Gas insulated wall bushing, type GGFL
Installation and maintenance guide
Recommended practices

ABB recommends careful consideration of the following factors when installing bushings:

- Before you install or commission a unit, make sure that the personnel doing the job have read and fully understood the Installation Guide provided with this unit.
- To avoid damaging the unit, never exceed the operation limits stated in delivery documents and on rating plates.
- Do not alter or modify a unit without first consulting ABB.
- Follow local and international wiring regulations at all times.
- Use only factory authorized replacement parts and procedures.

Safety information

Keep this instruction available to those responsible for the installation, maintenance, and operation of the bushing.

The installation, operation, and maintenance of a bushing present numerous potential unsafe conditions, including, but not limited to, the following:

- High pressures
- Lethal voltages
- Moving machinery
- Heavy components
- Slip, stumble or fall

Specialized procedures and instructions are required and must be adhered to when working on such apparatus. Failure to follow the instructions could result in severe personal injury, death, and/or product or property damage.

Additionally, all applicable safety procedures such as regional or local safety rules and regulations, safe working practices, and good judgement must be used by the personnel when installing, operating, maintaining and/or disposing such equipment.

Safety, as defined in this instruction, involves two conditions:

1. Personal injury or death.
2. Product or property damage (includes damage to the bushing or other property, and reduced bushing life).

Safety notations are intended to alert personnel of possible personal injury, death or property damage. They have been inserted in the instructional text prior to the step in which the condition is cited.

The safety conditions are headed by one of the three hazard intensity levels which are defined as follows:

**DANGER**
Immediate hazard which will result in severe personal injury, death, or property damage.

**WARNING**
Hazard or unsafe practice which could result in severe personal injury, death, or property damage.

**CAUTION**
Hazard or unsafe practice which could result in minor personal injury, or property damage.
Warnings and cautions in this guide

**WARNING**

Keep the components clean, dry and undamaged during installation.

Lifting and handling of heavy components.

Do not energize the bushing before all preparations in this guide are done.

Damaging the silicon insulator may lead to partial discharge during operation.

Make sure that both sealing O-rings are undamaged, clean and correctly positioned if their respective grooves.

Make sure that no insects, water, dirt or any other particle can come through open holes during this operation.

The bushing is provided with a bursting disc as protection against over-pressure. Do not in any circumstances exceed maximum service pressure, 

\[ \text{MSP} = 0.60 \text{ MPa over-pressure} \]

Energizing the bushing without the appropriate corona shield may lead to flash over and serious damage to the equipment.

The bushing should always be earthed and de-energized when being worked on.

**CAUTION**

The bushing can operate without any restrictions down to the lowest alarm density corresponding to a pressure of 0.5 MPa (20°C, abs.). By monitoring all alarm levels planned, counter measures can be made before damaging the equipment.

The transport box is not designed for long term storage in high humidity and at varying temperatures. For long term storage in the transport box, keep it indoors with controlled temperature and low humidity.

Make sure that the supports do not damage the insulator. The bushing should be handled with care.

The density guard is a calibrated monitoring instrument. It must be handled with care and protected against careless handling or any kind of mechanical damage. Do not open the package of the density guard until the guard is needed.

Check during gas filling that all alarm levels works and are correctly connected to the control system.

Dirt or damages on the corona shield may lead to partial discharge in the air. Be careful during assembly and clean away all dirt.

To avoid external heating of the bushing, the connection of the external bus must be assembled and connected according to the instruction from the supplier.
## Table of contents

1. Description
   - 1.1 Design
   - 1.2 Operating conditions
   - 1.3 Repair of bushing
   - 1.4 Electrical and mechanical data
   - 1.5 Gas density
     - 1.5.1 Pressure gauge and density monitor

2. Installation
   - 2.1 Recommended fitting sequence
   - 2.2 Tools
   - 2.3 Transport, storage and handling
   - 2.4 Lifting
   - 2.5 Gas filling and emptying
   - 2.6 End connection
   - 2.7 Flange earthing

3. Maintenance and supervision
   - 3.1 Gas
   - 3.2 Electrical conduction

4. Disposal after end of service life

5. References
1. Description

1.1 Design

The wall bushing is a gas-insulated bushing based on the larger type GGFL bushing intended and primarily developed for use in HVDC valve halls, and also on the gas-insulated GIS bushing GGA. The main insulation consists of compressed SF$_6$ gas (sulphur hexafluoride).

The GGFL bushing is assembled by a welded aluminium intermediate flange (wall flange) fitted with two insulators, one for each side of the wall. Grading of the electrical field is accomplished by internal conical aluminium shields instead of a conventional condenser core. The design yields a light weight, yet robust, design. A typical comparison is a weight of about 25% to that of a conventional oil impregnated porcelain wall bushing, when comparing bushings with capacities in the same range.

The insulators consist of a glass fibre reinforced epoxy tube covered by weather sheds made of silicone rubber. The tubes are manufactured in one piece and equipped with glued on cast aluminium flanges at both ends. The design gives a rigid bushing with excellent mechanical properties.

These flanges are bolted on the low voltage end to the wall flange, and covers are attached in a similar way with bolts and O-ring seals to the high voltage ends. The outer current connections are welded to the covers, and the current path goes through the cover to a multiple silver plated spiral contact and onto a tubular aluminium conductor. The flexible contact is positioned at one end of the bushing, compensating for thermal expansion of the conductor tube, while the other end of the conductor is welded to the inside of the cover.

Some of the GGFL bushings are equipped with a separate measuring tap. If the bushing does not have a measuring tap, the capacitance of the bushing may be measured between the wall flange and the high voltage end. The connections on the wall flange consists of a gas valve and a bursting disc.

![Diagram of bushing design](image)

*Fig. 1. Bushing design.*
1.2 Operating conditions

The table below shows the standard technical specifications for the GGFL wall bushing. For condition exceeding the below values, please contact the manufacturer.

<table>
<thead>
<tr>
<th>Common specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application: HVDC valve halls</td>
</tr>
<tr>
<td>Classification: SF₆ gas insulated bushing</td>
</tr>
<tr>
<td>Ambient temperature: +60 to –20 °C for use in valve halls or equivalent environment</td>
</tr>
<tr>
<td>Altitude of site: &lt; 1000 m</td>
</tr>
<tr>
<td>Type of immersion medium: SF₆ gas at 5.7 bar absolute at 20 °C</td>
</tr>
<tr>
<td>Markings: Conforming to IEC/IEEE</td>
</tr>
</tbody>
</table>

1.3 Repair of bushing

In the event of major damage to the bushing, we recommend sending it back to the manufacturer for repair and electrical testing.

1.4 Electrical and mechanical data

The capacitance between conductor and earth (C) is stated for each bushing in its test certificate. The data plate and dimensional drawing of the bushing give the test voltages, operating voltage and operating current.

<table>
<thead>
<tr>
<th>Bushing</th>
<th>Article no.</th>
<th>Calculated C (pF)</th>
<th>Mass with SF₆ gas (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GGFL 530</td>
<td>1ZSC002980-AAD</td>
<td>110 ± 10</td>
<td>302</td>
</tr>
<tr>
<td>GGFL 650</td>
<td>1ZSC002980-AAE</td>
<td>130 ± 10</td>
<td>308</td>
</tr>
<tr>
<td>GGFL 650</td>
<td>1ZSC002980-AAF</td>
<td>100 ± 10</td>
<td>270</td>
</tr>
<tr>
<td>GGFL 550</td>
<td>1ZSC002980-AAG</td>
<td>145 ± 10</td>
<td>289</td>
</tr>
<tr>
<td>GGFL 787</td>
<td>1ZSC002994-AAB</td>
<td>60 ± 10</td>
<td>407</td>
</tr>
<tr>
<td>GGFL 782</td>
<td>1ZSC002994-AAC</td>
<td>55 ± 10</td>
<td>434</td>
</tr>
<tr>
<td>GGFL 550</td>
<td>LF 150 001-B</td>
<td>90 ± 10</td>
<td>125</td>
</tr>
<tr>
<td>GGFL 450</td>
<td>LF 150 001-G</td>
<td>184 ± 20</td>
<td>185</td>
</tr>
<tr>
<td>GGFL 325</td>
<td>LF 152 001-H</td>
<td>115 ± 10</td>
<td>115</td>
</tr>
<tr>
<td>GGFL 450</td>
<td>LF 152 001-M</td>
<td>110 ± 10</td>
<td>145</td>
</tr>
<tr>
<td>GGFL 450</td>
<td>1ZSC001982-AAA</td>
<td>100 ± 10</td>
<td>125</td>
</tr>
<tr>
<td>GGFL 450</td>
<td>1ZSC001982-AAB</td>
<td>140 ± 15</td>
<td>145</td>
</tr>
<tr>
<td>GGFL 450</td>
<td>1ZSC001982-AAC</td>
<td>105 ± 10</td>
<td>135</td>
</tr>
<tr>
<td>GGFL 530</td>
<td>1ZSC002980-AAA</td>
<td>100 ± 10</td>
<td>255</td>
</tr>
<tr>
<td>GGFL 378</td>
<td>1ZSC002980-AAB</td>
<td>110 ± 10</td>
<td>290</td>
</tr>
<tr>
<td>GGFL 325</td>
<td>1ZSC002980-AAC</td>
<td>100 ± 10</td>
<td>265</td>
</tr>
<tr>
<td>GGFL 857</td>
<td>1ZSC002994-AAA</td>
<td>80 ± 10</td>
<td>495</td>
</tr>
</tbody>
</table>

Maximum permitted mechanical load at service, 1000 N, unless anything else is specified.

1.5 Gas density

The two purposes of the compressed SF₆ gas are to cool the tubular conductor and insulate it from earth. Its capacity for doing so depends on the density of the gas. The bushing is filled for operation with gas at a pressure of 570 kPa (5.7 bar) abs. at 20°C. The gas density is monitored by a density monitor which gives an electrical signal at three alarm levels. The first is activated at a pressure of 530 kPa (5.3 bar) abs. at 20°C to indicate low gas density. The second signal level is activated at 520 kPa (5.2 bar) abs. at 20°C to indicate very low gas density. The third level gives an alarm at 500 kPa (5 bar) abs. at 20°C, which is the dimensioning density of the bushing. At gas densities below 500 kPa the type test levels for dielectric strength do not apply. The ability of the bushing to conduct current declines progressively with falling gas density.
### 1.5.1 Pressure gauge and density monitor

The pressure gauge is normally supplied separately from the bushing and is fitted as follows:

- Unscrew the protective cap from the valve.
- Check that the valve and the pressure gauge orifice are clean.
- Introduce the pressure gauge orifice into the valve and screw down the clamping nut. Torque at 20 Nm.

The fitting sequence for the density monitor is the same as for the pressure gauge, but add the following: Connect signal cables.

Fig. 3 shows the circuit diagram for the connections to the density monitor.

![Density guard](image1)

**Fig. 2. Density guard.**

![Circuit diagram example](image2)

**Fig. 3. Circuit diagram example.**

- Alarm level 1 (530 kPa): Switch number D1 is activated, circuit 11-13 is opened and 11-12 is closed.
- Alarm level 2 (520 kPa): Switch number D2 is activated, circuit 21-23 is opened and 21-22 is closed.
- Alarm level 3 (500 kPa): Switch number D3 is activated, circuit 31-33 is opened and 31-32 is closed. At gas densities below 500 kPa the type test levels for dielectric strength do not apply.
2. Installation

2.1 Recommended fitting sequence

1. Check that all necessary tools, accessories and equipment are at hand. See chapter 2.2.
2. Check the packaging for damages.
3. Unpack. See chapter 2.3.
4. Lift the bushing out and place it on ground. Use the supports that come with the box. Carry out visual inspection of the bushing. See chapter 2.3.
5. Lift and screw firmly into wall. Make sure to tighten the nuts evenly and crosswise in order to avoid damages to the flange.
6. Fit the corona shields.
7. Preferable, connect the bushing to the main circuit via the end connections. See chapter 2.7.
8. Vacuum and gas filling process. See chapter 2.5.
9. Mount the density guards on the bushing.
10. Connect the signal cables to the density guards.
11. Check the density guards.
12. Earth the bushing. See chapter 2.7.

2.2 Tools

- Soft slings
- Gas of correct kind in sufficient quantity
- Thermometer to measure ambient temperature, filling device appropriate to bushing filling valve, and precision manometer with range covering at least 100 - 600 kPa abs.
- Torque wrench

2.3 Transport, storage and handling

Care must be taken when storing the bushing so that the silicone rubber sheds are not damaged. For instance, rodents, insects or birds can destroy the sheds.

**CAUTION**

The transport box is not designed for long term storage in high humidity and at varying temperatures. For long term storage in the transport box, keep it indoor with controlled temperature and low humidity.

The bushing shall also be protected from penetrating water if stored outdoors. This means that it shall not be stored in areas where it can be foreseen that the ground will be wet and muddy during heavy rain. Shelter the bushing from rain and snow with a tarpaulin or roofing.

The bushing is supplied with the gas volume filled with nitrogen gas (N₂) at a pressure of 25 kPa gauge. This pressure should be maintained during shipping and storage.

The bushings are normally delivered from ABB in boxes with the busing supported by blocks and fibre boards. The boxed are marked with “Top end”. This information can be important and shows how the bushing is oriented inside the box.
2.4 Lifting

**WARNING**

In view of the risks involved in lifting pressurised items, no lifting should take place at more than transport pressure.

Prior to shipping from the manufacturer, the bushing is filled with pure nitrogen to transport pressure 125 kPa (1.25 bar) abs. at 20°C. The bushing should be lifted and handled at transport pressure.

The bushing can be lifted by applying the soft sling around the intermediate flange.

**WARNING**

Damaging the silicone insulator may lead to partial discharge during operation.

2.5 Gas filling and emptying

The gas used should meet the requirements of IEC 60376 “Specification of new SF<sub>6</sub>”.

The gas quantity required appears in the dimensional drawing. The bushing is filled with nitrogen at 125 kPa (1.25 bar) abs. at 20°C at the time of delivery. Filling is carried out via the gas valve on the intermediate flange. See Fig. 4. Before filling the bushing with SF<sub>6</sub>, it must be evacuated to at least 2 mbar. In order to preserve the purity of the SF<sub>6</sub>, it is recommended to evacuate to 1 mbar.

For environmental reasons, avoid letting gas escape when filling or emptying SF<sub>6</sub>. Try to keep the gas in a closed system at all times.

Apply the cap to the gas valve after filling, otherwise corrosive substances from the environment may disrupt the sealing function.

Fig. 4. Gas filling equipment and gas valve.

Fig. 5. Nozzle for connection to gas valve.
<table>
<thead>
<tr>
<th>Filling pressure in MPa (abs) shown on data plate</th>
<th>Ambient temperature in °C</th>
<th>Filling pressure in MPa (gauge pressure) read on pressure gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.57</td>
<td>-30°C</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>-20°C</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>-10°C</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>0°C</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>+10°C</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>+20°C</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>+30°C</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>+40°C</td>
<td>0.52</td>
</tr>
</tbody>
</table>

When correct gas pressure has been set, remove the filling hose and fit the airtight bonnet to the check valve.

**CAUTION**
The bushing is provided with a bursting disc as protection against overpressure. Do not in any circumstances exceed 700 kPa (7.0 bar) gauge pressure.

2.6 End connection

**CAUTION**
Before connection of conductor clamps, the outer terminals of aluminium must be carefully wire brushed and greased with a contact compound or vaseline.

The end connection is made of untreated aluminium and should always be cleaned with Scotch-Brite or a similar product and lubricated with a suitable contact paste or a suitable grease before connection to the main circuit.

2.7 Flange earthing

The bushing flange should be earthed in order to prevent electrical discharges between the bushing flange and the wall to which the bushing is installed. This may be done by applying a flexible cable between one of the fastening screws and the mounting plate in the wall.
3. Maintenance and supervision

3.1 Gas

WARNING
No work at all can be performed on the bushing while it is energized or not earthed.

The gas density should not be allowed to fall below the nominal insulating density. Checking that the density monitor and any pressure gauge are operating as intended may be carried out according to 1.5. Gas moisture content may be checked according to IEC 60376 B “Specification of Dew Point Measuring”. Checking of gas characteristics may be carried out according to IEC 60480 “Guide for checking SF₆ taken from electrical equipment”.

3.2 Electrical conduction

The temperature in the bushing may be checked using Termovision infrared-sensitive equipment during operation. The normal temperature rise at rated current is 20 - 30 K above ambient.

4. Disposal after end of service life

The aluminium parts of the bushing conform to Swedish Standard SS14. Cast parts are made of 4245 (ISO Al-Si,Mg). The tubular conductor is made of 4102 (~AA 6101).

The shielding parts are made of 4107 (ISO Al-SiMg, AA 6005). The epoxy tube and the silicone rubber contain no poisons or heavy metals and may be burned or deposited without harmful environmental effects.

The approximate material composition of GGFL is as follows:
- 40 % aluminium of various compositions
- 25 % glass fibre reinforced epoxy
- 35 % silicone rubber.

SF₆ gas is handled according to chapter 2.5.

5. References

Test certificate
Dimensional drawing
IEC 60376 “Specification and acceptance of new sulphur hexafluoride”
ANSI/IEEE C57.19.01-1991
IEC 60376 B “Specification of Dew Point Measuring”
IEC 60480 “Guide for checking SF₆ taken from electrical equipment”