Test adapter
Installation and maintenance guide
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1 Safety

1.1 Levels of safety risks

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

Symbols and their meanings

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

DANGER!

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

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

CAUTION!

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

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

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

NOTE!

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

Torque

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

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

### 1.3 Safety precautions

<table>
<thead>
<tr>
<th>Precaution</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer oil</td>
<td>Collect used transformer oil in drums. Transformer oil is dangerous. Fumes from hot oil can cause irritation to the respiratory organs and the eyes. Long and repeated contact with transformer oil can cause damage to your skin.</td>
</tr>
<tr>
<td>SF₆ gas</td>
<td>SF₆ gas must be recycled and never released into the atmosphere.</td>
</tr>
<tr>
<td>Waste and cleaning up</td>
<td>Clean up liquid waste with an adsorbent. Treat waste as hazardous to the environment.</td>
</tr>
<tr>
<td>Fire</td>
<td>Extinguish fires with powder, foam or carbon dioxide.</td>
</tr>
</tbody>
</table>
2 Product description

2.1 Design

Overview

The test adapter from ABB Components can permanently connect the tap on the bushing to measuring equipment, for monitoring of the bushing during service.

All transformer bushings and some wall bushings that are manufactured by ABB Components, are capacitance-graded bushings that are equipped with a voltage tap or test tap.

Tap types

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Large tap. Voltage tap (two connected layers), or test tap (one connected layer).</td>
</tr>
<tr>
<td>B</td>
<td>Small tap. Test tap (one connected layer).</td>
</tr>
<tr>
<td>3</td>
<td>Cover</td>
</tr>
<tr>
<td>4</td>
<td>Stud</td>
</tr>
<tr>
<td>5</td>
<td>Grounding spring</td>
</tr>
<tr>
<td>6</td>
<td>O-ring</td>
</tr>
</tbody>
</table>

![Diagram of test adapter showing components labeled A and B with numbers 3, 4, 5, and 6.](image)
### Test adapter, 2769522-C

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Terminal box</td>
</tr>
<tr>
<td>2</td>
<td>Plug</td>
</tr>
<tr>
<td>3</td>
<td>Cover*</td>
</tr>
<tr>
<td>4</td>
<td>Nut</td>
</tr>
</tbody>
</table>

*This cover is installed on the bushing on delivery from ABB.*

### Test adapter, 1ZSC003881-AAC

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Terminal cover</td>
</tr>
<tr>
<td>2</td>
<td>Extension</td>
</tr>
<tr>
<td>3</td>
<td>Plug</td>
</tr>
</tbody>
</table>
2.2 Usage

Overview

Use the test adapter only as described in this installation and maintenance guide, and obey the limitations of the test adapter. Refer to Description and limitations of the tap, page 9.

Grounding

The tap is not self grounding, and must always be grounded or connected to an external impedance. Because $C_2$ usually is relatively small, the test tap must never be open-circuited when the bushing is energized.

If the tap is not grounded when the bushing is energized, failure of the bushing will occur.

**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.

2.3 Description and limitations of the tap

Overview

The values of impedance for the main insulation and the tap are unique to every bushing. Refer to the rating plate on the bushing or to the bushing installation and maintenance guide.

The value of the capacitance $C_2$ depends on the design of the bushing and on its installation, and can thus vary more or less. The capacitance $C_2$ should be measured after installation of the bushing, to get an accurate value.

**CAUTION!**

Do not connect a circuit that overloads test adapter. This will lead to partial discharge in the bushing, which will cause damage to the bushing.

**NOTE!**

The test adapter limits the amount of power that can be passed through the tap, despite a higher capacity of the tap.

---

*The connected circuit is the equipment and cables that are connected to the test adapter.*
## Limitation of the connected circuit

| Maximum allowed voltage, $U_{2}$: | At service voltage: 110 V  
At lightning impulse: 200 V |
|----------------------------------|-----------------------------|
| Maximum inductive and/or resistive loads, $Z$: | $\omega L = 100 \, \text{m}\Omega$  
$R = 100 \, \text{m}\Omega$ |

<table>
<thead>
<tr>
<th>Unit</th>
<th>Definition</th>
</tr>
</thead>
</table>
| $C_1$ | Capacitance 1 in condenser core, [F]  
Refer to the test report for the bushing. |
| $C_2$ | Capacitance 2 in condenser core, [F]  
Refer to the test report for the bushing when it was installed on the transformer. |
| $U_2$ | Tap voltage, [V] |
| $U_{2\text{max}}$ | The maximum service voltage, [V] |
| $U_1$ | Voltage between outer terminal and earth, [V] |
| $R$ | Resistance, [Ω] |
| $Z$ | Impedance, [Ω] |
| $\omega$ | Angular velocity for AC voltage [rad/s] |
| $L$ | Inductance, [H] |
| $\omega L$ | Inductive reactance, [Ω] |
| $Z$ | Inductive and/or resistive loads, [Ω] |
3 Delivery

3.1 Incoming inspection

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

3.2 Transportation

Keep the test adapter in the original packaging during transportation.

3.3 Storage

Keep the test adapter in the original packaging until installation.
The test adapter must be stored indoors, in a controlled temperature with low humidity.
4 Installation

4.1 Tools

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque wrench</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Crosshead screwdrivers</td>
<td>-</td>
<td>Phillips type and Pozidriv type.</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>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 Installation of the test adapter, 1ZSC003881-AAC

Overview

DANGER!
Risk of death to personnel!

Make sure that the bushing is de-energized and out of service.

Make sure that the high-voltage parts are visibly grounded, before removing the cover on the tap.

CAUTION!
Do not energize the bushing without a test adapter (4) or the cover (1) installed. The bushing is grounded through the test adapter (4) or cover (1) and this prevents damage to the bushing.

Procedure

1. Remove the cover (1).
2. Remove the protective cap (6).

3. Apply Mobilgrease 28 to the O-ring (2) and the threads of the test adapter (4).

4. Put the O-ring (2) in the groove in the test adapter (4).

5. Install the test adapter (4), and tighten it.

Torque
15 Nm

End of instruction
4.4 Installation of electrical circuits, 1ZSC003881-AAC

Procedure

1. Remove the terminal cover (5), and the O-ring (7).

2. Apply Mobilgrease 28 to the O-ring (7) and put it in the groove.

3. Remove the grounding cable (6).
4. Remove the plug (11).

5. Put the signal cable through the cable gland (9).

**CAUTION!**
Make sure that the seal (8) has a correct seal against the signal cable. An incorrect seal will cause water to leak into the terminal cover.

**NOTE!** If the bushing is used outdoors: the cable gland must be of IP67 classification or better, and have a rubber seal (8).

**NOTE!** The cable gland must have PR 16 threads.

6. Install the cable gland (9) to the terminal cover (5).
7. Install the signal cable for the measuring equipment, refer to the instructions from the manufacturer.

**CAUTION!**
Use a signal cable of sufficient size for the amperage and voltage. Make sure that the signal cable is rated for outdoor use, and that it has the correct shielding for this application.

8. Make sure that the measuring equipment receives signals correctly.

9. Apply Mobilgrease 28 to the threads of the terminal cover (5), and install it.

**CAUTION!**
Make sure that the terminal cover seals correctly. An incorrect seal will cause water to leak into the test adapter.

10. Make sure that the flexible rubber seal (8) has a correct seal against the signal cable.

**CAUTION!**
An incorrect seal will cause water to leak into the test adapter.

End of instruction
4.5 Installation of the test adapter, 2769522-C

Overview

**DANGER!**
Risk of death to personnel!
Make sure that the bushing is de-energized and out of service.
Make sure that the high-voltage parts are visibly grounded, before removing the cover on the tap.

**CAUTION!**
Do not energize the bushing without the cover (1) installed. The bushing is grounded through the cover and this prevents damage to the bushing.

Procedure

1. Remove the cover (1).
2. With the screws (5), adjust the nut (2) to a distance of 1.5 mm (±0.5 mm) from the terminal box (4).

3. Apply Mobilgrease 28 to the O-ring (3), and put it in the groove (7) in the terminal box.

   **CAUTION!**
   Do not remove the plug (11) until the measuring circuits are installed. Moisture will enter the terminal box.

4. Install the test adapter (8).
5. Tighten the four screws (5).

6. Make sure that the O-ring seals correctly.

   **CAUTION!**
   An incorrect seal will cause water to leak into the terminal box.

7. Apply Mobilgrease 28 to the threads on the cover (1), and then install the cover (1).

   **CAUTION!**
   Do not energize the bushing without the cover (1) installed. The bushing is grounded through the cover and this prevents damage to the bushing.

End of instruction
4.6 Installation of electrical circuits, 2769522-C

Procedure

1. Remove the cover (1).

2. Remove the grounding cable (6).

3. Remove the plug (11).
4. Install a cable gland (9).

**NOTE!**
If the bushing is used outdoors: the cable gland must be of IP67 classification or better, and have a flexible rubber seal (8).

**NOTE!**
The cable gland (9) must have PG 22.5 threads.
Available space for the cable gland is Ø36 mm.

5. Install the signal cable for the measuring equipment, refer to the instructions from the manufacturer.

**CAUTION!**
Use a signal cable of sufficient size for the amperage and voltage. Make sure that the signal cable is rated for outdoor use, and that it has the correct shielding for this application.

6. Make sure that the measuring equipment receives signals correctly.

7. Make sure that the flexible rubber seal (8) has a correct seal against the signal cable.

**CAUTION!**
An incorrect seal will cause water to leak into the terminal box.
8. Apply Mobilgrease 28 to the O-ring (7) and put it in the groove.

9. Apply Mobilgrease 28 to the threads on the cover (1), and then install it.

Torque
62 Nm

End of instruction
5 Commissioning

5.1 Output error sources

The permittivity increases with temperature. The increase is maximum $0.5 \times 10^{-3} \text{[K}^{-1}]$ relative increase for OIP, and for RIP the change of permittivity is maximum $1.5 \times 10^{-3} \text{[K}^{-1}]$ in the interval from 20 °C to 110 °C.

Losses vary with temperature. For correction of losses, refer to the instruction Bushing diagnostics and conditioning Product information 2750 515-142.

Lab/production measured values may differ from site measurements because of different ground plane conditions etc. The typical relative error is <1 %.

Additional error sources are the tolerances in the measuring equipment, and the timing when the operator reads the output.

5.2 Insulation test

1. Do an insulation test according to ABB:s installation and commissioning guide for the specific bushing.

   CAUTION!
   Do not energize the bushing without the test adapter, or the cover installed. The cover connects the bushing to ground, and will prevent damage to the bushing.

End of instruction
6 Disposal and environmental information

6.1 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.

6.2 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 amount 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.

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. Following the removal of any paint or other surface coating, 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 amounts 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 designed 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 various purposes.

Rubber is used in various seals.

Other materials

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

7.1 Summary

- IEEE standard performance characteristics and dimensions for outdoor apparatus bushings
  IEEE C57.19.01-1991
- Bushing diagnostics and conditioning, ABB document 2750 515-142