ZX0.2 version 2015
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.
# Contents

<table>
<thead>
<tr>
<th>Standards, regulations, notes, further documents</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Despatch and storage</td>
<td>10</td>
</tr>
<tr>
<td>1.1 Condition on delivery</td>
<td>10</td>
</tr>
<tr>
<td>1.2 Delivery</td>
<td>10</td>
</tr>
<tr>
<td>1.3 Packaging</td>
<td>10</td>
</tr>
<tr>
<td>1.4 Handling</td>
<td>10</td>
</tr>
<tr>
<td>1.4.1 Handing by fork lift truck or trolley jack</td>
<td>10</td>
</tr>
<tr>
<td>1.4.2 Handling by crane</td>
<td>11</td>
</tr>
<tr>
<td>1.4.3 Handling by hydraulic lift trolley</td>
<td>12</td>
</tr>
<tr>
<td>1.5 Intermediate storage</td>
<td>13</td>
</tr>
<tr>
<td>2 Installation of the switchgear at site</td>
<td>13</td>
</tr>
<tr>
<td>2.1 Fundamental notes on installation work</td>
<td>13</td>
</tr>
<tr>
<td>2.1.1 Safety notes</td>
<td>13</td>
</tr>
<tr>
<td>2.1.1.1 General site requirements</td>
<td>13</td>
</tr>
<tr>
<td>2.1.2 Tightening torques</td>
<td>13</td>
</tr>
<tr>
<td>2.1.3 Handling sulphur hexafluoride (SF6)</td>
<td>14</td>
</tr>
<tr>
<td>2.2 Foundation bars</td>
<td>14</td>
</tr>
<tr>
<td>2.2.1 Installation of standard foundation frames</td>
<td>15</td>
</tr>
<tr>
<td>2.3 Assembly of the switchgear</td>
<td>17</td>
</tr>
<tr>
<td>2.3.1 Preparatory work</td>
<td>17</td>
</tr>
<tr>
<td>2.3.1.1 Checking the SF6 pressure in the gas compartments</td>
<td>17</td>
</tr>
<tr>
<td>2.3.1.2 Greasing the foundation bars</td>
<td>18</td>
</tr>
<tr>
<td>2.3.1.3 Preparing the panels</td>
<td>18</td>
</tr>
<tr>
<td>2.3.2 Erection of the panels</td>
<td>19</td>
</tr>
<tr>
<td>2.3.3 Installation of tall low voltage compartments</td>
<td>26</td>
</tr>
<tr>
<td>2.3.4 Installation of the busbar</td>
<td>29</td>
</tr>
<tr>
<td>2.3.4.1 General notes on busbar installation</td>
<td>29</td>
</tr>
<tr>
<td>2.3.4.2 Assembling the busbar</td>
<td>30</td>
</tr>
<tr>
<td>2.3.4.3 Earthing the busbar</td>
<td>30</td>
</tr>
<tr>
<td>2.3.4.4 Mounting of the capacitive indicator on the busbar</td>
<td>32</td>
</tr>
<tr>
<td>2.3.4.5 Installation of the busbar current transformers</td>
<td>34</td>
</tr>
<tr>
<td>2.3.4.6 Installation of the busbar and current transformers between a sectionaliser and riser</td>
<td>45</td>
</tr>
<tr>
<td>2.3.4.7 Installation of the busbar voltage transformers</td>
<td>49</td>
</tr>
<tr>
<td>2.3.4.8 Installation of busbar current sensors</td>
<td>57</td>
</tr>
<tr>
<td>2.3.4.9 Installation of busbar voltage sensors</td>
<td>58</td>
</tr>
<tr>
<td>2.3.5 Installation of voltage transformers in the cable compartment</td>
<td>61</td>
</tr>
<tr>
<td>2.3.5.1 Wiring of the voltage transformers</td>
<td>62</td>
</tr>
<tr>
<td>2.3.6 Installation of damping resistors</td>
<td>67</td>
</tr>
<tr>
<td>2.3.7 Fitting the cover plates</td>
<td>68</td>
</tr>
<tr>
<td>2.4 Connecting the main earthing bar</td>
<td>68</td>
</tr>
<tr>
<td>2.5 Connection of cables and wiring</td>
<td>68</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2.5.1</td>
<td>Control cables and wiring</td>
</tr>
<tr>
<td>2.5.2</td>
<td>High voltage cables</td>
</tr>
<tr>
<td>2.6</td>
<td>Concluding installation work</td>
</tr>
<tr>
<td>3</td>
<td>Commissioning</td>
</tr>
<tr>
<td>3.1</td>
<td>Conditions for commissioning of the switchgear</td>
</tr>
<tr>
<td>3.2</td>
<td>Energizing the system</td>
</tr>
<tr>
<td>4</td>
<td>Operation</td>
</tr>
<tr>
<td>4.1</td>
<td>Panels with circuit-breakers and three position disconnectors</td>
</tr>
<tr>
<td>4.1.1</td>
<td>Notes on earthing of an outgoing feeder or system section</td>
</tr>
<tr>
<td>4.1.2</td>
<td>Operation of the circuit-breaker</td>
</tr>
<tr>
<td>4.1.2.1</td>
<td>Manual operation of the circuit-breaker</td>
</tr>
<tr>
<td>4.1.2.2</td>
<td>Emergency manual operation of the circuit-breaker</td>
</tr>
<tr>
<td>4.1.3</td>
<td>Operation of the three position disconnector</td>
</tr>
<tr>
<td>4.1.3.1</td>
<td>Manual operation of the three position disconnector (manual mechanism)</td>
</tr>
<tr>
<td>4.1.3.2</td>
<td>Operation of the three position disconnector (motor operated mechanism)</td>
</tr>
<tr>
<td>4.1.3.3</td>
<td>Emergency manual operation of the three position disconnector (motor operated mechanism)</td>
</tr>
<tr>
<td>4.2</td>
<td>Panels with three position switch-disconnectors and HRC fuses</td>
</tr>
<tr>
<td>4.2.1</td>
<td>Notes on earthing of an outgoing feeder or system section</td>
</tr>
<tr>
<td>4.2.2</td>
<td>Operation of the three position switch-disconnectors and HRC fuses</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Replacement of HRC fuses</td>
</tr>
<tr>
<td>4.3</td>
<td>Gas monitoring with density sensors</td>
</tr>
<tr>
<td>4.4</td>
<td>Operation of the isolating device for voltage transformers and voltage sensors</td>
</tr>
<tr>
<td>5</td>
<td>Test procedures</td>
</tr>
<tr>
<td>5.1</td>
<td>Testing for the off-circuit condition</td>
</tr>
<tr>
<td>5.1.1</td>
<td>LRM system</td>
</tr>
<tr>
<td>5.1.2</td>
<td>KVDS und CAVIN systems and systems Wega 1.2 C and 2.2 C</td>
</tr>
<tr>
<td>5.2</td>
<td>Testing for the in-phase condition</td>
</tr>
<tr>
<td>5.3</td>
<td>High voltage tests</td>
</tr>
<tr>
<td>5.3.1</td>
<td>Cable tests with DC voltage</td>
</tr>
<tr>
<td>5.3.2</td>
<td>Voltage test of the main circuit</td>
</tr>
<tr>
<td>5.4</td>
<td>Secondary protection testing</td>
</tr>
<tr>
<td>5.5</td>
<td>Protection testing by primary current injection</td>
</tr>
<tr>
<td>6</td>
<td>Service</td>
</tr>
<tr>
<td>6.1</td>
<td>Inspection and maintenance of the switchgear</td>
</tr>
<tr>
<td>6.2</td>
<td>Maintenance of the switching devices and their operating mechanisms</td>
</tr>
<tr>
<td>7</td>
<td>Actions at the end of the service life</td>
</tr>
<tr>
<td>8</td>
<td>Overview of the busbar parts and assemblies</td>
</tr>
<tr>
<td>8.1</td>
<td>Busbar 1250 A</td>
</tr>
<tr>
<td>8.2</td>
<td>Busbar 2500 A</td>
</tr>
<tr>
<td>9</td>
<td>List of tools</td>
</tr>
<tr>
<td>10</td>
<td>Working materials, auxiliary materials and accessories</td>
</tr>
<tr>
<td>10.1</td>
<td>Working materials</td>
</tr>
<tr>
<td>10.2</td>
<td>Auxiliary materials</td>
</tr>
<tr>
<td>10.3</td>
<td>Accessories</td>
</tr>
<tr>
<td>11</td>
<td>Technical data</td>
</tr>
</tbody>
</table>
## The relevant standards for switchgear over 1 kV and their switching devices

<table>
<thead>
<tr>
<th>IEC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgear 62271-1</td>
<td>Common specifications for high-voltage switchgear and controlgear standards</td>
</tr>
<tr>
<td>Switchgear 62271-200</td>
<td>High-voltage switchgear and controlgear, Part 200: A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV</td>
</tr>
<tr>
<td>Circuit-breaker 62271-100</td>
<td>High-voltage switchgear and controlgear Part 100: High voltage alternating current circuit-breakers</td>
</tr>
<tr>
<td>Disconnector and earthing switch 62271-102</td>
<td>High-voltage switchgear and controlgear Part 102: Alternating current disconnectors and earthing switches</td>
</tr>
<tr>
<td>Switch disconnector – fuse combination 62271-105</td>
<td>High-voltage switchgear and controlgear Part 105: Alternating current switch-fuse combinations</td>
</tr>
<tr>
<td>HRC - fuses 60282</td>
<td>High-voltage fuses - Part 1: Current-limiting fuses</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 and the safety data sheets for the used auxiliary materials.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<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>DIN EN 50110</td>
<td>Operation of electrical installations</td>
</tr>
<tr>
<td>National technical accident prevention regulations e.g. for electrical systems and equipment and SF₆ installations</td>
<td></td>
</tr>
<tr>
<td>Safety data sheets for auxiliary materials</td>
<td></td>
</tr>
</tbody>
</table>
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.

خطأ | Error
---|---

⚠️ 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 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>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Duration of fault current
- Level of fault current
- Successfully tested accessibility of the area behind the switchgear (R - rear)
- Successfully tested accessibility of the area to the side of the switchgear (L - lateral)
- Successfully tested accessibility of the area in front of the switchgear (F - front)
- Switchgear installed in closed rooms with access restricted to authorised personnel
- Internal arc classification

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 603).

The IAC qualification relies on a system consisting of at least three panels.
You have chosen a gas-insulated switchgear of series ZX0.2. This switchgear from the ZX range is notable for the following features:

- SF₆ gas-insulated with hermetically sealed pressure systems
- Solid insulated busbar
- Rated voltages up to 36 kV
- Up to 1250 A and 31.5 kA
- Single busbar design
- Stainless steel encapsulations, manufactured 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 panels ex-works
- Indoor installation
- Wall mounting installation and free-standing installation
- Operator controls separate from low voltage compartment
- Operator controls on the panel accessible from the outside

Please observe further documents in addition to this manual. The documents relevant to your switchgear are part of the final documentation.

- Installation checklist MC 603
- Order documents
  - Single line diagram
  - Front view
  - Construction data if compiled specifically for this order
  - Circuit diagrams
  - Earthing diagram – switchgear earth to station earth (not part of ABB supply)
- Instruction manuals
  - Use of SF₆ insulating gas HB 605
  - Circuit-breaker VD4X and VD4X PT for ZX0.2 Type 1 (Fig. 1) BA 611
  - Circuit-breaker VD4X and VD4X PT for ZX0.2 Type 2 (Fig. 2), Panel width 450 mm BA 611
  - Circuit-breaker VD4X Type 2 (Fig. 2), Panel width > 450 mm BA 545
  - Material supplement BA 509
- Operating instructions and directions for components, e.g.
  - Surge arresters
  - Current and voltage transformers
  - Current and voltage sensors
  - Protection and control devices
  - Capacitive indicators
  - Solid insulated busbar.

Fig. 1: Circuit-breaker VD4X, type 1 with outgoing cable-harness

Fig. 2: Circuit-breaker VD4X, type 2, plugs for connection of the wiring are located directly on the mechanism

If you have technical questions, please contact our service staff

Power technology customer service Call number +49 180 6222-007
Fig. 3: Circuit-breaker panel, 1250 A, panel width 600 mm, example configuration

In order to prevent accidents (particularly injury to hands!) extreme care should be taken during all repair work on the operating mechanism, especially with front plate removed.

The spiral spring in the spring energy storage mechanism, for instance, retains a basic tension which is independent of the charging and discharging processes during switching, so as to ensure correct function. This spring energy can be inadvertently released if work is performed incorrectly on the spring mechanism!

Wear appropriate work clothes and protective gloves during the installation work to avoid injuries particularly at sharp-edged sheet metall parts of the switchgear.

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

Panel module  
Circuit-breaker pole  
Circuit-breaker operating mechanism  
Outer cone  
Sockets for capacitive voltage indicator system  
Current transformer  
Gas density sensor  
Gas filling valve  
Cast resin bushing to bus-bar  
Pressure relief disk  
Busbar  
Three position disconnector  
Operating mechanism for three position disconnector  
Cable termination compartment  
Cable connector  
High voltage cable  
Main earthing bar  
Floor plate  
Main earthing bar  
Secondary cable entry  
Low voltage compartment door  
Mechanism bay  
Busbar cover  
Pressure relief duct (optional, for pressure relief to the outside)
1 Despatch and storage

1.1 Condition on delivery

The panels have been routine tested to IEC 62271-200.

- In normal cases, the gas compartments have been filled with sulphur hexafluoride (SF₆) insulating gas to the rated filling pressure. When airfreighted, however, the panels 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).

- The individual parts of the busbars, the installation material and accessories and the documentation are packaged separately from the panels.

Busbars for 2500 A are supported on spacers in the packaging. When the busbars are removed from the packaging, do not lay them on their silicone surfaces. As the copper is very heavy, the silicone can be damaged even if the components are incorrectly stored for a short period only. Always use the spacers supplied for storage.

Tall low voltage compartments are delivered separately and have to be installed at site on completion of panel assembly (see section 2.3.3). In such cases, panel assembly without the low voltage compartment is to be performed as described in section 2.3.

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.

1.4 Handling

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. When using hydraulic lift trolleys to transport panels of 450 mm width or during positioning of the panels on the foundation rails, there is a high risk of them tipping. Therefore always fit support plates as shown in figure 1.4.3.1 to prevent them from doing so.

Only ever handle the panels by

- fork lift truck,
- trolley jack,
- crane, or
- hydraulic lift trolley (Support plates required for panels of 450 mm width!)

1.4.1 Handling by fork lift truck or trolley jack

The panels must each be mounted on a pallet and secured with straps. The pallet must rest fully on the forks of the truck or jack. The high centre of gravity means there is a high risk of tipping. Avoid jerky motions.
1.4.2 Handling by crane

- As shown in figure 1.4.2.1, fasten one lifting bracket each to the left and right of the front roof section of the panel module, using two M 8 x 35 cheese-head screws with dished washers in each case.

- Attach suspension ropes of a sufficient load bearing capacity (see section 11, Technical data, for the panel weights) and sufficient length to the lifting brackets using shackles. Thread the suspension ropes through the cutouts in the rope guides. The ABB scope of supply does not include suspension ropes and shackles.

Abb. 1.4.2.1: Preparing a panel for handling by crane
1.4.3 Handling by hydraulic lift trolley

Attach hydraulic lift trolleys of sufficient capacity to the front and rear of the panel in accordance with the manufacturer's instructions (fig. 1.4.3.2).

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

When moving panels of 450 mm width, fit the support plates supplied as shown in figure 1.4.3.1 to prevent them from tipping. Remove the cover on the cable termination compartment and bolt the support plates to the side walls of the cable termination compartment.

Fig. 1.4.3.1: Support plates fitted

Fig. 1.4.3.2: Hydraulic lift trolley

8 x Cheese head screw M 8 x 25
16 x Dished washer 8
8 x Nut M 8
2 x Support plate
1.5 Intermediate storage

- Store the panels in the upright position.
- Do not stack the panels.
- 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 a switchgear installation (see IEC 62271-1).
- Cover the unpackaged panels with protective sheeting, remembering to preserve sufficient air circulation.
- Prevent condensation on the panels by partially opening the packaging and heating the storeroom 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 Safety notes

In order to prevent accidents (especially hand injuries!), extreme care is to be exercised during all work on the operating mechanism with the mechanism bay covers removed.

In order to ensure correct function, the spiral spring in the energy store of the circuit-breaker operating mechanism is permanently subjected to a basic pre-tension which is independent of the charging and discharging processes during switching. This spring energy can be suddenly released if work is performed incorrectly in the area of the stored energy spring!

2.1.2 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.

2.1.3 Tightening torques

Use DIN screws of tensile class 8.8. Use the tightening torques stated in table 2.1.3.1. 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 2.1.3.1: Tightening torques</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Nut on studbolt</td>
</tr>
<tr>
<td>Steel screw in pulling nut</td>
</tr>
<tr>
<td>Other screws of tensile class 8.8</td>
</tr>
</tbody>
</table>
2.1.4 Handling sulphur hexafluoride (SF₆)

This product contains SF₆. ¹¹

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 frames

- 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.

In addition to a standard foundation frame for conventional applications, a reinforced foundation frame for earthquake applications is also available. Both frames are made of aluminum profiles. In conventional applications, the panels are fixed in the upper slot of the aluminum profiles by means of slot rods. In the reinforced version, the panels are fastened with slot rods in the lower slot of the profiles.

Frames with a width of 600 mm are used for panel widths 600 mm, 2 x 900 mm and 1200 mm. For 450 mm wide panels, a further version with a corresponding width is available (see figure 2.2.1).

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.

Fig. 2.1.1: Foundation frames, top view

¹¹ SF₆ is a fluorinated greenhouse gas with a GWP of 22800. The maximum quantity per panel is 9 kg. That corresponds to a CO₂ equivalent of 205 t. Each gas compartment has a gas leakage monitor, and therefore regular leakage testing (to Fluorinated Gas Regulation 517/2014) is not required.
2.2.1 Installation of standard foundation frames

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

Installation principle:

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

Detailed description of installation

- If reinforced foundation frames are to be installed, slide six slot rods per frame into the lower slots prior to installation and fix each with a cheese head screw (Fig. 2.2.1.1). Do not remove the protective film from the profiles.

- For the further process of assembly, observe Fig. 2.2.1.2.

- Position the foundation frame sections in the correct locations 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.

- Slide one slot rod (6) into the front slot of the front section and one into the rear slot of the rear section. Fasten the slot rods in position by inserting the grub screws.

- 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 two M 8 x 100 cheese head screws (7) and nuts and washers. Tighten the grub screws in the slot rods.

- 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: Preparing reinforced foundation frames

![Diagram of foundation frame with labels: 6 x Cheese head screw M 10 x 50, 6 x Washer, 6 x Slot rod, Section A-A, Washer 10, Slot Rod, Cheese head screw M 10 x 50]
Fig. 2.2.1.2: Installation of the floor frame

*: Only in the case of reinforced foundation frames
2.3 Assembly of the switchgear

2.3.1 Preparatory work

2.3.1.1 Checking the SF$_6$ pressure in the gas compartment

Each panel contains a gas compartment and is fitted with a filling connector (Fig. 2.3.1.1.3). The filling connector is located in the operating mechanism bay behind the operator controls on the panel.

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

- Dismantle the covers on the mechanism bays by removing the screws marked in Fig. 2.3.1.1.
- Remove the protective cap (2) from the filling connector (1) by turning it counter-clockwise (Fig. 2.3.1.1.2).
- Do not press the valve pin (3) (Fig. 2.3.1.1.3) in, as otherwise gas will flow out of the valve.
- Pull the locking ring (4 in Fig. 2.3.1.1.4) of the manometer coupling piece towards the manometer, push the coupling piece onto the filling connector up to the stop and slide the locking ring towards the filling connector.
- Check the reading on the scale of the temperature-compensated 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.
- Pull the locking ring of the manometer coupling piece towards the manometer and pull the manometer from 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 panels

- Remove the covers from the cable termination compartments on all panels.

Fitting the studbolts for the solid-insulated busbars

- The studbolts are part of the busbar supply. Use original studbolts only.

- For 1250 A cast resin bushings, use M16 / M12 studbolts, and for 2500 A cast resin bushings use M16 / M16 studbolts.

- Screw the studbolts into the cast resin bushings on the panels until the stop is reached (fig. 2.3.1.3.1). Tighten the studbolts with a torque wrench. The torque for 1250 A cast resin bushings is 10 Nm, and for 2500 A cast resin bushings 30 Nm.

- Measure the length of the studbolts projecting from the cast resin bushings. See figure 2.3.1.3.2 for the specified dimensions.
2.3.2 Erection of the panels

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

**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 (Fig. 2.3.2.1 and Fig. 2.3.2.2).

- Use four fastening points for panels of 450 mm and 600 mm width, six for panels of 900 mm width, and eight for panels of 1200 mm width (fig. 2.3.2.1).

**When a special foundation frame or raised false floor is used:**

Fasten the panels in accordance with the instruction documents supplied.

---

Fig. 2.3.2.1: Fastening points for panels of various widths
Fig. 2.3.2.2: Fastening the panel to the conventional foundation frame

Slot in the foundation frame section

T-nut, M 8

Fig. 2.3.2.3: Fastening of the panel to the foundation frame

Fastening of the panels when using the reinforced standard foundation frame:

- To fasten the panels, use bars for each panel as a support, screws M 10 x 50 and washers (Fig. 2.3.2.3 a). Refer to Fig. 2.3.2.3 b for the position and number of fastening elements.

6 x Washer 10
6 x Cheese head screw M 10 x 50
3 x bar

Fig. 2.3.2.3 a: View into the cable compartment of an exemplary panel, Fastening of the panel on the reinforced foundation frame
When a special foundation frame or raised false floor is used:

Fasten the panels in accordance with the instruction documents supplied.
– Carefully slide the panel to be installed up to the panel which is already in place.

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.

– Check the position of the panel and align the panel to the precise dimensions if necessary.

– Fasten the low voltage compartments, the operating mechanism bays and the cable termination compartments of the two panels together at the points provided (fig. 2.3.2.4) using screws and nuts.

Fig. 2.3.2.4: Fastening points for panel to panel bolting

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

2) Cheese head screw, M 8 x 100  
   Nut, M 8  
   2 x dished washer, 8

3) Coupling link  
   Cheese head screw, M 8 x 30  
   Nut, M 8  
   2 x dished washer, 8

– Fit the coupling link at the rear of the panels.

– Fasten the panel to the foundation frame as described above.

– Measure the centre to centre distances L of the adjacent cast resin bushings (fig. 2.3.2.5) for all three phases. The specified dimensions for distance L can be found in tables 2.3.2.1 and 2.3.2.2.

– If the measured dimension L deviates from that specified, correct the position of the panel.
**Fig. 2.3.2.5:** Distance $L$ to be measured between the cast resin bushings of adjacent panels

**Table 2.3.2.1: Specified dimensions for distance $L$, busbars up to 1250 A**

<table>
<thead>
<tr>
<th>Panel widths of the adjacent panels [mm]</th>
<th>Specified dimension for $L$ in figure 2.3.2.5 [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>450 - 450</td>
<td>450</td>
</tr>
<tr>
<td>450 - 600</td>
<td>485</td>
</tr>
<tr>
<td>450 - 600 (Transferpanel)</td>
<td></td>
</tr>
<tr>
<td>600 - 450</td>
<td>565</td>
</tr>
<tr>
<td>600 (Transferpanel) - 450</td>
<td>395</td>
</tr>
<tr>
<td>600 (Transferfeld) - 600</td>
<td>430</td>
</tr>
<tr>
<td>600 - 600</td>
<td>600</td>
</tr>
</tbody>
</table>
### Specified dimensions for distance L, busbars up to 2500 A

<table>
<thead>
<tr>
<th>Panel widths of the adjacent panels [mm]</th>
<th>Specified dimension for L in figure 2.3.2.5 [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>450 - 600</td>
<td>485 +2 0</td>
</tr>
<tr>
<td>450 - 900</td>
<td>635 +2 0</td>
</tr>
<tr>
<td>450 - 1200</td>
<td>785 +2 0</td>
</tr>
<tr>
<td>600 - 450</td>
<td>565 +2 0</td>
</tr>
<tr>
<td>600 - 600</td>
<td>600 +2 0</td>
</tr>
<tr>
<td>900 - 450</td>
<td>715 +2 0</td>
</tr>
<tr>
<td>1200 - 450</td>
<td>865 +2 0</td>
</tr>
<tr>
<td>600 - 900</td>
<td>900 - 600</td>
</tr>
<tr>
<td>900 - 900</td>
<td>1200 - 600</td>
</tr>
<tr>
<td>900 - 1200</td>
<td>1200 - 900</td>
</tr>
<tr>
<td>1200 - 1200</td>
<td></td>
</tr>
</tbody>
</table>
- Install the further panels in the manner described.

- Guide the control cables for the panel to panel connections through the opening in the low voltage compartment of the relevant adjacent panel. Fit the control wiring plugs into the corresponding connector sockets as shown in the circuit diagram.

- Connect the earthing bars of the panels together (figure 2.3.2.6) 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. 2.3.2.6: View into the cable termination compartment: Installation of the earthing bar
2.3.3 Installation of tall low voltage compartments

The sequence of installation work (e.g. busbar installation before installation of the low voltage compartment) is to be determined to suit the individual situation (e.g. free-standing or wall-mounted installation).

We recommend that installation be performed by a team of three fitters.

The points for fastening of the low voltage compartment to the panel are shown in figure 2.3.3.2.

Fig. 2.3.3.1: Side view of the panel with low voltage compartment

Fig. 2.3.3.2: Fastening points for the low voltage compartment
- Lift the low voltage compartment with suitable lifting gear (see figure 2.3.3.3).

- Set the low voltage compartment down on the mechanism bay and screw it tight at the points shown in figures 2.3.3.2 and 2.3.3.4, observing the specified tightening torques.

Fig. 2.3.3.3: Examples of lifting the low voltage compartment

Fig. 2.3.3.4: Fasteners (shown on the right only)

4 x Nut M8
4 x Dished washer 8

2 x Cheese head screw M 8 x 25
2 x Nut M 8
2 x Washer A 10,5
4 x Dished washer 8
– Bolt the adjacent low voltage compartments together as shown in figure 2.3.3.5.

– Guide the plugs of the relevant cable harnesses through the opening provided in the low voltage compartment (figure 2.3.3.6).

– Insert the plugs into the sockets provided.

Fig. 2.3.3.5: Bolting adjacent low voltage compartments together

![Diagram of bolted compartments with labeled parts: 3 x Cheese head screw M 8 x 25, 3 x Nut M 8, 6 x Dished washer 8]

Fig. 2.3.3.6: Opening for the cable harness in the side wall of the low voltage compartment

![Image of cable harness opening in a low voltage compartment]
2.3.4 Installation of the busbar

2.3.4.1 General notes on busbar installation

The individual parts of the busbar adapters (connections between the busbar sections of each panel) are supplied packaged for all three phases. Parts lists are enclosed with the material.

See section 8 for the part numbers of the adapters and the required lengths of the busbars for the adjacent panels.

End adapters are used at the ends of the switchgear system and on sectionaliser, riser and transfer panels. Cross adapters are to be installed in the busbar run.

The packaging for the busbar adapters contains assembly paste. Use only this assembly paste to grease the busbar components.

If it is intended to fit current transformers or sensors in the busbar run, please note that the current transformers or sensors are to be installed during fitting of the busbars (see section 2.3.3.6):

Storage of the busbars

Busbars for 2500 A are supported on spacers in the packaging. When the busbars are removed from the packaging, do not lay them on their silicone surfaces. As the copper is very heavy, the silicone can be damaged even if the components are incorrectly stored for a short period only. Always use the spacers supplied for storage.

Checking the silicone surfaces of the components

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.

Cleaning soiled silicone surfaces

Components removed from the packaging can as a rule be installed directly without cleaning. If cleaning should nevertheless be necessary, clean the components immediately before installation as follows:

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

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

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

- 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.

Checking the copper ends of the busbars

- Inspect the copper ends for oxidation and discoloration.

Cleaning the copper ends of the busbars

- In the case of oxidation or the presence of discoloration, clean the copper ends immediately before installation with a clean non-woven cloth. Inspect and clean the silicone surfaces of the busbars as described above.

Checking the cast resin bushings

- Inspect the cast resin bushings for damage. If damage to a cast resin bushing is found, please contact our service department.

Cleaning the cast resin bushings

- Remove surplus or dirty grease from the silicone part with a soft, clean, non-fraying cloth.
Only use intensive cleaner M.X.T. 60 forte as the cleaning agent.

- Clean the cast resin bushing with the cleaning agent and a soft, clean, non-fraying cloth. Only lightly moisten the cloth with intensive cleaner.

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

2.3.4.2 Assembling the busbar

The studbolts (8) have been fitted as described in section 2.3.1.3. The insertion depth of the studbolts and the centre to centre distances have been checked in accordance with table 2.3.2.1.

Note on installation of the insulating plugs:

If the pick-off for capacitive indication of the busbar voltage is to be installed on the panel concerned, use insulating plugs marked “MP” (see section 2.3.4.4). These insulating plugs contain the capacitive pick-off.

Assemble the busbars considering the assembly instruction delivered by the manufacturer. The assembly instruction is part of the busbar delivery.

2.3.4.3 Earthing the busbar

The busbar adapters are to be earthed at the earthing lugs and additionally by means of earthing clamps. Depending on the position and design of the bars, the corresponding clamps as shown in figure 2.3.4.3.1 are to be used. The earthing sets listed in table 2.3.4.3.1 contain the earthing material (clamps, earthing leads and materials for fastening to the clamps) for three phases. The adapters are supplied with earthing leads pre-assembled to the earthing lugs. The material for fastening the earthing leads to the enclosure is provided separately.

Fig.: 2.3.4.3.1: Earthing the busbar

Table 2.3.4.3.1: Earthing sets and clamps by type of use

<table>
<thead>
<tr>
<th>Description</th>
<th>Use in figure 2.3.4.3.1</th>
<th>Diameter, closed / mm</th>
<th>nkt part number for 3-phase set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthing set for all cross and end adapters</td>
<td>Earthing clamp A</td>
<td>77</td>
<td>26 587 05</td>
</tr>
<tr>
<td>Earthing set for busbars, 1250 A</td>
<td>Earthing clamp B</td>
<td>54</td>
<td>26 587 39</td>
</tr>
<tr>
<td>Earthing set for busbars, 1250 A</td>
<td>Earthing clamp B</td>
<td>74</td>
<td>26 587 63</td>
</tr>
</tbody>
</table>
Fit the clamps and connect the earthing leads to the clamps in accordance with the assembly instructions from busbar manufacturer nkt as supplied. Fasten the earthing leads for the earthing lugs and the earthing leads for earthing clamps A on the adapter to a common earthing point on the earthing plate (figures 2.3.4.3.2 and 2.3.4.3.3) using an M8 cheese-head screw, two dished washers 8 and an M8 hexagon nut. Connect the earthing leads from earthing clamps B in the same way, each to one earthing point on the earthing plate.

**Fig. 2.3.4.3.2: Earthing of the busbar, earthing plate**

**Fig. 2.3.4.3.3: Earthing of the busbar, connection of the leads**

- Single connection for the earthing leads of earthing clamps B
- Double connection for the earthing leads of earthing clamps A and the earthing lugs on the same adapter

Cheese head screw M8 x 25 GCE0303551P0100
Dished washer 8 GCE0407004P0100
Nut M8 GCE0352411P0100
Dished washer 8 GCE0407004P0100
2.3.4.4 Mounting of the capacitive indicator on the busbar

The following components are required for connection of the capacitive indicator to the busbar (fig. 2.3.4.4.1): Insulating plug with identification marking “MP”, tab terminal with male thread and lock nut, cap, covering cap for end or cross adapter, made-up cable and fastening materials.

The insulating plugs are usually installed in the course of fitting the busbars.

The length of the cable is relevant to the function of the indicator. The cable must therefore not be shortened or lengthened or otherwise modified.

The made-up cables are connected to the indicator unit at the works, and are rolled up at the rear of the low voltage compartment. The further components are packaged separately and supplied with the site material.

Fig. 2.3.4.4.1: Components for connection of the capacitive indicator to the busbar for one phase

1 Insulating plug with identification marking “MP”
2 Tab terminal with male thread and lock nut
3 Protection cap
4 Covering cap for end or cross adapter
5 Made-up cable
Remove the covering caps from the end or cross adapters of the relevant panel.

Check whether the insulating plugs are marked "MP". If this is not the case, the insulating plugs have to be exchanged.

Screw the tab terminals with male threads into the insulating plugs on the busbars of the relevant panel. Lock the thread with the flat nut supplied (see figure 2.3.4.4.2).

Lead the cable through the opening in the covering cap for the end or cross adapter (4 in figure 2.3.4.4.1) and through the hole in the protection cap (3). Connect the plug on the cable to the tab terminal in the insulating plug (figure 2.3.4.4.2). Press protection cap (3) onto the terminal and the covering cap onto the end or cross adapter. Connect the earthing conductor of the cable to one of the two connecting brackets on the reinforcement section of the enclosure (figure 2.3.4.4.3) using an M6 x 10 self-tapping screw, a contact washer and a dished washer. Connect the cables for the other two phases in the same way. Fasten the cables to the appropriate plates with cable ties and adhesive pads.

Check the function of the capacitive indicator, for instance in the course of high voltage testing.

---

Fig. 2.3.4.4.2: Tab terminal with male thread screwed into in insulating plug.

Fig. 2.3.4.4.3: Connection of the earthing cable to the enclosure.
2.3.4.5 Installation of the busbar current transformers

Table 2.3.4.5.1 shows the sections to be consulted in relation to the busbar current and the widths of the panels on which the current transformers are installed.

<table>
<thead>
<tr>
<th>Max. busbar current / A</th>
<th>Panel width, left</th>
<th>Panel width, right</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1250</td>
<td>600</td>
<td>450, 600, 600</td>
<td>2.3.4.5.1</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>600, 900, 1200</td>
<td>2.3.4.5.2</td>
</tr>
<tr>
<td></td>
<td>450</td>
<td>900, 1200</td>
<td>2.3.4.5.2</td>
</tr>
<tr>
<td></td>
<td>900</td>
<td>450, 600, 1200</td>
<td>2.3.4.5.3</td>
</tr>
<tr>
<td></td>
<td>1200</td>
<td>450, 600, 900, 1200</td>
<td>2.3.4.5.3</td>
</tr>
</tbody>
</table>

2.3.4.5.1 Installation of the busbar current transformers, variant 1

- Screw the base plates to the current transformers as shown in figure 2.3.4.5.1.1.

Fig. 2.3.4.5.1.1: Screwing the base plates to the current transformers
- Screw the mounting plates to the sections of the relevant panel modules as shown in figure 2.3.4.5.1.2.

Fig. 2.3.4.5.1.2: Screwing the mounting plates to the sections of the panel modules

- During installation of the busbars, guide the busbar through the aperture in the current transformer. Avoid damage to the conductive layer of the busbar.

- On completion of busbar installation, screw the base plates of the current transformers to the previously fitted mounting plates as shown in figure 2.3.4.5.1.3.

Fig. 2.3.4.5.1.3: Installing the current transformer
2.3.7 Fitting the cover plates

- Follow the same procedure to install the further transformers.

- If the transformer is fitted with a terminal board, wire this up as shown in the circuit diagram.

- Slide the reducer rings over the transformer leads. During assembly of the busbar cover or pressure relief duct, route the transformer leads through the opening in the relevant plate behind the low voltage compartment. The opening is sealed off by a cover (see figure 2.3.4.5.1.4).

Fig. 2.3.4.5.1.4: Installing the further current transformers
2.3.4.5.2 Installation of the busbar current transformers, variant 2

The illustrations in this section show two panels of 600 mm width. Installation is to take place accordingly for other panel widths in the right-hand position.

- Screw the base plates to the current transformers as shown in figure 2.3.4.5.2.1.

Fig. 2.3.4.5.2.1: Screwing the base plates to the current transformers
– Screw the mounting plates to the sections of the relevant panel modules as shown in figure 2.3.4.5.2.2. The distance (dimension a) of the mounting plates depends on the widths and the positions of the adjacent panels (see table 2.3.4.5.2.1).

![Diagram showing the mounting plates and screws](image)

**Fig. 2.3.4.5.2.2: Screwing the mounting plates to the sections of the panel modules**

**Table 2.3.4.5.2.1: Dimension a in figure 2.3.4.5.2.2 in relation to the width of the right-hand panel**

<table>
<thead>
<tr>
<th>Panel width, left</th>
<th>Panel width, right</th>
<th>Dimension a / mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>600</td>
<td>25</td>
</tr>
<tr>
<td>600</td>
<td>900</td>
<td>80</td>
</tr>
<tr>
<td>600</td>
<td>1200</td>
<td>231</td>
</tr>
</tbody>
</table>
– During installation of the busbars, guide the busbar through the aperture in the current transformer. Avoid damage to the conductive layer of the busbar.

– On completion of busbar installation, screw the base plates of the current transformers to the previously fitted mounting plates as shown in figure 2.3.4.5.2.3.

Fig. 2.3.4.5.2.3: Installing the current transformer
– Follow the same procedure to install the further transformers.

– If the transformers are fitted with a terminal board, wire these up as shown in the circuit diagram.

– Slide the reducer rings over the transformer leads. During assembly of the busbar cover or pressure relief duct, route the transformer leads through the opening in the relevant plate behind the low voltage compartment. The opening is sealed off by a cover (see figure 2.3.4.5.2.4).

Fig. 2.3.4.5.2.4: Installing the further current transformers
2.3.4.5.3 Installation of the busbar current transformers, variant 3

Figure 2.3.4.5.3.1 shows a 3D view of a completely installed current transformer set in a 1200 mm wide panel with a 600 mm wide panel positioned to the right. The figure also shows the positions of the current transformer sets on the panels which are important for their function, as plan views in relation to the relevant panel widths.

Fig. 2.3.4.5.3.1: Position of the current transformer set
– Screw the base plates to the current transformers as shown in figure 2.3.4.5.3.2.

The further illustrations in this section refer to the installation of current transformers on a panel with a width of 1200 mm, with an adjacent panel to the right with a width of 600 mm. Installation is to take place accordingly for other panel widths in accordance with table 2.3.4.5.1.
– If the relevant left-hand panel is 900 mm wide and the right-hand panel 600 mm wide, remove the strip from the support plate as shown in figure 2.3.4.5.3.2. In all other cases, the strip must remain on the support plate.

Fig. 2.3.4.5.3.2: Removing the strip from the support plate (only when the left-hand panel is 900 mm wide and the right-hand panel 600 mm wide)

– Screw the support plate to the sections of the relevant panel module at two points as shown in figure 2.3.4.5.3.3.

Fig. 2.3.4.5.3.3: Screwing the support plate to the sections of the panel module

Support plate 1VB8003794R0111

Strip

Cheese head screw M8 x 20 GCE0303049P0100
Dished washer 8 GCE0407004P0100
During installation of the busbars, guide the busbar through the aperture in the current transformer. Avoid damage to the conductive layer of the busbar.

On completion of busbar installation, screw the base plate of the current transformer to the previously fitted support plate as shown in figure 2.3.4.5.3.4.

Fig. 2.3.4.5.3.4: Installing the current transformer

Follow the same procedure to install the further transformers.

If the transformers are fitted with a terminal board, wire these up as shown in the circuit diagram.

Slide the reducer rings over the transformer leads. During assembly of the busbar cover or pressure relief duct, route the transformer leads through the opening in the relevant plate behind the low voltage compartment. The opening is sealed off by a cover (see figure 2.3.4.5.3.5).

Fig. 2.3.4.5.3.5: Installing the further current transformers
2.3.4.6 Installation of the busbar and current transformers between a sectionaliser and riser

The illustrations in this section refer to sectionaliser and riser panels with a width of 600 mm (1250 A). The current transformers are installed similarly in panels with a width of 900 mm (> 1250 A).

Assemble the busbars considering the assembly instruction delivered by the manufacturer. The assembly instruction is part of the busbar delivery.

- We recommend completely dismantling the main earthing bar in both the panels.
- Screw the fastening plates to the current transformers as shown in figure 2.3.4.6.2.

Fig. 2.3.4.6.1: Sectional view of sectionaliser panel, width 600 mm (1250 A), with current transformers between the sectionaliser and riser

![Sectional view of sectionaliser panel](image)

Fig. 2.3.4.6.2: Screwing the fastening plates to the current transformers

![Screwing the fastening plates](image)

Cheese head screw M8X16 GCE0303047P0100
Dished washer 8 GCE0407004P0100

Fastening plates
Busbar 1250 A: 1VB8003024P0101
Busbar 2500 A: 1VB8003024P0102
– Start installation with the rear bar.

– Fit the two bushings concerned with studbolts as described in section 2.3.1.3 (see figure 2.3.4.6.3).

– The specified dimensions for distance L between the bolts (see figure 2.3.4.6.3) can be found in tables 2.3.2.1 and 2.3.2.2. Observe the dimensions in figure 2.3.1.3.2.

**Fig. 2.3.4.6.3: View into the termination compartments from the front: Prepared bushings**

– Insert the bars through the current transformers outside the panels.

– In the further course of installation, observe the general notes on busbar installation in section 2.3.3.1 with regard to inspection and cleaning of soiled silicone parts, busbars and cast resin bushings and the use of assembly paste.

– Prepare the two end adapters with covering caps and insulating plugs as shown in figure 2.3.4.2.1.

– Fit the end adapters to the busbar (figure 2.3.4.6.4).

**Fig. 2.3.4.6.4: Prepared busbar with current transformer**
- Move the preassembled unit into the termination area, below the prepared bushings. Ensure that the external conductive layers of the busbar and adapter are not damaged.

- Lift the preassembled unit, plug the adapters onto the bushings and hang the current transformer’s fastening plate on the studbolts provided. The nuts on the studbolts hold the transformer in position. Fit the washers and nuts onto the studbolts in the bushings (see manufacturer’s instruction). The nuts hold the bar in position. Tighten the nuts for the bar and those for the current transformer’s fastening plate to the specified torque.

- Fit the insulating plugs and the covering caps due to the manufacturer’s instruction. Fix the earthing lead to the busbars as described in the manufacturer’s instruction. Fix the other end of the earthing lead to a suitable point on the enclosure.

Fig. 2.3.4.6.5: Busbar fitted to the rear bushings

Fig. 2.3.4.6.6: Current transformer fastenings below the enclosure
– Install the further busbars in the manner described above.

– Refit the main earthing bar and the connections between the main earthing bar and the adjacent panels.

Fig. 2.3.4.7.7: Completely assembled arrangement
2.3.4.7 Installation of the busbar voltage transformers

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 busbar measurement (type 3). We recommend having installation performed by two fitters. Observe the relevant accident prevention regulations in the country of installation.

The busbar voltage transformers are to be installed after installation of the busbars and before the busbar covers are fitted.

Perform high voltage testing of the busbars before installing the voltage transformers.

Before installing the voltage transformers, remove the insulating plugs from the relevant end or cross adapters.

Two types of voltage transformer are used:

- Type 1: For rated voltages up to 24 kV
- Type 2: For rated voltages greater than 24 kV and up to 36 kV

The two types are installed in different ways, which are described separately in the following two sections

2.3.4.7.1 Installation of the busbar voltage transformers, type 1

Bolt the four individual parts of the voltage transformer frame together (figure 2.3.4.7.1.1). Remove the cable covers for the front wall of the busbar cover and store the two parts for later use.

Fig. 2.3.4.7.1.1: Screwing the individual parts of the voltage transformer frame

4 x Cheese head screw, M 8 x 25
8 x dished washer, 8
4 x Nut, M 8

8 x Cheese head screw, M 8 x 25
16 x dished washer, 8
8 x Nut, M 8

2 x cable cover for the front wall of the busbar cover or the pressure relief duct (see separately provided assembling drawings)
Position of the frame on the roof plate of the panel

Use the bores in the feet of the frame to fasten it as shown in figure 2.3.4.7.1.2, Position A when the panel with the voltage transformers is a left-hand end panel or a right-hand section-aliser or riser panel. In all other cases use Position B.

Bolt the frame to the roof plate of the panel module as shown in figure 2.3.4.7.1.2.

Check the transformer for damage prior to installation.

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

- The surface of the cone must be free of
  - gas bubbles,
  - scoring,
  - damage,
  - abrasions,
  - foreign bodies.

Cleaning of soiled cone surfaces

Clean the cone of the transformer immediately prior to installation as follows:

- Remove surplus or dirty grease from the cone surface with a soft, clean, non-fraying cloth.
- Only use intensive cleaner M.X.T. 60 forte as the cleaning agent.
- Clean the surface of the cone with the cleaning agent and a soft, clean, non-fraying cloth.
- After cleaning with intensive cleaner M.X.T. 60 forte, wipe the surface of the cone with a dry cloth.

Cleaning the busbar adapters

- Only use intensive cleaner M.X.T. 60 forte as the cleaning agent.
- Clean the silicone surface with the cleaning agent and a soft, clean, non-fraying cloth.
- Only moisten the cloth slightly with intensive cleaner. Apply only moderate pressure when cleaning the silicone surfaces.
- After cleaning with intensive cleaner M.X.T. 60 forte, wipe the silicone surface with a dry cloth.
Greasing the cones

- Grease the cone of the transformer and the cone of the adapter lightly, evenly and completely with assembly paste (part number 1VB0000207P0101).

Installing the voltage transformers

Use the eyebolts supplied for lifting of the voltage transformer. Screw the eyebolts into the threads in the cast resin body of the voltage transformer and lift it using a suitable hoist.

On installation of the frame as shown in figure 2.3.4.7.1.2, Position B, the secondary terminals of the transformer are located on the left (as in figure 2.3.4.7.1.3). When the frame is installed as shown in figure 2.3.4.7.1.2, Position A, the secondary terminals of the transformer are located on the right.

Fig. 2.3.4.7.1.3: Mounting a voltage transformer

Position the voltage transformer above the corresponding busbar adapter. Lower the voltage transformer slowly and evenly, guiding the silicone insulating part of the transformer into the cone of the busbar adapter.

Bolt the base plate of the voltage transformer to the frame as shown in figure 2.3.4.7.1.3.
Install the voltage transformers for the other two phases in the same manner. Observe the position of the transformers in figure 2.3.4.7.1.4.

When the front wall of the busbar covers or the front wall of the pressure relief duct have been fitted (see next section), guide the cable harnesses with the instrument transformer secondary wiring and plugs from the low voltage compartment through the opening provided in the front plate of the busbar cover or in the front plate of the pressure relief duct, and close off the opening with the cable cover from figure 2.3.4.7.1.1.

Connect the plugs on the instrument transformer secondary wiring with the connectors on the transformers as shown in the circuit diagram.

Fig. 2.3.4.7.1.4: Three-phase voltage transformer set installed
(Example with secondary terminals on the left)
2.3.4.7.2 Installation of the busbar voltage transformers, type 2

Bolt the four individual parts of the voltage transformer frame together (figure 2.3.4.7.2.1). Remove the cable covers for the front wall of the busbar cover and store the two parts for later use.

Fig. 2.3.4.7.2.1: Screwing the individual parts of the voltage transformer frame

8 x Cheese head screw, M 8 x 25
16 x dished washer, 8
8 x Nut, M 8

2 x cable cover for the front wall of the busbar cover or the pressure relief duct (see separately provided assembling drawings)
Bolt the frame to the roof plate of the panel module as shown in figure 2.3.4.7.2.2.

Check the transformer for damage prior to installation.

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

- The surface of the cone must be free of
  - gas bubbles,
  - scoring,
  - damage,
  - abrasions,
  - foreign bodies.

Cleaning of soiled cone surfaces

Clean the cone of the transformer immediately prior to installation as follows:

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

Cleaning the busbar adapters

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

- Clean the surface of the cone with the cleaning agent and a soft, clean, non-fraying cloth.
- After cleaning with intensive cleaner M.X.T. 60 forte, wipe the surface of the cone with a dry cloth.

Cleaning the busbar adapters

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

- Clean the silicone surface with the cleaning agent and a soft, clean, non-fraying cloth.
- Only moisten the cloth slightly with intensive cleaner. Apply only moderate pressure when cleaning the silicone surfaces.
- After cleaning with intensive cleaner M.X.T. 60 forte, wipe the silicone surface with a dry cloth.
Greasing the cones

- Grease the cone of the transformer and the cone of the adapter lightly, evenly and completely with assembly paste (part number 1VB0000207P0101).

Installing the voltage transformers

Use the eyebolts supplied for lifting of the voltage transformer. Screw the eyebolts into the threads in the cast resin body of the voltage transformer and lift it using a suitable hoist.

Position the voltage transformer above the corresponding busbar adapter. Lower the voltage transformer slowly and evenly, guiding the silicone insulating part of the transformer into the cone of the busbar adapter.

Bolt the base plate of the voltage transformer to the frame as shown in figure 2.3.4.7.2.3.
Install the voltage transformers for the other two phases in the same manner. Observe the position of the transformers in figure 2.3.4.7.2.4.

When the busbar covers have been fitted (see next section), guide the cable harnesses with the instrument transformer secondary wiring and plugs from the low voltage compartment through the opening provided in the front plate of the busbar cover, and close off the opening with the cable cover from figure 2.3.4.7.2.1.

Connect the plugs on the instrument transformer secondary wiring with the connectors on the transformers as shown in the circuit diagram.

Fig. 2.3.4.7.2.4: Three-phase voltage transformer set installed
2.3.4.8 Installation of busbar current sensors

Observe the correction factors on the name plate of the sensors before mounting. These are required for the programming of the protection device.

– Carefully slide the earthing cuff, the current sensor and the earthing clamp over the busbar. Align the components according to Fig. 2.3.4.8.1. Attach the earthing clamp to the earthing cuff. Attach the current sensor on the earthing cuff centrally to the busbar using the fastener strap.

– Attach the earthing leads to grounding points (e.g., welding studbolts) of the encapsulation.

– After the assembly of all sensors has been completed, route the sensor cables to the low voltage compartment.

In case of busbars below a coupling and riser panel, route the sensor cable to the low voltage compartment within the right-hand panel.

– Insert the connectors of the sensor cables according to the circuit diagram into the sockets of the device provided for this purpose.

![Fig. 2.3.4.8.1: Busbar current sensor](image)

1 Earthing cuff (diameter 52 mm or 72 mm, depending on busbar)
2 Current sensor
3 Fastener strap at the current sensor
4 Earthing set (earthing clamp and fastening material) (diameter 54 mm or 74 mm, depending on busbar)
5 Earthing leads
6 Connector RJ54 at the sensor cable
2.3.4.9 Installation of busbar voltage sensors

Observe the correction factors on the name plate of the sensors before mounting. These are required for the programming of the protection device.

The busbar voltage sensors are to be installed after installation of the busbars and before the busbar covers are fitted.

Frames are used for voltage sensors on the busbar. Note that, in the case of a busbar for 1250A, the height of the console is 241 mm and in the case of a busbar for 2500 A the height of the console is 267 mm.

- Before installing the voltage transformers, remove the insulating plugs from the relevant end or cross adapters.
- Bolt the four individual parts of the voltage sensor frame together (figure 2.3.4.7.1.1). Remove the cable covers for the front wall of the busbar cover and store the two parts for later use.

Position of the frame on the roof plate of the panel

Use the bores in the feet of the frame to fasten it as shown in figure 2.3.4.7.1.2, Position A when the panel with the voltage transformers is a left-hand end panel or a right-hand sectionalis or riser panel. In all other cases use Position B.

Bolt the frame to the roof plate of the panel module as shown in figure 2.3.4.7.1.2.

Check the transformer for damage prior to installation.

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

- The surface of the cone must be free of
  - gas bubbles,
  - scoring,
  - damage,
  - abrasions,
  - foreign bodies.

Cleaning of soiled cone surfaces

Clean the cone of the transformer immediately prior to installation as follows:

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

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

- Clean the surface of the cone with the cleaning agent and a soft, clean, non-fraying cloth.

- After cleaning with intensive cleaner M.X.T. 60 forte, wipe the surface of the cone with a dry cloth.

Cleaning the busbar adapters

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

- Clean the silicone surface with the cleaning agent and a soft, clean, non-fraying cloth.

- Only moisten the cloth slightly with intensive cleaner. Apply only moderate pressure when cleaning the silicone surfaces.

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

Greasing the cones

- Grease the cone of the transformer and the cone of the adapter lightly, evenly and completely with assembly paste (part number 1VB0000207P0101).
Mounting the sensors (Fig. 2.3.4.9.1 to 2.3.4.9.3)

- Insert the cone of the voltage sensor together with a clean cable tie into the cone of the adapter. The cable tie serves to vent the area below the voltage transformer cone.

- Turn the internal thread of the voltage sensor on the threaded stud of the adapter and tighten the voltage sensor manually.

- Pull out the cable tie and turn the voltage sensor approximately 1.5 turns counter-clockwise.

- Tighten the voltage sensor to 30 Nm.

- Mount the pressure plate (Fig. 2.3.4.7.2).

- Mount the other sensors in the same way.

- Connect the earthing leads of the sensors to the earthing points of the console (Fig. 2.3.4.7.3).

- After installing the front wall of the busbar cover or the pressure relief channel (see separately supplied mounting drawings), pass the cable of the sensor cables, which are provided with plugs, through the openings provided in the low voltage compartment. Close the opening in the front wall of the busbar cover or the pressure relief duct with the cable cover in Fig. 2.3.4.7.1.1.

- Insert the connectors of the sensor cables according to the circuit diagram into the sockets of the device provided for this purpose.

Fig. 2.3.4.7.9.1: Mounting the voltage sensor
Fig. 2.3.4.7.9.2: Mounting the pressure plate

Pressure plate

4 x Cheese head screw M8 x 25
4 x Dished washer 8

Fig. 2.3.4.7.9.3: Fully assembled voltage sensor set

Earthing points
2.3.5 Installation of voltage transformers in the cable compartment

As a rule, voltage transformers in the cable compartment (Fig. 2.3.5.1) are supplied fitted and ready for operation. In individual cases, voltage transformers may also be supplied loose. Please contact ABB for installation information. If the transformers are fitted with a terminal board, wire the transformers after installation according to chapter 2.3.5.1.

Fig. 2.3.5.1: Voltage transformers in the cable compartment
2.3.5.1 Wiring of the voltage transformers

The voltage transformers are fitted with terminal boards. The possible configurations of terminal boards can be found in figure 2.3.5.1.1 and table 2.3.5.1.1.

Fig. 2.3.5.1.1: Possible terminal board configurations

<table>
<thead>
<tr>
<th>Windings</th>
<th>Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>open delta winding</td>
<td>N</td>
</tr>
<tr>
<td>N</td>
<td>a</td>
</tr>
<tr>
<td>N</td>
<td>a1</td>
</tr>
<tr>
<td>N</td>
<td>a1</td>
</tr>
<tr>
<td>N</td>
<td>1a</td>
</tr>
<tr>
<td>N</td>
<td>1a1</td>
</tr>
</tbody>
</table>

Table 2.3.5.1.1: Possible terminal board configurations

In a voltage transformer version with 2 windings plus tap or 2 windings plus open delta 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 2.3.5.1.2 illustrates this using the example of a voltage transformer with one secondary winding.

Fig. 2.3.5.1.2: 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 open delta windings

If the open delta 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 2.3.5.1.3) or

– on the terminal block of a voltage transformer (figure 2.3.5.1.4).

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

Fig. 2.3.5.1.3: Earthing of the circuit in the low voltage compartment

Do not earth here!

Without earthing screw on terminal "dn"

Earthing here!

With earthing screw on terminal "dn"

Fig. 2.3.5.1.4: Earthing the circuit on the terminal board of a transformer
Remove the earthing screws of the open delta windings from the terminal boards of the voltage transformers in accordance with the circuit diagrams (figure 2.3.5.1.5) or earth the open delta windings using the earthing screw (figure 2.3.5.1.6).

Earth the circuit at one point only.

Fig. 2.3.5.1.5: View of the terminal board of a voltage transformer with open delta winding: Earthing screw (arrow) in isolated position (no earthing)

Fig. 2.3.5.1.6: View of the terminal board of a voltage transformer with open delta winding: Earthing screw (arrow) in earthing position (dn terminal earthed)
### Checking the wiring

Finally, check the earthing system of the voltage transformer wiring in accordance with table 2.3.5.1.2.

**Table 2.3.5.1.2: Earthing of terminals on the voltage transformer terminal board**

<table>
<thead>
<tr>
<th>Windings</th>
<th>Number</th>
<th>Tap</th>
<th>Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td></td>
<td>N a n da dn</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td>N a n da dn</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td>N a1 a2 n da dn</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>N 1a 1n 2a 2n da dn</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>1a 1n 2a 2n da dn</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>1a1 1a2 1n 2a1 2a2 2n da dn</td>
</tr>
</tbody>
</table>

- **N** The terminal must be earthed via the earthing screw!
- **n** Earthing of the terminal in accordance with the circuit diagram!
- **dn** Earthing screw fitted in accordance with the circuit diagram and figure 2.3.5.1.3 or 2.3.5.1.4!

When 2 windings plus a tap or 2 windings plus open delta winding, are used, "N" is implemented by the works at the base plate of the voltage transformer.
Damping resistors, if required, are usually installed on site above the low-voltage cabinet (fig. 2.3.6.1).

Wiring of the damping resistors

The damping resistors have several taps. The clamps of the taps are marked with resistance values in ohms (Fig. 2.3.6.2). Take the required resistance from the circuit diagram and connect the damping resistor according to the wiring diagram.

Attach the damping resistor according to the supplied assembly drawings.
2.3.7 Fitting the cover plates

Fit the rear cover plate (for free-standing installation), the busbar cover and the end covers as shown in the installation drawings supplied with the switchgear.

2.2 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).

2.3 Connection of cables and wiring

2.3.1 Control cables and wiring

Carry out the laying and connection of external control cables and the earthing of the cable screens of external control cables in accordance with the accepted EMC rules (EMC = electromagnetic compatibility).

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

- The cable entry for external control cables and wiring is located in the roof plate of the low voltage compartment or in the floor plate of the cable termination compartment.

Cable entry in the roof plate of the low voltage compartment

- Route the external control cables and wiring through the roof plate using reducer rings and connect them as shown in the circuit diagram.

Cable entry in the floor plate of the cable termination compartment

- Dismantle the left-hand secondary cable duct in the cable termination compartment. Using reducer rings, route the external control cables and wiring through the opening between the cable termination compartment and the operating mechanism bay, and through the opening between the operating mechanism bay and the low voltage compartment, and connect them as shown in the circuit diagram.

2.3.2 High voltage cables

The high voltage cables are installed after completion of the high voltage test on the busbar.

- Dismantle the cable mounting rails and floor plates in 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 onto the cables.

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

Checking the outer cones

Check the outer cones for damage. If there is damage to the outer cones, please contact our service department.

Cleaning the outer cones

Remove any surplus or dirty grease or soiling from the outer cones 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 outer cones in accordance with the manufacturer’s instructions.

Observe the tightening torques for screw connections given in the cable connector manufacturer’s instructions.
2.6 Concluding installation work

- Use a diagonal cutter to break out the required cable openings in the floor plates. Refit the floor plates. Press the cable bushings into the openings in the floor plates.

   Fit the cable mounting rails and fasten the high voltage cables to the cable mounting rails using the cable clamps.

- 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.

- Refit the covers on the panels.

- 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 outsides of the panels 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 SF₆ 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 mechanism 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 outer cones have been closed off and insulated.
- High voltage testing has been successfully completed.
- The high voltage cables have been installed (after high voltage testing of the busbar).
- 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 door.
  - 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 SF₆ (an example can be found in instruction manual HB 605) 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.

- Switch all circuit-breakers off.

- Switch all three position disconnectors off.

- Switch all three position switch-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.

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

Connecting the outgoing feeder panels (loads) when these are circuit-breaker panels

- Switch the three position disconnector in the outgoing feeder panel to the “Disconnector ON” position.

- Switch the circuit-breaker in the outgoing feeder panel “ON”.

- The loads are then switched on.

Connecting the outgoing feeder panels (loads) when these are switch-disconnector panels with fuses

- Switch the three position switch-disconnector in the outgoing feeder panel to the “Switch-disconnector ON” position.

- The loads are then switched on.

Switch the further loads on as described.

The switchgear is in operation.
General notes

- 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.

Optional interlocking of the cable termination compartment cover

The cover on the cable termination compartment can only be removed when the outgoing feeder of the relevant panel is earthed (earthing switch and circuit-breaker ON).

In the case of a panel with 1200 mm width, remove the left-hand cover first. Deblock the right-hand cover by pressing slide 1 in figure 4.1 to the left. Press slide 2 upwards to lock slide 1 in position (figure 4.2). Remove the right-hand cover. Press slide 2 downwards to activate the interlock.

Fig. 4.1: Deblocking of the right-hand cover on a panel of 1200 mm width

Fig. 4.2: Limit position of the slides with deblocked right-hand cover on a panel of 1200 mm width
4.1 Panels with circuit-breakers and three position disconnectors

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 (Fig. 4.1.1 and Fig. 4.1.2). Fig. 4.1.3 to Fig. 4.1.8 show the switching sequence for earthing of a busbar section using the sectionaliser and riser, on the basis of an example switchgear installation.

In order to avoid maloperation, the operating mechanisms are mechanically or electrically interlocked, and as an option also electrically interlocked between different panels.

- The three position disconnector (disconnector and earthing switch function) can only be operated when the circuit-breaker is open. The earthing switch can only be operated when the disconnector is open. The disconnector can only be operated when the earthing switch is open.

See the order documents for the conditions of optional panel to panel interlocks.

4.1.1 Notes on earthing of a feeder panel or system section

When feeder panels or section of the system has been earthed by operating the earthing switch and circuit-breaker (figures 4.1.1, and 4.1.3 to 4.1.8), secure it to prevent cancellation of earthing as follows:

Switch the mcbs 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.

---

**Fig. 4.1.1: Earthing a feeder and cancelling the earthing**

- Earth feeder
- Feeder disconnected
- Feeder earthed
- Earthing prepared
- Cancel feeder earthing

**Fig. 4.1.2: Connecting and disconnecting a feeder panel**

- Connect feeder
- Feeder disconnected
- Feeder connected
- Connection prepared
- Disconnect feeder
Fig. 4.1.3: Example switchgear, consisting of two busbar sections, in operation

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

Fig. 4.1.5: Opening the disconnectors and switch-disconnectors in the feeder panels in the area of the busbar section to be earthed
Fig. 4.1.6: Closing the disconnector in the sectionaliser

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

Fig. 4.1.8: Closing the circuit-breaker in the sectionaliser, left hand busbar earthed
4.1.2 Operation of the circuit-breaker

Depending on the version of the switchgear system, the circuit-breaker can be operated remotely (from the control room) or locally. At the panel, the circuit-breaker operating mechanism can be operated manually, or electrically if electrical controls (e.g. the human-machine interface of a control device) are fitted.

**Note on “securing to prevent cancellation of earthing” interlock**

The interlock has two different bores for U-locks. Use only U-locks with a shackle diameter of 10 mm for bores “A” in figure 4.1.2.1, and only U-locks with a shackle diameter of 5 mm for bores “B”.

Fig. 4.1.2.1: "Securing to prevent cancellation of earthing" interlock in the deblocked condition
4.1.2.1 Manual operation of the circuit-breaker

- Mechanical switch position indication is effected by graphical symbols (3 in Fig. 4.1.2.1.1) in the cover of the operator control area.

- Cancel any blocking of the relevant pushbutton by removing the padlock or by releasing a lock switch with a key.

- In order to change the switching condition of the circuit-breaker, press the mechanical OFF button (1) or the mechanical ON button (2).

Fig. 4.1.2.1.1: Indicators and controls for the circuit-breaker and three position switch operating mechanisms

1) Alternatively the mimic diagram and the position of the earthing switch indicator deviates from the illustration. This takes no effect to the operation and the function of the mechanisms.
4.1.2.2 Emergency manual operation of the circuit-breaker

On failure of the supply voltage, the circuit-breaker can be opened at any time by pressing the mechanical OFF button. 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 (10 in Fig. 4.1.2.2.1).

On failure of the supply voltage or the stored-energy spring charging motor for the circuit-breaker operating mechanism, the charging process can be performed or completed manually.

The receptacle for the charging lever for the stored-energy spring in panels of widths 600, 900 and 1200 mm is covered by a rotating flap (figure 4.1.2.5.2), and in panels of 450 mm width by a slide.

**Manual charging of the stored-energy spring**

Depending on the version, swing the flap to the side or move the slide upwards. Fit the charging lever (11) into the receptacle (12) and pump for approx. 25 strokes until the charged condition (10) 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. Contact the ABB Service Department if necessary.

---

Fig. 4.1.2.2.1: Manual charging of the stored-energy spring

10 Condition indicator for the stored energy spring
11 Charging lever
12 Receptacle for charging lever
4.1.3 Operation of the three position disconnector

Depending on the version of the switchgear system, the three position disconnector can be operated remotely (from the control room) or locally. At the panel, the three position disconnector operating mechanism can be operated manually, or electrically if a motor and electrical controls (e.g. the human-machine interface of a control device) are fitted.

4.1.3.1 Operation of the three position disconnector (manual mechanism)

Turning the selector lever (4) moves a sliding cover to release the opening (5 or 7) for the operating lever of the disconnector or earthing switch. The operating lever for the earthing switch (figure 4.1.3.1.1) has a hexagon socket and is marked red, and the operating lever for the disconnector (figure 4.1.3.1.2) has a splined socket and is marked black.

The selector lever can only be turned when the circuit-breaker is switched off. Turning the selector lever in the direction for earthing switch operation is only possible when the disconnector is switched off, and turning in the direction for disconnector operation is only possible when the earthing switch is switched off.

- The selector lever can be blocked by a padlock. To fit the padlock, press the selector lever towards the cover.

- Mechanical switch position indication is effected by graphical symbols (6 and 8) in the low voltage compartment door.

- Always perform all switching operations up to the stop.

If the stop is not reached by the manual switching motion, it is possible to remove the operating lever but the selector lever is not returned to its vertical initial position and the relevant opening (5 or 7) is not closed off. The circuit-breaker is blocked.

- When the operating lever is turned, increased force can be felt after approx. 30°, and this has to be overcome to reach the limit position (stop).

![Fig. 4.1.3.1.1: Operating lever with hexagon and red handle for operation of the earthing switch](image1.png)

![Fig. 4.1.3.1.2: Operating lever with splines and black handle for operation of the disconnector](image2.png)
**Operation of the disconnector**

- Turn the selector lever (4 in Fig. 4.1.2.1.3) counterclockwise and hold it fast.
- Insert the operating lever through the released opening (5) onto the splined shaft.

**Disconnector OFF ⇔ ON**

- Turn the operating lever clockwise until the stop is reached (< 90°).
- Withdraw the operating lever.
- Turn the selector lever into the vertical position without using force.

**Disconnector ON ⇔ OFF**

- Turn the operating lever counter-clockwise until the stop is reached (< 90°).
- Withdraw the operating lever.
- Turn the selector lever into the vertical position without using force.

---

**Operation of the earthing switch**

- Turn the selector lever (4 in Fig. 4.1.3.1.3) clockwise and hold it fast.
- Insert the operating lever through the released opening (7) onto the hexagon.

**Earthing switch OFF ⇔ ON**

- Turn the operating lever clockwise until the stop is reached (< 70°).
- Withdraw the operating lever.
- Turn the selector lever into the vertical position without using force.

**Earthing switch ON ⇔ OFF**

- Turn the operating lever counter-clockwise until the stop is reached (< 70°).
- Withdraw the operating lever.
- Turn the selector lever into the vertical position without using force.

---

1) Alternatively the mimic diagram and the position of the earthing switch indicator deviates from the illustration. This takes no effect to the operation and the function of the mechanisms.
4.1.3.2 Operation of the three position disconnector (motor operated mechanism)

The motor-operated three position disconnector operating mechanism is in principle identical to the manual mechanism, but additionally has a drive motor. The three position disconnector can thus be operated by the motor, or also manually as an alternative.

The three position disconnector is mechanically blocked when the circuit-breaker is closed. Operation of the earthing switch is only possible when the disconnector is open, and vice versa.

Motor operation

Motor operation of the three position disconnector is possible when electrical controls (e.g. the operator controls of a control unit) are fitted on the panel. Operate the corresponding controls to switch the three position disconnector on and off. The switch position is indicated on the display of the control unit and mechanically on the operating mechanisms.

Manual operation

Operation of the disconnector

- Turn the selector lever (4 in Fig. 4.1.3.1.3) counterclockwise and hold it fast.
- Insert the operating lever through the released opening (5) onto the splined shaft.

Disconnector OFF ⇒ ON

- Turn the operating lever slowly in the clockwise direction, applying force, through approx. 20° and then in the counter-clockwise direction through approx. 20° to disengage the motor from the mechanism.
- Turn the operating lever clockwise until the stop is reached (< 90°).
- Withdraw the operating lever.
- Turn the selector lever into the vertical position without using force.

Disconnector ON ⇒ OFF

- Turn the operating lever slowly in the counter-clockwise direction, applying force, through approx. 20° and then in the clockwise direction through approx. 20° to disengage the motor from the mechanism.
- Turn the operating lever counter-clockwise until the stop is reached (< 70°).
- Withdraw the operating lever.
- Turn the selector lever into the vertical position without using force.

Operation of the earthing switch

- Turn the selector lever (4 in Fig. 4.1.2.1.3) clockwise and hold it fast.
- Insert the operating lever through the released opening (7) onto the hexagon.

Earthing switch OFF ⇒ ON

- Turn the operating lever slowly in the clockwise direction, applying force, through approx. 20° and then in the counter-clockwise direction through approx. 20° to disengage the motor from the mechanism.
- Turn the operating lever clockwise until the stop is reached (< 70°).
- Withdraw the operating lever.
- Turn the selector lever into the vertical position without using force.

Earthing switch ON ⇒ OFF

- Turn the operating lever slowly in the counter-clockwise direction, applying force, through approx. 20° and then in the clockwise direction through approx. 20° to disengage the motor from the mechanism.
- Turn the operating lever counter-clockwise until the stop is reached (< 70°).
- Withdraw the operating lever.
- Turn the selector lever into the vertical position without using force.
4.1.3.3 Emergency operation of the three position disconnector (motor operated mechanism)

If the mechanism motor becomes defective or the auxiliary power fails when the three position disconnector is in an intermediate position, manual operation is only possible by performing work on the operating mechanism. This work may only be performed by qualified personnel. In such a case, please inform our service department.

If the three position disconnector is not in an intermediate position on failure of the auxiliary voltage, the operating mechanism can still be operated as described in 4.1.3.1 even without the auxiliary power. When blocking magnets are used for the selector lever, the mechanism can only be deblocked by qualified personnel. In such a case, please contact the ABB Service Department.
4.2 Panels with three position switch-disconnectors and HRC fuses

- The three switching positions of the three position switch-disconnector, “connecting”, “disconnecting” and “earth- ing” are clearly defined by the mechanical structure of the switch.

- Blowing of a fuse results in automatic tripping of the switch-disconnector.

- The current switch position is indicated mechanically by graphical symbols (7) in the cover of the operator control area (figure 4.2.1).

- The switch disconnector is always manually operated.

- Both earthing switches (upstream and downstream from the fuses) are operated in parallel.

- The operating mechanism can be secured with a padlock on the selector slide (6).

Consult the order documents for the conditions of any interlock.

4.2.1 Notes on earthing of an outgoing feeder or system section

When the outgoing feeder or section of the system has been earthed, secure it to prevent cancellation of earthing as follows:

Secure the selector slide with a padlock.

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

---

Fig. 4.2.1: Three position switch-disconnector operating mechanism

---

1 Mechanical OFF button for the switch-disconnector
2 Mechanical ON button for the switch-disconnector
3 Charging shaft for the switch-disconnector’s stored-energy spring
4 Condition indicator for the stored energy spring
5 Slide to release the charging shaft
6 Selector slide
7 Switch position indicator
8 “fuse blown” indicator
9 Shaft for earthing switch operation
4.2.2 Operation of the three position switch-disconnector with fuses

Operation of the switch is performed with the aid of an operating lever. Three different operating levers can be supplied:

- Operating lever for the charging shaft of the stored-energy spring and for the actuating shaft of the earthing switches (figure 4.2.2.1)

- Coded operating lever with black marking on the shaft for charging of the stored-energy spring (figure 4.2.2.2)

- Coded operating lever with red marking on the shaft for operation of the earthing switch (figure 4.2.2.3)

Fig. 4.2.2.1: Operating lever without coding

Fig. 4.2.2.2: Receptacle for the coded operating lever for operation of the stored energy spring charging shaft

Fig. 4.2.2.3: Receptacle for the coded operating lever for operation of the earthing switch (colour marking on the face of the shaft)
Operation of the earthing switch

- Remove any padlock fitted from the selector slide.
- Press the selector slide upwards and fit the operating lever onto the shaft for earthing switch operation (figure. 4.2.2.4 and 4.2.2.5).

Earthing switch OFF ⇔ ON

- Turn the operating lever approx. 180° clockwise.
- Withdraw the operating lever.

Earthing switch ON ⇔ OFF

- Turn the operating lever approx. 180° counter-clockwise.
- Withdraw the operating lever.

Fig. 4.2.2.4: Fitting the operating lever onto the shaft for earthing switch operation

Fig. 4.2.2.5: Operation of the earthing switch
**Operation of the switch disconnector**

- Remove any padlock fitted from the selector slide.

- Closing the switch-disconnector requires the stored-energy spring to be charged. Check the condition of the stored-energy spring at the charging condition indicator (figure 4.2.2.6).

  The closing switch disconnector procedure starts with charging the stored-energy spring.

- Opening of the switch-disconnector is possible without charging the stored-energy spring.

**Charging the stored-energy spring**

Only charge the stored-energy spring when the switch-disconnector is to be closed.

- Press the slide to release the charging shaft upwards and fit the operating lever onto the charging shaft (figure 4.2.2.7).

- Charge the stored-energy spring by turning the operating lever clockwise through approx. 90° until the stop is reached.

- Remove the operating lever.

**Switch-disconnector OFF ⇔ ON**

- Press the mechanical ON button.

**Switch-disconnector ON ⇔ OFF**

- Press the mechanical OFF button.

---

Fig. 4.2.2.6: Condition indicator for the stored energy spring

- Indication of spring charged

- Indication of spring discharged

Fig. 4.2.2.7: Fitting the operating lever onto the charging shaft
4.2.3 Replacement of HRC fuses

Blowing of a fuse is indicated mechanically (Fig. 4.2.3.1).

Blowing of a fuse results in automatic tripping of the switch-disconnector. The switch position indicator shows the OFF position of the switch-disconnector.

Conditions for replacement of a fuse:

- Earth the outgoing feeder of the relevant panel as described in section 4.1.
- Comply with the safety regulations to EN 50110.
- Secure the working area as described in section 4 and EN 50110 standard.

Always replace all three fuses in a panel, even if only one or two fuses have blown.

Use fuses from ABB or from Siba in accordance with tables 4.2.3.1 and 4.2.3.2. The fuse boxes are designed for a maximum fuse length of 442 mm and a maximum fuse diameter of 67 mm. Use adapters for smaller dimensions (see list of accessories).

Fig. 4.2.3.1: Fuse blown indication

Fuse blown:
Red indicator in the sight window

Fig. 4.2.3.2: Length adapter (1) and adapter for fuse diameter 53 mm (2)
Replacing fuses

- Remove the cover from the operating mechanism bay by releasing the plastic catches at the corners of the cover.

- Release the twist lock fastener (Fig. 4.2.3.3) and push the slide in front of the flap upwards. The fuse flap then automatically swings out (Fig. 4.2.3.4).

- Draw the lid with the fuse to be replaced out of the box (Fig. 4.2.3.5). Turning and gently shaking the lid makes it easier to withdraw it.

- Remove the lid with the fitted fuse.

- Loosen the clamping band and remove the fuse from the lid.

Fig. 4.2.3.3: Opening the fuse flap - 1

Fig. 4.2.3.5: Removing the lid with the fuse

Fig. 4.2.3.4: Opening the fuse flap - 2
– Clean the sealing collar (Fig. 4.2.3.6) on the lid with M.X.T. 60 forte intensive cleaner.

– Insert the new HRC fuse into the lid with the striker pin pointing towards the lid.

– Tighten the clamping band (Fig. 4.2.3.7). Ensure when doing so that the contact fingers of the ring contact are not deformed.

– Slide the fuse into the fuse box up to the stop.

– Replace the other fuses in the same manner.

– Swing the fuse flap upwards and fasten it with the twist lock fastener.

– Fit the cover on the operator control area and lock it in place with the plastic catches.

Fig. 4.2.3.6: Lid with fuse fitted

Fig. 4.2.3.7: Tightening the clamping band

1  Lid
2  Fuse
3  Ring contact
4  Clamping band screw
5  Sealing collar
Table 4.2.3.1: Selection table for HV HRC fuses, manufacturer ABB

<table>
<thead>
<tr>
<th>Operating voltage</th>
<th>Transformer capacity</th>
<th>Short-circuit voltage $u_k$</th>
<th>Rated transformer current</th>
<th>Type</th>
<th>Rated current of HRC fuse</th>
</tr>
</thead>
<tbody>
<tr>
<td>[kV]</td>
<td>[kVA]</td>
<td>[%]</td>
<td>[A]</td>
<td>min. [A]</td>
<td>max. [A]</td>
</tr>
<tr>
<td>6 ... 7.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>4.8</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>75</td>
<td>4</td>
<td>7.2</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>9.6</td>
<td>CEF-TCU</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>125</td>
<td>4</td>
<td>12.0</td>
<td>CEF-TCU</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>15.4</td>
<td>CEF-TCU</td>
<td>25</td>
<td>31.5</td>
</tr>
<tr>
<td>200</td>
<td>4</td>
<td>19.2</td>
<td>CEF-TCU</td>
<td>31.5</td>
<td>40</td>
</tr>
<tr>
<td>250</td>
<td>4</td>
<td>24.1</td>
<td>CEF-TCU</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>315</td>
<td>4</td>
<td>30.3</td>
<td>CEF-TCU</td>
<td>50</td>
<td>63</td>
</tr>
<tr>
<td>400</td>
<td>4</td>
<td>38.5</td>
<td>CEF-TCU</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>10 ... 12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>2.9</td>
<td>CEF-TCU</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>75</td>
<td>4</td>
<td>4.3</td>
<td>CEF-TCU</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>5.8</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>125</td>
<td>4</td>
<td>7.2</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>9.2</td>
<td>CEF-TCU</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>200</td>
<td>4</td>
<td>11.5</td>
<td>CEF-TCU</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>250</td>
<td>4</td>
<td>14.4</td>
<td>CEF-TCU</td>
<td>25</td>
<td>31.5</td>
</tr>
<tr>
<td>315</td>
<td>4</td>
<td>18.2</td>
<td>CEF-TCU</td>
<td>31.5</td>
<td>40</td>
</tr>
<tr>
<td>400</td>
<td>4</td>
<td>23.1</td>
<td>CEF-TCU</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>400</td>
<td>6</td>
<td>23.1</td>
<td>CEF-S-TCU</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>500</td>
<td>4</td>
<td>28.9</td>
<td>CEF-TCU</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>630</td>
<td>4</td>
<td>36.4</td>
<td>CEF-TCU</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>13.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>4</td>
<td>3.1</td>
<td>CEF-TCU</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>4.2</td>
<td>CEF-TCU</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>125</td>
<td>4</td>
<td>5.2</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>6.7</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>200</td>
<td>4</td>
<td>8.4</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>250</td>
<td>4</td>
<td>10.5</td>
<td>CEF-TCU</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>315</td>
<td>4</td>
<td>13.2</td>
<td>CEF-TCU</td>
<td>25</td>
<td>31.5</td>
</tr>
<tr>
<td>400</td>
<td>4</td>
<td>16.7</td>
<td>CEF-TCU</td>
<td>31.5</td>
<td>40</td>
</tr>
<tr>
<td>400</td>
<td>6</td>
<td>16.7</td>
<td>CEF-S-TCU</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>500</td>
<td>4</td>
<td>20.9</td>
<td>CEF-TCU</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>500</td>
<td>6</td>
<td>16.7</td>
<td>CEF-TCU</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>630</td>
<td>4</td>
<td>28.9</td>
<td>CEF-TCU</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>630</td>
<td>4</td>
<td>36.4</td>
<td>CEF-TCU</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>15 ... 17.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>4</td>
<td>2.9</td>
<td>CEF-TCU</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>3.8</td>
<td>CEF-TCU</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>125</td>
<td>4</td>
<td>4.8</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>6.2</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>200</td>
<td>4</td>
<td>7.7</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>250</td>
<td>4</td>
<td>9.6</td>
<td>CEF-TCU</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>315</td>
<td>4</td>
<td>12.1</td>
<td>CEF-TCU</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>500</td>
<td>4</td>
<td>19.2</td>
<td>CEF-TCU</td>
<td>31.5</td>
<td>31.5</td>
</tr>
<tr>
<td>500</td>
<td>6</td>
<td>19.2</td>
<td>CEF-TCU</td>
<td>31.5</td>
<td>31.5</td>
</tr>
<tr>
<td>630</td>
<td>4</td>
<td>24.2</td>
<td>CEF-TCU</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>630</td>
<td>6</td>
<td>24.2</td>
<td>CEF-TCU</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>2.9</td>
<td>CEF-TCU</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>125</td>
<td>4</td>
<td>3.6</td>
<td>CEF-TCU</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>4.6</td>
<td>CEF-TCU</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>200</td>
<td>4</td>
<td>5.8</td>
<td>CEF-TCU</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>250</td>
<td>4</td>
<td>7.2</td>
<td>CEF-TCU</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>315</td>
<td>4</td>
<td>9.1</td>
<td>CEF-TCU</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>400</td>
<td>4</td>
<td>11.5</td>
<td>CEF-TCU</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>500</td>
<td>4</td>
<td>14.4</td>
<td>CEF-TCU</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>630</td>
<td>4</td>
<td>18.2</td>
<td>CEF-TCU</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>630</td>
<td>6</td>
<td>18.2</td>
<td>CEF-S-TCU</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>
Table 4.2.3.2: Selection table for HV HRC fuses (U_r up to 13.8 kV), manufacturer Siba

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6 ... 7.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>4.8</td>
<td>HHD-B</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>75</td>
<td>4</td>
<td>7.2</td>
<td>HHD-B</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>9.6</td>
<td>HHD-B</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>125</td>
<td>4</td>
<td>12.0</td>
<td>HHD-B</td>
<td>20</td>
<td>31.5</td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>15.4</td>
<td>HHD-B</td>
<td>31.5</td>
<td>40</td>
</tr>
<tr>
<td>200</td>
<td>4</td>
<td>19.2</td>
<td>HHD-B</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>250</td>
<td>4</td>
<td>24.1</td>
<td>HHD-B</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>315</td>
<td>4</td>
<td>30.3</td>
<td>HHD-B</td>
<td>50</td>
<td>63</td>
</tr>
<tr>
<td>400</td>
<td>4</td>
<td>38.5</td>
<td>HHD-B</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>500</td>
<td>4</td>
<td>48.1</td>
<td>HHD-B</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>500</td>
<td>6</td>
<td>48.1</td>
<td>HHD-B</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>10 ... 12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>4</td>
<td>2.9</td>
<td>HHD-B</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>75</td>
<td>4</td>
<td>4.3</td>
<td>HHD-B</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>5.8</td>
<td>HHD-B</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>125</td>
<td>4</td>
<td>7.2</td>
<td>HHD-B</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>9.2</td>
<td>HHD-B</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>200</td>
<td>4</td>
<td>11.5</td>
<td>HHD-B</td>
<td>20</td>
<td>31.5</td>
</tr>
<tr>
<td>250</td>
<td>4</td>
<td>14.4</td>
<td>HHD-B</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>315</td>
<td>4</td>
<td>18.2</td>
<td>HHD-B</td>
<td>31.5</td>
<td>50</td>
</tr>
<tr>
<td>400</td>
<td>4</td>
<td>23.1</td>
<td>HHD-B</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>400</td>
<td>6</td>
<td>23.1</td>
<td>HHD-B</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>500</td>
<td>4</td>
<td>28.9</td>
<td>HHD-B</td>
<td>50</td>
<td>63</td>
</tr>
<tr>
<td>500</td>
<td>6</td>
<td>28.9</td>
<td>HHD-B</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>630</td>
<td>4</td>
<td>36.4</td>
<td>HHD-B</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>630</td>
<td>6</td>
<td>36.4</td>
<td>HHD-B</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>800</td>
<td>6</td>
<td>46.2</td>
<td>HHD-B</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>1000</td>
<td>6</td>
<td>57.7</td>
<td>HHD-B</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>13.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>4</td>
<td>3.1</td>
<td>HHD-B</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>4.2</td>
<td>HHD-B</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>125</td>
<td>4</td>
<td>5.2</td>
<td>HHD-B</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>6.7</td>
<td>HHD-B</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>200</td>
<td>4</td>
<td>8.4</td>
<td>HHD-B</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>250</td>
<td>4</td>
<td>10.5</td>
<td>HHD-B</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>315</td>
<td>4</td>
<td>13.2</td>
<td>HHD-B</td>
<td>25</td>
<td>31.5</td>
</tr>
<tr>
<td>400</td>
<td>4</td>
<td>16.7</td>
<td>HHD-B</td>
<td>31.5</td>
<td>40</td>
</tr>
<tr>
<td>400</td>
<td>6</td>
<td>16.7</td>
<td>HHD-B</td>
<td>31.5</td>
<td>31.5</td>
</tr>
<tr>
<td>500</td>
<td>4</td>
<td>20.9</td>
<td>HHD-B</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>630</td>
<td>4</td>
<td>26.4</td>
<td>HHD-B</td>
<td>50</td>
<td>63</td>
</tr>
<tr>
<td>800</td>
<td>6</td>
<td>33.5</td>
<td>HHD-B</td>
<td>63</td>
<td>63</td>
</tr>
</tbody>
</table>
Table 4.2.3.2: Selection table for HV HRC fuses (U<sub>r</sub> from 15 to 24 kV), manufacturer Siba

<table>
<thead>
<tr>
<th>Operating voltage [kV]</th>
<th>Transformer capacity [kVA]</th>
<th>Short-circuit voltage u&lt;sub&gt;k&lt;/sub&gt; [%]</th>
<th>Rated transformer current [A]</th>
<th>Type</th>
<th>Rated current of HRC fuse [A]</th>
</tr>
</thead>
</table>

### 15 ... 17.5

<table>
<thead>
<tr>
<th></th>
<th>75</th>
<th>100</th>
<th>125</th>
<th>160</th>
<th>200</th>
<th>250</th>
<th>315</th>
<th>400</th>
<th>500</th>
<th>630</th>
<th>630</th>
<th>800</th>
<th>1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>[kV]</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>2.9</td>
<td>3.8</td>
<td>4.8</td>
<td>6.2</td>
<td>7.7</td>
<td>9.6</td>
<td>12.1</td>
<td>15.4</td>
<td>19.2</td>
<td>24.2</td>
<td>24.2</td>
<td>30.8</td>
<td>38.5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>31.5</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>63</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>25</td>
<td>20</td>
<td>40</td>
<td>50</td>
<td>63</td>
<td>40</td>
<td>63</td>
<td>80</td>
</tr>
</tbody>
</table>

### 20 ... 24

<table>
<thead>
<tr>
<th></th>
<th>400</th>
<th>400</th>
<th>500</th>
<th>500</th>
<th>630</th>
<th>630</th>
<th>800</th>
<th>1000</th>
<th>1250</th>
</tr>
</thead>
<tbody>
<tr>
<td>[kVA]</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>[A]</td>
<td>11.5</td>
<td>11.5</td>
<td>14.4</td>
<td>14.4</td>
<td>18.2</td>
<td>18.2</td>
<td>23.1</td>
<td>28.9</td>
<td>36.1</td>
</tr>
<tr>
<td>[A]</td>
<td>20</td>
<td>20</td>
<td>25</td>
<td>25</td>
<td>31.5</td>
<td>31.5</td>
<td>40</td>
<td>50</td>
<td>63</td>
</tr>
</tbody>
</table>
4.3 Gas monitoring with density sensors

The high voltage compartments must have sufficient SF$_6$ pressure during operation. (Please consult the table entitled “Technical data” in section 10 for the pressure levels.) The SF$_6$ insulating gas pressure is monitored during operation by density sensors (temperature-compensated pressure sensors).

If the gas pressure falls below the alarm level, a signal to top up the insulating gas is issued. The signal appears at a warning lamp (figure 4.3.1) in the operator control area, or on a panel control unit.

When systems are isolated for a relatively long period the auxiliary power supply should be maintained to monitor the insulating gas density.

Fig. 4.3.1: Signal lamp for gas density

4.4 Operation of the isolating device for voltage transformers and voltage sensors

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

- Comply with the safety regulations to EN 50110.
- Check 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.

The operating mechanism for the voltage transformer isolating device is located in the cable termination compartment on the right-hand side wall (figure 4.4.1).

Dismantle the cover on the cable termination compartment. This is done by removing the two screws above the cover and pulling the cover upwards.

Fig. 4.4.1: A) Location of the controls for the voltage transformer isolating device (example configurations)
The controls and indicators for the voltage transformer isolating device are shown in figure 4.4.2. Check the switch position indicator (5 and 6). The isolating device can be secured with a padlock (3). Remove the padlock before operating the device.

Fig. 4.4.2: Controls and displays for the voltage transformer isolating device

1 Locking plate
2 Actuating plate
3 Padlock (optional)
4 Latching slot
5 Switch position indicator, “voltage transformer or voltage sensor earthed”
6 Opening for switch position indicator, “voltage transformer or voltage sensor connected”
Isolating and earthing the voltage transformers or voltage sensors

To isolate and earth the voltage transformers or voltage sensors, slide the locking plate (1) upwards and pull the actuating plate (2) to the front until the stop is reached. Allow the locking plate to slide into the appropriate latching slot (4) in the actuating plate (figure 4.4.3).

When the locking plate engages in the latching slot of the actuating plate, the dielectric strength of the isolating device is ensured.

Secure the isolating device with a padlock.

Connecting the voltage transformers or voltage sensors

To connect the voltage transformers or voltage sensors, slide the locking plate (1) upwards and pull the actuating plate (2) to the rear until the stop is reached. Allow the locking plate to slide into the appropriate latching slot (4) in the actuating plate (figure 4.4.3).

When the locking plate engages in the latching slot of the actuating plate, the current carrying capacity of the isolating device is ensured.

Secure the isolating device with a padlock.
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 on the outer cone). The following systems can be used (Fig. 5.1.1 to 5.1.5):

- LRM system,
- KVDS system,
- CAVIN system,
- System Wega 1.2 C or
- System Wega 2.2 C.

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.

5.1.1  LRM-system

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.

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.

Fig. 5.1.1: LRM system with display unit

Fig. 5.1.2: KVDS-system

Fig. 5.1.3: CAVIN-system

Fig. 5.1.4: System Wega 1.2 C

Fig. 5.1.5: System Wega 2.2 C

5.1.2  KVDS- und CAVIN- and Wega 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.

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

– Isolate all voltage transformers inside the switchgear section to be tested by operating the isolating device (see chapter 4.4) (Isolating of voltage sensors is not necessary).

– Dismantle any surge arresters in the relevant outgoing feeder.

– Short-circuit the sockets for the capacitive indicator system in the relevant switchgear section using the short-circuiting plug.

– Fit the high voltage testing set in accordance with the manufacturer’s instructions.

– Establish the test circuit in accordance with the manufacturers directions for the test apparatus.

– De-earth the switchgear section to be tested before switching the test voltage on.

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

– Earth the switchgear section after completion of parts of the test and on conclusion of testing.

– Remove the high voltage testing set.

– Refit any dismantled surge arresters.

– Close off free outer cones with insulating blanking plugs in accordance with the manufacturers instructions.

– Remove the short-circuiting plugs from the capacitive indicator.

– Reconnect the voltage transformers by operating the isolating device (see section 4.4)

– Refit the cover on the cable termination compartment.

5.3 High voltage tests

Direct access to the conductors via the fitted cable connectors is available for the performance of high voltage tests. The test voltage is applied through suitable test sets for the outer cone connector system used.

5.3.1 Cable tests with dc

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 switchgear section 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 switchgear section 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 switchgear section being energized by remote control.

Observe the instruction manual for the phase comparator.

\(^1\) mcb: miniature circuit-breaker
5.3.2 Voltage test of the main circuit

Perform a voltage test on the busbar after installation. We recommend feeding in the test voltage via an incoming or outgoing feeder panel. Use high voltage testing sets for the outer cones.

The test voltage can also be applied directly to the busbars. In this case, special test plugs for connection to the busbar adapters of any panel are required.

In the course of testing, the test voltage is applied in sequence to every conductor in the main circuit, with the other conductor earthed. Testing should be performed with at least 80% of the rated short-duration power frequency withstand voltage \(U_d\) as stated on the type plate. Testing with 100% of the rated short-duration power frequency withstand voltage as stated on the type plate is possible. Comply with the test conditions as set out in IEC 62271-200.

Comply with the safety regulations to EN 50110.

- Isolate the switchgear section 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 switchgear section 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 switchgear section being energized by remote control.

If there are isolatable voltage transformers or sockets for these within the section of the system to be tested, use the isolating device to isolate them (see section 4.4) (Isolating of voltage sensors is not necessary).

Remove the busbar voltage transformers within the section of the system to be tested, and close off all cross and end adapters with the insulating plugs provided (see section 2.2.3) (Isolating of voltage sensors is not necessary).

- Remove any surge arresters fitted in the section of the system to be tested in accordance with the manufacturer’s instructions.
- Short-circuit the sockets for the capacitive indicator system in the relevant switchgear section using the short-circuiting plug

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

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 mcbs 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 (shunt 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 or voltage sensors 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.

**Panels with current transformers**

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

**Panels with sensors**

Current and voltage sensors are generally connected to the protection device via a sensor test adapter which is installed in the low voltage compartment. The sensor test adapter (figure. 5.4.1) provides one socket for each phase for connection of a protection tester or protection testing apparatus by network cables (RJ45 interface) (see single line diagram in figure 5.4.2). Changing of the existing wiring is not necessary.

- Connect the test apparatus in accordance with the manufacturer’s instructions for the protection tester, and perform the test.

**Fig. 5.4.2: Connection of the protection tester to the sensor test adapter (example of one current sensor per phase and voltage sensors)**

---

¹ mcbs: miniature circuit-breaker
5.5 Protection testing by primary current injection

Direct access to the conductors for performance of protection tests by primary current injection is possible via the fitted cable connectors. The test current is applied via suitable testing sets for the cable connector system used.

- 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 example of primary side test circuits in figure 5.5.1.

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).

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.

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 Maintenance of the switching devices and their operating mechanisms

Please consult the relevant directions and instruction manuals for the actions and intervals required.

All parts in SF₆ are maintenance-free.

The manually operated three position disconnector and the manually operated three position switch-disconnector are maintenance-free within 1000 operating cycles; the motor-operated three position disconnector is maintenance-free within 2000 operating cycles.

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.

8 Overview of the busbar parts and assemblies

Three different busbar versions are available:
- 1250 A, up to 24 kV, conductor diameter 32 mm,
- 1250 A, up to 36 kV, conductor diameter 32 mm,
- 2500 A, up to 36 kV, conductor diameter 50 mm.

The busbars are supplied ready to assemble in the lengths required. End adapters and cross adapters can each be supplied in four versions:
- Busbar and outgoing feeder 1250 A, up to 24 kV
- Busbar and outgoing feeder 1250 A, up to 36 kV
- Busbar 2500 A and outgoing feeder 1250A, up to 36 kV
- Busbar and outgoing feeder 2500 A, up to 36 kV

End adapters and cross adapters are supplied packaged in sets (3 pcs. each) with all the necessary individual parts and the assembly paste. A list of the individual parts is supplied with the delivery. The assemblies for the end and cross adapters and the busbars are marked with the relevant part numbers. The following lists are intended to provide you with an overview of the end adapters, cross adapters and busbars to be used for the relevant application.
### 8.1 Busbar 1250 A

![Busbar 1250 A Diagram](image)

#### Table 8.2.1: Busbars for a busbar current of up to 1250 A

<table>
<thead>
<tr>
<th>Rated voltage [kV]</th>
<th>Designation</th>
<th>Widths of the panels to be connected [mm]</th>
<th>Length [mm]</th>
<th>Quantity</th>
<th>Supplier's part number</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>SS 1250 A 436</td>
<td>450 - 450</td>
<td>436</td>
<td>1 piece</td>
<td>2645069</td>
<td>1VB8001281R1141</td>
</tr>
<tr>
<td></td>
<td>SS 1250 A 471</td>
<td>450 - 600</td>
<td>450 - 600 (Transferpanel)</td>
<td>471</td>
<td>1 piece</td>
<td>2660150</td>
</tr>
<tr>
<td></td>
<td>SS 1250 A 551</td>
<td>600 - 450</td>
<td>551</td>
<td>1 piece</td>
<td>2660135</td>
<td>1VB8001281R1143</td>
</tr>
<tr>
<td></td>
<td>SS 1250 A 381</td>
<td>600 (Transferpanel) - 450</td>
<td>381</td>
<td>1 piece</td>
<td>On request</td>
<td>1VB8001281R1144</td>
</tr>
<tr>
<td></td>
<td>SS 1250 A 416</td>
<td>600 (Transferpanel) - 600</td>
<td>416</td>
<td>1 piece</td>
<td>2645056</td>
<td>1VB8001281R1101</td>
</tr>
<tr>
<td></td>
<td>SS 1250 A 586</td>
<td>600 - 600</td>
<td>586</td>
<td>1 piece</td>
<td>2645016</td>
<td>1VB8001281R1102</td>
</tr>
<tr>
<td>36</td>
<td>SS 1250 A 586</td>
<td>600 - 600</td>
<td>586</td>
<td>1 piece</td>
<td>2645116</td>
<td>1VB8001281R3102</td>
</tr>
</tbody>
</table>
### Table 8.1.2: End and cross adapter assemblies for a busbar current of up to 1250 A

<table>
<thead>
<tr>
<th>Rated voltage [kV]</th>
<th>Designation</th>
<th>Quantity</th>
<th>Supplier's part number</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>End adapter 1250 A</td>
<td>1 set (3 pcs.)</td>
<td>2612986</td>
<td>1VB8001283R1112</td>
</tr>
<tr>
<td></td>
<td>Cross adapter 1250 A</td>
<td>1 set (3 pcs.)</td>
<td>2612987</td>
<td>1VB8001283R1111</td>
</tr>
<tr>
<td>36</td>
<td>End adapter 1250 A</td>
<td>1 set (3 pcs.)</td>
<td>2621932</td>
<td>1VB8001283R3112</td>
</tr>
<tr>
<td></td>
<td>Cross adapter 1250 A</td>
<td>1 set (3 pcs.)</td>
<td>2621933</td>
<td>1VB8001283R3111</td>
</tr>
</tbody>
</table>
## 8.2 Busbar 2500 A

![Diagram of busbar 2500 A]

### Table 8.2.1: Busbars for a busbar current of up to 2500 A

<table>
<thead>
<tr>
<th>Designation</th>
<th>Widths of the panels to be connected [mm]</th>
<th>Length [mm]</th>
<th>Quantity</th>
<th>Supplier’s part number</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS 2500 A 432</td>
<td>450 - 450</td>
<td>432</td>
<td>1 piece</td>
<td>2648432</td>
<td>1VB8001281R0131</td>
</tr>
<tr>
<td>SS 2500 A 467</td>
<td>450 - 600</td>
<td>467</td>
<td>1 piece</td>
<td>On request</td>
<td>1VB8001281R0132</td>
</tr>
<tr>
<td>SS 2500 A 617</td>
<td>450 - 900</td>
<td>617</td>
<td>1 piece</td>
<td>On request</td>
<td>1VB8001281R0134</td>
</tr>
<tr>
<td>SS 2500 A 767</td>
<td>450 - 1200</td>
<td>767</td>
<td>1 piece</td>
<td>On request</td>
<td>1VB8001281R0136</td>
</tr>
<tr>
<td>SS 2500 A 547</td>
<td>600 - 450</td>
<td>547</td>
<td>1 piece</td>
<td>2648440</td>
<td>1VB8001281R0133</td>
</tr>
<tr>
<td>SS 2500 A 582</td>
<td>600 - 600</td>
<td>582</td>
<td>1 piece</td>
<td>2648401</td>
<td>1VB8001281R0102</td>
</tr>
<tr>
<td>SS 2500 A 697</td>
<td>900 - 450</td>
<td>697</td>
<td>1 piece</td>
<td>On request</td>
<td>1VB8001281R0135</td>
</tr>
<tr>
<td>SS 2500 A 847</td>
<td>1200 - 450</td>
<td>847</td>
<td>1 piece</td>
<td>On request</td>
<td>1VB8001281R0137</td>
</tr>
<tr>
<td>SS 2500 A 732</td>
<td>600 - 900 900 - 600</td>
<td>732</td>
<td>1 piece</td>
<td>2648307</td>
<td>1VB8001281R0103</td>
</tr>
<tr>
<td>SS 2500 A 882</td>
<td>900 - 900 1200 - 600 600 - 1200</td>
<td>882</td>
<td>1 piece</td>
<td>2648302</td>
<td>1VB8001281R0104</td>
</tr>
<tr>
<td>SS 2500 A 1032</td>
<td>900 - 1200 1200 - 900</td>
<td>1032</td>
<td>1 piece</td>
<td>2648305</td>
<td>1VB8001281R0105</td>
</tr>
<tr>
<td>SS 2500 A 1182</td>
<td>1200 - 1200</td>
<td>1182</td>
<td>1 piece</td>
<td>2648304</td>
<td>1VB8001281R0106</td>
</tr>
</tbody>
</table>
### Table 8.2.2: End and cross adapter assemblies for a busbar current of up to 2500 A / feeder current 1250 A

<table>
<thead>
<tr>
<th>Designation</th>
<th>Panel width [mm]</th>
<th>Quantity</th>
<th>Supplier's part number</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>End adapter 1250 A / 2500 A</td>
<td>600</td>
<td>1 set (3 pcs.)</td>
<td>2652688</td>
<td>1VB8001283R0112</td>
</tr>
<tr>
<td>Cross adapter 1250 A / 2500 A</td>
<td>600</td>
<td>Not in sectionaliser and riser</td>
<td>2652689</td>
<td>1VB8001283R0111</td>
</tr>
</tbody>
</table>

### Table 8.2.3: End and cross adapter assemblies for a busbar current of up to 2500 A / feeder current 2500 A

<table>
<thead>
<tr>
<th>Designation</th>
<th>Panel width [mm]</th>
<th>Quantity</th>
<th>Supplier's part number</th>
<th>ABB part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>End adapter 2500 A / 2500 A</td>
<td>900</td>
<td>1 set (3 pcs.)</td>
<td>2612988</td>
<td>1VB8001283R0114</td>
</tr>
<tr>
<td>Cross adapter 2500 A / 2500 A</td>
<td>1200</td>
<td>1 set (3 pcs.)</td>
<td>2612989</td>
<td>1VB8001283R0113</td>
</tr>
</tbody>
</table>
9 List of tools

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.

1 Temperature-compensated pressure gauge with coupling, for systems up to 24 kV, not for panels with switch-disconnector and fuses (ABB part number: 1VB8004775R0101, figure 2.3.1.1.4)
1 Temperature-compensated pressure gauge with coupling, for systems with a rated voltage over 24 kV and up to 36 kV and for panels with switch-disconnector and fuses (up to 24 kV) (ABB part number: 1VB8004775R0102, figure 2.3.1.1.4)
1 Set of open-ended spanners, 8 to 19 mm AF
1 Set of ring spanners, 8 to 19 mm AF
1 Ratchet, 3/8", with extensions and 8 to 19 mm AF socket keys and 4 to 10 mm Allen key inserts
1 Ratchet, 1/2", with extensions and 10 to 19 mm AF socket keys and 4 to 10 mm Allen key inserts
1 Socket insert 3/8", 19 mm AF, min. 82 mm long (for busbar installation, busbar current 1250 A)
1 Socket insert 1/2", 24 mm AF, min. 82 mm long (for busbar installation, busbar current 2500 A)
1 Set of screwdrivers for slotted and cross-head screws, sizes 1 to 3
1 Set of electrician’s pliers (end cutting nipper, pointed pliers, flat end pliers, stripping tongs)
1 Rubber mallet
1 Set of fitter’s hammers
1 Leveller
1 Plumb bob
1 Guide string
1 Scribing iron
1 Punch
1 Tri-square
1 Tape measure
1 Calliper gauge
1 Continuity tester
1 Multimeter (voltage, current and resistance)
1 Torque wrench, 0 – 40 Nm, calibrated
1 Torque wrench, 15 – 100 Nm, calibrated
1 Extension cable, 230 V, 15 m long 1 Cable drum, 230 V / 16 A, 50 m
1 Angle grinder, small
1 Hand-held drill, chuck up to 13 mm
1 Hammer drill
1 Welding machine + accessories
1 Set of steel drill bits, 1 to 13 mm
1 Set of concrete drill bits, 6 to 12 mm
1 Steps, 8 rung
2 Trolley jacks (recommended capacity 2 t) or
2 Hydraulic lift trolleys (recommended capacity 3.5 t per pair)
4 Lifting ropes, 0.75 m, recommended capacity 1 t
4 Lifting ropes, 1.5 m, recommended capacity 1 t
4 Shackles, capacity 1 t
2 Pinch bars
5 Handling tubes
2 Chain hoists, 0.25 t including chain
1 Site lighting
1 Torch
1 Hand-held lamp
1 Vacuum cleaner
Several wooden planks
Several wooden beams
Soft, non-fraying cleaning cloth, household cleaner, chlorine-free
10 Working materials, auxiliary materials and accessories

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

10.1 Working materials

SF₆ 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

As a rule, the panel modules 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 panel modules are filled at the works to a reduced insulating gas pressure, and therefore they have to be topped up with SF₆ at site. In this case SF₆ in cylinders is required. Further information on the handling of SF₆ can be found in instruction manual HB 605/E.

If extreme temperatures ≥ 50 °C during the storage, transport or temporary storage in the open air of the SF₆ 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.

10.2 Auxiliary materials

Assembly paste for silicone insulating parts,
Capacity 90 g

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

Paint, standard colour RAL 7035
Can, capacity 1 kg
10.3 Accessories

**Accessories for manual charging of the stored energy spring of the circuit-breaker**

Charging lever for VD4 X operating mechanism

ABB part number: GCE9477394R0101

**Accessories for manual operation of the three position disconnector**

Operating lever for earthing switch (Fig. 4.1.3.1.1)

ABB part number: 1VB8002443R0102

Operating lever for disconnector (Fig. 4.1.3.1.2)

ABB part number: 1VB8002443R0101

**Accessories for operation of the three position switch-disconnector with fuse**

Operating lever without coding (Fig. 4.2.2.1)

ABB part number: 1VB8004061R0101

Operating lever with coding for operation of the earthing switches (Fig. 4.2.2.3)

ABB part number: 1VB8004062R0101

Operating lever with coding for operation of the charging shaft (Fig. 4.2.2.2)

ABB part number: 1VB8004062R0102

**Accessories for HRC fuses**

Length adapter for fuse length 292 mm

and diameter 53 mm (Fig. 4.2.3.2)

ABB part number: GCE9015980R0101

Adapter for fuse diameter 53 mm (Fig. 4.2.3.2)

ABB part number: GCE9015982R0101

Fuse links (manufacturer Siba):

- HRC fuse links for indoor switchgear
- with striker pin 80 N
- and temperature limiter,
- nominal dimension “e”: 442 mm (or 292 mm with adapter)
- nominal dimension “d”: 67 mm (or 53 mm with adapter)

ABB part number: On request, depending on rated voltage and rated current

**Accessories for capacitive indicator, system LRM**

Display unit (Abb. 5.1.1.1)

ABB part number: GCE0931333P0101

Interface tester

ABB part number: GCE0900052P0102

Short-circuiting plug

ABB part number: GCE0909005P0101

**Other accessories**

Double bit key for barrel lock in panel door

ABB part number: GCE0990108P0100

Wall mounting for accessories

ABB part number: GCE9016025P0101

Wall mounting for three HRC fuses

ABB part number: GCE9016382P0102

Adapter for DILO filling truck

(further adapters on request)

- Anschluss M24 x 1,5
- Anschluss M20 x 1,5 (DN8)

ABB part number: 1VB8004776P0101

ABB part number: 1VB8007470P0101
11 Technical data

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 name plates are located in the immediate vicinity of the devices they describe.

Table 11.1: Technical data of the panels

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage / maximum operating voltage</td>
<td>12, 17.5, 24, 36 ¹</td>
</tr>
<tr>
<td>Rated power-frequency withstand voltage</td>
<td>28, 38, 50, 70 ¹</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage</td>
<td>75, 95, 125, 170 ¹</td>
</tr>
<tr>
<td>Rated frequency ²</td>
<td>50</td>
</tr>
<tr>
<td>Rated normal current of busbars</td>
<td>... 630, ... 1250, ... 2500</td>
</tr>
<tr>
<td>Rated normal current</td>
<td>... 630, ... 1250, ... 2500</td>
</tr>
<tr>
<td>Rated short-time withstand current</td>
<td>... 25 (Panel width 450 mm)</td>
</tr>
<tr>
<td>Rated peak withstand current</td>
<td>... 31.5 (Panel width 600 mm, 900 mm and 1200 mm)</td>
</tr>
<tr>
<td>Rated duration of short-circuit</td>
<td>... 80 (Panel width 600 mm, 900 mm and 1200 mm)</td>
</tr>
<tr>
<td>Insulating gas system</td>
<td></td>
</tr>
<tr>
<td>Alarm level for insulation</td>
<td>120 ⁶, 140</td>
</tr>
<tr>
<td>Rated filling level for insulation</td>
<td>130 ⁷</td>
</tr>
<tr>
<td>Minimum functional level for operation ⁸</td>
<td>140 ⁹</td>
</tr>
<tr>
<td>Rated filling level for switch ⁸</td>
<td>150 ¹⁰</td>
</tr>
<tr>
<td>Degree of protection for parts under high voltage</td>
<td>IP65</td>
</tr>
<tr>
<td>Degree of protection of the low voltage compartment and mechanism bay ⁸</td>
<td>IP3X</td>
</tr>
</tbody>
</table>

¹) Except for panels with switch-disconnector and transfer panels, Panel with a width of 450 mm
²) Rated current for 60 Hz on request
³) Insulating gas: SF₆ (sulphur hexafluoride)
⁴) All pressures stated are absolute values relative to 20 °C
⁵) 100 kPa = 1 bar
⁶) Three position switch-disconnector: 140 kPa
⁷) Three position switch-disconnector: 150 kPa
⁸) Applies to switch-disconnectors only
⁹) Higher degrees of protection on request
11.2: Operating conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature, maximum</td>
<td>°C</td>
</tr>
<tr>
<td>Ambient temperature, maximum 24 h average</td>
<td>°C</td>
</tr>
<tr>
<td>Ambient temperature, minimum</td>
<td>°C</td>
</tr>
<tr>
<td>Site altitude</td>
<td>m</td>
</tr>
<tr>
<td>Average humidity measured over 24 h</td>
<td>%</td>
</tr>
<tr>
<td>Average relative humidity in one month</td>
<td>%</td>
</tr>
<tr>
<td>Ambient air</td>
<td></td>
</tr>
</tbody>
</table>

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

Table 11.3: Panel weights

<table>
<thead>
<tr>
<th>Panel type</th>
<th>Panel width [mm]</th>
<th>Rated normal current [A]</th>
<th>Weight, max. [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel with three-position switch-disconnector and fuses</td>
<td>600</td>
<td>Depends on fuses</td>
<td>600</td>
</tr>
<tr>
<td>Feeder panel</td>
<td>450</td>
<td>630</td>
<td>450</td>
</tr>
<tr>
<td>Feeder panel</td>
<td>600</td>
<td>1250</td>
<td>900</td>
</tr>
<tr>
<td>Sectionaliser panel</td>
<td>600</td>
<td>1250</td>
<td>900</td>
</tr>
<tr>
<td>Riser panel</td>
<td>600</td>
<td>1250</td>
<td>700</td>
</tr>
<tr>
<td>Transfer panel</td>
<td>600</td>
<td>1000 (1250)</td>
<td>800</td>
</tr>
<tr>
<td>Incomer panel</td>
<td>1200</td>
<td>2500</td>
<td>2200</td>
</tr>
<tr>
<td>Sectionaliser panel</td>
<td>900</td>
<td>2500</td>
<td>1600</td>
</tr>
<tr>
<td>Riser panel</td>
<td>900</td>
<td>2500</td>
<td>1200</td>
</tr>
</tbody>
</table>

1) Higher ambient temperature on request
2) Greater site altitudes on request
3) Take suitable action to prevent condensation in the low voltage compartment.
Panel with three position switch-disconnector and fuses

1.0 Panel module
1.1 Circuit-breaker pole
1.2 Circuit-breaker operating mechanism
1.3 Outer cone
1.5 Measuring sockets for capacitive voltage indicator system
1.7 Isolating system for voltage transformer or voltage sensor
1.8a Voltage transformer for busbar measurement (optional)
1.8b Voltage transformer for feeder measurement (optional)
1.9a Current transformer
1.9b Current sensor
1.10 Gas density sensor
1.11 Filling valve
1.12 Cast resin bushing to busbar
1.13 Pressure relief disk
1.15 Three position switch disconnector
1.16 Three position switch disconnector mechanism
1.17 Fuse box
1.18 Heat sink

2.1 Busbar
2.3 Three position disconnector
2.4 Three position disconnector mechanism
3.0 Cable compartment
3.1 Cable connector
3.2 High voltage cable
3.3 Cable fastener
3.5 Main earthing bar
3.6 Floor plate
3.8 Mechanism for the voltage transformer isolating device (optional)
6.0 Low voltage compartment
6.5 Secondary cable entry
6.6 Low voltage compartment door
6.10 Mechanism bay
7.0 Busbar cover
7.1 Pressure relief duct

---

Insulating Gas SF₆