2750 515-12 en, Rev. 9

Transformer bushings, type GOB
Installation and maintenance guide

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Safety information

Keep this instruction available to those responsible for the installation, maintenance, and operation of the bushing.

The installation, operation, and maintenance of a bushing present numerous potential unsafe conditions, including, but not limited to, the following:

- High pressures
- Lethal voltages
- Moving machinery
- Heavy components
- Slip, stumble or fall

Specialized procedures and instructions are required and must be adhered to when working on such apparatus. Failure to follow the instructions could result in severe personal injury, death, and/or product or property damage.

Additionally, all applicable safety procedures such as regional or local safety rules and regulations, safe working practices, and good judgement must be used by the personnel when installing, operating, maintaining and/or disposing such equipment.

Safety, as defined in this instruction, involves two conditions:

1. Personal injury or death.
2. Product or property damage (includes damage to the bushing or other property, and reduced bushing life).

Safety notations are intended to alert personnel of possible personal injury, death or property damage. They have been inserted in the instructional text prior to the step in which the condition is cited.

The safety conditions are headed by one of the three hazard intensity levels which are defined as follows:

DANGER

Immediate hazard which will result in severe personal injury, death, or property damage.

WARNING

Hazard or unsafe practice which could result in severe personal injury, death, or property damage.

CAUTION: *Hazard or unsafe practice which could result in minor personal injury, or property damage.*

Contents

1 Description

1.1.1 Design

The design and dimensions of bushings type GOB are given in the Technical Guide, *1ZSE 2750-102*. The design principle is also shown in Figs. 1a–d. For bushings with a relatively small oil quantity the expansion space at the top of the insulator is sufficient. For bushings with larger oil quantity the expansion space has been increased with at top housing according to Fig. 1b. An alternative design, with an oil level glass of prisma type according to Fig. 1c is also available. All GOB bushings are equipped with a test tap, see Fig. 2, connected to the outer layer of the condenser body. The test tap can be used for checking of the bushing insulation by capacitance and dissipation factor measurements. The maximum test voltage for the test tap is 2 kV, one minute at 50 to 60 Hz. It serves as a test tap, and in connection with an external capacitance it can be used as a voltage tap. The operation voltage is limited to 600 V. An adapter is available for permanent connection to measuring circuits, see Fig. 3.

Fig. 1. Design principle

1) Outer terminal stud
2) Oil filling holes with sealing plug M8, 2522 731-A
3) Oil
4) Expansion space
5) Prism type glass
   a) GOB 250 - 650 2911 720-2
   b) GOB 750 - 1050 2911 730-1
6) Gasket
   a) GOB 250 - 650 O-ring 49.5 x 3 2152 2012-416
   b) GOB 750 - 1050 O-ring 34.2 x 3 2152 2011-410
7) Porcelain insulator, air side
8) Test tap
9) Mounting flange
10) Condenser body
11) Insulated shield (integrated or separate)
12) Flange extension
13) Porcelain insulator, oil side

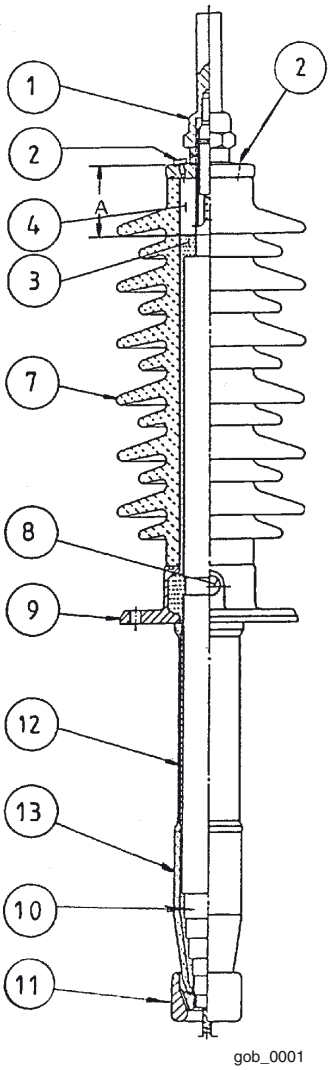


Fig. 1a

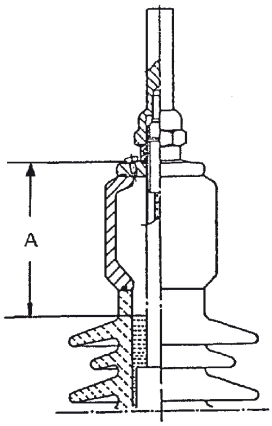


Fig. 1b

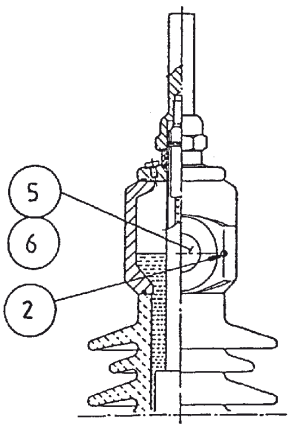


Fig. 1c

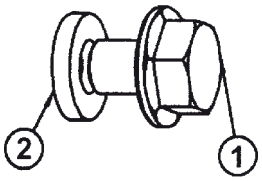


Fig. 1d. Sealing plug, 2522 731-A

1) Bolt with flange DIN 6921, 2121 738-18
2) Gasket, 2152 899-132

Fig. 2. Test tap 2769 531-B (not self-earthing)

1) Bushing for test tap
2) Disc spring
3) Press nut
4) Cover 2749 528-B with O-ring 2152 484-2
5) Contact pin, 4 mm
6) O-ring
7) O-ring
8) Cable

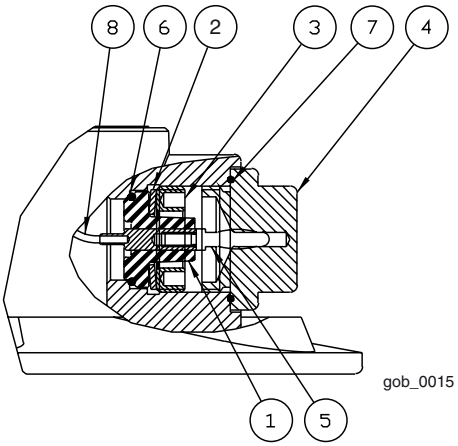
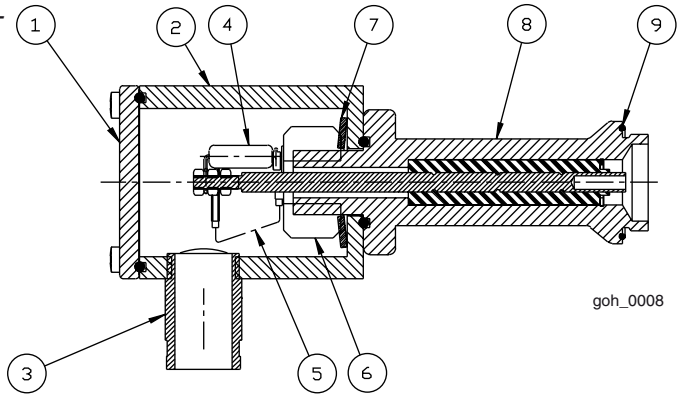


Fig. 3. Adapter for permanent connection to measuring circuits 2769 531-D

1) Cover
2) Box
3) Cable gland Pr (screwed steel conduit) 22.5 (Pg 16 acc. to DIN 40430)
4) Protecting resistor, 10 kW, 5 W
5) Earthing connection (to be removed before connection of outer cable)
6) Nut
7) Belleville spring washer
8) Connector to test tap
9) O-ring



1.1.2 Design of horizontally mounted bushings

If a bushing shall be mounted in horizontal position this must be clearly stated in the order. The bushing flange is then supplied with an oil hole at the oil side of the flange for connection of the bushing oil system to the transformer oil. As horizontally mounted bushings must be completely oil filled this hole will provide the necessary oil expansion for the bushing.

At delivery the hole is covered by a flat rubber gasket and a steel plate as shown in the figure below. This arrangement makes sure that the hole is opened before mounting of the bushing. It is important to check that the gasket on the transformer flange does not cover this hole in service. The hole is located between two mounting holes and at a distance B from the flange edge.

Table 1.

Type GOB	Dimension B
250/800	54
250/1250	78
325/800	54
380/800	54
380/1250	78
450/800	54
550/800	60
550/1250	65
650/1250	65
750/1250	60

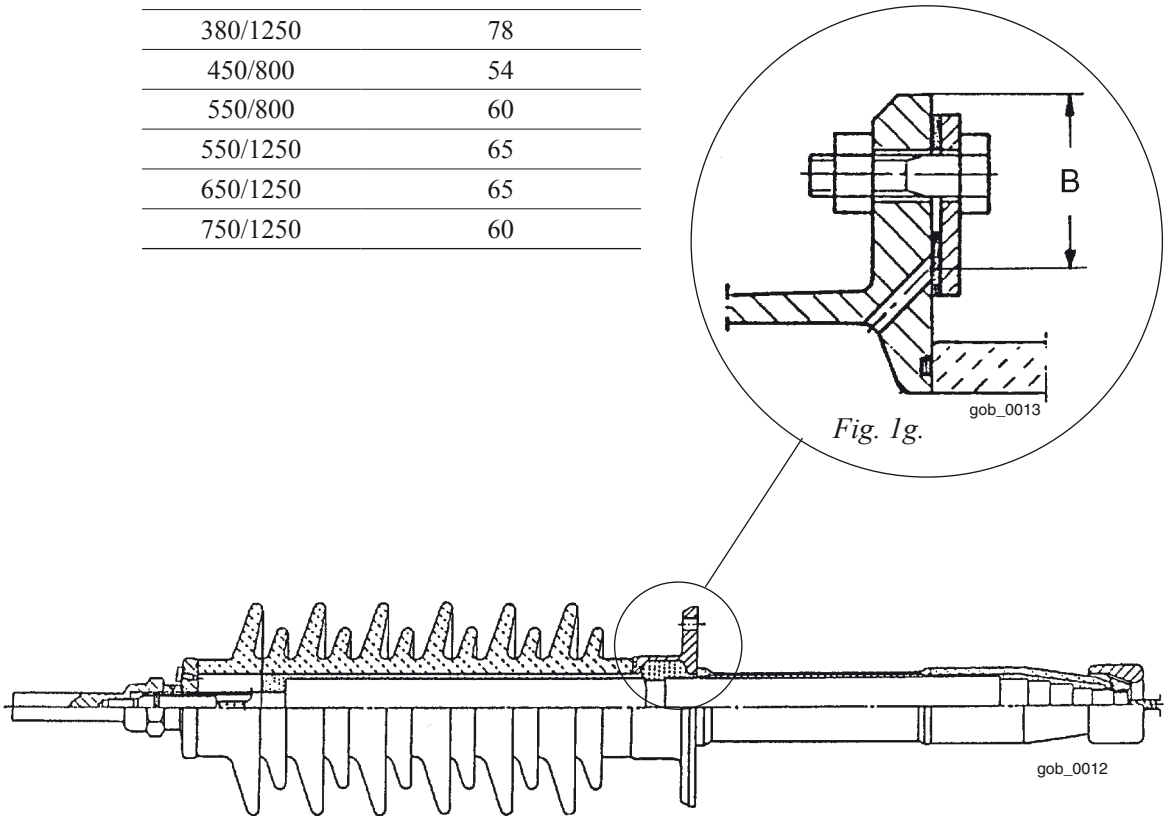


Fig. 1g.

Fig. 1f. Design principle - horizontally mounted bushing.

1.2 Operating conditions

The table below show the standard technical specifications for the GOB Oil - Air bushings. For conditions exceeding the below values, please contact ABB.

Common specifications:	
Application:	Transformers
Classification:	Oil impregnated paper, capacitance graded, outdoor-immersed bushing
Ambient temperature:	+40 to -40 °C, minimum value as per temperature class 2 of IEC 60137
Altitude of site:	< 1 000 m
Level of rain and humidity:	1-2 mm rain/min horizontally and vertically, as per IEC 60060-1
Pollution level:	According to specified creepage distance and IEC 60815 ("Guide for the selection of insulators in respect of polluted conditions")
Type of immersion medium:	Transformer oil. Maximum daily mean oil temp. 90 °C. Maximum temporary oil temperature 115 °C
Oil level below bushing flange:	Maximum 30 mm
Max. pressure of medium:	100 kPa overpressure
Markings:	Conforming to IEC/ IEEE

1.3 Mechanical loading

The bushings are designed for the following cantilever loads applied to the midpoint of the top end terminal, perpendicularly to the bushing axis. The bushing mounting angle can be 0 – 45° from vertical or horizontal (if the bushing is ordered for horizontal mounting).

In axial direction, the GOB bushings can be loaded with 10 kN continuously. The bushing can withstand 30 Nm torque on the outer terminals.

Table 2. Mechanical loading

Bushing	**Type test load 1 minute (N)**	**Max. service load (N)**
GOB 250/800	2340	1800
GOB 250/1250	4000	3000
GOB 325/800	1950	1500
GOB 380/800	1800	1400
GOB 380/1250	3750	2900
GOB 450/800	1500	1150
GOB 550/800	1700	1300
GOB 550/1250	3100	2400
GOB 650/1250	3380	2600
GOB 750/1250	3350	2600
GOB 1050/1100	3200	1250

1.4 Spare parts

In case of major damage to the bushing we recommend that it is sent back to ABB for possible repair and re-testing. Certain parts (Figs. 1, 2, 7, 8 and 9), which may be damaged or lost during transport or installation, can be ordered from ABB.

2 Installation

2.1 Tools

- Soft slings
- Lifting eye screw M12 (DIN 580) for mounting at an angle, 2183 2001-3
- Pull-through cord with M8 swivel, 9760 669-A
- Torque wrench key for hexagon head screws, head width 16 mm (M10) and adjustable up to 66 mm
- Key for hexagon socket head cap screw 6 mm (Only for previous design of test tap cover)

2.2 Consumables

- Water free vaseline, Mobilgrease 28 or other lubricant not harmful to the transformer oil, to lubricate screws that come into contact with the transformer oil.
- Mobilgrease 28 or other suitable grease to lubricate and protect the earthing screw and the outer terminal o-ring gasket.

2.3 Transport and handling

CAUTION: *The bushing may be transported and stored horizontally up to 6 months. For storing over 6 months it is recommended to raise the bushing to vertical position with the top end upwards or inclined position with the top end upwards and at an angle of at least 7°. Keep the bushings dry and clean and protected against mechanical damage.*

Keep the bushings protected from penetrating water when stored outdoors. This means that the case must not be stored in areas where it can be foreseen that the ground will be wet and muddy during heavy rains. Shelter the case from rain and snow with a tarpaulin or roofing.

Carefully inspect the bushing on receiving with regard to shipping damage. Please note that the bushing has been routine tested in oil and some oil may be left, especially in the narrow openings between porcelain and metal. Vaseline is used for lubrications of threads, and at some temperatures the vaseline may appear as oil

The bushings are normally delivered from ABB in boxes with the bushing supported by blocks and fibre boards. The boxes are marked with "Top End".

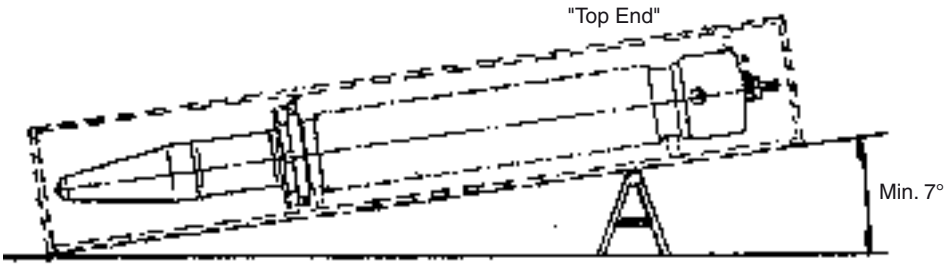


Fig. 4. Long-term storage.

2.4 Lifting from the box

WARNING

For lifting the bushing from the box, apply two clean lifting slings as shown in the figure below. Support the bushing at the same points as in the box if placed on the ground or block it under the flange and the metal top piece. Light bushings may be handled manually.

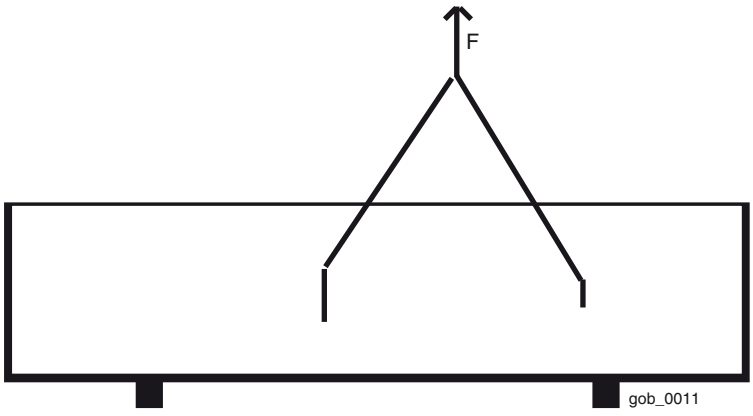


Fig. 5.
Lifting from the box.

2.5 Mounting

CAUTION: *Bushings mounted horizontally must be specially ordered for that, and mounted according to section 2.5.4. If additional requirements are not fulfilled, the bushing can be damaged.*

WARNING

Light bushings may be handled manually. Lift heavier bushings with the aid of a lifting tool, see section 2.1 Tools. Lift the bushing to vertical position and to an angle according to the figures below. Use a soft bedding under the bottom end of the bushing, e.g. a rubber mat.

The mass of the bushing is stated on the marking plate. Carefully clean and inspect the oil end of the bushing and the inside of the centre hole before mounting on the transformer.

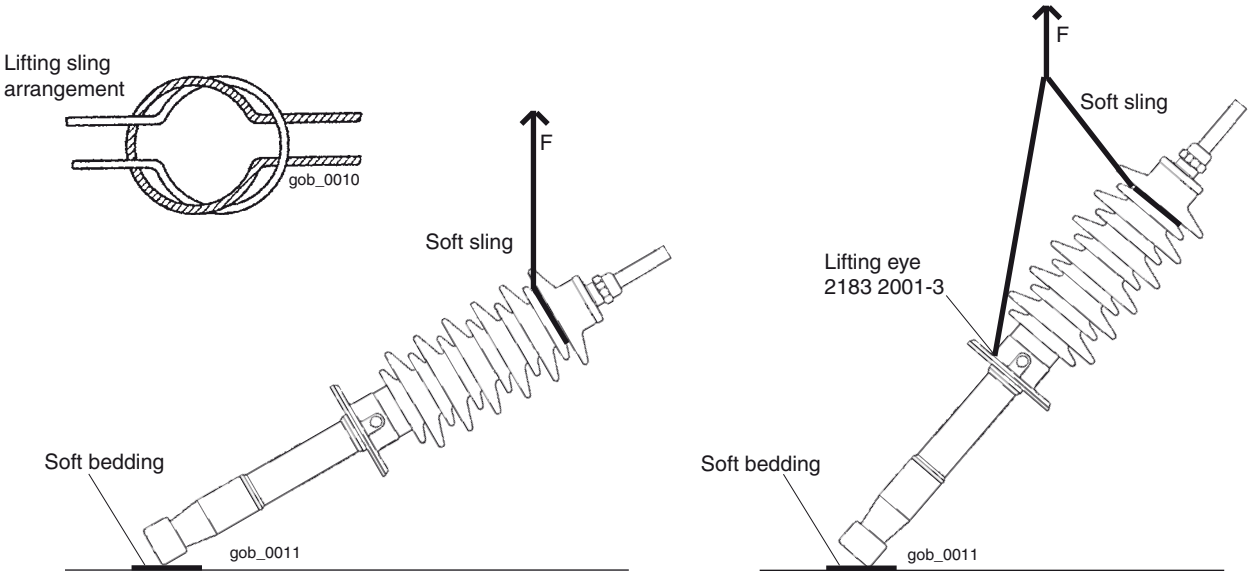


Fig. 6. Mounting.

2.5.1 Mounting of oil end-shield

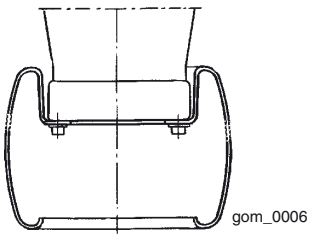
CAUTION: *If the bushing is lowered in transformer oil, the air cushion in the end-shield must be vented by a hose.*

The shield is packed in a plywood box with the fastening screws and the washers included.

The end-shield is mounted on the bottom end of the bushing according to Fig. 7.

Fig. 7. Mounting of end-shield.

1) End-shield
2) Washer 6.4 x 12 x 1.5
3) Socket screw M6 x 16



2.5.2 Inner terminal / Stranded cable

CAUTION: *Mounting of the conductor must be performed according to the procedure below. The contact surfaces must be clean. The oxide on brazed terminals is to be removed by brushing.*

1. Stretch the stranded cable with the brazed or crimped inner terminal, normally fastened to the cover plate. Avoid making any loops.
2. Drop the pull-through cord through the bushing centre hole.
3. Lift the bushing above the opening.
4. Fasten the M8 swivel to the inner terminal at the end of the stranded cable. Lower the bushing into the transformer while directing the stranded cable by keeping the pull-through cord taut.
5. Fix the bushing to the cover. Torque M12 to 50 ±5 Nm, 1/2" UNC to 55 ±5 Nm. Ensure to tighten the bolts evenly crosswise in order to avoid damages to the flange.
6. Lock the inner terminal with the locking pin according to Fig. 8.
7. Gently release the pull-through cord so the conductor rests on the locking pin.
8. Remove the pull-through cord.
9. Proceed immediately to section 2.6 Mounting of outer terminal.

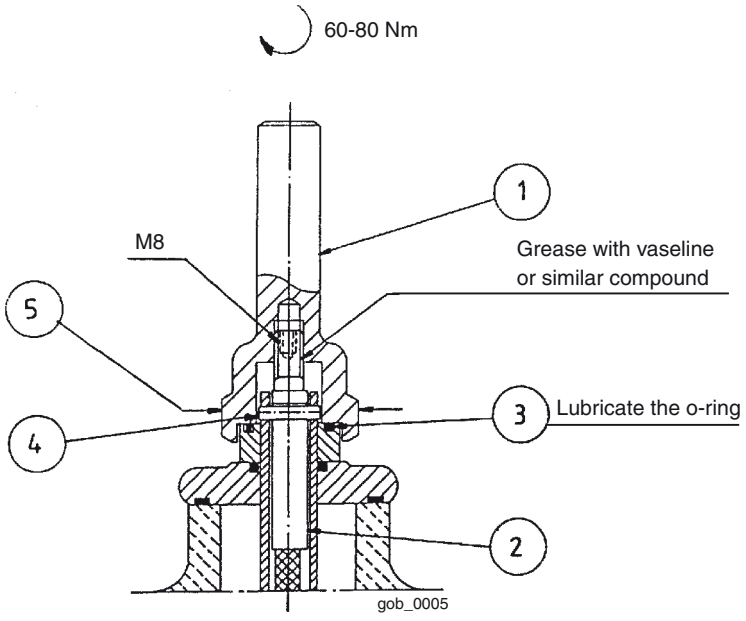


Fig. 8. Outer and inner terminal stud.

1) Outer terminal
2) Inner terminal

3)	O-ring	800 A:	2152 2011-412; 39.2 x 3
		1100/1250 A:	2152 2012-420; 59.2 x 3
4)	Locking pin	800 A:	2111 764-A
		1100/1250 A:	2111 764-B
5)	Width across flats for wrench	800 A:	55 mm
		1100/1250 A:	66 mm

2.5.3 Solid rod conductor

CAUTION: *Mounting of the conductor must be performed according to the procedure below. The contact surfaces must be clean.*

If turning of the conductor is needed to line up the holes for the locking pin in the conductor tube with the hole in the conductor, the conductor must definitely be turned clockwise. Turning in opposite direction may loosen the current carrying joint in 800 A conductors.

The lower part of the solid conductor is normally fastened to the cover plate of the transformer. The top part is usually delivered to site with the bushing.

1. Drop the pull-through cord through the bushing centre hole.
2. Fasten the M8 swivel to the top part of the solid conductor.
3. Partly pull the top part of the solid rod up into the bushing centre hole, leaving the part with the jointing hole(s) sticking out.

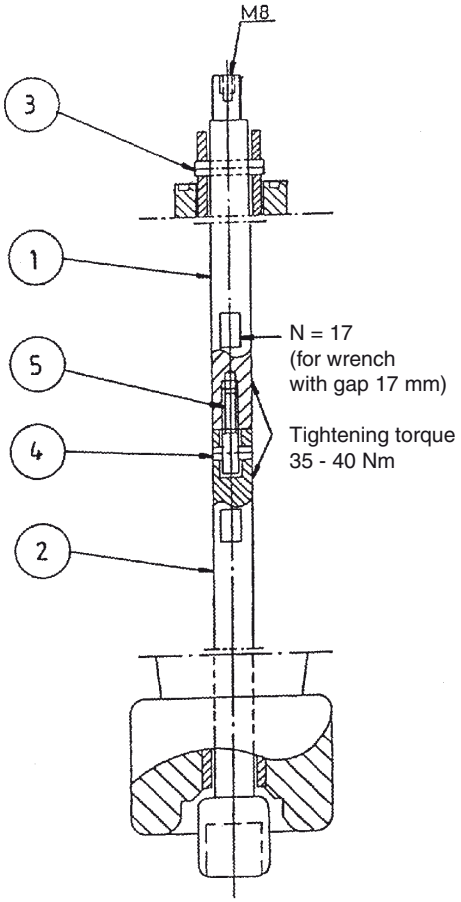


Fig. 9. Solid conductor 800 A

1) Upper conductor
2) Lower conductor
3) Locking pin, 2111 764-A
4) Locking pin, 2111 764-C
5) Screw, 2122 751-2

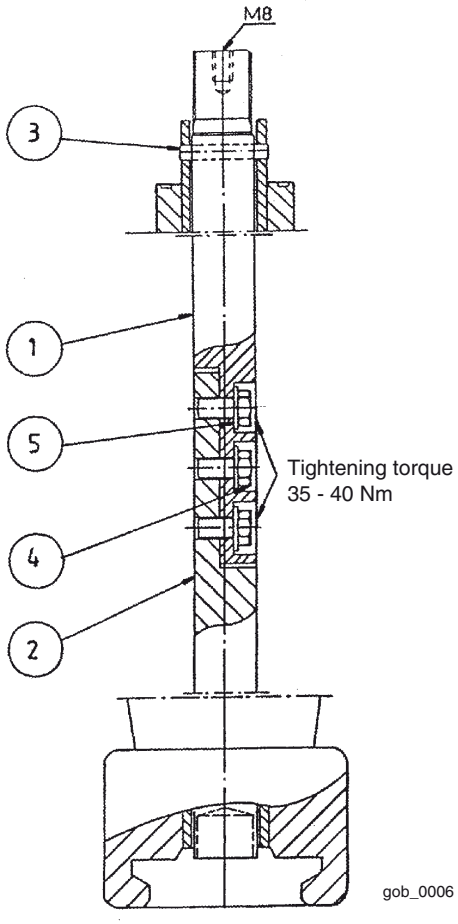


Fig. 10. Solid conductor 1100/1250 A

1) Upper conductor
2) Lower conductor
3) Locking pin, 2111 764-B
4) Hexagon head screw M10 x 20
   Previous non-captive design, 2121 2033-490
   New captive design, 2121 738-19
5) Belleville spring washer, 2154 717-5

4. Secure the pull-through cord so the solid rod conductor top part cannot fall out of the bushing.
5. Lift the bushing with the solid rod attached above the opening.
6. Lower the bushing until the two solid conductor parts meet.
7. Lubricate 1 x M12 (800 A) or 3 x M10 (1100/1250 A) screws with water-free vaseline, Mobilgrease 28 or other lubricant not harmful to the transformer oil. Insert and tighten to 35-40 Nm.
8. Lower the bushing into the transformer while directing the assembled solid rod conductor by keeping the pull-through cord taut.
9. Fix the bushing to the cover. Torque M12 to 50 ±5 Nm, 1/2" UNC to 55 ±5 Nm. Ensure to tighten the bolts evenly crosswise in order to avoid damages to the flange.
10. Lock the solid rod with the locking pin according to Figs. 9 and 10.
11. Gently release the pull-through cord so the conductor rests on the locking pin.
12. Remove the pull-through cord.
13. Proceed immediately to section 2.6 Mounting of outer terminal.

2.5.4 Horizontal mounting of bushing

A horizontal GOB bushing normally has the tap to the left, seen from the air side when the bushing is mounted according to the instructions below.

Alternative 1. At vacuum filling of transformer.

Open the oil hole in the flange. Mount the bushing with the hole upwards. The bushing will be completely oil filled at the filling of the transformer.

Alternative 2. Filling of transformer without vacuum.

Place the bushing vertically and open one of the filling plugs at the top. Add clean and dry transformer oil until the bushing is completely filled. Put back and tighten the plug and place the bushing horizontally with the opening in the flange upwards. Remove the covering plate or plug immediately and mount the bushing in the transformer without turning or tilting it.

2.6 Mounting of outer terminal

CAUTION: *Before connection of conductor clamps, the outer terminals of aluminium must be carefully wire brushed and greased with a contact compund or vaseline.*

In order to obtain the correct pressure and a low contact resistance, the following must be carried out:

1. Clean the contact and gasket surfaces carefully.
2. The inner terminal / solid rod thread is to be lubricated with vaseline or other lubricant not harmful to the transformer oil.
3. Lubricate the o-ring before putting it into the groove.
4. Screw on the outer terminal and tighten with 60-80 Nm according to Fig. 8.

2.7 Flange earthing

WARNING

Proper earthing is essential!

The bushing flange is provided with a tapped hole M12. After tightening the bolts fixing the bushing to the transformer tank, the flange should be earthed. This prevents electrical discharges between bushing flange and transformer tank under normal service conditions.

Alternative 1

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

Alternative 2

Apply a flexible cable between the M12 earthing hole in the bushing flange and a corresponding connection point in the transformer. Grease the screw (Mobilgrease 28 recommended) and tighten the M12 in the bushing to 40 Nm. Connect the other end of the cable to the transformer.

2.8 Waiting time before energizing

CAUTION: *When a bushing has been stored horizontally, it must be raised with the top up for at least 12 hours before service voltage is applied and 24 hours before test voltage is applied. If, by mistake, the bushing has been stored horizontally more than one year, it must be placed in the vertical position for at least one week before energizing. Some waiting time may be necessary before energizing in order to avoid flashovers or partial discharges due to airbubbles at the bushing surface. Choose a suitable procedure below.*

Vacuum filled transformer

No waiting time is necessary from the bushing point of view.

De-gassed oil-filled transformer

During mounting, use a clean and dry paintbrush to release surface bubbles. Wait 6 hours before energizing.

Gas-saturated oil-filled transformer

During mounting, use a clean and dry paintbrush to release surface bubbles. Wait 24 hours before energizing.

De-gassed oil filled transformer with reduced oil-level

After restoring the oil-level, wait 24 hours before energizing.

For all alternatives except vacuum-filled transformer, the oil should be allowed to enter the centre tube to at least flange height by releasing the outer terminal sealing system and allowing air to escape this way.

2.9 Recommended tests before energizing

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

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

2.9.1 Tightness test between transformer and bushing flange

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

2.9.2 Tightness test of bushing outer terminal

Since the top terminal is often situated above the oil level of the transformer expansion system, a leak at this point is extremely serious, because water could enter directly into the transformer insulation this way. It is thus recommended to make a tightness test after assembly, preferably both with vacuum and over-pressure. Several different methods may be used and we refer to instructions given by the firm responsible for the field erection.

One possible method is the tracer gas method:

1. Put a tracer gas into the centre tube before mounting the outer terminal. The oil level of the transformer must be above the bottom end of the bushing but below the bushing flange.
2. Increase the pressure in the center tube by increasing the oil level as much as possible.
3. Search with a gas detector (sniffer) for leaking gas at the gasket.

2.9.3 Measurement of capacitance and tan δ

WARNING

The test tap is not self-earthing.

Since C_2 usually is relatively small, the test tap must never be open-circuited when applying a voltage to the bushing. It shall always be earthed or connected to an external impedance. No connection may destroy the bushing. Recommended maximum voltage for C_1 is 10 kV and for C_2 500 V.

CAUTION: *When not measuring, always make sure that the cap nut is properly tightened with the gasket in place. This is to prevent dust and water from coming in to the test tap.*

After mounting, a capacitance measurement is recommended. Connect a measuring bridge between the outer terminal and the test tap by using a ø 4 mm lead coupler or ABB's test tap adapter 2749 510-U. This is possible without removing the bushing as the bushing has an insulated test tap, see Fig. 2. More details can be found in product information *2750 515-142*, "Bushing diagnostics and conditioning".

With the transformer de-energized and the bushing outer terminal disconnected, the test tap cover is removed. The measuring equipment is connected to the test tap and the measuring voltage source to the bushing terminal.

The capacitances C_1 between the centre tube and the tap, and the capacitance C_2, between the test tap and earth are marked on the marking plate. The nominal capacitances C_1 of the different bushing types are listed in Table 3. C_2 is highly dependent on the surrounding parts inside the transformer and it is not possible to give a nominal value valid for all service conditions.

Table 3. Nominal capacitances in pF (Manufacturing tolerances for C1 ± 10%).

Type	Catalogue No.	Nominal capacitance (pF)	
	LF 123	C_1	C_2
GOB 250	013, 014, 171, 172	125	90
	015, 016, 173, 174	205	500
	017, 167	165	110
	019, 168	270	750
	083, 084, 175, 176	275	800
	085, 169	375	1200
GOB 325	025, 026, 177, 178	135	95
	027, 028, 179, 180	200	200
	089, 090, 181, 182	260	425
GOB 380	037, 038, 183, 184	145	110
	039, 040, 185, 186	200	335
	041, 101	185	150
	043, 102	265	550
	095, 096, 187, 188	245	550
	097, 103	320	1150
GOB 450	049, 050, 145, 146	145	125
	051, 052, 147, 148	200	570
	053, 054, 149, 150	245	770
GOB 550	061, 189, 062	150	156
	063, 190, 064	170	400
	107, 191, 108	210	750
	065, 142	170	150
	067, 143	195	320
	109, 144	240	575
GOB 650	073,192	205	200
	075, 193	235	340
	113, 194	280	550
GOB 750	077, 104	205	390
	078, 105	235	565
	079, 106	275	950
GOB 1050	281	310	450
	280	367	700

The dissipation factor varies with the temperature of the bushing body, and the measured value should thus be multiplied with the correction factor (multiplier) given in Table 4.

Table 4. Dissipation factor variations as a function of temperature.

Bushing body temperature °C	Multiplier to 20 °C
0-2	0.80
3-7	0.85
8-12	0.90
13-17	0.95
18-22	1.00
23-27	1.05
28-32	1.10
33-37	1.15
38-42	1.20
43-47	1.25
48-52	1.30
53-57	1.34
58-62	1.35
63-67	1.35
68-72	1.30
73-77	1.25
78-82	1.20
83-87	1.10

2.9.4 Check of through resistance

This method can be used to detect very large faults in the current path, such as disruptions, and is not a tool for diagnostic of the bushing.

The through resistance measurement method depends on the design of the transformer. Generally, a current is applied from bushing to bushing. The voltage drop from outer terminal to outer terminal is measured. The resistance is calculated with Ohm's law, U = R·I. (U: Measured voltage drop. I: Through current. R: Total circuit resistance.)

The total through resistance is the sum of the transformer winding and lead resistance and the bushing conductor and contact resistance. The additional resistance from he bushing conductor should not be more than 150 mΩ. Since the through resistance of the HV winding of a typical power transformer is in the order of 0.1 ..1 Ω, this is a very rough method.

Less-than-perfect contacts can only be detected by making a sensitive measurement across each connection point, or by measuring the temperature increase during operation with an infrared sensitive camera (thermovision).

3 Maintenance

The GOB bushings are maintenance-free. For bushings with oil-level glass, it is recommended to note the oil level during normal routine inspections in the plant.

DANGER

No work at all can be performed on the bushing while it is energized or not earthed.

3.1 Recommended maintenance and supervision

1. Cleaning of insulator surface
2. Measurement of capacitance and tan δ
3. Thermovision (infrared camera) check for local overheating on connectors
4. Check for leakage
5. Checking and adjustment of the oil level

3.1.1 Cleaning of insulator surface

CAUTION: *Avoid having solvent on the bushing gasket and porcelain joints.*

Under conditions of extreme pollution it may be necessary to clean the porcelain insulator surface. This should be done by water-jet or by wiping with a moist cloth. If necessary, ethyl-alcohol or ethyl-acetate may be used.

3.1.2 Measurement of capacitance and tan δ

Please refer to Chapter 2 Installation.

3.1.3 Thermovision (infrared camera) check for local overheating on connectors

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

3.1.4 Check for leakage

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

3.1.5 Checking and adjustment of the oil level

CAUTION: *Oil sampling and dissolved gas in oil analysis.*

Normally we do not recommend taking oil samples or opening our bushings. The bushing is sealed and tightness tested at the time of manufacturing. An oil sampling means that the bushing has to be opened. Thus, there is also a risk of improper sealing after the sampling is finished. However, when a problem is known, for example high power factor over C_1 or visible leakage, there might be a need for oil sampling and gas analysis or oil level check. In this case, ask for product information 2750 515-142 "Bushing diagnostics and conditioning".

Bushings with one oil level glass should show the oil level in the middle of the glass at 20 °C. The oil level change is approximately 3 mm per 10 °C.

GOB 750 and 1050 has two glasses and the oil level at 20 °C is to be at the oil level plug between the two glasses. The oil level change is approximately 6 mm per 10 °C.

The oil level in bushings without oil level glass may be checked through one of the two oil filling holes at the top end. A dry and clean dipstick should be used. In one of these holes there is a rubber plug. This plug may be pressed down into the bushing so that checking of the oil level can be carried out. Correct oil level is shown in Table 5. For bushings mounted at an angle it may be necessary to check at both holes and calculate the average. If the oil level is too high, oil can be sucked out by means of a narrow hose. If the oil level is too low, clean and dry transformer oil must be added. Adjustment of oil level is allowed only when the temperature of the bushing is +5 °C to +35 °C. It is recommended to provide the sealing plug with a new gasket after the check. The sealing plug is to be tightened with 20 Nm. For further information on oil sampling, see product information *2750 515-142*.

For topping-up of the bushing, any clean and dry transformer oil available at site may be used.

Table 5. Oil level for bushings without oil level gauge

Type GOB	Oil level A mm at 20 ±10 °C		Oil level change mm/10 °C (The bushing in vertical position)
	Fig. 1a	Fig. 1b	
250	110 ±8	165 ±10	4
325	110 ±8	165 ±10	5
380	110 ±8	165 ±10	5
450	110 ±8	165 ±10	6
550	170 ±10	270 ±15	7
650	175 ±10	275 ±15	9
750	275 ±15	330 ±15	11

3.1.6 De-mounting of horizontally mounted bushings

When the bushing is removed from the transformer it is completely filled with oil. Drain a small volume of oil and tighten the flange hole with the gasket and cover plate or plug. Place the bushing vertically and adjust the oil level according to 3.1.5.

3.2 Disposal after end of service life

The bushing consists of the following material:

- Conductor of copper or low-alloy aluminium.
- Terminals of copper, brass or low-alloy aluminium may be plated with for instance silver, tin, gold or nickel in layer thickness up to 20 µm.
- Transformer oil as per IEC 60296, class 2.
- Transformer oil impregnated condenser body consists of paper and 1 % aluminium foils.
- Centre tube, on which the condenser body is wound, consists of aluminium alloy.
- Top washer, top housing, flange, top nut, flange extension and end-shield consist of aluminium alloys.
- Press ring for oil level glass and previous design of test tap cap consist of plated brass. New design of test tap consists of stainless steel.
- Prism glass consists of glass.
- Insulators consist of quartz or alumino silicated based porcelain.

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 2750 515-12 en, Rev. 9, 2006-10-15

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