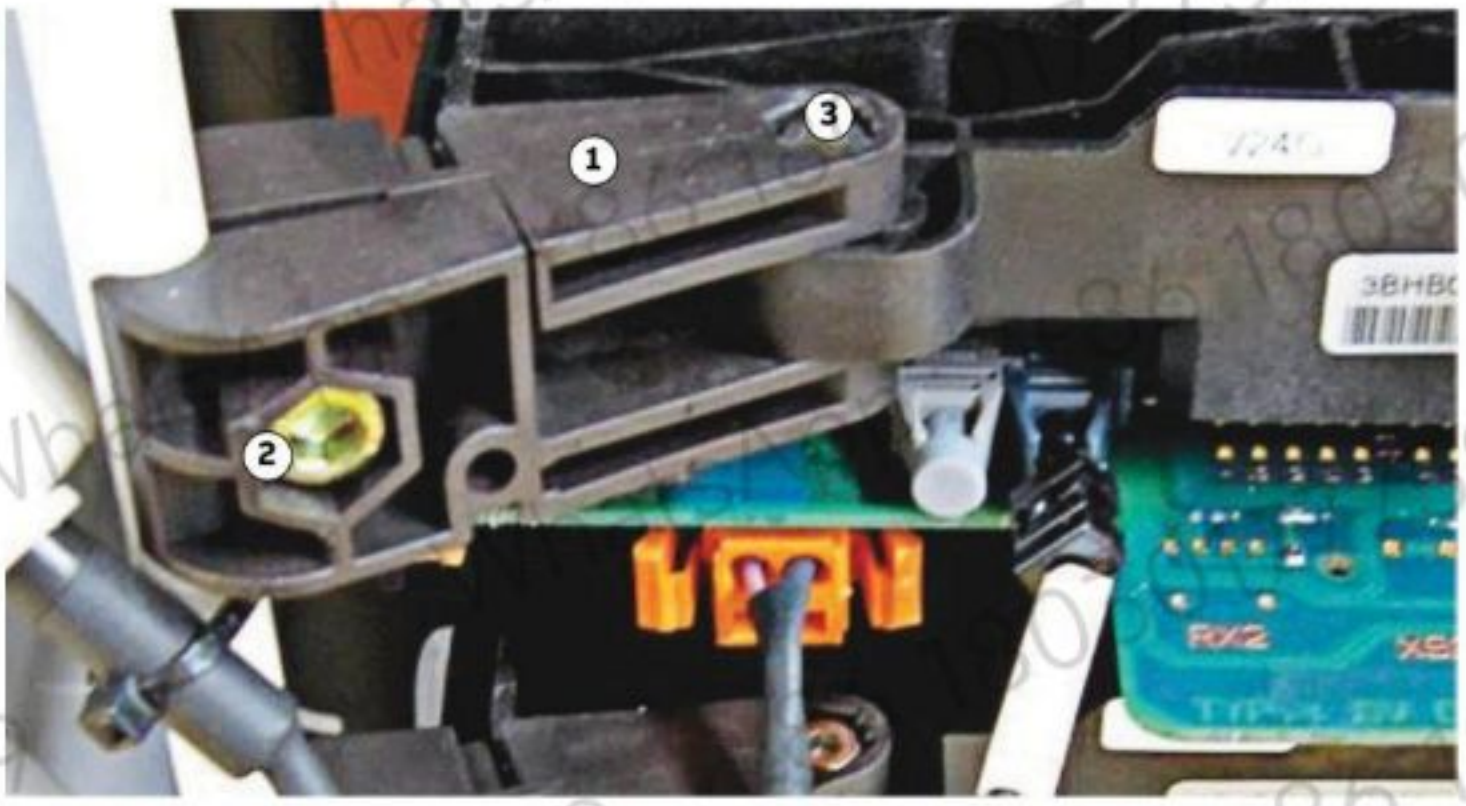

Figure 10–14 Removing the gate unit fixations of the IGCT

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.

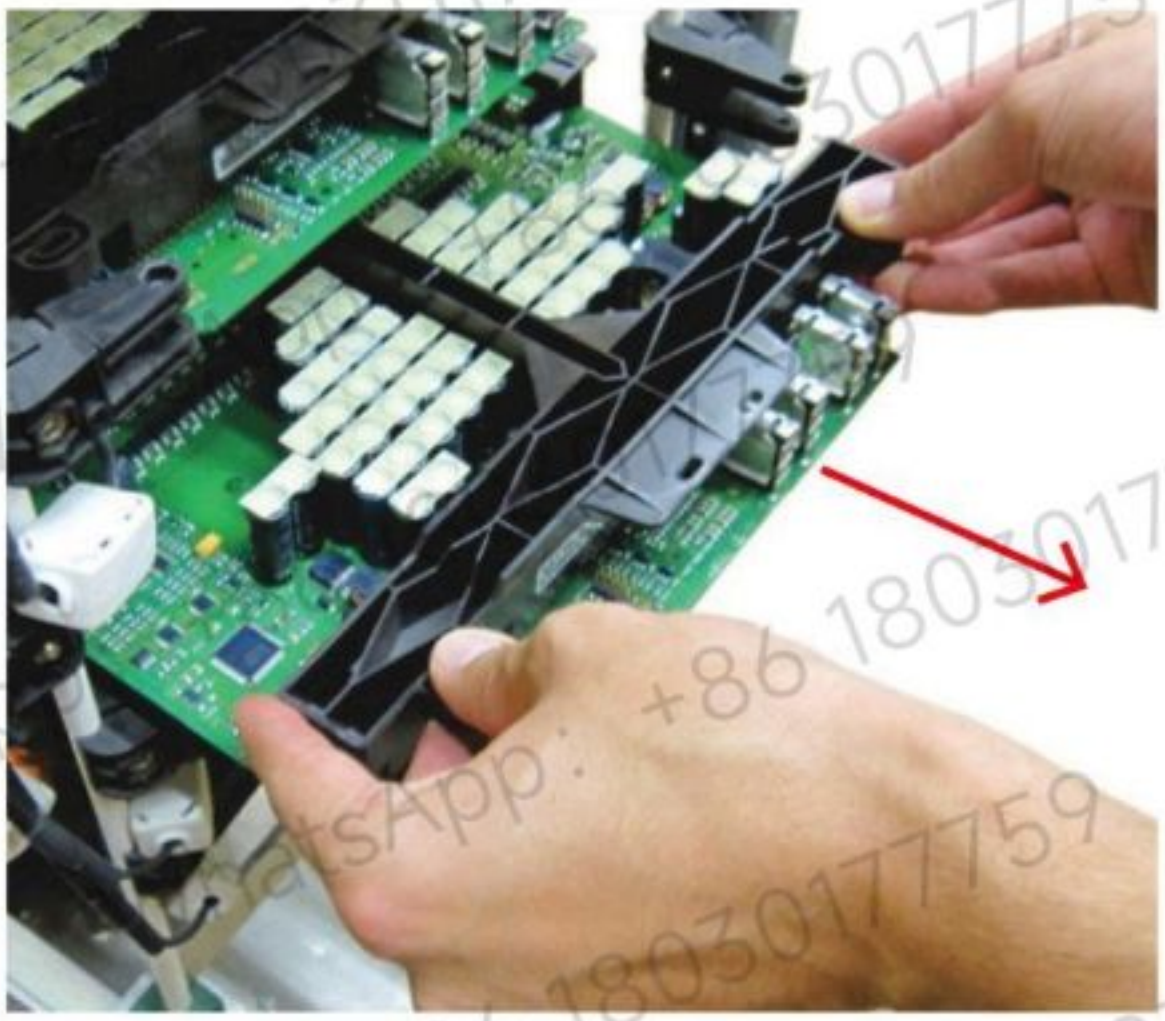

Figure 10–15 Extracting the IGCT

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.

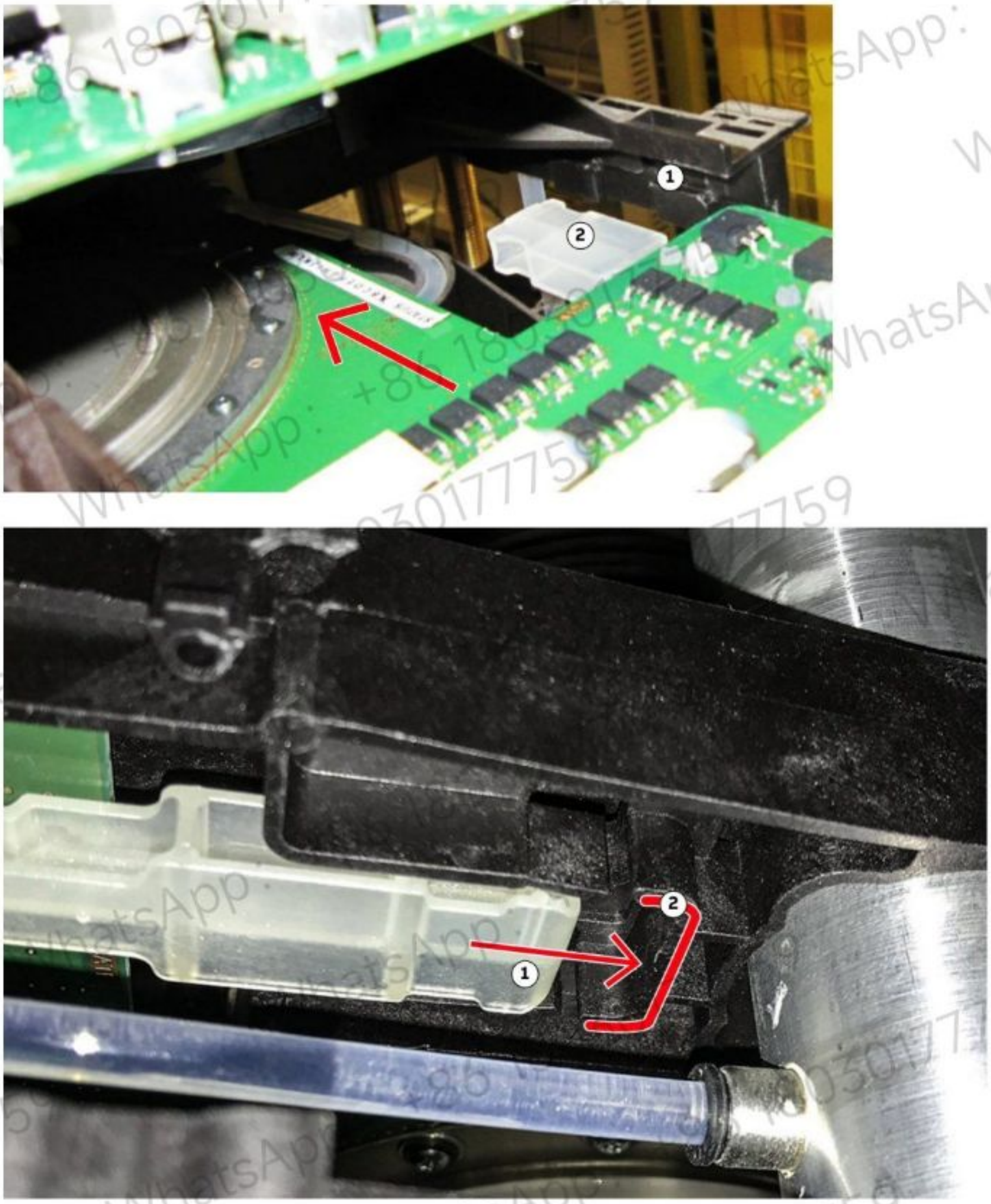

Figure 10–17 Inserting the IGCT

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.

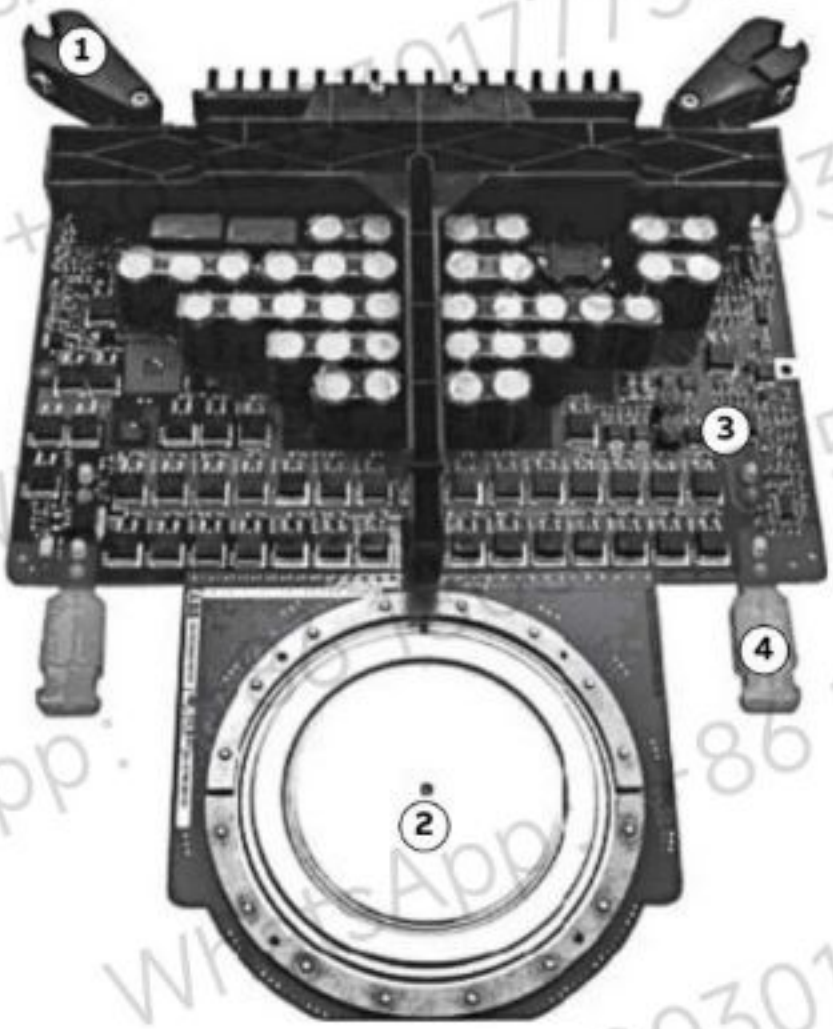

Figure 10–18 IGCT components

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.

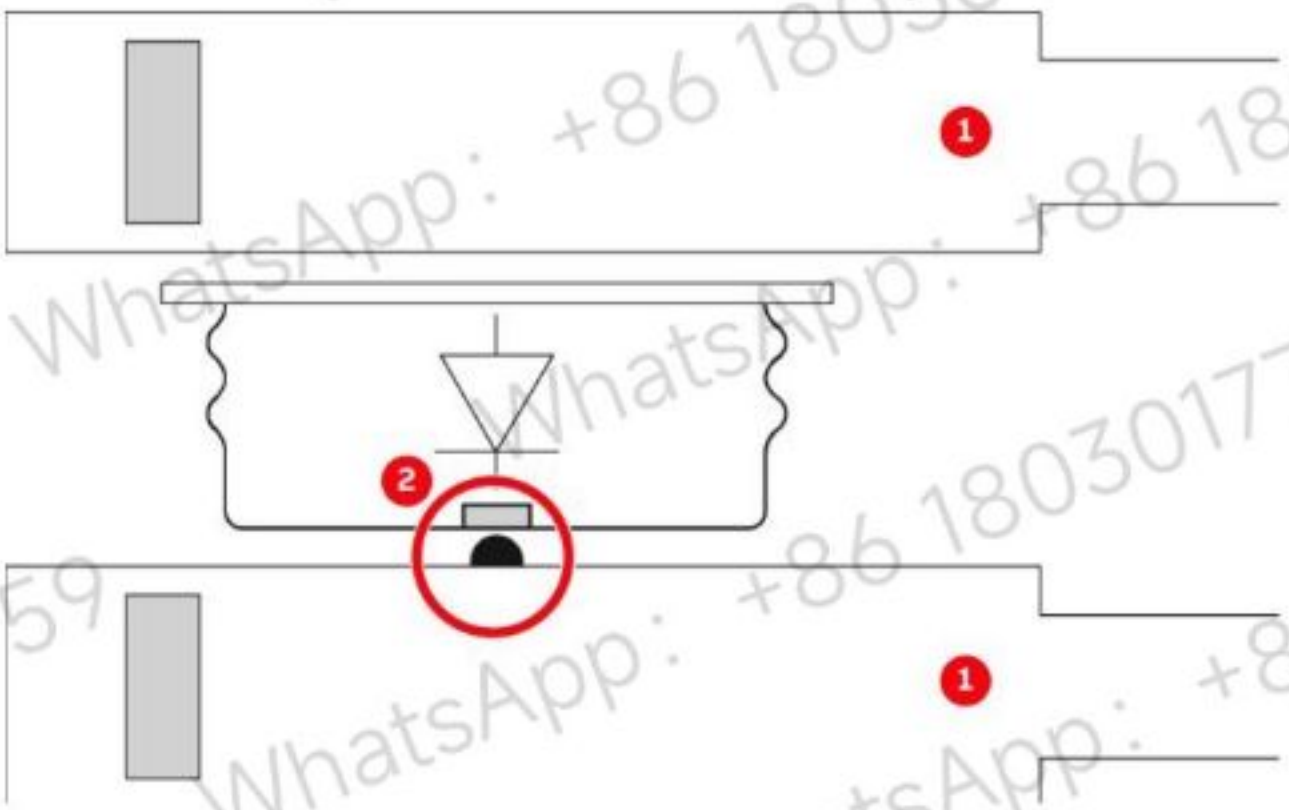


Figure 10–19 Centering freewheeling and neutral point diodes

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.

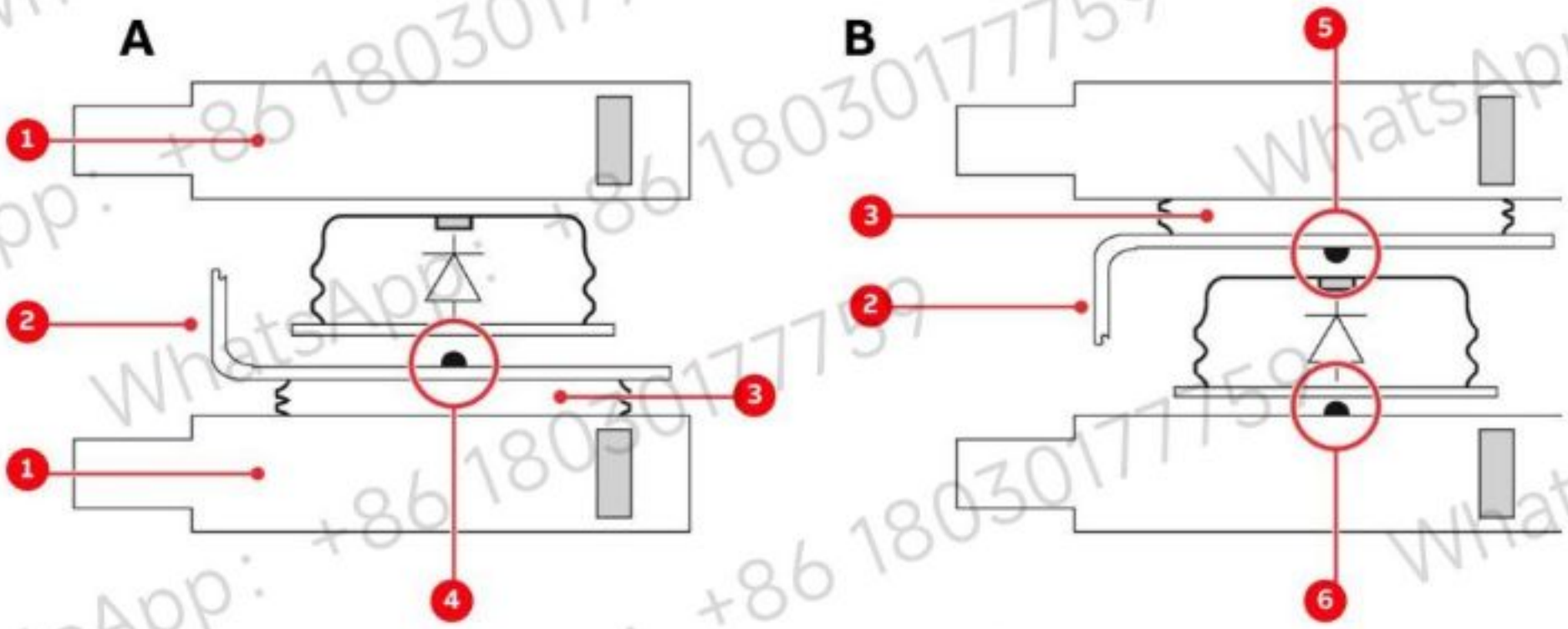


Figure 10–22 Centering upper (A) and lower (B) clamp diodes

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).

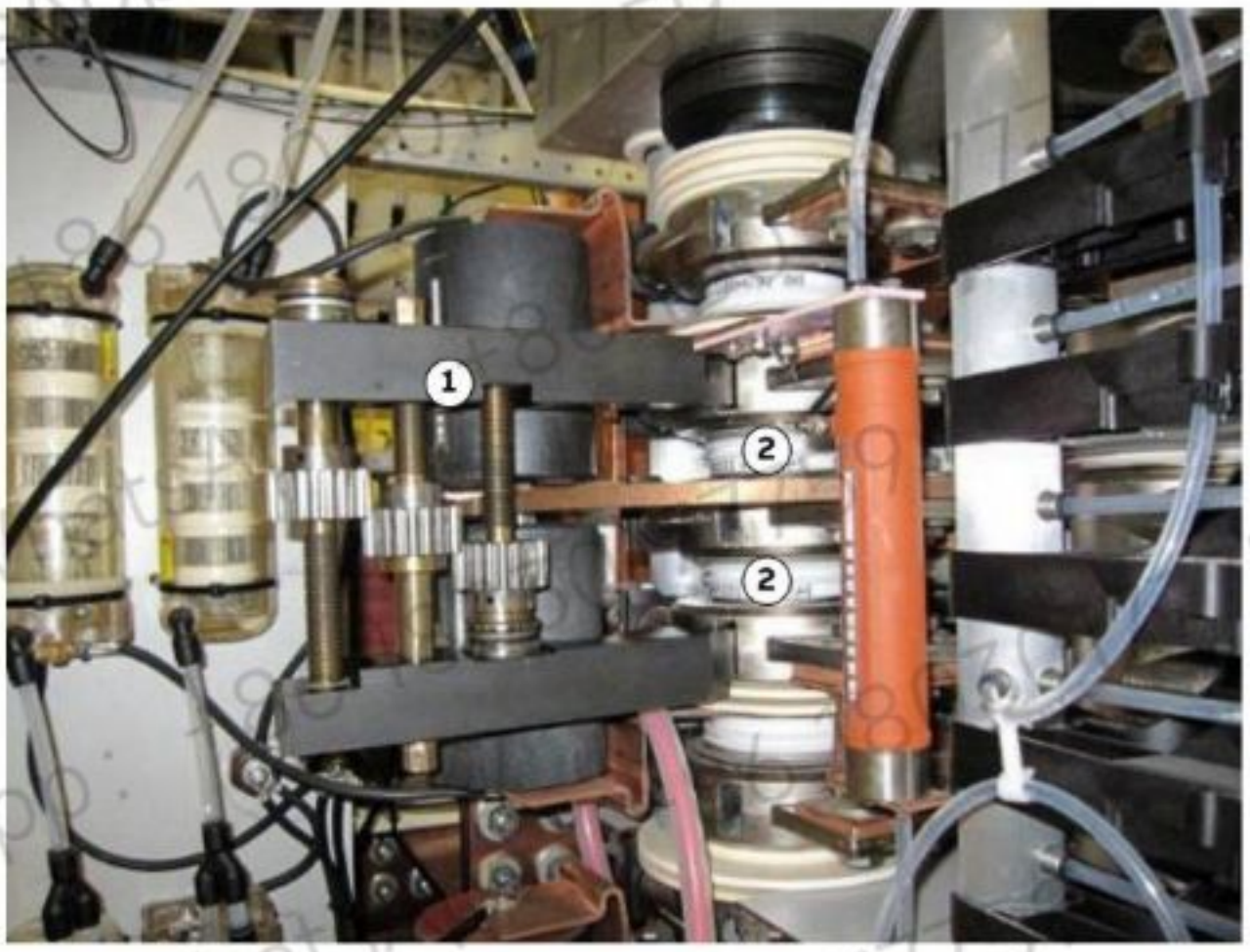


Figure 10–23 NP diodes

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.

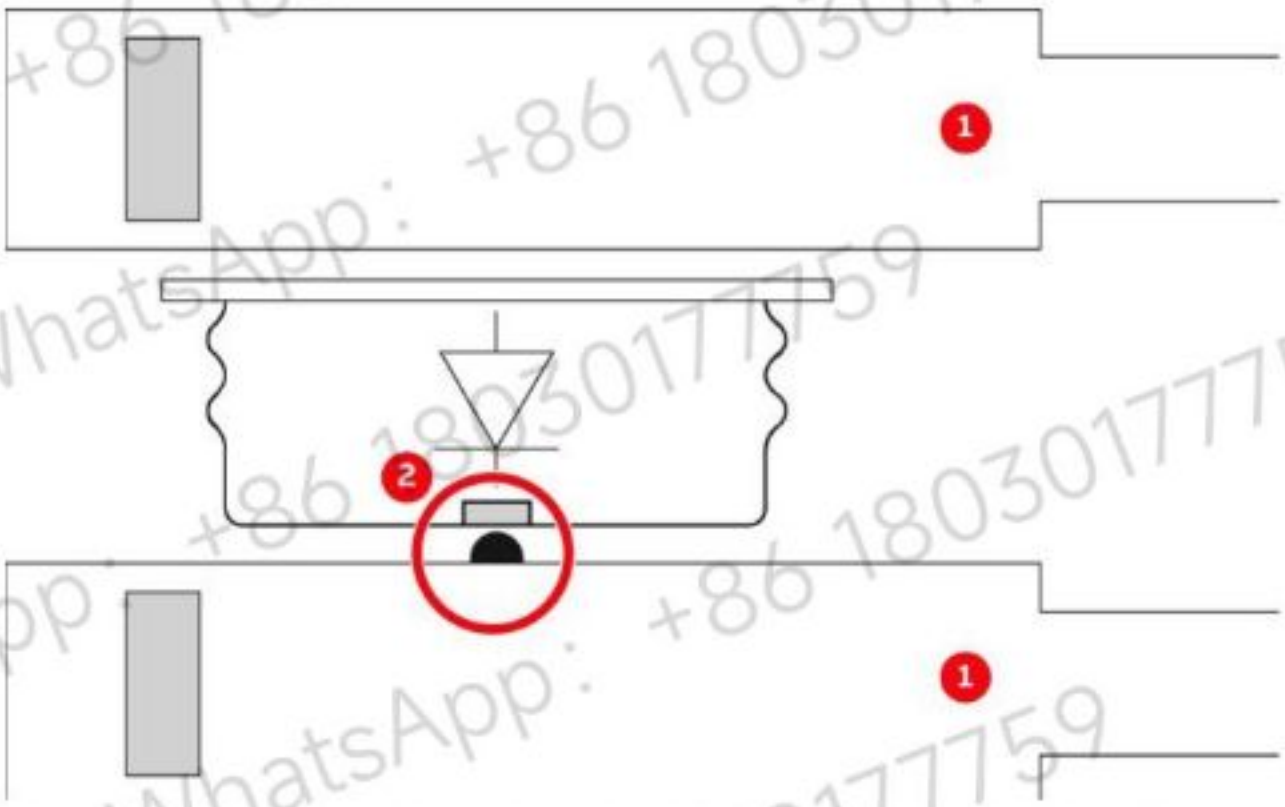


Figure 10–24 Centering freewheeling and neutral point diodes

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).

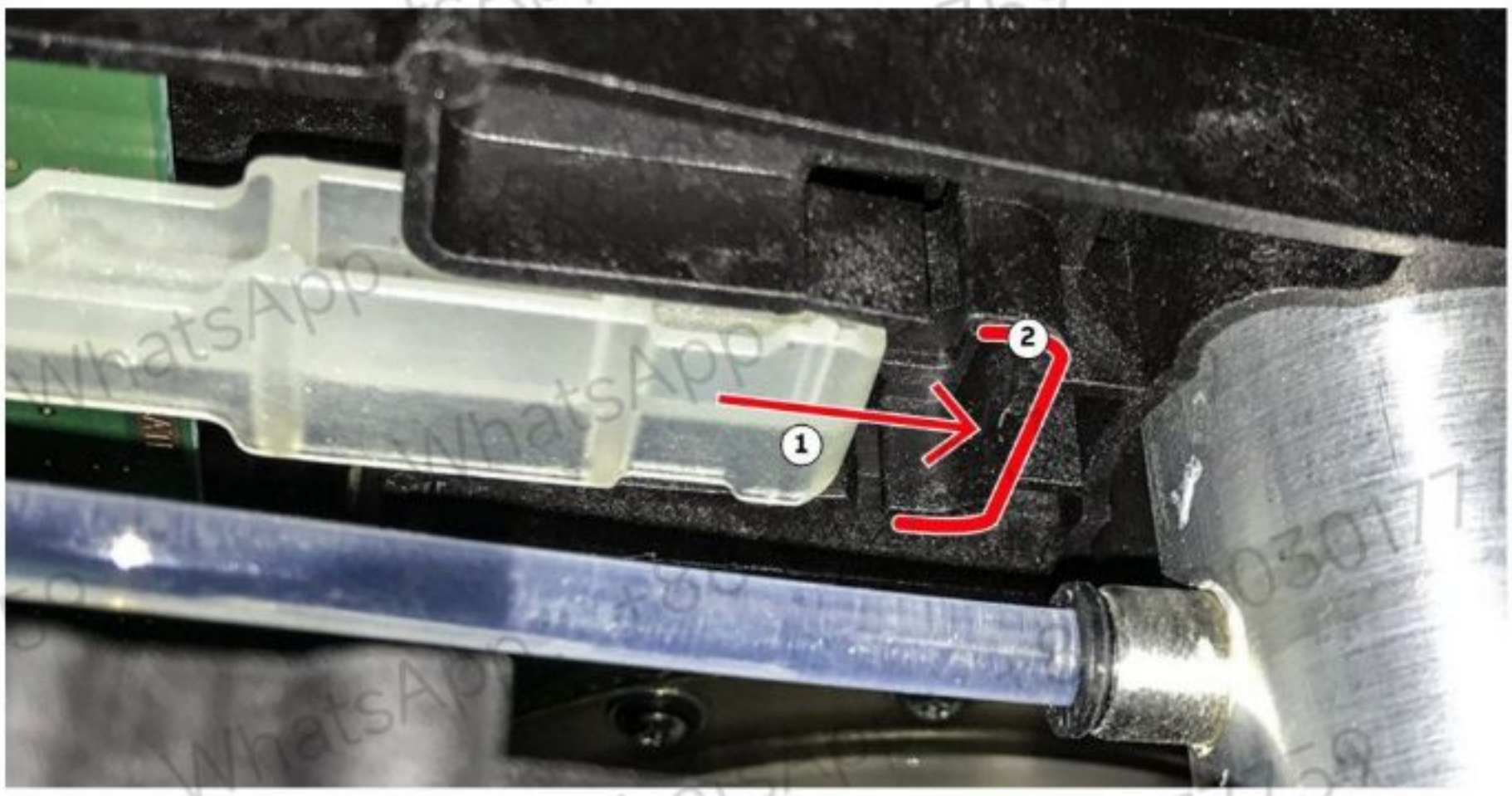


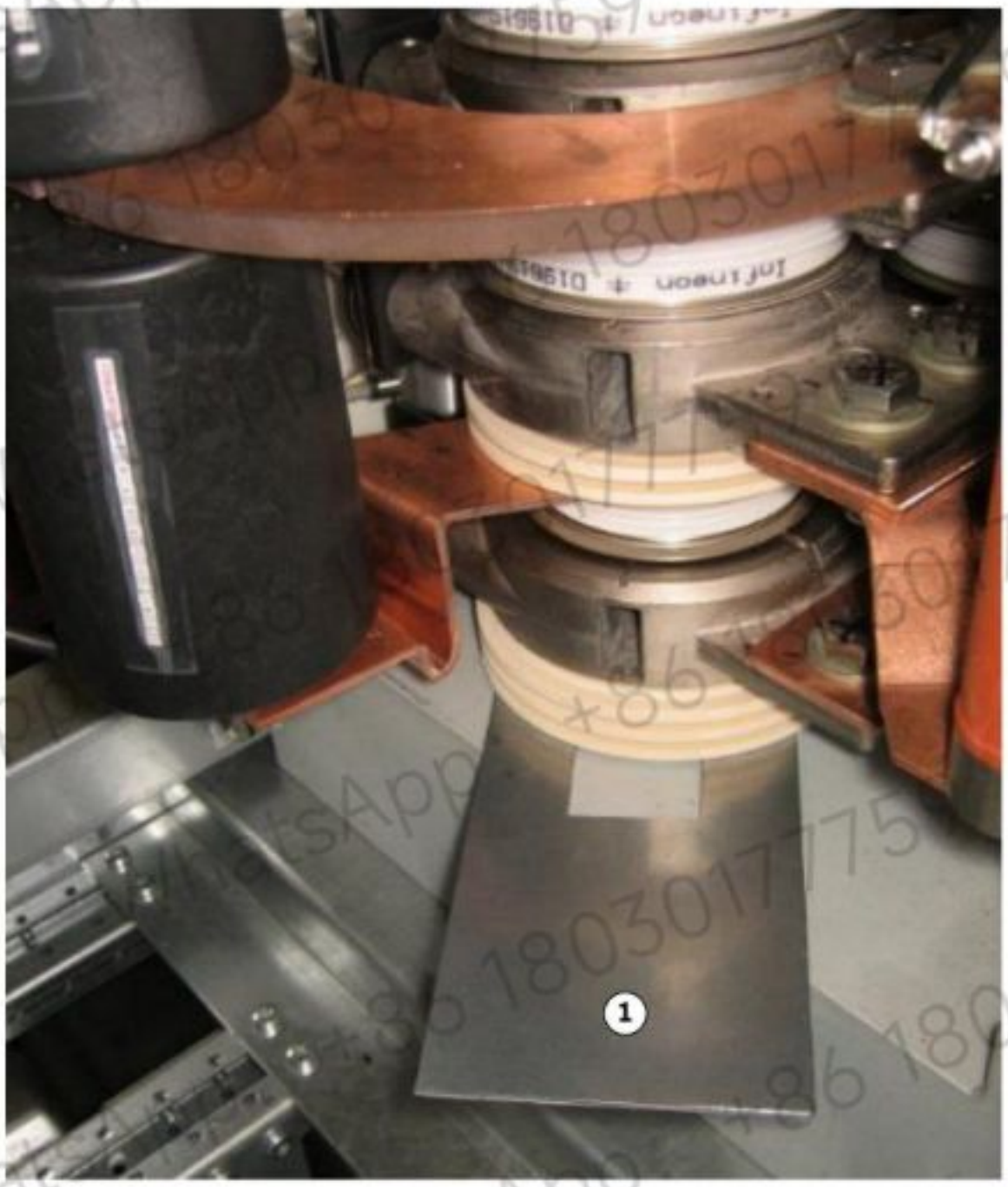
Figure 10–25 Example of positioning and stop device not fully inserted yet

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.

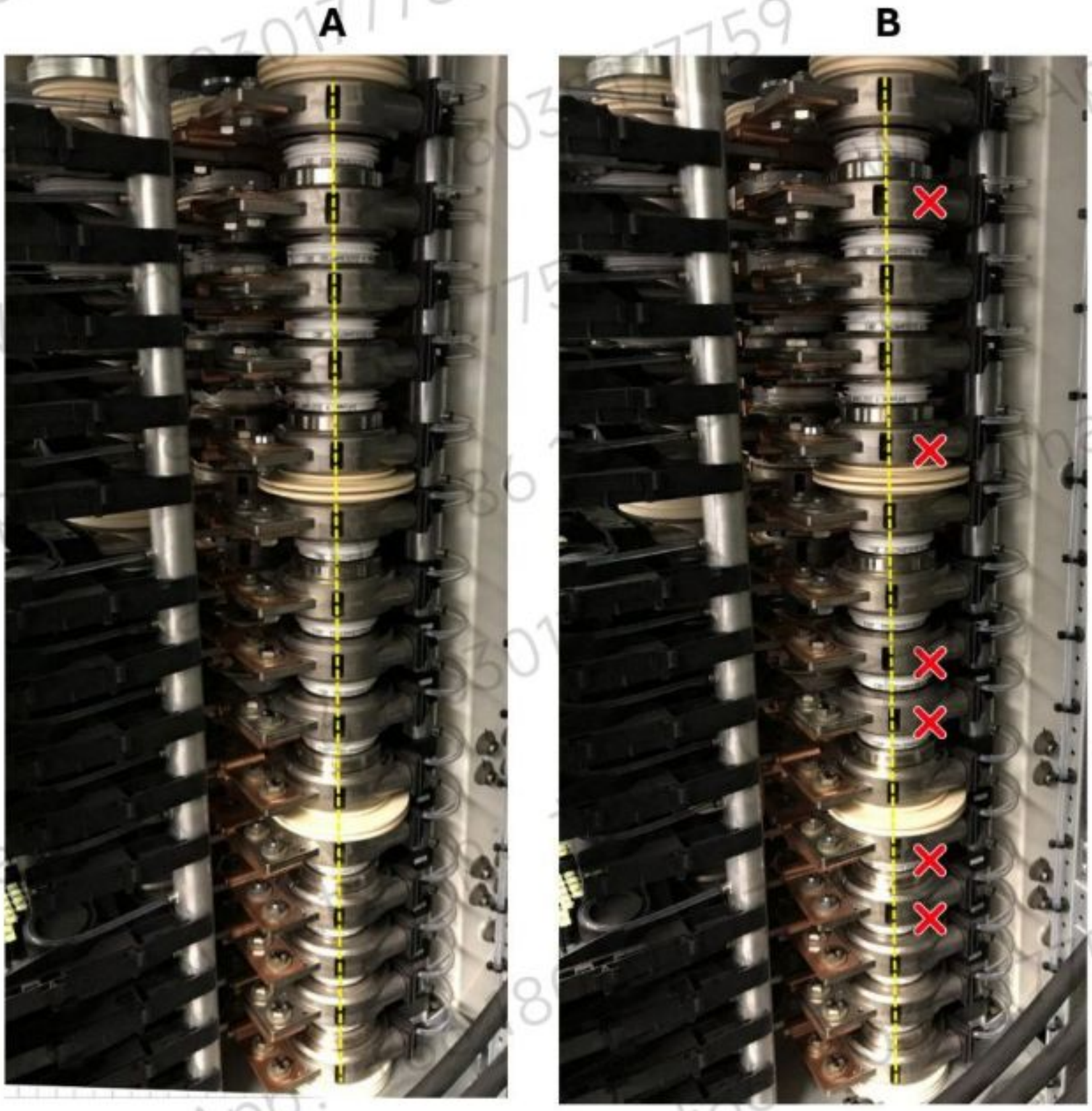


Figure 10–26 Freewheeling diode stack with aligned heat sinks (A) and misaligned heat sinks (B).

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.

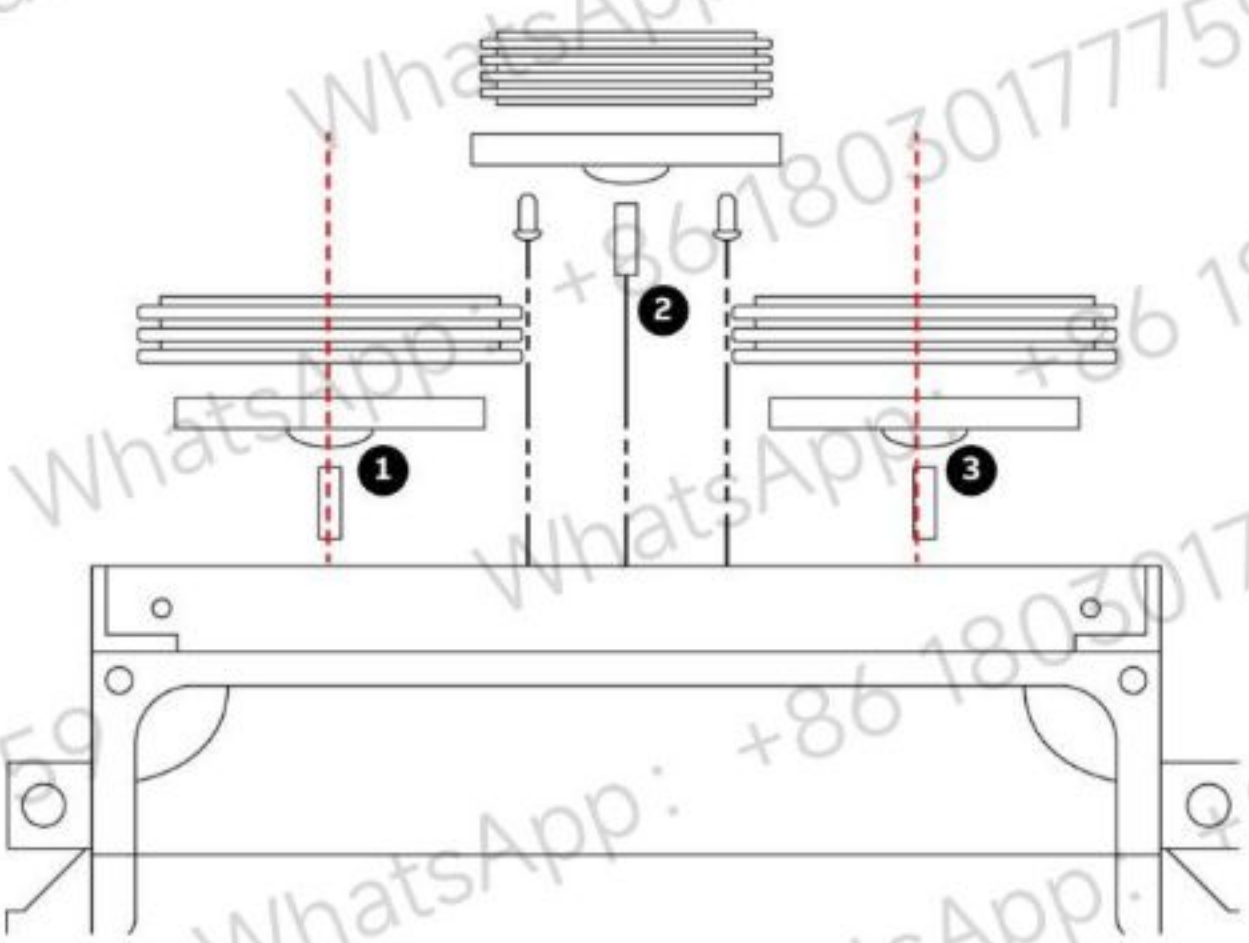


Figure 10–28 Power module assembly (back view)

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

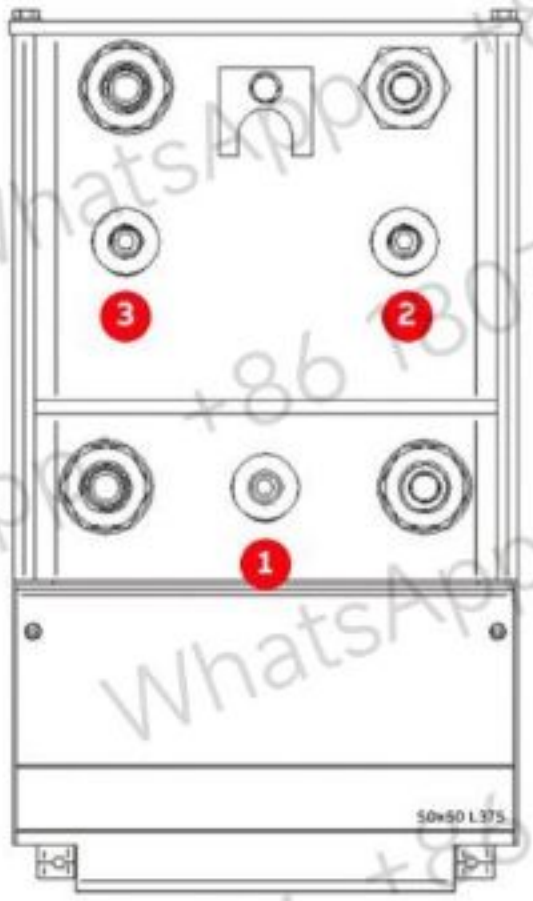


Figure 10–30 Order of tightening the clamping screws

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.

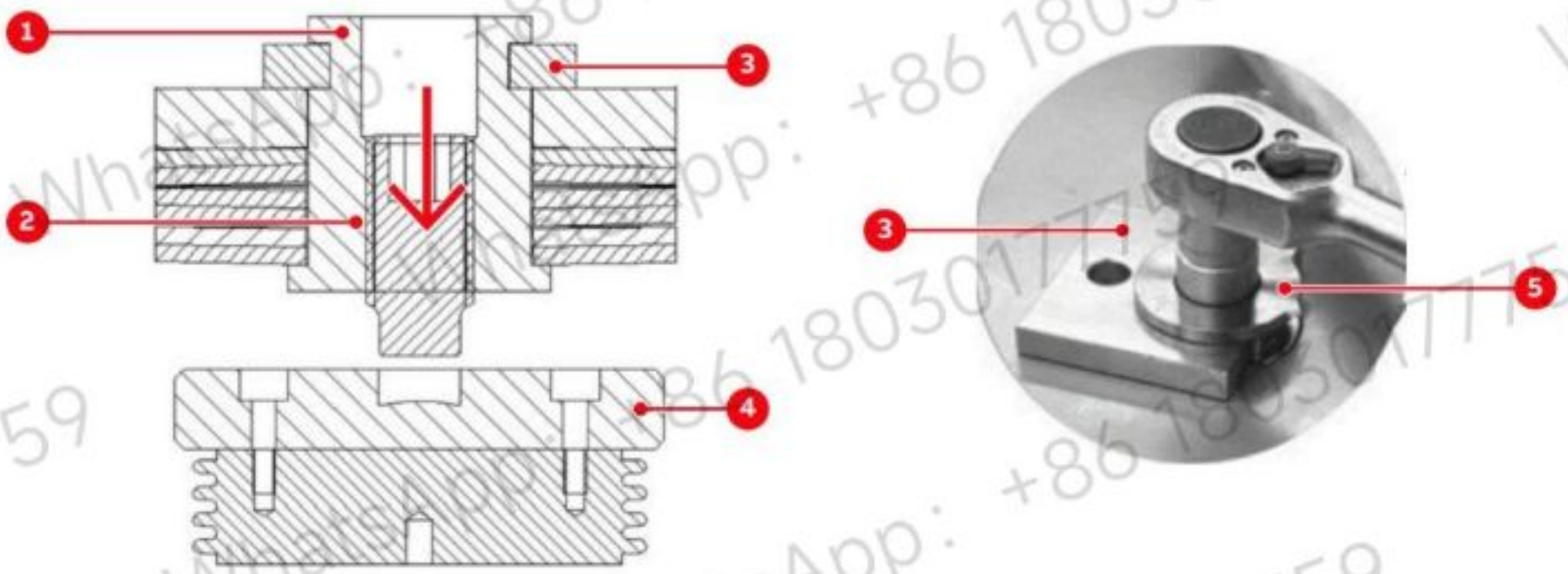


Figure 10–31 Tightening the clamping screw

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

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).

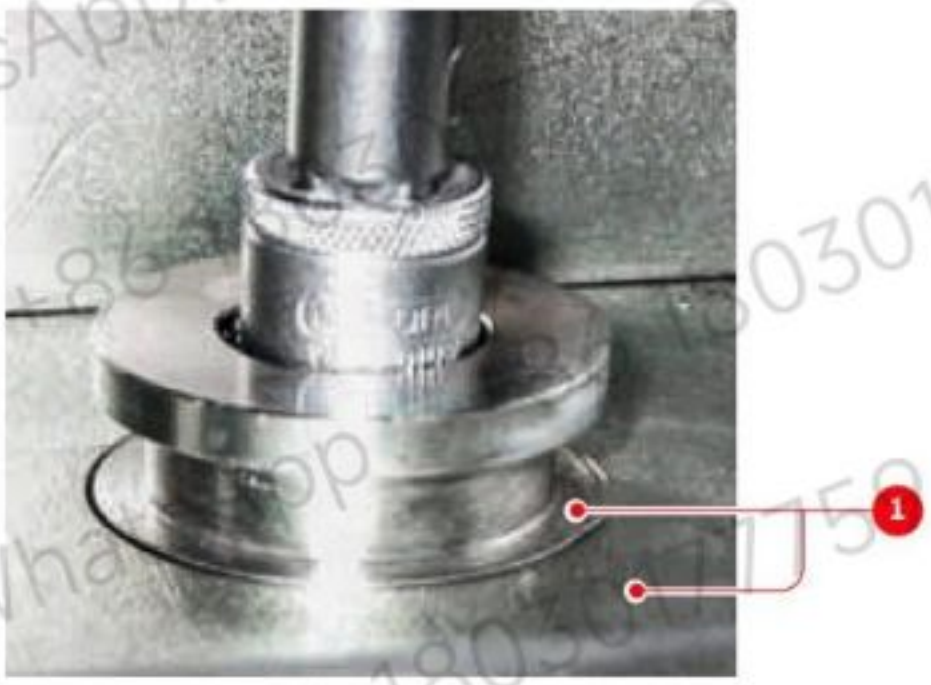


Figure 10–32 Adjusting clamp pressure of stack

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.

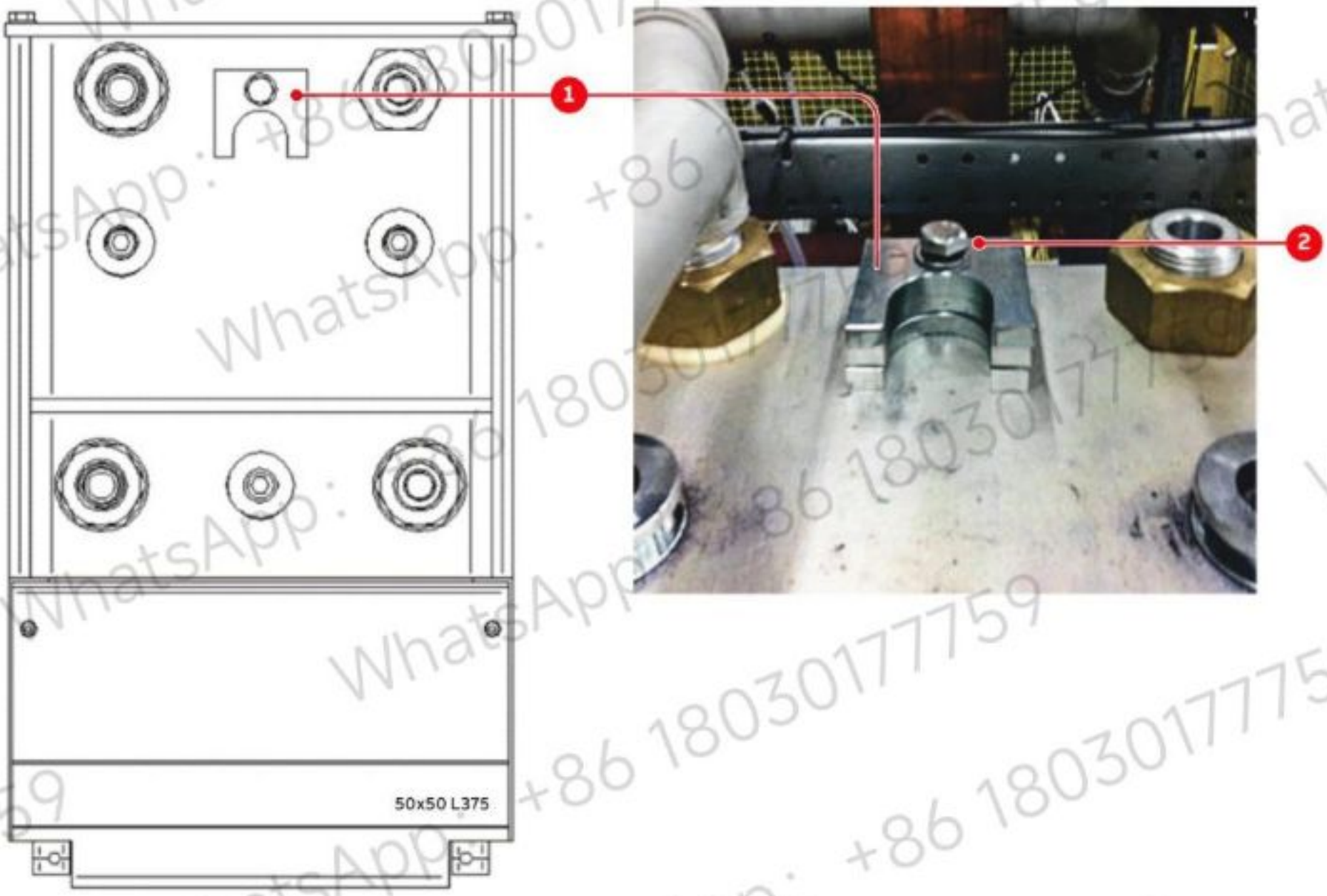


Figure 10–33 Pressure loading gauges storage place

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

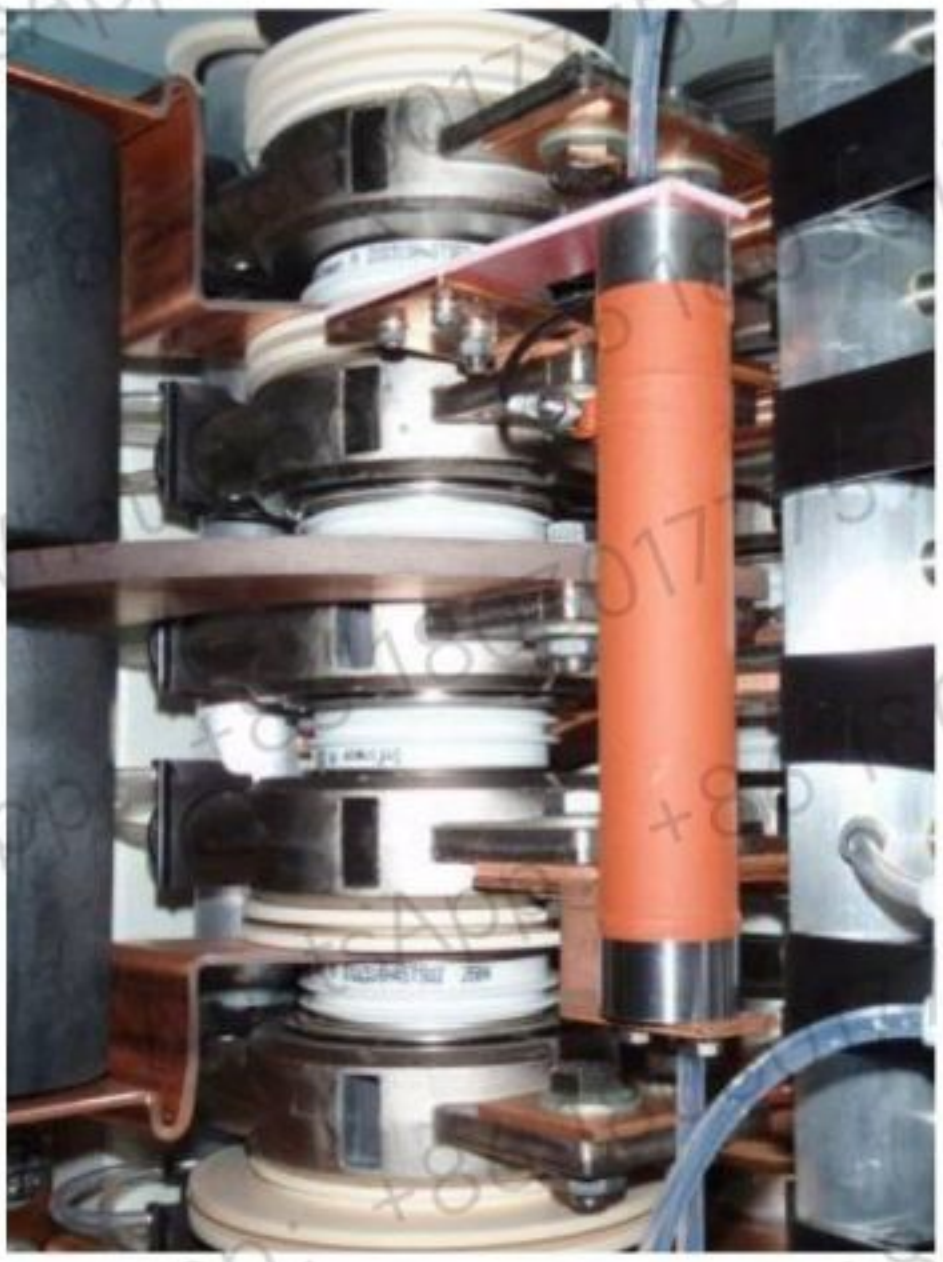


Figure 10–36 Symmetry resistor

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.