Resin impregnated paper bushing, oil-to-air, type GSB 800
Installation and maintenance guide
Original instruction

The information provided in this document is intended to be general and does not cover all possible applications. Any specific application not covered should be referred directly to ABB, or its authorized representative.

We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

We reserve all rights in this document and in the subject matter and illustrations contained therein. Any reproduction, disclosure to third parties or utilization of its contents – in whole or in parts – is forbidden without prior written consent of ABB.
Table of contents

1. Description 5
   1.1 Design 5
   1.2 Operating conditions 6
   1.3 Mechanical loading 6
   1.4 Spare parts 6
   1.5 Installation information 6

2. Installation 7
   2.1 Transport boxes 7
   2.2 General tools 7
   2.3 GSB 800 tools (to be ordered from the supplier) 7
   2.4 Consumables 7
   2.5 Transport, storage and handling 8
   2.6 Opening of crate 9
   2.7 Lifting from the crate 10
   2.8 Removal of protective hood 11
   2.9 Removal of draw rod 12
   2.10 Draw-rod system 13
   2.11 Flange grounding 20
   2.12 Mounting of outer terminal 21
   2.13 Oil-filling of voltage tap housing 23
   2.14 Waiting time before energizing 24
   2.15 Recommended tests before energizing 24
   2.16 Repacking of bushing after transformer FAT-tests 26

3. Maintenance 29
   3.1 Recommended maintenance and inspections 29
   3.2 Disposal after end of service life 29
Safety information
Keep this instruction available for those responsible for the installation, maintenance and operation of the bushing.

Installation, operation and maintenance of a bushing present numerous potentially unsafe conditions, including but not limited to the following:
• High pressures
• Lethal voltages
• Moving machinery
• Heavy components
• Slipping, stumbling or falling

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 judgment 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, as well as reduced bushing life).

Safety notifications are intended to alert personnel of possible risk of 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 following warnings and notes are used in the manual:

WARNING
WARNING indicates an imminently hazardous situation, which if not avoided, will result in death or serious injury. This level is to be limited to the most extreme situations.

WARNING also indicates a potentially hazardous situation, which if not avoided, could result in death or serious injury.

CAUTION
CAUTION indicates a potentially hazardous situation, which if not avoided, may result in minor or moderate injury. It may also be used to alert of unsafe practices.

CAUTION may also indicate hazards solely related to property damage.

INFO provides additional information to assist in carrying out the tasks described and to provide trouble-free operation.
1. Description

1.1 Design
GSB is a resin-impregnated paper (RIP) bushing intended for immersed oil-to-air service. The bushing is built around a copper center tube on which the condenser core is wound. The core is wound from crepe paper with aluminum foil inserts for electrical stress control. The core is impregnated and cured in a vacuum, giving a partial discharge-free bushing with low dissipation factor (\(\tan \delta\)). A flange and composite insulator with silicone sheds are mounted, and the space between the condenser core and the insulator is filled with insulating gel.

GSB uses the copper center tube as a current conductor, where the oil-side connection is made with a draw-rod and a bottom contact. The bottom contact is normally delivered with a standard end-shield. For the top connection there are outer terminal studs available in a number of standard configurations, but it can also be customized.

The bushing is designed to be mounted at any angle, from horizontal to vertical.
1.2 Operating conditions
The table below shows the general specifications for the GSB bushings. For conditions exceeding the specifications below, please contact the supplier.

<table>
<thead>
<tr>
<th>Table 1. General specifications:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application: Transformers</td>
</tr>
<tr>
<td>Classification: Resin-impregnated paper, capacitance-graded, outdoor immersed bushing, temperature class E (120°C) according to IEC 60137</td>
</tr>
<tr>
<td>Ambient temperature: +40°C to -40°C, including minimum value according to temperature class 2 of IEC 60137 (-50°C and other temperatures on request, subject to agreement)</td>
</tr>
<tr>
<td>Altitude of site: &lt; 1000 m</td>
</tr>
<tr>
<td>Level of rain and humidity: 1-2 mm rain/min. horizontally and vertically, as per IEC 60060-1, and 5 mm/min. as per IEEE Std. C57.19.00-2004 (Std. 4, conventional procedure in USA.)</td>
</tr>
<tr>
<td>Pollution level: According to specific creepage distance and IEC 60815 (“Guide for selection of insulators with respect to polluted conditions”)</td>
</tr>
<tr>
<td>Immersion medium: Transformer oil. Oil temperatures for normal load: Maximum daily mean temperature +90°C. Maximum temporary temperature: +100°C. Oil temperatures for long- and short-term overload: Maximum daily mean temperature +90°C. Maximum temporary temperature: +115°C.</td>
</tr>
<tr>
<td>Maximum pressure of medium: 100 kPa (over-pressure)</td>
</tr>
<tr>
<td>Angle of mounting: Horizontal to vertical</td>
</tr>
<tr>
<td>Voltage tap: Dimensions according to IEEE Potential tap type A. Ur = 6 kV</td>
</tr>
<tr>
<td>Capacitance C_2 of the voltage tap: &lt; 29,400 pF</td>
</tr>
<tr>
<td>Conductor: Center tube. Inner terminal for flexible draw lead available on request.</td>
</tr>
<tr>
<td>Minimum creepage distance: 27.500 mm.</td>
</tr>
<tr>
<td>Markings: In conformance with IEC/IEEE.</td>
</tr>
</tbody>
</table>

1.3 Mechanical loading
The cantilever operating loads (for vertical and horizontal mounting) and the test load are specified in Table 2. The force is applied at the center of the outer terminal of the bushing.

<table>
<thead>
<tr>
<th>Table 2. Mechanical loads.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting angle</td>
</tr>
<tr>
<td>Vertical</td>
</tr>
<tr>
<td>Horizontal</td>
</tr>
</tbody>
</table>

For extraordinary requirements relating to earthquakes, extreme environmental conditions and heavy equipment, consult the supplier.

<table>
<thead>
<tr>
<th>Table 3. Earthquake loading.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic standard</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>IEC 61463 AG5 (5 m/s^2)</td>
</tr>
<tr>
<td>IEEE 693-2005</td>
</tr>
</tbody>
</table>

1.4 Spare parts
In the event of major damage to the bushing, we recommend that it be sent back to the supplier for possible repair and re-testing. Certain parts, which may be damaged or lost during transport or installation, can be ordered from the supplier.

1.5 Installation information
If the bushings are mounted on seismic-exposed equipment, M27 fastening bolts with property class 8.8 (according to EN-ISO 898-1) must be used on the bushing mounting flange.

If bolts with other dimensions and property classes are used (e.g. for low seismic exposure levels), please contact the supplier for approval.
2. Installation

2.1 Transport boxes
The bushing and its corona ring are packed in two separate transport boxes. If lifting tools are ordered, they also come in a separate transport box. Check that the parts delivered agrees with the delivery documents to make sure all the transport boxes are included in the delivery before start of installation.

Check that the bushing and its accessories are undamaged. If transport damage is found a damage report should be sent to the insurance company. It is also recommended that photographs are taken of the damaged detail. Mark the photos with ABB’s reference number and serial number of the bushing and send them to ABB for comments.

2.2 General tools
- Soft slings.
- Shackles, Ø 32 mm holes on the lifting adapters, for connection of soft slings.
- Torque wrench key for hexagon head screws, head width 16 mm (M10) and 13 mm (M8).
- Tackle for mounting the bushing at a specific angle.
- Soft bedding.

2.3 GSB 800 tools (to be ordered from the supplier)
- Lifting adapter, 1ZSC004867-AAB; see Fig. 2.
- Lifting gear, 1ZSC004867-AAA; see Fig. 3.
- Flexible pull-through cord, 9760 669-A, for assembly of draw-rod.

2.4 Consumables
- Water-free vaseline, Mobilgrease 28 or other lubricant that is not harmful to the transformer oil, to lubricate screws that come in contact with the transformer oil.
- Mobilgrease 28 or other suitable grease to lubricate and protect the ground screw and the outer terminal gasket.
- Molykote Multilub, article number 1236 0011-127, or other suitable compound to lubricate the screws making contact and sealing at the outer terminal.
2.5 Transport, storage and handling
The bushing may be transported and stored at any angle. Carefully inspect the bushing when received with regard to shipping damage. Please note that the bushing has been routine tested in oil and some oil may remain. Vaseline is used for lubrication of threads, and at some temperatures the vaseline may appear as oil.

When removing the sealing tube, be careful not to damage the tube gasket. The sealing tube, with the gasket, drying agent and fasteners should be reassembled after the transformer test at a torque 50 Nm.

---

The metallic sealing tube on the oil side, shown in Fig. 5, must be mounted on the bushing during long-term storage (>1 year).

Protect the bushing from water when stored outdoors. The crate must not be stored at a location where the ground can become wet and muddy during heavy rain. Shelter the crate from rain and snow with a tarpaulin or roofing.
2.6 Opening of crate
Follow these steps to open the bushing crate and unpack the bushing.

1. Check that the bushing and its accessories are undamaged.
2. Open the covers by removing the screws on the top cover; see Fig. 6.
3. Remove the tightening strap at the top end; see Fig. 7.
4. The flange are fixed by a support block of wood. Remove the screws at the flange from outside the crate (the screws are holding the support block of wood). After removing the screws, remove the support block by lifting it upwards in its lifting strap. See Fig. 8.
5. Lift the bushing from its crate according to section 2.7.
2.7 Lifting from the crate
When lifting the bushing from the crate with a lifting adapter, position a clean soft sling around the outer terminal and another on the shackle attached to the lifting adapter as shown in Fig. 9.

If a lifting adapter is not available, the bushing can be lifted by positioning a clean soft sling around the mounting flange instead; see Fig. 10.

The lifting gear and lifting adapter are delivered in a separate crate.

CAUTION
Slings must not be placed around the insulator because this could cause damage to the sheds. If placed on the ground, the bushing must be supported the same way as in the crate, e.g. at the mounting flange and the outer terminal. It may not be supported by the sheds.

CAUTION
The sling at the outer terminal can be damaged by sharp edges. Be sure to protect the sling from damage.

DO NOT lift at the silicone part of the composite insulator. The silicone filling or fiberglass tube may be damaged.

It is important that the bushing is repacked in the same way as it was delivered. The bushing should be axially and radially fixed in place, and secured against rotation by wooden supports.

At the supplier’s plant, the crate’s lid is secured with screws and plastic straps. It is recommended that screws and plastic straps be used when re-fitting the lid.
2.8 Removal of protective hood
1. Support the bushing at the flange and at the top piece by placing it on supports. The supporting block of wood removed from the crate can be used. See Fig. 11.
2. Use a soft sling placed at the middle of the protective hood as support while disassembling the screws from the flange, preventing the metallic hood to fall down on the painted surface on the bushing oil side. See Fig. 12.
3. Carefully remove the protective hood. See Fig. 13.

---

**CAUTION**

Be careful when removing the protective hood not to damage the painted surface of the bushing oil side.
2.9 Removal of draw rod

See Fig. 14.

1. Unscrew the outer terminal and its gasket.
2. Remove the nut and washers mounted on the draw rod inside the tube.
3. Pull the draw rod out of the bushing from the oil side.
2.10 Draw-rod system
The draw-rod system can be divided level with the mounting flange. Fig. 16 shows the draw-rod system and the joints that are locked at delivery.

The additional joint at flange level must be locked with locking fluid (Loctite 242 and activator Loctite T747) on site. The threads must be degreased before applying the locking fluid.

Supporting the lower draw-rod during transportation
The lower draw-rod can be used for supporting the bottom contact and the cables in the transformer tank during transport of the transformer/reactor, as shown in Fig. 15.

Mounting of the draw-rod must be performed according to the described procedures.

---

15 Lower draw-rod support during transportation.  
16 Joints of the draw-rod system.
2.10.1 Installation of standard end-shield

Alternative 1: Mounting the standard end-shield on the bottom contact adapter. Fig. 17.
1. Mount the socket screws with springs to the bottom contact adapter.
2. Connect the cable lugs to the bottom contact.
   Tightening torque 68 ± 6 Nm.
3. Push the end-shield gently against the bottom contact adapter, guiding the socket screws through the key holes.
4. While applying force, turn the end-shield clockwise approximately 20° and then release when in locked position.

Alternative 2: Mounting the standard end-shield on the bottom contact. Fig. 18.
1. Mount the socket screws with springs to the bottom contact.
2. Connect the cable lugs to the bottom contact.
   Tightening torque 68 ± 6 Nm.
3. Push the end-shield gently against the bottom contact, guiding the socket screws through the key holes.
4. While applying force, turn the end-shield clockwise approximately 20° and then release when in locked position.
2.10.2 Docking of bushing to transformer
1. Completely remove the outer terminal.
2. Mount the lifting gear (1ZSC004867-AAA) and the lifting adapters (1ZSC004867-AAB) according to Fig. 29. Also see section 2.10.3.
3. Pull the flexible pull-through cord through the bushing until it is visible on the oil-side and connect it to the top of the upper draw-rod.
4. The upper draw-rod is now pulled through the bushing, leaving the joint at flange level hanging outside the conductor tube or the standard end-shield on the oil-side.
5. Raise the bushing according to steps 1 and 2 in Section 2.10.3.

19 Installation of draw-rod into bushing, using pull-through cord, lifting adapters and lifting gear. The right view shows the bushing after mounting.
CAUTION

The bushing must not be lifted by the insulator.

6. Remove the transformer cover from the transformer/reactor, leaving the lower draw-rod connected to the cables.
7. Carefully clean and inspect the oil-end below the mounting flange before mounting on the transformer.
8. Place the bushing over the transformer/reactor and connect the lower draw-rod with the upper draw-rod and firmly tighten.
9. With the flexible pull-through cord fully tensioned, the bushing is lowered into the transformer/reactor.
10. Fasten the bushing flange to the transformer/reactor, and tighten according to the transformer/reactor supplier’s specified torque, and remove the flexible pull-through cord at the top of the bushing.

CAUTION

If fixed stud bolts are used on the transformer tank for securing the bushing flange, it is recommended that plastic sleeves be placed on two or three of the studs in order to guide the bushing flange and to prevent metal chips, which could fall down into the transformer tank.

---

20 Two methods of assembling the end-shield.

21 Installation of bushing into transformer/reactor.
11. Apply a generous amount of Molykote Multilub (art. no. 1236 0011-127) on the nut, washer and draw-rod bolt. Remove any excess Molykote Multilub with a rag.
12. Tighten the nut to 20 Nm and measure the distance a, from the top of the nut to the top of the draw-rod bolt.
13. Continue tightening the nut until the measured distance 
   \[ b = a + 9 \text{ mm} \]. Each turn corresponds to an extension of 2 mm.
14. Continue at section 2.11 to ground the bushing flange.

**WARNING**

If the measured distance \[ b = a + 9 \text{ mm} \] is not achieved before reaching 160 Nm, this indicates that the threads are too poorly lubricated. If the threads are not damaged, remove the nut and draw-rod bolt to apply more Molykote Multilub and tighten again. If the threads are damaged, the nut and draw-rod bolt must be replaced.

Please contact the supplier if the specified values cannot be attained after following the instructions above.
1. Bottom contact
2. Bottom contact adapter
3. Inner draw ring
4. Support tube
5. Jointing sleeve
6. Joint
7. Tube end

24 Draw-rod system.
2.10.3 Lifting of bushing for mounting on transformer

Alternative 1: Raising the bushing to a vertical position.

1. Place soft bedding - e.g. a rubber mat or a wooden board - under the bottom end of the bushing to avoid damage to the bottom contact or center tube.
2. When raising the bushing to a vertical position, the lifting gear must be arranged according to Fig. 25.

**CAUTION**
The bushing must not be lifted by the insulator.

Alternative 2: Raising the bushing to a specific angle.

1. Place soft bedding - e.g. a rubber mat or a wooden board - under the bottom end of the bushing to avoid damage to the bottom contact or center tube.
2. When raising the bushing to a specific angle, the lifting gear and tackle must be arranged according to Fig. 26.

**CAUTION**
The bushing must not be lifted by the insulator.
2.11 Flange grounding
The bushing flange is provided with a tapped M12 hole, see Fig. 27. The bushing flange should be grounded to prevent electrical discharges between bushing flange and transformer/reactor during service.

Alternative 1
Insert a greased (Mobilgrease 28 recommended) pointed set screw M12 (preferably stainless steel A4-80). Tighten to 40 Nm, penetrating the paint of the transformer/reactor down to the metal beneath. This makes an electrical connection between the bushing and the transformer/reactor, keeping them at the same voltage.

Alternative 2
Connect a flexible cable between the M12 grounding hole in the bushing flange and a corresponding connection point on the transformer. Grease the screw (Mobilgrease 28 recommended) and tighten the M12 screw in the bushing to 40 Nm. Connect the other end of the cable to the transformer.
### 2.12 Mounting of outer terminal

Before connecting conductor clamps, the outer terminal studs must be carefully wire brushed and greased with a contact compound or vaseline. The inner contact surfaces on the aluminum outer terminal studs are tin-zinc plated, and may not be wire brushed; see Fig. 28.

In order to obtain the correct pressure and low contact resistance, the outer terminal must be removed and refitted as follows:

1. Remove the outer terminal and inspect the contact surface of the outer terminal and the conductor tube.
2. Carefully clean the contact and gasket surfaces.
3. Lubricate the gasket with Mobilgrease 28.
4. Assemble the tightening ring, the gasket and the outer terminal stud and push them over the conductor tube. Make sure that the tightening ring is mounted with the gasket track towards the gasket. An extra gasket is supplied with the bushing and intended for final installation.
5. Grease all bolt threads and surfaces beneath the bolt heads with Molykote Multilub or other suitable compound.
6. Insert the M10 screws with flat washers, which press the stud against the conductor tube and the upper draw-rod. Tighten in steps to a final torque of 40 ±4 Nm.
7. Insert the M8 screws with conical spring washers and flat washers that hold the tightening ring. Tighten them to press the gasket into place. Tighten in steps to a final torque of 20 ±2 Nm.

It is extremely important in both cases to tighten evenly. Gradually tighten the bolts, working in a crosswise pattern.

---

28 Outer terminal.
2.12.1 Unpacking and mounting the corona shield
The corona shield is delivered in a separate box.

1. Remove the plastic and unscrew the screws on the top cover. See Fig. 29. Remove the top cover.
2. Make sure the screws and washers for mounting the corona ring to the bushing is included in the delivery. Remove the plastic wrapping from the corona ring. See Fig. 30.

Use a soft sling for lifting the corona ring. Mount the corona shield on top of the top piece with screws. Note that the metallic end at one of the spokes is bent/curved to reduce the risk of mounting upside down. See Fig. 31.
2.13 Oil-filling of voltage tap housing
The GSB 800 bushing is equipped with a voltage tap, providing a voltage source while the bushing is in operation.

The voltage tap housing should be filled with oil when the continuous voltage exceeds 600 V. For voltages below 600 V, the voltage tap housing does not need to be oil filled.

The voltage tap housing should be filled with clean and dry transformer oil. This will prevent corrosion and condensation. Fill the tap housing as follows:
1. Remove the sealing plug on the top of the voltage tap; see Fig. 32.
2. Fill the tap housing, leaving a space of approximately 6-10 mm for oil expansion.
3. Firmly tighten the sealing plug.

The voltage tap adapter is used for permanent connection to measuring circuits; see Fig. 33.

**WARNING**

The voltage tap adapter must be equipped with suitable over-voltage protection to prevent damage during service. The cable gland must be oriented downwards in order to prevent water from entering the equipment.

If the connected impedance is too high, it can cause over-voltages on the voltage tap adapter during transient conditions leading to flashover. It is important to use the correct impedance for the actual transient frequencies at the installation on site.

Contact the supplier for more detailed information.
2.14 Waiting time before energizing

Different waiting times are required, depending on the transformer oil filling process, in order to avoid flashover caused by air bubbles. Choose a suitable method below.

**Vacuum-filled transformer**
No waiting time is necessary regarding the bushing.

**De-gassed, oil-filled transformer**
During mounting, use a clean and dry paintbrush to release surface bubbles. Wait 6 hours before energizing.

**Gas-saturated oil-filled transformer**
During mounting, use a clean and dry paintbrush to release surface bubbles. Wait 24 hours before energizing.

**De-gassed, oil-filled transformer with reduced oil-level**
After restoring the oil-level, wait 24 hours before energizing.

For all alternatives except “vacuum-filled transformer”, when used according to IEC 60137, the oil should be allowed to enter the center tube to at least 1/3 of the height to the external part, and when used for IEEE C57.19.01 the oil level shall be at least at flange height. This is done by releasing the outer terminal sealing system and allowing air to escape.

2.15 Recommended tests before energizing

The following tests should be performed to check the insulation, sealing and current path of the bushing. The tests should be carried out after mounting, but before connecting the outer terminal of the bushing to the rest of the switchyard power circuit.

1. Tightness test between transformer and bushing flange
2. Tightness test of outer terminal
3. Measurement of capacitance and tan δ
4. Check of resistance

2.15.1 Tightness test between transformer and bushing flange

Several different methods may be used for this test but we refer to instructions provided by the company responsible for field erection. As an example, the tightness of the sealing between the transformer and bushing flange can be checked when the transformer is oil-filled by using chalk or paper strips.

2.15.2 Tightness test of outer terminal

Since the top terminal is often situated above the oil level of the transformer expansion system, a leak at this point is extremely serious because water could enter directly into the transformer insulation. It is therefore recommended to perform a tightness test after assembly, preferably both with under vacuum and over-pressure. Several different methods may be used but we refer to instructions provided by the company responsible for field erection. One possible method is the tracer gas method:

5. Fill tracer gas into the center tube before mounting the outer terminal. The oil level of the transformer must be above the bottom end of the bushing but below the bushing flange.
6. Increase the pressure in the center tube by increasing the oil level as much as possible.
7. Search for leaking gas at the gasket with a gas detector (sniffer).
2.15.3 Measurement of capacitance and tan δ

**CAUTION**

The voltage tap cover must never be removed when applying voltage to the bushing. It must always be grounded or connected to an external impedance. No connection may destroy the bushing.

When not measuring, always make sure that the tap cover is properly tightened with the gasket in place. This is to prevent dust and water from entering the voltage tap; see Fig. 32.

After mounting, a capacitance and tan δ measurement is recommended by connecting a measuring bridge between the outer terminal and the voltage tap. This can be done without removing the bushing from the transformer as the bushing has an insulated voltage tap. More details can be found in the product information 2750 515-142, "Bushing diagnostics and conditioning".

With the transformer de-energized and the bushing outer terminal disconnected from any power source, the voltage tap cover can be removed. The measuring equipment is connected to the voltage tap and the voltage measuring source is connected to the bushing terminal. The main capacitance $C_1$ is measured between the outer terminal and the voltage tap. The tap capacitance $C_2$ is measured between the voltage tap and the mounting flange. These capacitances are also marked on the rating plate. The nominal capacitance $C_1$ is given in Table 4.

<table>
<thead>
<tr>
<th>Bushing GSB</th>
<th>$C_1 \text{(pF)}$</th>
<th>$C_2 \text{(pF)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>723</td>
<td>&lt; 29,400</td>
</tr>
</tbody>
</table>

2.15.4 Check of resistance

The resistance measurement method depends on the design of the transformer. In general, a current is applied from bushing to bushing. The voltage drop from outer terminal to outer terminal is then measured.

The resistance is calculated with Ohm's law: $U = R \cdot I$
- $U$: Measured voltage drop
- $R$: Total circuit resistance
- $I$: Current

The total resistance is the sum of the transformer winding and lead resistance, and the bushing conductor and contact resistance. The additional resistance from the bushing with the copper conductor should not be more than 100 µΩ. Since the resistance of the HV winding of a typical power transformer is in the order of 0.1... 1 Ω, this is a very rough method that can only be used to detect very large faults in the current path, such as disruptions.

Less-than-perfect contacts can only be detected by making a sensitive measurement across each connection point, or by measuring the temperature increase during operation with thermo vision (infrared camera).
2.16 Repacking of bushing after transformer FAT-tests

After the transformer FAT-tests, the bushing shall be repacked in its crate.

Mount the draw rod with its bottom contact in its intended position in the bushings center tube and tighten in accordance with section 2.10.2.

In the crate there is a separate box in the air-side end of the bushing, where two sealed plastic bags with drying agent are enclosed; see Fig. 35. Open the bags and replace the used drying agent in the protective metallic hood on the oil-side; Fig. 36. Discard the old drying agent. Check that the seal for the metallic protective hood is in good condition and properly fitted on the hood sealing surface; Fig. 37.

Reassemble the metallic hood to the flange at the oil side; see Fig. 38. Tighten the screws for the hood with 50 Nm.
Mount the outer terminal in accordance with section 2.12.

Place the bushing in the crate on the two supports; see Fig. 39. Make sure that the flange is inserted in the slot in the corresponding support to prevent the busing from sliding axially in the crate during transportation. This will also ensure that the top piece is correctly positioned at the top end support in the crate. The previous mentioned support for flange is made of two parts and after placing the bushing in the lower part the supports upper half shall be placed on the top side of the flange and secured by wood screws; Fig. 40. Also the top of the bushing shall be fixed by a clamping strap to the top end support which is a one piece support contrary to the flange support; Fig. 41. Lift the top cover in its straps and attach it to the box with screws; Fig. 42.
Repack the corona ring in its own crate; see Fig. 43. Make sure all screws and washers in the delivery are repacked.

Before sending busing to site, check that there are a minimum of two crates: one for bushing and one for the air side corona shield. If there are lifting tools included in the order, check that the third box is also sent to the transformer site together with the bushing.
The GSB bushings are basically maintenance free; no regular maintenance is needed.

**WARNING**

No work can be performed on the bushing while energized. Before starting any work, the bushing must be grounded.

### 3.1 Recommended maintenance and inspections

1. **Cleaning of insulator surfaces**
2. **Measurement of capacitance and tan δ**
3. **Thermo vision (infrared camera) check for local overheating of connectors**
4. **Check for leakage**

#### 3.1.1 Cleaning of insulator surfaces

Avoid solvent coming in contact with the bushing gasket and porcelain joints.

Composite: Under conditions with extreme pollution it may be necessary to clean the silicone rubber insulator surface. This should be done by wiping with a moist cloth. If necessary, ethyl-alcohol or ethyl-acetate may be used. Trichloroethane or methylchloride are not recommended.

#### 3.1.2 Measurement of capacitance and tan δ

Please refer to Section 2.15.3 Measurement of capacitance and tan δ.

#### 3.1.3 Thermo vision (infrared camera) check for local overheating of connectors

At maximum rated current the outer terminal of the bushing reaches a temperature of 35 to 45°C above the ambient air temperature. Significantly higher temperature can be a sign of bad connections, especially at lower current loads.

#### 3.1.4 Check for leakage

Make a visual inspection for oil leakage between the bushing and transformer flange during normal station inspections.

### 3.2 Disposal after end of service life

The GSB bushing is delivered in a wooden crate with a stainless steel sealing tube for moisture protection. The bushing consists of the following:

The composite insulator consists of silicone rubber on a tube of fiberglass-reinforced epoxy. Between the insulator and condenser core, there is silicone gel.

The resin-impregnated paper (RIP) condenser core consists mainly of epoxy, crepe paper and an embedded conductor tube in copper. The core also contains a smaller amount of aluminum foil inserts, rubber-bonded cork, rubber sealings, braided copper wire (tinned), braided copper straps, silver glue and lead. By crushing the core, the conductor tube can be separated and sorted while the rest of the core can be incinerated in a suitable furnace.

The removable flange is made of cast aluminum, the bolts of stainless steel and the gaskets of rubber. The gaskets in the flange are easily removed.

Removable voltage tap containing a tap body in epoxy, tap cover in aluminum, cable, contacts in brass and gaskets. By crushing the body of the voltage tap, the embedded brass contact stud can be separated.

The flange is filled with approximately 2 deciliters of silicone gel. When the flange is separated from the condenser core the gel can be scraped out and separated.

The outer terminal is either copper or aluminum, which may be coated. The coating material can vary due to special requests from the customer. The stainless steel bolts and rubber gaskets can be easily separated.

The draw-rod contains parts made of steel, brass and nylon. The bottom contact is pure copper.

The end-shield is epoxy-coated aluminum.
ABB AB, Components
SE-771 80 Ludvika
Sweden
E-mail: sales@se.abb.com

www.abb.com/transformercomponents