Medium-voltage switchgear

GMA

Gas-insulated switchgear up to 24 kV - 2500 A - 31.5 kA

Assembly Instructions
Technical Manual

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As our products are subject to continuous further development, we reserve the right to make changes regarding standards, illustrations and technical data. All dimensions specified in this manual are in millimeters. This Technical Manual cannot describe every imaginable individual case or every customer-specific version of the product. For information which is not included in this manual, please contact the manufacturer.

Purpose and target group

This Technical Manual describes the assembly of gas-insulated medium-voltage switchgear units of the GMA series. It is exclusively intended for use by the manufacturer's staff or by persons certified for the GMA series (training certificate). The work described in this manual may only be performed by specialist electricians with proven experience in conjunction with:

- the GMA series (training certificate).
- all relevant safety provisions.

This Technical Manual is an integral part of the product and must be stored so that it is readily accessible at all times for and can be used by persons who are to work on the switchgear. If the switchgear is relocated to another site, this Technical Manual must be passed on to the new operators along with the unit.

Reference documents

The following additional documents must be complied with:

- purchase agreement with the stipulations regarding the switchgear-specific equipment and the legal details
- the appropriate switchgear-specific circuit diagrams / documentation
- Operating and Maintenance Manual for GMA (no. AGS 531021-01)
- the Operating Manuals of the devices installed in the switchgear:
  - Voltage detection systems, e. g. IVIS (no. AGS 531751-01)
  - Optional: System for the detection of internal arcs ILIS (no. AGS 531761-01)
  - Devices in the low-voltage cabinet
- the Assembly Instructions of the manufacturer of the cable connection systems to be connected to the switchgear
- the assembly drawings supplied with the equipment

Terms and symbols used

This Technical Manual uses certain terms and symbols. They warn about dangers or provide important information which must be complied with in order to avoid danger to persons and damage to equipment:

- **“Danger!”**
  This danger symbol warns about dangerous electrical voltage. Contact with voltage may result in fatal injury!

- **“Warning!”**
  This danger symbol warns about the risk of injury. Please comply with all the provisions identified by this symbol in order to avoid death or serious injury.

- **“Notice:”**
  This instruction symbol is used for information which is important to avoid material damage.

Abbreviations used

- \( U_r \): Rated voltage
- \( I_r \): Rated current
- SS: Busbar

Any questions or suggestions?

Do you have any questions or suggestions regarding this manual, or do you require further information?

We always strive to provide you with the best-possible information for optimum, safe use of our products. Thus, do not hesitate to contact us if you have any recommendations, amendments or proposals for improvement.
1 Safety provisions

The work described in this manual may only be performed by specialist electricians with proven experience in conjunction with the GMA series and the applicable safety provisions.

Please read the whole manual carefully before working on the switchgear.

Applicable standards and regulations:

- Metal-enclosed AC switchgear for rated voltages > 1 kV up to including 52 kV:
  IEC 62271-200
- Use and handling of sulphur hexafluoride (SF₆) in high-voltage switchgear:
  IEC 62271-303
- The locally applicable accident prevention, operating and work instructions must be complied with.
- Installation: IEC 61936-1 / EN 50522¹
- Operation of electrical equipment: EN 50110-1¹

¹ The national standards applicable in the country where the equipment is to be installed must be complied with.

Before performing work on the panel, it is essential that you comply with the following instructions:

Danger!
Risk of fatalities due to high voltage!
► Isolation from high voltage and earthing must always be ensured before performing assembly or maintenance work on high-voltage components.

Danger!
Risk of fatalities due to supply voltage!
► Isolation from supply voltage must always be ensured before performing assembly or maintenance work on low-voltage components.

Warning!
After removing covers from a switchgear unit, operator safety may be restricted regarding internal arcs unless the switchgear is isolated from the power supply.
► Optimum operator safety is only ensured if the switchgear is completely disconnected from the power supply and grounded during assembly.

Warning!
Risk of injury due to movable parts in mechanical drives!
Before performing assembly and maintenance work,
► isolate the system from the supply voltage
► release the circuit-breaker’s energy storing device by OFF-ON-OFF operation
► release the busbar earthing switch’s energy storing device by ON operation

5 Safety rules

1. Isolate from the power supply,
2. make sure that unintentional restart (reclosure) is prevented,
3. verify zero voltage,
4. earth and short-circuit,
5. cover or cordon off adjacent live components.
1 Safety provisions

Behaviour in case of incidents or accidents

For the case of an internal fault, the GMA switchgear features pressure relief ports which prevent the panels and the switchgear from bursting.

This Technical Manual does not include information regarding the safety of buildings in case of internal faults (pressure load of the switchgear room and necessary pressure relief ports). Pressure calculations for switchgear rooms incl. recommendations regarding pressure relief ports can be provided on request against a fee. For further details, please contact the manufacturer.

In case of fire or of internal faults, toxic and caustic decomposition products may be produced. Comply with the locally applicable accident and safety provisions.

In case of personal injury, take first-aid measures or cause them to be taken.
2.1 Basic panels GMA with circuit-breaker

The illustrations show the panel types with their respective basic equipment without pressure relief duct. Customized models or additional equipment are described in the switchgear-specific documentation.

Fig. 1
Circuit-breaker panel GMA with outer cone-type bushing
1 Low-voltage cabinet
2 Control unit "GemControl" including insulation gas monitoring
3 Protection unit, e.g. "Micom"
4 Socket-contacts for voltage detection systems (optional "IVIS" system)
5 Manual operator interface
6 Cable compartment cover
7 High-voltage cable connection on the standardized outer cone-type connection system
8 Earth bus
9 Illustrated: Voltage transformer on cable terminal (optional voltage transformer on busbar available)
10 Current transformer
11 Insulating gas tank with
   - vacuum circuit-breaker,
   - 3-position switch (disconnector and earthing switch),
   - disconnecting device for voltage transformer (optional)
12 Earthed, contact-proof single-pole busbar system
13 Busbar cover (optional)
Fig. 2
Incoming feeder panel with circuit-breaker, voltage transformer and double cable terminal

1 Low-voltage cabinet
2 Control unit "GemControl" including insulation gas monitoring
3 Protection unit, e. g. "Micom"
4 Socket-contacts for voltage detection systems (optional "IVIS" system)
5 Manual operator interface
6 Cable compartment cover
7 High-voltage cable connection on the standardized outer cone-type double connection system
8 Earth bus
9 Illustrated: Voltage transformer on cable terminal (optional voltage transformer on busbar available)
10 Current transformer
11 Insulating gas tank with
   - vacuum circuit-breaker,
   - 3-position switch (disconnector and earthing switch),
   - disconnecting device for voltage transformer (optional)
12 Earthed, contact-proof single-pole busbar system
13 Busbar cover (optional)
Fig. 3
Bus section
Shown with circuit-breaker and two 3-position switches (for busbar earthing)
1 Earthed, contact-proof and single-pole busbar system;
   additional busbar cover optionally available
2 Insulating gas tank with
   - vacuum circuit-breaker,
   - two 3-position switches (disconnector and earthing switch)
3 Cable compartment cover
4 Manual operator interface
5 Control unit “GemControl” including insulation gas monitoring
6 Low-voltage cabinet
2 Design, description, variants

2.2 Panel variants

The schedule contains all the typical standard variants for the GMA series.

All the panel variants shown are designed for:
- a rated voltage of: 12 - 17.5 - 24 kV
- a rated short-circuit current (3 s): 16 - 31.5 kA
- a rated current for the busbar: ≤ 2500 A

Capacitive uncoupling for voltage testing devices on the busbar optionally available.

Customized models or additional equipment are described in the switchgear-specific documentation.

<table>
<thead>
<tr>
<th>Feeder panels</th>
<th>( I_r ) (feeder) [A]</th>
<th>Panel width [mm]</th>
<th>Depth [mm]</th>
</tr>
</thead>
</table>
| - Disconnector  
  - Earthing switch  
  - Circuit-breaker  
  - 1 outer cone-type terminal per phase  
  - Voltage transformer with disconnecting device (optional) for module width 600 mm available | \( \geq 800 \) | 450 | 875 |
| - Disconnector  
  - Earthing switch  
  - Circuit-breaker  
  - 2 outer cone-type terminals per phase  
  - Voltage transformer with disconnecting device (optional) | \( \geq 1250 \) | 600 | 1005 |
| - Bus riser with disconnector  
  - Earthing switch (optional)  
  - Current transformer (optional)  
  - Voltage transformer with disconnecting device (optional) for module width 600 / 800 mm available  
  - 2 outer cone-type terminals per phase for \( I_r \geq 1250 - 2500 \) A | \( \leq 800 \) | 450 | 875 |
| - Bus riser without switching devices  
  - 2 outer cone-type terminals per phase for \( I_r \geq 1250 - 2500 \) A | \( \geq 1250 \) | 600 | 1005 |
| -  | \( > 1250 - 2500 \) | 800 | 1330 |
| -  | \( \leq 1250 \) | 450 | 875 |
| -  | \( > 1250 - 2500 \) | 800 | 1330 |
2 Design, description, variants

Dimension diagram for feeder panel with one outer cone-type terminal per phase

![Diagram of feeder panel with one terminal per phase](image1)

**Fig. 4**
Feeder panel with circuit-breaker, disconnector and earthing switch, voltage transformer for outgoing feeder cable or busbar optional (only available for 600 mm module width)

Dimension diagram for incoming feeder panel with two outer cone-type terminals per phase and cooling systems

![Diagram of incoming feeder panel with two terminals per phase](image2)

**Fig. 5**
Feeder panel with circuit-breaker, disconnector and earthing switch, voltage transformer for outgoing feeder cable (optional)
1 Gas cooler attachment (only required for rated current in feeder \( I_r = 2500 \) A)
## 2 Design, description, variants

<table>
<thead>
<tr>
<th>Busbar coupler</th>
<th>( I_e ) (busbar) [A]</th>
<th>Panel width [mm]</th>
<th>Depth [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus section with integrated busbar earthing</td>
<td>( \leq 1250 )</td>
<td>800</td>
<td>1005</td>
</tr>
<tr>
<td>- Disconnector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Earthing switch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Circuit-breaker</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus riser</td>
<td>( &gt; 1250 - 2500 )</td>
<td>1000</td>
<td>1320</td>
</tr>
<tr>
<td>- Disconnector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Earthing switch</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Bus section with bus riser                  | \( \leq 1250 \)       | 800              | 1005       |
| Bus riser                              | \( > 1250 - 2500 \)    | 1000             | 1320       |

**Dimension diagram for bus section in one panel module with integrated busbar earthing**

![Dimension diagram](image)

*Fig. 6*

Bus section with circuit-breaker, disconnector and earthing switch,
Bus riser with disconnector and earthing switch

1 Gas cooler attachment (only required for rated current in feeder \( I_e = 2500 \) A)
2.3 Busbar attachments

<table>
<thead>
<tr>
<th>Busbar attachments</th>
<th>( I_\text{busbar} ) [A]</th>
<th>Panel width [mm]</th>
<th>Depth [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Busbar earthing panel</td>
<td>( \leq 2500 )</td>
<td>450</td>
<td>875</td>
</tr>
<tr>
<td>Current transformer on the busbar</td>
<td>No additional panel required; panel configuration acc. to Table on page 11.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage transformer on busbar – Disconnecting device option-ally available</td>
<td>No additional panel required. Voltage transformer on busbar only available for module width 600 mm. In this case, outgoing feeder voltage transformers are not available in this panel. Panel configuration acc. to Table on page 11.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surge arrester on busbar</td>
<td>Surge arresters are located directly on the busbar's crossover adapter</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.4 Weights

The total weight results from the total of the individual weights, depending on equipment included in switchgear.

<table>
<thead>
<tr>
<th>Weights incl. low-voltage cabinet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel with circuit-breaker, switch disconnector, earthing switch</td>
</tr>
<tr>
<td>Module width 450 mm with 630 A / 800 A rated current</td>
</tr>
<tr>
<td>Module width 600 mm with 630 A / 800 A / 1250 A rated current</td>
</tr>
<tr>
<td>Module width 800 mm with &gt; 1250 A / 2000 A / 2500 A rated current</td>
</tr>
<tr>
<td>Bus section</td>
</tr>
<tr>
<td>Panel width 800 mm</td>
</tr>
<tr>
<td>Panel width 1000 mm</td>
</tr>
<tr>
<td>Components</td>
</tr>
<tr>
<td>+ voltage transformer set (3x 40 kg)</td>
</tr>
<tr>
<td>+ pressure relief duct per panel</td>
</tr>
<tr>
<td>2x end walls (each for 40 mm module width)</td>
</tr>
<tr>
<td>+ busbar up to 1250 A per panel</td>
</tr>
<tr>
<td>+ busbar up to 2500 A per panel</td>
</tr>
</tbody>
</table>
2 Design, description, variants

2.5 Applicable standards

Series GMA switchgear units are
- metal-enclosed
- SF<sub>6</sub>-insulated
- type-tested and prefabricated
- tested for internal faults (qualification IAC)
- dimensioned for indoor installation

GMA switchgear units meet the following standards and regulations:

<table>
<thead>
<tr>
<th>Designation</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgear</td>
<td>IEC 62271-200</td>
</tr>
<tr>
<td>Internal arc classification (IAC)</td>
<td>IEC 62271-200</td>
</tr>
<tr>
<td>Circuit-breaker</td>
<td>IEC 62271-100</td>
</tr>
<tr>
<td>Earthing switch</td>
<td>IEC 62271-102</td>
</tr>
<tr>
<td>Disconnector</td>
<td>IEC 62271-102</td>
</tr>
<tr>
<td>Current transformer</td>
<td>IEC 61869-2</td>
</tr>
<tr>
<td>Voltage transformer</td>
<td>IEC 61869-3</td>
</tr>
<tr>
<td>Voltage detecting systems</td>
<td>IEC 61243-5</td>
</tr>
<tr>
<td>Protection against accidental contact, foreign bodies and water</td>
<td>IEC 60529</td>
</tr>
<tr>
<td>Installation</td>
<td>IEC 61936-1</td>
</tr>
<tr>
<td>Operation of electrical equipment</td>
<td>EN 50110-01</td>
</tr>
<tr>
<td>Insulating gas sulphur hexafluoride SF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>IEC 60376</td>
</tr>
<tr>
<td>Use and handling of sulphur hexafluoride (SF&lt;sub&gt;6&lt;/sub&gt;)</td>
<td>IEC 62271-303</td>
</tr>
</tbody>
</table>

Degree of protection against accidental contact and foreign objects

<table>
<thead>
<tr>
<th>Degrees of protection against accidental contact and foreign objects according to IEC 60529</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulating gas tank</td>
</tr>
<tr>
<td>Drive mechanisms</td>
</tr>
<tr>
<td>Low-voltage cabinet</td>
</tr>
<tr>
<td>Cable compartment cover</td>
</tr>
</tbody>
</table>

2.6 Environmental and operating conditions

GMA is an indoor switchgear and may only be operated under normal conditions in acc. with IEC 62271-1.

Operation under conditions deviating from these is only admissible subject to consultation with and written approval from the manufacturer.

<table>
<thead>
<tr>
<th>Ambient conditions (in accordance with IEC 62271-1-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature class</td>
</tr>
<tr>
<td>Min./max. ambient temperature</td>
</tr>
<tr>
<td>Average value over 24 hours</td>
</tr>
<tr>
<td>Mean rel. air humidity: 24 hour/1 month</td>
</tr>
<tr>
<td>Installation altitude above sea-level</td>
</tr>
</tbody>
</table>

<sup>1</sup> Other values available on request
2 Design, description, variants

2.7 Intended use

Gas-insulated GMA medium-voltage switchgear units are exclusively intended for switching and distributing electrical energy. They may only be used in the scope of the specified standards and the switchgear-specific technical data. Any other utilization constitutes improper use and may result in dangers and damage.

Disclaimer of liability

The manufacturer shall not be held responsible for damage which occurs if
- instructions in this Technical Manual are not complied with;
- the switchgear is not operated according to its intended use (see above);
- the switchgear is assembled, connected or operated improperly;
- accessories or spare parts are used which have not been approved by the manufacturer,
- the switchgear is converted without the manufacturer’s approval, or if inadmissible parts are added.

No liability is accepted for parts provided by customer, e.g. for current transformers.

2.8 Disposal after the end of service life

A material and recycling data sheet can be provided on request for the disposal of series GMA switchgear units at the end of their service life.
Disposal is performed as a service by the manufacturer’s Service Center and is subject to a fee.
The operating equipment contains the fluorinated greenhouse gas SF₆ covered by the Kyoto Protocol, with a global warming potential (GWP) of 22 200.
SF₆ must be recovered and must not be released into the atmosphere. When transporting and handling SF₆, the specifications in IEC 62271 High-Voltage Switchgear and Controlgear – Part 303 Use and Handling of Sulphur Hexafluoride (SF₆), must be complied with.
3 Packaging and transport

3.1 Shipping units

Delivery is effected in terms of prefabricated single switchgear panels. One transport unit consists of max. 2 individual switchgear panels which are fastened to the pallet. The insulating gas compartment with three-position switch and circuit-breaker are mounted ready for connection and routine-tested. The individual busbar links and busbars are mounted on site. The low-voltage cabinets are assembled in the factory or supplied as accessories, depending on the customer’s wishes.

Notice:
The weight of the entire transport unit is indicated on the packaging.

Packaging

- If packed exclusively for truck transport, the panels are delivered on a pallet with PE protective film.
- For sea transport, the units are packed in sealed aluminium foil with desiccant and in a closed wooden case with tightly closed wooden base (also for container transport).
- In case of air transport, the panels are packaged in wooden crates with a protective PE film hood (dust protection) or in wooden crates, also with closed wooden bases, however without protective hoods (dust protection).

3.2 Transport

Warning! Risk of injury due to tipping load!

Transport units must be protected sufficiently against slipping and tipping during transport.

When transporting panels, make sure that the transport units do not slip or tip over (if applicable, nail transport pallet down onto the loading platform).

Transport using a forklift truck

The panel may only be transported on a pallet. The entire length of the forks must be placed under the transport unit (Fig. 8).
3 Packaging and transport

Delivery

- Handle shipping units carefully when unloading and unpacking them.
- Shipping units must be checked upon receipt. Any damage which may have occurred in transit must be recorded and reported to the manufacturer immediately.
- The consignment must be checked for completeness based on the shipping documents.
- The supplier must be notified in writing without delay about any possible deviations.

3.3 Storage

Warning!
Risk of injury due to tipping load!

► Sufficient stability and evenness of the supporting area (floor) must be ensured.

If the panels are not installed immediately after delivery, they can be stored under the following conditions:

Fig. 9
Diagram showing the storage conditions

- Panels must be stored in vertical position, and must not be stacked.
- Storage only admissible indoors.
- Panels and accessories must be packed in a wooden crate with a desiccant and sealed in aluminium foil (storage period max. 2 years after date of packaging).
4 Installation of panels

4.1 Safety provisions and instructions for assembly

The switchgear panels may only be installed by the manufacturer’s staff or by persons who have been certified for this work.

The GMA series switchgear panels are delivered with the circuit-breaker set to “OFF”, the energy storing device released and the disconnector and earthing switch set to “OFF”.

The make-proof busbar earthing switch (see Chapter 2.3, page 14) is supplied in position “ON”.

**Danger!**
Danger due to insufficient dielectric strength of high-voltage connections in case of assembly under aggravated ambient conditions!

► During assembly, it is essential to avoid condensation, dirt and dust deposits.

**Warning!**
Risk of injury due to movable parts in mechanical drives!

► While the front cover is removed, the closing spring of the circuit-breaker must not be charged!

**Warning!**
Risk of injury via movable drive components caused by unintended opening (OFF) of the circuit-breaker!

► In case of feeder panels, the circuit-breaker’s opening spring is always charged!

► Never touch the drive components!

**Warning!**
Risk of falling during installation of the switchgear!

► Watch out for floor openings in the switchgear room.

**Warning!**
The top sides of the panels are not meant to be walked on. Persons may fall, get injured or may damage the panel.

► When working on top of the panel (e.g. assembly of busbar system or of pressure relief ducts), make sure that the working place is kept appropriately safe.

**Notice:**

- The tightening torques in the Annex, Chapter 13.3 on page 80, must be used for all screw connections which are not directly defined in the assembly description.

- Before starting assembly work, observe the attachment drawings enclosed with the consignment.
4.2 Requirements regarding the switchgear room

Minimum dimensions within the building

Fig. 10
Example for switchgear acc. to IEC 62271-200, internal arc classification IAC AFL

1 Cable tray or dimensions of cable basement depending on the admissible minimum bending radius of the high-voltage cables

Dimension A = panel depth
Dimension B = aisle width, also possible for replacement of panels.
   Smaller dimensions available on request
Dimension C = front edge of panel to building wall
* Reduced dimensions for room height available on request

Switchgear with internal arc qualification IAC AFL

<table>
<thead>
<tr>
<th>Panel type</th>
<th>Rated current</th>
<th>Module width</th>
<th>Dimension A</th>
<th>Dimension B</th>
<th>Dimension C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[A]</td>
<td>[mm]</td>
<td>[mm]</td>
<td>[mm]</td>
<td>[mm]</td>
</tr>
<tr>
<td>Feeder panel</td>
<td>630 - 800</td>
<td>450</td>
<td>875</td>
<td>1100</td>
<td></td>
</tr>
<tr>
<td>Feeder panel</td>
<td>630 - 1250</td>
<td>600</td>
<td>1005</td>
<td>1300</td>
<td></td>
</tr>
<tr>
<td>Bus section</td>
<td>≤ 1250</td>
<td>800</td>
<td>1005</td>
<td>1300</td>
<td></td>
</tr>
<tr>
<td>Feeder panel</td>
<td>&gt; 1250 - 2500</td>
<td>800</td>
<td>1280</td>
<td>1750</td>
<td>1390</td>
</tr>
<tr>
<td>Bus section</td>
<td>&gt; 1250 - 2500</td>
<td>1000</td>
<td>1280</td>
<td>1750</td>
<td></td>
</tr>
</tbody>
</table>

Notice:
- The overall depth of the switchgear and the minimum dimensions within the building are indicated in Fig. 12 and 13 on page 22.
- Dimension B also allows for possible replacement of the switchgear from a multiple switchgear assembly.
- Reduced size B for the aisle width in front of the switchgear possible on request.
4 Installation of panels

Minimum dimensions in the building (free-standing installation)

Fig. 11
Example for switchgear acc. to IEC 62271-200, internal arc classification IAC AFLR
1 Opening for placement
2 Cable tray or dimensions of cable basement depending on the admissible minimum bending radius of the high-voltage cables

Dimension A = panel depth
Dimension B = aisle width, also possible for replacement of panels.
Small dimensions available on request
* Reduced dimensions for room height available on request
** Reduction possible down to 500 mm

Switchgear with internal arc qualification IAC AFLR

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeder panel</td>
<td>630 - 800</td>
<td>450</td>
<td>1125</td>
<td>1250</td>
</tr>
<tr>
<td>Feeder panel</td>
<td>630 - 1250</td>
<td>600</td>
<td>1125</td>
<td>1400</td>
</tr>
<tr>
<td>Bus section</td>
<td>≤ 1250</td>
<td>800</td>
<td>1125</td>
<td>1400</td>
</tr>
<tr>
<td>Feeder panel</td>
<td>&gt; 1250 - 2500</td>
<td>800</td>
<td>1400</td>
<td>1800</td>
</tr>
<tr>
<td>Bus section</td>
<td>≥ 1250</td>
<td>1000</td>
<td>1400</td>
<td>1800</td>
</tr>
</tbody>
</table>

Notice:
- The maximum panel depth (for dimension A, see the Table above and Fig. 11) within the switchgear configuration determines the total width of the switchgear and the minimum dimensions in the building.
- Pressure relief duct for pressure relief outside of the building available on request.
- Dimension B also allows for possible replacement of the switchgear from a multiple switchgear assembly. Reduced size B for the aisle width in front of the switchgear possible on request.
4  Installation of panels

4.3  Arrangement of base frame

Fig. 12
Example for switchgear with a rated current of \( \leq 1250 \) A
Configuration acc. to IEC 62271-200 with internal arc classification IAC AFL

Fig. 13
Example for switchgear with a rated current of \( > 1250 \) A \(- 2500\) A
Configuration acc. to IEC 62271-200 with internal arc classification IAC AFL

- Steel base frame, 40 x 40 x 4 mm
  Upper edge of floor = upper edge of base frame

- Cross bracings may be inserted between the panel units (e.g. 20 x 40 x 2 mm)
  Cross bracings are required e. g. in case of false floors, to ensure reinforcement.

- Infeed of external low-voltage cables

- Panel fastening (provided with bore-holes during assembly)

- Steel base frame, 40 x 40 x 4 mm
  A third base frame to support the panels is required in case of a busbar rated current > 1250 A.
  Base frames are only used to support these panels and are not screw-fastened to the panels.

A closed floor which at the time of installation of the switchgear only provides openings for high-voltage cables and low-voltage cables (for example: concrete floor) does not require a 3rd base frame to support the panels. The closed floor must be strong enough to bear the weight of the panel!
4 Installation of panels

Fig. 14
Example for switchgear with a rated current of ≤ 1250 A
Configuration acc. to IEC 62271-200 with internal arc classification IAC AFLR

Fig. 15
Example for switchgear with a rated current of > 1250 A – 2500 A
Configuration acc. to IEC 62271-200 with internal arc classification IAC AFLR

- Steel base frame, 40 x 40 x 4 mm
  Upper edge of floor = upper edge of base frame

- Cross bracings may be inserted between the panel units (e.g. 20 x 40 x 2 mm)
  Cross bracings are required e.g. in case of false floors, to ensure reinforcement.

- Infeed of external low-voltage cables

- Panel fastening (provided with bore-holes during assembly)

- Steel base frame, 40 x 40 x 4 mm
  Base frames are only used to support these panels and are not screw-fastened to the panels.
4 Installation of panels

4.4 Transporting the panels on the construction site

**Warning!**
**Danger due to tipping load!**

- Never move panels without using transport aids.
- During transport, pay attention to the weight distribution. The center of gravity is at gas tank level in the upper part of the switchgear panel.
- Make sure the ropes / chains are strong enough to bear the weight of the transport unit. The appropriate regulations for hoisting equipment must be complied with.
- Sufficient stability and evenness of the supporting area (floor) must be ensured.
- Make sure the U profiles (traversing aid for lift trolley) are strong enough to bear the maximum panel weight!

Before installing the switchgear panels, make sure that the switchgear room is checked according to the switchgear documentation:

- Opening for placement
  Width ≥ 1200 mm, Height ≥ 2300 / 2450 mm depending on low-voltage cabinet (if height dimension are undercut: delivery without attached low-voltage cabinet)
- Check cutouts for high-voltage and low-voltage cables.
- Check position of base frame.
- The load-bearing capacity of the fastening points must correspond to the weight of the switchgear (have a stress analysis of the building performed).
- Observe the minimum distance between the switchgear and the rear wall of the building.
- Check base frame for dimensions and tolerances in position.

Before the switchgear is positioned at its site of installation, check that the base frame dimensions are absolutely accurate.

- Flatness: ± 2 mm / meter
- Straightness: ± 2 mm / meter
- Parallelism: ± 2 mm / meter
- Height difference over the entire length of the switchgear: ± 2 mm.

**Notice:**
*Observe switchgear-specific space assignment plan.*
4 Installation of panels

Transport by means of a crane:
Comply with angle specified for the crane mounting harness.

Attach 4-fold crane mounting harness to the lateral jack rings of the tank side walls. Release panel fastening from the pallet (see Fig. 16). Lift the panel carefully and deposit it slowly onto the floor at its place of destination.

Transport by means of a lift trolley:

1. Screw-fasten lift trolley to both sides of the panel (see Fig. 17, item 3). Spacers must be used at the rear fastening points between the lift trolley and the panel supporting structure to align the lift trolley parallel to the side of the panel.
2. Raise panel on the left and right sides uniformly using the hydraulic lifting device.
3. Place two U profiles (not included in scope of supplies) on the base frame as traversing aid (item 2) and block them by (lower) stops against slipping in the base frame. Adjust the distance between the two U profiles in accordance with the panel width.
4. Position the panel on the base frame using the transport rollers. Make sure that the transport rollers are located in each of the U profiles.
5. Lower the panel onto the base frame using the star handle on the hydraulic cylinder.
6. Disassemble the lift trolley. Remove U profiles.

Fig. 16
Transport by means of a crane
1 4-fold crane mounting harness
2 Jack rings
3 Panel fastening

Fig. 17
Transport by means of a lift trolley
1 Center of gravity (label)
2 U profile as traversing aid
3 Lift trolley
4.5 Removing cable compartment cover

The cable compartment cover is designed as detachable cover plate which is secured by means of 2 screws at the bottom.

An optional mechanical interlock prevents the cable compartment cover from being removed as long as the earthing switch is not switched ON.

### Interlocking matrix

<table>
<thead>
<tr>
<th>Cable compartment cover</th>
<th>Earthing switch</th>
<th>Cable compartment cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>attached</td>
<td>unlocked</td>
<td>–</td>
</tr>
<tr>
<td>removed</td>
<td>locked</td>
<td>–</td>
</tr>
<tr>
<td>Earthing switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ON</td>
<td>–</td>
<td>unlocked</td>
</tr>
<tr>
<td>OFF</td>
<td>–</td>
<td>locked</td>
</tr>
</tbody>
</table>

### Removing cable compartment cover

1. Isolate the outgoing feeder cable from the supply and earth it (Fig. 18, item A), see also Operating Manual.
2. Push interlocking slide of cable compartment cover (Fig. 18, item B) upwards. At the same time, the cable compartment cover is unlocked and actuation of the earthing switch (A) is interrupted mechanically and electrically.
3. Release two screws on the lower end of the cable compartment cover (C).
4. Lift and remove the cable compartment cover (D).

After removing the cable compartment cover, it is impossible to push the slide down. The earthing switch remains locked.

![Diagram](image-url)
4 Installation of panels

**Danger! Risk of fatalities due to high voltage!**

Optimum operator safety is only ensured if the cable compartment is completely isolated from the power supply and earthed for assembly work.

Special panels:
- Panels without earthing switch
- Bus sections
- Panels with earthing switch, but without automatic intertripping of the circuit-breaker for earthing.

These variants are not equipped with an interlocked cable compartment cover. In these panels, the cable compartment cover is secured by the two securing bolts on the front side (see Fig. 19, item A). Release these two screws and lift and remove the cable compartment cover (see Fig. 19, item B).

**Mounting cable compartment cover again**

1. Reinsert and lower the cable compartment cover.
2. Secure cable compartment cover on the underside by means of two screws, Fig. 19, item A.
3. Optional in case of panel with cable compartment interlock:
   Push interlocking slide down. The cable compartment cover is locked and the earthing switch re-enabled.
4  Installation of panels

4.6 Remove cover of transport securing device

**Danger!**

Risk of fatalities due to high voltage!

The transport protection caps located on the high-voltage terminals by the factory are not surge-proof.

> Prior to commissioning, the transport protection caps must be replaced by surge-proof caps.

The busbar terminals are supplied by the factory with transport protection caps. An additional box with the appropriate accessories for the panel screw connections and fastening on the base frame is located above the transport protection caps.

1. Remove cardboard box by pulling it upwards.
2. Do not remove the various transport protection caps until just before busbar assembly is started.

![Fig. 20](image)

**Cover of transport securing device**
1. Box containing accessories for panel screw fastening
2. Red protective caps above the busbar bushings

4.7 Placing and connecting panels

**Notice:**

- Please comply with the safety provisions and mounting instructions in Chapter 4.1 on page 19.
- Observe the switchgear-specific layout for arrangement of the panels!
- If panels are installed in a corner of a building (see Chapter 7 as of page 49), the appropriate end wall must be mounted on the base frame before the first panel is positioned. Observe the changed sequence of assembly operations!

1. The position of the first panel is decisive for placement of the subsequent panels, thus it is essential that measuring is effected with the utmost precision!
2. Position panel on the base frame according to the switchgear-specific space assignment plan. To facilitate subsequent lining up of the panels, the base frames can be greased.
3. Align panels. Check the panel front for correct horizontal and vertical position. If applicable, lift the panel and place shims in the direct vicinity of the fastening points, until the horizontal position has been reached.
4. Position the following panel on the base frames next to the first panel according to the switchgear-specific space assignment plan.
5. Push panels carefully together. Align the panels to the front side according to the space assignment plan.
## 4 Installation of panels

### Connect panels at the rear

**Assembly drawing**

AGS 006959-01

### Table: Panel width and clearance

<table>
<thead>
<tr>
<th>Panel width Basic panel [mm]</th>
<th>Panel width In-line panel, right-hand [mm]</th>
<th>Clearance X*2</th>
<th>Length of busbar Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>450</td>
<td>436</td>
<td>432</td>
</tr>
<tr>
<td>600</td>
<td>525</td>
<td>511</td>
<td>507</td>
</tr>
<tr>
<td>Bus section 800</td>
<td>525</td>
<td>511</td>
<td>−</td>
</tr>
<tr>
<td>800 / Bus section 1000</td>
<td>565</td>
<td>−</td>
<td>547</td>
</tr>
<tr>
<td>450</td>
<td>525</td>
<td>511</td>
<td>507</td>
</tr>
<tr>
<td>600</td>
<td>600</td>
<td>586</td>
<td>582</td>
</tr>
<tr>
<td>Bus section 800</td>
<td>600</td>
<td>586</td>
<td>−</td>
</tr>
<tr>
<td>800 / Bus section 1000</td>
<td>640</td>
<td>−</td>
<td>622</td>
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<td>450</td>
<td>685</td>
<td>−</td>
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</tr>
<tr>
<td>600</td>
<td>760</td>
<td>−</td>
<td>742</td>
</tr>
<tr>
<td>800 / Bus section 1000</td>
<td>800</td>
<td>−</td>
<td>782</td>
</tr>
<tr>
<td>Bus section 800</td>
<td>450</td>
<td>436</td>
<td>−</td>
</tr>
<tr>
<td>600</td>
<td>525</td>
<td>511</td>
<td>−</td>
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<tr>
<td>Bus section 1000</td>
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<tr>
<td>600</td>
<td>525</td>
<td>−</td>
<td>507</td>
</tr>
<tr>
<td>800</td>
<td>565</td>
<td>−</td>
<td>547</td>
</tr>
</tbody>
</table>

### Fig. 21

Observe settings for busbar terminals (see Table above)

### Fig. 22

Connect panels at the rear after alignment

1. Connecting links (U profile)
2. Screw-fasten connecting links to the reinforcements of the insulating gas tanks

6. Align the panels to the busbar terminals on the rear acc. to Fig. 21 and the above Table. If applicable, lift the panel and place shims in the direct vicinity of the fastening points, until the horizontal position has been reached. Shims are not included in the scope of supplies.

7. The rear panel screw-fastening is effected using two U profiles. The U profiles plus screws are located in the cardboard box, see Chapter 4.4, page 24. Check clearance X (see above Table) between the busbar bushings once more before screw-fastening the panels. Screw-fasten the two U profiles using the upper tank reinforcements acc. to the assembly drawing.

**Notice:**

If current transformers are provided on the busbar, setting nuts must be inserted previously into the U profiles (see Chapter 5.2.4, page 40).
8. Remove cable compartment cover (see Chapter 4.5 as of page 26). Remove left-hand and right-hand cable tray covers in the cable compartment. Open the door of the low-voltage cabinet.

9. Screw-fasten the panels at the front below the low-voltage cabinet and in the cable connection compartment according to the assembly drawing. Should the side walls of the panels not be in contact without leaving a gap, the panels can be screw-fastened additionally in the front drive mechanism area. Release screw connection of the front cover from the 4 fastening points and remove front cover. Observe the safety provisions in Chapter 4.1, page 19, as long as the front cover is removed. Identify front cover according to the labelling of the panel in order to avoid mixing it up with other removed front covers. Screw-fasten panels in drive mechanism area additionally to achieve a closed front.

**Notice:**
Low-voltage cabinets mounted by the factory still have to be subjected to the acceptance test for busbar assembly, according to installation conditions; see Chapter 6 on page 46. The low-voltage cabinets may not be screw-fastened until after the busbars have been mounted.

---

**Fig. 23**
Screw-fastening the panels to one another (self-locking screw connections)
1 Screw-fasten low-voltage cabinets on the front (only after busbar assembly)
2 Screw-fasten the panels below the low-voltage cabinet. The screw-fastening points are accessible through the low-voltage cabinet.
3 Remove left-hand and right-hand cable tray covers.
4 Screw-fasten panels 3x in cable compartment.
4.8 Fastening panels onto the base frame

4.8.1 Standard model
Each panel is screw-fastened to the base frame in two positions at the front and rear each.
Panels with voltage transformers:
Each of the two rear fastening points is located between voltage transformers.
The screws are located in the cardboard box which is located on the busbar terminals as transport securing device, Fig. 24.

Notice:
The switchgear panels may not be screw-fastened to the base frame until they have been installed and adjusted.

Comply with assembly drawing AGS 006959-01

1. Drill preliminary bore-holes (Ø 7.2 mm) in the specified positions into the panel supporting structure in the base frame (see Fig. 25).
2. Fasten panel to the base frame in 4 positions using self-tapping screws M8.

Fig. 25
Fasten panel onto the base frame.
1. Base frame
2. 4 panel fastening points
3. Panel supporting structure
4. Self-tapping hex. bolt M8
4.8.2 Model with reinforced floor fastening

This floor fastening replaces the standard fastening and is mandatory in case of specific requirements, e. g. seismic design.

Assembly is effected on site.
Supplementary profiles and fasteners, consisting of self-locking screws and washers M10, are supplied in loose condition.

<table>
<thead>
<tr>
<th>Panel type</th>
<th>Panel width [mm]</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outgoing feeder panel</td>
<td>450</td>
<td>AGS 007732-01</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>AGS 007732-02</td>
</tr>
<tr>
<td></td>
<td>800</td>
<td>AGS 007732-03</td>
</tr>
<tr>
<td>Bus section</td>
<td>800</td>
<td>AGS 007732-05</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>AGS 007732-04</td>
</tr>
</tbody>
</table>

Fig. 26
The illustration shows the model “Outgoing feeder panel, width 450 mm” as an example
1 Front screw connection (5 self-locking screws M10)
2 Central screw connection (2 self-locking screws M10)
3 Rear screw connection (2 self-locking screws M10 with washer)
4.9 Connecting the earth cables

Variants overview

<table>
<thead>
<tr>
<th>Panel width [mm]</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>AGS 006960-01</td>
</tr>
<tr>
<td>600</td>
<td>AGS 006961-01</td>
</tr>
<tr>
<td>800</td>
<td>AGS 006962-01</td>
</tr>
<tr>
<td>1000</td>
<td>AGS 006963-01</td>
</tr>
</tbody>
</table>

The earth cable is screw-fastened to the front crossbar of the panel. The complete attachment has been preassembled in the factory.

Notice: Observe the specific standards referring to earthing systems which apply in the country in question!

Assembly procedure

1. Clean all contact areas of the earth, connecting and fastening bars in the switchgear panels and coat them with lubricant KL (see Chapter 13.2, page 79).
2. Slip the connecting bar (Fig. 27, item 6) into the adjacent panel's supporting structure through the cutout in the panel.
3. Screw-fasten the connecting bar with the support brackets on either side to the earth bar in question and screw-fasten the support brackets to the panel.
4. Connect the earth bus to the earthing system of the switchgear building. (Connection lines are not included in the scope of supplies.) The unit earth bar should be connected to the building earth at least on both ends. On principle, each panel has a facility for connection to the building earth.

Fig. 27
Connecting the earth cables
1 Support brackets
2 Connecting point (M12) for connection line to building earth
3 Earth bar
4 Self-locking screw, washer, nut M8
5 Screw, spring washer, washer, nut M8
6 Connecting bar to adjacent panel
4.10 Options

An earth bar reaching down into the cable basement (Fig. 28) is optionally available. It may be mounted, if applicable, in every fifth switchgear panel.

<table>
<thead>
<tr>
<th>Additional earth bar into the cable basement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Options</strong></td>
</tr>
<tr>
<td>An earth bar reaching down into the cable basement (Fig. 28) is optionally available. It may be mounted, if applicable, in every fifth switchgear panel.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Center panel / end panel, right-hand</strong></td>
</tr>
<tr>
<td>AGS 007504-01</td>
</tr>
</tbody>
</table>

Fig. 28
1 Earth bar to cable basement (optional)

<table>
<thead>
<tr>
<th>Isolated earth bar on cable support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgear panels can be supplied with optionally an additional isolated earthing bar mounted to the cable support in question. Please contact the manufacturer to this effect.</td>
</tr>
</tbody>
</table>
5  Busbar assembly

5.1 Delivery status and overview

**Danger!**
Risk of fatalities due to high voltage!
► Before commencing assembly, earth the switchgear and check it for zero voltage.

**Warning!**
Risk of injury due to falling!
► Use appropriate auxiliary products (e. g. assembly platforms).
► Provide for sufficient space for assembly and secure the assembly platform.

The single parts of the busbar system with solid insulation are supplied separately with the accessories.
The required materials should not be removed from the packaging until directly before starting assembly work.
Before commencing assembly of the busbar, make sure the panels are already screw-fastened completely and secured to the base frame (see Chapter 4 as of page 19).

**Access to the busbar area:**

Access from the operator side:
Attachment of the low-voltage cabinets supplied separately is not admissible until after busbar assembly. In case of limited space, any low-voltage cabinets attached in the factory can be removed, if applicable.
The busbar area is normally also accessible from the rear, depending on the switchgear configuration.

---

Fig. 29
Busbar system with current transformer on the busbar
1  Phase grouping for the busbars
2  Current transformer on the busbar (optional)
3  Crossover adapter with feeder per panel
4  Earthed, contact-proof single-pole busbar system
5  Busbar cover (optional)
5  Busbar assembly

5.2  Assembly procedure

5.2.1  Instructions for assembly

Preparations:
Before assembly of the busbars, check all single parts for the crossover and end adapters and panel bushings to detect any soiling and damage.

Notice:
- The tightening torques in Chapter 13 "Annex" on page 79 must be used for all screw fastenings which are not directly defined in the assembly description.
- Only the assembly paste supplied with the equipment in the accessories may be used for the busbar system. The use of other lubricants is not admissible!

Preparation of the electrical contact surfaces:
Preparatory treatment of the electrical contact surfaces on busbars, half-shells and bushings:

1. Cleaning:
   - Silver-plated surfaces: Clean using a lint-free cloth; in case of severe soiling, use white spirit
   - Copper: Clean using a lint-free cloth; in case of severe soiling, using white spirit, and expose metallic surface by treating the entire surface with emery cloth (grain size 100 or 80).

2. Immediately after cleaning the contact surfaces, coat them with a thin and uniform film of assembly paste

Preparation of all high-quality electrical joints / insulating surfaces:
Preparatory treatment of all high-quality electrical joints / insulating surfaces of busbars, end and crossover adapters with threaded inserts and bushings:
Clean high-quality electrical joints / insulating surfaces using a lint-free cloth (also microfiber cloths).
Coat the entire surface spreading a thin and uniform film of assembly paste. Blank spots not covered by grease should be avoided on all accounts. Once treated, do not touch the surfaces of the high-quality electrical joints again.

Preassembly
(see Chapter 5.2.2, page 37)
It is recommended to pre-assemble the busbar with the (end and) crossover adapter separately as busbar sub-section. This pre-assembly can be effected preferably on a separate, clean working place outside of the busbar area. Attachment of preassembled busbar sub-sections to the panel can thus be facilitated considerably.

Attachment of the preassembled busbar sub-sections to the panel
(see Chapter 5.2.3, page 39)
Make sure that the busbar sub-sections are mounted first onto all phases of a panel before the system is extended on the next panel.
The following is a detailed description of assembly.

Notice:
For assembly of the busbar system, the assembly instructions enclosed in the packaging must be observed additionally.
5.2.2 Preassembly of a busbar sub-section
Assembly should be effected separately before the busbar link is mounted to the panel.

Notice:
Comply with the switchgear configuration!
- Observe busbar length \( Y \) acc. to Table on page 29!
- If current transformers are envisaged on the busbar, these must be pushed onto the appropriate busbar prior to assembly.

Preassembly of busbar sub-section

Pre-coat all electrical contact surfaces on busbars and half-shells.
Pre-coat all high-quality electrical joints / insulating surfaces of busbars, end and crossover adapters.

1. Stack contact shells (incl. fitting part in case of end adapters) and push the stack through the greased busbar opening up to the center. The set of contact shells must be aligned so that the bore-holes are aligned with the take-up direction of the threaded pin.

2. Push busbar inside up to the center of the end adapter. The conductive layer of the busbar which is marked in black must no longer be visible. The busbar must be visible in the bore-holes of the contact shells.

3. Crossover adapter
Stack contact shells and push the stack through the greased busbar opening up to the center. The set of contact shells must be aligned so that the bore-holes are aligned with the take-up direction of the threaded pin.

4. Preparing current transformer assembly (optional) on the busbar:
   - Mount retaining plate for current transformer on the busbar (see Chapter 5.2.4, page 40)
   - Push current transformer over the busbar.

5. Push busbar inside up to the center of the crossover adapter. The conductive layer of the busbar which is marked in black must no longer be visible. The busbar must be visible in the bore-holes of the contact shells.

Busbar end section: The preassembled busbar sub-section consists of end adapter, busbar and crossover adapter.

Busbar center section: The preassembled busbar sub-section consists of busbar and a crossover adapter.

Fig. 30
Preassembly of busbar sub-section

1 End adapter
2 Contact shell
3 Crossover adapter
4 Contact shell
5 Busbar
6 Contact shell
7 Fitting part for end adapter
5  Busbar assembly

Fig. 31  
Single parts of the complete busbar system
1  Cap
2  Threaded insert; tightening torque 30 Nm
3  Nut; tightening torque
   - for Ir busbar ≤ 1250 A: 50 Nm
   - for Ir busbar > 1250 A – 2500 A: 70 Nm
4  Spring washer
5  End adapter
6  Threaded pin, tightening torque
   - for Ir busbar ≤ 1250 A: 10 Nm
   - for Ir busbar > 1250 A – 2500 A: 15-3 Nm
7  Bushing on the panel
8  Earth terminal on the adapter
9  Contact shell
10 Busbar
11 Cable clamp for bleeding
12 Crossover adapter
13 Observe busbar length Y (see Table on page 30)
14 Contact shell
15 Fitting part for end adapter

Fig. 32  
Busbar mounted on an end panel and center panel
5.2.3 Assembly on the busbar

**Notice:**
- Pre-treat contact surfaces and insulating surfaces on the busbar bushings on the panel acc. to Chapter 5.1, page 35.
- Depending on the switchgear configuration, the individual parts for the busbar system are supplied for a busbar rated current \( \leq 1250 \text{ A} \) or \( 2500 \text{ A} \). For assembly of the complete busbar system, the assembly instructions enclosed in the packaging must also be observed.
- In case of a switchgear configuration with bus section and busbar rated current of \( 2500 \text{ A} \) with pressure relief, please refer to Chapter 5.5, page 45.

**Assembly workflow for end panels**

1. Screw-fasten the threaded pins supplied with the switchgear to the busbar bushings of the two end panels of each switchgear unit.
2. Push the preassembled busbar sub-section (end adapter, busbar and crossover adapter) onto the busbar bushings of the first two panels, starting from the left-hand or right-hand end panel.
3. Also mount all the other phases of the two panels according to operations 1 and 2.

**Assembly workflow for center panels**

4. Screw-fasten the threaded pin supplied with the switchgear to the busbar bushings of each panel.
   - In case of busbar systems with a rated current of \( 2500 \text{ A} \), the threaded pin can also be screw-fastened after the pre-assembled busbar sections have been positioned. This may facilitate positioning.
5. Lining up busbars next to the adjacent panels:
   - Lift the crossover adapter of the busbar sub-section already mounted to the panel and insert busbar of the new sub-section into the crossover adapter.
   - The conductive layer of the busbar which is marked in black must no longer be visible. The busbar must be visible in the bore-hole of the upper contact shell.
   - Push crossover adapter of the new sub-section onto the busbar bushing of the panel.
6. Also mount all the other phases of the two panels according to operations 5 and 6.

**Screw-fastening and checking contact systems**

7. For each adapter, screw-fasten the entire contact system with spring washer, nut and threaded pin.

**Final steps**

8. Close each adapter using one pretreated threaded insert. To this effect, always use a cable clamp for bleeding. Screw-fasten the threaded insert to the threaded pin.
9. Connect all earth cables of the end and crossover adapters to the panel.
10. Cover each adapter by means of the cap.
5.2.4  Current transformer on the busbar (optional)

### Variants overview

<table>
<thead>
<tr>
<th>Panel width [mm]</th>
<th>Panel arrangement</th>
<th>Side for attachment of current transformer to busbar</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 / 800</td>
<td>End panel left-hand Center panel</td>
<td>right-hand side</td>
<td>AGS 006956-01</td>
</tr>
<tr>
<td></td>
<td>Center panel End panel, right-hand</td>
<td>left-hand side</td>
<td></td>
</tr>
<tr>
<td>Bus section 800 /1000</td>
<td>Center panel</td>
<td>right-hand side</td>
<td>AGS 006956-02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>left-hand side</td>
<td>AGS 006956-03</td>
</tr>
</tbody>
</table>

Fastening is effected on a retaining plate between 2 panels. Attachment is possible on each busbar section, except between panels with a width of 450 mm.

### Current transformer type

- Inductive low-voltage toroidal-core current transformers
- Standard design: Zelisko, type CMS125
  - Other models available on request. Please contact the manufacturer to this effect.

### Mounting retaining plate

1. Observe the location of the current transformers based on the customer's specific switchgear documentation.
2. Insert setting nut into the rear connecting bar in question
3. Fasten connecting bar between the panels, see Chapter 4.7, page 28.
4. Fasten retaining plate on the two rear connecting bars using self-locking screws.

### Mounting current transformer

5. Mount busbar with pushed-on current transformer, see Chapter 5.2.3, page 39. Position the current transformers on the retaining plate accurately during busbar assembly.
6. After busbar assembly, screw-fasten the current transformer onto the retaining plate using self-locking screws.
7. Mount the residual phases according to operations 5 and 6.
8. Current transformer low-voltage connection:
   - Observe the allocation of the current transformers to the low-voltage cabinet according to the wiring diagram!
   - The current transformers cannot be connected to panels with a width of 450 mm.
9. Establish cable bushing in the appropriate low-voltage cabinet.
   - Break-out perforated plates on the low-voltage cabinet and on the front cover plate of the busbar cover (optional) and mount an edge protector.
10. Connect current transformer acc. to wiring diagram in low-voltage cabinet.
Fig. 33

1 Current transformer low-voltage connection:
   Comply with assignment to the low-voltage cabinet as specified in the wiring diagram!

2 Cable bushing current transformer wiring:
   Break-out perforated plate and mount edge protector.
   The cable bushing is available in each panel, except for panel widths of 450 mm

3 Current transformer:
   Type CMS125 made by Zelisko (other versions optionally available)

4 Single-pole busbar system

5 Retaining plate

6 Screw-fastening of current transformer to the retaining plate

7 Screw-fasten retaining plate onto the two rear connecting bars.

8 Insert setting nuts into the connecting bar in question.
5.2.5 Surge arrester on busbar
Mount surge arrester onto the appropriate end or crossover adapter according to the manufacturer's specifications. Comply with the switchgear configuration.
The contact areas of the earth connections must be coated as described in Chapter 13.2 on page 79. Connect earth cables to the panel.

![Surge arrester on busbar](image)

Fig. 34
Surge arrester on busbar

5.3 Protective edgings on end of busbar
Attachment of the protective edgings is only required if an optional busbar cover is attached subsequently; see Chapter 5.4, page 43.
The protective edgings are included in the accessories.
Fasten a protective edging on the left-hand and right-hand end of the busbar in acc. with Fig. 35 on the top tank reinforcements using self-locking screws. Comply with the clearance specified in the drawing.

![Assembly drawing](image)

Assembly drawing
AGS 007150-02

Fig. 35
1 Protective edging on the busbar
2 Left-hand busbar
3 Right-hand busbar
5 Busbar assembly

5.4 Busbar cover (optional)

<table>
<thead>
<tr>
<th>Panel width [mm]</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>AGS 006950-01</td>
</tr>
<tr>
<td>600</td>
<td>AGS 006951-01</td>
</tr>
<tr>
<td>800</td>
<td>AGS 006952-01</td>
</tr>
<tr>
<td>1000</td>
<td>AGS 006953-01</td>
</tr>
</tbody>
</table>

As a protection against mechanical damage and sizable foreign bodies, an additional mechanical cover can be supplied (Fig. 32) for the busbar system (optional). Installation of the optional busbar cover is not possible for the model with pressure relief to the outside of the room.

Fig. 36
Busbar cover (optional)
5 Busbar assembly

Assembly procedure

1. Screw-fasten front cover plate on tank (Fig. 37, item 6). If the low-voltage cabinets have already been mounted in the factory, the front cover plate is also pre-assembled (item 6).
2. Screw-fasten the rear cover plate (item 4) on the tank (item 5).
3. Preassemble all the other panels according to operations 1 and 2.
4. Screw-fasten the panels to the front (1x) and rear (2x) cover plates.
5. Fasten top cover plate (item 2) onto the front and rear cover plate using self-tapping screws (item 1 and 3).
6. Preassemble all the other panels according to operation 5.
7. Screw-fasten the panels to each other via the top cover plates.
8. If the low-voltage cabinet is supplied with the accessories, first mount the low-voltage cabinet according to Chapter 6.1, page 46. Fasten low-voltage cabinet to the top and the front cover plate using self-tapping screws.

Fig. 37 Mounting the busbar cover
1  Screw-fastening of top cover plate to front cover plate
2  Top cover plate
3  Screw-fastening of top cover plate to rear cover plate
4  Rear cover plate
5  Screw-fastening of rear cover plate to tank
6  Screw-fastening of front cover plate to tank
7  Screw-fastening of front cover plate to low-voltage cabinet
8  Front cover plate
9  Screw-fastening of front cover plate to low-voltage cabinet
10 Screw-fastenings to the adjacent panel in question
5.5 Supplementary attachments for pressure relief to outside of the room

Variants overview

<table>
<thead>
<tr>
<th>Width of in-line panel, left-hand [mm]</th>
<th>Width of bus section panel [mm]</th>
<th>Assembly drawing</th>
<th>BB-Length [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>1000</td>
<td>AGS007470-01</td>
<td>551</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>AGS007470-02</td>
<td>626</td>
</tr>
<tr>
<td>800</td>
<td></td>
<td>AGS007470-03</td>
<td>786</td>
</tr>
</tbody>
</table>

In the configuration “switchgear with busbar rated current of 2500 A with bus section and pressure relief to outside of the room, it is essential to mount a supplementary busbar on the bus section (left-hand panel part) (Fig. 38). It is not possible to attach busbar current transformers in the link between the bus section panel and the left-hand adjacent panel.

Notice:
For assembly of the supplementary busbar system, the assembly instructions enclosed in the packaging must also be observed.

Fig. 38
Mounting the supplementary busbar
1 Bus section panel
2 Left-hand adjacent panel
3 Supplementary busbar
4 Busbar link to adjacent panel
6.1 Attachment of low-voltage cabinet

The low-voltage cabinets are either supplied as accessories or may already be mounted to the panel, depending on the transport requirements.

1. Assign the low-voltage cabinet to the appropriate panel and remove the packaging. Position low-voltage cabinet carefully on top of the appropriate panel from above.

2. Open the switch cabinet door using the double-bit key.
   Screw-fasten low-voltage cabinet on the rear (self-locking screw connection M8, see Fig. 39, item 1).
   Screw-fasten the bottom of the low-voltage cabinet to the panel on the front (self-locking screw connection, see Fig. 39, item 2).

3. Screw-fasten the low-voltage cabinets laterally to one another (see Chapter 4.7, page 28).

Assembly drawing
AGS 007006-01
6 Low-voltage cabinet

Connecting internal control lines of panel:

4. Slip the terminals of the drive box wiring onto the terminal strips in the low-voltage cabinet according to the marking on the connector (Fig. 40, item 1).

Fig. 40
Connection of the internal control lines of the panel
1 Terminal strip with labelling of terminals
2 Internal wiring within the panel with designated connector

6.2 Connecting the ring circuits

1. Route the ring circuits (Fig. 41, item 1) for the cross-panel wiring through the lateral oval openings of the low-voltage cabinet (item 2).
2. The ring circuits are connected to the appropriate terminal strips (item 3) in the low-voltage cabinet according to the wiring diagram.
3. Fasten the ring circuits using suitable cable supports (item 4).

Fig. 41
Panel-to-panel ring circuit
1 Ring circuits
2 Lateral openings in low-voltage cabinet
3 Terminal strips
4 Cable support
6.3 Placing external control cables

Customized low-voltage cables are always placed on the right inside of a panel from the cable basement to the low-voltage cabinet (see Fig. 42) as standard.

**Center panel**

1. Place external cables from cable basement in the right-hand cable tray of the panel to the low-voltage cabinet. Fasten cables to panel using cable clamps (Fig. 42).
2. Connect external cables to the transfer terminal strip in the low-voltage cabinet according to the circuit diagram. Additionally, ground shielded lines on the cable supports.
3. Re-fasten metallic cable tray covers in the supporting structure.

**End panel**

Depending on accessibility to the end wall (see Chapter 7 as of page 49), the following supplementary options are available in the end panels.

- Cable routing laterally on the panel, fastened by means of cable clamp and, if required, by means of cementing clips (Fig. 42). Access to the low-voltage cabinet via the ring circuit openings (left-hand side) or via the instrument recess (right-hand side).
- Routing of cables in cable tray of the side wall (Fig. 42). Access to the low-voltage cabinet via the ring circuit openings.

**Design is identical for the right-hand and left-hand sides.**

---

**Fig. 42**
Routing external control cables in the cable tray of the side wall (left-hand side shown)

1. Cable tray in the side wall
2. External control lines
3. Cable clamp
4. Release screw fastening and remove cable tray cover
5. Route external control lines from the cable basement to the low-voltage cabinet on the right-hand side of the panel
6. Connection to terminal strip
7 Switchgear termination

7.1 Switchgear without pressure relief duct (IAC AFL)

Front and lateral covers are necessary if the qualification IAC AFL acc. to IEC 62271-200 is required.

- Illustrated in Fig. 44:
  The switchgear is accessible from the front and on the right-hand side (the switchgear is located in the left-hand corner of the room).
- The switchgear is accessible from the front and from the left-hand side (the switchgear is located in the right-hand corner of the room).
- The switchgear is accessible from the front and from both sides (the switchgear is located against the wall of the building, but not in a corner of the room).

Notice:
Comply with the appropriate documentation for the switchgear. It defines the applicable variant in accordance with the customer's requirements.

Fig. 43
Example for switchgear with a rated current of 1250 A for installation in the left-hand corner of the room;
Configuration acc. to IEC 62271-200 with internal arc classification IAC AFL

Fig. 44
Example for switchgear with a rated current of 2500 A for installation in the left-hand corner of the room;
Configuration acc. to IEC 62271-200 with internal arc classification IAC AFL

1 Switchgear 5 Remove rear gap cover (see Chapter 7.3, page 52).
2 Remove front gap cover (see Chapter 7.4, page 53) 6 Wall of building
3 End wall (see Chapter 7.2, page 50)
4 End wall extension for switchgear units with rated current
> 1250 - 2500 A (see Chapter 7.2, page 50)
7 Switchgear termination

7.2 Attachment of end wall and end wall extension

The assembly procedure for attachment of the end walls is identical for the right-hand and left-hand switchgear sides:

<table>
<thead>
<tr>
<th>Panel width [mm]</th>
<th>Busbar nominal current [A]</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Attachment, left-hand</td>
</tr>
<tr>
<td>450</td>
<td>≥ 1250</td>
<td>AGS 006900-01</td>
</tr>
<tr>
<td></td>
<td>≥ 1250</td>
<td>AGS 006901-01</td>
</tr>
<tr>
<td>600</td>
<td>≥ 1250</td>
<td>AGS 006902-01</td>
</tr>
<tr>
<td>800</td>
<td>≥ 1250</td>
<td>AGS 006903-01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AGS 006904-01</td>
</tr>
</tbody>
</table>

If the switchgear is installed in the corner of a room, the end wall in question must be mounted on the base frame of the panel before the end panel is positioned.

Push the end panel with the mounted end wall into its end position onto the base frame according to the space assignment plan.

All individual parts incl. the fastening material are included in the accessories.

The following illustration shows attachment to the left-hand switchgear side.

![Attachment of the fastening profiles for the end wall support according to the assembly drawing](image)

Fig. 45
Illustrated: Panel with module width 450 mm
1 Attachment of the fastening profiles in question for the end wall support according to the assembly drawing
7 Switchgear termination

Mounting the end wall support to the support brackets according to the assembly drawing

Mounting the end wall covering to the end wall support according to the assembly drawing

Fig. 46
1 Assembly of the base for the end wall
2 Assembly of the base for extension of the end wall. Only required for switchgear with a rated current of > 1250 - 2500 A
3 Openings for external control lines to low-voltage cabinet
4 Opening to place external control lines in the end wall
5 Placing external control lines in cable duct of end wall support possible as required (see also Chapter 6.3 on page 48 "Connection of external control lines").

Fig. 47
1 Switchgear units with a heightened low-voltage cabinet (850 mm); attachment of an end wall adapter acc. to assembly drawing AGS 007 441-01
2 Mounting the end wall covering
3 Facing for the end wall extension
4 Mounting the cover strip
7 Switchgear termination

7.3 Rear gap cover

The assembly procedure is identical for the right-hand and left-hand switchgear sides:

The rear gap cover is attached between the mounted end wall and the building wall Fig. 48.

The gap cover can be used to compensate a clearance of 0 to max. 20 mm between the end wall and the building wall.

The oblong holes for fastening the gap cover are arranged symmetrically. Thus, the gap cover can be turned for adaptation to the specified clearance.

1. Apply rear gap cover as shown in the drawing and mark securing bore-holes on the wall of the building and, if necessary, on the front gap cover.
2. Remove rear gap cover and provide securing bore-holes on the building wall (diameter 10 mm). Subsequently, mount dowel pins.
3. Screw-fasten the rear gap cover to the building wall (Fig. 48, item 5, tightening torque 10 Nm).
4. Screw-fasten rear gap cover to the end wall covering or as facing for the end wall extension. (Item 6).

<table>
<thead>
<tr>
<th>Height (mm)</th>
<th>Nominal dimension (mm)</th>
<th>Tolerance range (mm)</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2200</td>
<td>0</td>
<td>0 - 20</td>
<td>AGS 007163-01</td>
</tr>
</tbody>
</table>

Fig. 48
Assembly of the rear gap cover
Left-hand view for switchgear with a rated current of up to 1250 A
Right-hand view for switchgear with a rated current of > 1250 - 2500 A and end wall extension
1 Wall of building
2 Screw-fastening to the wall of the building
3 Rear gap cover
4 Screw-fastening to the end wall. (Use existing screws, tightening torque: 20 ± 2 Nm)
5 End wall / end wall extension
7.4  Front gap cover to side wall of building

<table>
<thead>
<tr>
<th>Height</th>
<th>Nominal dimension</th>
<th>Tolerance range</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2200 mm</td>
<td>100 mm</td>
<td>± 15 mm</td>
<td>AGS 007164-01</td>
</tr>
</tbody>
</table>

The front gap cover is installed between the end panel and the side wall of the building (Fig. 49).

The nominal width of the gap cover is always 100 mm.

The oblong holes for fastening the gap cover are arranged symmetrically.

1. Screw-fasten support bracket to the panel.
   (Use existing screws, tightening torque: 20 ± 2 Nm)
2. Position gap cover acc. to (Fig. 49, item 3) and mark securing bore-holes onto the building wall.
3. Remove gap cover and provide securing bore-holes Ø 10 mm.
4. Mount gap cover to the building wall using dowel pins and securing bolts (item 2).
5. Screw-fasten gap covers and support brackets to one another (item 7).

---

Fig. 49
Front gap cover
1  Wall of building
2  Screw-fastening to the wall of the building
3  Gap cover
4  Switchgear panel
5  Screw fastening to the panel (Use existing screws, tightening torque: 20 ± 2 Nm)
6  Screw-fasten support bracket to the panel
7  Screw-fastening of gap cover to support bracket
7.5 Protective cover on the end wall

<table>
<thead>
<tr>
<th>Assembly drawing</th>
<th>Attachment to left-hand end wall</th>
<th>Attachment to right-hand end wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGS 007330-01</td>
<td>AGS 007330-02</td>
<td></td>
</tr>
</tbody>
</table>

Attachment of the protective cover to the end wall is always required (except in case of the model with pressure relief to the outside of the room).

![Diagram of protective cover attachment](image)

**Fig. 50**
Fastening the protective cover to the end wall
1. Protective cover for switchgear with IAC classification AFL
2. Protective cover for switchgear with IAC classification AFLR
3. Screw-fastening to the end wall
4. End wall
8 Switchgear with pressure relief device

8.1 Overview

Switchgear units are provided with pressure relief duct, if the following is required:
- Accessibility in acc. with IEC 62271-200: Qualification IAC AFLR (accessibility from all sides) and / or
- pressure relief to outside of the switchgear room.

Switchgear units with pressure relief duct are accessible on all sides and can thus be located centrally in the room, independent of the walls of the building.

All attachments for the pressure relief duct are included in the accessories.

The pressure relief ducts are attached on the construction site.

**Note:**
For pressure relief from the switchgear, the customized pressure relief duct between the switchgear and the wall of the building is not included in the scope of supplies.

Fig. 51
GMA switchgear with pressure relief out of the switchgear room, taking the standard IEC 62271-200 with internal arc qualification IAC AFLR into account
8 Switchgear with pressure relief device

Fig. 52
Illustrated: GMA switchgear with pressure relief into the switchgear room, taking the standard IEC 62271-200 with internal arc qualification IAC AFLR into account

1. Switchgear unit
2. Side walls
3. Building wall

Switchgear, accessible from the rear: ≥ 800 (reduced dimension available on request)
8 Switchgear with pressure relief device

Sequence of mounting operations:

1. Position panels; mount busbar and low-voltage cabinet (see Chapters 4, 5 and 6)
   Panels with pressure relief to outside of the room are designed on principle without busbar enclosure (see Fig. 53, right-hand variant).
2. Mount pressure relief duct incl. deflector plate
3. Mount end walls (Chapter 5.2, from page 36) and protective cover (Chapter 5.4, page 43).
4. Mount pressure relief collecting duct (only in case of pressure relief to outside of the room)
5. Screw-fasten upper cover (only in case of pressure relief to outside of the room)
6. Mount rear cover of pressure relief chamber (cover flap must be open)
7. Mount rear compensation profiles.

Fig. 53
Individual parts for mounting the pressure relief duct
1 Pressure relief collecting duct (see Chapter 8.6, page 62)
2 Upper cover with flaps (see Chapter 8.5, page 61)
3 Support bracket (see Chapter 8.4, page 60)
4 Pressure relief chamber (see Chapter 8.3, page 59)
5 Adapter housing (see Chapter 8.2.1, page 58)
6 Busbar enclosure (optional)
7 Deflector plate (is supplied in duct including fasteners)
8 Switchgear with pressure relief device

8.2 Modules required for attachment of the pressure relief duct

8.2.1 Adapter housing

The adapter housing, Fig. 54, is supplied to the construction site with accessories in pre-assembled condition and fastened to the supporting structure using the fasteners included in the scope of supplies.

The adapter housing is used for pressure relief both into the room and to outside of the room.

The following Table shows the variants which require attachment of the adapter housing.

<table>
<thead>
<tr>
<th>Panel width [mm]</th>
<th>( I_r ) (busbar) [A]</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>( \leq 1250 )</td>
<td>AGS007276-01</td>
</tr>
<tr>
<td>450</td>
<td>( &gt; 1250 )</td>
<td>AGS007274-01</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>AGS007275-01</td>
</tr>
</tbody>
</table>

Fig. 54
Adapter housing (example for panel width of 450 mm)
8 Switchgear with pressure relief device

8.3 Attachment of the pressure relief chamber

State as delivered:

Prior to mounting, the rear cover of the chamber must be removed. The fasteners required for screw-fastening incl. angle bracket are supplied in the duct in a bag. Make sure that the cover flaps of the duct (Fig. 55) are secured by a plastic rivet in open condition.

During assembly of the pressure relief duct, the panel width of the panel concerned must be checked in the area of the pressure relief duct, and complied with.

![Attachment of the pressure relief chamber to the panel](image)

**Fig. 55**
1. Cover flaps of pressure relief duct
   - The cover flaps must be open.
2. Plastic rivet

Attachment of the pressure relief duct is described in the assembly drawing in question:

<table>
<thead>
<tr>
<th>Panel width [mm]</th>
<th>Panel type</th>
<th>( I_r ) (busbar) [A]</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td></td>
<td>1250 / 2500</td>
<td>AGS007300-01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AGS007300-21</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>1250 / 2500</td>
<td>AGS007300-02</td>
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<td></td>
<td></td>
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<tr>
<td>800</td>
<td>LK</td>
<td>( \leq 1250 )</td>
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<td>800</td>
<td></td>
<td>&gt; 1250</td>
<td>AGS007300-03</td>
</tr>
<tr>
<td>1000</td>
<td>LK</td>
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<td></td>
<td></td>
<td>AGS007300-24</td>
</tr>
</tbody>
</table>
8 Switchgear with pressure relief device

8.4 Attachment of support bracket

The support brackets (Example: Fig. 56, item 2) are included in the accessories. These are fastened to the tank of the panel and on the pressure relief duct. For the individual variants depending on panel width, panel type and rated busbar current, please refer to the Table below.

Fig. 56
Example for attachment of support angle
1 Pressure relief duct
2 Support bracket
3 Self-locking screw M8x16
4 Nut M8

For details, please refer to the assembly drawing included in the scope of supplies, according to the following Table:

<table>
<thead>
<tr>
<th>Panel width [mm]</th>
<th>Panel type</th>
<th>( I_r ) (busbar) [A]</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td></td>
<td>( \leq 1250 )</td>
<td>AGS007475-01</td>
</tr>
<tr>
<td>450</td>
<td></td>
<td>&gt; 1250</td>
<td>AGS007476-01</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>( \leq 1250 )</td>
<td>AGS007477-01</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>&gt; 1250</td>
<td>AGS007478-01</td>
</tr>
<tr>
<td>800</td>
<td>LK</td>
<td>( \leq 1250 )</td>
<td>AGS007477-01</td>
</tr>
<tr>
<td>800</td>
<td>LK</td>
<td>&gt; 1250</td>
<td>AGS007479-01</td>
</tr>
<tr>
<td>1000</td>
<td>LK</td>
<td>&gt; 1250</td>
<td>AGS007480-01</td>
</tr>
</tbody>
</table>
8 Switchgear with pressure relief device

8.5 Top covers with cover flaps

The model with top cover and flaps is only required in case of pressure relief to outside of the room. Top covers are included as a module in completely pre-assembled condition.

The material required for screw-fastening the top cover is included in the scope of supplies and supplied with the accessories.

Make sure that the cover flaps of the duct (Fig. 55, page 59) are in open condition.

For details, please refer to the assembly drawing included in the scope of supplies, according to the following Table:

<table>
<thead>
<tr>
<th>Panel width [mm]</th>
<th>Panel type</th>
<th>$I_r$ (busbar) [A]</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td></td>
<td>$\leq 1250$</td>
<td>AGS007429-01</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>$\leq 1250$</td>
<td>AGS007429-02</td>
</tr>
<tr>
<td>800</td>
<td>LK</td>
<td>$\leq 1250$</td>
<td>AGS007429-13</td>
</tr>
<tr>
<td>450</td>
<td></td>
<td>$&gt; 1250$</td>
<td>AGS007428-01</td>
</tr>
<tr>
<td>600</td>
<td></td>
<td>$&gt; 1250$</td>
<td>AGS007428-02</td>
</tr>
<tr>
<td>800</td>
<td>LK</td>
<td>$&gt; 1250$</td>
<td>AGS007428-03</td>
</tr>
<tr>
<td>1000</td>
<td>LK</td>
<td>$&gt; 1250$</td>
<td>AGS007428-04</td>
</tr>
</tbody>
</table>
8.6 Pressure relief collecting duct for pressure relief to outside of the switchgear room

Depending on the switchgear configuration, the pressure relief collecting duct can be connected on the left and/or right side of the switchgear unit to a customized pressure relief duct (not included in the scope of supplies) using a connecting piece; see also Fig. 52 on page 56.

It is essential to assemble the pressure relief duct prior to mounting the rear side of the pressure relief duct.

Attachment of the pressure relief collecting duct is described in the assembly drawing in question:

**Pressure relief collecting duct** (Fig. 58, item 3)

<table>
<thead>
<tr>
<th>Panel width [mm]</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>AGS007419-01</td>
</tr>
<tr>
<td>600</td>
<td>AGS007419-02</td>
</tr>
<tr>
<td>800</td>
<td>AGS007419-03</td>
</tr>
<tr>
<td>1000</td>
<td>AGS007419-04</td>
</tr>
</tbody>
</table>

**Connecting piece, left-hand and right-hand** (Fig. 58, item 2)

<table>
<thead>
<tr>
<th>Attachment side</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>left-hand side</td>
<td>AGS007421-01</td>
</tr>
<tr>
<td>right-hand side</td>
<td>AGS007420-01</td>
</tr>
</tbody>
</table>

**End cap** (Fig. 58, item 1)

<table>
<thead>
<tr>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGS007426-01</td>
</tr>
</tbody>
</table>
Compensating profiles

The compensating profiles at the rear (Fig. 59) are required for both pressure relief variants. Make sure the rear chamber cover is mounted before attaching the compensating profiles.

The compensating profiles are screw-fastened between the individual panels on the rear of the chamber cover and on the left and right of both end panels.

Compensating profiles are available for center panels and end panels (on the left and right sides).

The assembly drawings concerned are listed in the following Table.

<table>
<thead>
<tr>
<th>Panel type</th>
<th>Assembly drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>End panel, left-hand</td>
<td>AGS007481-01</td>
</tr>
<tr>
<td>Center panel</td>
<td>AGS007482-01</td>
</tr>
<tr>
<td>End panel, left-hand</td>
<td>AGS007483-01</td>
</tr>
</tbody>
</table>

Fig. 59

1. Compensating profile for center panel
2. Compensating profile for end panel
9.1 Description of the panel connections

The switchgear has been designed as standard with outer cone-type bushings for mains outgoing feeder cable:

Components fitted to the panel for high-voltage connection

- Outer cone-type bushing acc. to EN 50181, terminal type C2
  - Rated current \( I_r = 1250 \text{ A} \) with screw-type connection, inner thread M 16x2 for the cable lugs of the cable screw-type plugs.
  - Circuit-breaker panels, module width 600 mm with output currents \( \leq 1250 \text{ A} \):
    - 1x bushing, terminal type C2 / phase
  - Circuit-breaker panels, module width 800 mm with output currents > 1250 A to 2500 A:
    - 2x bushings, terminal type C2 / phase

Practically all the commercially available cable connection systems (fully insulated, metal-enclosed or partially insulated) can be mounted to the medium-voltage switchgear. The available cable connection systems have been defined already in the Switchgear Configuration for the series GMA. In case of doubt, please consult the manufacturer in advance regarding the envisaged cable connection system.

Tools and accessories (cable clips, screws etc.) for the assembly of the cable connection systems (cable fittings and T connectors) are not included in the scope of supplies.

The switchgear is accessible from the front to enable assembly of the cable connection systems.

To this effect, remove front cable compartment covers (see Chapter 4.5, page 26).

Fig. 60
Circuit-breaker panel with 2x outer cone-type bushing per phase, terminal type C2 per bushing
9.2 Dimension drawings for the cable compartment

### Dimensions for optional base plates

<table>
<thead>
<tr>
<th>Panel width [mm]</th>
<th>Number of cables per phase</th>
<th>Clearance X [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>100 - 115</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>100 - 115</td>
</tr>
<tr>
<td>600</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>100 - 115</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>100 - 115</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>800</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>100 - 115</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>100 - 115</td>
</tr>
</tbody>
</table>

Fig. 61
Dimension drawings and representation of the cable connection variants with regard to the module width

For the clearance X in question, please refer to the above Table.
Panel with one outer cone-type bushing per phase
Rated current ≤ 1250 A

Current transformer block on bushings, module width 450 / 600 mm

Panel with two outer cone-type bushings per phase
Rated current > 1250 - 2500 A

Current transformer blocks on both bushings. Module width 800 mm

Fig. 62
Panel with module width 450 / 600 mm

Fig. 63
Panel with module width 800 mm
9 High-voltage connection

9.3 Base plates in the cable compartment (optional)

The panels can be supplied optionally with metallic base plates (Fig. 64, item 2) in the cable compartment. In this case, the base plates have been installed by the factory and must be removed before cable assembly. The plastic sleeves for the high-voltage cables are enclosed as accessories.

1. Before assembly of the high-voltage cables, the base plates and - if applicable - the cable supports must be removed.
2. Cut the plastic sleeves to fit the cable diameter and slip them over the cable before mounting the cable connectors.
3. Mount first cable per phase with cable connector acc. to Chapter 9.4, page 68.
4. After mounting the cables, position plastic sleeves, then reinsert and screw-faste the removed base plate.
5. Assembly of further cables per phase:
   The base plates are adjustable in design and can be set to the appropriate clearance X (see Table on page 52) depending on the cable connector used.
6. After adjustment, re-tighten securing bolts (Fig. 64, item 3).

Fig. 64
Mounting the base plates.
1 If necessary, the front crossbar can be removed from the panel.
2 Base plates
3 Securing bolts
4 Cable support
9.4 Mounting the high-voltage cable connector

**Danger!**
Risk of fatalities due to high voltage!
- Close non-assigned outer cone-type bushings using surge-proof covers.
  (Surge-proof covers are not included in the scope of supplies).

**Warning!**
Risk of injury if dielectric strength is not ensured!
Due to inadmissible stress, the bushings can be damaged and insulating gas can escape.
- The cable support must be set and the cable fastened so as to ensure that no additional forces act on the outer cone-type bushing!
- Make sure damage to the outer cone-type bushings is avoided!

**Notice:**
The assembly instructions of the manufacturers of cables and cable connectors must be complied with precisely.

Assembly procedure

1. Mount cable connector onto high-voltage cable according to the manufacturer's specifications.
2. Remove protective transport caps from the outer cone-type bushings.
3. Connect cable connector to the panel.
   - Expose metallic surface of contact surfaces of Cu insert on the outer cone-type bushing (see Chapter 13.2, page 79). Clean the insulating surfaces of the T connector and the appliance coupler carefully and apply a uniform film of special paste (see instructions of manufacturer).
   - Position cable connector and align it in parallel.
   - Screw-fasten contacts (thread M16).
     The tightening torque of 50 Nm must not be exceeded!
   - Position terminating elements acc. to manufacturer's specifications and screw-fasten them.

Fig. 65
Detail view of cable connector
1 Terminating element
2 Contact screw-connection
3 Cable lug
4 Cable T connector
5 Outer cone-type bushing
6 Retaining plate for outer cone-type bushing (do not detach!)
5. Surge arrester on the cable connection:
   - For assembly, refer to the instructions issued by the manufacturer of the surge arresters.
   - The contact surfaces of the earth terminals must be coated as described in Chapter 13.2, page 79.

Fig. 66
Fasten high-voltage cable and connect earth cables
1 Connect earth cables of T connector
2 Fasten high-voltage cables using a cable clip
3 Reposition the base plates
4 Cable support adjustable and pre-assembled
5 Connect earth cables of high-voltage cable
6 Surge arrester
10 Final steps

10.1 Accessories

Mobile accessory board
(Fig. 67)

Item no. AGS 007165-03

The mobile accessory board can be suspended centrally on a wall of the switchgear building via two securing bolts, and can be removed if required. A handle ensures safe transport.

A mobile accessory board can accommodate the following elements:
- crank of 3-position switch
- emergency crank, energy-storing device of circuit-breaker
- double-bit key
- kit of pluggable voltage indicators (3 pcs.)
- documents regarding the switchgear (DIN A4)

10.2 Cleaning and checking assembly

Danger!
Risk of fatalities due to high voltage!

High-voltage terminals must be closed with surge-proof terminations - either using approved cable fittings or suitable dummy plugs (not included in the manufacturer’s scope of supplies).

- Clean the switchgear, removing contamination resulting from assembly work.
- Remove all the attached information tags, cards, brochures and instructions no longer needed.
- Check the tightening torques of all screw fastenings and connections established on the site of installation:
  - Earth cable
  - Panel screw fastenings
  - Special attachments.
10 Final steps

Remount / close covers
(see Chapter 4.5, page 26)

- Lateral cable tray cover in cable compartment
- Cable compartment cover
- Front cover
- Cable compartment cover
- Door of low-voltage cabinet

Damaged paint

The components are powder-coated. Minor damage to the paint can be repaired using an approved touch-up pen (standard colour RAL 9003 or corresponding colour).

Inspection

- Check the switchgear for damage which might be due to transport or assembly work.
- Compare data on nameplate to the required ratings.
- Check supply voltage of control and operating devices.
- Check wiring laid on site.
- Check insulation gas monitoring

10.3 Switching tests on the switching devices

Danger!
Risk of fatalities due to high voltage!

- During the tests (e.g. switching operations), high voltage must not be connected.
- The switchgear must be de-energized and earthed as specified.

Notice:

- Refer to the Operating Manual of the GMA series.
- While the power supply is not available, blocking coils (locking the interrogation slides and circuit-breaker push-buttons, depending on design) are in “locked” position. An undervoltage release (optional) has dropped out. In this case, first perform items 3 to 5 described below.
- The energy-storing device of the circuit-breaker mechanism is charged autonomously as soon as the supply voltage is applied.
- In case of irregularities, please contact the manufacturer.

Sequence of operations:

1. Perform approx. 5 manual switching tests on each of the individual switching devices.
2. Check switch position indicators.
3. Apply supply voltage.
4. Check electrical functions of control and operating devices:
   - Motor drives for disconnector and earthing switch (optional)
   - Closing and opening releases for circuit-breaker
5. Check switch position indicators and interlocks.
6. Before connecting, check the connected feeder cables for phase coincidence (see appropriate Operating Manual for GMA panels).
11 Commissioning

11.1 Power frequency withstand test on the busbar (optional)

General

A power frequency withstand test of the busbar can be performed optionally. The test voltage is supplied via the high-voltage terminal of a panel. To this effect, a test unit and test cables are required, which are not included in the scope of supplies.

Before the test, all live components must be checked for zero voltage.

Danger!
Risk of fatalities due to high voltage!

No high-voltage cables must be connected in the panel used for the voltage test and on the busbar

► Mount test cables safely to the high-voltage terminal.
► During the test, close all accessible high-voltage terminals in a surge-proof fashion.
► Earth the residual phases using a commercially available earthing device.

Notice:
All the switching operations mentioned in this context must be performed in accordance with the applicable Operating Manual for GMA.

Notice:
Should the switchgear include busbar voltage transformers, please make sure they are designed for repeat tests in accordance with IEC 62271-200 for 80% $U_d$ at 50 Hz.

Preparations

1. All panels must be isolated from the power supply, and earthed.
2. Busbar:
   - Earth the voltage transformers and capacitive measuring points.
   - Disconnect surge arresters and close open high-voltage terminals in a surge-proof fashion.
3. Close open high-voltage terminals in a surge-proof fashion. Prepare incoming feeder panel for voltage test:
   - Remove the cable compartment cover.
   - Earth the voltage transformers and capacitive measuring points. Disconnect surge arresters.
   - Close open high-voltage terminals in a surge-proof fashion.
11 Commissioning

Schematic diagram of switchgear in test position (example)

Fig. 68
1 Busbar voltage transformer
2 Outgoing feeder panels
3 Voltage transformer
4 Test cable
5 Test unit (e.g. high-voltage source, test transformer)
6 Close other parallel high-voltage terminals in a surge-proof fashion.
7 Incoming feeder panel for voltage test
8 Busbar

Power frequency withstand test:

4. Power frequency withstand test of the busbar:
   – Connect test unit to the test cable.
   – Switch earthing switch in the incoming feeder panel OFF.
   – Switch disconnector and circuit-breaker in the incoming feeder panel ON.
   – Perform power frequency withstand tests successively for all phases (L1, L2, L3) according to the specifications of the test unit manufacturer.

Notice:
Observe admissible test values for the switchgear and the admissible test values for power-frequency tests after installation of the switchgear in accordance with IEC 62271-200.

5. Once the power-frequency withstand test has been completed, earth all the tested high voltage lines again.

Comply with the applicable safety provisions!

Once the power-frequency withstand test has been completed:

6. Once the power-frequency withstand test has been completed:
   – remove the test unit and the test cable,
   – Reconnect earthed or removed voltage transformers, capacitive measuring connectors or surge arresters.
   – Mount high-voltage cable or surge-proof covers on the incoming feeder panel and reinsert cable compartment cover.
11 Commissioning

11.2 Cable testing

General

- Cable tests with connected cables can be performed for each phase.
- For cable testing, a test unit and a test adapter are required, which are not included in the scope of supplies.
- The busbar can be operated at nominal voltage during cable tests in the outgoing feeder.

**Danger!**

Risk of voltage surges due to external events (e.g., stroke of lightning or earth fault) in panels with busbar voltage transformers during the cable test!

Due to the open cable compartment cover, internal arc protection only exists to a limited extent.

Thus, panels with service voltage existing on the busbar are under maintenance conditions during the cable test.

- During the cable test, safety clearances must be determined and cordoned off.

**Notice:**

- All the switching operations mentioned in this context must be performed in accordance with the applicable Operating Manual for GMA.
- The assembly, operating and testing instructions for cable fittings and connectors and the test unit must be taken into consideration.
- Do not exceed the admissible limits (see Table on page 78). Other limits are only admissible after having obtained the written approval of the manufacturer.

Preparations

1. Isolate the outgoing feeder cable of the appropriate switchgear panel from the power supply.
2. Isolate outgoing feeder cable in remote station.
3. Earth outgoing feeder cable.
4. Remove cable compartment cover (see Chapter 4.5, page 26).
5. Earth connected voltage transformers in the outgoing feeder cable.
6. Earth capacitive measuring points in outgoing feeder cable.
7. Remove surge-proof covers from measuring points:
   - Outer cone:
     Remove terminating elements in Tee plugs as specified by the manufacturer.

Performing the cable test

8. Connect test adapter to test connector and test unit (Fig. 71, page 76).
   Comply with the manufacturer’s provisions.

**Notice:**

- Make sure that the distance between the metallic components of the test adapter and the earthed supporting structure of the switchgear is sufficiently dimensioned.
- Earth the residual phases using commercially available earthing devices.
9. In case of optional interlocking of the cable compartment cover, the circuit-breaker cannot be switched off until after simulation of a cable compartment cover (Fig. 57).

**Danger!**

**Risk of fatalities as there is no interlocking protection in the cable compartment cover!**

- With the cable compartment cover removed, the earthing switch interlock may only be eliminated during the cable test. This may only be performed by certified staff, taking the safety provisions into account.

- Swing interlock (Fig. 57, item 1) of the cable compartment cover downwards and keep it in this position.
- Push interlocking slide (item 2) down; the actuating port for the earthing switch is set free.

**Test position:**

- Earthing switch ON
- Circuit-breaker OFF

**Electrical equivalent circuit diagram:**

10. Set switchgear panel to test position.

- If an intertripping circuit is provided, the circuit-breaker is switched OFF by actuation of the earthing switch towards "OFF" (Fig. 70).
- Free actuating port of the earthing switch (B) by shifting the interrogation slide (A) to the left and insert the crank (C).  
- Turn crank counterclockwise by max. 3 rotations, until the circuit-breaker has switched OFF (D).
- Leave the earthing switch crank in this position. The crank cannot be removed. The earthing switch is still connected to the earthing contacts on the panel (and thus grounds the switchgear section between the disconnector and the circuit-breaker).
Notice:
Once the cable testing position has been reached, the electrical and mechanical position indicator of the earthing switch is in its intermediate position.

11. Perform cable test according to the specifications of the manufacturer of the cable or the cable connector. Do not exceed the admissible limits in this process.

<table>
<thead>
<tr>
<th>$U_r$ [kV]</th>
<th>DC test voltage for initial / repeat test [kV] max. 15 min</th>
<th>0.1 Hz AC test voltage [kV] max. 60 min.</th>
<th>45-65 Hz AC test voltage $^2$ [kV] max. 60 min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>34</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>24</td>
<td>67</td>
<td>45</td>
<td>24</td>
</tr>
</tbody>
</table>

Perform cable test for all phases.

Admissible limits for the switchgear panels in case of cable tests

![Schematic layout for cable test (example)](#)

1 Control unit
2 Test transformer
3 High-voltage cables
4 Test adapter and test connector on high-voltage cable
5 The other phases must be earthed
11 Commissioning

After the cable test

12. Earth outgoing feeder cable again:
   - Switch earthing switch completely OFF
   - Charge spring mechanism
   - Switch earthing switch ON again

13. Remove test set.
   - Inner cone-type socket:
     Close test socket “surge-proof” using the dummy plug.
   - Outer cone-type bushing:
     Provide cable fittings with terminating element according to the manufacturer’s instructions.


15. De-earth the capacitive measuring points in the outgoing feeder cable.

16. Remount cable compartment covers (see Chapter 4.5, page 26).

11.3 Cable jacket test

If there are no documents to inform whether a cable jacket test may be performed on the cable connection system, the manufacturer of the cable connection system must be consulted before performing such test.

**Notice:**

Do not connect the cable’s earth conductor to the connector housing (contact-making). Make sure to check the earth conductor directly.

1. To perform the cable jacket test, disconnect the earth connections (Cu shield) from the cable support.

2. To determine any damage on the outer plastic jackets or sheathes between the cable’s Cu shield and the earth, apply a test DC voltage in accordance with the applicable standard or the instructions of the cable manufacturer.

3. Once the test has been completed, re-mount the earth connection (Cu shield) to the cable support.

Fig. 72
Cable jacket testing principle
for outer cone
12 Replacement of components and panels

Drive mechanisms, current transformers, voltage transformers, testing and monitoring systems and even complete switchgear panels can be replaced as required.

Should you have any queries regarding replacement of components or panels, please contact the manufacturer’s Service Center.

For correct processing of your inquiry, the following data of the nameplate of the panel concerned are required (see Operating Instructions AGS 531 521-01, Chapter 2.5): Type designation
- Type designation
- Serial number
- Year of construction.
13.1 Auxiliary products

The auxiliary products are available from the manufacturer. The use of other auxiliary products is not admissible.

**Warning!**

*Risk of injury if these products are handled improperly!*

*Observe the safety data sheets of the manufacturers of the auxiliary products.*

<table>
<thead>
<tr>
<th>Auxiliary products</th>
<th>Ref. no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning agent</td>
<td>S 008 152</td>
</tr>
<tr>
<td>Synthetic lubricant (KL), 0.5 kg can</td>
<td>ST 312-111-835</td>
</tr>
<tr>
<td>Touch-up pen, 50 ml (specify colour shade):</td>
<td></td>
</tr>
<tr>
<td>– Covers RAL 9003 (white)</td>
<td></td>
</tr>
<tr>
<td>– Front cover RAL 7016 (anthracite grey)</td>
<td>S 009 562</td>
</tr>
<tr>
<td>– Special paint</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Auxiliary products for assembly of the busbar link</th>
<th>Ref. no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning agent Ethanol, type 641 (methylated spirit)</td>
<td>S 009 002 Ä</td>
</tr>
<tr>
<td>Lint-free cloth (also micro-fiber cloths)</td>
<td>–</td>
</tr>
<tr>
<td>Lint-free rubber gloves</td>
<td>–</td>
</tr>
</tbody>
</table>

13.2 Coating the contact surfaces

**Notice:**

*Contact areas, once coated with synthetic lubricant, should not be touched, if possible.*

1. Contact surfaces must be subjected to preliminary treatment before screw-fastening (see Table below).
2. Immediately after the pre-treatment, coat both contact surfaces sparingly with a thin and uniform film of synthetic lubricant so that the space between the contact surfaces is completely filled once the screws have been fastened.

<table>
<thead>
<tr>
<th>Material of contact surfaces</th>
<th>Pre-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver-plated</td>
<td>Clean¹</td>
</tr>
<tr>
<td>Copper or copper alloy</td>
<td>Clean¹, expose metallic surface²</td>
</tr>
</tbody>
</table>

1 Clean by means of a lint-free cloth; use cleaning agent in case of serious contamination
2 Expose metallic surface
   - by treating the entire surface with emery cloth or a rotating grinding tool (grain size 100 or 80) or
   - using a wire brush which is clearly marked for use exclusively for copper
### 13.3 Specifications for screw connections

**Notice:**
- The threads of screws and bolts must generally not be pre-treated!
- Max. tolerance for the effective tightening torques: ± 15%
- The nut must correspond in strength to the grade of the screw/bolt used or be of better quality.

#### General screw connections

<table>
<thead>
<tr>
<th>Screw / bolt</th>
<th>Grade or material</th>
<th>Plastic</th>
<th>≥ 8.8 ≤ 10.9</th>
<th>Self-locking screw ≥ 8.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thread Ø</td>
<td>Tightening torques [Nm]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M 4</td>
<td>0.25</td>
<td></td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>M 5</td>
<td>0.5</td>
<td></td>
<td>5.0</td>
<td>7.0</td>
</tr>
<tr>
<td>M 6</td>
<td>0.8</td>
<td></td>
<td>8.8</td>
<td>12.3</td>
</tr>
<tr>
<td>M 8</td>
<td>1.8</td>
<td></td>
<td>21.0</td>
<td>30.0</td>
</tr>
<tr>
<td>M 10</td>
<td>3.5</td>
<td></td>
<td>42.0</td>
<td>59.0</td>
</tr>
<tr>
<td>M 12</td>
<td>6.0</td>
<td></td>
<td>70.0</td>
<td>97</td>
</tr>
<tr>
<td>M 16</td>
<td>12</td>
<td></td>
<td>170</td>
<td></td>
</tr>
</tbody>
</table>

#### Screw connection for current transmission

Screws and bolts: Grade ≥ 8.8

<table>
<thead>
<tr>
<th>Conductor material: copper</th>
<th>Thread Ø</th>
<th>Tightening torques [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 6</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>M 8</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>M 10</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>M 12</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>M 16</td>
<td>135</td>
<td></td>
</tr>
</tbody>
</table>

#### Screw connection for terminal strips

<table>
<thead>
<tr>
<th>Thread Ø</th>
<th>Tightening torques [Nm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 2.5 (M 2.6)</td>
<td>0.5</td>
</tr>
<tr>
<td>M 3</td>
<td>0.7</td>
</tr>
<tr>
<td>M 3.5</td>
<td>1.0</td>
</tr>
<tr>
<td>M 4</td>
<td>1.5</td>
</tr>
<tr>
<td>M 5</td>
<td>2.5</td>
</tr>
</tbody>
</table>
13.4 Required tools (not included in the scope of supplies)

<table>
<thead>
<tr>
<th>Tool</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutter</td>
<td><img src="image" alt="Cutter Image" /></td>
</tr>
<tr>
<td>Nail puller</td>
<td><img src="image" alt="Nail Puller Image" /></td>
</tr>
<tr>
<td>Approved torque wrenches with different bits for hexagon socket screws and socket-head screws and nuts; bits for screw and nut grades M 5, M 6, M 8, M 10, M 12</td>
<td><img src="image" alt="Torque Wrench Image" /></td>
</tr>
<tr>
<td>Screwdriver and Philips screwdriver</td>
<td><img src="image" alt="Screwdriver Image" /></td>
</tr>
<tr>
<td>Nipping pliers</td>
<td><img src="image" alt="Nipping Pliers Image" /></td>
</tr>
<tr>
<td>Lint-free, clean cloths</td>
<td><img src="image" alt="Cloths Image" /></td>
</tr>
<tr>
<td>Crane mounting harness, see Chapter 4.4, as of page 24</td>
<td><img src="image" alt="Crane Mounting Harness Image" /></td>
</tr>
<tr>
<td>Lift trolleys and U profiles, see Chapter 4.4, as of page 24</td>
<td><img src="image" alt="Lift Trolleys and Profiles Image" /></td>
</tr>
</tbody>
</table>
As our products are subject to continuous development, we reserve the right to make changes regarding the standards, illustrations and technical data described in this Technical Manual. For any requests, please contact the address given below.

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