ZX2 Version for ANSI markets
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 engage ABB to provide technical assistance.
- Ensure that installation, operation and maintenance are only performed by specialist electricians familiar with this manual.
- Comply in full with the internationally recognized standards (IEC/DIN VDE/IEEE/OSHA), 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 local applicable regulations and below safety rules.
- Always observe the following five safety rules set out in EN 50110 for ensuring that the electrical installation (at the work location) is dead and secure for the duration of work to be done on the switchgear (or identified as a dead working location).

  Disconnect completely
  Verify the off-circuit condition
  Earth/ground and short-circuit
  Secure to prevent reconnection
  Provide protection against adjacent live parts

- Personnel installing, operating, or maintaining this equipment must have thorough knowledge of all applicable local, regional, industrial, governmental, and OSHA safety procedures as well as commonly accepted safe working practices. Personnel working in, or around this equipment must also exhibit common sense and good judgement regarding the potential hazards for themselves and other personnel in the area. These instructions are intended for use by fully qualified personnel and are not a substitute for adequate training, experience, and supervision. Should clarification or additional information be required, refer the matter to your ABB sales office. When communicating with ABB regarding the product covered by this Instruction book, always reference the ABB assigned Shop Order (S.O.) number or Serial Number.

- If you have any further questions about this manual, the members of our field service organization will be pleased to provide the required information.
## Contents

<table>
<thead>
<tr>
<th>1</th>
<th>Standards, regulations, notes, further documents</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Despatch and storage</td>
<td>11</td>
</tr>
<tr>
<td>2.1</td>
<td>Condition on delivery</td>
<td>11</td>
</tr>
<tr>
<td>2.2</td>
<td>Delivery</td>
<td>11</td>
</tr>
<tr>
<td>2.3</td>
<td>Packaging</td>
<td>11</td>
</tr>
<tr>
<td>2.4</td>
<td>Handling</td>
<td>11</td>
</tr>
<tr>
<td>2.4.1</td>
<td>Handling by fork lift truck</td>
<td>12</td>
</tr>
<tr>
<td>2.4.2</td>
<td>Handling by trolley jack</td>
<td>13</td>
</tr>
<tr>
<td>2.4.3</td>
<td>Handling by crane</td>
<td>13</td>
</tr>
<tr>
<td>2.4.4</td>
<td>Handling by hydraulic lift trolley</td>
<td>15</td>
</tr>
<tr>
<td>2.5</td>
<td>Intermediate storage</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>Installation of the switchgear at site</td>
<td>16</td>
</tr>
<tr>
<td>3.1</td>
<td>Fundamental notes on installation work</td>
<td>16</td>
</tr>
<tr>
<td>3.1.1</td>
<td>General site requirements</td>
<td>16</td>
</tr>
<tr>
<td>3.1.2</td>
<td>Tightening torques</td>
<td>16</td>
</tr>
<tr>
<td>3.1.3</td>
<td>General information on treatment of plug-in connectors with silicone insulating parts</td>
<td>16</td>
</tr>
<tr>
<td>3.1.4</td>
<td>Handling sulphur hexafluoride (SF₆)</td>
<td>18</td>
</tr>
<tr>
<td>3.2</td>
<td>Foundation bars</td>
<td>18</td>
</tr>
<tr>
<td>3.2.1</td>
<td>Installation of standard foundation frames</td>
<td>18</td>
</tr>
<tr>
<td>3.2.1.1</td>
<td>Foundation frames made of aluminum profiles</td>
<td>18</td>
</tr>
<tr>
<td>3.2.1.2</td>
<td>Reinforced foundation frames</td>
<td>21</td>
</tr>
<tr>
<td>3.2.1.3</td>
<td>Special considerations with raised false floor</td>
<td>23</td>
</tr>
<tr>
<td>3.3</td>
<td>Assembly of the switchgear</td>
<td>24</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Preparatory work</td>
<td>24</td>
</tr>
<tr>
<td>3.3.1.1</td>
<td>Checking the SF₆ pressure in the gas compartments</td>
<td>24</td>
</tr>
<tr>
<td>3.3.1.2</td>
<td>Greasing the foundation bars</td>
<td>25</td>
</tr>
<tr>
<td>3.3.1.3</td>
<td>Preparing the panels</td>
<td>25</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Erection of the panels</td>
<td>25</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Closure of extendable busbar sockets</td>
<td>35</td>
</tr>
<tr>
<td>3.3.4</td>
<td>Installation of plenums and end covers</td>
<td>36</td>
</tr>
<tr>
<td>3.3.5</td>
<td>Handling of voltage transformers</td>
<td>36</td>
</tr>
<tr>
<td>3.3.5.1</td>
<td>Dismantling of voltage transformers (metering 1)</td>
<td>37</td>
</tr>
<tr>
<td>3.3.5.2</td>
<td>Installation of voltage transformers (metering 1)</td>
<td>39</td>
</tr>
<tr>
<td>3.3.5.3</td>
<td>Installation of voltage transformers (metering 2)</td>
<td>41</td>
</tr>
<tr>
<td>3.3.5.4</td>
<td>Dismantling of voltage transformers (metering 2)</td>
<td>46</td>
</tr>
<tr>
<td>3.3.5.5</td>
<td>Wiring of the voltage transformers</td>
<td>47</td>
</tr>
<tr>
<td>3.3.5.6</td>
<td>Installation of damping resistors</td>
<td>52</td>
</tr>
<tr>
<td>3.4</td>
<td>Connecting the main grounding bar</td>
<td>53</td>
</tr>
<tr>
<td>3.5</td>
<td>Connection of cabling and wiring</td>
<td>53</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Control cables and wiring</td>
<td>53</td>
</tr>
<tr>
<td>3.5.2</td>
<td>High voltage cables</td>
<td>53</td>
</tr>
<tr>
<td>3.6</td>
<td>Fitting surge arresters</td>
<td>54</td>
</tr>
<tr>
<td>3.7</td>
<td>Fitting blanking plugs</td>
<td>55</td>
</tr>
<tr>
<td>3.8</td>
<td>Fitting insulating covers for unused outer cones</td>
<td>55</td>
</tr>
<tr>
<td>3.9</td>
<td>Concluding installation work</td>
<td>55</td>
</tr>
<tr>
<td>4</td>
<td>Commissioning</td>
<td>56</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>4.1 Conditions for commissioning of the switchgear</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>4.2 Energizing the system</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>5 Operation</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>5.1 General notes</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>5.2 Line side grounding and grounding of system sections</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>5.2.1 Line side grounding of panels in single busbar systems</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>5.2.2 Line side grounding of panels in double busbar systems</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>5.2.3 Busbar grounding of double busbar systems with bus tie</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>5.3 Non-interrupting bus transfer</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>5.4 Electrical operation</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>5.5 Emergency manual operation</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>5.5.1 Emergency manual operation of the circuit-breaker</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>5.5.2 Emergency manual operation of the three-position disconnect and the disconnect</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>5.6 View Ports</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>5.6.1 Switch position grounding switch closed</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>5.6.2 Switch position open</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>5.6.3 Switch position disconnect switch closed</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>5.7 Gas monitoring with density sensors</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>5.8 Operation of the isolating device for voltage transformers</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>5.8.1 Operation of the isolating device for voltage transformers in metering panels</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>6 Test procedures</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>6.1 Testing for the off-circuit condition</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>6.1.1 LRM system</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>6.1.2 KVDS, CAVIN and Wega systems</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>6.2 Testing for the in-phase condition</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>6.3 High voltage tests</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>6.3.1 Cable tests with DC voltage</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>6.3.2 Voltage test of the main circuit</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>6.4 Secondary protection testing</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>6.5 Protection testing by primary current injection</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>7 Service</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>7.1 Inspection and maintenance of the switchgear installation</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>7.2 Inspection and servicing of individual components</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>7.3 Checking the dimensional accuracy of the control wire settings</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>7.4 Outlet filter</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>8 Actions at the end of the service life</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>9 List of tools</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>10 Working materials, auxiliary materials and accessories</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>10.1 Working materials</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>10.2 Auxiliary materials</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>10.3 Accessories</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>11 Technical data</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>12 Disclaimer</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>12.1 Disclaimer of warranties and limitation of liability</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>12.2 ABB Disclaimer for operator's use of equipment &amp; No ABB liability for mistakes by operator or others</td>
<td>87</td>
<td></td>
</tr>
</tbody>
</table>
1 Standards, regulations, notes, further documents

The relevant standards for switchgear over 1 kV and their switching devices can be found in the following table 1.1.

<table>
<thead>
<tr>
<th>Table 1.1: Standards for switchgear and switching devices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Switchgear, General</strong></td>
</tr>
<tr>
<td><strong>Switchgear</strong></td>
</tr>
<tr>
<td><strong>Circuit-breaker</strong></td>
</tr>
<tr>
<td><strong>Disconnect and grounding switch</strong></td>
</tr>
</tbody>
</table>

Take particular account of the relevant standards listed in Table 1.2. 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>Table 1.2: Relevant standards and regulations and safety data sheets</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60364</td>
</tr>
<tr>
<td>IEC 61936</td>
</tr>
<tr>
<td>DIN EN 50110</td>
</tr>
</tbody>
</table>

National technical accident prevention regulations e.g. for electrical systems and equipment and SF₆ installations

Safety data sheets for auxiliary materials
<table>
<thead>
<tr>
<th>Switchgear</th>
<th>C37.122.2</th>
<th>IEEE Guide for the Application of Gas-Insulated Substations 1 kV to 52 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit-breaker</td>
<td>C37.04 1)</td>
<td>IEEE Standard Rating structure for AC High-Voltage Circuit Breakers</td>
</tr>
<tr>
<td>Circuit-breaker</td>
<td>C37.06 1)</td>
<td>IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis—Preferred Ratings and Related Required Capacities for Voltages Above 1000 V</td>
</tr>
<tr>
<td>Circuit-breaker</td>
<td>C37.09 1)</td>
<td>IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis</td>
</tr>
</tbody>
</table>

Standards to be mainly observed for safety, planning, operation and maintenance purposes

| NFPA 70E | Standard for Electrical Safety in the Workplace |
| IEEE Std 141 | (*Red Book*) Recommended Practice for Electrical Power Distribution in Industrial Plants |
| IEEE Std 142 | (*Green Book*) Recommended Practice for Grounding of Industrial and Commercial Power Systems |
| IEEE Std 493 | (*Gold Book*) Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems |
| IEEE Std 902 | (*Yellow Book*) Guide for Maintenance, operation and Safety of Industrial and Commercial Power Systems |

1) As requested by IEEE C37.122.2 IEEE Guide for the Application of Gas-Insulated Substations 1 kV to 52 kV
Fundamental notes on this manual:

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

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

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

- **Important note**, injury and damage may occur if the actions described are not performed.

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

Note on safety

The internal arc classification IAC to IEC 62271-200 confirms a tested degree of operator protection. The information on accessibility of the switchgear as required by IEC 62271-200 can be found on the type plates of the panels. AFLR according to IEC 62271-200 is similar to type 2B acc. to IEEE C37.20.7 for air insulated switchgear. 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>
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<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 authorized personnel**

The switchgear operator 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 in 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 636).

With pressure relief into the switchgear room, the IAC qualification requires a switchgear installation consisting of at least four panels. If a plenum leading to the outside is used, at least two panels are required for the IAC qualification.
You have chosen a gas-insulated switchgear of series ZX2. This switchgear from the ZX range is notable for the following features:

- SF₆ gas-insulated with hermetically sealed pressure systems
- Rated voltages up to 38kV (40.5 kV)
- Lightning impulse withstand voltage up to 200 kV
- Up to 2500 A and 40 kA
- Single busbar and double busbar design
- Stainless steel enclosures, fabricated from laser cut sheet steel
- Modular structure
- Switchgear with a leakage rate of less than 0.1 % per year
- Integrated routine leakage testing of the panels ex-works
- Indoor installation
- Panel widths 23.62 in and 31.50 in

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

- Installation checklist MC 644 en

![Fig. 1.1: Circuit-breaker VD4X, type 1 with outgoing cable-harness](image1)

![Fig. 1.2: Circuit-breaker VD4X, type 2, plugs for connection of the wiring are located directly on the mechanism](image2)

- Order documents
  - Single line diagram
  - Front view
  - Construction data if compiled specifically for this order
  - Circuit diagrams
  - Grounding diagram - switchgear ground to station ground (not part of ABB supply)

- Instruction manuals
  - Use of SF₆ insulating gas HB 645 en
  - Circuit-breaker VD4X, type 1 according to Fig. 1 BA 646 en
  - Circuit-breaker VD4X, type 2 according to Fig. 2 BA 647 en
  - Material supplement BA 509 en

- Operating instructions and directions for components, e.g.
  - Surge arresters
  - Current and voltage transformers
  - Protection and control devices
  - Capacitive voltage indicator system
  - In case of gasworks (as a rule not necessary) HB 602 en

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

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

If you have technical questions, please contact our service staff
Power technology customer service Call number +1 843 413 4702
Fig. 1.3: Feeder panel, 1250 A, Double busbar, example configuration

1.0 Circuit-breaker compartment
1.1 Circuit-breaker pole
1.2 Circuit-breaker operating mechanism
1.3 Cable socket
1.4 Test socket (also for use with other plug-in devices)
1.5 Capacitive voltage indicator system
1.8 Voltage transformer
1.9 Block-type transformer
1.12 Bushing, circuit-breaker/ busbar compartment
1.13 Pressure relief disk
2.0 Busbar compartment
2.1 Busbar system
2.3 Three position disconnect
2.4 Disconnect
2.5 Three position disconnect mechanism
2.6 Disconnect mechanism
2.7 View ports
3.0 Cable termination compartment
3.1 Cable connector
3.2 High voltage cable
3.3 Cable fastener
3.5 Main grounding bar
4.0 Plenum, rear
(for circuit-breaker compartment and cable termination compartment)
4.1 Plenum, top
(for busbar compartment)
6.0 Low voltage compartment
2 Despatch and storage

2.1 Conditions on delivery

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

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

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

- 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 645 en for the procedure to be adopted).

- As a rule, no further gaswork is required on site. Should gas work be required in exceptional cases, the procedure is to be taken from the manuals HB 602 and HB 605.

- The installation material, accessories and the documentation are packaged separately from the panels.

2.2 Delivery

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

2.3 Packaging

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

The possible packaging methods are as follows:

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

2.4 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 center of gravity of the panels, there is a risk that the transport units may tip over! Take all precautions to protect personnel and the material transported.

Only handle the panels by

- fork lift truck,
- trolley jack,
- crane, or
- hydraulic lift trolley.
2.4.1 Handling by fork lift truck

The panels can be handled upright on a pallet or by fork lift truck without a pallet. Use lifting sections when handling a panel without a pallet.

Handling with a pallet

! The pallet must rest fully on the forks of the truck or jack. The high center of gravity means there is a high risk of tipping. Avoid jerky motions.

Handling without a pallet

Fasten one lifting section to each side of the panel. Use five M 8 x 35 cheese head screws with dished washers for each lifting section. See figure 2.4.1.1 for the position of the fastening points.

The full length of the lifting sections must rest on the forks of the truck (see figure 2.4.1.2). The high center of gravity means there is a high risk of tipping. Avoid jerky motions.

Fig. 2.4.1.1: Preparation of a panel for handling by fork lift truck

Fig. 2.4.1.2: Handling by fork lift truck
2.4.2 Handling by trolley jack

The panel must be standing on a pallet. The pallet must rest fully on the forks of the truck or jack. The high center of gravity means there is a high risk of tipping. Avoid jerky motions.

2.4.3 Handling by crane

- Fasten one rope guide to the top brackets of the busbar compartments at each of the left and right using two M 10 x 25 cheese head screws with nuts and dished washers as shown in figure 2.4.3.1.

- Fasten two lifting lugs to the sections between the circuit-breaker compartment and busbar compartment on each of the left and right, using two M 8 x 35 cheese head screws with dished washers as shown in figure 2.4.3.1.

- Fasten lifting ropes with a sufficient capacity (see section 11, Technical data, for panel weights) and sufficient length as specified in figure 1.4.3.2 to the lifting lugs using shackles. Thread the lifting ropes through the cut-outs in the rope guides. The lifting ropes and shackles are not included in the ABB scope of supply.

Fig. 2.4.3.1 a: Lifting lugs and rope guides for handling by crane
Single busbar at the front

Fig. 2.4.3.2: Rope length and rope arrangement for handling by crane, dimensions in inches

Double busbar or single busbar at the rear
2.4.4 Handling by hydraulic lift trolley

- Fasten a hydraulic lift trolley of suitable capacity to each of the front and rear of the panel (figure 1.4.4.1) in accordance with the manufacturer’s instructions.

![Warning: The high center of gravity means there is a high risk of tipping. Avoid jerky motions!]

Fig. 2.4.4.1: Handling by hydraulic lift trolley

2.5 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 storage room must comply with the normal operating conditions for the 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 storage room accordingly.

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

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

3.1 Fundamental notes on installation work

3.1.1 General site requirements

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

3.1.2 Tightening torques

Use DIN screws of tensile class 8.8. Observe the tightening torques in table 3.1.2.1. The tightening torques apply to un lubricated screw connections.

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

Table 3.1.2.1: Tightening torques in Pound-force feet (ft·lbf)

<table>
<thead>
<tr>
<th></th>
<th>M 5</th>
<th>M 8</th>
<th>M 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel screw in T-nut (foundation frame)</td>
<td></td>
<td>19.2</td>
<td></td>
</tr>
<tr>
<td>Nut on studbolt</td>
<td>2.2</td>
<td></td>
<td>9.2</td>
</tr>
<tr>
<td>Steel screw in pulling nut</td>
<td></td>
<td>13.3 - 17.7</td>
<td>18.4 - 35.4</td>
</tr>
<tr>
<td>Nut on hammer head screw in aluminium section</td>
<td></td>
<td>18.4</td>
<td></td>
</tr>
<tr>
<td>Screw in inner cone socket</td>
<td></td>
<td>14.8</td>
<td></td>
</tr>
<tr>
<td>Other screws of tensile class 8.8</td>
<td>19.2</td>
<td></td>
<td>36.9</td>
</tr>
</tbody>
</table>

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

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

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

Perform the following work to prepare silicone insulating parts for assembly:

- Inspect the silicone insulating parts
- Clean soiled silicone insulating parts
- Grease the insulating parts
- Clean the sockets, the contact tubes and the outer cone

Inspecting the silicone insulating parts

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

Check the silicone insulating part for damage prior to installation.

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

The silicone surface must be free of

- gas bubbles,
- scoring,
- damage,
- abrasions,
- foreign bodies.
Cleaning of soiled silicone insulating parts

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

− Remove surplus or dirty grease from the silicone part with a soft, clean, non-fraying cloth.
− Clean the silicone insulating part when required with intensive cleaner M.X.T. 60 forte and a soft, non-fraying cloth.
− Only use intensive cleaner M.X.T. 60 forte as the cleaning agent.
− Only moisten the cloth slightly with intensive cleaner. Apply only moderate pressure when cleaning the insulating parts of busbar connections. Do not wipe from the black areas towards the light insulating surfaces. By adopting this procedure you avoid transferring black, conductive material onto the light, insulating area.
− After cleaning with intensive cleaner M.X.T. 60 forte, wipe the silicone insulating part with a dry cloth.
− As the cleaner causes the silicone to swell slightly, it then has to dry for approximately 15 minutes in the air.

Greasing the insulating parts

Grease the components immediately before use as follows:

− Use the quantities of assembly paste listed in table 3.1.3.1.
− Silicone insulating parts on the busbar connection:
  Evenly grease the light, outer areas of the silicone insulating part as shown in figure 3.1.3.1.
− Blanking plugs for the busbar connection:
  Evenly grease the light, outer areas of the blanking plug as shown in figure 3.1.3.2.

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity of assembly paste to be used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone insulating part on the busbar connection, both sides</td>
<td>Approximately 0.71 oz. each insulating part</td>
</tr>
<tr>
<td>Blanking plugs for the busbar bushing,</td>
<td></td>
</tr>
<tr>
<td>Silicone insulating parts on voltage transformers.</td>
<td>Approximately 0.35 oz. each part</td>
</tr>
<tr>
<td>Blanking plugs for voltage transformer sockets,</td>
<td></td>
</tr>
<tr>
<td>Test plugs</td>
<td></td>
</tr>
</tbody>
</table>
Cleaning the busbar sockets, the contact tubes, the cable sockets, the sockets for voltage transformers, the test sockets and the outer cones

- Degrease and clean the components with intensive cleaner M.X.T. 60 forte.
- Assemble the components immediately to avoid soil-ing.

3.1.4 Handling sulphur hexafluoride \((\text{SF}_6)\)

This product contains sulphur hexafluoride \((\text{SF}_6)\).

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

- Evenness tolerance: \(\pm 0.036" / \text{Yd}\)
- Straightness tolerance: Max. 0.036" / Yd but max. 0.079" for the entire length

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

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

The standard foundation frames are shown in figure 3.2.1.1.

3.2 Foundation bars

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

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

- If there is a concrete floor a foundation frame is required.

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

- Evenness tolerance: \(\pm 0.036" / \text{Yd}\)
- Straightness tolerance: Max. 0.036" / Yd but max. 0.079" for the entire length

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

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

The standard foundation frames are shown in figure 3.2.1.1.

3.2.1 Installation of standard foundation frames

Two versions of standard foundation frames are available.

1st: Foundation frames made of aluminum profiles which have to be fixed to the concrete floor. These frames have to be embedded in screed.

2nd: Reinforced, earthquake-proof foundation frames made of steel profiles which have to be fixed to the concrete floor. These frames do not have to be embedded in screed.

Both versions are pre-assembled delivered to site.

3.2.1.1 Foundation frames made of aluminum profiles

Installation principle:

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

Detailed description of installation (figure 3.2.1.1)

- Position the first foundation frame in the correct location on the concrete floor.

- Align the foundation frame vertically with the four screws (1), taking account of any deviation in floor level in the direction of the foundation frames which are still to be laid.

We recommend that gas work should only be performed by personnel trained in the handling of \text{SF}_6. Gas may only be extracted by certified personnel. See manual HB 645 en “Use of \text{SF}_6 insulating gas” for details on handling \text{SF}_6.
- 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 three 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.

- Ground 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. Fill in the marked area in figure 2.2.1.2 with topping material. (Details on the height of the finished floor can be found in figure 3.2.1.1, section A-A.).

When voltage transformers are used in the cable termination compartment, the panel floor plate needs to be supported. That support is ensured by complete backfilling with topping material in the marked area in figure 3.2.1.2. If the floor plate is not supported by topping material at the rear of the cable termination compartment (e.g. in the case of cable openings elongated to the rear), an additional structural beam is required. The position of that beam can be found in figure 3.2.1.2.

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**Fig. 3.2.1.2:** Plan view of standard foundation frame: Embedding of the foundation frame in floor topping.
3.2.1.2 Reinforced foundation frames

Installation principle:

The foundation frames are bolted together three times along the longitudinal sections. Vertical alignment is effected by jacking screws. The frames are fastened to the floor by means of brackets, which are welded to the frames after alignment and screwed to the concrete floor.

Detailed description of installation (Fig. 3.2.1.2.1)

- Position the first foundation frame in the correct location on the concrete floor.
- Position the shims (1) below the screws (2). 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. Counter the screws (2) with the nuts (3) after aligning the frame.
- Position the second foundation frame and align the frame as described for the first frame. Screw the adjacent frames together using three cheese head screws M 8 x 110 (M 8 x 140, if at least one of the two frames to be bolted has a width of 840 mm) using two washers 8 and a hexagon nut M 8 each.
- Align the foundation frame vertically as described above.
- Install the following foundation frames in the same way.
Note on the required welding procedure:

When welding, wear personal protective equipment in accordance with the safety regulations. Observe all other relevant safety regulations. Before welding, remove the zinc layer of the components in the area of the welding seams.

- Weld two brackets to each individual frame at the front and rear. Weld three brackets to each side of both frames at the end of the system. The position of the brackets and notes on the weld seam can be found in Fig. 3.2.1.2.2.

- Treat the welded areas and areas without zinc coating with suitable anti-corrosion paint according to the manufacturer’s instructions.

- Fix the welded angles of the Flureisen frames to the concrete floor using one knock-in anchor and one screw with dished washer each.

- Earth the completely assembled frame. Further details on this can be found in the order documents.

Fig. 3.2.1.2.2: Welding the brackets

Section A-A
3.2.1.3 Special considerations
with the raised false floor

Raised false floor sections for panels with voltage transformers in the cable termination compartment must be fitted with an additional supporting beam for the voltage transformers.

Fig. 3.2.2.1: Plan view of a supporting beam for the switchgear when a raised false floor is used: Additional supporting beam for a panel with voltage transformers in the cable termination compartment.
3.3 Assembly of the switchgear

3.3.1 Preparatory work

3.3.1.1 Checking the SF₆ pressure in the gas compartments

– Each panel may consist of one to three gas compartments, depending on the version (see manual HB 645 en). Each gas compartment is fitted with one filling connector (figure 3.3.1.1.1). The filling connectors for the circuit-breaker compartment and the front busbar compartment are located in the low voltage compartment and are accessible from the front when the low voltage compartment door is open. The filling connector for the rear busbar compartment is located behind the top rear cover.

– 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:

1. Dismantle the rear covers on the rear busbar compartments if fitted.
2. Remove the protective cap (2) from the filling connector (1) by turning it counter-clockwise.
3. Do not press the valve pin (3) (figure 3.3.1.1.2) in, as otherwise gas will flow out of the valve.
4. Pull the locking ring (4 in figure 3.3.1.1.3) 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.
5. Check the reading on the scale of the pressure gauge.
6. 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 3281 ft, please contact us.
7. Pull the locking ring of the manometer coupling piece towards the manometer and pull the manometer from the filling connector.
8. Screw the protective cap onto the filling connector.

Fig. 3.3.1.1.1: Filling connector (1) with protective cap (2) in the low voltage compartment

Fig. 3.3.1.1.2: Filling connector (1) with valve pin (3)

Fig. 3.3.1.1.3: Filling connector with pressure gauge, locking ring (4)
3.3.1.2 Greasing the foundation bars

Remove the protective film when a standard foundation frame is supplied. Grease the top surfaces of the foundation frame or raised false floor beams. This facilitates erection and alignment of the panels.

3.3.1.3 Preparing the panels

- During installation, do not tread on the marked pressure relief disks in the roof plates of the panels.
- Dismantle the covers on the cable termination compartments and the covers on the plenums of all panels.
- Dismantle the rear covers on the rear busbar compartments if fitted.

3.3.2 Erection of the panels

- Screw two guide pins to each of the upper brackets of the busbar compartments on the side of the panel to be extended, using nuts and dished washers (see figure 3.3.2.1 a). In the case of sectionaliser panels in double busbar design, there is a further fastening bracket below the busbar bushings of the circuit-breaker compartment. Fasten the guide pins to that bracket using nuts and dished washers (figure 3.3.2.1 b).
- Guide pins are only to be fitted to one of the panels at the joint between two panels. The guide pins remain in the relevant position after erection of the panels and must not be removed.
- Lightly grease the guide pins for better sliding.
- Set up the furthest panel precisely at the specified position.

Fig. 3.3.2.1 a: Fitting guide pins

Fig. 3.3.2.1 b: Additional guide pins in a double busbar sectionaliser panel
Fastening the panels to foundation frames

When the standard foundation frame is used:

- Insert M 8 T-nuts through the holes in the floor plates into the slots in the foundation frame sections. Join the floor plates using washers (1 x washer 8.5 x 30 x 3 and 1 x dished washer 8) and M 8 x 16 cheese head screws to the previously positioned T-nuts (figures 3.3.2.2 a + b).

Fig. 3.3.2.2 a: Fastening the panel to the foundation frame made of aluminum
Fig. 3.3.2.2 b: Fastening the panel to the foundation frame made of aluminum profiles

Slot in the foundation frame section

M 8 T-nut

Fastening of the panel to the foundation frame
Fastening the panels to reinforced foundation frames

Reinforced foundation frames are equipped with internal threads for fastening the panels. They are fastened by means of cheese head screws M 10 x 25 and dished washers, usually using one shim each positioned between the dished washer and the base frame of the panel (Fig 3.3.2.3 d). See Fig. 3.3.2.3 a-d for the position and number of screw connections. The torque for all cheese head screws below 1) and 2) is 40 Nm.

Fig. 3.3.2.3 a: View from above onto the base plate of the panel, fastening of the panel to the reinforced foundation frame, double feeder panel

1) Shim
   Cheese head screw M 10 x 25, 40 Nm
   Dished washer 8

Fig. 3.3.2.3 b: View from above onto the base plate of the panel, fastening of the panel to the reinforced foundation frame, panel width 600 mm (shown: version with inner cone termination system)

Fig. 3.3.2.3 c: View from above onto the base plate of the panel, fastening of the panel to the reinforced foundation frame, panel widths 800 mm or 840 mm (shown: version with inner cone termination system)

2) Cheese head screw M 10 x 25, 40 Nm
   Dished washer 8
When a special foundation frame or raised false floor is used:

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

Remove the protective caps (figure 2.3.2.4) from the busbar sockets.
Check the busbar sockets, the insulating parts and the contact tubes of the relevant panel as specified in section 3.1.3.

Prepare the busbar sockets, contact tubes and insulating parts for the relevant panel (clean and grease as necessary) as described in section 3.1.3. Protect the components from soiling.

– Then, carefully insert the contact tubes into the previously installed panel up to the stop, and then insert the insulating parts (figure 3.3.2.5).

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

Align the contact tubes horizontally.

– Slide the extension panel carefully against the existing system without tipping it, in such a way that the contact tubes slide into the busbar sockets and the guide pins into the corresponding bores in the fastening bracket.

![Fig. 3.3.2.5: Fitted contact tubes and silicone insulating parts](image1)

![Fig. 3.3.2.6 a: Coupling of the panels](image2)

![Fig. 3.3.2.6 b: Coupling of the panels](image3)
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.

− As soon as the distance between the two panels is appropriately small, connect the fastening brackets of two adjacent busbar compartments with three M 10 x 50 cheese head screws (per busbar compartment), dished washers and nuts (figure 3.3.2.6). Initially, only lightly tighten the bolt connection.

Fig. 3.3.2.7: Bolting the panels together

− Connect the brackets on the adjacent busbar compartments with one M 8 x 40 cheese head screw, nut and washers for each connecting point (figure 2.3.2.7). A spacer is used to bridge the distance between the two brackets (figure 3.3.2.8). In the case of the rear busbar compartment with the cover removed, the brackets are accessible from the rear, and in the case of the front busbar compartment they are accessible from the front when the low voltage compartment is open. Initially, only lightly tighten the bolt connection.

− Connect the two panels together by tightening the screws across the diagonal at the points marked in figures 3.3.2.9 - 12. Fully tighten the bolted connections shown in figures 3.3.2.7 and 3.3.2.8 across the diagonal.

− Check the alignment of the panel and fasten it to the foundation frame rails as described above.

Fig. 3.3.2.8: Bolting the panels together (view of the busbar compartment from the rear)
Fig. 3.3.2.9: Panel joints for double busbar panel

Fig. 3.3.2.10: Panel joints for single busbar panel, busbar at front

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

2) Hexagon screw, M 8 x 25
   Dished washer, 8

3) Cheese head screw, M 8 x 25
   Dished washer, 8

4) Spacer
   Cheese head screw, M 8 x 40
   Nut, M 8
   2 x dished washer, 8
   (see figure 3.3.2.8)

5) Cheese head screw, M 10 x 50
   Nut, M 10
   2 x dished washer 10
   (see figure 3.3.2.7)
Fig. 3.3.2.11: Panel joints for single busbar panel, busbar at rear

Fig. 3.3.2.12: Panel joints for sectionaliser panel with double busbar

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

2) Hexagon screw, M 8 x 25
Dished washer, 8

3) Cheese head screw, M 8 x 25
Dished washer, 8

4) Spacer
Cheese head screw, M 8 x 40
Nut, M 8
2 x dished washer, 8
(see figure 3.3.2.8)

5) Cheese head screw, M 10 x 50
Nut, M 10
2 x dished washer 10
(see figure 3.3.2.7)
- Lead the control wiring for the panel-panel connection through the opening in the adjacent panel.

- Connect the grounding bars of the panels together (figure 3.3.2.13) by dismantling the grounding link fitted at the works for transport, guiding it through the opening to the adjacent panel and tightening the screws with the specified torque.

- Install the further panels in the manner described in section 3.3.2.
3.3.3 Closure of extendable busbar sockets

On the outer sides of the end panels, extendable busbar sockets are as a rule fitted with insulating blanking plugs at the works. This can be seen from the pressure plates mounted at the sides of the busbar compartments of the extendable panels (figure 3.3.3.1). The pressure plates are used to fasten the insulating blanking plugs in place.

If extendable busbar sockets at the ends of the end panels are not closed off with insulating blanking plugs, the blanking plugs must be fitted at site in accordance with section 3.1.3 and with the aid of the assembly drawings provided.

Operation of the switchgear with open busbar sockets (including those in the course of the busbars, e.g. in sectioniser panels, etc.) is not permissible!

Fig. 3.3.3.1: Blanking plugs for busbar sockets
3.3.4 Installation of plenums and end covers

Plenums and the end covers are to be installed in accordance with the assembly drawings supplied with the panels.

3.3.5 Handling of voltage transformers

As a rule, voltage transformers for feeder measurement (transformers of metering 1 in figure 3.3.5.1) are supplied fitted and ready for operation. These voltage transformers must be dismantled prior to installation of the cables and re-installed after high voltage testing of the switchgear system.

Voltage transformers for integrated busbar measurement (transformers of metering 2 in figure 3.3.5.1) are supplied loose and have to be installed at site after high voltage testing.

Wire the transformers after installation according to chapter 3.3.5.8.

The weight of a voltage transformer can be over 66 lbs. Use suitable lifting gear (e.g. a mobile gantry crane) to install the voltage transformers for integrated busbar measurement (type 2). We recommend having installation performed by two fitters. Observe the relevant accident prevention regulations in the country of installation.
3.3.5.1 Dismantling of voltage transformers (metering 1)

If the switchgear is in operation:

- Isolate the relevant outgoing feeder panel before dismantling the voltage transformers.
- Comply with the safety regulations of EN 50110.
- Test the feeder panel for the off-circuit condition in accordance with section 6.1.
- Ground the feeder panel and secure the working area in accordance with section 5 and EN 50110 standard.
- Switch the MCBs ¹ for the relevant operating mechanisms off so that the feeder panel cannot be switched on by remote control.

Fig. 3.3.5.1.1: View from the rear into the cable termination compartment with the cover removed: position of the fastening screws for the lower crossbeam

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³ MCB: miniature circuit breaker

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Fig. 3.3.5.1.2: Installation position of the voltage transformers secured by retaining plate and padlock

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Fig. 3.3.5.1.3: Locking knob and locking plate

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- Remove the cover from the cable termination compartment.
- Dismantle the lower crossbeam in the cable termination compartment by removing the screws marked in figure 3.3.5.1.1.
- Disconnect the plugs for the secondary wiring of the voltage transformers.
- Remove the padlock (figure 3.3.7.1.2), slide the retaining plate to the right and also remove it. Store the parts for further use.

Only disengage the locking knob (figure 3.3.5.1.3) when the relevant voltage transformer is supported by the assembly aid (also named “VT-truck compact”) as described below.

- Start dismantling with the middle voltage transformer. Insert the assembly aid into the cable termination compartment up to the stop. Allow the assembly aid to engage with the stop.

---

Padlock Retaining plate
- Crank the assembly aid up to the stop (= baseplate of the voltage transformer), ensuring that the centerring washers in the assembly aid are in line with the bores in the base plate of the voltage transformer.

- Disengage the locking plate by sliding the locking knob to the right (figure 3.3.5.1.3). The locking plate is pressed outwards by approximately 0.8 inches, thus releasing the voltage transformer.

**Fig. 3.3.5.1.4:** Crank for assembly aid

- Crank the voltage transformer down until the stop is reached (figure 3.3.5.1.6).

- Disengage the assembly aid (figure 3.3.5.1.6) and roll the assembly aid with voltage transformer out of the panel.

- Lift the voltage transformer off the assembly aid using the lifting handle (figure 3.3.5.1.7).

- Dismantle the further voltage transformers in the same way.

- Fit the protective caps supplied to protect the silicone insulating parts of the voltage transformers from soiling and damage.

- Close off the open voltage transformer sockets with insulating blanking plugs prior to bringing the panel on line or performing high voltage testing.

- Refit the lower crossbeam in the cable termination compartment (figure 3.3.5.1.1).

- Hang the cover of the cable termination compartment in position and screw the cover tight.

**Fig. 3.3.5.1.5:** Assembly aid (also named “VT-truck compact”) in the cable termination compartment beneath a voltage transformer

**Fig. 3.3.5.1.6:** Disengaging the assembly aid

**Fig. 3.3.5.1.7:** Voltage transformer with lifting handle

- Lift the voltage transformer off the assembly aid using the lifting handle (figure 3.3.5.1.7).
3.3.5.2 Installation of voltage transformers (metering 1)

If the switchgear is in operation:

- Isolate the relevant outgoing feeder panel before installing the voltage transformers.
- Comply with the safety regulations of EN 50110.
- Test the feeder panel for the off-circuit condition in accordance with section 6.1.
- Ground the feeder panel and secure the working area in accordance with section 5 and EN 50110 standard.
- Switch the MCBs for the relevant operating mechanisms off so that the feeder panel cannot be switched on by remote control.

- Remove the cover from the cable termination compartment.
- Dismantle the lower crossbeam in the cable termination compartment by removing the screws marked in figure 3.3.5.1.1.
- Remove the padlock from the retaining plate (figure 3.3.5.1.2) and slide the retaining plate to the right. Remove the retaining plate and store the parts for further use.
- Deblock the locking knobs (3.3.5.1.3) for the three phases one after another (= slide them to the right). The locking plates (5.6) are pressed outwards by approximately 0.8” in that process.
- First install the two outer voltage transformers and then the middle voltage transformer as described below.
- Remove the protective caps from the silicone parts of the voltage transformers and store them for further use.

Check the silicone part of the voltage transformer for damage. Observe the notes in section 3.1.3.

Clean and grease the silicone insulating part of the voltage transformer as described in section 3.1.3.

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

Ground the threaded bores in the voltage transformer sockets by fitting them with countersunk screws, DIN 7991, M8 x 30 (unless already fitted). (Figure 3.3.5.2.1).

Clean the voltage transformer socket as described in section 3.1.3.

- Position the assembly aid in front of the cable termination compartment. Place the voltage transformer on the assembly aid using the transport shackle (a correct position is obtained with the aid of two centering washer on the assembly aid and bores in the base plate of the voltage transformer).
- Roll the assembly aid bearing the voltage transformer into the intended position below the voltage transformer sockets in the cable termination compartment and engage it with the stop.
- First crank the voltage transformer up by a few inches only and ensure that the silicone insulating part of the voltage transformer can be inserted into the socket without obstruction. Crank the voltage transformer up until the bore in the retaining plate of the transformer is aligned with the locking pin (figure 3.3.5.2.2). This is the case when the locking plate can be pressed into the locking position.

MCB: miniature circuit breaker
- When the locking plate has been pressed into the locking position, slide the locking knob to the left into its limit position (figure 3.3.5.2.2). The voltage transformer is then fixed in the correct position.

- Lower the voltage transformer truck by turning the crank until the stop is reached.

- Disengage the assembly aid (figure 3.3.5.1.6) and remove it from the cable termination compartment.

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

- Install the further voltage transformers in the same way.

- Fit the retaining plate and secure it with the padlock (figure 3.3.5.2.2).

- Insert the secondary side plugs into the sockets provided on the voltage transformers. Lock the plugs in place with the integrated clamps.

  Ensure that the plugs are correctly assigned to the relevant voltage transformers.

- Refit the lower crossbar in the cable termination compartment. (figure 3.3.5.1.1).

- Fit and screw in the cover of the cable termination compartment.

Fig. 3.3.5.2.2: Cranking the voltage transformer up until the locking pin is aligned with the bore
3.3.5.3 Installation of voltage transformers (metering 2)

If the switchgear is in operation:

- Isolate the relevant switchgear section before installing the voltage transformers.
- Comply with the safety regulations of EN 50110.
- Test the switchgear section for the off-circuit condition in accordance with section 6.1.
- Ground the switchgear section and secure the working area in accordance with section 5 and EN 50110 standard.
- Switch the MCBs \(^1\) for the relevant operating mechanisms off so that the switchgear section cannot be switched on by remote control.

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

   ![Check the silicone part of the voltage transformer for damage. Observe the notes in section 3.1.3.](image)

   ![Clean and grease the silicone insulating part of the voltage transformer as described in section 3.1.3.](image)

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

   ![Clean the voltage transformer socket as described in section 3.1.3.](image)

\(^1\) MCB: miniature circuit breaker
Voltage transformers for operating voltages > 24 kV

Ground the threaded bores in the voltage transformer sockets by fitting them with countersunk screws, DIN 7991, M 8 x 30 (unless already fitted). (Figure 3.3.5.2.1).

− In the case of systems with an operating voltage > 24 kV, hexagonal pins are used to fasten the voltage transformers. Screw the hexagonal pins to the studbolts on the enclosure (tightening torque 9.2 ft·lbf) as shown in figure 3.3.5.3.1.

− Slowly and carefully insert the transformer into the socket. The plug-in connection must slide easily into the corresponding socket. Check the position of the silicone parts in relation to the socket continuously and correct if necessary. A counter-pressure will become noticeable approximately 0,8” before the limit position is reached.

− Initially, only fasten the voltage transformer with screws at the points marked in figure 3.3.5.3.2. Install the further voltage transformers in the same way.

Fig. 3.3.5.3.1: Hexagonal pins for fastening of the voltage transformer

Fig. 3.3.5.3.2: Fastening of the voltage transformer, version for operating voltage > 24 kV

2 x cheese head screw, M 10 x 25 DIN 912
2 x dished washer, 10 DIN 6796
Voltage transformers for operating voltages up to 24 kV

- Remove the three grounding screws (figure 3.3.5.3.1) on the flange of the voltage transformer socket, if fitted.

- Slowly and carefully insert the transformer into the socket. The plug-in connection must slide easily into the corresponding socket. Check the position of the silicone parts in relation to the socket continuously and correct if necessary. A counter-pressure will become noticeable approximately 0.8” before the limit position is reached.

- Screw the flange of the voltage transformer to the voltage transformer socket (see figure 3.3.5.3.3) in the panel, tightening the screws across the diagonal.

The further installation procedure is identical for both types of voltage transformer.

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

- Screw the fastening bracket to the roof plate of the plenums as shown in figure 3.3.5.3.4.

---

**Fig. 3.3.5.3.3:** Fastening of the voltage transformer, version for operating voltage up to 24 kV

3 x cheese head screw M 8 x 40 DIN 912
3 x washer 8,4 DIN 433
3 x spring washer A8 DIN 127

**Fig. 3.3.5.3.4:** Fitting the fastening bracket

Fastening bracket
3 x cheese head screw M 8 x 20 DIN 912
3 x dished washer 8 DIN 6796
- Fasten the transformer cover to the previously fitted fastening bracket and to the top plates of the voltage transformers (figure 3.3.5.3.5).

- Lead the transformer wiring through the gland in the transformer cover.

- Wire the transformers as set out in section 2.3.5.5.

- Install the damping resistor if necessary (figure 3.3.5.3.6).

- Lead the wiring for the damping resistor through the gland in the transformer cover.

- If required, wire and mount the damping resistor according to figure 2.3.5.3.6 and chapter 2.3.5.6.

- Fit the cover plate (figure 3.3.5.3.6).

---

Fig. 3.3.5.3.5: Assembly of the transformer cover

Fig. 3.3.5.3.6: Fitting the damping resistor and the cover plate

6 x cheese head screw, M 10 x 25 DIN 912
6 x dished washer 10 DIN 6796

Damping resistor
8 x self-tapping screw M 6 x 12

Transformer cover
4 x cheese head screw, M 8 x 25 DIN 912
4 x dished washer, 8 DIN 6796

Cover
2 x self-tapping M 6 x 12
Installation of the casing (figure 3.3.5.3.7)

- First fit the C section above the transformer cover. Use the available transformer fastening screws.

- Screw the two side plates to the inside of the transformer cover.

- Screw the rear cover to the side covers.

- Finally fasten the top plate to the plates previously fitted.

Fig. 3.3.5.3.7: Installation of the casing

- 14 x cheese head screw M 8 x 25 DIN 912
- 14 x dished washer 8 DIN 6796
- 6 x cheese head screw M 10 x 25 DIN 912
- 6 (12) x dished washer 8 DIN 6796
- (Hexagonal nut M 8 DIN 934)
- (Material for 24 kV voltage transformers in brackets)
3.3.5.4 Dismantling of voltage transformers (metering 2)

If the switchgear is in operation:

- Isolate the relevant switchgear section before dismantling the voltage transformers.
- Comply with the safety regulations of EN 50110.
- Test the switchgear section for the off-circuit condition in accordance with section 6.1.
- Ground the switchgear section and secure the working area in accordance with section 5 and EN 50110 standard.
- Switch the MCBs for the relevant operating mechanisms off so that the switchgear section cannot be switched on by remote control.

- Dismantle the cover plate (figure 3.3.5.3.7).
- Dismantle the wiring for the voltage transformers and the damping resistor as far as necessary.
- Dismantle the transformer cover (figure 3.3.5.3.5).
- Start the dismantling procedure with one of the outer voltage transformers.

Voltage transformers for operating voltages > 24 kV

- Remove the two screws on the hexagonal pins as shown in figure 3.3.5.3.2.

Voltage transformers for operating voltages up to 24 kV

- Remove the screws in the flange of the voltage transformer.

The further dismantling procedure is identical for both types of voltage transformers.

- Draw the voltage transformers vertically out of the sockets.
- Cover the silicone insulating parts of the voltage transformers with the protective caps supplied to protect them from soiling and damage.
- Remove the three grounding screws (figure 3.3.5.3.1) on the flange of the voltage transformer socket, if fitted.

---

1) MCB: miniature circuit breaker

Close off the open voltage transformer sockets with insulating blanking plugs prior to bringing the panel on line or performing high voltage testing.
3.3.5.5 Wiring of the voltage transformers

The voltage transformers are fitted with terminal boards. The possible configurations of terminal boards can be found in figure 3.3.5.5.1 and table 3.3.5.5.1.

Table 3.3.5.5.1: Possible terminal board configurations

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

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.
Grounding of terminals on the voltage transformer terminal board using grounding screws

Connections to ground potential can be established by means of grounding screws on the terminals of the terminal board. Figure 3.3.5.5.2 illustrates this using the example of a voltage transformer with one secondary winding.

Fig. 3.3.5.5.2: Grounding of terminals using grounding 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 grounding of the voltage transformers in accordance with the circuit diagrams.
- Check that all terminal screws including the grounding screws are tightly fastened.
- Releasing the grounding screw on the 'N' terminal leads to potentially lethal high voltage at the terminal when the voltage transformer is in operation!
- Releasing the grounding screw on the 'N' terminal is only permissible for test purposes on voltage transformers with de-energized primary!
- Always use the original grounding screws!
Grounding 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 grounded at one point. The circuit can be grounded

- in the low voltage compartment (figure 3.3.5.5.3) or
- on the terminal block of a voltage transformer (figure 3.3.5.5.4).

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

Fig. 3.3.5.5.3: Grounding of the circuit in the low voltage compartment

Do not ground here!

Without grounding screw on terminal "dn"
Remove the grounding screws of the open delta windings from the terminal boards of the voltage transformers in accordance with the circuit diagrams (figure 3.3.5.5.5) or ground the open delta windings using the grounding screw (figure 3.3.5.5.6).

Ground the circuit at one point only.

Fig. 3.3.5.5.5: View of the terminal board of a voltage transformer with open delta winding: Grounding screw (arrow) in isolated position (no grounding)

Fig. 3.3.5.5.6: View of the terminal board of a voltage transformer with open delta winding: Grounding screw (arrow) in grounding position (dn terminal grounded)
Checking the wiring

Finally, check the grounding system of the voltage transformer wiring in accordance with table 3.3.5.5.2.

<table>
<thead>
<tr>
<th>Number</th>
<th>Tap</th>
<th>open delta winding</th>
<th>Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>N</td>
<td>a</td>
</tr>
<tr>
<td>1</td>
<td>●</td>
<td>N</td>
<td>a</td>
</tr>
<tr>
<td>1</td>
<td>●</td>
<td>N</td>
<td>a1</td>
</tr>
<tr>
<td>1</td>
<td>●</td>
<td>N</td>
<td>a1</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>N</td>
<td>1a</td>
</tr>
<tr>
<td>2</td>
<td>●</td>
<td>1a</td>
<td>1n</td>
</tr>
<tr>
<td>2</td>
<td>●</td>
<td>1a1</td>
<td>1a2</td>
</tr>
</tbody>
</table>

The terminal must be grounded via the grounding screw!

Grounding of the terminal in accordance with the circuit diagram!

Grounding screw fitted in accordance with the circuit diagrams and figures 3.3.5.5.3 to 3.3.5.5.6!

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.
3.3.5.6 Installation of damping resistors

Damping resistors, if required, are usually mounted on site. The intended position depends on the type of the panel. Take the respective position of Fig. 3.3.5.6.1.

Wiring of the damping resistors

The damping resistors have several taps. The clamps of the taps are marked with resistance values in ohms (Fig. 3.3.5.6.2). 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.
3.4 Connecting the main grounding bar

- Connect the main grounding bar to the station ground.

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

3.5 Connection of cables and wiring

3.5.1 Control cables and wiring

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

3.5.2 High voltage cables

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

- Dismantle the cable supports within the cable compartment. Dismantle the floor plates of the cable termination compartments. Remove the cable bushings from the floor plates.
- Lay the high voltage cables to the panels in accordance with the project planning.

Ensure that the phase positions of the cables are correct!
- Slide the cable bushings over the cables.
- Connect the cable connectors to the cables in accordance with the manufacturer's instructions.

Checking the cable sockets and/or the outer cones

Check the cable sockets and/or the outer cones for damage. If there is damage to the outer cones, please contact our service department.

Cleaning the cable sockets and/or the outer cones

Remove any surplus or dirty grease or soiling from the cable sockets and/or 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 cable sockets or outer cones in accordance with the manufacturer's instructions.
- Observe the tightening torques for screw connections given in the cable connector manufacturer's instructions.
- Refit the floor plates. Press the cable bushings into the openings provided in the floor plates.

Refit the cable supports and fasten the high voltage cables with the aid of the cable clamps to the cable supports.
- Connect the grounding conductors of the cable screens to the grounding bar in the panel.
- If window-type current transformers are used, route the grounding conductors of the cable screen back through the current transformers and connect the grounding conductor to the grounding bar in the panel.

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

- Refit covers of the cable compartment.
3.6 Fitting surge arresters

If the switchgear is in operation:

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

- Prepare the surge arresters in accordance with the manufacturer’s instructions.
- Install the surge arresters in accordance with the manufacturer’s instructions.
- Connect the grounding terminal of the surge arrester to the main grounding bar of the panel using the wires provided (cross section 25 mm² (approximately AWG 3) with cable lugs), as shown in figure 3.6.1. Configure the connection of the grounding leads to the surge arrester in accordance with the manufacturer’s instructions.
- Fit and screw in the cover of the cable termination compartment.

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**Fig. 3.6.1: Grounding of surge arresters**

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MCB: miniature circuit breaker
3.7 Fitting blanking plugs

Innercone sockets (cable sockets and sockets for voltage transformers) are equipped with dust covers (figure 3.7.1) on the factory side.

The dust covers are not voltage-proof. Close unused cable sockets and voltage transformer sockets with voltage-proof blind plugs (figure 3.7.2) as follows:

- Treat the silicone insulating parts of the blanking plugs and the sockets for the voltage transformers as described in section 3.1.3.
- Remove the three grounding screws (figure 3.7.2.1) on the flange of the voltage transformer socket, if fitted.
- Insert the blanking plugs into the sockets and, without tilting them, fasten them in place by tightening the screws across the diagonal to the specified tightening torque (section 3.1.2).

3.8 Fitting insulating covers for unused outer cones

Close off all unused outer cones with insulating covers in accordance with the manufacturer’s instructions.

3.9 Concluding installation work

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

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

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

4.1 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 mechanisms has been successfully performed.
− Testing of the panel and switchgear interlocks has been successfully performed.
− Several trial switching operations (without service voltage) on all switching devices have been successfully performed.
− Switch positions are correctly displayed on the panels and – if necessary – in the control room.
− If remote control systems are fitted, these have been successfully tested.
− Unused cable sockets, voltage transformer sockets and extendable busbar sockets have been closed off with insulating blanking plugs.
− Unused outer cones have been closed off and insulated.
− High voltage testing at 80 % of rated short-duration power-frequency withstand voltage \( U_d \) to IEC 62271-200 has been passed.
− High voltage cables have been installed (after performance of high voltage testing).

− All cladding and covers have been fitted.

The following accessories have been handed over to the operators:

− This manual,
− the corresponding documents and order documents,
− double bit key or barrel lock key for opening and closing of the low voltage compartment doors,
− levers and cranks for operation of the operating mechanisms (see list of accessories),
− grounding set (optional),
− plug-in indicator unit for capacitive indication – if necessary (see section 6.1),
− phase comparator in the case of more than one incoming feeder (optional),
− crank for voltage transformer truck.
− A work instruction for handling of SF₆ (an example can be found in instruction manual HB 645 en) 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.
4.2 Energizing the system

**Switchgear with single busbar**

- Please consult section 5 for procedures for operating the devices. Also observe section 4.1.
- Close all low voltage compartment doors.
- Switch all circuit-breakers off.
- Switch all three position disconnects off.

**Connecting the incoming feeder panels**

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

Before connecting further incoming feeder panels, ensure that the phase angle of the panels is identical (section 6.2).

**Connecting the outgoing feeder panels**

- Switch the three position disconnect in the outgoing feeder panel to be connected to the “Disconnect ON” position.
- Switch the circuit-breaker in the outgoing feeder panel “ON”.
- The load is then switched on.

Switch the further loads on as described.

The switchgear is in operation.

**Switchgear with double busbar**

- Please consult section 5 for procedures for operating the devices. Also observe section 4.1.
- Close all low voltage compartment doors.
- Switch all circuit-breakers off.
- Switch all three position disconnects and disconnectors off.

**Connecting the incoming feeder panels**

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

Before connecting further incoming feeder panels, ensure that the phase angle of the panels is identical (section 6.2).

**Connecting the outgoing feeder panels**

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

Switch the further loads on as described.

The switchgear is in operation.
5 Operation

− All activities in connection with operation of the switchgear require compliance with EN 50110 standard or relevant national regulations regarding the operation of electrical installations (see also page 6).

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

5.1 General notes

The three switching positions of the three position disconnect, “connecting”, “disconnecting” and “preparing for grounding” are clearly defined by the mechanical structure of the switch and can be visually checked by using view ports. Connecting and disconnecting the operating current and grounding are performed exclusively by the circuit-breaker. For details on how to operate the switches and how to operate the view-ports, please refer to chapters 5.4 to 5.6.

Figures 5.1.5 to 5.1.9 show the operating sequence for grounding of a busbar by means of the bus tie, on the basis of an example switchgear system.

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

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

Please consult the order documents for the conditions of further internal electrical interlocks in the panels (e.g. disconnect – disconnect interlocks in double busbar systems) and panel to panel electrical interlocks.
5.2 Line side grounding and grounding of system sections

When the feeder panel or section of the system has been grounded by operating the grounding switch and circuit-breaker (chapters 5.2.1 to 5.2.3), secure it to prevent cancellation of grounding as follows:

- Switch the MCBs for the circuit-breaker release circuit and for the motor-operated mechanism of the three position disconnect in the relevant panel off.
- Lock the low voltage compartment door or where appropriate the mechanical OFF button for the circuit-breaker (figure 5.2.1).
- Affix a sign to the panel to indicate that grounding has been performed.

Fig. 5.2.1: Secured grounding status by means of locked OFF-button of the circuit-breaker
5.2.1 Line side grounding of panels in single busbar systems

Observe the following single line diagrams for grounding the line side of a feeder panel.

Fig. 5.2.1.1: Line side grounding

5.2.2 Line side grounding of panels in double busbar systems

Observe the following single line diagrams for grounding the line side of a feeder panel (initial situation: panel connected to rear busbar exemplary)

Fig. 5.2.2.1: Line side grounding
5.2.3 Busbar grounding of double busbar systems with bus tie

Figures 5.2.3.1 to 5.2.3.4 show the operating sequence for grounding of busbar 2 (SS2) in an example switchgear system.

Fig. 5.2.3.1: Example switchgear system, double busbar with bus tie, system in operation via busbar 2 (SS2)

Fig. 5.2.3.2: Closing the disconnect (busbar 1) in the bus tie
Fig. 5.2.3.3: Closing the grounding switch (busbar 2) in the bus tie

Fig. 5.2.3.4: Closing the circuit-breaker in the bus tie: Busbar 1 grounded
5.3 Non-interrupting bus transfer

A non-interrupting bus transfer is only possible when the switchgear installation has a bus tie in the related section. The interlocks must be designed for the corresponding switching operations. A non-interrupting bus transfer is only possible with electrical operation of the switches, as the three position disconnect and the disconnect in a panel are mechanically interlocked.

![Warning]

It must be ensured that the voltage levels and phases of both busbars are synchronous.

It is assumed in the following description that a feeder panel (in this case =J01) is to be switched over from busbar 1 (front) to busbar 2 (rear). For details of switch operation, please consult the following sections. The initial situation is shown in figure 5.3.1. Switchover from busbar 2 to busbar 1 is a similar procedure in reverse.

- Close the bus tie (figure 5.3.2)
- Close the disconnect -QBD in the relevant feeder (figure 5.3.3).

Note to the backwards interlocking: As long as both disconnects in one feeder are switched ON, the tripping or manually opening of the bus tie circuit breaker is blocked.

- Open the disconnect -QZD in the relevant feeder (figure 5.3.4).
- Open the bus tie (figure 5.3.5).

Fig. 5.3.1: Initial situation – outgoing feeder =J01 in operation on busbar 1
Fig. 4.3.2: Closing the bus tie

Fig. 4.3.3: Closing the disconnect -QBD

Fig. 4.3.4: Opening the disconnect -QZD

Fig. 4.3.5: Opening the bus tie

64 | Manual ZX2 HB 644 en - Revision 03
5.4 Electrical operation

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

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

in general with the low voltage compartment door closed.

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

Use of the protection and control unit

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

Conventional solution (figure 5.4.1)

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

Fig. 5.4.1: Standard solution for conventional control and display at the panel
5.5 Emergency manual operation

Upon failure of auxiliary voltage, the charging motor of a circuit-breaker or the operating mechanism motor of a three position disconnect or disconnect, refer to emergency manual operation.

In the case of double busbar panels, no uninterrupted change of busbar is possible in emergency manual operation when a mechanical interlock is used, as the interlock prevents simultaneous closing of both disconnects in an outgoing feeder panel.

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

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

Electrical protection against maloperation is then ineffective.

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

5.5.1 Emergency manual operation of the circuit-breaker

Controls for the circuit-breaker operating mechanism

The front of the operating mechanism (figure 5.5.1.1) accommodates the mechanical on (1) and off (2) pushbuttons, the receptacle for manual charging of the stored-energy spring (3), the mechanical indicators for “Circuit-breaker ON” “Circuit-breaker OFF” (4), “Stored-energy spring charged”, “Stored-energy spring discharged” (5), an operating cycle counter (6) and the name plate for the circuit-breaker (7).

Operation

− Before operating the circuit-breaker, observe the switch position indicator (4) in figure 5.5.1.1.

− Before pressing a push button, the flap in front of the push button must be unlocked and the flap must be turned to the right.

− On failure of auxiliary voltage, it is possible to open the circuit-breaker using the mechanical OFF button at any time. Closing of the circuit-breaker with the mechanical ON button is dependent on the stored energy spring mechanism being charged. The condition of the stored energy spring mechanism is displayed mechanically (figure 5.5.1.1).

− On failure of auxiliary voltage or the stored energy spring charging motor for the circuit-breaker, the charging process can be carried out or completed manually.

− To do this, insert the charging lever (8 in figure 5.5.1.2) into the receptacle and perform approximately 25 strokes until the charged condition is indicated.

− When the charged condition is reached, the charging mechanism is disengaged, and no further movements of the charging lever can be made.

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

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

1) MCB: miniature circuit breaker
Fig. 5.5.1.1: Control side of the circuit-breaker operating mechanism

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

Indication of spring discharged

Indication of spring charged

Fig. 5.5.1.2: Manual charging of the stored energy spring

8. Charging lever
5.5.2 Emergency manual operation of the three-position disconnect and the disconnect

Operator control area of the three-position disconnect mechanism

The operator control area of the three position disconnect operating mechanism (figures 5.5.2.1 and 5.5.2.2) consists of the mechanical switch position indicators ((1) for the grounding switch, (2) for the disconnect), the mechanical access lock (3) and the hand crank receptacle (4).

Operator control area of the disconnect mechanism

The operator control area of the disconnect operating mechanism (figure 5.5.2.3) consists of the mechanical switch position indicator (2), the mechanical access lock (3) and the hand crank receptacle (4).

**Fig. 5.5.2.1:** Operator control area of the three position disconnect mechanism with the access lock closed

**Fig. 5.5.2.2:** Operator control area of the three position disconnect mechanism with the access lock open

**Fig. 5.5.2.3:** Operator control area of the disconnect mechanism with the access lock open
Conditions for operations

− A crank is required for manual operation of the switch (figure 5.5.2.4).

− Observe the switch position indicator before operating the three position disconnect or the disconnect.

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

− If fitted: Swing the flap of the mechanical access lock to the right (figure 5.5.2.5). (It is not possible to move the flap when the circuit-breaker is closed.)

− In double busbar systems, when the mechanical access lock is used, the three position disconnect and the disconnect in a panel are interlocked. It is possible to move the flap of one switch when the other switch is in the OFF position.

− Insert the crank into the shaft of the three position disconnect mechanism (figure 5.5.2.6).

Always perform switching operations right up to the stop.

Operation of the three-position disconnect

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

Approximately 24 turns of the crank are required from the OFF position of the three position disconnect to the ON position of the grounding switch or disconnect and vice versa.

− Grounding switch OFF ⇒ ON
  
  − To close the grounding switch, turn the crank counter-clockwise until the stop is reached.
  
  − Withdraw the crank.
  
  − Close the flap of the mechanical access lock.

− Disconnect OFF ⇒ ON
  
  − To close the disconnect, turn the crank clockwise until the stop is reached.
  
  − Withdraw the crank.
  
  − Close the flap of the mechanical access lock.
Grounding switch ON ⇒ OFF ⇒ disconnect ON

- Turn the crank clockwise until the stop is reached.
- The three-position disconnect is then in the OFF position.
- Withdraw the crank and reinsert it. Turn the crank clockwise until the stop is reached.
- Withdraw the crank.
- Close the flap of the mechanical access lock.

Disconnect ON ⇒ OFF ⇒ grounding switch ON

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

Operation of the disconnect

- Approximately 24 turns of the crank are required from the OFF position to the ON position of the disconnect and vice versa.

Disconnect OFF ⇒ ON

- To close the disconnect, turn the crank clockwise until the stop is reached.
- Withdraw the crank.
- Close the flap of the mechanical access lock.

Disconnect ON ⇒ OFF

- Turn the crank counter-clockwise until the stop is reached.
- Withdraw the crank.
- Close the flap of the mechanical access lock.

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

The three position disconnect and the disconnect can be fitted with a blocking magnet -RLE1. In certain situations, the blocking magnet prevents the devices from being operated. On failure of auxiliary voltage, the blocking magnet permanently prevents the access lock from being opened. Deblocking of the blocking magnet requires work on the operating mechanism and may only be performed by qualified personnel. Please contact the ABB Service Department if required.
5.6 View ports

The switchgear is equipped with view ports to safely verify the contact positions of the busbar three-position disconnect and the busbar disconnect. The locations of these view ports are shown in figure 5.6.1 below.

![Fig. 5.6.1: Positions of the view ports](image)

To open the view port cover, move the bolt upwards and to the left as shown in figure 5.6.2. When you have finished using the view ports, close the cover by moving the bolt in the reverse direction.

Visual checking of the switch position, using the example of the three-position switch in busbar compartment I:

- Move the switch.
- Open the view port cover.
- Point a flashlight through one view port, and check the position of the moving contact through the other view port. Always use the best view port for viewing when checking the three phases of a switch.

![Fig. 5.6.2: View ports, closed](image)

![Fig. 5.6.3: View ports, open](image)

The view port must be closed during movement of a switching device to prevent possible damage to the unprotected eye.
5.6.1 Switch position grounding switch CLOSED

The red mark on the moving contact must be flush against the face of the central part of the disconnect switch (moving contact bridges central part of disconnect switch and grounding switch contact - figures 5.6.1.1 and 5.6.1.2).

Fig. 5.6.1.1: Switch position grounding switch CLOSED

Fig. 5.6.1.2: Switch position grounding switch CLOSED (viewed through view port)

5.6.2 Switch position OPEN

The sliding contact is in the central part of the disconnect, such that the face surface of the sliding contact is flush with the face surface of the central part of the disconnect (central position of the sliding contact - see figures 5.6.2.1 and 5.6.2.2).

Fig. 5.6.2.1: Switch position OPEN

Fig. 5.6.2.2: Switch position OPEN (viewed through view port)
5.6.3 Switch position disconnect switch CLOSED

The red mark on the moving contact must be flush against the face of the disconnect switch contact (moving contact bridges central part of disconnect switch and disconnect switch contact - see figure 5.6.3.1).

Fig. 5.6.3.1: Switch position disconnect switch CLOSED
5.7 Gas monitoring with density sensors

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

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

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

5.8 Operation of the isolating device for voltage transformers

The voltage transformers in the metering panel can be isolated manually from the corresponding switchgear section. Cross-sections of these panels showing the positions of the controls can be found in figure 5.8.1.

The isolating devices may only be operated when the switchgear section concerned is in the off-circuit condition.

Fig. 5.8.1: A) Position of the controls for the voltage transformer isolating device
5.8.1 Operation of the isolating device for voltage transformers in metering panels

- Isolate the relevant switchgear section before connecting or disconnecting voltage transformers.
- Comply with the safety regulations to EN 50110.
- Check the switchgear section for the off-circuit condition as described in section 6.1.
- Ground the switchgear section and secure the working area in accordance with section 5 and EN 50110 standard.
- Switch the MCBs \(^1\) of the relevant operating mechanisms off in order to prevent the switchgear section being energized by remote control.

The controls and displays for the voltage transformer isolating device can be found behind the flap. Observe warning label (7). Check the switch position indicator (6).

Grounding the voltage transformers

To ground the voltage transformers, pull out the lock knob (3) and turn the operating lever (4) with a key (see accessories) counter-clockwise as shown on the direction of rotation indicator (5). Release the lock knob. Turn the operating lever counter-clockwise until the lock knob engages in the limit position of the isolating device.

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

Close flap (2) and secure the isolating device with a padlock.

Connecting the voltage transformers

To connect the voltage transformers, pull out the lock knob (3) and turn the operating lever (4) with a key (see accessories) clockwise as shown on the direction of rotation indicator (5). Release the lock knob. Turn the operating lever clockwise until the lock knob engages in the limit position of the isolating device.

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

Close flap (2) and secure the isolating device with a padlock.

Fig. 5.8.1.1: Controls and displays for the voltage transformer isolating device with flap (2) opened

The isolating device can be secured with a padlock. Remove the padlock prior to operation. Swing flap (2) to the left.

---

1) MCB: miniature circuit breaker
6 Test procedures

6.1 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 6.1.1.1 to 6.1.2.5):

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

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.

6.1.1 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.

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.

6.1.2 KVDS, CAVIN system and Wega Systems

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

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

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

Observe the instruction manual for the phase comparator.

6.3 High voltage tests

Panels with inner cone

The test voltage is applied via the test socket on the panel (inner cone, size 2).

Panels with outer cone

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 plug system used.

6.3.1 Cable tests with DC-voltage

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

Comply with the safety regulations to EN 50110.

- Isolate the panel whose cables are to be tested in accordance with section 5.
- Test the outgoing feeder for the off-circuit condition as described in section 6.1.

- Ground the outgoing feeder and secure the working area in accordance with section 5 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.

- Dismantle the cover on the relevant cable termination compartment.

Dismantle plugged-in transformers in the relevant outgoing feeder as described in section 3.3.6 or remove the blanking plugs from the test sockets.

Close off any free cable sockets with blanking plugs.

Dismantle any surge arresters in the relevant outgoing feeder in accordance with the manufacturer’s instructions.

Short-circuit the sockets for the capacitive indicator system in the outgoing feeder using the short-circuiting plug.

Short-circuit the cores of the current transformers concerned which are located in gas compartments and ground them.

Panel with inner cone sockets

- Fit test plugs or test cables to test sockets of the panel.

Panel with outer cones

- Fit the high voltage testing set to the (outer cone) plug system of the panel in accordance with the manufacturer’s instructions.

Test sequence

- Establish the test circuit in accordance with the manufacturer’s directions for the test apparatus.
- Cancel the grounding of the system section to be tested before applying the test voltage by opening the circuit-breaker.
- Perform the cable test in accordance with the manufacturer’s directions for the test apparatus.
- Ground the system section on completion of individual tests and on conclusion of testing by closing the circuit-breaker.
- Dismantle the test cables or test plugs.

1) MCB: miniature circuit breaker
6.3.2 Voltage test of the main circuit

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

Comply with the safety regulations to EN 50110.

− Isolate the section to be tested in accordance with section 5.

− Test the switchgear sections for the off-circuit condition as described in section 6.1.

− Ground the section to be tested and secure the working area in accordance with EN 50110 standard.

− Switch the MCBs of the relevant operating mechanisms off in order to prevent the switchgear section being energized by remote control.

If there are busbar metering panels within the system section to be tested, isolate the relevant voltage transformers in the metering panels by operating the isolating device (see section 4.5).

Dismantle plugged-in voltage transformers within the system section to be tested (see section 2.3.6).

Dismantle any surge arresters within the system section to be tested in accordance with the manufacturer’s instructions.

Close off free (inner cone) sockets within the system section to be tested with insulating blanking plugs.

Close off free outer cones within the system section to be tested with insulating blanking plugs in accordance with the manufacturer’s instructions.

Short-circuit the cores of the current transformers concerned which are located in gas compartments and ground them.

Application of test voltage via a panel with inner cone sockets

− Fit test plugs or test cables to test sockets or free cable sockets in the panel to which the test voltage is to be applied.

Application of test voltage via a panel with outer cones

− Fit the high voltage testing set to the (outer cone) plug system of the panel to which the test voltage is to be applied, in accordance with the manufacturer’s instructions.
Test sequence

- Connect the test transformer to the test plug or test cable and ground the other two phases of the main circuit.
- Connect the second terminal of the test transformer to system ground.
- Connect other sections of the switchgear to be tested by operating the relevant disconnects and circuit-breakers.
- Cancel the grounding of the system section to be tested before applying the test voltage.
- Perform the high voltage test.
- Ground the system section on completion of individual tests and on conclusion of testing.
- Dismantle the test cables or test plugs.
- Fit any surge arresters and voltage transformers required.
- Close off any free test sockets and cable sockets with blanking plugs.
- Close off free outer cones with insulating blanking plugs in accordance with the manufacturer’s instructions.
- Cancel any isolation of voltage transformers in metering panels.
- Remove the short-circuiting plugs from the capacitive indicator.
- Refit the cover on the cable termination compartment.

6.4 Secondary protection testing

Comply with the safety regulations to EN 50110.

- Isolate the feeder panel to be tested in accordance with section 5.
- Test the switchgear section for the off-circuit condition as described in section 6.1.
- Ground the outgoing feeder and secure the working area in accordance with section 5 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 (shut release OFF) for a period of 1000 ms. If this time is exceeded the coil will burn out. For this reason, the protection testing system must be shut down by the OFF command, or the shunt release OFF must be disconnected.

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

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

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

\(^1\) MCB: miniature circuit breaker
6.5 Protection testing by primary current injection

Comply with the safety regulations to EN 50110.

- Isolate the relevant switchgear section in accordance with section 5.
- Test the switchgear section for the off-circuit condition as described in section 6.1.
- Ground the switchgear section and secure the working area in accordance with section 5 and EN 50110 standard.
- Switch the MCBs $^1$ of the relevant operating mechanisms off in order to prevent the switchgear section being energized by remote control.

- Observe the examples of primary side test circuits in figures 6.5.1 and 6.5.2.

If the circuit-breaker is also to be tested, please note that grounding 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).

**Fig. 6.5.1:** Panel with inner cone, test transformer connected to the test socket via a current testing plug, current flow via the current transformer and circuit-breaker to the grounding contact of the three-position disconnect.

**Fig. 6.5.2:** Panel with outer cone, test transformer connected to the cable connector via suitable test leads, current flow via the current transformer and circuit-breaker to the grounding contact of the three-position disconnect.

$^1$ MCB: miniature circuit breaker
Panels with inner cone

Direct access to the conductors for performance of protection tests by primary current injection is possible via current testing plugs which are fitted to the test sockets of the panel.

− Dismantle the cover on the cable termination compartment of the relevant panel.

− Dismantle any voltage transformers fitted as described in section 2.3.6, and also any surge arresters or blanking plugs on the test sockets of the relevant outgoing feeder.

− Clean the current testing plug.

− Insert the current testing plugs into the test sockets and screw the plugs to the sockets.

− Establish the test configuration in accordance with the manufacturer's instructions for the protection testing equipment and perform the protection test.

− Ground the switchgear section after completion of the test.

− Immediately on completion of testing, remove the current testing plugs and replace them with the intended devices (voltage transformers, surge arresters or blanking plugs).

− Refit the cover on the cable termination compartment.

Panels with outer cone

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.

− Dismantle the cover on the cable termination compartment of the relevant panel.

− Fit the testing set in accordance with the manufacturer’s instructions.

− Establish the test configuration in accordance with the manufacturer's instructions for the protection testing equipment and perform the protection test.

− Ground the switchgear section after completion of the test.

− Remove the testing set.

− Refit the insulating ends of the cable connectors in accordance with the manufacturer’s instructions.

− Refit the cover on the cable termination compartment.

7 Service

7.1 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.

7.2 Inspection and servicing of individual components

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

All parts in SF₆ are maintenance-free.

The three position disconnect is maintenance-free for 2000 operating cycles, and the disconnect for 1000 operating cycles.
7.3 Checking the dimensional accuracy of the control wire settings

Check the play on the control wires on the circuit-breaker operating mechanism in the course of an inspection.

The mounting for the control wires of the mechanical interlock is located above the circuit-breaker operating mechanism (figure 6.3.1).

When the access interlock for the three-position disconnect mechanism (figure 6.3.2) is opened, the slide must be directly operated by the control wire. If this is not the case, use the control wire nipple to adjust the control wire so that there is no play with the flap closed.

7.4 Outlet filter

Low voltage compartments with operating currents > 2000 A are fitted with outlet filters. The outlet filters are located on the roof plates of the low voltage compartments. Replace the filter mats when required.

Draw the louvred grating off by gripping the recesses at the bottom end of the filter. Replace the filter mat and snap the louvred grating back into position.

8 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.
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 (ABB part number 1VB8004775R01xx) (figure 3.3.1.1.3)
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, ½", with extensions and 10 to 19 mm AF socket keys and 4 to 10 mm Allen key inserts
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 – 30 ft·lbf, calibrated
1. Torque wrench, 20 – 80 ft·lbf, calibrated
1. Extension cable, 16 A, 15 m
1. Cable drum, 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 5000 lbs) or
2. Hydraulic lift trolleys (recommended capacity 8000 lb per pair)
4. Lifting ropes, 30", recommended capacity 2500 lbs
4. Lifting ropes, 60", recommended capacity 2500 lbs
4. Shackles, capacity 2500 lbs
2. Pinch bars
5. Handling tubes
2. Chain hoists, 600 lbs 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

$\text{SF}_6$ insulating gas

Pressure-liquefied gas in steel cylinders,
Capacity: 11 lbs
Capacity: 88 lbs

- Quality to IEC 60376

Observe sample instruction manual included in manual HB 645 en.

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

In the case of airfreight, the gas compartments of the panels are filled at the works to a reduced insulating gas pressure, and therefore they have to be topped up with $\text{SF}_6$ at site. In this case $\text{SF}_6$ in cylinders is required. Further information on the handling of $\text{SF}_6$ can be found in instruction manual HB 645 en.

If extreme temperatures $\geq 122 \text{ °F}$ during the storage, transport or temporary storage in the open air of the $\text{SF}_6$ cylinders with exposure to sunlight cannot be ruled out, please provide in your order for a reduced filling factor of 0.75 kg/l (6.26 lbs / gal.) for safety reasons.

Filter mats for outlet filters (panels > 2000 A)

10.2 Auxiliary materials

Assembly paste for silicone insulating parts, capacity 3.17 oz.

Cleaning agent for silicone insulating parts, busbar sockets, outer cones and fuse sealing collars Intensive cleaner M.X.T. 60 forte, capacity 0.26 gal.

Paint, standard color RAL 7035, Can, capacity 35 oz.
10.3 Accessories

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

Charging lever for VD4 X operating mechanism (figure 5.5.1.2)  GCE9477394R0101

Accessories for emergency manual operation of the three-position disconnect and the disconnect

Crank for emergency manual operation, length: 31.3 " (standard, figure 5.5.2.4)  GCE7006002R0103
Crank for emergency manual operation, length: 47.6 "  GCE7006002R0102

Accessories for operation of the isolating device in metering panels

Key for isolating device, hex. 17/350  1VB0000038P0100

Accessories for the voltage transformer truck

Crank (figure 2.3.7.1.4 and 2.3.7.3.3)  GCE8008184P0101

Testing accessories

Voltage testing plug up to 36 kV for inner cone, size 2  GCE0920226P0101
Voltage testing plug up to 36 kV for inner cone, size 3  GCE0920226P0102
Voltage testing cable up to 36 kV for inner cone, size 2  GCE0920226P0105
Voltage testing cable up to 36 kV for inner cone, size 3  GCE0920226P0106
Current testing plug for inner cone, size 2, I_n = 800 A, I_p = 2500 A / 4 min.  GCE0920226P0103
Current testing plug for inner cone, size 3, I_n = 1250 A, I_p = 3150 A / 4 min.  GCE0920226P0104

Blanking plugs

Blanking plug for inner cone, size 2  GCE8011949R0101
Blanking plug for inner cone, size 3  GCE0909097P0100

Accessories for visible grounding by grounding set

Grounding set for inner cone, size 2, 29.5 kA  GCE0920226P0107
Grounding set for inner cone, size 3, 29.5 kA  GCE0920226P0108
Rod for grounding set, hinged  GCE0920226P0109
Wall mounting for grounding set  1VB0000074P0100

Accessories for capacitive indicator, system LRM

Display unit (figure 6.1.1.1)  GCE0931333P0101
Interface tester  GCE0990005P0102
Short-circuiting plug  GCE0909005P0100

Other accessories

Lifting section for fork lift truck (figures 2.4.1.1, 2.4.1.2)  GCE9015358R0102
Double bit key for barrel lock in panel door  GCE0990108P0100
Wall mounting for accessories  1VB8000533R0101
Adapter for DILO filling truck (further adapters on request)
Anschluss M24 x 1,5  1VB8004776P0101
Anschluss M20 x 1,5 (DN8)  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 type plates for individual components can be found in the immediate vicinity of the devices concerned.

<table>
<thead>
<tr>
<th>Table 11.1: Technical data of the panels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage / maximum operating voltage 1)</td>
</tr>
<tr>
<td>Rated power-frequency withstand voltage 1)</td>
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<tr>
<td>Rated lightning impulse withstand voltage 1)</td>
</tr>
<tr>
<td>Rated frequency</td>
</tr>
<tr>
<td>Rated normal feeder current 2) and current of busbars at 50 Hz</td>
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<tr>
<td>Rated normal feeder current 2) and current of busbars at 60 Hz</td>
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<tr>
<td>Rated short-time withstand current</td>
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<tr>
<td>Rated peak withstand current at 50 Hz</td>
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<tr>
<td>Rated peak withstand current at 60 Hz</td>
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<tr>
<td>Rated duration of short-circuit</td>
</tr>
<tr>
<td>Insulating gas system 3) 4)</td>
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<tr>
<td>Rated filling level for insulation</td>
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<tr>
<td>Rated filling level for insulation</td>
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<tr>
<td>Degree of protection for parts under high voltage</td>
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<tr>
<td>Degree of protection of the low voltage compartment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 11.2: Operating conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature, maximum 5)</td>
</tr>
<tr>
<td>Ambient temperature, maximum 24 h average 5)</td>
</tr>
<tr>
<td>Ambient temperature, minimum</td>
</tr>
<tr>
<td>Site altitude 6)</td>
</tr>
<tr>
<td>Average humidity measured over 24 h 7)</td>
</tr>
<tr>
<td>Average relative humidity in one month 7)</td>
</tr>
<tr>
<td>Ambient air</td>
</tr>
<tr>
<td>Seismic withstand capability 8)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 11.3: Panel weights</th>
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</thead>
<tbody>
<tr>
<td>Panel type</td>
</tr>
<tr>
<td>Single busbar</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Double busbar</td>
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<tr>
<td>Lateral plenum (Increase in weight of the end panel)</td>
</tr>
</tbody>
</table>

1) Higher levels to international standards on request
2) Higher rated currents on request
3) Insulating gas: SF_6 (sulphur hexafluoride)
4) All pressures stated are absolute values relative to 68 °F
5) Higher ambient temperature on request
6) Greater site altitudes on request
7) Take suitable action to prevent condensation in the low voltage compartment.
8) On request
12  Disclaimer

12.1 Disclaimer of warranties and limitation of liability

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ABB shall have no obligation hereunder with respect to any equipment which (i) has been improperly repaired or altered; (ii) has been subjected to misuse, negligence or accident; (iii) has been used in a manner contrary to ABB’s written instructions; (iv) is comprised of materials provided by or a design specified by Purchaser; or (v) has failed as a result of ordinary wear and tear.
Outgoing feeder panel with outer cone, 1250 A, single busbar, example configuration

Outgoing feeder panel with inner cone, 1250 A, double busbar, example configuration
1.0 Circuit-breaker compartment
1.1 Circuit-breaker pole
1.2 Circuit-breaker operating mechanism
1.3 a Cable socket
1.3 b Outer cone
1.4 Test socket
(also for use with other plug-in devices)
1.5 Capacitive voltage indicator system
1.8 Voltage transformer
1.9 Block-type current transformer
1.10 Ring core current transformer
1.12 Bushing, circuit-breaker/busbar compartment
1.13 Pressure relief disk
1.15 Current transformer
1.20 Heat sink
2.0 Busbar compartment
2.1 Busbar system
2.3 Three position disconnect
2.4 Disconnect
2.5 Three-position disconnect mechanism
2.6 Disconnect mechanism
2.7 View ports
3.0 Cable termination compartment
3.1 Cable connector
3.2 High voltage cable
3.3 Cable fastener
3.5 Main grounding bar
4.0 Plenum, rear
(for circuit-breaker compartment and cable termination compartment)
4.1 Plenum, top
(for busbar compartment)
6.0 Low voltage compartment