1ZSC000563-AAC EN, REV. 9

Transformer bushings type GSB

Technical guide

Original instruction

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 authorized representative.

We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

Table of contents

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 or porcelain. 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.

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

Features and 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.
- Non-shattering materials – Silicone insulator. 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.
- Seismic qualified by shake table tests.

Transportation and long term storage
On the oil side of the bushing, a metallic sealing container, containing drying agent, is fitted. The sealing container will protect the oil side from moisture absorption. It is important that the sealing container is fitted during transport and storage. The container is suitable both for short-time storage (≤6 months) and long-time storage. The bushing can be stored outdoors when the sealing container is fitted.

As an option, the moisture barrier “RIPCOAT” can be supplied as extra protection when the container is not mounted.

1. Outer terminal
2. Top piece
3. Composite or porcelain insulator
4. Test tap
5. Mounting flange
6. RIP core
7. Bottom contact

—
01 Transformer bushing type GSB oil – air.

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 to -40 °C (-60 °C according to GOST 10693-81 in applicable parts.)
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:	According to specific creepage distance and IEC 60815
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. U_r = max. 600 V
Voltage tap:	Dimensions according to IEEE Potential tap type A. U_r = 6 kV
Capacitance C_2 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

Testing

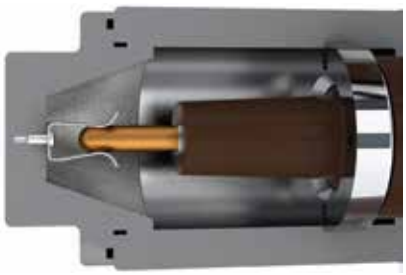
Routine testing
The bushing is routine tested according to applicable standards. The tests include measurement of partial discharge quantity, tan δ, capacitance, and dry power frequency voltage withstand test. The flange is separately tightness tested with helium. A visual inspection is performed and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

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

Seismic qualification
GSB bushing with composite insulator have been qualified in shake table tests for High Performance Level IEEE 693-2005. Executed tests also satifies seismic requirements for AG5 (0.5g) of IEC TS 61463.

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.

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.



— 02 Test tap.

— 03 Test tap adapter.

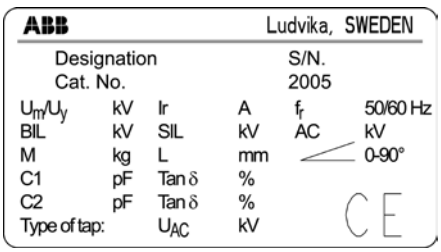
Electrical data

Table 2. 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) (Equal to dry lightning impulse withstand voltage.)	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					
Al conductor	2000	1600	1600	1600	1600
Cu conductor	3150	3150	2500	2500	2500
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	695	750	750
Nominal capacitance between conductor and test tap C_1 ±10 % (pF), with space for current transformer CT = 300/600 mm	663/769	619/701	579/652	553/612	553/612

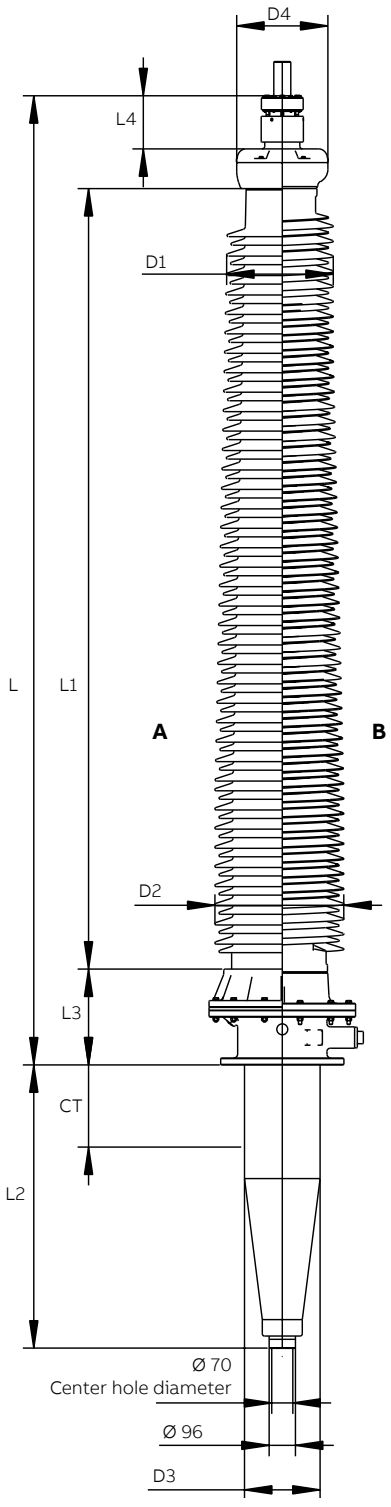
Table 3. Draw lead current.

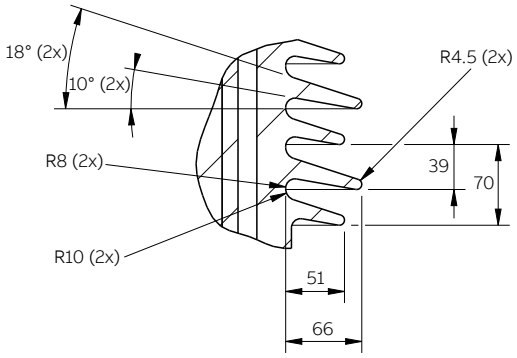
	GSB 245		GSB 362		GSB 420		GSB 550-1675 and 550-1800	
Draw lead current	**IEC**	**IEEE**	**IEC**	**IEEE**	**IEC**	**IEEE**	**IEC**	**IEEE**
1x50 mm²	190	130	160	110	140	100	120	80
1x95 mm²	290	200	280	190	240	170	200	140
1x150 mm²	410	290	380	260	370	300	350	240
(3x95) 285 mm²	700	490	570	400	570	400	510	350
(3x150) 450 mm²	900	630	850	590	830	580	740	510
(3x240) 720 mm²	1220	850	1120	780	1120	780	1000	700



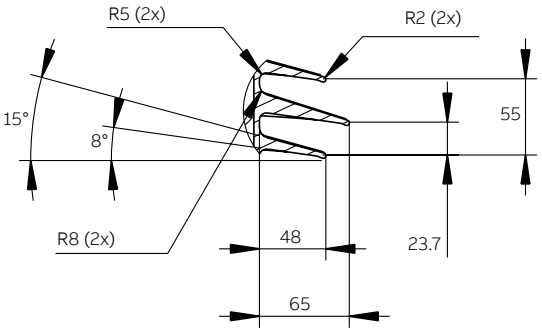
04 Nameplate with marking example.

Dimensions

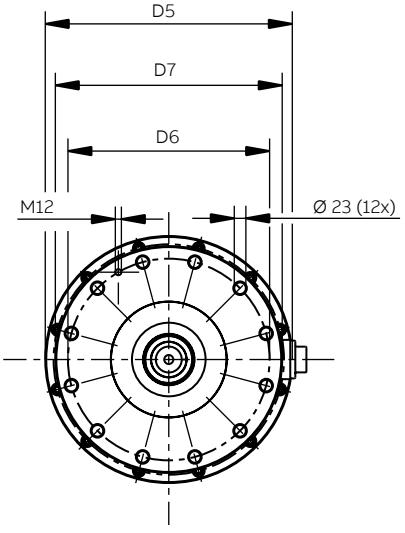




A: Porcelain



B: Composite



—
05 Dimensions.

—

Table 4. Dimensions.
Dimensions are subject to modification without notice.

						Dimensions (mm)				
Type GSB	**Cat. No. 1ZSC... (Al / Cu)**	**Air insulator type /color**	**Cat. No. 1ZSC... (Al / Cu)**	**Air insulator type /color**	**Test tap**	**L**	**L1**	**L2**	**L3**	**L4**
245	901245-AAA	Porcelain, brown	901245-BAA	Porcelain, grey	Test tap	2650	2005	920	305	195
	901245-ABA	Porcelain, brown	901245-BBA	Porcelain, grey	Voltage tap 6 kV					
	901245-AAB	Porcelain, brown	901245-BAB	Porcelain, grey	Test tap			1220		
	901245-ABB	Porcelain, brown	901245-BBB	Porcelain, grey	Voltage tap 6 kV					
	901245-CAA / -CCA	Composite			Test tap			920		
	-CBA / -CDA	Composite			Voltage tap 6 kV					
	-CAB / -CCB	Composite			Test tap			1220		
	-CBB / -CDB	Composite			Voltage tap 6 kV					
362	901362-AAA	Porcelain, brown	901362-BAA	Porcelain, grey	Test tap	3540	2860	1035	340	195
	901362-ABA	Porcelain, brown	901362-BBA	Porcelain, grey	Voltage tap 6 kV					
	901362-AAB	Porcelain, brown	901362-BAB	Porcelain, grey	Test tap			1335		
	901362-ABB	Porcelain, brown	901362-BBB	Porcelain, grey	Voltage tap 6 kV					
	901362-CAA / -CCA	Composite			Test tap			1035		
	-CBA / -CDA	Composite			Voltage tap 6 kV					
	-CAB / -CCB	Composite			Test tap			1335		
	-CBB / -CDB	Composite			Voltage tap 6 kV					
420	901420-AAA	Porcelain, brown	901420-BAA	Porcelain, grey	Test tap	3920	3235	1090	345	195
	901420-ABA	Porcelain, brown	901420-BBA	Porcelain, grey	Voltage tap 6 kV					
	901420-AAB	Porcelain, brown	901420-BAB	Porcelain, grey	Test tap			1390		
	901420-ABB	Porcelain, brown	901420-BBB	Porcelain, grey	Voltage tap 6 kV					
	901420-CAA / -CCA	Composite			Test tap			1090		
	-CBA / -CDA	Composite			Voltage tap 6 kV					
	-CAB / -CCB	Composite			Test tap			1390		
	-CBB / -CDB	Composite			Voltage tap 6 kV					
550-1675	901550-AAA	Porcelain, brown	901550-BAA	Porcelain, grey	Test tap	4950	4230	1285	375	200
	901550-ABA	Porcelain, brown	901550-BBA	Porcelain, grey	Voltage tap 6 kV					
	901550-AAB	Porcelain, brown	901550-BAB	Porcelain, grey	Test tap			1585		
	901550-ABB	Porcelain, brown	901550-BBB	Porcelain, grey	Voltage tap 6 kV					
	901550-CAA / -CCA	Composite			Test tap			1285		
	-CBA / -CDA	Composite			Voltage tap 6 kV					
	-CAB / -CCB	Composite			Test tap			1585		
	-CBB / -CDB	Composite			Voltage tap 6 kV					
550-1800	901550-DAA	Porcelain, brown	901550-EAA	Porcelain, grey	Test tap	4950	4230	1285	375	200
	901550-DBA	Porcelain, brown	901550-EBA	Porcelain, grey	Voltage tap 6 kV					
	901550-DAB	Porcelain, brown	901550-EAB	Porcelain, grey	Test tap			1585		
	901550-DBB	Porcelain, brown	901550-EBB	Porcelain, grey	Voltage tap 6 kV					
	901550-FAA / -FCA	Composite			Test tap			1285		
	-FBA / -FDA	Composite			Voltage tap 6 kV					
	-FAB / -FCB	Composite			Test tap			1585		
	-FBB / -FDB	Composite			Voltage tap 6 kV					

										Creepage distance (mm)	
D1	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**Rated current (A) (Al / Cu)**	**Space for current transformer CT (mm)**	**Net mass (kg) (Al / Cu)**	**Nominal**	**Minimum**
396	444	228	335	490	400	450	2000 / 3150	300	470 / 550	7022	6740
								600	490 / 570		
373	405							300	300 / 380	8705	8355
								600	320 / 400		
406	492	274	335	535	400	450	1600 / 3150	300	720 / 820	10371	9955
								600	750 / 850		
372	446							300	450 / 550	12861	12345
								600	480 / 580		
412	527	300	335	560	450	500	1600 / 2500	300	940 / 1050	11852	11550
								600	970 / 1080		
376	480							300	540 / 650	14322	13747
								600	570 / 680		
466	602	374	455	635	500	550	1600 / 2500	300	1550 / 1690	15519	15125
								600	1610 / 1750		
448	548							300	950 / 1090	19242	18755
								600	1010 / 1150		
466	602	374	455	635	500	550	1600 / 2500	300	1550 / 1690	15519	15125
								600	1610 / 1750		
448	548							300	950 / 1090	19242	18755
								600	1010 / 1150		

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.

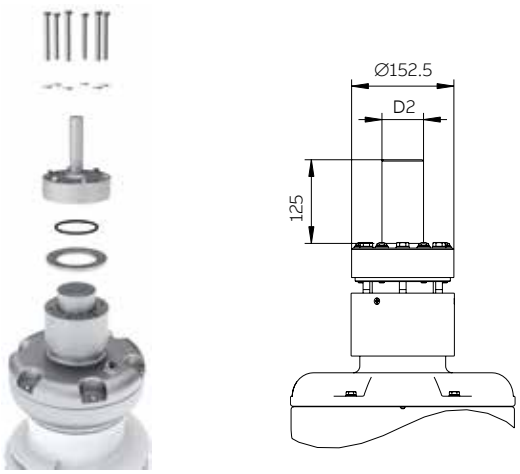
The outer terminal is available in a number of standard configurations. Other configurations can be supplied on request.

Table 5. Outer terminal. Max. torque on outer terminal 200 Nm.

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

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 (Cat. No. 2748 682-DN) and 550 (Cat. No. 2748 682-DY). 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 shield (Cat. No. 2748 682-DN) can be supplied on request also for these.



06 Outer terminal.

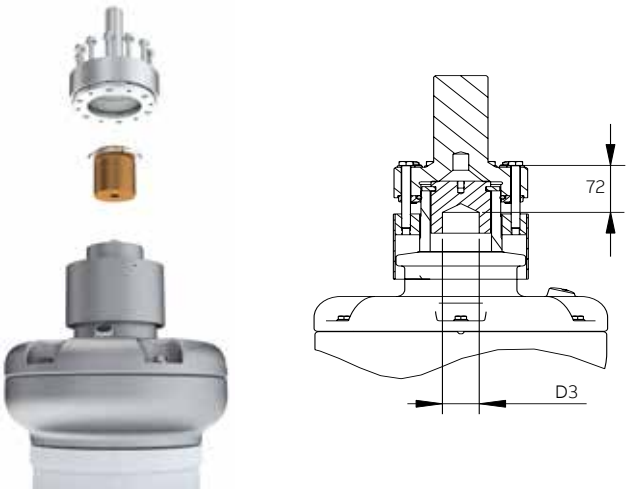
07 Outer shield - GSB 420 and 550.

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 (Cat. No. 1ZSC999002-AAG) is used.

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

—
Table 6. Inner terminal.

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



—
08 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. The lower draw rod includes bottom contact, guide cone, rod and joint. The upper draw rod consists of compensating device, rods, joints, washer and nut.

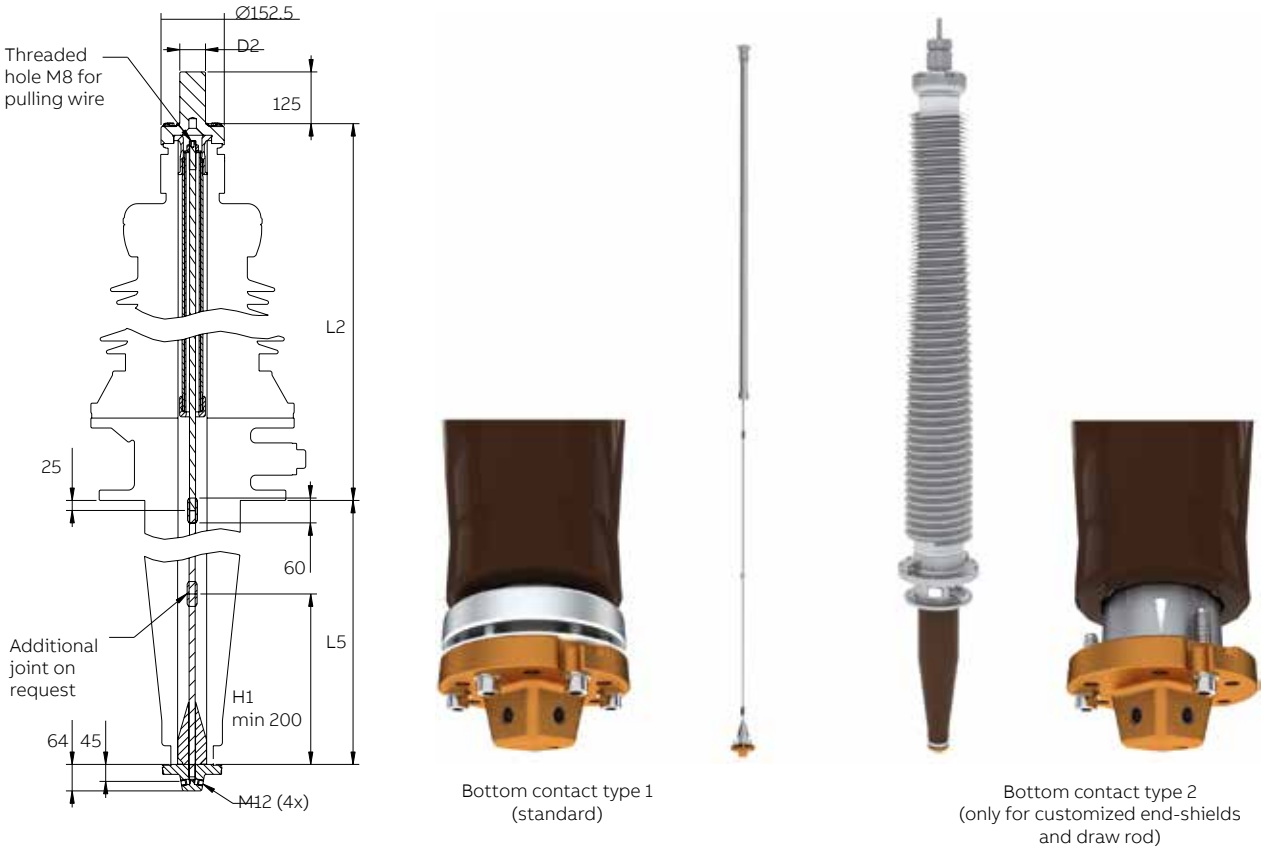
If required to meet the transport conditions, an additional joint can be positioned at any desired level below the flange. This must be stated in the order. The lower part with contact and end-shield can then be secured to the transport cover during transport and storage of the transformer.

Bottom contacts with 4 threaded holes for cable lugs are available. The bottom contacts are made of copper in one piece. There are standard end-shields for type 1 bottom contacts available; see Standard end shield and Table 8. The type 2 bottom contact is intended to use with customized shields, using three M10 holes at diameter 125 mm for shield assembly. Special bottom contacts are available on request.

—

Table 7. Draw rod system.

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



—

09 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.

Standard end-shield

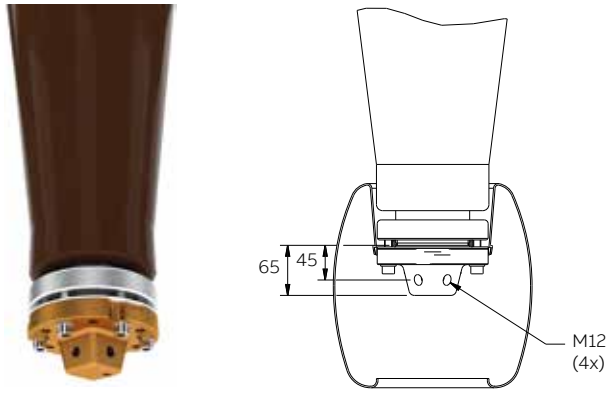
The end-shield is made of aluminium and coated with insulating epoxy paint or 3 mm of pressboard. The design enables easy installation and should be used with standard draw rod bottom contact, the fixed bottom contact system and the adapter for the inner terminal.

Table 8. End-shield. Bottom contact type 1 (see Fig. 11) must be used together with standard end-shield.

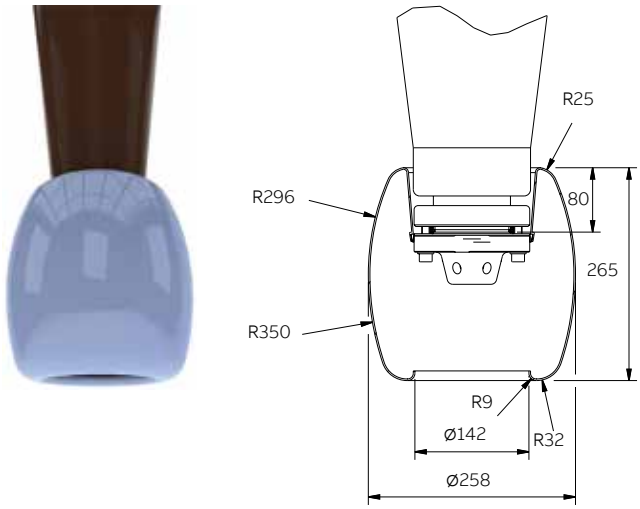
Cat. No.	Coating
1ZSC999003-AEA	Epoxy paint
1ZSC999003-AEB	3 mm pressboard

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.



10 Fixed bottom contact 1ZSC999002-AAE.



11 End-shield.

Conductor loading and mechanical loading

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 60076-7 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.

Table 9. Short-time current.

Type GSB	Rated current A	Short-time current (I_{th}) kA, rms, 2 s	Dynamic current (I_d) kA, peak
245	2000	100	250
	3150	100	250
362	1600	100	250
	3150	100	250
420	1600	100	250
	2500	100	250
550	1600	100	250
	2500	100	250

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. All cantilever loads exceed IEC 60137 Level II and IEEE C57.19.01-2000.

Table 10. Mechanical loading.

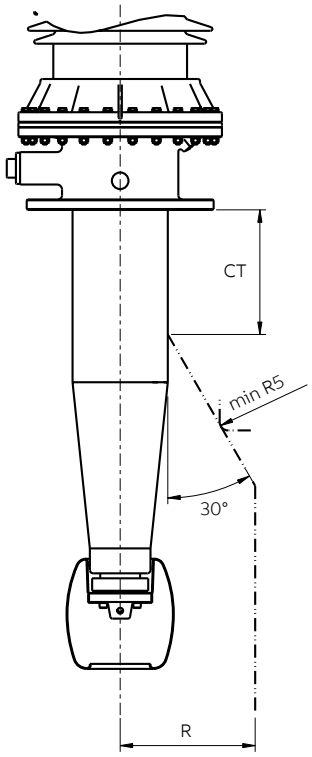
Type GSB	Max. cantilever operating load for vertical mounting kN	Max. cantilever operating load for horizontal mounting kN	Max. cantilever test load kN
245	2.8	2	5.6
362	6.0	4	12
420	6.5	4	13
550	6.5	4	13

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.

Table 11. Recommendations for positioning.

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



12 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 245/2000/0,6 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

ABB AB, Components
SE-771 80 Ludvika
Sweden
E-mail: sales@se.abb.com

www.abb.com/transformercomponents

1ZSC000563-AAC en, Rev. 9, 2018-11-15