Transformer bushing, type GOB
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 about functional requirements when assembling or removing equipment where there is a risk of damage to the product or that it might cause 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 the 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. Then earth all objects at the workplace.</td>
</tr>
<tr>
<td></td>
<td>If work must be carried out close to live plant components, then</td>
</tr>
<tr>
<td></td>
<td>make sure that the safety distance is in compliance with the</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>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 warm 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 fire with powder, foam or carbon dioxide.</td>
</tr>
</tbody>
</table>
2 Product description

2.1 Design

Overview

The GOB is a capacitance graded oil impregnated paper bushing made for immersed oil/air service. The bushing is available with an oil-level sight glass or without, bushings without a sight-glass has an increased expansion space for the oil.

For a detailed description, please refer to the Technical guide, 1ZSE 2750-102.

General schematics

1. Outer terminal
2. Insulator
3. Mounting flange
4. Flange extension
5. End shield
6. Test tap
7. Insulator
8. Rating plate
9. Oil-level sight-glass
Terminal system

The bushing can be configured with one of two terminal systems: the stranded cable system, or the solid-rod conductor system.

Horizontal installation

⚠️ CAUTION!
Do not install bushings that does not have the oil passage (2) in the horizontal position.

If the bushing will be installed in the horizontal position, then this must be specified in the order. Because horizontally installed bushings must be fully filled with oil (there is no expansion space for the oil), the oil must flow freely to and from the transformer tank through an oil passage (2).

The bushing is delivered with expansion space for the oil, and the bushing must be filled at installation.

When the bushing is delivered, the oil passage (2) is covered with a covering plate (1) and a rubber gasket. This configuration makes sure that it will be removed at installation on the transformer.
**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 500 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.

---

**Stud**

**Grounding spring**

**Cover**

**O-ring**

---

**Test adapter, 1ZSC003881-AAC, optional equipment**

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

Arcing horns are available as optional equipment, they are made of galvanised 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>Type</th>
<th>K (mm)</th>
<th>C (mm)</th>
<th>H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOB 250</td>
<td>230–440</td>
<td>315</td>
<td>112</td>
</tr>
<tr>
<td>GOB 325</td>
<td>320–580</td>
<td>315</td>
<td>112</td>
</tr>
<tr>
<td>GOB 380</td>
<td>400–620</td>
<td>315</td>
<td>112</td>
</tr>
<tr>
<td>GOB 450</td>
<td>400–780</td>
<td>315</td>
<td>112</td>
</tr>
<tr>
<td>GOB 550</td>
<td>620–960</td>
<td>315</td>
<td>114</td>
</tr>
<tr>
<td>GOB 650</td>
<td>700–1080</td>
<td>380</td>
<td>224</td>
</tr>
<tr>
<td>GOB 750</td>
<td>820–1290</td>
<td>380</td>
<td>224</td>
</tr>
<tr>
<td>GOB 1050</td>
<td>950–1840</td>
<td>420</td>
<td>410</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>• Oil impregnated paper, capacitance graded, oil immersed.</td>
<td></td>
</tr>
<tr>
<td>• For outdoor and indoor use.</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature limits:</td>
<td>-40 °C to +40 °C.</td>
</tr>
<tr>
<td>( -60 °C according to GOST 10693-81 item 2.26.)</td>
<td></td>
</tr>
<tr>
<td>Maximum altitude of site:</td>
<td>1000 m (Bushings for other altitudes can be provided on request.)</td>
</tr>
<tr>
<td>Level of rain and humidity:</td>
<td>1-2 mm rain/minute horizontally and vertically, according to IEC 60060-1 and IEEE Std 4.</td>
</tr>
<tr>
<td>Maximum pollution level:</td>
<td>According to the specific creepage distance, and IEC 60815.</td>
</tr>
<tr>
<td>Immersion medium:</td>
<td>Transformer oil.</td>
</tr>
<tr>
<td>• Maximum daily mean oil temperature: +90 °C.</td>
<td></td>
</tr>
<tr>
<td>• Maximum temporary oil temperature, at short time overload: +115 °C.</td>
<td></td>
</tr>
<tr>
<td>Oil-level in transformer:</td>
<td>Not lower than 30 mm from the bushing flange.</td>
</tr>
<tr>
<td>Maximum pressure of medium:</td>
<td>$p_g$ 100 kPa ($p_g =$ relative to ambient pressure).</td>
</tr>
<tr>
<td>Angle of installation:</td>
<td>Standard bushings: 0 to 45° from vertical.</td>
</tr>
<tr>
<td>• Bushings for horizontal installation: 45° to 90° from vertical.</td>
<td></td>
</tr>
<tr>
<td>Test tap:</td>
<td>Test tap with 4 mm male contact pin.</td>
</tr>
<tr>
<td>Arcing horns:</td>
<td>Optional</td>
</tr>
<tr>
<td>Conductor:</td>
<td>Solid or flexible draw-lead conductor.</td>
</tr>
<tr>
<td>Markings:</td>
<td>Conforming to IEC/IEEE.</td>
</tr>
</tbody>
</table>

2.2.2 Mechanical loading

Maximum permitted static load on the outer terminal

The load must be applied at the midpoint of the outer terminal or below. The total cantilever load must be perpendicular to the bushing axis. The bushing installation angle can be 0° – 45° from vertical. (GOB 1050: 0° – 30° from vertical.)

In the axial direction, the bushing can withstand a static load of 10 kN. The maximum static torque on the outer terminal stud can not be more than 30 Nm.

NOTE!
The loads described in this section are static loads, for dynamic loads such as earthquakes and extreme weather conditions, please contact your ABB sales representative.
1 Maximum cantilever load

2 GOB 1050

3 Maximum axial static load

4 Load applied below the midpoint

<table>
<thead>
<tr>
<th>Type</th>
<th>Test load 1 minute (N)</th>
<th>Maximum cantilever operating load (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOB 250/800</td>
<td>2000</td>
<td>1800</td>
</tr>
<tr>
<td>GOB 250/1250</td>
<td>2500</td>
<td>3000</td>
</tr>
<tr>
<td>GOB 325/800</td>
<td>2000</td>
<td>1500</td>
</tr>
<tr>
<td>GOB 380/800</td>
<td>1800</td>
<td>1400</td>
</tr>
<tr>
<td>GOB 380/1250</td>
<td>2500</td>
<td>2000</td>
</tr>
<tr>
<td>GOB 450/800</td>
<td>1500</td>
<td>1150</td>
</tr>
<tr>
<td>GOB 550/800</td>
<td>1600</td>
<td>1300</td>
</tr>
<tr>
<td>GOB 550/1250</td>
<td>3100</td>
<td>2400</td>
</tr>
<tr>
<td>GOB 650/1250</td>
<td>3200</td>
<td>2600</td>
</tr>
<tr>
<td>GOB 750/1250</td>
<td>3200</td>
<td>2600</td>
</tr>
<tr>
<td>GOB 1050/1100</td>
<td>3200</td>
<td>1250</td>
</tr>
</tbody>
</table>
3 Delivery

3.1 Receiving inspection

- Make sure that all items are 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.
- The bushing can be transported in both the vertical, and the horizontal positions.
- Carefully inspect the bushing for damage after transportation.

3.3 Storage

Short term storage, less than 6 months

- 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

- 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.
- Lift the bushing to the vertical position with the top end upwards, and put it in a safe stand.
  - As an alternative: keep the bushing in the transport box and lift it to an inclined position, with the top end upwards and at an angle of at least 7°.

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*, this identifies the end to lower when the bushing is in storage.
3.4 Lifting

3.4.1 Lifting of the transport box

Overview

![Diagram showing lifting points and angles](image)

1. Center of gravity
2. Soft lifting slings
3. Forklift lifting points

Procedure

1. Make sure that the crane and the soft lifting slings can lift the transport box with the bushing. Refer to the weight in the packing list.

2. Attach soft lifting slings (2) to the correct locations.

3. Make sure that the angle of the soft lifting sling does not exceed 20°.

4. Carefully lift the transport box.

5. Put down the transport box on flat ground.

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

Overview

![Diagram of lifting the bushing](image)

Procedure

1. Make sure that the crane can lift the bushing. Refer to the weight on the rating plate.

2. Open the transport box.

   **NOTE!**
   The cover is attached with bolts.

3. Attach a soft lifting sling to the lower part of the flange and to the crane hook.
4. Attach a soft lifting sling to the insulator shed under the top housing.

**CAUTION!**
Attach the soft lifting sling as close to the top housing as possible, or damage will occur.

5. Carefully lift the bushing.

6. Lower the bushing onto soft bedding.

**CAUTION!**
Do not apply force to the ceramic insulator, it will break.

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>-</td>
<td>-</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>Lifting eye M12 (DIN 580)</td>
<td>2183 2001-3</td>
<td>For installation of the bushing at an angle.</td>
</tr>
<tr>
<td>Pull-through cord</td>
<td>9760 669-A</td>
<td>With M8 terminal.</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>Open wrench, 55 or 66 mm.</td>
<td>-</td>
<td>For removal, and installation of the outer terminal.</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>Part number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil based Vaseline</td>
<td>Unilever</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>11714014-407</td>
<td>Lubricates and protects metals against corrosion. Protects rubber. Does not react with transformer oil.</td>
</tr>
</tbody>
</table>
4.3 Preparations

4.3.1 Removal of the outer terminal

Procedure

1. Turn the outer terminal (5) counter clockwise, and remove it.

   NOTE!
   The outer terminal has key grips (2) for a wrench.

2. Remove the O-ring (3).

   NOTE!
   Keep the O-ring, it will be used again.

End of instruction

4.3.2 Lifting the bushing for installation on the transformer

Procedure

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

2. Align the crane hook with the lifting tool on the bushing.
3. Attach soft lifting slings (8) around the top of the insulator.

**CAUTION!**
Put soft bedding (2) under the bottom contact. The bottom contact is made of soft metal, and contact with the floor can cause damage.

4. For installation of the bushing at a specific angle:
   1. Attach soft lifting slings with a shackle (9) on the flange and to the crane hook.

5. Carefully lift the bushing from the floor.

**CAUTION!**
Make sure that the bushing does not rotate.

6. Adjust the shackle (9) until the bushing flange has the same angle as the transformer flange.

7. Lift the bushing to a position above the transformer.

**CAUTION!**
Make sure that the bushing does not rotate.
8. Align the bushing with the hole in the transformer turret.

End of instruction

4.3.3 Installation of the end-shield on GOB 1050

Overview

This procedure only applies to GOB 1050. The end-shield and the fasteners are in a small plywood box inside the transport box.

Procedure

1. Install the end-shield (1) with bolts (2) and washers.

2. Tighten the bolts (2).

CAUTION!
If the bushing is lowered into transformer oil, remove the air cushion in the end-shield with a hose.

Torque
10 Nm

End of instruction
4.3.4 Horizontal installation

Overview

This procedure must be done immediately before installation of the bushing on the transformer, because there is no expansion space for the oil after this procedure is completed. Thus, changes in the ambient temperature will cause the oil to expand or contract, this will cause damage to the seals in the bushing.

⚠️ **CAUTION!**

Do not leave the bushing fully filled with oil.

Installation must be done immediately after the bushing is sealed. If not, changes in the ambient temperature will cause damage to the seals in the bushing.

Procedure

1. Lift the bushing to the vertical position.

2. Remove one of the oil-plugs (4).

3. Add clean and dry transformer oil until the bushing is completely filled.

   ⚠️ **CAUTION!**

   Make sure that the bushing is completely full of transformer oil. Air left in the bushing can cause damage.

4. Install the oil-plug (9).

5. Lower the bushing to the horizontal position.

6. Install the bushing in the transformer immediately, refer to *Installation with solid rod conductor*, page 27.

End of instruction
4.4 Installation of the bushing on the transformer

4.4.1 Installation with stranded cable

Overview

![Diagram of bushing and cable installation]

1  Bushing  
2  Inner terminal  
3  Stranded cable  
4  Pull-through cord

Procedure

1. Solder the stranded cable from the transformer windings to the inner terminal

   **NOTE!**
   As an alternative, the stranded cables 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. If the bushing is installed in the horizontal position:
   1. Make sure that the covering plate (1) is in the top dead center position.
   2. Remove the covering plate (1).
6. 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 stranded cable is entering the bushing correctly. Monitor the stranded cable 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.

7. 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.

8. 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
9. Install the inner terminal (7):
   1. Carefully lower the inner terminal (7) until the holes (15) match.
   2. Put the locking pin (3) into the inner terminal (7).

10. Remove the pull-through cord.

11. Continue with Installation of the outer terminal, page 36.

End of instruction

4.4.2 Installation with solid rod conductor

1 Bushing
2 Solid-rod conductor
3 Pull-through cord
Procedure for 800 A

1. 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.

2. Carefully clean and inspect the oil end (16) of the bushing, and the inside of the bushing.

3. Lower the pull-through cord (10) through the bushing.
4. Attach the pull-through cord (10) to the solid rod (7).

5. Pull up the upper part (7) of the solid rod until the joining surface (17) is accessible.

6. Clean the contact surfaces (17) on the lower (12) and the upper (7) parts of the solid rod.

   Apply Mobilegrease 28 to the contact surfaces (17).

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

<table>
<thead>
<tr>
<th>Part</th>
<th>Article number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locking pin</td>
<td>2111 764-C</td>
</tr>
<tr>
<td>Screw</td>
<td>2122 751-2</td>
</tr>
</tbody>
</table>
7. Connect the upper (7) and lower (12) parts of the solid rod:
   1. Apply Mobilgrease 28 to the threads (14) and the contact surfaces (17).
   2. Connect the two parts and tighten them.

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

   **NOTE!**
   The key-grips (18) on the solid-rod fit 17 mm wrenches.

---

8. 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.

---

9. 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.
10. Install the nuts and washers. Tighten the nuts in a crosswise sequence.

11. Install the solid-rod (7):
   1. Carefully lower the solid-rod (7) until the holes (15) match.
   2. Put the locking pin (3) into the solid-rod (7).

12. Remove the pull-through cord.

13. Continue with Installation of the outer terminal, page 36.

End of instruction
Procedure for 1250 A

1. 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.

2. Carefully clean and inspect the oil end (16) of the bushing, and the inside of the bushing.

3. Lower the pull-through cord (10) through the bushing.
4. Attach the pull-through cord (10) to the solid rod (7).

5. Pull up the upper part (7) of the solid rod until the joining surface (17) is accessible.

6. Clean the contact surfaces (17) on the lower (12) and the upper (7) parts of the solid rod.

**NOTE!**
Or use a lubricant similar to Mobilegrease 28.
7. Connect the upper (7) and lower (12) parts of the solid rod:
   1. Apply Mobilgrease 28 to the bolts (11) and washers.
   2. Install the bolts (11) and washers.

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

   ![Diagram](image1)

   **Torque**
   35-40 Nm

8. 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.

   ![Diagram](image2)

9. 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.

   ![Diagram](image3)
10. Install the nuts and washers. Tighten the nuts in a crosswise sequence.

![Diagram showing the nuts and washers installation]

**Torque**

- M12 50 ±5 Nm
- 1/2” UNC 55 ±5 Nm

11. Install the solid-rod (7):
   1. Carefully lower the solid-rod (7) until the holes (15) match.
   2. Put the locking pin (3) into the solid-rod (7).

![Diagram showing the installation of the solid-rod]

12. Remove the pull-through cord.

13. Continue with *Installation of the outer terminal, page 36.*

End of instruction
4.4.3 Installation of the outer terminal

Procedure

1. 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).

   ![Diagram](image1.png)

   **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.

2. Carefully clean the contact surface (6) and gasket surface (3) with a soft cloth, and then apply Mobilgrease 28.

   ![Diagram](image2.png)

3. Apply Vaseline to the thread of the terminal stud.

   ![Diagram](image3.png)

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

4. Install the O-ring (8) and the outer terminal (5).

   ![Diagram](image4.png)
5. Tighten the outer terminal (5).

<table>
<thead>
<tr>
<th>Type</th>
<th>Width of key grip (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 A</td>
<td>55 mm</td>
</tr>
<tr>
<td>1250 A</td>
<td>66 mm</td>
</tr>
</tbody>
</table>

- **Torque**
  - 55 mm: 60 Nm
  - 66 mm: 80 Nm

6. 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.

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

End of instruction
4.4.4 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. Put a flexible cable (14) between the grounding hole in the bushing flange and a grounding point on the transformer.

2. 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.

3. Install the bolt (13).

   Torque
   M12: 40 Nm

4. 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.
5 Commissioning

5.1 Waiting time before energization

General requirements for the bushing

- If the bushing has been stored in the vertical position with the top end upwards, then no waiting time is required.
- If the bushing has been stored in the horizontal position, or in an inclined position of 7°, then air bubbles must be removed from the oil before it can be energized. Refer to the table.
- The waiting times can be met with the bushing installed on the transformer.

When the bushing is in the vertical position, air bubbles that are trapped in the oil collects at the top.

<table>
<thead>
<tr>
<th>Storage time in the horizontal position</th>
<th>Minimum required waiting time in the vertical position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before service voltage application</td>
</tr>
<tr>
<td>Less than one year</td>
<td>12 hours</td>
</tr>
<tr>
<td>More than one year</td>
<td>7 days</td>
</tr>
</tbody>
</table>

**CAUTION!**
If you do not obey this procedure, flashovers or partial discharges can occur inside the bushing.

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.

<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 manufacturers 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 energizing

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.

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”.

The measurements can be done with a measuring bridge directly connected to the test tap, or with ABB’s test adapter (1ZSC003881-AAC).

- \( C_1 \) 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.
<table>
<thead>
<tr>
<th>Type</th>
<th>Catalog No</th>
<th>Nominal capacitance (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LF 123 ...</td>
</tr>
<tr>
<td>GOB 250</td>
<td>013, 014, 171, 172</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>015, 016, 173, 174</td>
<td>205</td>
</tr>
<tr>
<td></td>
<td>017, 167</td>
<td>165</td>
</tr>
<tr>
<td></td>
<td>019, 168</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td>083, 084, 175, 176</td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>085, 169</td>
<td>375</td>
</tr>
<tr>
<td>GOB 325</td>
<td>025, 026, 177, 178</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>027, 028, 179, 180</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>089, 090, 181, 182</td>
<td>260</td>
</tr>
<tr>
<td>GOB 380</td>
<td>037, 038, 183, 184</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>039, 040, 185, 186</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>041, 101</td>
<td>185</td>
</tr>
<tr>
<td></td>
<td>043, 102</td>
<td>265</td>
</tr>
<tr>
<td></td>
<td>095, 096, 187, 188</td>
<td>245</td>
</tr>
<tr>
<td></td>
<td>097, 103</td>
<td>320</td>
</tr>
<tr>
<td>GOB 450</td>
<td>049, 050, 145, 146</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>051, 052, 147, 148</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>053, 054, 149, 150</td>
<td>245</td>
</tr>
<tr>
<td>GOB 550</td>
<td>061, 189, 062</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>063, 190, 064</td>
<td>170</td>
</tr>
<tr>
<td></td>
<td>107, 191, 108</td>
<td>210</td>
</tr>
<tr>
<td></td>
<td>065, 142</td>
<td>170</td>
</tr>
<tr>
<td></td>
<td>067, 143</td>
<td>195</td>
</tr>
<tr>
<td></td>
<td>109, 144</td>
<td>240</td>
</tr>
<tr>
<td>GOB 650</td>
<td>073, 192</td>
<td>205</td>
</tr>
<tr>
<td></td>
<td>075, 193</td>
<td>235</td>
</tr>
<tr>
<td></td>
<td>113, 194</td>
<td>280</td>
</tr>
<tr>
<td>GOB 750</td>
<td>077, 104</td>
<td>205</td>
</tr>
<tr>
<td></td>
<td>078, 105</td>
<td>235</td>
</tr>
<tr>
<td></td>
<td>079, 106</td>
<td>275</td>
</tr>
<tr>
<td>GOB 1050</td>
<td>281</td>
<td>310</td>
</tr>
<tr>
<td></td>
<td>280</td>
<td>367</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).

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

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.

5. Measure the capacitance \(C_1\) between the outer terminal and the stud (1).

   **NOTE!**
   Refer to the table for the nominal capacitance \(C_1\), Nominal capacitance, page 43.

6. Measure the capacitance \(C_2\) between the stud (1) and the flange.

   **NOTE!**
   Record the capacitance \(C_2\) for future reference.

7. 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.

8. 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, $U = R \times I$. $(U$: Measured voltage drop; $I$: Through-current; $R$: Total circuit resistance).

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 draw rod is 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!
No work at all may be performed on the bushing while it is energized or ungrounded.

ℹ️ NOTE!
For bushings with oil-level sight glass, it is recommended to check the oil-level at plant supervision.

Cleaning of the insulator surface
If the insulator shed 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 insulator sheds with a high pressure water jet. This can cause damage to the insulator sheds.

Measurement of capacitance and dissipation factor
Please refer to Measurement of capacitance and dissipation factor, page 43.

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. Refer to Measurement of capacitance and dissipation factor, page 43.
6.2 Taking an oil sample

Overview

Taking oil samples is generally not recommended.

Take an oil sample only if a problem is known, for example a high power factor over $C_1$, or visible oil leakage. For more information, please refer to product information 2750 515-142 "Bushing diagnostics and conditioning".

NOTE!

Procedure

1. Remove the oil-plug at the top of the bushing (4).

   CAUTION!
   Install the oil-plug as soon as possible, contamination can enter the bushing.

2. Suck the oil sample from the bushing through a rubber hose with a syringe, or a pump.

   CAUTION!
   Do not use a metal pipe to suck the oil. A metal pipe can cause damage to the inner parts of the bushing.
3. Install the oil plug (4) with a new gasket, and tighten the oil plug.

Gasket part number: 2152 899-132

<table>
<thead>
<tr>
<th>Gasket</th>
<th>d (mm)</th>
<th>D (mm)</th>
<th>T (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M8</td>
<td>8</td>
<td>16</td>
<td>3</td>
</tr>
</tbody>
</table>

Torque
M8: 20 Nm

End of instruction
6.3 Checking the oil-level

Overview

Procedure, with sight-glass

1. Check the oil-level.
   - If the bushing has one oil-level sight glass: the correct oil-level is in the middle of the sight glass.
   - If the bushing has two oil-level sight glasses: the correct oil-level is between the two sight glasses.

2. If the oil-level is low, fill the bushing with transformer oil.
   1. Remove the oil-plug (9).
   2. Fill the bushing with transformer oil.
   3. Install and tighten the oil-plug (9).
      Use a new gasket, part number: 2750 515-142.

   CAUTION!
   Be careful when the oil-plug is removed, contamination can enter the bushing.

   CAUTION!
   Do not use a pipe to fill the bushing with transformer oil, it can cause damage to the parts in the bushing.
   Use a plastic or rubber hose.

Procedure without sight level glass

1. Remove the oil-plug (9).

   CAUTION!
   Be careful when the oil-plug is removed, contamination can enter the bushing.
2. With a clean dipstick, check the oil-level (10).

<table>
<thead>
<tr>
<th>Type</th>
<th>Oil-level A @ 20 °C</th>
<th>Temperature correction mm/10 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fig A</td>
<td>Fig B</td>
</tr>
<tr>
<td>250</td>
<td>110 ±8</td>
<td>165 ±10</td>
</tr>
<tr>
<td>325</td>
<td>110 ±8</td>
<td>165 ±10</td>
</tr>
<tr>
<td>380</td>
<td>110 ±8</td>
<td>165 ±10</td>
</tr>
<tr>
<td>450</td>
<td>110 ±8</td>
<td>165 ±10</td>
</tr>
<tr>
<td>550</td>
<td>170 ±10</td>
<td>270 ±15</td>
</tr>
<tr>
<td>650</td>
<td>175 ±10</td>
<td>175 ±15</td>
</tr>
<tr>
<td>750</td>
<td>275 ±15</td>
<td>333 ±15</td>
</tr>
</tbody>
</table>

3. If the oil-level is low, fill the bushing with transformer oil.

1. Fill the bushing with transformer oil.
2. Install and tighten the oil-plug (9).
   Use a new gasket, part number: 2750 515-142.

   **CAUTION!**
   Do not use a pipe to fill the bushing with transformer oil, it can cause damage to the parts in the bushing. Use a plastic or rubber hose.

End of instruction
7 Re-packing

7.1 Removal of horizontally installed bushings

Overview

This procedure applies to bushings that are connected to the transformer oil-system. It is important to remove a small quantity of transformer oil to make space for thermal expansion.

Procedure

1. Remove the bushing from the transformer.

2. Drain a small quantity of transformer-oil.

3. Install the blanking plate (1) and the gasket (2) over the oil-passage.

   ![Diagram](image)

   **Torque**
   M12 50 ±5 Nm

4. Put the bushing in the vertical position.

5. Remove the oil-plug (9).

   ![Diagram](image)
6. Remove transformer oil until the oil-level is correct for storage.
   - Bushings with one sight-glass: the correct oil-level is in the middle of the sight-glass.
   - Bushings without sight-glasses: check the oil-level through the oil-filling hole (9), with a dry and clean dip-stick.

   **NOTE!**
   The values in the table apply to bushings without sight-glasses.

<table>
<thead>
<tr>
<th>Type</th>
<th>Oil-level at 20 ±10 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without top-housing (mm)</td>
</tr>
<tr>
<td>GOB 250-450</td>
<td>110 ±8</td>
</tr>
<tr>
<td>GOB 550</td>
<td>170 ±10</td>
</tr>
<tr>
<td>GOB 650</td>
<td>175 ±10</td>
</tr>
<tr>
<td>GOB 750</td>
<td>275 ±15</td>
</tr>
</tbody>
</table>

7. Install and tighten the oil-plug (9). Use a new gasket.
   Gasket part number: 2152 899-132

   **CAUTION!**
   Use only a gasket that is made from nitrile rubber, with a hardness of 70 shore. Other materials will cause oil-leakage.

<table>
<thead>
<tr>
<th>Gasket</th>
<th>d (mm)</th>
<th>D (mm)</th>
<th>T (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M8</td>
<td>8</td>
<td>16</td>
<td>3</td>
</tr>
</tbody>
</table>

End of instruction
7.2 Re-packing of the bushing

Overview

Procedure

1. Lift the bushing. Refer to *Lifting the bushing out of the transport box*, page 16.

2. Lower the bushing into the transport box.

   **CAUTION!**

   Make sure that there is soft bedding in the transport box.

   **CAUTION!**

   Make sure that the oil-valves and voltage 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 of the transport box*, page 15 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.
9 Disposal and environmental information

9.1 Overview

This chapter specifies the materials used in the bushing. Obey 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 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 experience in each country. Non-recyclable components should be sent to an approved environmental waste treatment plant for destruction or disposal.

The bushing has these parts and materials

- The current path is made of aluminum or copper alloy.
- Terminals are made of copper, brass, or low-alloy aluminum. Aluminum terminals can be plated with silver, tin, gold, or nickel in layer thickness up to 20 μm.
- Gaskets are made of rubber.
- Transformer oil, refer to IEC 60296, class 2.
- Insulators are made of porcelain.
- The mounting flange is made of corrosion-resistant aluminum alloy.
- The flange extension is made of corrosion-resistant aluminum alloy.
- The condenser core is made of paper, 1 % aluminum foil (by weight), 2 g of carbon and 1 g of lead.
- The end shield is made of corrosion-resistant aluminum alloy.
- The top-housing and top-washer are made of corrosion-resistant aluminum alloy.
- The oil-level sight glass is made of glass, and its press-ring is made of brass.
- The cover for the test tap is made from stainless steel.

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 company, or sorted into different component materials for correct treatment.
**Metals**

Metals should be sorted according to type and surface coating, and sent to an approved recycling company. 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 paths, contacts and cables. Some contacts are silver-plated. Fumes from some metals may cause environmental damage, this applies to copper, 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 company. 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 company. 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.