1ZSC000563-ABA EN, REV. 5

Resin impregnated paper bushing, oil to air, type GSB 800

Technical guide

Original instruction

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Table of contents

Design

GSB is a RIP (Resin Impregnated Paper) bushing intended for immersed oil-to-air service. The bushing is built around a copper center tube on which the condenser core is wound. The core is wound from crepe paper with aluminum foil inserts for electrical stress control. The core is impregnated and cured in a vacuum, producing a partial discharge-free bushing with a low dissipation factor (tan δ). A flange and composite insulator with silicone sheds are mounted, and the space between the condenser core and the insulator is filled with insulating gel.

GSB uses the copper center tube as a current conductor, with the oil-side connection made with a draw-rod and a bottom contact. The bottom contact is normally delivered with a standard end-shield. For the top connection there are outer terminal studs available in a number of standard configurations, but it can also be customized.

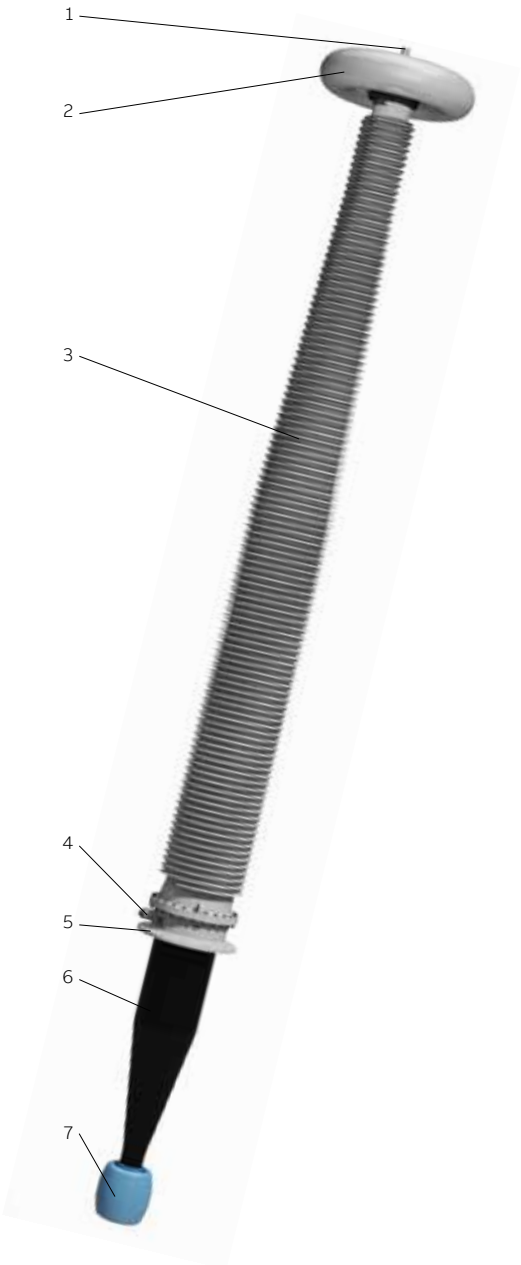
The bushing is designed to be mounted at any angle from horizontal to vertical.

Standards
The GSB bushing is designed and tested according to IEC 60137.

The GSB bushing is designed and tested according to IEEE C57.19.00/01 with exception of the dimension requirements that are excluded.

The GSB bushing is also designed for seismic requirements according to IEC 61463 and IEEE 693-2005 standards.

1. Outer terminal
2. Corona shield
3. Silicone rubber insulator
4. Test tap
5. Mounting flange
6. RIP core
7. Bottom contact with end-shield



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01 Transformer bushing type GSB 800.

Features and benefits

- Solid (oil-free) main insulation.
- Reduced risk of fire and oil leakage from the bushing.
- Oil leakage from the condenser core is eliminated.
- Seals the transformer in the event of a failure.
- Composite insulator with silicone sheds:
  - Non-brittle material.
  - Protection of staff and equipment.
  - Improved performance in heavily polluted and salty fog conditions due to its hydrophobic properties.
- Easy transport and handling.
- The lightweight draw-rod enables lifting by one person, thereby significantly simplifying inclined mounting.
- Functionally compatible with GOE 2550, article number LF 121 082-A.
- A lightweight, top-mounted bottom contact eliminates the need for installation technicians to enter the transformer.
- Protective epoxy paint on the oil side protects against impurities and moisture.
- The bushing can be equipped with an external capacitance unit for monitoring purposes.
- Can be energized immediately without any waiting time.

Transportation and long term storage

On the oil side a special metallic sealing tube is fitted, containing a drying agent. This sealing tube will protect the bushing during transport and storage.

The metallic sealing tube must be fitted on the bushing during long-term storage (>1 year).

The moisture barrier “RIPCOAT” is standard for GSB 800.

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Table 1. General specifications

For conditions exceeding the standard specification, please consult the supplier.

Application:	Transformers
Classification:	Resin-impregnated paper, capacitance-graded, outdoor immersed bushing, temperature class E (120°C) according to IEC 60137
Ambient temperature:	+40°C to -40°C, including minimum value according to temperature class 2 of IEC 60137 (-50°C and other temperatures on request, subject to agreement)
Altitude of site:	< 1000 m
Level of rain and humidity:	1-2 mm rain/min. horizontally and vertically, as per IEC 60060-1, and 5 mm/min. as per IEEE Std. C57.19.00-2004 (Std. 4, conventional procedure practice in U.S.A.)
Pollution level:	According to specific creepage distance and IEC 60815 ("Guide for selection of insulators with respect to polluted conditions")
Immersion medium:	Transformer oil. Oil temperatures for normal load: Maximum daily mean temperature +90°C. Maximum temporary temperature: +100°C. Oil temperatures for long- and short-term overload: Maximum daily mean temperature +90°C. Maximum temporary temperature: +115°C.
Maximum pressure of medium:	100 kPa (over-pressure)
Angle of mounting:	Horizontal to vertical
Voltage tap:	Dimensions according to IEEE Potential tap type A. Ur = 6 kV
Capacitance C_2 of the voltage tap:	< 29400 pF
Conductor:	Center tube. Inner terminal for flexible draw lead available on request.
Minimum creepage distance:	27500 mm.
Markings:	Conforming to IEC/IEEE.

Testing

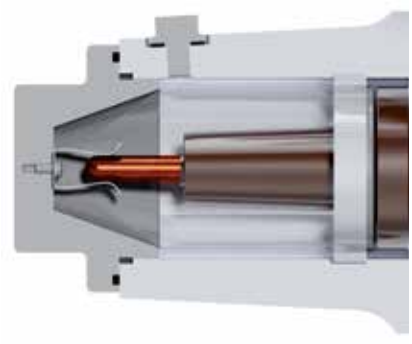
Routine testing
The bushing is routine tested according to applicable standards. The tests include measurement of partial discharge quantity, tan δ and capacitance, and a dry power frequency voltage withstand test. The flange is tightness tested. Individual routine test reports are issued with each bushing.

Type tests
Complete type tests have been performed and reports are available on request.

Voltage tap
The mounting flange is an aluminum alloy casting with the gasket surface machined flat. There is a voltage tap on the mounting flange with a maximum test voltage of 20 kV. The outer conducting layer of the condenser core is connected to the insulated voltage tap. During operation, the protective cap must be mounted in order to ground the outer conducting layer of the flange.

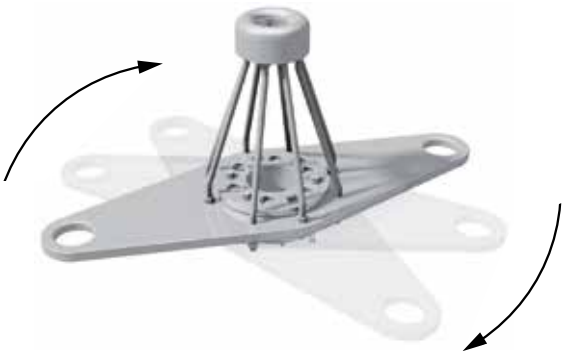
The voltage tap can be connected to an external capacitance (e.g. potential device) for continuous measuring purposes according to IEC 60137. The maximum service voltage of the voltage tap is 6 kV.

Tools
The following tools are to be ordered from the supplier:
- Lifting adapter, 1ZSC004867-AAB, Fig. 3.
- Lifting gear, 1ZSC004867-AAA, Fig. 4.
- Flexible pull-through cord, 9760 669-A, for assembly of draw-rod.



02 Voltage tap.

03 Lifting adapter, 1ZSC004867-AAB.



04 Lifting gear, 1ZSC004867-AAA.

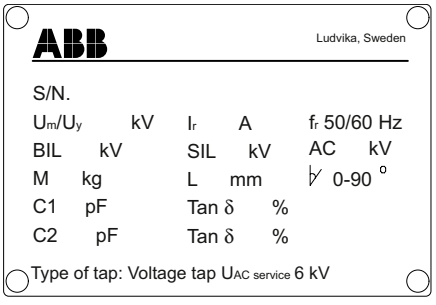
Electrical data

Table 2. Electrical data

Ratings GSB 800	
Rated voltage IEC (kV)/Nominal system voltage	800
Rated phase-to-ground voltage IEC (kV)/Insulation class (kV)	485
Rated line-to-ground voltage IEEE (kV)	485
Basic Insulation Level (kV) (Equal to dry lightning impulse withstand voltage)	2550
Dry switching impulse (kV)	1600
Wet switching impulse (kV)	1600
Rated current (A) IEC/IEEE	2000
Rated frequency (Hz)	50 - 60
Temporary over-voltage (kV) IEC (phase-to-ground voltage)	640
Wet power frequency AC (kV)	n.a.
Dry power frequency, routine test 1 minute AC (kV)	1075
Nominal main capacitance measured between conductor and voltage tap C_1 ±10% (pF), with space for current transformer CT = 600 mm	723

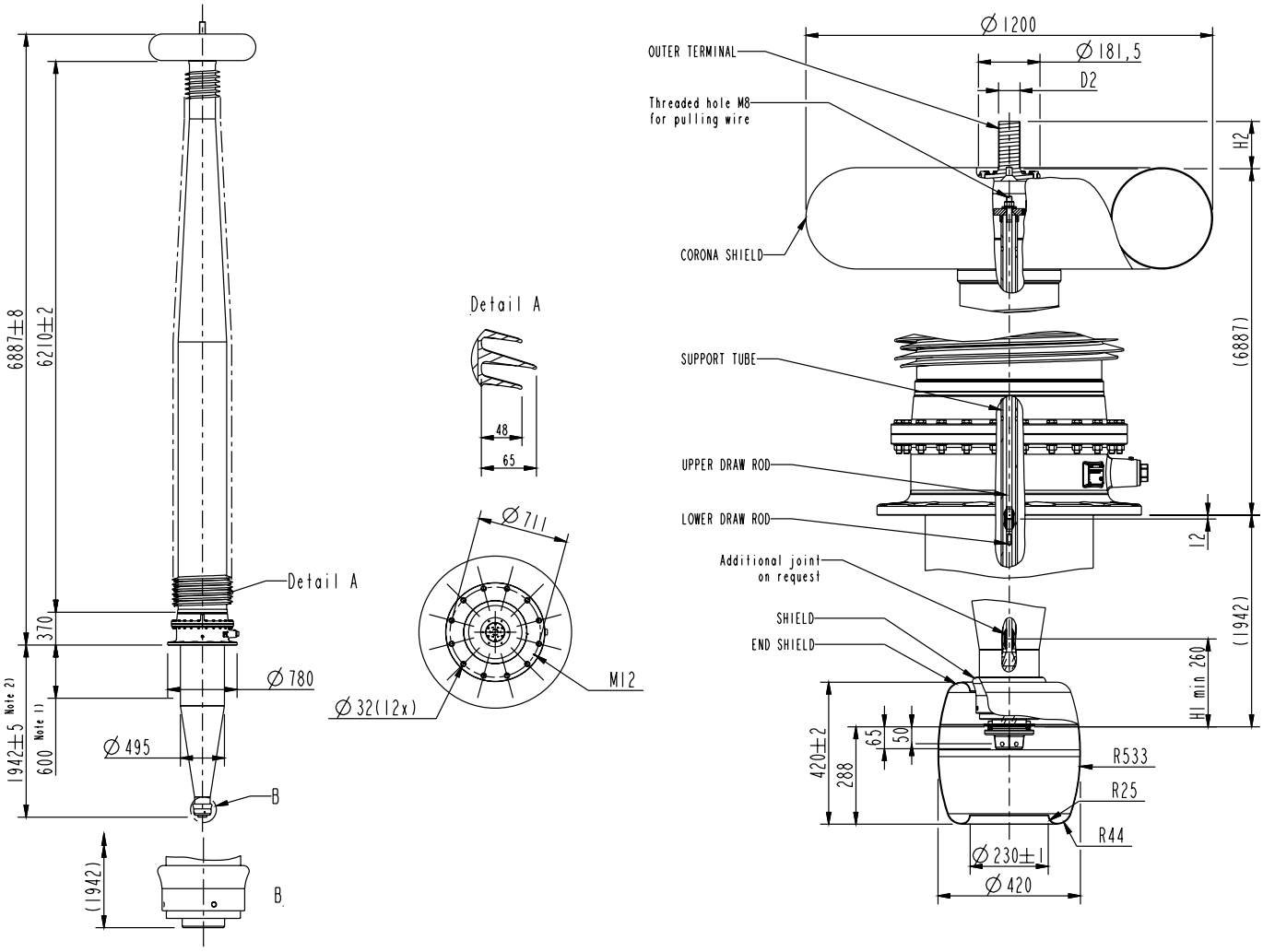
Table 3. Draw lead current.

	IEC (A)	**IEEE (A)**
1x50 mm²	120	80
1x95 mm²	200	140
1x150 mm²	350	240
(3x95) 285 mm²	510	350
(3x150) 450 mm²	740	510
(3x240) 720 mm²	1000	700
(5x240) 1200 mm²	1250	900



05 Nameplate with marking example.

Dimensions



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06 Dimensions.

1) Space for earthed parts, e.g. CT and transformer turret flange.

2) Oil side length at high and low temperatures on page 10.

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Table 4. Dimensions (subject to modification without notice).

Type GSB	Cat. No.	Voltage tap (kV)	Rated current (A)	Space for current transformer, CT (mm)	Net mass (kg)	Minimum creepage distance (mm)
800	1ZSC901800-CDB	6	2000	600	2450	27500

Connection details

The bushing has connection components at the top and bottom. For the top connection there is an outer terminal stud and a standard corona shield. For the bottom, the connection is made with a draw-rod system, bottom contact and a standard end-shield.

Outer terminal
The outer terminal consists of a terminal stud, a tightening ring, gasket, bolts and washers. The electrical contact function and the sealing function are completely separated. This provides a proper electrical contact as well as a corrosion-protected contact surface.

Other configurations, including custom lengths (L) and terminal stud diameters (D2), can be supplied on request. The maximum torque (M) allowed on the outer terminal stud is 250 Nm.

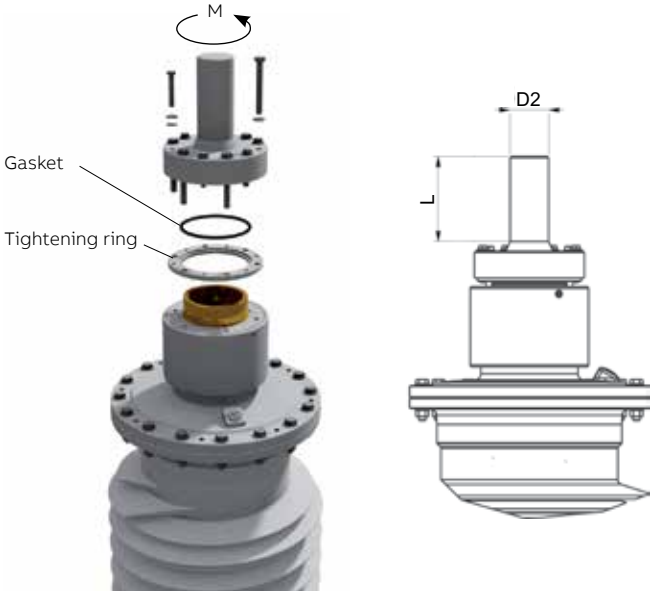
Table 5. Outer terminal.

Cat. No.	Material	Length, L (mm)	Terminal stud, D2
1ZSC004322-AAA	Aluminum	140	2.5”-12UN-2A
1ZSC004322-AAB	Copper	140	2.5”-12UN-2A

Corona shield
This shield is standard for GSB 800 and fulfills all requirements of the IEC and IEEE tests. However, extra shielding of the power line connector may be required depending on the design of the connector.

Oil side length at high and low temperatures
The dimension for oil side length, 1942 mm, and its tolerance stated in Fig. 6, is applicable for 20°C. For higher and lower temperatures the total oil side length must be considered. The total oil side length adds thermal movement, i.e. elongation/contraction, to the manufacturing tolerance. The total oil side length are valid for temperature conditions according to IEC 60137 and IEEE C57.19.00 and in addition also includes low temperature condition -50°C.

Total oil side length with tolerances and thermal elongation/ contraction included:
- Max length at high temperature condition, full load: 1960.0 mm
- Min length at low temperature condition, no load: 1928.0 mm



07 Outer terminal.

08 Corona shield - GSB 800.

Inner terminal
The inner terminal for connection of the draw lead is made of copper. It consists of the terminal, with a hole for brazing the cable, and a divided ring for mounting. To fit the end-shield, an adapter (Cat. No. 1ZSC999002-AAG) is used.

If an inner terminal is used, no current passes through the center tube.

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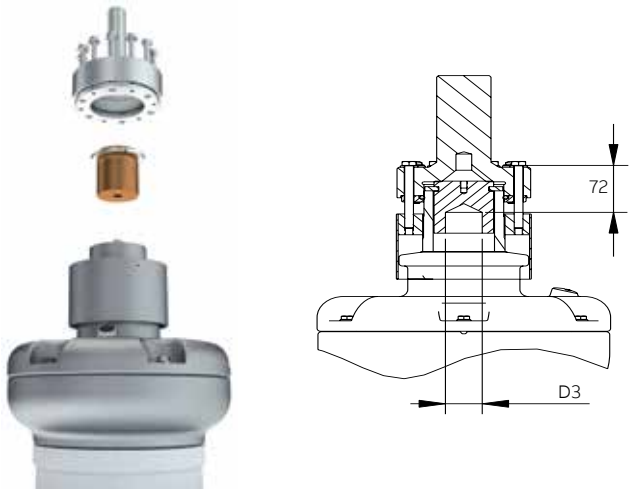
Table 6. Inner terminal.

Cat. No.	Conductor diameter, D3 (mm)
1ZSC029167-AAC	3 x 28
1ZSC029167-AAF	5 x 28



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08 Inner terminal.

Draw-rod system
The draw-rod system is a top-mounted bottom contact with the final assembly at the top of the bushing.

The draw-rod system offers the following advantages compared to other methods used for high currents:
- No manholes required in the transformer tank.
- Bushing can be replaced without draining all the oil in the transformer.
- Perfect guiding of the bushing into the transformer.

The transformer leads are fitted with cable lugs for the bottom contact. The bottom contact is then tightened to the lower end of the bushing by a draw-rod system, designed to produce the required contact load at all temperatures. The draw-rod is divided into three parts and can be divided level with the mounting flange. If required to meet the transport conditions, an additional joint can be positioned below the flange on request. The position of the additional joint must be stated in the order; see the order example.

For dimensions, see Fig. 6.

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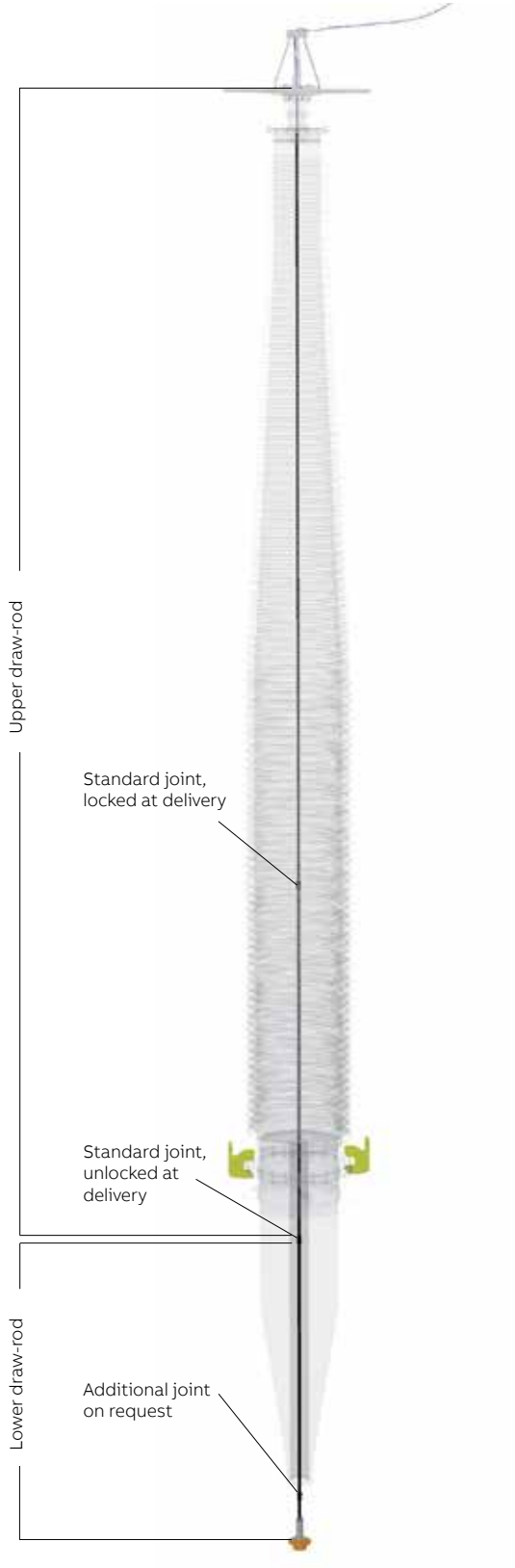
Table 7. Ordering particulars for draw-rod system.

Cat. No.	Type of draw-rod
LF 170 059	Lower draw-rod[1)]
1ZSC004375-AAB	Upper draw-rod[2)]

1) Lower draw-rod includes bottom contact, guiding cone and draw-rod up to mounting flange level; see Fig. 9.

2) Upper draw-rod includes the complete draw-rod above the mounting flange level; see Fig. 9.



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09 Draw rod system.

Bottom contact

Bottom contacts with 4 and 6 threaded holes for cable lugs are available; see Table 8. The bottom contacts are made of copper and in a single piece. There is a suitable standard end-shield for these bottom contacts; see the section “Standard end-shield” for more information.

Special bottom contacts are available on request.

Table 8. Bottom contact.

Cat. No.	Number of threaded holes
4649 131-F	N=4
4649 131-G	N=6

10 Bottom contact, N=6.

Standard end-shield

The standard end-shield is made of aluminum and coated with insulating epoxy paint or 5-mm pressboard; see Table 5 for catalog numbers. The design enables easy installation and should be used with the standard draw rod system with bottom contact and the adapter for the inner terminal.

Other end-shields are available on request.

For dimensions, see Fig. 5.

Table 9. Standard end-shield. Bottom contact (see Fig. 7) must be used together with the standard end-shield.

Cat. No.	Coating	
LF 170 046-X	Insulating epoxy paint	Used with draw rod system
LF 170 046-XP	6 mm pressboard	Used with draw rod system
LF 170 046-Z	Insulating epoxy paint	Used with inner terminal
LF 170 046-ZP	6 mm pressboard	Used with inner terminal

11 End-shield with insulating epoxy paint.

Conductor insulation

Draw leads must be insulated with vacuum oil-impregnated insulating paper or equivalent, to give sufficient insulation integrity. The paper insulation must be a minimum of 2 mm. The paper insulation must be taken at least 30 mm inside the end-shield hole.

Conductor loading and mechanical loading

Conductor loading

The GSB bushings fulfill the temperature rise test requirements according to IEC for the currents in Table 10. The short-time current is also calculated according to IEC 60137 and listed in the table.

Overloading of bushings according to IEC

If the conductor for the bushing is selected with 120 % of the rated current of the transformer, the bushing is considered to be able to withstand the overload conditions stated in IEC 600076-7 when following these instructions:

- For long-term and short-term emergency loading, the oil temperature must be no more than +115°C.
- The daily mean oil temperature must be no more than +90 °C.

For overload conditions other than those mentioned above for IEC overload, contact the supplier for permissible currents and temperatures.

Short-term current

The rated thermal short-term current (I_{th}) is calculated according to IEC 60137.

Table 10. Short-term current.

Bushing GSB	Rated current (A)	Short-term current (I_{th}) (kA, rms, 2 s)	Dynamic current (I_d) (kA, peak)
800	2000	100	250

Mechanical loading

The cantilever operating loads (for vertical and horizontal mounting) and the test load are specified in Table 11. The force is applied at the center of the outer terminal of the bushing.

Table 11. Mechanical loads.

Mounting angle	Max. cantilever operating load according to IEC or continuous cantilever loading according to IEEE (kN)	Max. cantilever test load (kN) IEC and IEEE
Vertical	7.5	15
Horizontal	3.2	6.4

For extraordinary requirements relating to earthquakes, extreme environmental conditions and heavy equipment, consult the supplier.

Table 12. Earthquake loading.

Seismic standard	Allowed earthquake load	Installation angle from vertical	Verified by
IEC 61463	AG5 (5 m/s²)	45°	Static coefficient calculation
IEEE 693-2005	0.3 g	20°	Time history shake table test

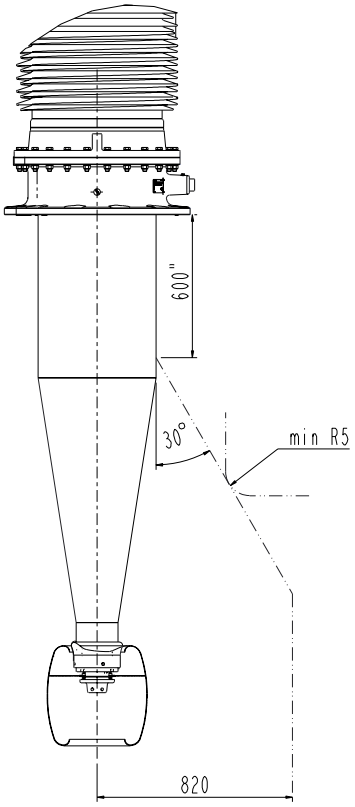
Installation information

If the bushings are mounted on seismic-exposed equipment, M27 fastening bolts with property class 8.8 (according to EN-ISO 898-1) must be used on the bushing mounting flange.

If bolts with other dimensions and property classes are used (e.g. for low seismic exposure levels), please contact the supplier for approval.

Recommendations for positioning

The maximum stresses in the oil at the surface of the conductor insulation must be limited to the normal values for insulated conductors and similar components in the same transformer. The adjacent recommendations are intended as guidelines when complete calculations are not carried out.



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12 Recommendations for positioning.
1) Space for earthed parts, e.g. CT and transformer turret flange.

Ordering particulars

When ordering, please state:
- Catalog number of bushing.
- Catalog number for outer terminal stud.
- Additional accessories or modifications.
- Tests required in addition to the normal routine tests.

When ordering an additional joint, please state the required H1-dimension, otherwise state “No additional joint“ in the order.

Ordering example:	
Bushing GSB 800:	1ZSC901800-CDB
Additional joint:	Yes, H1 = 260 mm
Bottom contact:	4649 131-G
End-shield:	LF 170 046-X
Outer terminal:	1ZSC004322-AAA
Lifting adapter:	Qty: 2 pcs, Art. No. 1ZSC004867-AAB
Lifting gear:	Qty: 1 pc, Art. No. 1ZSC004867-AAA
Flexible pull-through cord:	Qty: 1 pc, Art. No. 9760 669-A

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