1ZSC000563-AAC en, Rev. 4

Resin impregnated paper bushing, oil to air, type GSB
Technical guide

Power and productivity
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This Technical Guide has been produced to allow transformer manufacturers, and their designers and engineers, access to all the technical information required to assist them in their selection of the appropriate transformer bushing. The guide should be used in conjunction with the *Selection Guide* to allow the optimum selection to be made.

The technical information pertaining to bushings manufactured by ABB has been divided into separate documents, with one document for each type.

The information provided in this document is intended to be general and does not cover all possible applications. Any specific application not covered should be referred directly to ABB, or its authorised representative.

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Standards

The GSB bushing is designed and tested according to IEC 60137 and IEEE C57.19.00/01.

Design

GSB is a Resin Impregnated Paper (RIP) bushing intended for immersed oil – air service. The bushing is built up around an aluminium center tube on which the condenser core is wound. The core is wound from crepe paper with aluminium foil inserts for electrical stress control. The core is impregnated and cured in a vacuum, giving a partial discharge free bushing with low tan δ (dissipation factor). After curing, the core is machined and a flange and an insulator are fitted. The insulator is made of composite. The space between the RIP core and the insulator is then filled with an insulating gel.

As a current conductor, GSB uses the center tube on which the RIP core is molded. The oil side connection can be made with a draw-rod system, an inner terminal for draw lead, or a fixed bottom contact. The bottom contact is normally delivered with a standard end-shield. An alternative bottom contact is available to fit customized end-shields for draw rod only. For the air side connection there are studs available in a number of standard configurations, but it can also be modified to suit any connection need.

The bushing is designed to be mounted at an angle not exceeding 90° from the vertical. The standard colour of the composite insulator is ANSI 70 light gray.

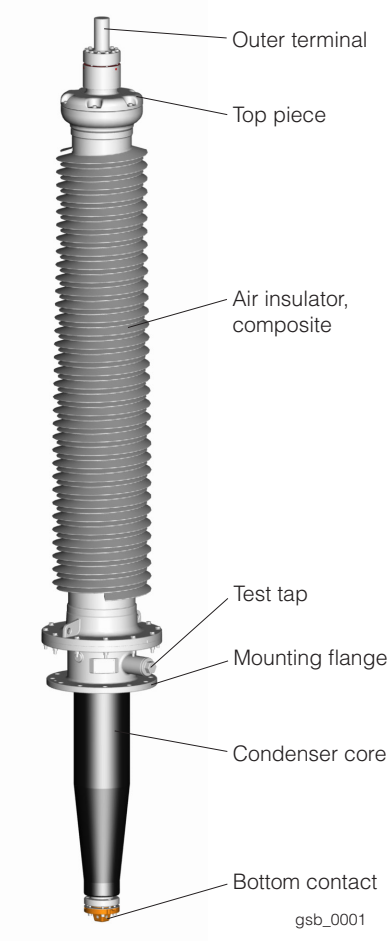

Fig. 1. Transformer bushing type GSB oil – air.

RIPCOAT

Water uptake on the oil-side of RIP bushings during transport, handling and storage leads to increased dielectric losses. At site this means that the bushings might need to be dried before assembling leading to delays. A water barrier "RIPCOAT" has been developed to solve this problem. The time to reach critical dissipation factor has been stretched by a factor of up to 80 by using RIPCOAT compared to bushings with an unprotected oil-side. Actual time depends highly on level of relative humidity and temperature.

Test tap

The mounting flange is an aluminium alloy casting with the gasket surface machined flat. On the flange there is a test tap. The outer conducting layer of the condenser body is connected to the insulated test tap. During operation the protective cap must be fitted to ground the outer conducting layer to the flange. The maximum test voltage is 2 kV, 50 Hz for 1 minute. The maximum service voltage is 600 V. Voltage tap, U_r= 6 kV, available as option.

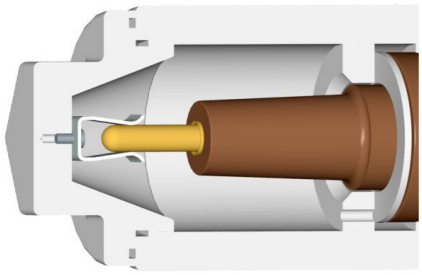

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Fig. 2. Test tap.

Test tap adapter

For permanent connection of the test tap to measuring circuits, a test tap adapter is sometimes required, for example if the IEEE dimension standard for measuring tap is not used.

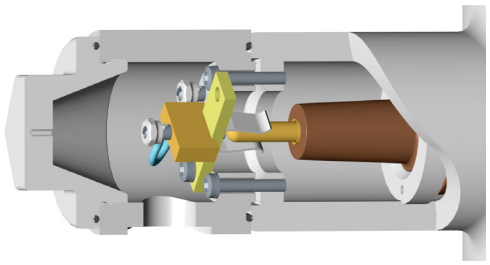

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Fig. 3. Test tap adapter.

Features	**Benefits**
Solid (Oil free)	Reduced risk of fire. Oil leakage from the bushing eliminated.
Seals the transformer	Reduced risk of fire. Risk of oil leakage from the transformer reduced.
Silicone insulator	Non-brittle material. Protection of people and equipment.
Easy handling	Safe transport - even when mounted on the transformer.
Light weight, compact	Easy handling, small space requirements inside transformer, low life cycle environmental impact.

Testing

Routine testing

The bushing is routine tested according to applicable standards. The tests include measurement of partial discharge quantity, tan δ, capacitance, and dry power frequency voltage withstand test. The flange is separately tightness tested with helium. A visual inspection is performed and an individual routine test report is issued with each bushing.

Type tests

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

Transportation and storage

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

Long term storage

Bushing for long term storage (>1 year) must be fitted with a metallic sealing tube. Metallic sealing tube will be included in the supply on request.

Electrical data

Ratings GSB	245	362	420	550-1675	550-1800
Rated voltage IEC (kV) / Nominal system voltage	245	362	420	550	550
Rated phase-to-ground voltage IEC (kV) / Insulation class (kV)	146	220	243	318	318
Rated line-to-ground voltage IEEE (kV)	146	220	243	318	318
Basic Insulation Level (kV)	1050	1175	1550	1675	1800
Dry switching impulse (kV)	850	950	1050	1300	1300
Wet switching impulse (kV)	750	950	1050	1300	1300
Rated current (A) IEC/IEEE	1600	1600	1600	1600	1600
Rated frequency (Hz)	50-60	50-60	50-60	50-60	50-60
Temporary over voltage (kV) IEC (phase-to-ground voltage)	196	290	336	440	440
Wet power frequency AC (kV)	460	n.a.	650	750	750
Dry power frequency, routine test 1 min. (kV)	506	561	693	750	750
Nominal capacitance between conductor and test tap C1 ±10 % (pF), with space for current transformer CT = 300/600 mm	663/769	619/701	579/652	553/612	553/612

[1)] Equal to dry lightning impulse withstand voltage.

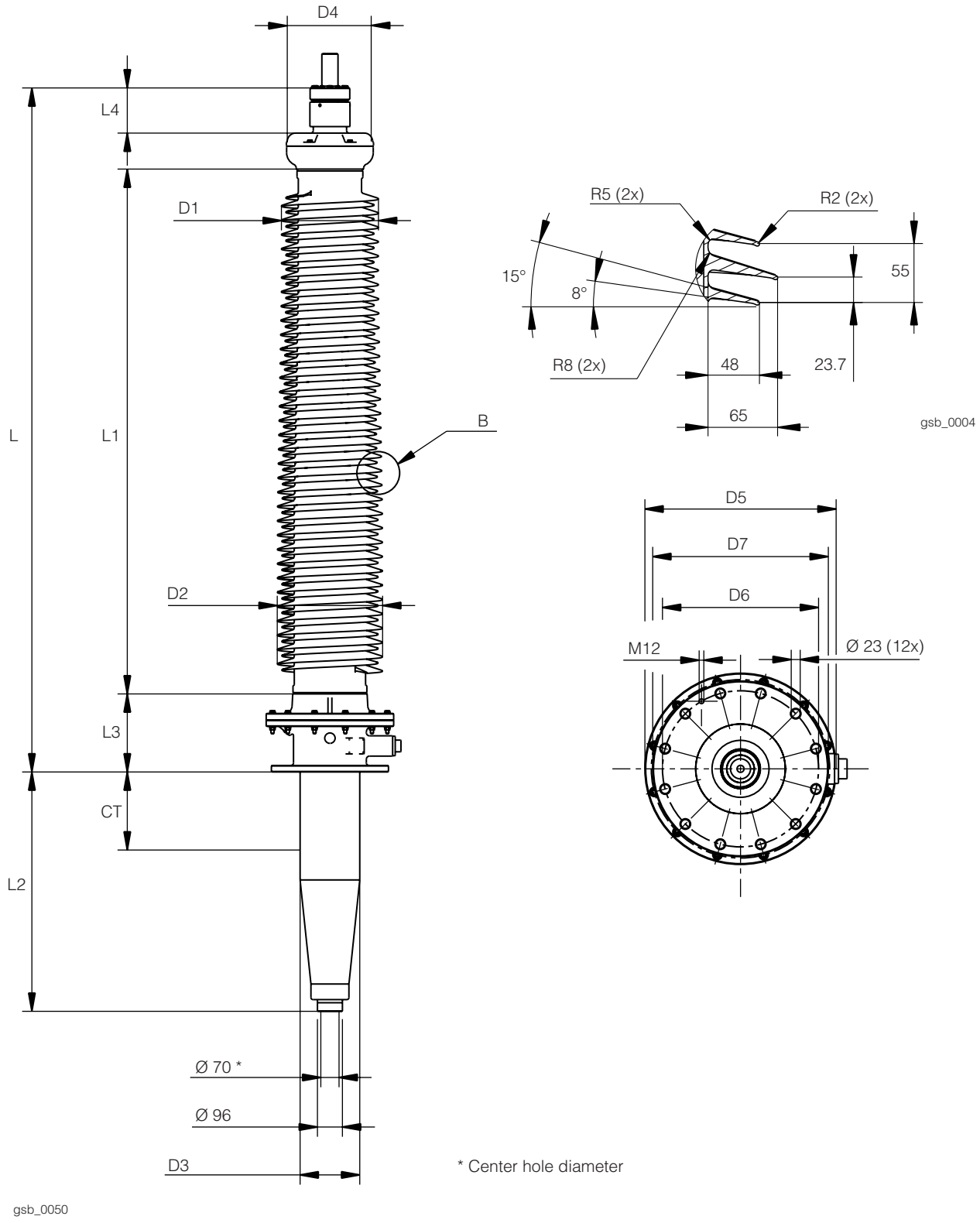
Draw lead current	GSB 245		GSB 362		GSB 420		GSB 550-1675 and 550-1800	
	IEC	IEEE	IEC	IEEE	IEC	IEEE	IEC	IEEE
1x50 mm^2	190	130	160	110	140	100	120	80
1x95 mm^2	290	200	280	190	240	170	200	140
1x150 mm^2	410	290	380	260	370	300	350	240
(3x95) 285 mm^2	700	490	570	400	570	400	510	350
(3x150) 450 mm^2	900	630	850	590	830	580	740	510
(3x240) 720 mm^2	1220	850	1120	780	1120	780	1000	700

General specifications

Application:	Transformers
Classification:	Resin impregnated paper, capacitance graded, outdoor immersed bushing, temperature class E (120 °C) acc. to IEC 60137
Ambient temperature:	+40 °C to -40 °C, minimum value acc. to temperature class 2 of IEC 60137
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
Pollution level:	Acc. 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 time overload: Maximum daily mean temperature +90 °C. Maximum temporary temperature: +115 °C.
Max pressure of medium:	100 kPa (over pressure)
Angle of mounting:	Horizontal to vertical
Test tap:	Dimensions according to IEEE Potential tap type A. Ur = max. 600 V
Voltage tap:	Dimensions according to IEEE Potential tap type A. Ur = 6 kV
Capacitance C2 of test tap:	< 5000 pF
Conductor:	Center tube or flexible draw lead conductor.
Markings:	Conforming to IEC/IEEE.
Cenelec Technical specification 50458	Yes, for GSB 245 and GSB 420

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

Dimensions



* Center hole diameter

Fig. 4. Dimensions.

Table 1. Dimensions (subject to modification without notice).

Type GSB	Cat. No. 1ZSC...	Test tap	Rated current (A)	Space for current transformer CT (mm)	Net mass (kg)	Creepage distance	
						Nominal	Minimum
245	901245-CAA	Test tap	1600	300	300	8705	8355
	-CBA	Voltage tap 6kV			300		
	-CAB	Test tap		600	320		
	-CBB	Voltage tap 6kV			320		
362	901362-CAA	Test tap	1600	300	450	12861	12345
	-CBA	Voltage tap 6kV			450		
	-CAB	Test tap		600	480		
	-CBB	Voltage tap 6kV			480		
420	901420-CAA	Test tap	1600	300	540	14322	13747
	-CBA	Voltage tap 6kV			540		
	-CAB	Test tap		600	570		
	-CBB	Voltage tap 6kV			570		
550-1675	901550-CAA	Test tap	1600	300	950	19242	18755
	-CBA	Voltage tap 6kV			950		
	-CAB	Test tap		600	1010		
	-CBB	Voltage tap 6kV			1010		
550-1800	901550-FAA	Test tap	1600	300	950	19242	18755
	-FBA	Voltage tap 6kV			950		
	-FAB	Test tap		600	1010		
	-FBB	Voltage tap 6kV			1010		

Dimensions

L	L1	L2	L3	L4	D1	D2	D3	D4	D5	D6	D7
2649	2005	920	305	193	373	405	230	335	490	400	450
		1220									
3539	2860	1035	340	194	372	446	276	335	535	400	450
		1335									
3919	3235	1090	345	194	376	480	300	335	560	450	500
		1390									
4949	4230	1285	375	199	458	548	374	455	635	500	550
		1585									
4949	4230	1285	375	199	458	548	374	455	635	500	550
		1585									

Connection details

The outer terminal needs to be specified in each case. The outer terminal is then used together with a draw rod, an inner terminal, or a fixed bottom contact.

Outer terminal

The outer terminal consists of a cylindrical stud. The mounting arrangements are the same for all GSB bushings, regardless of size, current rating and internal connection system. All GSB terminal studs will thus fit any GSB bushing.

The terminal stud assembly consists of a stud, a tightening ring, a gasket, bolts and washers. The electrical contact function and the sealing function are completely separated. The stud is first fastened to the bushing top with 6 bolts, M10, which provide the proper electrical contact. The contact surface is located inside the gasket and is thus well protected from corrosion. Finally, the tightening ring with the gasket is pressed against the stud by means of 6 additional bolts, M8.

The outer terminal is available in a number of standard configurations. Other configurations can be supplied on request.

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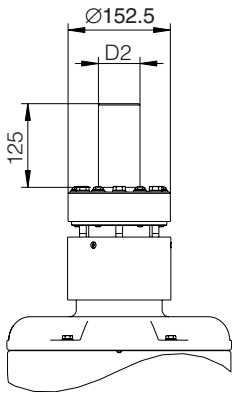

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Fig. 5. Outer terminal.

Cat. No.	Material	Plating	Stud diameter, D2 (mm)
1ZSC999001-AAA	Aluminium	-	30
1ZSC999001-AAB	Aluminium	-	60
1ZSC999001-AAC	Copper	-	30
1ZSC999001-AAD	Copper	-	40

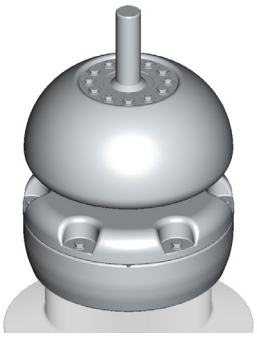
Table 2. Outer terminal. Max. torque on outer terminal 200 Nm.

Separate terminal plate with bolts

The separate terminal plate is available for stud with ø30 mm, and used for connecting the bushing to the line conductor.

Outer shield

This shield is standard for GSB 420 and 550. GSB 245 and 362 fulfil all requirements of the IEC and IEEE tests without outer shield. However, if extra shielding of the connected power lines is required, outer shields can be supplied on request also for these.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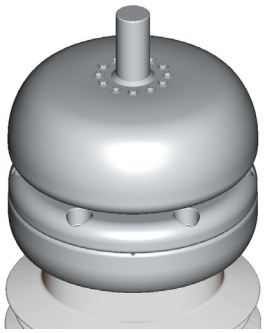
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Fig. 6. Outer shield - GSB 420 and 550.

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 is used.

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

Cat. No.	Conductor diameter, D3 (mm)
1ZSC999005-AAA	15
1ZSC999005-AAB	30
1ZSC999005-AAC	40
1ZSC999005-AAD	42

Table 4. Inner terminal.


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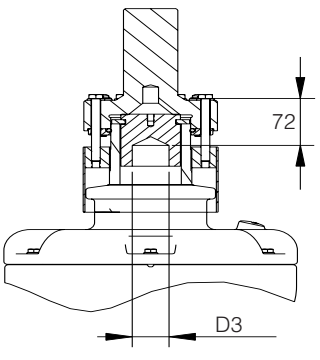

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Fig. 7. Inner terminal.

Draw rod system

The draw rod system offers the following advantages compared to other methods used for high currents:

- No manholes required in the transformer tank.
- The bushing tube is used as a conductor.
- No special supports required in the transformer, as is the case with plug contacts.
- Perfect guiding of the bushing into the transformer.

The center tube of the bushing is used as conductor. The transformer leads are fitted with cable lugs, bolted to a bottom contact. This contact is tightened to the lower end of the bushing tube by a steel draw rod. The upper end of this rod is bolted to a spring device, which consists of two concentric tubes of different materials, designed to give the required contact load at all temperatures. The draw rod is divided into two parts at level with the flange. If required to meet the transport conditions, an additional joint can be positioned at any desired level below the flange. This must be stated in the order. The lower part with contact and end-shield can then be secured to the transport cover during transport and storage of the transformer.

Bottom contacts with 4 threaded holes for cable lugs are available. The bottom contacts are made of copper in one piece. There is a suitable end-shield (Cat. No. 1ZSC999003-AEA) for this bottom contact. For more information, see *Standard end shield*. Special bottom contacts are available on request.

Cat. No.	Type of draw rod
1ZSC999006	Lower draw rod
1ZSC999007	Upper draw rod

Table 3. Draw rod system.

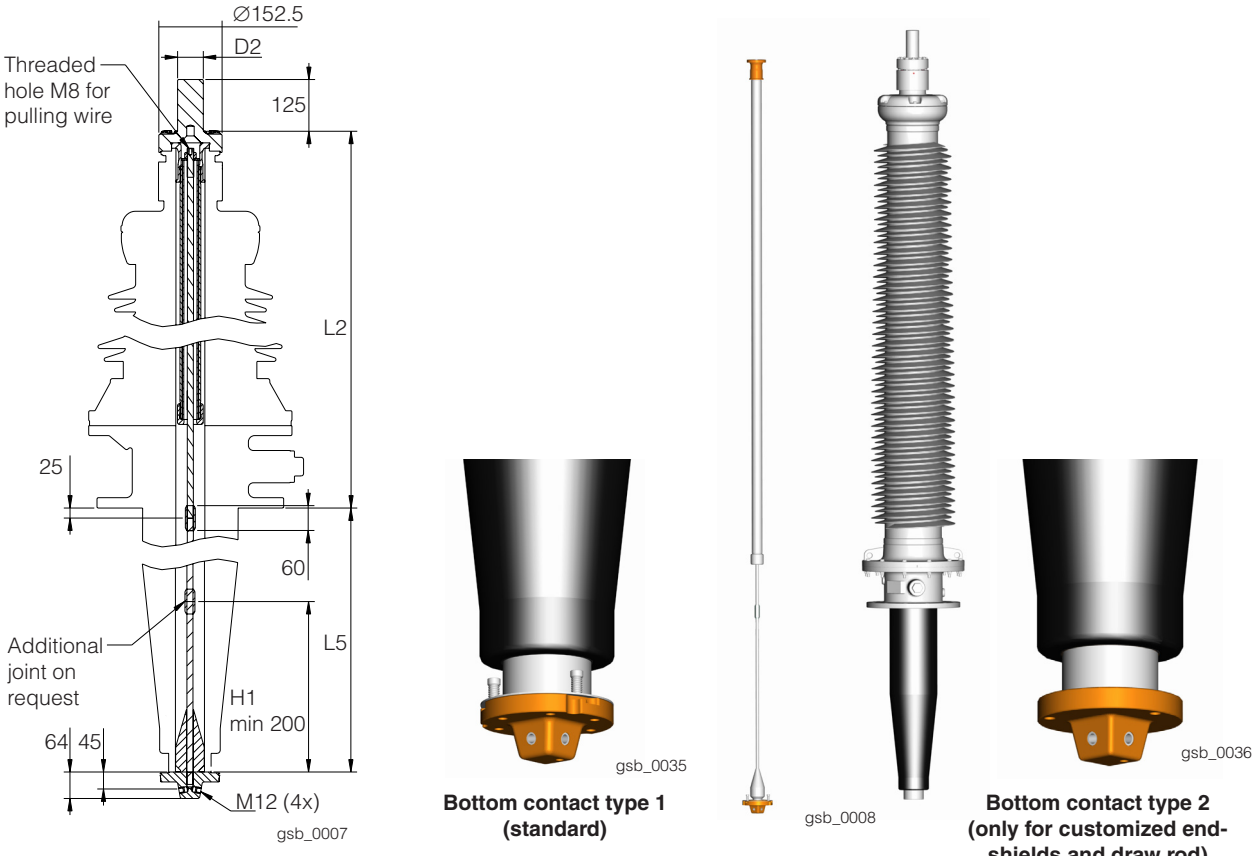


Fig. 8. Draw rod system.

Fixed bottom contact

The fixed bottom contact (Cat. No. 1ZSC999002-AAE) uses the same bottom contact as in the draw rod system, i.e. it is made of copper in one piece and has 4 threaded holes for cable lugs. The fixed bottom contact system also uses the center tube as a current conductor but it is secured to the center tube with a pulling ring instead of the draw rod. The pulling ring is made of aluminium and is threaded on to the center tube. The bottom contact is then fastened to the ring with six M10 bolts, similar to the outer terminal. End-shield, Cat. No. 1ZSC999003-AEA, is suitable for the bottom contact. Type 2 bottom contact cannot be used with fixed bottom contact.

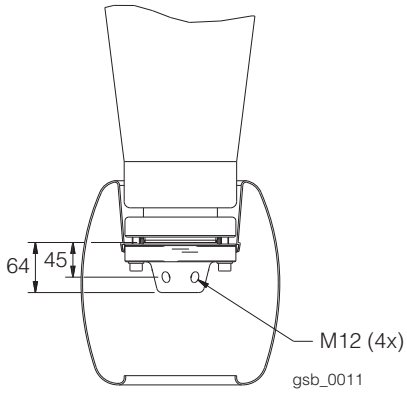


Fig. 9. Fixed bottom contact 1ZSC999002-AAE.

Standard end-shield

The end-shield is made of aluminium and coated with insulating epoxy paint or 3 mm of pressboard. The design enables easy installation and should be used with standard draw rod bottom contact, the fixed bottom contact system and the adapter for the inner terminal.

Cat. No.	Coating
1ZSC999003-AEA	Epoxy paint
1ZSC999003-AEB	3 mm pressboard

Table 5. End-shield. Bottom contact type 1 (see Fig. 10) must be used together with standard end-shield.

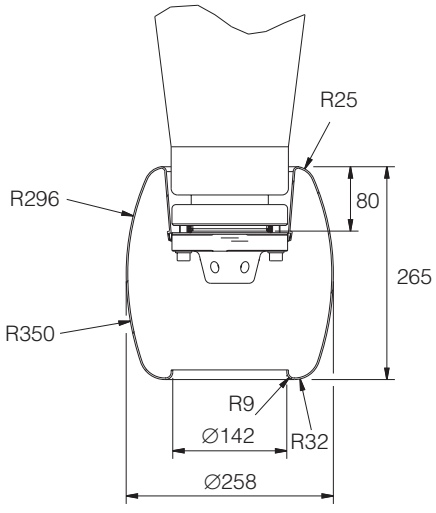


Fig. 10. End-shield.

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

The GSB bushings fulfill the temperature rise test requirements according to IEC for the currents in the table below. The short-time current is also calculated according to IEC 60137 and listed in Table 6.

Overloading of bushings acc. 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 the directions: for long time and short time emergency loading the oil temperature must be 115 °C max. and the daily mean oil temperature must be 90 °C max.

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

Short-time current

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

Bushing GSB	Rated current A	Short-time current (I_{th}) kA, rms, 2 s	Dynamic current (I_d) kA, peak
245	1600	40	100
362	1600	40	100
420	1600	40	100
550	1600	40	100

Table 6. Short-time current.

Mechanical loading

The cantilever operational and test loads are given in Table 7. The force is applied at the center of the outer terminal of the bushing. For extraordinary requirements which include earthquakes, extreme environmental conditions and heavy equipment, consult the supplier. The tests are performed in accordance with IEC 60137 and IEEE C57.19.00.

Bushing GSB	Max. cantilever operating load for vertical mounting kN	Max. cantilever operating load for horizontal mounting kN	Max. cantilever test load kN
245	2.8	2	5.6
362	3.2	2	6.3
420	3.3	2	6.6
550	6.5	4	13

Table 7.

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.

Type	CT (mm)	R (mm)
GSB 245/1600/0.3	300	325
GSB 245/1600/0.6	600	325
GSB 362/1600/0.3	300	360
GSB 362/1600/0.6	600	360
GSB 420/1600/0.3	300	460
GSB 420/1600/0.6	600	460
GSB 550/1600/0.3	300	510
GSB 550/1600/0.6	600	510

Table 8.

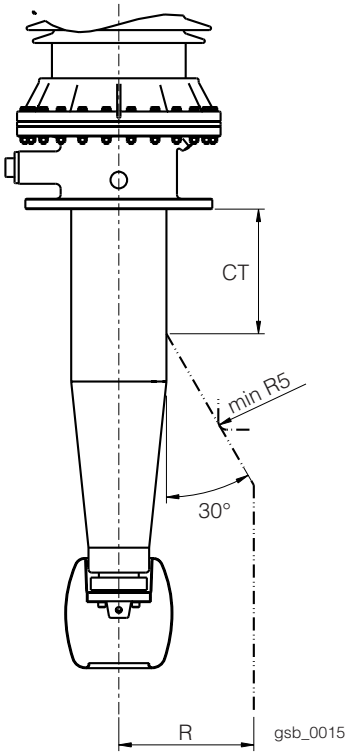


Fig. 11. Recommendations for positioning.

Ordering particulars

When ordering, please state:

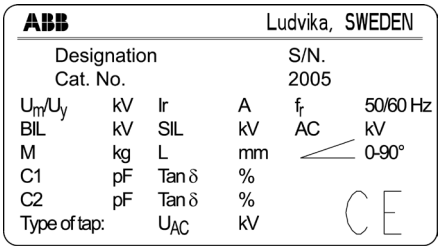
- Type and catalogue number for bushing.
- Catalogue number for inner terminal, fixed bottom contact or draw rod, lower and upper part.
- Catalogue number for outer terminal.
- Additional accessories or modifications.
- Test required, in addition to the normal routine tests.

Ordering example 1:

Bushing:	GSB 245/1600/0,6 Composite, test tap	1ZSC901245-CAB
Connection:	Draw rod, lower, additional joint H1 = 300 mm	1ZSC999006
	Draw rod, upper, bottom contact type 1 standard	1ZSC999007
Outer terminal:	Copper/Silver, D2 = 30 mm	1ZSC999001-AAC
End-shield:	Epoxy insulated	1ZSC999003-AEA

Ordering example 2:

Bushing:	GSB 420/1600/0,3 Composite, voltage tap	1ZSC901420-CBA
Connection:	Inner terminal D3 = 30 mm	1ZSC999005-AAB
Outer terminal:	Aluminium, D2 = 60 mm	1ZSC999001-AAB
End-shield:	Pressboard insulated	1ZSC999003-AEB



Nameplate

Contact us

ABB AB
Components
Visiting address: Lyviksvägen 10
Postal address: SE-771 80 Ludvika, Sweden
Phone: +46 240 78 20 00
Fax: +46 240 121 57
E-Mail: sales@se.abb.com

www.abb.com/electricalcomponents