Transformer bushing, type GSA-OA
Installation and maintenance guide
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1 Safety

1.1 Levels of safety risks

Throughout the manual, various types of safety risks are indicated. The most serious level on this scale provides a warning about serious personal injury or possible death, or major damage to a product, if the instructions are not observed.

Symbols and their meanings

The following describes the symbols that appear in the manual, along with their meaning.

DANGER!
The yellow, filled warning triangle warns that an accident will occur if the instructions are not complied with and that it will result in serious personal injury or death and/or major damage to the product.

It is used, for example, to warn of such dangers as: contact with high voltage, explosion or fire risk, risk for toxic gases, risk of crushing, impacts, falls from high places, etc.

CAUTION!
The round warning symbol warns that an accident could occur if the instructions are not observed, and that this could result in personal injury and/or damage to the product.

It is also used to warn of risks that entail burns, eye or skin injuries, impaired hearing, crushing or slipping injuries, tripping, impacts, falls from high places, etc.

In addition, it is used to warn of functional requirements when assembling or removing equipment where there is a risk of damage to the product or downtime.

NOTE!
The comment symbol identifies important information and conditions. Also used to indicate any danger that could lead to property damage.

Torque
The torque symbol indicates tightening torque.
1.2 Hazardous working situations

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working close to high voltage.</td>
<td>Disconnect all plant power. Ground all objects at the workplace. If work must be done close to live plant components, make sure that the safety distance is in compliance with the applicable safety regulations.</td>
</tr>
<tr>
<td>Working on ladders and platforms.</td>
<td>Work must be done in accordance with the applicable safety regulations. Do not use ladders or platforms in poor weather conditions.</td>
</tr>
<tr>
<td>Working with heavy objects.</td>
<td>Do not walk under lifted objects. Make sure that heavy objects are stable before starting work.</td>
</tr>
</tbody>
</table>

1.3 Safety precautions

<table>
<thead>
<tr>
<th>Precaution</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer oil</td>
<td>Collect used transformer oil in drums. Transformer oil is dangerous. Fumes from hot oil can cause irritation to the respiratory organs and the eyes. Long and repeated contact with transformer oil can cause damage to your skin.</td>
</tr>
<tr>
<td>Waste and cleaning up</td>
<td>Clean up liquid waste with an adsorbent. Treat waste as hazardous to the environment.</td>
</tr>
<tr>
<td>Fire</td>
<td>Extinguish fires with powder, foam or carbon dioxide.</td>
</tr>
</tbody>
</table>
2 Product description

2.1 Design

Overview

The GSA type is a transformer bushing. It is made for immersed oil to air service. The bushing is of the dry, gas-free type, with a resin impregnated paper RIP condenser core as the primary insulation, and silicone rubber (SiR) sheds as outdoor insulation. Bushings of this design can be installed at any angle from vertical to horizontal.

For a detailed description, please refer to the Technical guide, 1ZSE 2750-111.

General schematics

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Outer terminal</td>
</tr>
<tr>
<td>2</td>
<td>Outdoor insulator (SiR)</td>
</tr>
<tr>
<td>3</td>
<td>Mounting flange</td>
</tr>
<tr>
<td>4</td>
<td>RIP condenser core</td>
</tr>
<tr>
<td>5</td>
<td>Conductor</td>
</tr>
<tr>
<td>6</td>
<td>Test tap</td>
</tr>
</tbody>
</table>
Test tap

The bushing has a test tap that is connected to the outermost conductive layer of the condenser core. The test tap is used to measure the bushing insulation by capacitance and dissipation factor. The cover connects the outermost conductive layer to ground, and must always be installed when the bushing is energized.

The maximum one minute test voltage for this test tap is $2 \text{kV}_{\text{rms}}$. The test tap can be used as a power source, if it is connected to an external capacitance. The operating voltage is limited to 600 V.

**CAUTION!**

Do not energize the bushing without a test adapter or the cover installed. The bushing is grounded through the cover to prevent damage to the bushing.

![Diagram of test tap and adapter](image)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stud</td>
</tr>
<tr>
<td>2</td>
<td>Grounding spring</td>
</tr>
<tr>
<td>3</td>
<td>Cover</td>
</tr>
<tr>
<td>4</td>
<td>O-ring</td>
</tr>
</tbody>
</table>

Test adapter, 1ZSC003881-AAC, optional equipment

The test adapter 1ZSC003881-AAC is available for permanent connection to measuring circuits. Please refer to Test adapter – Technical guide 1ZSC000563-ACS and Installation and maintenance guide 1ZSC000563-ACD.
Arcing horns, optional equipment

Arcing horns are available as optional equipment, they are made of galvanized steel.

Refer to the table for the gap distances (K) of standard arcing horns, other gap distances are available on request.

<table>
<thead>
<tr>
<th>Bushing type</th>
<th>K (mm)</th>
<th>C (mm)</th>
<th>H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSA 52</td>
<td>230-440</td>
<td>315</td>
<td>112</td>
</tr>
<tr>
<td>GSA 73</td>
<td>400-620</td>
<td>315</td>
<td>112</td>
</tr>
<tr>
<td>GSA 123</td>
<td>620-960</td>
<td>315</td>
<td>114</td>
</tr>
<tr>
<td>GSA 145</td>
<td>700-1080</td>
<td>380</td>
<td>224</td>
</tr>
<tr>
<td>GSA 170</td>
<td>820-1290</td>
<td>380</td>
<td>224</td>
</tr>
</tbody>
</table>
2.2 Technical specifications

2.2.1 General specifications

Refer to the table for the standard technical specifications of the bushing. For conditions exceeding the specifications, please contact ABB.

<table>
<thead>
<tr>
<th>Application:</th>
<th>Transformers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification:</td>
<td>Transformer bushing</td>
</tr>
<tr>
<td></td>
<td>• Resin impregnated paper, capacitance graded, oil immersed.</td>
</tr>
<tr>
<td></td>
<td>• For outdoor and indoor use.</td>
</tr>
<tr>
<td></td>
<td>• Temperature class E (120 °C) according to IEC 60137.</td>
</tr>
</tbody>
</table>

| Ambient temperature limits: | -40 °C to +40 °C. |
| Maximum altitude of site: | 1000 m (Bushings for other altitudes can be provided on request.) |
| Level of rain and humidity: | 1-2 mm rain/minute horizontally and vertically, according to IEC 60060-1 and IEEE Std 4. |
| Maximum pollution level: | According to the specific creepage distance, and IEC 60815. |
| Immersion medium: | Transformer oil. |
| | • Maximum daily mean oil temperature: +90 °C. |
| | • Maximum temporary oil temperature, at normal load: +100 °C. |
| | • Maximum temporary oil temperature, at short time overload: +115 °C. |
| Oil-level in transformer: | Not lower than 25 mm from the bushing flange. |
| Maximum pressure of medium: | $p_g \leq 100$ kPa ($p_g$ = relative to ambient pressure). |
| Angle of installation: | From horizontal to vertical. |
| Test tap: | Test tap with 4 mm male contact pin. |
| Capacitance $C_2$ of test tap: | $<5000$ pF |
| Arcing horns: | Optional |
| Conductor: | Solid-rod conductor or draw lead. |
| Markings: | Conforming to IEC/IEEE. |
List of bushings applicable to this installation guide

<table>
<thead>
<tr>
<th>Type</th>
<th>Article number</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>GSA-OA 52/2000</td>
<td>LF 130 052</td>
<td>-BA</td>
</tr>
<tr>
<td>/0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/0.3</td>
<td></td>
<td>-BB</td>
</tr>
<tr>
<td>/0.5</td>
<td></td>
<td>-BC</td>
</tr>
<tr>
<td>GSA-OA 73/2000</td>
<td>LF 130 073</td>
<td>-BA</td>
</tr>
<tr>
<td>/0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/0.3</td>
<td></td>
<td>-BB</td>
</tr>
<tr>
<td>/0.5</td>
<td></td>
<td>-BC</td>
</tr>
<tr>
<td>/0</td>
<td></td>
<td>-DA</td>
</tr>
<tr>
<td>/0.3</td>
<td></td>
<td>-DB</td>
</tr>
<tr>
<td>GSA-OA 100/1600</td>
<td>LF130 100</td>
<td>-BA</td>
</tr>
<tr>
<td>/0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/0.3</td>
<td></td>
<td>-BB</td>
</tr>
<tr>
<td>/0.5</td>
<td></td>
<td>-BC</td>
</tr>
<tr>
<td>GSA-OA 123/1600</td>
<td>LF 130 123</td>
<td>-BA</td>
</tr>
<tr>
<td>/0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/0.3</td>
<td></td>
<td>-BB</td>
</tr>
<tr>
<td>/0.5</td>
<td></td>
<td>-BC</td>
</tr>
<tr>
<td>/0</td>
<td></td>
<td>-CA</td>
</tr>
<tr>
<td>/0.3</td>
<td></td>
<td>-CB</td>
</tr>
<tr>
<td>/0.5</td>
<td></td>
<td>-CC</td>
</tr>
<tr>
<td>GSA-OA 145/1600</td>
<td>LF 130 145</td>
<td>-BA</td>
</tr>
<tr>
<td>/0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/0.3</td>
<td></td>
<td>-BB</td>
</tr>
<tr>
<td>/0.5</td>
<td></td>
<td>-BC</td>
</tr>
<tr>
<td>GSA-OA 170/1600</td>
<td>LF 130 170</td>
<td>-BA</td>
</tr>
<tr>
<td>/0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/0.3</td>
<td></td>
<td>-BB</td>
</tr>
<tr>
<td>/0.5</td>
<td></td>
<td>-BC</td>
</tr>
<tr>
<td>/0</td>
<td></td>
<td>-CA</td>
</tr>
<tr>
<td>/0.3</td>
<td></td>
<td>-CB</td>
</tr>
<tr>
<td>/0.5</td>
<td></td>
<td>-CC</td>
</tr>
</tbody>
</table>
2.2.2 Mechanical loading

Maximum permitted static load on the outer terminals

<table>
<thead>
<tr>
<th>Type</th>
<th>Type test load 1 minute (N)</th>
<th>Maximum cantilever operating load (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSA-OA 52/2000</td>
<td>4000</td>
<td>2000</td>
</tr>
<tr>
<td>GSA-OA 73/2000</td>
<td>4000</td>
<td>2000</td>
</tr>
<tr>
<td>GSA-OA 100/1600</td>
<td>4000</td>
<td>2000</td>
</tr>
<tr>
<td>GSA-OA 123/1600</td>
<td>4000</td>
<td>2000</td>
</tr>
<tr>
<td>GSA-OA 145/1600</td>
<td>4000</td>
<td>2000</td>
</tr>
<tr>
<td>GSA-OA 170/1600</td>
<td>4000</td>
<td>2000</td>
</tr>
</tbody>
</table>
3 Delivery

3.1 Incoming inspection

- Make sure that all items have been delivered, refer to the packing list.
- Carefully inspect the bushings for shipping damage.

3.2 Transportation

- The bushing must be transported in the transport box.
- Carefully inspect the bushing for damage after transportation.

3.3 Storage

Short term storage, less than 6 months

- Make sure that the bushing is wrapped in the original (or equivalent) moisture-proof wrapping.
  If the drying agent inside the wrapping has been exposed to the atmosphere, replace it.
- The bushing can be stored outdoors, if it is in the transport box.
  Keep the transport box protected from water, when the bushing is stored outdoors.
- Keep the bushing dry, clean and protected against mechanical damage.
- The bushing can be stored in both the vertical, and horizontal positions.

Long term storage, more than 6 months

- Use a transport container on the oil side of the bushing, this has to be ordered separately.
  Put drying agent in the transport container.
- Make sure that the air side of the bushing is wrapped in the original (or equivalent) moisture-proof wrapping.
  If the drying agent inside the wrapping has been exposed to the atmosphere, replace it.
- The bushing can be stored outdoors, if it is in the transport box.
  Keep the transport box protected from water, when the bushing is stored outdoors.
- Keep the bushing dry, clean and protected against mechanical damage.
- The bushing can be stored in both the vertical, and horizontal positions.
- The outer terminal must be installed on the bushing.

The bushing is delivered from ABB in a transport box, and the bushing is held in place by support blocks and fiberboard in the box.
The transport box is marked with Top end.
3.4 Lifting

3.4.1 Lifting the transport box

Overview

1. Center of gravity
2. Soft lifting slings

Procedure

1. Make sure that the crane and the soft lifting slings are approved for the total weight of the transport box and bushing. Refer to the weight in the packing list.

2. Attach soft lifting slings (2).

3. Make sure that the angle of the soft lifting sling is not more than 20°.

4. Carefully lift the transport box.

5. Set down the transport box on a flat surface.

End of instruction
3.4.2 Lifting the bushing out of the transport box

Overview

Procedure

1. Make sure that the crane is approved for lifting the weight of the bushing. Refer to the weight on the rating plate.

   ![NOTE!]
   Light bushings can be lifted by hand.

2. Open the transport box.

   ![NOTE!]
   The cover is attached with bolts.

3. Attach a soft lifting sling to the bottom end housing, as close to the flange as possible, and then to the crane hook.

   ![CAUTION!]
   Do not put the soft lifting slings on the silicone insulator, damage will occur.

4. Attach a soft lifting sling to the outer terminal and then to the crane hook.

5. Carefully lift the bushing.

6. Lower the bushing onto soft bedding.

End of instruction
4 Installation

4.1 Tools

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifting tool</td>
<td>2183 789-2</td>
<td>For solid rod conductor Ø 49 mm. Max load 125 kg.</td>
</tr>
<tr>
<td>Soft bedding</td>
<td>-</td>
<td>E.g. rubber mat or wood board</td>
</tr>
<tr>
<td>Soft lifting slings</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Pull-through cord</td>
<td>9760 669-A, -D</td>
<td>With M8 terminal. For assembly and disassembly of the draw rod.</td>
</tr>
<tr>
<td>Torque wrench key for hex socket screws, 16 mm (M10) and 13 mm (M8), torque 20 to 40 Nm.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wrench for hex socket screws 30 mm or adjustable wrench for 30 mm bolts or larger.</td>
<td>-</td>
<td>For the test tap cover.</td>
</tr>
<tr>
<td>Tackle</td>
<td>-</td>
<td>For installation of the bushing at a specific angle.</td>
</tr>
</tbody>
</table>

4.2 Consumables

<table>
<thead>
<tr>
<th>Item</th>
<th>Brand</th>
<th>ABB part number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil based Vaseline</td>
<td>Fuchs</td>
<td>1171 5011-102</td>
<td>For treatment of contact surfaces. Does not react with transformer oil.</td>
</tr>
<tr>
<td>Mobilgrease 28</td>
<td>MOBIL</td>
<td>1171 4014-407</td>
<td>Lubricates and protects metals against corrosion. Protects rubber. Does not react with transformer oil.</td>
</tr>
<tr>
<td>Molykote 1000</td>
<td>Dow Corning</td>
<td>1171 2016-618</td>
<td>For the sealing and lubrication of the contact on the outer terminal.</td>
</tr>
</tbody>
</table>
4.3 Preparations

4.3.1 Lifting the bushing

Overview

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lifting tool</td>
</tr>
<tr>
<td>2</td>
<td>Soft bedding, e.g. rubber mat or woodboard</td>
</tr>
<tr>
<td>3</td>
<td>Lifting eye</td>
</tr>
</tbody>
</table>

Procedure

1. Make sure that the crane can lift the bushing. Refer to net weight in the packing list.

2. Loosen the M8 bolts (1).

NOTE!
It is not necessary to remove the M8 bolts.
3. Remove the M10 bolts (4) and washers (5), and then remove the outer terminal (6).

**NOTE!**
Keep the outer terminal (6), nuts (5) and bolts (4), they will be used again.

4. Remove the item (7):
   1. Attach the pull-through cord to item (7).
   2. Remove item (7) and the divided ring (6).

**NOTE!**
Item (7) is the inner terminal, or solid-rod conductor.

**NOTE!**
Keep item (7) and the divided ring (6), they will be used again.

5. Install the lifting tool (1), and install the bolts (7) with the washers (5).

**NOTE!**
The bolts (7) are not supplied with the lifting tool (1), use three M10x20 bolts.

6. Align the crane hook with the lifting tool on the bushing.

7. Carefully lift the bushing.

**CAUTION!**
Make sure that the bushing does not rotate.
8. Lower the bushing onto soft bedding.

**CAUTION!**
Make sure that the bottom contact does not come in contact with the ground, or the floor. The bottom contact is made of soft metal.

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### 4.4 Installation on the transformer

#### 4.4.1 Installation with draw lead

**Overview**

1. Bushing
2. Inner terminal
3. Draw lead
4. Pull-through cord
Procedure

1. Solder the draw lead from the transformer windings to the inner terminal

   **NOTE!**
   As an alternative, the draw lead can be crimped to the inner terminal.

2. Carefully clean the bottom end of the bushing, and the inside of the center hole. Look for damage.

3. Lower the pull-through cord (10) through the bushing.

4. Apply Molykote 1000 to the pull-through cord (10), and attach it to the inner terminal (7).

   **NOTE!**
   The terminal (7) has M8 threads.
5. Hold the pull-through cord (12) in tension, while lowering the bushing onto the transformer.

**CAUTION!**
Do not damage the stud bolts on the transformer. There is a risk of metal falling into the transformer.

**CAUTION!**
Make sure that the draw lead is entering the bushing correctly. Monitor the draw lead through the inspection openings on the transformer.

**NOTE!**
Plastic sleeves put on two or three of the stud bolts will help to guide the flange, and will prevent damage to the stud bolts.

6. When installing the bushing at the transformer factory:
   1. Make sure that the bushing is installed in the correct orientation.
   2. Make permanent markings (16) on the bushing flange and the transformer turret.

7. Install the bolts and washers. Tighten the bolts in a crosswise sequence.
   - When installing the bushing at site, make sure that the marking (16) on the bushing flange lines up with the marking on the transformer turret.

**CAUTION!**
Make sure that the bolts are tightened evenly.
First tighten all bolts to half the torque, then to the full torque.

**Torque**
- M12 50 ±5 Nm
- 1/2” UNC 55 ±5 Nm
8. Put the divided ring (6) in the slot in the inner terminal (7).

9. Carefully lower the inner terminal (7) with the pull-through cord (10) until the divided ring (6) touches the bushing top surface.

**NOTE!**
The divided ring is held in position only by the weight of the inner terminal. Install the outer terminal as soon as possible.

10. Remove the M10 bolts (6), the washers (7), and the lifting tool (1).


End of instruction
4.4.2 Installation with solid-rod conductor

Overview

1. Bushing
2. Solid-rod conductor
3. Pull-through cord

Procedure

1. Loosen the captive screws (11), and disassemble the solid-rod conductor.

**NOTE!**
The captive screws (11) cannot be removed from the upper solid-rod conductor (7).
2. Solder the winding cables (2) from the transformer to the end of the solid-rod conductor (12).

**NOTE!**
As an alternative, the winding cables can be crimped to the solid-rod conductor.

3. Apply insulation to the winding cables and the lower solid-rod conductor.

**NOTE!**
The insulation must cover the recess in the lower solid-rod conductor.

4. Carefully clean and inspect the oil end (16) of the bushing, and the inside of the bushing.
5. Lower the pull-through cord (10) through the bushing.

6. Attach the pull-through cord (10) to the solid-rod conductor (7).

7. Pull up the upper part (7) of the solid-rod conductor until the joining surface (17) is accessible.
8. Clean the contact surfaces (17) on the lower (12) and the upper (7) parts of the solid-rod conductor. Apply Mobilegrease 28 to the contact surfaces (17).

**NOTE!**
Or use a lubricant similar to Mobilegrease 28.

9. Connect the upper (7) and lower (12) parts of the solid-rod conductor:
   1. Apply Mobilgrease 28 to the threads of the captive screws (11), and the washers.
   2. Assemble the solid-rod conductor, and tighten the captive screws (11).

**NOTE!**
Or use a lubricant similar to Mobilegrease 28.

10. Hold the pull-through cord (12) in tension, and at the same time lower the bushing onto the transformer.

   **CAUTION!**
   Do not damage the stud bolts. There is a risk of metal falling into the transformer.

   **NOTE!**
   Plastic sleeves put on two or three of the stud bolts will help to guide the flange, and will prevent damage to the stud bolts.
11. When installing the bushing at the transformer factory:
   1. Make sure that the bushing is installed in the correct orientation.
   2. Make permanent markings (16) on the bushing flange and the transformer turret.

12. Install the bolts and washers. Tighten the bolts in a crosswise sequence.

   **NOTE!**
   When installing the bushing at site, make sure that the marking (16) on the bushing flange lines up with the marking on the transformer turret.

   **CAUTION!**
   Make sure that the bolts are tightened evenly.
   First tighten all bolts to half the torque, then to the full torque.

   **Torque**
   M12 50 ±5 Nm
   1/2" UNC 55 ±5 Nm

13. Put the divided ring (6) in the slot in the solid-rod conductor (7).
14. Carefully lower the inner terminal (7) with the pull-through cord (10) until the divided ring (6) touches the bushings top surface.

15. Remove the pull-through cord.

16. Remove the M10 bolts (6), the washers (7), and the lifting tool (1).

17. Continue with *Installation of the outer terminal, page 31*.

End of instruction
4.4.3 Oil-filling

Overview

Start this procedure when the transformer oil has reached the bottom of the bushing.

- This procedure is NOT applicable if the transformer is oil-filled with the vacuum process.

The purpose of this procedure is to remove as much air as possible from the center tube of the bushing. Because air is soluble in transformer oil, air will go into the transformer oil and will cause its performance to deteriorate. The amount of air that can be removed depends on the bushings position in relation to the transformers oil-conservator.

Oil spillage

Oil spillage attracts dirt and this can reduce the performance of the electrical insulation. Large quantities of oil can cause the silicone rubber to expand and deform. Remove oil-spills with paper towels.

⚠️ CAUTION!
Do not allow oil that has been in contact with silicone-rubber to enter the transformer. It can contain small amounts of silicone oil that will reduce the surface tension of the transformer oil, this will cause foaming in forced oil circulation.

Procedure

1. Make sure that the transformer oil-level is maximum 25 mm from the flange.

⚠️ CAUTION!
A lower oil-level will decrease the cooling of the bushing, and can cause spontaneous flashovers.
2. Wait until the oil-level (h) in the center-tube has risen to the same height as the oil-level in the transformers oil-conservator.
   - If the top of the bushing is lower than the transformers oil-conservator, wait until oil flows out from top of the bushing.

   **NOTE!**
   Air is soluble in transformer oil, thus as much as possible must be released from the bushing center-tube.

---

### 4.4.4 Installation of the outer terminal

**Procedure**

1. Carefully clean the contact and gasket surfaces with a soft cloth, and then apply Mobilgrease 28.

   **CAUTION!**
   Do not use a wire brush on aluminium surfaces, or zinc coated surfaces. A wire brush can make scratches in the surfaces.

2. Carefully clean the contact and gasket surfaces with a soft cloth, and then apply Mobilgrease 28 to the contact surfaces and the O-ring (3).

   **NOTE!**
   Or use a lubricant with equal properties to Mobilgrease 28.

   **NOTE!**
   When the outer terminal (5) is installed at site for grid operation, replace the used O-ring (3) with a new O-ring. A new O-ring is supplied with the bushing.
3. Assemble the tightening ring (4), the O-ring (3), and the outer terminal (5).

4. Apply Molykote 1000 to the washers (2) and (10), and the threads of the M8 bolts (1).

5. Install the M8 bolts (1), the spring washers (2), and the plain washers (10).
   - **Torque**
   - Tighten with your fingers.

6. Put the outer terminal (5) on the bushing.

7. Apply Molykote 1000 to the washers, and to the threads and the shank of the M10 bolts (2).
   - **NOTE!**
   - Or use a lubricant with equal properties to Molykote 1000.

8. Install the M10 bolts (2) and plain washers.
   - **Torque**
   - Tighten the bolts in a crosswise sequence.
   - **CAUTION!**
   - Do **NOT** use an impact driver / wrench!
9. Prepare the contact surface of the outer terminal for the external connection:
   1. Carefully remove oxide with a wire-brush.
   2. Clean with a soft cloth.
   3. Apply Vaseline.

   **NOTE!**
   Or use a lubricant with equal properties to Vaseline.

10. Install the external connections. Refer to the documentation from the supplier of the external connection.

   End of instruction
4.4.5 Grounding of the bushing flange

Overview

The bushing flange must be grounded to the transformer tank. This prevents electrical discharge between the bushing flange and the transformer tank under normal service conditions.

There are two alternatives.

DANGER!
Make sure that the grounding is correct. An unsatisfactory grounding can cause damage to equipment, or death to personnel.

Procedure with a cone point set screw

1. Apply a large quantity of Mobilgrease 28 to the cone point set screw (13).

   CAUTION!
   The quality of the cone point set screw is important, stainless steel of A4-80 quality is recommended.

   NOTE!
   Or use a lubricant similar to Mobilgrease 28.

2. Install the cone point set screw (13).

   NOTE!
   The cone point of the set screw penetrates the paint. This makes an electrical connection between the bushing and the transformer tank, keeping them at the same potential.

   Torque
   M12: 40 Nm

End of instruction
Procedure with a flexible cable

1. Clean the contact surfaces.

2. Put a flexible cable (14) between the grounding hole in the bushing flange and a grounding point on the transformer.

3. Apply a large quantity of Mobilgrease 28 to the bolt (13).

   CAUTION!
   The quality of the bolt is important, stainless steel of A4-80 quality is recommended.

   NOTE!
   Or use a lubricant similar to Mobilgrease 28.

4. Install the bolt (13).

   Torque
   M12: 40 Nm

5. Connect the other end of the flexible cable (14) to the transformer.

   NOTE!
   This makes an electrical connection between the bushing and transformer tank, keeping them at the same potential.

End of instruction
5 Commissioning

5.1 Waiting time before energization

Waiting times after oil-filling of the transformer

Some waiting time is necessary after the transformer has been oil-filled, before the bushing is energized. The reason for this is that air bubbles stick to the bushings surface when the transformer is filled with oil, and flashovers and partial discharges can form in the bubbles. Thus, it is important to let the necessary waiting time pass, to make sure that all the air bubbles have risen to the surface of the oil before the bushing is energized. Refer to the table.

<table>
<thead>
<tr>
<th>The transformer is oil-filled with</th>
<th>Necessary waiting time</th>
</tr>
</thead>
<tbody>
<tr>
<td>The vacuum process</td>
<td>No waiting time is necessary, air bubbles does not form in vacuum. Refer to the transformer manufacturer’s instructions.</td>
</tr>
<tr>
<td>Gas-saturated transformer oil</td>
<td>After the oil-filling process has been completed, wait for 24 hours before energizing the transformer.</td>
</tr>
<tr>
<td>De-gassed transformer oil</td>
<td>After the oil-filling process has been completed, wait for 6 hours before energizing the transformer.</td>
</tr>
<tr>
<td>A reduced oil-level</td>
<td>After the oil-level has been restored, wait 24 hours before energizing the transformer.</td>
</tr>
</tbody>
</table>

5.2 Recommended tests before energization

5.2.1 Overview

The tests should be done to check the insulation, sealing and current path of the bushing.

NOTE!
The tests should be done after installation, but before connecting the outer terminal of the bushing to the power circuit.

5.2.2 Tightness test between transformer and bushing flange

Several different methods can be used and we thus refer to the instructions given by the company responsible for field erection. As an example, the tightness of the seal between the transformer and the bushing flange can be checked when the transformer is oil-filled by using chalk or, perhaps easier, with paper strips.
### 5.2.3 Tightness test of bushing outer terminal

#### Overview

Because the outer terminal is often situated above the oil level of the transformer oil expansion system, a leak at the outer terminal is serious. Water could enter directly into the transformer insulation. It is thus recommended to do a tightness test after installation of the bushing, both with vacuum and pressure.

Different methods can be used, and ABB refers to the instructions given by the company responsible for the field erection of the bushing.

#### Example procedure

1. Put tracer gas into the center tube before installation of the outer terminal.

   **NOTE!**
   
   The oil level of the transformer must be above the bottom end of the bushing, but below the bushing flange.

2. Increase the oil level to just below the bushing flange, to raise the pressure in the center tube.

3. Find leaking gas with gas detector (sniffer) near the gasket.

End of instruction

### 5.2.4 Measurement of capacitance and dissipation factor

#### Overview

After installation of the bushing, it is recommended to measure the capacitance values for future reference, such as repairs, service etc. This can be done on an installed bushing because it has an insulated test tap. Refer to 2750 515-142, “Bushing diagnostics and conditioning”.

- $C_1$ is the capacitance between the test tap and the outer terminal.
- $C_2$ is the capacitance between the test tap and ground.

**NOTE!**

The transport container must be removed before measuring the capacitance and dissipation factor ($\tan \delta$).
### Nominal capacitance

The capacitance ($C_2$) depends on the transformer, and it is not possible to give a nominal value that is valid for all service conditions. Thus, it is important to measure and record the capacitance ($C_2$) for future reference, such as repairs, service etc.

#### GSA-OA 52

<table>
<thead>
<tr>
<th>Article number</th>
<th>Space for CT = 0 mm</th>
<th>Space for CT = 300 mm</th>
<th>Space for CT = 500 mm</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>$C_1$</td>
<td>$C_1$</td>
<td>$C_1$</td>
</tr>
<tr>
<td>LF 130 052-BA</td>
<td>215</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LF 130 052-BB</td>
<td>-</td>
<td>417</td>
<td>-</td>
</tr>
<tr>
<td>LF 130 052-BC</td>
<td>-</td>
<td>-</td>
<td>543</td>
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#### GSA-OA 73

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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$C_1$</td>
<td>$C_1$</td>
<td>$C_1$</td>
</tr>
<tr>
<td>LF 130 073-BA</td>
<td>325</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LF 130 073-BB</td>
<td>-</td>
<td>512</td>
<td>-</td>
</tr>
<tr>
<td>LF 130 073-BC</td>
<td>-</td>
<td>-</td>
<td>636</td>
</tr>
<tr>
<td>LF 130 073-DA</td>
<td>303</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LF 130 073-DB</td>
<td>-</td>
<td>460</td>
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#### GSA-OA 100

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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$C_1$</td>
<td>$C_1$</td>
<td>$C_1$</td>
</tr>
<tr>
<td>LF 130 100-BA</td>
<td>294</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LF 130 100-BB</td>
<td>-</td>
<td>397</td>
<td>-</td>
</tr>
<tr>
<td>LF 130 100-BC</td>
<td>-</td>
<td>-</td>
<td>488</td>
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</table>

#### GSA-OA 123

<table>
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</thead>
<tbody>
<tr>
<td></td>
<td>$C_1$</td>
<td>$C_1$</td>
<td>$C_1$</td>
</tr>
<tr>
<td>LF 130 123-BA</td>
<td>216</td>
<td>-</td>
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<tr>
<td>LF 130 123-BB</td>
<td>-</td>
<td>319</td>
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<tr>
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<td>369</td>
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</tr>
<tr>
<td>LF 130 123-CB</td>
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<td>260</td>
<td>-</td>
</tr>
<tr>
<td>LF 130 123-CC</td>
<td>-</td>
<td>-</td>
<td>356</td>
</tr>
</tbody>
</table>
Dissipation factor, tan δ

The dissipation factor varies with the temperature of the bushing body, and thus the measured dissipation factor must be multiplied with the correction factor given below.

<table>
<thead>
<tr>
<th>Bushing body temperature °C</th>
<th>Correction factor to 20 °C (IEC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>0.76</td>
</tr>
<tr>
<td>3-7</td>
<td>0.81</td>
</tr>
<tr>
<td>8-12</td>
<td>0.87</td>
</tr>
<tr>
<td>13-17</td>
<td>0.93</td>
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<tr>
<td>18-22</td>
<td>1.00</td>
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<tr>
<td>23-27</td>
<td>1.07</td>
</tr>
<tr>
<td>28-32</td>
<td>1.14</td>
</tr>
<tr>
<td>33-37</td>
<td>1.21</td>
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<tr>
<td>38-42</td>
<td>1.27</td>
</tr>
<tr>
<td>43-47</td>
<td>1.33</td>
</tr>
<tr>
<td>48-52</td>
<td>1.37</td>
</tr>
<tr>
<td>53-57</td>
<td>1.41</td>
</tr>
<tr>
<td>58-62</td>
<td>1.73</td>
</tr>
<tr>
<td>63-67</td>
<td>1.43</td>
</tr>
<tr>
<td>68-72</td>
<td>1.42</td>
</tr>
<tr>
<td>73-77</td>
<td>1.39</td>
</tr>
<tr>
<td>78-82</td>
<td>1.35</td>
</tr>
<tr>
<td>83-87</td>
<td>1.29</td>
</tr>
</tbody>
</table>
Procedure

1. De-energize the transformer.

2. Disconnect the external connections from the outer terminal of the bushing.

3. Remove the cover (2).

4. Connect the measuring equipment.
   1. Connect the low voltage cable to the stud (1).
   2. Connect the high voltage cable to the outer terminal.
   3. Connect the ground cable to the bushing flange (3).

5. Measure the capacitance \( C_1 \) between the outer terminal and the stud (1).
   - Record the capacitance \( C_1 \) for future reference.

   **NOTE!**
   Refer to the table for the nominal capacitance \( C_1 \), *Nominal capacitance*, page 39.

6. Measure the capacitance \( C_2 \) between the stud (1) and the flange.
   - Record the capacitance \( C_2 \) for future reference.

7. Measure the dissipation factor:
   1. Start the measurements with a low sensitivity setting on the measuring bridge.
   2. Gradually increase the sensitivity setting on the measuring bridge to the highest possible.
   3. Calculate the dissipation factor with the correction factor, refer to *Dissipation factor, tan \( \delta \)*, page 40.

   **NOTE!**
   In some cases, external interference can make it difficult to set the measuring bridge to zero.
8. Install the cover (2).

**CAUTION!**
The test tap is not self-grounding!
The bushing can be destroyed if the test tap is not grounded. Because the capacitance \( C_2 \)
is usually relatively small, the test tap must never be open-circuited when applying a
voltage to the bushing. It must always be grounded or connected to an external impedance.

**CAUTION!**
Do not energize the bushing without the cover or a test adapter installed. The cover
connects the outermost conductive foil to ground and will prevent damage to the bushing.

**CAUTION!**
Make sure that the cover is correctly installed with the O-ring in place, when the bushing is
not in use. The purpose is to prevent dust and water from entering the tap.

9. Connect the outer terminal of the bushing to the external connections.

End of instruction

5.2.5 Measurement of through-resistance

**Overview**

The method to use for measuring the through-resistance depends on the design of the transformer. In general,
a current is applied from bushing to bushing. The voltage drop from the outer terminal to outer terminal is
measured. The resistance is calculated with Ohm's law, \( R = \frac{U}{I} \).

\( R: \) total circuit resistance, \( U: \) measured voltage drop, \( I: \) through-current.

The total through-resistance is the sum of the transformer winding, lead resistance, the bushing conductor,
and contact resistance. The additional resistance from the bushing conductor should not be more than 10 to
100 mΩ. Because the through-resistance of the HV winding of a typical power transformer is in the order of
0.1 to 1 Ω, this is a very rough method that can only be used to detect very large faults in the current path,
such as open circuits.

Small faults in the current path can only be detected by making sensitive measurements across each
connection point, or by measuring the temperature increase during operation with an infrared sensitive
camera (thermovision).

The through-resistance of an installed bushing can only be measured from the outer terminal of one bushing,
to the outer terminal of the other bushing on the same transformer winding. The through-resistance will
include the resistance of both bushings, all connections and the transformer winding.

**Procedure**

1. Record the temperature of the transformer winding.

**NOTE!**
The resistance of metals depends on their temperature. Because the transformer winding
usually dominates the total resistance, the average winding temperature at the time of
measurement must be recorded.

2. Measure the through-resistance from outer terminal to outer terminal.
3. Calculate the measured resistance to the reference temperature. Then compare the calculated resistance to the reference resistance.
   A difference of less than 2% is acceptable.

   **NOTE!**
   The transformer manufacturer gives the reference temperature for through-resistance measurements.

4. If the calculated difference of resistance is more than 2% from the reference resistance:
   1. Make sure that the external connections have low resistance, and make sure that the outer terminal and the internal connections are correctly installed.
   2. Measure the through-resistance again.

5. If the calculated difference of resistance again is more than 2%:
   • Wait 24 hours and do steps 1 through 5 again.

End of instruction
6 Maintenance

6.1 Recommended maintenance

General

The bushings are maintenance free, no regular maintenance is necessary.

⚠️ DANGER!

Risk of electrocution!

Do not go near the bushing while it is energized, or ungrounded. High voltages can kill you.

Make sure that the bushing is de-energized, and grounded before you do work on it.

Cleaning of the insulator surface

If the insulator is exposed to very high pollution, it can be necessary to clean the surface. Remove the pollution with a moist cloth. If necessary, put isopropyl alcohol on the cloth.

⚠️ DANGER!

1,1,1-Trichloroethane or Methyl-chloride are not recommended as detergents, because they are dangerous to persons and the environment.

⚠️ CAUTION!

Do not wash the insulators with a high pressure water jet. This can cause damage to the insulators.

Measurement of capacitance and dissipation factor

Please refer to Measurement of capacitance and dissipation factor, page 38.

Thermovision (infrared camera) check for local overheating on connectors

At the maximum rated current, the bushing outer terminal normally operates at a temperature of about +35 °C to +45 °C above the ambient temperature. Significantly higher temperatures can be a sign of bad connections, especially at lower current loading.

Checking of oil leakage

Make a visual inspection for oil leakage during regular station supervision.

After repairs

ABB recommends that the capacitance is measured after repairs have been done, after maintenance of connected equipment, or after work near the bushing is completed.

It is important to compare the capacitance before energization with the capacitance that was measured at commissioning. A change in capacitance gives indication of a fault. Refer to Measurement of capacitance and dissipation factor, page 38.
7 Re-packing

7.1 Re-packing of the bushing

Overview

Procedure

1. Lift the bushing. Refer to Lifting the bushing out of the transport box, page 15.

2. Lower the bushing into the transport box.
   
   **CAUTION!**
   
   Do not apply force to the polymeric insulator, deformation will occur.
   
   **CAUTION!**
   
   Make sure that there is soft bedding in the transport box.
   
   **CAUTION!**
   
   Make sure that the test tap does not make contact with the transport box, or other objects.

3. Attach the bushing to the transport box in the same way as when it was delivered.
   
   **CAUTION!**
   
   Make sure that the bushing cannot move or rotate in the transport box.
4. Close the transport box.

**NOTE!**
Refer to *Lifting the transport box*, page 14 and *Transportation*, page 13.

End of instruction
8 Spare parts

8.1 Summary

If the bushing is damaged, we recommend that it is returned to ABB for repairs and re-testing. Some parts that are damaged or lost during transportation or installation can be ordered from ABB.

8.2 Spare parts

Cover

For the test tap.

<table>
<thead>
<tr>
<th>Position</th>
<th>Part</th>
<th>Article number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cover</td>
<td>2749 528-B</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>O-ring</td>
<td>1ZSC001606-AAW</td>
<td>-</td>
</tr>
</tbody>
</table>

![Diagram of Cover](image)
### 8.3 Special tools

#### Lifting tool

<table>
<thead>
<tr>
<th>Part</th>
<th>Article number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifting tool</td>
<td>2183 789-2</td>
<td>-</td>
</tr>
</tbody>
</table>

![Lifting tool image](image1.png)

#### Pull-through cord

<table>
<thead>
<tr>
<th>Part</th>
<th>Article number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull-through cord</td>
<td>9760 669-A</td>
<td>With M8-terminal.</td>
</tr>
</tbody>
</table>

![Pull-through cord image](image2.png)
9 Disposal and environmental information

9.1 Overview

This chapter specifies the materials used in the bushing. Comply with local environmental regulations on disposal of this product, the materials used are specified for this purpose.

9.2 Disposal and recycling

ABB strives to minimize the product's impact on the environment throughout its entire life cycle. Technical and product development focuses on environmental aspects. The ecocycle approach is striven for, and consideration is taken to the materials' environmental impact and recycling alternatives. The manufacturing processes are selected to be as safe for the environment as possible.

Disposal of worn-out equipment

Worn-out equipment must be disposed of in an environmentally sound manner.

Much of the material, or the energy content in the material, can be recycled if it is sorted and cleaned. The quantity of material that can be recycled varies depending on the technical resources and capabilities in each country. Non-recyclable components should be sent to an approved environmental waste treatment plant for destruction or disposal.

Porcelain

After cleaning, the porcelain can be sent for disposal or used for other purposes, such as for use as filling material.

Electronics

Electronics equipment should be sent to an approved recycling plant, or sorted into different component materials for correct processing.

Metals

Metals should be sorted according to type and surface coating, and sent to an approved recycling plant. After the removal of paint or other surface coatings, clean metal can usually be melted down and used in new products. Many metal components of iron, steel and aluminum are large and easy to identify, e.g. support structures. ABB strives to reduce the use of precious metals and the release of environmentally hazardous metals.

The recycling of precious metals is particularly important. Metals such as copper and silver are expensive, and are only present in small quantities in the earth's crust. Copper is primarily used in current conductors, contacts and cables. Some contacts are silver plated. Fumes from some metals can cause environmental damage, this applies to zinc and nickel, which are used sparingly as surface coatings.
Plastics

The different types of plastic should be separated and sent to an approved environmental waste treatment plant or recycling plant. The energy content in thermoplastics and thermosetting plastics can often be recovered through combustion at a plant built for the purpose. Thermoplastics can usually be melted down and reused without significant loss of quality. Composites can be fractioned and used as filling materials in other materials, or be disposed of.

Oils and greases

Before disposal of the bushing, oil, grease and similar products must be removed and sent to an approved environmental waste treatment plant or recycling plant. By utilizing gravimetric forces, oil waste can be separated into oil, water and a range of contaminants. In many cases, the oil can then be reused. As an alternative, the energy content in oil can be recovered through combustion at a plant designed for the purpose.

Rubber

Send rubber to an approved environmental waste treatment plant, either for disposal or reuse for different purposes.

Rubber is used in seals and gaskets.

Other materials

Sort other materials and send them to an approved environmental waste treatment plant.