Manual for installation and operation HB 601/03 en

ZX1.2
Gas-insulated medium voltage switchgear
That’s why our instruction manual begins with these recommendations:

- Operate the switchgear as prescribed for its intended purpose.

- Ensure that the technical data on the name plate and in the specification are not exceeded during operation of the switchgear.

- Only install the switchgear in enclosed rooms suitable for electrical equipment.

- With the aim of a smooth installation sequence and ensuring a high quality standard, have installation at site performed by specially trained personnel or managed and supervised by the ABB Service Department.

- Ensure that installation, operation and maintenance are only performed by specialist electricians familiar with this manual.

- Comply in full with the legally recognized standards (IEC / DIN VDE), the connection conditions of the local electrical utility and the applicable safety at work regulations.

- Follow the instructions in the documentation when performing any work on switching devices and switchgear.

- Keep all documentation accessible to all persons concerned with installation, operation and maintenance.

- The user’s personnel bear unlimited responsibility in all matters affecting safety at work and the correct handling of the switchgear in accordance with EN 50110 and national regulations.

- Always observe the five safety rules set out in EN 50110 on establishing and securing the off-circuit condition at the place of work for the duration of work on the switchgear. Gas-insulated switchgear are notable for maximum safety, as the circuit-breaker performs the earthing switch function in conjunction with the three position disconnector. The sequence of safety rules therefore deviates from that proposed in the standard as follows:

  - Isolate
  - Check the off-circuit condition
  - Earth and short-circuit
  - Secure to prevent reconnection
  - Cover or guard off adjacent live parts

If you have any further questions on this manual, the members of our field organization will be pleased to provide the required information.
## Standards, regulations, notes, further documents

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## The relevant standards for switchgear over 1 kV and their switching devices

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<td>IEC 62271-1</td>
<td>Common specifications for high-voltage switchgear and controlgear standards</td>
</tr>
<tr>
<td>Switchgear</td>
<td>IEC 62271-200</td>
<td>High-voltage switchgear and controlgear</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Part 200: A.C. metal-enclosed switchgear and controlgear for rated voltages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>above 1 kV and up to and including 52 kV</td>
</tr>
<tr>
<td>Circuit-breaker</td>
<td>IEC 62271-100</td>
<td>High-voltage switchgear and controlgear</td>
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<td>IEC 62271-102</td>
<td>High-voltage switchgear and controlgear</td>
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<td></td>
<td></td>
<td>Part 102: Alternating current disconnectors and earthing switches</td>
</tr>
</tbody>
</table>

Take particular account of the relevant standards listed below. Observe the national technical specifications and the accident prevention regulations of the country in which the switchgear is operated.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>IEC 60364</td>
<td>Low-voltage electrical installations</td>
</tr>
<tr>
<td>IEC 61936</td>
<td>Power installations exceeding 1 kV a.c.</td>
</tr>
<tr>
<td>EN 50110</td>
<td>Operation of electrical installations</td>
</tr>
</tbody>
</table>

National technical accident prevention regulations e.g. for electrical systems and equipment and SF₆ installations
Fundamental notes on this manual:

Read the relevant sections of this manual through in full before performing work, so as to ensure correct handling.

Paragraphs in this manual are marked in accordance with their significance. The markings mean the following:

- **Hazard warning**, meaning in this manual that death or serious injury and considerable damage may occur if the actions described are not performed.

- **Important note**, meaning in this manual that injury and damage may occur if the actions described are not performed.

- **Attention is drawn to further documents.**

Note on safety

The internal arc classification IAC to IEC 62271-200 confirms a tested degree of operator protection. The information on accessibility of the switchgear as required by IEC 62271-200 can be found on the type plates of the panels. The coding is as follows (exemplary):

<table>
<thead>
<tr>
<th>IAC</th>
<th>AFLR</th>
<th>31.5 kA</th>
<th>1 sec</th>
</tr>
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<tr>
<td></td>
<td></td>
<td>Duration of fault current</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level of fault current</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Successfully tested accessibility of the area behind the switchgear (R – rear, only with pressure relief duct and enclosed cable termination compartment)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Successfully tested accessibility of the area to the side of the switchgear (L - lateral)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Successfully tested accessibility of the area in front of the switchgear (F - front)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Switchgear installed in closed rooms with access restricted to authorised personnel</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal arc classification</td>
<td></td>
</tr>
</tbody>
</table>

The operator of the switchgear must prevent access by personnel to non-arc classified areas, for instance by issuing instructions.

Within the ratings stated on the type plate, the switchgear is safe for operating personnel in accordance with IEC 62271-200 when all system components are completely and properly installed.

Commissioning, servicing and extension work require special attention with regard to safety (see also IEC 62271-200).

Operator safety in accordance with IEC 62271-200 assumes that the conditions stipulated by us are complied with (see also Technical Catalogue TK 501).

The IAC qualification relies on a system consisting of at least three panels.

---

1) The following applies to cable-in, cable-out panels: IAC AFLR 25 kA 1s with end covers at both ends for pressure relief (width 250 mm each) and pressure relief duct to the outside.
You have chosen a gas-insulated switchgear of series ZX1.2. This switchgear from the ZX range is notable for the following features:

- $\text{SF}_6$ gas-insulated with hermetically sealed pressure systems
- Rated voltages up to 36 kV (40.5 kV)
- Up to 2500 A and 31.5 kA
- Single busbar
- Stainless steel enclosures, fabricated from laser cut sheet steel
- Modular structure
- Switchgear with a leakage rate of less than 0.1 % per year
- Integrated routine leakage testing of the panel blocks ex-works
- Indoor installation
- Panel widths 600 mm and 800 mm

Do not use cleaning agent containing chlorine for cleaning the switchgear.

If you have technical questions, please contact our service staff

Power technology customer service
Call number +49 180 6222-007
1.0 Circuit-breaker compartment
1.1 Circuit-breaker pole
1.2 Circuit-breaker operating mechanism
1.3 Cable socket
1.4 Test socket
1.5 Capacitive voltage indicator system
1.6 Sockets for voltage transformer
1.7 Isolating system for voltage transformer
1.8 Voltage transformer
1.9 Block-type transformer or sensor
1.12 Bushing, circuit-breaker/busbar compartment
1.13 Pressure relief disk
1.15 Controls for the voltage transformer isolating device

2.0 Busbar compartment
2.1 Busbar compartment
2.3 Three position disconnector
2.5 Three position disconnector mechanism

3.0 Cable termination compartment
3.1 Cable connector
3.2 High voltage cable
3.3 Cable fastener
3.5 Main earthing bar

4.0 Pressure relief duct, bottom
5.0 Plasma diverter

6.0 Low voltage compartment
6.1 Central unit of a combined protection and control device
6.2 Human-machine interface of a combined protection and control device
1 Despatch and storage

1.1 Conditions on delivery

The panel blocks have been routine tested to IEC 62271-200.

- The busbar sockets are closed off with lids to protect them from damage during transport.

The busbar sockets are not insulated in that transport condition. Do not put the switchgear into operation when busbar sockets (e.g. on extendable end panels) are only fitted with transport covers. Close off unused busbar sockets with insulating blanking plugs (see section 2.3.3).

- The panels are prepared for crane handling with rope guides and lifting lugs (figure 1.4.2.1).

- In normal cases, the gas compartments have been filled with sulphur hexafluoride ($\text{SF}_6$) insulating gas to the rated filling pressure. When airfreighted, however, the panel blocks are delivered with reduced pressure.

- If delivered by airfreight, increase the pressure to the rated filling pressure before installing the panels (see instruction manual HB 605/E for the procedure to be adopted).

- Circuit-breaker compartments which are to be fitted with heat sinks at site are filled with nitrogen ($\text{N}_2$) at the works. These gas compartments must be filled with $\text{SF}_6$ after the heat sinks have been fitted (see section 2.3.4 and manual HB 605).

- The installation material and accessories and the documentation are packaged separately from the panel blocks.

The possible packaging methods are as follows:

- No packaging
- Packaged in plastic sheeting
- Packaged in plastic sheeting and surrounded by protective cardboard
- Heat sealed in plastic sheeting with drying agent enclosed
- Packaged in aluminium foil in a transport crate with drying agent enclosed

1.2 Delivery

Check the consignment for completeness and freedom from damage. Document any transport damage found on the waybill and inform us of it immediately. Take photographs of the damage.

1.3 Packaging

The panels have been prepared for transport by the agreed method and for the desired duration of any interim storage required. Details of the length of preservation and the storage location (indoors or outdoors) can be found in the order documents. If the panels are packaged, they are mounted on a pallet and secured to prevent them from slipping.

The transport units are the panels

Always handle the panels in the upright position.

Take account of the weight of the transport units when selecting the handling equipment.

Due to the high centre of gravity of the panels, there is a risk that the transport units may tip over! Take all precautions to protect personnel and the materials transported.

Only ever handle the panel blocks by

- fork lift truck,
- trolley jack
- crane, or
- hydraulic lift trolley.

The panels can be handled upright on a pallet or by fork lift truck, or using a hydraulic lift trolley.

Lifting lugs (2 x left as shown, 2 x right)
1.4.2 Handling by crane

- The panels are delivered with rope guides and lifting lugs fitted.

- Fasten lifting ropes with a sufficient capacity (see section 10, Technical data, for panel weights) and sufficient length as specified in figure 1.4.2.2 and 1.4.2.3 to the lifting lugs using shackles. Thread the lifting ropes through the cut-outs in the rope guides (Crane handling of metering panels does not require rope guides – see figure 1.4.2.3). The lifting ropes and shackles are not included in the ABB scope of supply.

Fig. 1.4.2.1: Lifting lugs and rope guides for handling by crane
Fig. 1.4.2.2: Lifting lugs and rope guides for handling by crane
Fig. 1.4.2.3: Rope fastening for crane handling of a metering panel

Diagram showing rope fastening for crane handling of a metering panel. The diagram indicates a minimum rope angle of 60° for crane handling.
1.4.3 Handling by hydraulic lift trolley

Fasten a hydraulic lift trolley of suitable capacity to each of the front and rear of the panel (figure 1.4.3.1) in accordance with the manufacturer’s instructions.

⚠️ The high centre of gravity means there is a high risk of tipping. Avoid jerky motions!

![Image of hydraulic lift trolley]

Fig. 1.4.3.1: Handling by hydraulic lift trolley

1.5 Intermediate storage

- Store the panels in the upright position.
- Do not stack the panel blocks.
- Protect the transport units from damage.

The conditions for optimum intermediate storage without packaging or with basic packaging are as follows:

- The storeroom must comply with the normal operating conditions for the switchgear installation (see IEC 62271-1).
- Cover the unpackaged panel blocks with protective sheeting, remembering to preserve sufficient air circulation.
- Prevent condensation on the panels by partially opening the packaging and heating the storage room accordingly.

The conditions for optimum intermediate storage with packaging and preservation are as follows:

- Check the packaging for damage.
- Store the transport units in a dry place protected from the weather.
- Contact us if
  - the storage life of the preservation is exceeded,
  - the packaging with preservation is damaged.
2 Installation of the switchgear at site

2.1 Fundamental notes on installation work

2.1.1 General site requirements

At the start of installation, the switchgear room at site must be complete and fitted with lighting and power for the installation work. It must also be lockable, dry, and with good ventilation facilities. All necessary provisions such as openings, ducts, etc. for laying of the power cables must already be in place. Compliance with the conditions for indoor switchgear to IEC 62271-1 must be ensured.

2.1.2 Tightening torques

Use DIN screws of tensile class 8.8. Observe the tightening torques in table 2.1.2.1. The tightening torques apply to unlubricated screw connections.

Please consult the manufacturer’s installation instructions for the tightening torques of cable connectors and surge arresters.

<table>
<thead>
<tr>
<th>Table 2.1.2.1: Tightening torques in Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 5</td>
</tr>
<tr>
<td>Steel screw in T-nut (foundation frame)</td>
</tr>
<tr>
<td>Nut on studbolt</td>
</tr>
<tr>
<td>Steel screw in pulling nut</td>
</tr>
<tr>
<td>Nut on hammer head screw in aluminium section</td>
</tr>
<tr>
<td>Screw in inner cone socket</td>
</tr>
<tr>
<td>Other screws of tensile class 8.8</td>
</tr>
</tbody>
</table>

2.1.3 General information on treatment of plug-in connectors with silicone insulating parts

This section generally explains the procedure for treatment of silicone insulating parts in the busbar sockets, blanking plugs for the busbars, the silicone insulating parts on plug-in voltage transformers and blanking plugs for voltage transformer sockets. Only treat the silicone parts immediately before use. Section 2.3 indicates when the treated silicone parts are needed.

Please consult the documents from the cable connector manufacturer for details of the treatment procedure for silicone insulating parts on the cable connectors.

- Perform the following work to prepare silicone insulating parts for assembly:
  - Inspect the silicone insulating parts
  - Clean soiled silicone insulating parts
  - Grease the insulating parts
  - Clean the sockets, the contact tubes and the outer cone

Inspection of the silicone insulating parts

- Only remove the relevant component from its protective packaging immediately before assembly.

- Check the silicone insulating part for damage prior to installation.

- If you note any damage on the silicone insulating part, only use the component after this has been agreed with our service department.

- The silicone surface must be free of
  - gas bubbles,
  - scoring,
  - damage,
  - abrasions,
  - foreign bodies.
Reinigen von verschmutzten Silikonisolierteilen

- Perform cleaning work immediately before assembly of the relevant component as follows:

- Remove surplus or dirty grease from the silicone part with a soft, clean, non-fraying cloth.

- Clean the silicone insulating part when required with intensive cleaner M.X.T. 60 forte and a soft, non-fraying cloth.

- Only use intensive cleaner M.X.T. 60 forte as the cleaning agent.

- Only moisten the cloth slightly with intensive cleaner. Apply only moderate pressure when cleaning the insulating parts of busbar connections. Do not wipe from the black areas towards the light insulating surfaces. By adopting this procedure you avoid transferring black, conductive material onto the light, insulating area.

- After cleaning with intensive cleaner M.X.T. 60 forte, wipe the silicone insulating part with a dry cloth.

- As the cleaner causes the silicone to swell slightly, it then has to dry for approx. 15 minutes in the air.

Greasing the insulating parts

- Grease the components immediately before use as follows:

- Use the quantities of assembly paste listed in table 2.1.3.1

- Silicone insulating parts on the busbar connection:
  Evenly grease the light, outer areas of the silicone insulating part as shown in figure 2.1.3.1.

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity of assembly paste to be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone insulating part on the busbar connection, both sides</td>
<td>Approx. 20 g each insulating part</td>
</tr>
<tr>
<td>Blanking plugs for the busbar bushing, silicone insulating parts of voltage transformers, blanking plugs for voltage transformer sockets, voltage test plug</td>
<td>Approx. 10 g each part</td>
</tr>
</tbody>
</table>

- Blanking plugs for the busbar connection:
  Evenly grease the light, outer areas of the blanking plug as shown in figure 2.1.3.2.

- Silicone insulating parts of plug-in voltage transformers or surge arresters:
  Evenly grease the silicone insulating part as shown in figure 2.1.3.3.
2.1.3 Greasing the silicone insulating part of the voltage transformer in the area between the arrows

Clean the busbar sockets, the contact tubes, the cable sockets, the sockets for voltage transformers and the test sockets and the outer cones.

- Degrease and clean the components with intensive cleaner M.X.T. 60 forte.

Assemble the components immediately to avoid soiling.

2.1.4 Handling sulphur hexafluoride (SF₆)

As a rule, no gas work is required during installation.

We recommend that gas work should only be performed by personnel trained in the handling of SF₆. Gas may only be extracted by certified personnel. See manual HB 605 “Use of SF₆ insulating gas” for details on handling SF₆.

2.2 Foundation bars

- When a raised false floor is used, load-bearing sections of the floor frame serve as supports for the panels. No additional foundation frame is necessary.

The slabs of the raised false floor must be fastened to the supporting frame.

- If there is a concrete floor a foundation frame is required. Standard foundation frames supplied by ABB must be embedded in the floor topping.

Maintain the following evenness and straightness tolerances when installing the foundation frame or a raised false floor:

- Evenness tolerance: ± 1 mm / m

- Straightness tolerance: Max. 1 mm / m, but max. 2 mm for the entire length

Consult the order documents for the position of the foundation bars in the switchgear room.

If no standard ABB foundation frames are used, observe the relevant construction and laying drawings for the special frames.

The standard foundation frames are shown in figure 2.2.1.1
2.2.1 Installation of the standard foundation frame

Standard foundation frames are delivered to site completely pre-assembled.

**Installation principle:**

The foundation frames are bolted together at the front and rear and three times along the longitudinal sections. Vertical alignment is effected by jacking screws. Brackets are used to fasten the frames to the floor. The foundation frames are finally embedded in floor topping to provide their load bearing capacity.

**Detailed description of installation (Fig. 2.2.1.1)**

- For transport reasons, the foundation frames are delivered with brackets (2) mounted on the inside of the rear sections. Refit the rear brackets on the outside.
- Position the first foundation frame in the correct location on the concrete floor.
- Align the foundation frame vertically with the four screws (1), taking account of any deviation in floor level in the direction of the foundation frames which are still to be laid.
- Fasten the brackets (2) of the foundation frame to the floor, using one knock-in anchor (5) and one screw (3) with dished washer (4) for each bracket.
- When the depths of the foundation frames to be installed are the same, slide one slot rod (6) into each front slot of the front section and each rear slot of the rear section. Fasten the slot rods in position by inserting the grub screws. When the depths of the foundation frames to be connected are different, use a slot rod (6) at the front and a corner bracket (7) at the rear.
- Place the following foundation frame in the correct position on the floor, allowing the inserted slot rods to slide into the sections of the frame to be installed. Bolt the foundation frames together with three M 8 x 100 cheese head screws (8) and nuts and washers. Tighten the grub screws in the slot rods. Screw the corner brackets in place, if used.
- Align the foundation frame vertically as described above and fasten it to the floor.
- Install the following foundation frames in the same way.
- Earth the completely assembled frame. Further details on this can be found in the order documents.

When applying the floor topping, carefully fill under the foundation frame with topping material.
Fig. 2.2.1.1: Installation of the floor frame

1. Rear
2. Front
3. Topping material
4. Top of finished floor
5. Section A-A
6. V3
7. 55 ± 5
8. Topping material
2.3 Assembly of the switch-gear

2.3.1 Preparatory work

2.3.1.1 Checking the SF₆ pressure in the gas compartments

Each panel may consist of one to two gas compartments, depending on the version (see manual HB 605). Each gas compartment is fitted with one filling connector. The filling connectors for the circuit-breaker compartment and the front busbar compartment are located in the low voltage compartment and are accessible from the front when the low voltage compartment door is open.

- Check the gas pressure in each gas compartment with a temperature-compensated pressure gauge (see list of tools) before aligning and connecting the panel blocks, as follows:

  - Remove the protective cap (2) from the filling connector (1) by turning it counter-clockwise.

  ![Fig. 2.3.1.1.1: Filling connector (1) with protective cap (2) in the low voltage compartment](image)

  - Do not press the valve pin (3) in, as otherwise gas will flow out of the valve.

  ![Fig. 2.3.1.1.2: Filling connector (1) with valve pin (3)](image)

- While pulling the locking ring (4) outwards, press the coupling of the pressure gauge (5) into the filling connector.

  ![Fig. 2.3.1.1.3: Filling connector with pressure gauge (5) and locking ring (4)](image)

- Check the reading on the scale of the pressure gauge.

  - The reading must be in the green area of the instrument’s scale. If it is not, or if the site altitude is greater than 1000 m, please contact us.

  - Remove the pressure gauge by pulling out the locking ring on the filling connector.

  - Screw the protective cap onto the filling connector.
2.3.1.2 Greasing the foundation bars

When a standard foundation frame supplied by ABB is used, remove the protective film. Grease the top surfaces of the foundation frame or raised false floor beams. This facilitates erection and alignment of the panels.

2.3.1.3 Preparing the panel blocks

- Dismantle any rear covers fitted to the cable termination compartments.

During installation, do not tread on the marked pressure relief disks in the roof plates of the panels.

2.3.2 Erection of the panels

- Screw two guide pins to each of the brackets of the busbar compartments on the side of the panel to be extended, using nuts and dished washers (see figure 2.3.2.1 a). In the case of sectionalizer panels in double busbar design, there is a further fastening bracket below the busbar bushings of the circuit-breaker compartment. Fasten the guide pins to that bracket using nuts and dished washers (figure 2.3.2.1 b).

Guide pins are only to be fitted to one of the panels at the joint between two panels. The guide pins remain in the relevant position after erection of the panels and must not be removed.

- Lightly grease the guide pins for better sliding.

- Set up the furthest panel block precisely at the specified position.

Fig. 2.3.2.1 a: Fitting Guide pins
Fig. 2.3.2.1 b: Position of the guide pins

Any incoming or outgoing feeder panel

Sectionalizer and riser panel for up to 1250 A

Sectionalizer and riser panel > 1250 A
When the standard foundation frame is used:

- Insert M 8 T-nuts through the holes in the floor plates into the slots in the foundation frame sections. Join the floor plates using washers (1 x washer 8.5 x 30 x 3 and 1 x dished washer 8) and M 8 x 16 cheese head screws to the previously positioned T-nuts (figures 2.3.2.2 a to c).
When a special foundation frame or raised false floor is used:

- Fasten the panels in accordance with the instruction documents supplied.

- Remove the protective caps (figure 2.3.2.3) from the busbar sockets.

- Check the busbar sockets, the insulating parts and the contact tubes of the relevant panel as specified in section 2.1.3.

- Prepare the busbar sockets, contact tubes and insulating parts for the relevant panel (clean and grease as necessary) as described in section 2.1.3. Protect the components from soiling.
- Then, carefully insert the contact tubes into the previously installed panel up to the stop, and then insert the insulating parts (figure 2.3.2.4).

Greater force is needed to overcome the spring force of the second spiral contact inside the busbar socket (for rated busbar voltages over 2000 A, two contacts are used) and press the contact tube up to the stop in the busbar socket.

Apply drawing or pressing tools to a large area on the panel directly above the floor (for instance by using a wooden beam between the tool and the panel) so as to avoid damage to the panel.

- Slide the extension panel carefully against the existing system without tipping it, in such a way that the contact tubes slide into the busbar sockets and the guide pins into the corresponding bores in the fastening bracket (Fig. 2.3.2.5 a + b).

Fig. 2.3.2.4: Fitted contact tubes and silicone insulating parts

Fig. 2.3.2.5 a: Coupling of the panels
(View of the rear area of the busbar compartments)
As soon as the distance between the two panels is appropriately small, connect the fastening brackets of two adjacent busbar compartments with three M 10 x 50 cheese head screws, dished washers and nuts (figure 2.3.2.5). Initially, only lightly tighten the bolt connection.

- Connect the two panels together by tightening the screws across the diagonal at the points marked in figures 2.3.2.8 - 9.
- Check the alignment of the panel and fasten it to the foundation frame rails as described above.

Fig. 2.3.2.6: Bolting the panels together
(View of the rear area of the busbar compartments)
Fig. 2.3.2.7: Bolted joints for any type of incoming or outgoing feeder panel

Fig. 2.3.2.8: Bolted joints for a sectionalizer and riser panel up to 1250 A
1) Cheese head screw, M 10 x 35  
   Nut, M 8  
   Dished washer, 8

2) Cheese head screw, M 8 x 25  
   Nut, M 8  
   Dished washer, 8

3) Cheese head screw, M 8 x 90  
   Nut, M 8  
   Washer 8,4  
   Spring washer A 8
– Mount partition plates below the busbar compartments of two adjacent panels (figure 2.3.2.10).

Fig. 2.3.2.10: Installation of the partition plates
− Lead the control wiring for the panel-panel connection through the opening in the adjacent panel.

− Connect the earthing bars of the panels together (figure 2.3.2.11) by dismantling the earthing link fitted at the works for transport, guiding it through the opening to the adjacent panel and tightening the screws with the specified torque.

Fig. 2.3.2.11: View from the rear into the cable termination compartment (version with partitioning): earthing link fitted
2.3.3 Closure of extendable busbar sockets

On the outer sides of the end panels, extendable busbar sockets are as a rule fitted with insulating blanking plugs at the works. This can be seen from the pressure plates mounted at the sides of the busbar compartments of the extendable panels (figure 2.3.3.2). The pressure plates are used to fasten the insulating blanking plugs in place.

Fig. 2.3.3.1: Blanking plugs for busbar sockets

If extendable busbar sockets at the ends of the end panels are not closed off with insulating blanking plugs, the blanking plugs must be fitted at site in accordance with section 2.1.3 and with the aid of the assembly drawings provided. Operation of the switchgear with open busbar sockets (including those in the course of the busbars, e.g. in sectionalizer panels, etc.) is not permissible!
Fig. 2.3.3.1: Blanking plugs for busbar sockets

- Busbar compartment
- Busbar socket
- Blanking Plug
- Pressure plate
- Section A-A
2.3.4 Installation of the heat sinks

Heat sinks fitted on the circuit breaker compartment for rated currents > 2000 A are as a rule supplied separately and installed after the panels have been set up.

The relevant circuit-breaker compartments are filled with N₂ (nitrogen) for transport. (With regard to the gas work required, consult instruction manual HB 605 E - use of SF₆ insulating gas).

The weight of a heat sink is approx. 90 kg. Use suitable lifting gear (e.g. a mobile gantry crane) to assemble the heat sinks. We recommend having installation performed by two fitters. Observe the relevant accident prevention regulations in the country of installation.

Assembly (see fig. 2.3.4.1):

Follow the installation drawings supplied when fitting the heat sinks.

Assembly must take place in as clean (dust-free) conditions as possible.

- Release the gas (N₂) from the relevant circuit-breaker compartment into the atmosphere by pressing the valve pin (see HB 605 E) until the pressure is equalised.

- Dismantle the transport lid on the heat sink.

- When plasma deflectors are used, the heat sink is mounted on the front opening of the circuit-breaker compartment only (see figure 2.3.4.1). In special cases, when a pressure relief duct is used, it is necessary to install the heat sink shown in figure 2.3.4.1 on the rear opening of the circuit-breaker compartment. Consult the order documents for the required position of the heat sink.

- Remove the relevant transport lid from the roof plate of the circuit-breaker compartment (the remaining lid on the roof plate is fitted with a rupture disk).

- Remove the transport drying agent bags from the gas compartments and replace them with new bags with the same quantity of drying agent. Continue assembly immediately, so as not to impair the effectiveness of the drying agent material.

- Clean the sealing surfaces of the circuit-breaker compartment, the heat sink and the sealing ring with a dry, clean, non-fraying cloth.

- Thinly grease the entire surface of the sealing ring with silicone paste.

- Set the sealing ring on the roof plate of the circuit-breaker compartment and align it symmetrically to the opening. Use suitable lifting gear to set the heat sink on the busbar compartment in such a way that the relevant studbolts in the circuit-breaker compartment engage in the bores in the flange plate on the heat sink, taking care to ensure that the sealing ring is correctly positioned in the slot of the heat sink flange.

- Align the bores in the flange plate so that they are centred around the studbolts.

- Fasten the heat sink across the diagonal at all studbolts, using washers, spring washers and nuts, with a torque of 12.5 Nm (for unlubricated studbolts).

- Evacuate and fill the gas compartment (circuit-breaker compartment + heat sink) with SF₆ as described in manual HB 605. Check the gas compartment for leakage.

2.3.5 Installation of the pressure relief ducts, plasma diverters and end covers

The pressure relief ducts, the plasma diverters and the end covers are to be installed in accordance with the assembly drawings supplied with the panels.
Fig. 2.3.4.1: Installation of the heat sinks, position of the heat sink when plasma deflectors are used

- Hexagonal nut M8 DIN 934 - 8 (20 x)
- Dished washer 8 DIN 6796 (20 x)
- Sealing ring
- Heat sink
- Pressure relief disk
2.3.6 Handling of voltage transformers

Voltage transformers for outgoing feeder metering (metering 1 in figure 2.3.6.1) are as a rule supplied loose and have to be installed at site.

As a rule, voltage transformers for busbar metering (metering 2 and 3 in figure 2.3.6.1) are supplied fitted and ready for operation.

The weight of a voltage transformer can be over 30 kg. Use suitable lifting gear (e.g. a mobile gantry crane) to install the voltage transformers for metering 1. We recommend having installation performed by two fitters. Observe the relevant accident prevention regulations in the country of installation.

Fig. 2.3.6.1: Installation positions of voltage transformers
2.3.6.1 Installation of voltage transformers (metering 1)

If the switchgear is in operation:

− Isolate the relevant outgoing feeder panel before installation the voltage transformers.
− Comply with the safety regulations of EN 50110.
− Test the feeder panel for the off-circuit condition in accordance with section 5.1.
− Earth the feeder panel and secure the working area in accordance with section 4 and EN 50110 standard.
− Switch the mcbs ¹ for the relevant operating mechanisms off so that the feeder panel cannot be switched on by remote control.

− Remove the protective caps from the silicone parts of the voltage transformers and store them for further use.

Check the silicone part of the voltage transformer for damage. Observe the notes in section 2.1.3.

Clean and grease the silicone insulating part of the voltage transformer as described in section 2.1.3.

− Remove the dust protection cap or blanking plug from the voltage transformer socket and store the components for further use.

Clean the voltage transformer socket as described in section 2.1.3.

Voltage transformers for panel width 800 mm

− Earth the threaded bores in the voltage transformer sockets by fitting them with countersunk screws, DIN 7991, M8 x 30 (unless already fitted). (Figure 2.3.6.1.1).

Fig. 2.3.6.1.1: Socket for voltage transformer: earthing the threaded bores (arrows) with countersunk screws, DIN 7991, M8 x 30

¹ mcb: miniature circuit breaker
- Screw the fastening plate with the studbolts to the roof plate of the panel as shown in figure 2.3.6.1.2.

- Hexagonal pins are used to fasten the voltage transformers. Screw the rear hexagonal pins to the studbolts in the enclosure and the front hexagonal pins to the studbolts in the fastening plate (tightening torque 12.5 Nm) as shown in figure 2.3.6.1.3.

- Slowly and carefully insert the transformer into the socket. The plug-in connection must slide easily into the corresponding socket. Check the position of the silicone parts in relation to the socket continuously and correct if necessary. A counter-pressure will become noticeable approx. 20 mm before the limit position is reached.

- Wipe any surplus grease off from the area of the voltage transformer flange above the voltage transformer’s plug-in connection as far as possible.
– Initially, only fasten the voltage transformer with screws at the points marked in figure 2.3.6.1.4. Install the further voltage transformers in the same way (Fig. 2.3.6.1.5).

– Screw the front plate to the previously installed fastening plate as shown in figure 2.3.6.1.6.

– Fasten the front plate and the steel plates of the voltage transformers to the previously installed hexagonal pins (figure 2.3.6.1.6).

Fig. 2.3.6.1.4: Fastening of the voltage transformer to the rear hexagonal pins

2 x Cheese head screw M 10 x 25
2 x Dished washer 10

Fig. 2.3.6.1.6: Fastening of the front plate

3 x Cheese head screw M 8 x 20
3 x Dished washer 8

6 x Cheese head screw M 10 x 25
6 x Dished washer 10
- Lead the transformer wiring through the gland in the front plate.
- Wire the transformers as described in section 2.3.6.4.

**Use of a damping resistor**

- Lead the wires of the damping resistor through the two plastic bushings in the cover. Fasten the damping resistor to the cover with two screws (figure 2.3.6.1.7).
- Wire up the damping resistor in accordance with the circuit diagram.
- Screw the cover with damping resistor to the front plate (figure 2.3.6.1.7).

**Installation without damping resistor**

- Screw the cover to the front plate (figure 2.3.6.1.7).
Voltage transformers for panel width 600 mm

- Voltage transformers of type 1 for panels of 600 mm width are to be bolted by the flange to the voltage transformer socket. For this reason, if fitted, remove the three earthing screws (figure 2.3.6.1.1) in the flange of the voltage transformer socket.

- Slowly and carefully insert the transformer into the socket. The plug-in connection must slide easily into the corresponding socket. Check the position of the silicone parts in relation to the socket continuously and correct if necessary. A counter-pressure will become noticeable approx. 20 mm before the limit position is reached.

- Screw the flange of the voltage transformer to the voltage transformer socket (see figure 2.3.6.1.8) in the panel, tightening the screws across the diagonal.

- Wipe any surplus grease off from the area of the voltage transformer flange below the voltage transformer’s plug-in connection as far as possible.

- Install the further voltage transformers in the same way (Fig. 2.3.6.1.9).

Fig. 2.3.6.1.8: Fastening the voltage transformer to the flange

Fig. 2.3.6.1.9: Voltage transformer installed
– Screw the front plate as shown in figure 2.3.6.1.10 to the studbolts in the roof plate and to the steel plates on the voltage transformers.

Fig. 2.3.6.1.10: Installed voltage transformer with front plate

– Wire the transformers as described in section 2.3.6.4.

Use of a damping resistor

– Lead the wires of the damping resistor through the two plastic bushings in the cover. Fasten the damping resistor to the cover with two screws (figure 2.3.6.1.8).

– Wire up the damping resistor in accordance with the circuit diagram.

– Screw the cover with damping resistor to the front plate (figure 2.3.6.1.11).

Installation without damping resistor

– Screw the cover to the front plate (figure 2.3.6.1.11).

Fig. 2.3.6.1.11: Voltage transformer: Completely assembled unit with damping resistor
2.3.6.2 Installation of voltage transformers (metering 2)

As a rule, voltage transformers for metering 2 are mounted ready for operation at the works. In exceptional cases, these voltage transformers are delivered separately. The assembly work then required at site is described below.

If the switchgear is in operation:

- Isolate the relevant switchgear section before installing the voltage transformers.
- Comply with the safety regulations of EN 50110.
- Test the switchgear section for the off-circuit condition in accordance with section 5.1.
- Earth switchgear section and secure the working area in accordance with section 4 and EN 50110 standard.
- Switch the mcbs \(^1\) for the relevant operating mechanisms off so that the switchgear section cannot be switched on by remote control.

- Remove the protective caps from the silicone parts of the voltage transformers and store them for further use.

- Check the silicone part of the voltage transformer for damage. Observe the notes in section 2.1.3.

- Clean and grease the silicone insulating part of the voltage transformer as described in section 2.1.3.

- Remove the dust protection caps or blanking plugs from the voltage transformer sockets and store the components for further use.

- Remove the dust protection cap or blanking plug from the voltage transformer socket and store the components for further use.

- Clean the voltage transformer socket as described in section 2.1.3.

\(^1\) mcb: miniature circuit breaker
Voltage transformers for panel width 800 mm

- Screw the hexagonal pins to the studbolts on the enclosure (tightening torque 12.5 Nm) as shown in figure 2.3.6.2.1.

Earth the threaded bores in the voltage transformer sockets by fitting them with countersunk screws, DIN 7991, M8 x 30 (unless already fitted). (Figure 2.3.6.1.1).

- Slowly and carefully insert the transformer into the socket. The plug-in connection must slide easily into the corresponding socket. Check the position of the silicone parts in relation to the socket continuously and correct if necessary. A counter-pressure will become noticeable approx. 20 mm before the limit position is reached.

- Screw the voltage transformer firmly to the hexagonal pins (figure 2.3.6.2.2). Install the further voltage transformers (figure 2.3.6.2.3).

Fig. 2.3.6.2.1: Hexagonal pins for fastening of the voltage transformer
- Wire the transformers as described in section 2.3.6.4.
Voltage transformers for panel width 600 mm

- Voltage transformers for metering 2 for panels of 600 mm width are to be bolted by the flange to the voltage transformer socket. For this reason, if fitted, remove the three earthing screws (figure 2.3.6.2.2) in the flange of the voltage transformer socket.

- Screw the hexagonal pins to the studbolts on the enclosure (tightening torque 12.5 Nm) as shown in figure 2.3.6.2.4. Use dressed hexagonal pins for the rear fastening of the voltage transformers. The dressed surface of the hexagonal pins must be at the bottom.

- Slowly and carefully insert the transformer into the socket. The plug-in connection must slide easily into the corresponding socket. Check the position of the silicone parts in relation to the socket continuously and correct if necessary. A counter-pressure will become noticeable approx. 20 mm before the limit position is reached.

- Screw the flange of the voltage transformer to the voltage transformer socket (see figure 2.3.6.2.5) in the panel, tightening the screws across the diagonal.

- Wipe any surplus grease off from the area of the voltage transformer flange above the voltage transformer’s plug-in connection as far as possible.

- Screw the voltage transformer with the mounting below (figure 2.3.6.2.5) firmly to the hexagonal pins. Install the further voltage transformers (figure 2.3.6.2.6).

Fig. 2.3.6.2.4: Installation of the hexagonal pins
Fig. 2.3.6.2.5: Fastening the voltage transformer to the hexagonal pins

3 x cheese head screw M 10 x 40
3 x washer 8.4
3 x spring washer A8

4 x cheese head screw M 8 x 25
4 x dished washer 8

Wire the transformers as described in section 2.3.6.4.

Fig. 2.3.6.2.6: Voltage transformers installed
2.3.6.3 Installation of voltage transformers (metering 3)

As a rule, voltage transformers for metering 3 are mounted ready for operation at the works. In exceptional cases, these voltage transformers are delivered separately. The assembly work then required at site is described below.

If the switchgear is in operation:

- Isolate the relevant switchgear section before installing the voltage transformers.
- Comply with the safety regulations of EN 50110.
- Test the switchgear section for the off-circuit condition in accordance with section 5.1.
- Earth switchgear section and secure the working area in accordance with section 4 and EN 50110 standard.
- Switch the mcbs \(^1\) for the relevant operating mechanisms off so that the switchgear section cannot be switched on by remote control.

- Remove the protective caps from the silicone parts of the voltage transformers and store them for further use.

\[\text{Check the silicone part of the voltage transformer for damage. Observe the notes in section 2.1.3.}\]

\[\text{Clean and grease the silicone insulating part of the voltage transformer as described in section 2.1.3.}\]

- Remove the dust protection caps or blanking plugs from the voltage transformer sockets and store the components for further use.

\[\text{Clean the voltage transformer socket as described in section 2.1.3.}\]

\(^1\) mcbs: miniature circuit breaker

Voltage transformers for panel width 800 mm

- Screw the hexagonal pins to the studbolts on the enclosure (tightening torque 12.5 Nm) as shown in figure 2.3.6.3.1.

\[\text{Earth the threaded bores in the voltage transformer sockets by fitting them with countersunk screws, DIN 7991, M8 x 30 (unless already fitted). (Figure 2.3.6.3.2).}\]
Fig. 2.3.6.3.1: Installation of the hexagonal pins

Fig. 2.3.6.3.2: Socket for voltage transformer: earthing the threaded bores (arrows) with countersunk screws, DIN 7991, M8 x 30
- Slowly and carefully insert the transformer into the socket. The plug-in connection must slide easily into the corresponding socket. Check the position of the silicone parts in relation to the socket continuously and correct if necessary. A counter-pressure will become noticeable approx. 20 mm before the limit position is reached.

- Screw the voltage transformer firmly to the hexagonal pins (figure 2.3.6.3.3). Install the further voltage transformers (figure 2.3.6.3.4) as described.

- Fit the transformer support plate (see figure 2.3.6.3.5).
– Wire the transformers as described in section 2.3.6.4.
– Fit the cover plate (see figure 2.3.6.3.6).

Fig. 2.3.6.3.6: Fitting of the cover plate

8 x cheese head screw M 6 x 16
8 x dished washer 6
8 x countersunk rivet nut (fitted at the works)
Voltage transformers for panel width 600 mm

- Voltage transformers for metering 3 for panels of 600 mm width are to be bolted by the flange to the voltage transformer socket. For this reason, if fitted, remove the three earthing screws (figure 2.3.6.3.2) in the flange of the voltage transformer socket.

- Slowly and carefully insert the transformer into the socket. The plug-in connection must slide easily into the corresponding socket. Check the position of the silicone parts in relation to the socket continuously and correct if necessary. A counter-pressure will become noticeable approx. 20 mm before the limit position is reached.

- Screw the flange of the voltage transformer to the voltage transformer socket (see figure 2.3.6.3.7) in the panel, tightening the screws across the diagonal.

- Wipe any surplus grease off from the area of the voltage transformer flange above the voltage transformer’s plug-in connection as far as possible.

- Install the further voltage transformers in the same way (Fig. 2.3.6.3.8).

- Install the transformer support plate (figure 2.3.6.3.9).

---

Fig.2.3.6.3.7: Fastening the voltage transformer to the flange

3 x cheese head screw M 8 x 40
3 x washer 8,4
3 x spring washer A8

Fig.2.3.6.3.8: Voltage transformers installed
Fig. 2.3.6.3.9: Installation of the transformer support plate

- 6 x cheese head screw M 8 x 35
- 12 x dished washer 8
- 6 x hexagonal nut M 8

- 2 x hexagonal nut M 8
- 2 x washer 8,4
- 2 x spring washer A8

Fig. 2.3.6.3.10: Fitting of the cover plate

- 7 x cheese head screw M 6 x 16
- 7 x dished washer 6
- 7 x countersunk rivet nut (fitted at the works)

- Wire the transformers as described in section 2.3.6.4.

- Fit the cover plate (see figure 2.3.6.3.10).

- Wire any damping resistor fitted as shown in the circuit diagram. Verwenden Sie zur Leitungsführung Kabelbänder, die Sie mit den Stehbolzen M5 verschrauben und Drehver- schlüsse, die als Haltepunkte für Kabelbinder dienen.
2.3.6.4 Wiring of the voltage transformers

The voltage transformers are fitted with terminal boards. The possible configurations of terminal boards can be found in figure 2.3.6.4.1 and table 2.3.6.4.1.

Fig. 2.3.6.4.1: Possible terminal board configurations

Table 2.3.6.4.1: Possible terminal board configurations

<table>
<thead>
<tr>
<th>Number</th>
<th>Tap</th>
<th>e-n winding</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
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<tbody>
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<td></td>
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<td>2n</td>
<td>da</td>
<td>dn</td>
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<td></td>
<td>1a</td>
<td>1a2</td>
<td>1n</td>
<td>2a1</td>
<td>2a2</td>
<td>2n</td>
</tr>
</tbody>
</table>

In a voltage transformer version with 2 windings plus tap or 2 windings plus e-n winding, "N" is implemented at the base plate of the voltage transformer.
Earthing of terminals on the voltage transformer terminal board using earthing screws

Connections to earth potential can be established by means of earthing screws on the terminals of the terminal board. Figure 2.3.6.4.2 illustrates this using the example of a voltage transformer with one secondary winding.

Fig. 2.3.6.4.2: Earthing of terminals using earthing screws

Wiring the voltage transformers

The cable harnesses for wiring of the transformers are prepared at the works and wired to the low voltage compartment. Wire the transformers as follows.

- Wire the secondary terminals and the earthing of the voltage transformers in accordance with the circuit diagrams.
- Check that all terminal screws including the earthing screws are tightly fastened.
- Releasing the earthing screw on the 'N' terminal leads to potentially lethal high voltage at the terminal when the voltage transformer is in operation!
- Releasing the earthing screw on the 'N' terminal is only permissible for test purposes on voltage transformers with de-energized primary!
- Always use the original earthing screws!
Earthing of e-n windings

If the e-n windings of the voltage transformers are damped with a resistor, the windings connected in an open delta are to be earthed at one point. The circuit can be earthed

– in the low voltage compartment (figure 2.3.6.4.3) or

– on the terminal block of a voltage transformer (figure 2.3.6.4.4).

Perform measurements to ascertain which earthing method applies to your system.

Fig. 2.3.6.4.3: Earthing of the circuit in the low voltage compartment

Do not earth here!

Without earthing screw on terminal "dn"

Earthing in the low voltage compartment

Do not earth here!

Without earthing screw on terminal "dn"

Earth here!

With earthing screw on terminal "dn"

Fig. 2.3.6.4.4: Earthing the circuit on the terminal board of a transformer
Remove the earthing screws of the e-n windings from the terminal boards of the voltage transformers in accordance with the circuit diagrams (figure 2.3.6.4.5) or earth the e-n windings using the earthing screw (figure 2.3.6.4.6).

Earth the circuit at one point only.

Fig. 2.3.6.4.5: View of the terminal board of a voltage transformer with e-n winding: Earthing screw (arrow) in isolated position (no earthing)

Fig. 2.3.6.4.6: View of the terminal board of a voltage transformer with e-n winding: Earthing screw (arrow) in earthing position (dn terminal earthed)
2.3.5.5 Installation of the optional cover

The voltage transformers of metering systems 1 and 3 can be fitted with a cover. Installation is described below using the example of a panel with voltage transformers on the outgoing feeder and a width of 600 mm. The procedure for installation of the covers on other variants is almost identical.

It is useful to fit the fastening plates for the covers while installing the voltage transformers.

![Checking the wiring]

Finally, check the earthing system of the voltage transformer wiring in accordance with table 2.3.6.4.2.

<table>
<thead>
<tr>
<th>Windings</th>
<th>Terminals</th>
</tr>
</thead>
<tbody>
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<td>Number</td>
<td>Tap</td>
</tr>
<tr>
<td>1</td>
<td>●</td>
</tr>
<tr>
<td>1</td>
<td>•</td>
</tr>
<tr>
<td>2</td>
<td>●</td>
</tr>
<tr>
<td>2</td>
<td>●</td>
</tr>
</tbody>
</table>

The terminal must be earthed via the earthing screw!

Earthing of the terminal in accordance with the circuit diagram!

Earthing screw fitted in accordance with the circuit diagram and figure 2.3.6.4.3 or 2.3.6.4.4!

When 2 windings plus a tap or 2 windings plus e-n winding, are used, “N” is implemented by the works at the base plate of the voltage transformer.

Table 2.3.6.4.2: Earthing of terminals on the voltage transformer terminal board

- Windings
- Terminals
- Number
- Tap
- e-n winding
- N
- a
- n
- da
- dn
The voltage transformers of metering systems 1 and 3 can be fitted with a cover. Installation is described below using the example of a panel with voltage transformers on the outgoing feeder and a width of 600 mm. The procedure for installation of the covers on other variants is almost identical.

It is useful to fit the fastening plates for the covers while installing the voltage transformers.

Fig. 2.3.6.5.1: Fitting the fastening brackets
Fit the rear wall as shown in figure 2.3.6.5.2. If the fastening bracket at the base of the voltage transformer has been installed, screw the rear wall to that.

**Fig. 2.3.6.5.2: Fitting the rear wall**

Screw the side walls to the rear wall as shown in figure 2.3.6.5.3.

**Fig. 2.3.6.5.3: Fitting the side walls**
Screw the cover to the front fastening bracket, the rear wall and the side walls as shown in figure 2.3.6.5.4 with a total of 12 cheese-head screws of size M 8 x 25, using dished washers.

Fig. 2.3.6.5.3: Fitting the cover
2.4 Connection of cables and wiring

2.4.1 Control cables and wiring

- Establish the panel to panel connections of the control wiring. The panel to panel connections are of the plug-in type.

- The secondary cable entry for external control cables and wiring is located in the floor plate of the low voltage compartment. Lead external control cables and wiring through the floor plate using reducer rings, and connect these in accordance with the wiring diagram.

- Earth the cable screen for the external control cables in accordance with the accepted EMC (electromagnetic compatibility) rules.

External control cables should be screened.

The lengths of the external control cables should not exceed 200 m. With greater lengths, use for example interposing relays or optical fibre cables.

2.4.2 High voltage cables

The high voltage cables are to be installed after high voltage testing.

- Dismantle the floor plates of the cable termination compartments. Remove the cable bushings from the floor plates.

- Lay the high voltage cables to the panels in accordance with the project planning.

Ensure that the phase positions of the cables are correct!

- Slide the cable bushings over the cables.

- Connect the cable connectors to the cables in accordance with the manufacturer's instructions.

Checking the cable sockets

Check the cable sockets for damage. If there is damage to the cable sockets, please contact our service department.

Cleaning the cable sockets

Remove any surplus or dirty grease or soiling from the cable sockets with a soft, clean, non-fraying cloth. Use intensive cleaner M.X.T. 60 forte for cleaning if necessary.

Fitting the cable connectors

- Connect the cable connectors to the relevant cable sockets or outer cones in accordance with the manufacturer's instructions.

- Connect the earthing conductors of the cable screens to the earthing bar in the panel. If window-type current transformers are used, route the earthing conductors of the cable screen back through the current transformers and connect the earthing conductor to the earthing bar in the panel.

The earthing conductors of the cable screens should always be routed to the earthing bar in the shortest possible distance.

Observe the tightening torques for screw connections given in the manufacturer's instructions.

- Press the cable bushings into the openings provided in the floor plates.

- Refit the floor plates and covers on the panels.
2.5 Fitting of surge arresters

If the switchgear is in operation:

− Isolate the relevant feeder panel before installing the surge arresters.
− Comply with the safety regulations of EN 50110.
− Test the feeder panel for the off-circuit condition in accordance with section 5.1.
− Earth the feeder panel and secure the working area in accordance with section 4 and EN 50110 standard.
− Switch the mcbs \(1\) for the relevant operating mechanisms off so that the feeder panel cannot be switched on by remote control.

− Dismantle the cover on the cable termination compartment, if fitted.
− Remove the dust cap or blanking plug from the relevant socket and store the components for further use.

Prepare the surge arresters in accordance with the manufacturer’s instructions.

Install the surge arresters in accordance with the manufacturer’s instructions.

− Connect the earthing terminal of the surge arrester to the main earthing bar of the panel using the wires provided (cross section 16 mm² with cable lugs), as shown in figure 2.5.1. Configure the connection of the earthing leads to the surge arrester in accordance with the manufacturer’s instructions.

− Refit the cover on the cable termination compartment if available.

Fig. 2.5.1: Earthing of surge arresters

\[1\] mcb: miniature circuit breaker
2.6 Fitting blanking plugs

- Close off unused cable sockets and voltage transformer sockets with blanking plugs as follows:
- Treat the silicone insulating parts of the blanking plugs and the sockets for the voltage transformers as described in section 2.1.3.
- Remove the three earthing screws (figure 2.3.6.2.1) on the flange of the voltage transformer socket, if fitted.
  - Insert the blanking plugs into the sockets and, without tilting them, fasten them in place by tightening the screws across the diagonal to the specified tightening torque (section 2.1.2).

2.7 Connecting the main earthing bar

- Connect the main earthing bar to the station earth.

Details of the cross section and the number of connections can be found in the earthing diagram (not included in ABB's scope of supply)

- Establish the earthing connections in accordance with IEC 61936 and IEC 62271-1 from the points of view of shock-proof capability, short-circuit capability and electromagnetic compatibility (EMC).

2.8 Concluding installation work

- Remove all tools and other foreign bodies from the switchgear.
- Refit any cladding, covers, cable ducts, etc. removed during the installation work.

⚠️ Use only chlorine-free cleansers for cleaning of the switchgear.

- Clean the external surfaces of the enclosure and low voltage compartments where necessary.
- Touch up any damage to paintwork with a suitable paint.
- Check that the switchgear room is in proper condition for operation and establish that condition if necessary.
3 Commissioning

3.1 Conditions for commissioning of the switchgear

The conditions for commissioning of the switchgear are as follows:

- Supply voltage is available.
- There are no active SF$_6$ gas pressure alarms.
- Visual examination and sample checks on installation in accordance with this document have been performed.
- External control cables and wiring have been installed.
- Testing of the specified protection data of the secondary equipment has been successfully performed.
- Protection testing has been passed.
- Testing of all mechanical and electrical functions of the switching devices and corresponding operating mechanisms has been successfully performed.
- Testing of the panel and switchgear interlocks has been successfully performed.
- Several trial switching operations (without service voltage) on all switching devices have been successfully performed.
- Switch positions are correctly displayed on the panels and – if necessary – in the control room.
- If remote control systems are fitted, these have been successfully tested.
- Unused cable sockets, voltage transformer sockets and extendable busbar sockets have been closed off with insulating blanking plugs.
- High voltage testing at 80 % of rated short-duration power-frequency withstand voltage Ud to IEC 62271 - 200 has been passed.
- High voltage cables have been installed (after performance of high voltage testing).
- All cladding and covers have been fitted.
- The following accessories have been handed over to the operators:
  - This manual
  - The corresponding documents and order documents
  - Double bit key or barrel lock key for opening and closing of the low voltage compartment doors
  - Levers and cranks for operation of the operating mechanisms (see list of accessories)
  - Earthing set (optional)
  - Plug-in indicator unit for capacitive indication – if necessary (see section 5.1)
  - Phase comparator in the case of more than one incoming feeder (optional)
  - A work instruction for handling of SF$_6$ (an example can be found in instruction manual HB 605/E) is displayed in the switchgear room.
- The operators have been instructed in the theory and practice of operation of the switchgear and are familiar with all details of operation.
3.2 Energizing the system

- Please consult section 4 for procedures for operating the devices. Also observe section 3.1.
- Close all low voltage compartment doors.
- Switch all circuit-breakers off.
- Switch all three position disconnectors off.

Connecting the incoming feeder panels

- Switch the three position disconnector in the incoming feeder panel to the “Disconnector ON” position.
- Switch the circuit-breaker in the incoming feeder panel “ON”.
- The busbar is then at operating voltage.

Before connecting further incoming feeder panels, ensure that the phase angle of the panels is identical (section 5.2).

Connecting the outgoing feeder panels

- Switch the three position disconnector or the disconnector (whichever conducts busbar voltage) in the outgoing feeder panel to be connected to the “Disconnector ON” position.
- Switch the circuit-breaker in the outgoing feeder panel “ON”.
- The load is then switched on.

Switch the further loads on as described.

The switchgear is in operation.
4 Operation

- All activities in connection with operation of the switchgear require compliance with EN 50110 standard or relevant national regulations regarding the operation of electrical installations.

- Always make sure that switching operations have been completed before performing the next switching operation.

4.1 General notes

The three switching positions of the three position disconnector, “connecting”, “disconnecting” and “preparing for earthing” are clearly defined by the mechanical structure of the switch. Connecting and disconnecting the operating current and earthing are performed exclusively by the circuit-breaker. (figures 4.1.1 bis 4.1.2). Figures 4.1.3 to 4.1.9 show the operating sequence for earthing of a busbar by means of the bus tie, on the basis of an example switchgear system.

In order to avoid maloperation, the operating mechanisms of any panel are electrically, and as an option mechanically interlocked.

4.2 Notes on earthing of feeder panels or system sections

When feeder panels or sections of the system has been earthed by operating the earthing switch and circuit-breaker (figures 4.1.1, 4.1.2 and 4.1.5 to 4.1.8), secure it to prevent cancellation of earthing as follows:

Switch the mcbs \(^1\) for the circuit-breaker release circuit and for the motor-operated mechanism of the three position switch in the relevant panel off.

Lock the low voltage compartment door or where appropriate the mechanical OFF button for the circuit-breaker.

Affix a sign to the panel to indicate that earthing has been performed.

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1) mcb: miniature circuit breaker
Fig. 4.1.3: Example switchgear system, consisting of two busbar sections, in operation

Fig. 4.1.4: Opening the circuit-breakers in the outgoing feeder panels in the area of the busbar section to be earthed

Fig. 4.1.5: Opening the disconnectors in the outgoing feeder panels in the area of the busbar section to be earthed
Fig. 4.1.6: Closing the disconnector in the sectionalizer

Fig. 4.1.7: Closing the earthing switch in the riser panel

Fig. 4.1.8: Closing the circuit-breaker in the sectionalizer, left-hand busbar earthed
4.3 Electrical operation

In normal cases, all switches are operated electrically by means of

- a combined protection and control unit, or
- classically by conventional ON and OFF buttons

in general with the low voltage compartment door closed.

Warning: Opening the low voltage compartment door permits intervention in the interlock system.

Use of the protection and control unit

Information on operation of the protection and control unit can be found in the separate instruction manual.

Conventional solution (figure 4.3.1)

Closing and opening of the circuit-breakers, three position disconnectors and disconnectors are effected by ON and OFF buttons. The positions of the switching devices are displayed by LEDs or optionally with the aid of electro-mechanical bar indicators.

Fig. 4.3.1: Standard solution for conventional control and display at the panel
4.4 Emergency manual operation

On failure of auxiliary voltage, the charging motor of a circuit-breaker or the operating mechanism motor of a three position disconnector or disconnector, emergency manual operation is as a rule possible.

The operating mechanisms in a panel can be either
- mechanically interlocked, or
- not mechanically interlocked.

Emergency manual operation is performed with the low voltage compartment door open.

Opening of the low voltage compartment door permits intervention in the interlock system

Electrical protection against maloperation is then ineffective.

In the case of panels without mechanical interlocks, there is no protection against maloperation.

Prior to emergency manual operation, switch the mcb's 1) for the motorized mechanism of the three position disconnector and the circuit-breaker operating mechanism (release circuit and charging motor) off.

4.4.1 Emergency manual operation of the circuit-breaker

Controls for the circuit-breaker operating mechanism

The front of the operating mechanism (fig. 4.4.1.1) accommodates the mechanical on (1) and off (2) pushbuttons, the receptacle for manual charging of the stored-energy spring (3), the mechanical indicators for “Circuit-breaker ON” “Circuit-breaker OFF” (4), “Stored-energy spring charged”, “Stored-energy spring discharged” (5), an operating cycle counter (6) and the name plate for the circuit-breaker (7).

Operation

- Before operating the circuit-breaker, observe the switch position indicator (4) in figure 4.4.1.1.
- On failure of auxiliary voltage, it is possible to open the circuit-breaker using the mechanical OFF button at any time. Closing of the circuit-breaker with the mechanical ON button is dependent on the stored energy spring mechanism being charged. The condition of the stored energy spring mechanism is displayed mechanically (figure 4.4.1.1).
- On failure of auxiliary voltage or the stored energy spring charging motor for the circuit-breaker, the charging process can be carried out or completed manually.
- To do this, insert the charging lever (8 in figure 4.4.1.2) into the receptacle and perform approximately 25 strokes until the charged condition is indicated. When the charged condition is reached, the charging mechanism is disengaged, and no further movements of the charging lever can be made.

Circuit-breaker operating mechanism fitted with optional blocking magnet -RLE1

The blocking magnet -RLE1 blocks the mechanical ON button of the circuit-breaker in certain situations. This interlock is active on failure of the supply voltage. Deblocking of the blocking magnet requires work inside the circuit-breaker operating mechanism, and may only be performed by qualified personnel. Please contact the ABB Service Department if required.

1) mcb: miniature circuit breaker
Fig. 4.4.1.1: Control side of the circuit-breaker operating mechanism

1. ON button for circuit-breaker
2. OFF button for circuit-breaker
3. Receptacle for manual charging of the stored energy spring
4. Switch position indicator
5. Condition indicator for the stored energy spring
6. Operating cycle counter
7. Type plate of the circuit-breaker

Indication of spring discharged
Indication of spring charged

Fig. 4.4.1.2: Manual charging of the stored energy spring

8. Charging lever
4.4.2 Emergency manual operation of the three position disconnector

Operator control area of the three position disconnector mechanism

The operator control area of the three position disconnector operating mechanism (figures 4.4.2.1 and 4.4.2.2) consists of the mechanical switch position indicators ((1) for the earthing switch, (2) for the disconnector), the optional mechanical access lock (3) and the hand crank receptacle (4).

Fig. 4.4.2.1: Operator control area of the three position disconnector mechanism with the access lock closed

Fig. 4.4.2.2: Operator control area of the three position disconnector mechanism with the access lock open

1 Switch position indicator for the earthing switch
2 Switch position indicator for the disconnector
3 Mechanical access lock (optional)
4 Hand crank receptacle
Conditions for operation

- A crank is required for manual operation of the switch (figure 4.4.2.3).

![Crank for emergency manual operation of the three position disconnector](image)

- Observe the switch position indicator before operating the three position disconnector.

- Switch the circuit-breaker in the relevant panel off.

- If fitted: Swing the flap of the mechanical access lock to the right (figure 4.4.2.4). (It is not possible to move the flap when the circuit-breaker is closed.)

![Opening the flap of the mechanical access lock](image)

Insert the crank into the shaft of the three position disconnector mechanism (figure 4.4.2.5).

![Inserting the crank into the shaft of the operating mechanism](image)

Always perform switching operations right up to the stop.

Operation of the three position disconnector

When using the crank, ensure that pressure is continuously applied via the mushroom handle at the end of the crank throughout the complete switching operation.

Approx. 24 turns of the crank are required from the OFF position of the three position disconnector to the ON position of the earthing switch or disconnector and vice versa.

Earthing switch OFF ⇒ ON

- To close the earthing switch, turn the crank counterclockwise until the stop is reached.

- Withdraw the crank.

- Close the flap of the mechanical access lock, if fitted.

Disconnector OFF ⇒ ON

- To close the disconnector, turn the crank clockwise until the stop is reached.

- Withdraw the crank.

- Close the flap of the mechanical access lock, if fitted.
Earthing switch ON ⇒ OFF ⇒ disconnector ON

− Turn the crank clockwise until the stop is reached.
− The three position disconnector is then in the OFF position.
− Withdraw the crank and reinsert it. Turn the crank clockwise until the stop is reached.
− Withdraw the crank.
− Close the flap of the mechanical access lock, if fitted.

Disconnector ON ⇒ OFF ⇒ earthing switch ON

− Turn the crank counter-clockwise until the stop is reached.
− The three position disconnector is then in the OFF position.
− Withdraw the crank and reinsert it. Turn the crank counter-clockwise until the stop is reached.
− Withdraw the crank.
− Close the flap of the mechanical access lock, if fitted.

Equipping of the three position disconnector and disconnector with blocking magnet -RLE1

When a mechanical access lock (figure 4.4.2.1) is used, the three position disconnector can be fitted with a blocking magnet. In certain situations, the blocking magnet prevents the device from being operated. On failure of auxiliary voltage, the blocking magnet permanently prevents the access lock from being opened. Debloking of the blocking magnet requires work on the operating mechanism and may only be performed by qualified personnel. Please contact the ABB Service Department if required.
4.5 Gas monitoring with density sensors

The high voltage compartments must have a sufficient insulating gas pressure during operation (please see the table entitled “Technical data” for the pressures). The density of the SF₆ insulating gas is monitored during operation by a density sensor (temperature-compensated).

If the gas pressure falls below the level for a warning signal, a signal indicating that the insulating gas should be topped up is issued via an LED on a bay control unit or via a warning lamp.

When a switchgear is isolated for a relatively long period, the auxiliary power supply is to be maintained in order to monitor the insulating gas density.

4.6 Operation of the isolating device for voltage transformers

Isolate the relevant feeder panel or switchgear section before connecting or disconnecting voltage transformers.

− Comply with the safety regulations to EN 50110.
− Check the feeder panel or switchgear section for or the off-circuit condition as described in section 5.1.
− Earth the feeder panel or switchgear section and secure the working area in accordance with section 4 and EN 50110 standard.
− Switch the mcbs ¹ of the relevant operating mechanisms off in order to prevent the switchgear section being energized by remote control.

In the cases of metering panels and cable connection panels, isolating devices for the voltage transformers are located in the low voltage compartment. In the case of integrated busbar metering, the isolating devices are located at the rear of the relevant panels (fig. 4.6.1). The isolating device can be secured with a padlock. Remove the padlock prior to operation (fig. 4.6.2).

Observe warning label (6). Check the switch position indicator (5).

Isolating the voltage transformers

To isolate the voltage transformers, pull out the lock knob (2) and turn the operating lever on the shaft in the counter-clockwise direction as shown on the direction indicator (4). Release the lock knob. Turn the operating lever in the counter-clockwise direction until the “OFF” position is indicated (5) and the lock knob engages.

When the lock knob engages in the limit position, the dielectric strength of the isolating device is ensured.

Secure the isolating device with a padlock.

Connecting the voltage transformers

To connect the voltage transformers, pull out the lock knob (2) and turn the operating lever on the shaft in the clockwise direction as shown on the direction indicator (4). Release the lock knob. Turn the operating lever in the clockwise direction until the “ON” position is indicated (5) and the lock knob engages.

When the lock knob engages in the limit position, the current carrying capacity of the isolating device is ensured.

Secure the isolating device with a padlock.

¹ mcb: miniature circuit breaker
Fig. 4.6.1: A) Position of the controls for the voltage transformer isolating device in a cable connection panel, a metering panel and a sectionalizer panel

Fig. 4.6.2: Controls and displays for the voltage transformer isolating device (example of isolating device in an outgoing cable feeder panel)

1 Padlock
2 Lock knob
3 Operating lever
4 Direction of rotation indicator
5 Switch position indicator
6 Warning sign
5 Test procedures

5.1 Testing for the off-circuit condition

The off-circuit condition on the cable side is tested by means of the capacitive voltage indicator (pick-off at the test sockets, and additionally at the cable sockets with a system in the low voltage compartment door). Four systems can be used:

- LRM system
  - Single phase
  - Three phase
- KVDS system, or
- CAVIN system.

Observe the instruction manual for the system used.

- Check the function of the equipment immediately before use. The optical display must be clearly visible!
- The sockets of the capacitive indicator system must never be short-circuited, except during voltage testing on the switchgear.

5.1.1 LRM-systems

Testing for the off-circuit condition is performed with a plug-in display unit (design to IEC 61243-5) at the three pairs of measuring sockets.

Perform repeat tests on the system in accordance with IEC 61243-5, for instance with interface tester KSP. Observe the instructions for the interface tester.

Fig. 5.1.1.1: Single phase LRM system with display unit on the rear of a panel

Fig. 5.1.1.2: Three-phase LRM system with display unit on the front of a panel
5.1.2 KVDS- und CAVIN systems

Testing for the off-circuit condition is performed with the display on the unit. No separate display unit is required.

5.2 Testing for the in-phase condition

Testing for the in-phase condition, e.g. when there is more than one incoming feeder, can be performed with a suitable phase comparator at the measuring sockets of the capacitive voltage indication system.

The phase comparator must comply with IEC 61243-5 and correspond to the technical design of the indicator system used.

Observe the instruction manual for the phase comparator.

Abb. 5.1.2.1: KVDS system

Abb. 5.1.2.2: CAVIN system

5.3 High voltage tests

The test socket in the panel (inner cone, size 2) is used to apply the test voltage.

5.3.1 Cable test with DC voltage

Do not exceed the maximum test voltages and the maximum test duration as specified in IEC 60502-2.

Comply with the safety regulations to EN 50110.

- Isolate the panel whose cables are to be tested in accordance with section 4.
- Test the outgoing feeder for the off-circuit condition as described in section 5.1.
- Earth the outgoing feeder and secure the working area in accordance with section 4 and EN 50110 standard.
- Switch the mcb 1) of the relevant operating mechanisms off in order to prevent the outgoing feeder being energized by remote control.

- Isolate any voltage transformers fitted in the outgoing feeder in accordance with section 4.5.
- Dismantle any surge arresters in the relevant outgoing feeder in accordance with the manufacturer’s instructions.
- Close off any free cable sockets with blanking plugs.
- Dismantle the blanking plates (figure 5.3.1.1) and remove the silicone blanking plugs from the test sockets.
- Check the silicone part of the voltage transformer for damage. Observe the notes in section 2.1.3.
- Clean and grease the silicone insulating part of the voltage transformer as described in section 2.1.3.
- Insert the test cables or test plugs into the test sockets and screw them firmly to the flanges of the test sockets.
- Short-circuit the sockets for the capacitive indicator system in the outgoing feeder using the short-circuiting plug.

1) mcb: miniature circuit breaker
Establish the test circuit in accordance with the manufacturer’s directions for the test apparatus.

Cancel the earthing of the system section to be tested before applying the test voltage by opening the circuit-breaker.

Perform the cable test in accordance with the manufacturer’s directions for the test apparatus.

Earth the system section on completion of individual tests and on conclusion of testing by closing the circuit-breaker.

Dismantle the test cables or test plugs.

Prepare the blanking plugs and test sockets in accordance with section 2.1.3. Close off the test sockets with blanking plugs and blanking plates.

Refit any dismantled surge arresters.

Switch any voltage transformers fitted on as described in section 4.5.

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5.3.2 Voltage test of the main circuit

In the course of testing, the test voltage is applied in sequence to every conductor in the main circuit, with the other conductors earthed. Do not exceed the test voltage levels (80% of the rated short-duration power frequency withstand voltage \(U_D\) as shown on the type plate). Comply with the test conditions as set out in IEC 62271-200.

Comply with the safety regulations to EN 50 110.

- Isolate the section to be tested in accordance with section 4.
- Test the switchgear sections for the off-circuit condition as described in section 5.1.
- Earth the section to be tested and secure the working area in accordance with EN 50110 standard.
- Switch the mcbs \(^1\) of the relevant operating mechanisms off in order to prevent the switchgear section being energized by remote control.
- Dismantle - if present - the covers on the cable termination compartments of the panels in the system section to be tested.

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Fig. 5.3.1.1: Blanking plates used to press and hold the silicone blanking plugs in the test sockets on the rear of the panel

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\(^1\) mcb: miniature circuit breaker
5.4 Secondary protection testing

- Isolate all voltage transformers in the section to be tested by operating the isolating device (see section 4.5).
- Dismantle any surge arresters fitted within the system section to be tested in accordance with the manufacturer’s instructions.
- Dismantle the blanking plates (figure 5.3.1.1) and remove the silicone blanking plugs from the test sockets.
- Prepare the silicone parts of the test cables or test plugs as described in section 2.1.3.
- Clean the test sockets if necessary as described in section 2.1.3.
- Insert the test cables or test plugs into the test sockets and screw them firmly to the flanges of the test sockets.
- Short-circuit the sockets for the capacitive indicator system in the outgoing feeder using the short-circuiting plug.
- Connect the test transformer to the test plug or test cable and earth the other two phases of the main circuit.
- Connect the second terminal of the test transformer to system earth.
- Connect other sections of the switchgear to be tested by operating the relevant disconnectors and circuit-breakers.
- Cancel the earthing of the system section to be tested before applying the test voltage.
- Perform the high voltage test.
- Earth the system section on completion of individual tests and on conclusion of testing.
- Dismantle the test cables or test plugs.
- Prepare the blanking plugs and test sockets in accordance with section 2.1.3. Close off the test sockets with blanking plugs and blanking plates.
- Refit any dismantled surge arresters.
- Switch the voltage transformers on as described in section 4.5.

Comply with the safety regulations to EN 50110.

- Isolate the feeder panel to be tested in accordance with section 4.
- Test the switchgear section for the off-circuit condition as described in section 5.1
- Earth the outgoing feeder and secure the working area in accordance with section 4 and EN 50110 standard.
- Switch the mcb's 1) of the relevant operating mechanisms off in order to prevent the outgoing feeder being energized by remote control.

Voltage may only be applied to the OFF release coil of the circuit-breaker (shut release OFF) for a period of 1000 ms. If this time is exceeded the coil will burn out. For this reason, the protection testing system must be shut down by the OFF command, or the shunt release OFF must be disconnected.

If the circuit-breaker is also to be tested, please note that earthing via the circuit-breaker is cancelled when the breaker is opened. Otherwise, disconnect the release coil before testing.

Note that when the voltage signals from the voltage transformers in the panel to be tested are used by other panels, the signals are not available during the work. This can lead to impairments of function in the other panels.

- Establish the test circuit in accordance with the protection tester manufacturer’s directions and perform the test.

1) mcb: miniature circuit breaker
5.5 Protection testing by primary current injection

Comply with the safety regulations to EN 50110.

- Isolate the relevant switchgear section in accordance with section 4.
- Test the switchgear section for the off-circuit condition as described in section 5.1.
- Earth the switchgear section and secure the working area in accordance with section 4 and EN 50110 standard.
- Switch the mcbs of the relevant operating mechanisms off in order to prevent the switchgear section being energized by remote control.
- Observe the examples of primary side test circuits in figures 5.5.1 and 5.5.2.

If the circuit-breaker is also to be tested, please note that earthing via the circuit-breaker is cancelled when the breaker is opened. Otherwise, disconnect the release coil before testing.

Note that when the voltage signals from the voltage transformers in the panel to be tested are used by other panels, the signals are not available during the work. This can lead to impairments of function in the other panels.

Do not exceed the maximum values for the current testing plug (see the section on accessories).

Panel with integrated current transformers

- Dismantle the blanking plates (figure 5.3.1.1) and remove the silicone blanking plugs from the test sockets.
- Clean the current testing plug.
- Insert the current testing plugs into the test sockets and screw the plugs to the sockets.
- Establish the test configuration in accordance with the manufacturer’s instructions for the protection testing equipment and perform the protection test.
- Earth the switchgear section after completion of the test.
- Remove the testing set.
- Prepare the blanking plugs and the test sockets in accordance with section 2.1.3. Close off the test sockets with blanking plugs and blanking plates.

Fig. 5.5.1: Connection of the test transformer to the test socket via a current testing plug, current flow via the current transformer and circuit-breaker to the earthing contact of the three position disconnector
6 Service

6.1 Inspection and maintenance of the switchgear

- Check that the switchgear room and the switchgear are in proper condition for the intended use at regular intervals.
- Check primarily for dirt, corrosion and moisture.

![Warning]

If you find that the switchgear is not in the proper condition, take appropriate action, e.g. cleaning of the switchgear, removal of corrosion or rectification of the cause of the moisture.

6.2 Inspection and servicing of individual components

Please consult the relevant directions and instruction manuals for the actions and intervals required. All parts in SF₆ are maintenance-free.

The three position disconnector is maintenance-free for 2000 operating cycles.

Panel with window-type current transformers

- Lead the test cable from the test transformer through the opening in the window-type current transformer.
- Establish the test configuration in accordance with the manufacturer's instructions for the protection testing equipment and perform the protection test.
- On completion of testing, remove the test cable of the test transformer.

Fig. 5.5.2: Test circuit when window-type current transformers are used, routing of a cable with sufficient cross-section from the test transformer
6.3 Checking the dimensional accuracy of the control wire settings

When a mechanical interlock is fitted (optional), check the play on the control wires on the circuit-breaker operating mechanism in the course of an inspection.

The mounting for the control wires of the mechanical interlock is located below the circuit-breaker operating mechanism (figure 6.3.1). When the access interlock for the three position disconnector mechanism (figure 6.3.2) is opened, the slide must be directly operated by the control wire. If this is not the case, use the control wire nipple to adjust the control wire so that there is no play with the flap closed.

7 Actions at the end of the service life

ABB can be appointed to decommission and dismantle the switchgear. The switchgear is then professionally dismantled by ABB and the SF6, which is normally reusable, removed before the switchgear is broken down into its remaining components.

Further notes on decommissioning at the end of the switchgear’s service life can be found in materials supplement BA 509 E.
The tools required for assembly of the switchgear system are detailed in the list below. Tools are not part of the ABB scope of supply.

All the tools listed must comply with the safety regulations of the country concerned.

Temperature-compensated pressure gauge with coupling (ABB part number GCE0905091P0101) (figure 2.3.1.1.3)
Set of open-ended spanners, 8 to 19 mm AF
Set of ring spanners, 8 to 19 mm AF
Ratchet, 3/8”, with extensions and 8 to 19 mm AF socket keys and 4 to 10 mm Allen key inserts
Ratchet, ½”, with extensions and 10 to 19 mm AF socket keys and 4 to 10 mm Allen key inserts
Set of screwdrivers for slotted and cross-head screws, sizes 1 to 3
Set of electrician's pliers (end cutting nipper, pointed pliers, flat end pliers, stripping tongs)
Rubber mallet
Set of fitter's hammers
Leveller
Plumb bob
Guide string
Scribing iron
Punch
Tri-square
Tape measure
Calliper gauge
Continuity tester
Multimeter (voltage, current and resistance)
Torque wrench, 0 – 40 Nm, calibrated
Torque wrench, 15 – 100 Nm, calibrated
Extension cable, 230 V, 15 m long
Cable drum, 230 V / 16 A, 50 m
Angle grinder, small
Hand-held drill, chuck up to 13 mm
Hammer drill
Welding machine + accessories
Set of steel drill bits, 1 to 13 mm
Set of concrete drill bits, 6 to 12 mm
Steps, 8 rung
Trolley jacks (recommended capacity 2 t) or
Hydraulic lift trolleys (recommended capacity 3.5 t per pair)
Lifting ropes, 0.75 m, recommended capacity 1 t
Lifting ropes, 1.5 m, recommended capacity 1 t
Shackles, capacity 1 t
Pinch bars
Handling tubes
Chain hoists, 0.25 t including chain
Site lighting
Torch
Hand-held lamp
Vacuum cleaner
Several wooden planks
Several wooden beams
Soft, non-fraying cleaning cloth
Household cleaner, chlorine-free
9 Working materials, auxiliary materials and accessories

Working materials, auxiliary materials and accessories are included in the scope of supply as contracted.

9.1 Working materials

$\text{SF}_6$ insulating gas

Pressure-liquefied gas in steel cylinders,
- Capacity: 5 kg
- Capacity: 40 kg

- Quality to IEC 60376

Observe sample instruction manual included in manual HB 605/E

As a rule, the gas compartments of the panels are filled with insulating gas at the works. For this reason, no gas cylinders are supplied with the switchgear. Gas cylinders are not normally part of the ABB scope of supply.

In the case of airfreight, the gas compartments of the panels are filled at the works to a reduced insulating gas pressure, and therefore they have to be topped up with $\text{SF}_6$ at site. In this case $\text{SF}_6$ in cylinders is required. Further information on the handling of $\text{SF}_6$ can be found in instruction manual HB 605/E.

If extreme temperatures $\geq 50 \, ^\circ\text{C}$ during the storage, transport or temporary storage in the open air of the $\text{SF}_6$ cylinders with exposure to sunlight cannot be ruled out, please provide in your order for a reduced filling factor of 0.75 kg/l for safety reasons.

9.2 Auxiliary materials

Lubricant: Isoflex Topas NB 52,
- Capacity 1 kg

GCE0007249P0100

Assembly paste for silicone insulating parts,
- Capacity 40 g

1VB0000207P0100

Cleaning agent for silicone insulating parts, busbar sockets, outer cones and fuse sealing collars
- Intensive cleaner M.X.T. 60 forte, capacity 1 l

1VB0000240P0100

Silicone paste for greasing of o-rings,
- filling quantity: 250 g

GCE0009048P0102

Paint, standard colour RAL 7035
- Can, capacity 1 kg

GCE9014060R0103

<table>
<thead>
<tr>
<th>ABB part number</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# 9.3 Accessories

<table>
<thead>
<tr>
<th>Accessories for manual charging of the stored energy spring of the circuit-breaker</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charging lever for VD4 X operating mechanism (figure 4.3.1.2)</td>
<td>GCE9477394R0101</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessories for emergency manual operation of the three position disconnector and the disconnector</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crank for emergency manual operation, length 795 mm (standard, figure 4.3.2.4)</td>
<td>GCE7006002R0103</td>
</tr>
<tr>
<td>Crank for emergency manual operation, length 1209 mm</td>
<td>GCE7006002R0102</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Testing accessories</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage testing plug up to 36 kV for inner cone, size 2</td>
<td>GCE0920226P0101</td>
</tr>
<tr>
<td>Voltage testing cable up to 36 kV for inner cone, size 2</td>
<td>GCE0920226P0105</td>
</tr>
<tr>
<td>Current testing plug for inner cone, size 2, ( I_n = 800 \text{ A}, I_p = 2500 \text{ A} / 4 \text{ min.} )</td>
<td>GCE0920226P0103</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Blanking plugs</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blanking plug for inner cone, size 2</td>
<td>GCE8011949R0101</td>
</tr>
<tr>
<td>Blanking plug for inner cone, size 3</td>
<td>GCE0909097P0100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessories for visible earthing by earthing set</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthing set for inner cone, size 2, 29.5 kA</td>
<td>GCE0920226P0107</td>
</tr>
<tr>
<td>Earthing set for inner cone, size 3, 29.5 kA</td>
<td>GCE0920226P0108</td>
</tr>
<tr>
<td>Rod for earthing set, hinged</td>
<td>GCE0920226P0109</td>
</tr>
<tr>
<td>Wall mounting for earthing set</td>
<td>1VB0000074P0100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessories for capacitive indicator, system LRM</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display unit (figure 5.1.1.1)</td>
<td>GCE0931333P0101</td>
</tr>
<tr>
<td>Interface tester</td>
<td>GCE0900052P0102</td>
</tr>
<tr>
<td>Short-circuiting plug</td>
<td>GCE0909005P0101</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other accessories</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double bit key for barrel lock in panel door</td>
<td>GCE0990108P0100</td>
</tr>
<tr>
<td>Wall mounting for accessories</td>
<td>1VB8000533P0101</td>
</tr>
<tr>
<td>Adapter between filling valve of panel module and the hose connection of a DILO filler truck (see manual HB 605)</td>
<td>1VB8000532R0101</td>
</tr>
</tbody>
</table>
The technical data of the switchgear can be found on the name plate. The name plate of the panel is located at the top on the right-hand side wall of the opened low voltage compartment. Further type plates for individual components can be found in the immediate vicinity of the devices concerned.

### Table 10.1: Technical data of the panels

<table>
<thead>
<tr>
<th>Description</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage / maximum operating voltage (^1)</td>
<td>(U_r)</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Rated power-frequency withstand voltage (^1)</td>
<td>(U_d)</td>
<td>28</td>
<td>50</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage (^1)</td>
<td>(U_p)</td>
<td>75</td>
<td>125</td>
</tr>
<tr>
<td>Rated frequency (^2)</td>
<td>(f)</td>
<td>Hz</td>
<td></td>
</tr>
<tr>
<td>Rated normal current of busbars (^3)</td>
<td>(I_n)</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Rated normal current (^3)</td>
<td>(I_n)</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Rated short-time withstand current (^3)</td>
<td>(I_k)</td>
<td>kA</td>
<td></td>
</tr>
<tr>
<td>Rated peak withstand current (^3)</td>
<td>(I_p)</td>
<td>kA</td>
<td></td>
</tr>
<tr>
<td>Rated duration of short-circuit (^3)</td>
<td>(t_d)</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Insulating gas system (^4(5))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated filling level for insulation (^6)</td>
<td>(p_{ae})</td>
<td>kPa</td>
<td>120</td>
</tr>
<tr>
<td>Rated filling level for insulation (^6)</td>
<td>(p_{re})</td>
<td>kPa</td>
<td>130</td>
</tr>
</tbody>
</table>

---

\(^1\) Higher levels to international standards on request  
\(^2\) Rated current for 60 Hz on request  
\(^3\) Higher rated currents on request  
\(^4\) Insulating gas: \(SF_6\) (sulphur hexafluoride)  
\(^5\) All pressures stated are absolute values relative to 20 °C  
\(^6\) 100 kPa = 1 bar
1) Higher ambient temperature on request
2) Greater site altitudes on request
3) Take suitable action to prevent condensation in the low voltage compartment.
4) Weight dependent on variant, design, panel width and equipment fitted.
5) Weight dependent on variant, design and equipment fitted.

Table 10.2: Operating conditions

<table>
<thead>
<tr>
<th></th>
<th>°C</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature, maximum</td>
<td>+40</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature, maximum 24 h average</td>
<td>+35</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature, minimum</td>
<td>-5</td>
<td></td>
</tr>
<tr>
<td>Site altitude</td>
<td>m</td>
<td>...1000</td>
</tr>
<tr>
<td>Average humidity measured over 24 h</td>
<td>%</td>
<td>≤ 95</td>
</tr>
<tr>
<td>Average relative humidity in one month</td>
<td>%</td>
<td>≤ 90</td>
</tr>
</tbody>
</table>

Ambient air

Ambient air not significantly contaminated by dust, smoke, corrosive or flammable gases or salts.

Table 10.3: Panel weights

<table>
<thead>
<tr>
<th>Panel Variants</th>
<th>Weight Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 - 1250 A panel variants</td>
<td>From approx. 550 kg to approx. 1000 kg</td>
</tr>
<tr>
<td>2500 A panel variants</td>
<td>Up to 1650 kg</td>
</tr>
</tbody>
</table>
Incomer panel 2000 A, example configuration

1.0 Circuit-breaker compartment
1.1 Circuit-breaker pole
1.2 Circuit-breaker operating mechanism
1.3 Cable socket
1.4 Test socket
1.5 Capacitive voltage indicator system
1.6 Sockets for voltage transformer
1.7 Isolating system for voltage transformer
1.8 Voltage transformer
1.9 Block-type transformer or sensor
1.12 Bushing, circuit-breaker/busbar compartment
1.13 Pressure relief disk
1.15 Controls for the voltage transformer isolating system
2.0 Busbar compartment
2.1 Busbar system
2.3 Three position disconnector
2.5 Three position disconnector mechanism
3.0 Cable termination compartment
3.1 Cable connector
3.2 High voltage cable
3.3 Cable fastener
3.4 Ring core transformer
3.5 Main earthing bar
4.0 Pressure relief duct, bottom
5.0 Plasma diverter
5.1 Pressure relief duct,
6.0 Low voltage compartment
6.1 Central unit of a combined protection and control device
6.2 Human-machine interface of a combined protection and control device
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