Transformer bushing, type GSB
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.</td>
</tr>
<tr>
<td></td>
<td>If work must be done close to live plant components, make sure that</td>
</tr>
<tr>
<td></td>
<td>the safety distance is in compliance with the applicable safety</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>Transformer oil is dangerous. Fumes from hot oil can cause irritation</td>
</tr>
<tr>
<td></td>
<td>to the respiratory organs and the eyes. Long and repeated contact</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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 GSB 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) or porcelain 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, 1ZSC000563-AAC.

General schematics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Outer terminal</td>
</tr>
<tr>
<td>2</td>
<td>Insulator of silicone rubber or porcelain</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>End shield</td>
</tr>
<tr>
<td>6</td>
<td>Test/voltage tap</td>
</tr>
</tbody>
</table>
The bushing can be configured with one of three terminal systems: the draw-lead system, the draw-rod system, or the fixed bottom contact system.

<table>
<thead>
<tr>
<th>Terminal system</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed bottom contact</td>
<td>-</td>
</tr>
<tr>
<td>Draw lead</td>
<td>-</td>
</tr>
<tr>
<td>Draw rod</td>
<td>Bottom contact type 1</td>
</tr>
<tr>
<td></td>
<td>Bottom contact type 2</td>
</tr>
</tbody>
</table>

1. Draw lead
2. Draw rod with bottom contact
3. Fixed bottom contact
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.
Voltage tap

The voltage tap is available as an option, instead of the test tap. The bushing has a voltage tap that is connected to the second outermost conductive layer of the condenser core. The voltage 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 voltage tap is 20 kV\textsubscript{rms}. The voltage tap can be used as a power source, if it is connected to an external capacitance. The operating voltage is limited to 6 kV.

⚠️ **CAUTION!**

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

---

**Stud**

**Cover**

**Grounding spring**

**O-ring**

---

**Test adapter, 2769 522-C, optional equipment**

The test adapter 2769 522-C is available for permanent connection to measuring circuits. Please refer to Test adapter – Technical guide 1ZSC000563-ACS and Installation and maintenance guide 1ZSC000563-ACD.
## 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>• Resin impregnated paper, capacitance graded, oil immersed.</td>
<td></td>
</tr>
<tr>
<td>• For outdoor and indoor use.</td>
<td></td>
</tr>
<tr>
<td>• Temperature class E (120 °C) according to IEC 60137.</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 in applicable parts.)</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 normal load: +100 °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 25 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>From horizontal to vertical.</td>
</tr>
<tr>
<td>Test tap:</td>
<td>According to IEEE potential tap type A. ( U_t ) = max 600 V.</td>
</tr>
<tr>
<td>Voltage tap:</td>
<td>According to IEEE potential tap type A. ( U_t ) = 6 kV.</td>
</tr>
<tr>
<td>Capacitance ( C_2 ) of test tap:</td>
<td>&lt;5000 pF</td>
</tr>
<tr>
<td>Capacitance ( C_2 ) of voltage tap:</td>
<td>Refer to Measurement of capacitance and dissipation factor, page 48.</td>
</tr>
<tr>
<td>Arcing horns:</td>
<td>N/A</td>
</tr>
<tr>
<td>Conductor:</td>
<td>Center-tube conductor, or draw lead.</td>
</tr>
<tr>
<td>Markings:</td>
<td>Conforming to IEC/IEEE.</td>
</tr>
</tbody>
</table>
List of bushings applicable to this installation guide

<table>
<thead>
<tr>
<th>Type</th>
<th>Article number</th>
<th>Article number</th>
<th>Article number</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSB 245/2000/0.3</td>
<td>1ZSC901245-AAA</td>
<td>1ZSC901245-ABA</td>
<td>1ZSC901245-BAA</td>
</tr>
<tr>
<td></td>
<td>1ZSC901245-BBA</td>
<td>1ZSC901245-CAA</td>
<td>1ZSC901245-CBA</td>
</tr>
<tr>
<td>GSB 245/2000/0.6</td>
<td>1ZSC901245-AAB</td>
<td>1ZSC901245-ABB</td>
<td>1ZSC901245-BAB</td>
</tr>
<tr>
<td></td>
<td>1ZSC901245-BB</td>
<td>1ZSC901245-CAB</td>
<td>1ZSC901245-CBB</td>
</tr>
<tr>
<td>GSB 245/3150/0.3 Cu</td>
<td>1ZSC901245-ACA</td>
<td>1ZSC901245-ADA</td>
<td>1ZSC901245-BCA</td>
</tr>
<tr>
<td></td>
<td>1ZSC901245-DA</td>
<td>1ZSC901245-CDA</td>
<td>1ZSC901245-CBA</td>
</tr>
<tr>
<td>GSB 245/3150/0.6 Cu</td>
<td>1ZSC901245-ACB</td>
<td>1ZSC901245-ADB</td>
<td>1ZSC901245-BCB</td>
</tr>
<tr>
<td></td>
<td>1ZSC901245-BB</td>
<td>1ZSC901245-CB</td>
<td>1ZSC901245-CDB</td>
</tr>
<tr>
<td>GSB 362/1600/0.3</td>
<td>1ZSC901362-AAA</td>
<td>1ZSC901362-ABA</td>
<td>1ZSC901362-BAA</td>
</tr>
<tr>
<td></td>
<td>1ZSC901362-BA</td>
<td>1ZSC901362-CA</td>
<td>1ZSC901362-CBA</td>
</tr>
<tr>
<td>GSB 362/1600/0.6</td>
<td>1ZSC901362-ABA</td>
<td>1ZSC901362-ABB</td>
<td>1ZSC901362-BAB</td>
</tr>
<tr>
<td></td>
<td>1ZSC901362-BB</td>
<td>1ZSC901362-CA</td>
<td>1ZSC901362-CBB</td>
</tr>
<tr>
<td>GSB 362/3150/0.3 Cu</td>
<td>1ZSC901362-ACA</td>
<td>1ZSC901362-ADA</td>
<td>1ZSC901362-BCA</td>
</tr>
<tr>
<td></td>
<td>1ZSC901362-BD</td>
<td>1ZSC901362-CD</td>
<td>1ZSC901362-DCA</td>
</tr>
<tr>
<td>GSB 362/3150/0.6 Cu</td>
<td>1ZSC901362-ACB</td>
<td>1ZSC901362-ADB</td>
<td>1ZSC901362-BCB</td>
</tr>
<tr>
<td></td>
<td>1ZSC901362-BB</td>
<td>1ZSC901362-CC</td>
<td>1ZSC901362-CDB</td>
</tr>
<tr>
<td>GSB 420/1600/0.3</td>
<td>1ZSC901420-AAA</td>
<td>1ZSC901420-ABA</td>
<td>1ZSC901420-BAA</td>
</tr>
<tr>
<td></td>
<td>1ZSC901420-BA</td>
<td>1ZSC901420-CA</td>
<td>1ZSC901420-CBA</td>
</tr>
<tr>
<td>GSB 420/1600/0.6</td>
<td>1ZSC901420-AAB</td>
<td>1ZSC901420-ABB</td>
<td>1ZSC901420-BAB</td>
</tr>
<tr>
<td></td>
<td>1ZSC901420-BB</td>
<td>1ZSC901420-CA</td>
<td>1ZSC901420-CBB</td>
</tr>
<tr>
<td>GSB 420/2500/0.3 Cu</td>
<td>1ZSC901420-CA</td>
<td>1ZSC901420-CD</td>
<td>-</td>
</tr>
<tr>
<td>GSB 420/2500/0.6 Cu</td>
<td>1ZSC901420-CCB</td>
<td>1ZSC901420-CDB</td>
<td>-</td>
</tr>
<tr>
<td>GSB 550/1600/0.3</td>
<td>1ZSC901550-AAA</td>
<td>1ZSC901550-ABA</td>
<td>1ZSC901550-DAA</td>
</tr>
<tr>
<td></td>
<td>1ZSC901550-DA</td>
<td>1ZSC901550-BAA</td>
<td>1ZSC901550-BBA</td>
</tr>
<tr>
<td></td>
<td>1ZSC901550-EB</td>
<td>1ZSC901550-CA</td>
<td>1ZSC901550-FA</td>
</tr>
<tr>
<td>GSB 550/1600/0.6</td>
<td>1ZSC901550-AAB</td>
<td>1ZSC901550-ABB</td>
<td>1ZSC901550-DAB</td>
</tr>
<tr>
<td></td>
<td>1ZSC901550-DB</td>
<td>1ZSC901550-BB</td>
<td>1ZSC901550-BBA</td>
</tr>
<tr>
<td></td>
<td>1ZSC901550-EB</td>
<td>1ZSC901550-CA</td>
<td>1ZSC901550-FA</td>
</tr>
<tr>
<td>GSB 550/2500/0.3 Cu</td>
<td>1ZSC901550-CA</td>
<td>1ZSC901550-CD</td>
<td>-</td>
</tr>
<tr>
<td>GSB 550/2500/0.6 Cu</td>
<td>1ZSC901550-CB</td>
<td>1ZSC901550-CF</td>
<td>-</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 (3) of the outer terminal or below. The bushing can be installed in all positions from horizontal to vertical.

In the axial direction, the bushing can withstand a static load of 20 kN. The maximum static torque on the outer terminal stud cannot be more than 200 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.

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum cantilever load in operation at installation angle (N)</th>
<th>Maximum cantilever test load (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0°</td>
<td>90°</td>
</tr>
<tr>
<td>GSB 245</td>
<td>2800</td>
<td>2000</td>
</tr>
<tr>
<td>GSB 362</td>
<td>6000</td>
<td>4000</td>
</tr>
<tr>
<td>GSB 420</td>
<td>6500</td>
<td>4000</td>
</tr>
<tr>
<td>GSB 550</td>
<td>6500</td>
<td>4000</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.

NOTE!
The bushing has been routine tested in oil, and there can be small quantities of oil remaining on the oil-side of the bushing. Vaseline is used for lubrication of threads, and at some temperatures Vaseline can appear as oil.

3.2 Transportation

• The bushing must be transported in the transport box.
• The transport container must be attached to the bushing, replace the drying agent if the transport container has been opened.
• The bushing must be transported in the horizontal position, with support over at least 75% of the length of the transport box.
• 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 transport container must be attached to the bushing, replace the drying agent if the transport container has been opened.
  – As an alternative, the moisture-barrier RIPCOAT can be used when the transport container is not attached.
• 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.
- The transport container must be attached to the bushing, replace the drying agent if the transport container has been opened.
- 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

![Diagram of lifting points](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 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.

2. Open the transport box.

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

3. Attach a soft lifting sling to the flange 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 (1) and then to the crane hook.

5. Carefully lift the bushing.

6. Lower the bushing onto soft bedding.

   **CAUTION!**
   Do not apply force to the silicone insulator, deformation will occur.

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>9760 667-A</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>Pull-through cord</td>
<td>9760 669-A</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>Shackles</td>
<td>-</td>
<td>To fit Ø 25 mm holes, for connection of the soft lifting slings to the bushing flange.</td>
</tr>
<tr>
<td>Hydraulic jack</td>
<td>2769 897-A</td>
<td>For removal, and installation of the bottom contact. Draw-rod system.</td>
</tr>
<tr>
<td>Box spanner</td>
<td>9760 669-B</td>
<td>For removal, and installation of the bottom contact. Draw-rod system.</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>
<tr>
<td>Thread-locking fluid grade 42</td>
<td>-</td>
<td>-</td>
<td>High strength thread-locking fluid, permanent locking.</td>
</tr>
</tbody>
</table>
4.3 General preparations

4.3.1 Installation of lifting tools

Overview

1. Lifting tool
2. Soft bedding, i.e. rubber mat or woodboard
3. Lifting eye

Procedure

1. Loosen the M8 bolts (1).

NOTE!
It is not necessary to remove the M8 bolts.
2. Remove the M10 bolts (6) and washers (7), and then remove the outer terminal.

**NOTE!**
Keep the outer terminal (5), washers (7) and bolts (6), they will be used again.

3. If the bushing has the draw-lead system, remove the divided ring (8) and the inner terminal (9).

4. Install the lifting tool (1), the M10 bolts (6) and the washers (7).

**NOTE!**
Align the lifting tool with the lifting-eyes on the flange.

End of instruction
4.4 Preparations at the transformer factory for draw rod

4.4.1 Removal of the lower draw rod with bottom contact from the bushing

Overview

The bottom contact is usually installed in the bushing when it is delivered from ABB, the first step at the transformer factory is thus to remove it.

Procedure

1. Remove the transport container.

   CAUTION!
   Do not cause damage to the RIP-core when removing the transport container.
2. Put the pull-through cord (12) through the box-spanner (13).

**NOTE!**
The terminal on the pull-through cord (12) has M8 threads.

3. Apply Vaseline to the threads on the pull-through cord (12), then connect it to the upper draw rod.

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

4. Remove the M16 nut (10) and washer (11), on the draw rod with the box spanner.

**CAUTION!**
Do not remove the compensation device.

**NOTE!**
Keep the draw-rod nut (10) and washer (11), they will be used again.
5. Pull down the draw rod from the bottom end of the bushing, and disassemble it at the lower joint (8).

**CAUTION!**
Do not disassemble the joint (7), this increases the risk of incorrect assembly.

The joint (7) is locked with high strength thread-locking fluid grade 70.

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

---

**4.4.2 Installation of the large bottom contact in the transformer**

**Overview**

1. Large bottom contact
Procedure

1. Remove the transformer cover (13) from the transformer turret (11).

2. Install the winding cables to the bottom contact.

   CAUTION!
   Make sure that there is no tension in the winding cables. Tension in the winding cables will cause damage to the bottom contact.

3. Bottom contact type 1: install the end shield.
   1. Push the end shield carefully against the pressing ring (17), until the springs are fully compressed.
   2. Turn the end shield approximately 20°, to its locked position.

4. Bottom contact type 2: install the end-shield in the three bolt holes.

   NOTE!
   The type 2 bottom contact is supplied by ABB Components when the customer supplies the end-shield.
4.5 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) to the lifting tool and to the crane hook.

   **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.

4.6 Installation with draw lead

Overview

1 Bushing
2 Inner terminal
3 Draw lead
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. Install the end shield:
   1. Push the end shield carefully against the pressing ring (17), until the springs are fully compressed.
   2. Turn the end shield clockwise approximately 20°, to its locked position.

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

**NOTE!**
The terminal (7) has M8 threads.

![Diagram](image1)

6. Hold the pull-through cord (10) 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.

![Diagram](image2)

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

![Diagram](image3)

**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](image4)

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.

![Diagram](image5)
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.

9. Put the divided ring (6) in the slot in the inner terminal (7).

10. 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.

11. Continue with *Installation of the outer terminal*, page 41.

   **End of instruction**
4.7 Installation with fixed bottom contact

Procedure

1. Make sure that there is a distance of 7 ±0.5 mm between the pressing ring (17) and the pulling ring (3).
2. Make sure with a torque wrench that the six bolts are tightened with a torque of 40 Nm.

3. Lower the bushing onto the transformer.

4. 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.
5. 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.

6. Remove the bolts (6), the washers (7) and the lifting gear (1).

7. Put the winding cables through the end-shield.
8. Install the winding cables to the bottom contact.

⚠️ **CAUTION!**
Make sure that there is no tension in the winding cables. Tension in the winding cables will cause damage to the bottom contact.

| Torque | 68 ± 6 Nm |

9. Install the end shield:
   1. Push the end shield carefully against the pressing ring (17).
   2. Turn the end shield approximately 20°, to its locked position.

End of instruction
4.8 Installation with draw rod

4.8.1 Installation of the bushing on the transformer

Overview

![Diagram of bushing installation]

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Draw-rod</td>
</tr>
<tr>
<td>10</td>
<td>Pull-through cord</td>
</tr>
</tbody>
</table>

Procedure

1. Connect the upper draw-rod (1) to the lower draw-rod (4).
   - When installing the bushing at site, apply thread-locking fluid grade 40 to the threads.
2. Hold the pull-through cord (12) in tension, while lowering 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.

3. When installing the bushing at the transformer factory:
Make permanent markings for the correct installation at site:
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.

4. 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.

Torque
Refer to the transformer manufacturers documentation.
5. Install the draw-rod nut (10):
   1. Apply a generous quantity of Molykote 1000 to the nut (10), and the threads of the draw rod.
   2. Install the washer (11) and nut (10) on the draw rod, tighten with your fingers.
   3. Remove excess Molykote 1000 with a rag.

   **CAUTION!**
   If the nut (10) is not lubricated correctly, it will not be tighten to the correct torque. This can cause the bushing to fail.

6. Tighten the draw-rod nut (10).

7. Remove the pull-through cord.

8. Remove the bolts (6), the washers (7) and the lifting gear (1).

9. Tighten the draw-rod nut, refer to *Hydraulic tightening of the draw-rod nut*, page 39, or *Manual tightening of the draw-rod nut*, page 38.

End of instruction
4.8.2 Manual tightening of the draw-rodnut

Overview

This procedure requires the draw-rodnut, washer and threads of the draw rod to be correctly lubricated. The draw rod will not get the correct tension if the fasteners are not correctly lubricated, this can cause the bushing to fail.

Procedure

1. Make sure that the draw-rodnut, and threads of the draw rod are correctly lubricated, and that the draw-rodnut is tightened to 10 Nm.

2. Measure the distance (a).

   NOTE!
   The bushing is delivered with an information sheet that specifies the measurement (b-a), and the torque of the draw-rodnut. These values are measured when the bushing is manufactured, and are unique to every unit.

3. Turn the nut clockwise until you get the correct extension (b).

   Distance (b) = (a) + extension, refer to the table.

   CAUTION!
   Make sure that you do not overtighten the nut. Use a torque wrench set to 140 Nm.

   NOTE!
   One turn of the nut corresponds to a 2 mm extension of the draw rod.

<table>
<thead>
<tr>
<th>Type</th>
<th>Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSB 245</td>
<td>7.0 mm</td>
</tr>
<tr>
<td>GSB 362</td>
<td>8.5 mm</td>
</tr>
<tr>
<td>GSB 420</td>
<td>9.5 mm</td>
</tr>
<tr>
<td>GSB 550</td>
<td>12.0 mm</td>
</tr>
</tbody>
</table>

4. Make sure with a torque wrench that the nut is tightened with a torque of more than 70 Nm and less than 140 Nm.

5. Continue with Installation of the outer terminal, page 41.

End of instruction
4.8.3 Hydraulic tightening of the draw-rod nut

Overview

Procedure

1. Install the hydraulic jack (8).

2. Pull the draw rod with a force according to the table.

<table>
<thead>
<tr>
<th>Type</th>
<th>Force</th>
<th>CT 300 mm</th>
<th>CT 600 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSB 245</td>
<td>36.0 kN</td>
<td>34.5 kN</td>
<td></td>
</tr>
<tr>
<td>GSB 362</td>
<td>37.5 kN</td>
<td>36.1 kN</td>
<td></td>
</tr>
<tr>
<td>GSB 420</td>
<td>38.1 kN</td>
<td>36.5 kN</td>
<td></td>
</tr>
<tr>
<td>GSB 550</td>
<td>38.5 kN</td>
<td>37.3 kN</td>
<td></td>
</tr>
</tbody>
</table>

3. Tighten the nut on the draw rod with your hand.

4. Remove the hydraulic jack (8).

End of instruction
4.9 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 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.

End of instruction

---

### 4.10 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).

**CAUTION!**
Do not use a wire brush on the zinc coating on aluminium outer-terminals. A wire brush can make scratches in the zinc coating.

**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 spring washers (2), and the threads of the M8 bolts (1).

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

6. Put the outer terminal (5) on the bushing.
7. Apply Molykote 1000 to the M10 bolts (6) and plain washers (7).

8. Install the M10 bolts (6) and plain washers (7).

9. 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.

10. Tighten the M10 bolts (6) in a crosswise sequence.

    **CAUTION!**
    Make sure that the outer terminal moves straight down. Turn each bolt a little, and then the next bolt, until all bolts can be tightened to the correct torque.

    Torque
    40 ± 4 Nm
11. Tighten the M8 bolts (1).
   Tighten the bolts in a crosswise sequence.

12. 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.

13. If supplied, install the outer shield on the outer terminal:
   1. Remove three M8 bolts.
   2. Put the outer shield on the outer terminal.
   3. Install the three M8 bolts.

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

End of instruction
4.11 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 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

Many different methods can be used, and we thus refer to the instructions given by the company responsible for field erection.

For example, the tightness of the seal between the transformer and the bushing flange can be examined when the transformer is oil-filled, with chalk or 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/voltage tap. Refer to 2750 515-142, “Bushing diagnostics and conditioning”.

- \( C_1 \) is the capacitance between the test/voltage tap and the outer terminal.
- \( C_2 \) is the capacitance between the test/voltage 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>Space for CT = 300 mm</th>
<th>Space for CT = 600 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$C_1$</td>
<td>$C_2$ (test tap)</td>
</tr>
<tr>
<td>GSB 245</td>
<td>633</td>
<td>&lt;5000</td>
</tr>
<tr>
<td>GSB 362</td>
<td>619</td>
<td>&lt;5000</td>
</tr>
<tr>
<td>GSB 420</td>
<td>579</td>
<td>&lt;5000</td>
</tr>
<tr>
<td>GSB 550</td>
<td>553</td>
<td>&lt;5000</td>
</tr>
</tbody>
</table>

Dissipation factor, $\tan \delta$

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>
</tr>
<tr>
<td>18-22</td>
<td>1.00</td>
</tr>
<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>
</tr>
<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 (C₁) between the outer terminal and the stud (1).
   - Record the capacitance (C₁) for future reference.

   **NOTE!**
   Refer to the table for the nominal capacitance (C₁), Nominal capacitance, page 49.

6. Measure the capacitance (C₂) between the stud (1) and the flange.
   - Record the capacitance (C₂) for future reference.

7. Measure the dissipation factor:
   1. Start the measurements with a low sensitivity setting on the measuring bridge.
   2. Gradually increased 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 δ, page 49.

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

**CAUTION!**
The voltage tap is not self-grounding!

The bushing can be destroyed if the voltage tap is not grounded. Because the capacitance \( C_2 \) is usually relatively small, the voltage 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.

---

### 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, \( R = \frac{U}{I} \).

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

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 150 \( \mu \Omega \). Because the through-resistance of the HV winding of a typical power transformer is in the order of 0.1 to 1 \( \Omega \), 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


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.

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 48.
7 Re-packing

7.1 Removal of the bushing from the transformer, fixed bottom contact

Procedure

1. Install the lifting tool, refer to *Installation of lifting tools*, page 20.

2. Remove the end shield:
   1. Push the end shield carefully against the pressing ring (17).
   2. Turn the end shield approximately 20°, and lower it.

3. Remove the winding cables from the bottom contact.
4. Remove the bolts and washers.

5. Carefully lift the bushing from the transformer.

⚠️ **CAUTION!**
Do not cause damage to the stud bolts, there is a risk of metal falling into the transformer.

6. Install the transport cover (13) on the transformer turret (11).

7. Lower the bushing to the floor.

⚠️ **CAUTION!**
Make sure that there is soft bedding, or support blocks on the floor.

End of instruction

### 7.2 Removal of the bushing from the transformer, draw lead

**Procedure**

1. Install the lifting tool, refer to *Installation of lifting tools, page 20.*
2. Put the pull-through cord (12) through the box-spanner (13).

**NOTE!**
The terminal on the pull-through cord (12) has M8 threads.

3. Apply Vaseline to the thread on the pull-through cord (12), then connect it to the inner terminal.

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

4. Carefully lift the inner terminal (7) and remove the divided ring (6).
5. Remove the bolts and washers.

6. Carefully lift the bushing from the transformer.

**CAUTION!**
Do not cause damage to the stud bolts, there is a risk of metal falling into the transformer.

7. Attach the inner terminal (7) to the transformer turret (11).
8. Install the transport cover (13) on the transformer turret (11).

9. Lower the bushing to the floor.

**CAUTION!**
Make sure that there is soft bedding, or support blocks on the floor.

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**7.3 Removal of the bushing from the transformer, draw rod**

**Procedure**

1. Install the lifting tool, refer to *Installation of lifting tools*, page 20.

2. Put the pull-through cord (12) through the box-spanner (13).

**NOTE!**
The terminal on the pull-through cord (12) has M8 threads.
3. Apply Vaseline to the thread on the pull-through cord (12), then connect it to the draw rod.

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

4. Remove the M16 nut (10) on the draw rod with the box spanner (13).

5. Remove the bolts and washers.
6. Hold the pull-through cord (12) in tension, while lifting the bushing from the transformer.

7. Disassemble the draw rod at the lower joint (8).

Use the key grip on the lower draw rod.

**DANGER!**
Make sure that the upper draw rod does not fall down when the lower joint (8) is disassembled.

**CAUTION!**
Do not disassemble the joint (7), this increases the risk of incorrect assembly.

The joint (7) is locked with tread-locking fluid grade 70.

8. Pull up the draw rod, and install the washer (11) and nut (10).

**CAUTION!**
Make sure that the centering ring (28) is in position, it is necessary for the correct installation of the draw rod.

9. Remove the pull-through cord.

10. Lower the bushing to the floor.

**CAUTION!**
Make sure that there is soft bedding, or support blocks on the floor.
11. Install the lower draw rod (4) in the transport cover (13).

12. Install the transport cover (13) on the transformer turret (11).

End of instruction

7.4 Re-packing of the bushing

Overview
Procedure

1. Install the transport container (1):
   1. Replace the drying agent in the transport container (1).
   2. Install the gasket (2).
   3. Carefully put the transport container on the bushing, and install the bolts.

   ! CAUTION!
   Make sure that the transport container does not cause damage to the condenser core.

Torque
50 Nm

2. Lift the bushing. Refer to Lifting the bushing out of the transport box, page 17.

3. Lower the bushing into the transport box.

   ! CAUTION!
   Make sure that the support blocks are in the correct positions in the transport box.
   Make sure that the there is soft bedding in the transport box.

   ! CAUTION!
   Make sure that the test/voltage tap does not make contact with the transport box, or other objects.

4. 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.

5. Close the transport box.

   NOTE!
   Refer to Lifting the transport box, page 16 and Transportation, page 15.

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. 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.

The bushing has these parts and materials
• The conductor is made of low-alloy aluminum.
• The terminals are made of copper, or low-alloy aluminum.
• The bottom contact is made of copper.
• The bushing flange, outdoor housing, tap cover, and end-shield are made of aluminum.
• The insulator shed is made of silicone rubber.
• The condenser core is made of paper, 1 % aluminum foil (by weight), 2 g of carbon and 1 g of lead.

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.
10 References

10.1 Summary

- Markings: Conforming to IEC/IEEE.
- Bushing diagnostics and conditioning, 2750 515-142.
- Test adapter, Installation and maintenance guide, 1ZSC000563-ACD.
- Transformer oil, IEC 60296, class 2.
- Handling and Cleaning of Composite Insulators, ABB Composites MB2193.