GE
Grid Solutions

PWO

Capacitance Graded Wall Bushings From 52 to 245 kV - Oil-impregnated Paper

PWOs are capacitance-graded bushings with oil impregnated paper insulation designed to transfer the electrical current through walls or frameworks when both sides are exposed to water or to industrial pollution. They comply with the latest edition of IEC 60137.

Conception, components and manufacturing technology ensure an average life time of over 30 years under normal operating conditions.

Manufacturing of Capacitance Graded Bushings

The main electrical insulation is provided by a condenser body made of a continuous sheet of pure Kraft paper wound round a conductor rod made of aluminum or copper, depending on the current rating. The paper is dried by heated cylinders and infrared rays during winding to reduce the water content in the paper to a maximum of 1 % maximum. During winding, a series of cylindrical aluminum foils are inserted coaxially between the layers of paper. These foils assure the best possible distribution of the radial and longitudinal electrical gradient between the conductor and the fixing flange, which is grounded. Winding is computer-controlled, with simultaneous machining to the final shape. After winding, the bushing is assembled and placed in an oven at 105°C.

Each bushing is individually vacuum treated, kept at 4.10-2 mbar for several days, and impregnated with oil, with a maximum humidity content of3 ppm. It is then suitably degassed. Impregnation is carried out under pressure to maximize efficiency and to test for tightness.

The whole treatment process is automatic and computer-controlled.

Outdoor Sides

Envelopes of both sides are made of porcelain (on request, resin fiber glass envelopes covered with a silicone shed).

The creepage distance has been defined for very highly polluted atmosphere (approximately 31 mm/kV). The shed configuration is alternate (small – large sheds). This is the most effective solution, as demonstrated by salt tests, and the shed profile complies with the recommendations of IEC 60815–1986. In case of a very long creepage distance or service at altitude, over and above the indications in the table on Page 3, a special design is available upon request.

Standards

- IEC 60137

Key Benefits

- Installation in any position
- Longer lifetime and higher reliability
- Utilization under extreme weather conditions
- No performance reduction with age

Imagination at work

PWO Outdoor-to-Outdoor Oil-impregnated Paper

- Porcelain envelope both sides
- Fully filled with oil with compensation bellows
- Mineral impregnating oil
- Partial discharges < 5 pC at 1.5 Um/√3
- Provided with power factor tap
- Flange of aluminum alloy casting
- Execution with solid conductor
- For horizontal or vertical installation

Oil Compensation Bellows

PWO bushings are completely filled with oil and are provided with one or more bellows located on the flange (52 to 170 kV bushings) or in the heads (245 kV bushing) to compensate for variation in the oil volume caused by temperature changes during the operation of the bushings. The number of bellows depends on the volume of oil to be compensated for.

The bellows are filled with oil and can expand without variation of pressure. A metal cover protects it.

Gaskets

They are made of Viton®, a fluorocarbon rubber elastomer (FPM), o-ring type. They are compatible with all the fluids they are in contact with. Air side gaskets are carefully protected, by means of a sealing, against influence of polluting weather elements.

For special requirements such as low ambient temperatures (down to -55 °C), special o-rings are used.

1. Closing and grounding cap
2. Measurement electrode
3. Insulating bushing
4. Gasket
5. Mounting flange
6. Last layer

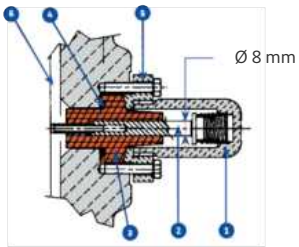


Fig. 2: Power factor tap

Bushing Designation PWO.145.650.1250

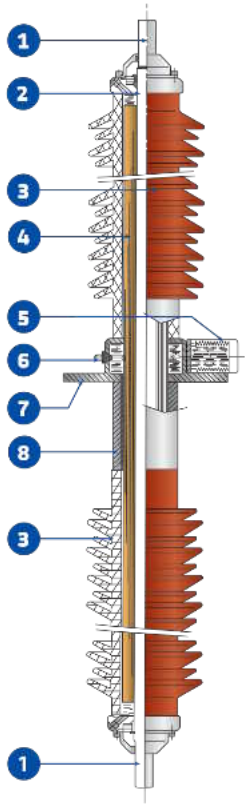
P	Condenser bushings (“P” from the Italian word “Passante”)
W	Through-wall type
O	Oil paper insulation (OIP)
145	Rated voltage in kV
650	BIL in kV
1250	Rated current in A

Flange

The flange is made of aluminum casting and equipped with the following accessories:

- Power factor tap (tested at 2.5 kV for 60 s)
- Lifting holes
- Grounding holes

The “K” dimension (column 23) is for standard a wall thickness (300 mm); other thicknesses in steps of 100 mm are available on request. If necessary the “K” dimensions can be used to accommodate a CT.



1. HV Terminal
2. Winding rod
3. Porcelain
4. OIP Condenser
5. Oil compensation bellows
6. Power factor tap
7. Flange
8. Earthing sleeve

Fig. 1: PWO

Arcing Horns

Adjustable arcing horns can be provided on request.
There are threaded holes on the flange for installing the lower one. The upper arcing horn is fixed with one of the screws used for the fixing of the HV terminal. Figure 6 shows the suggested discharge distance between arcing horns.

Test

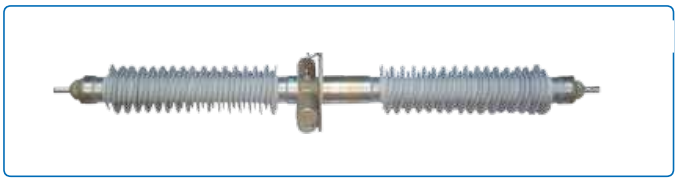
All the bushings are tested and have electrical characteristics in compliance with latest edition of IEC 60137 publication bushings for alternating voltage above 1000 V and the main national standards.

Electrical and Mechanical Data

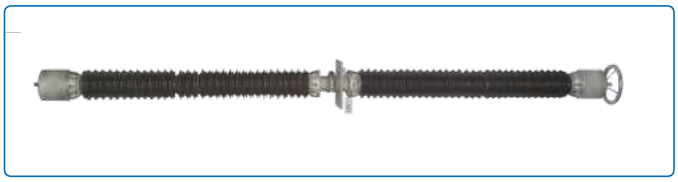
Type	Rated voltage	Rated phase to earth voltage	Dry and wet power frequency withstand voltage for 60 s.	Dry lightning impulse withstand voltage	Rated current	Free insulating lenght in air		Min. nominal creepage distance		Cantilever load		Weight		Maximum operating altitude	
						Fig. 4	Fig. 5	Fig. 4	Fig. 5	Fig. 4	Fig. 5	Fig. 4	Fig. 5	Fig. 4	Fig. 5
Type	kV	kV	kV	kV	A	mm	mm	mm	mm	N	N	kg	kg	m	m
52.250.1250	52	30	95	250	1250	495	435	1602	1542	1250	1600	70	74	3000	2000
52.250.1600					1600							88	92		
52.250.2000					2000					2000	2500	...	...		
72.5.325.1250	72.5	42	140	325	1250	645	585	1240	2180	1250	2000	90	94	3000	2000
72.5.325.1600					1600							110	114		
72.5.325.2000					2000					2000	3150	...	...		
100.450.1250	100	58	185	450	1250	870	810	2977	2917	1250	1600	110	114	3000	2500
100.450.1600					1600							135	139		
100.450.2000					2000					1600	2500				
123.550.1250	123	71	230	550	1250	1040	1210	3842	4339	1600	3150	170	220	2500	3000
123.550.1600					1600										
123.550.2000					2000					2000	4000	200	255		
145.650.1250	145	84	275	650	1250	1290	1210	4419	4339	1600	3150	215	220	3000	2500
145.650.1600					1600							250	255		
145.650.2000					2000					2000	4000				
170.750.1250	170	98	325	750	1250	1480	1400	5213	5133	1600	4000	230	235	2500	2000
170.750.1600					1600										
170.750.2000					2000					2000	5000	278	283		
245.1050.1250	245	142	460	1050	1250	...	2000	...	7611	...	4000	...	580	...	1000
245.1050.1600					1600										
245.1050.2000					2000					...	5000		660		

higher voltage current ratings available upon request

Type	L		L1		L2		L3	K	D1	D2	D3	D4	d1	c1	n	f	s	D5	D6	Terminal material
	Fig. 4	Fig. 5	Fig. 4	Fig. 5	Fig. 4	Fig. 5					Fig. 7							Fig. 8		
Type	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N°	mm	mm	mm	mm	mm
52.250.1250	1800	1765	820	845	980	920	185	300	145	240	420	480	40	80	4	22	20	...	...	AL
52.250.1600																				CU
52.250.2000	1880	1845	860	885	1020	960	225							120						
72.5.325.1250	2100	2065	970	995	1130	1070	185	300	145	240	420	480	40	80	4	22	20	...	...	AL
72.5.325.1600																				CU
72.5.325.2000	2180	2145	1010	1035	1170	1110	225							120						
100.450.1250	2550	2515	1195	1220	1355	1295	185	300	145	247	420	480	40	80	4	22	20	...	...	AL
100.450.1600																				CU
100.450.2000	2630	2595	1235	1260	1395	1335	225							120						
123.550.1250	2890	3335	1365	1640	1525	1695	185	300	170	275	420	480	40	80	4	22	20	...	...	AL
123.550.1600																				CU
123.550.2000	2970	3415	1405	1680	1565	1735	225							120						
145.650.1250	3390	3335	1615	1640	1775	1695	185	300	170	275	420	480	40	80	4	22	20	...	...	AL
145.650.1600																				CU
145.650.2000	3470	3415	1655	1680	1815	1735	225							120						
170.750.1250	3770	3715	1805	1830	1965	1885	185	300	170	275	420	480	40	80	4	22	20	420	480	AL
170.750.1600	3810	3755	1825	1850	1985	1905	205						50	100						CU
170.750.2000	3850	3795	1845	1870	2005	1925	225							120						
245.1050.1250	....	5620	...	2770	...	2850	550	300	380	330	...	...	40	80	4	22	21	420	480	AL
245.1050.1600		5660		2790		2870	570						50	100						
245.1050.2000		5700		2810		2890	590							120						



PWO 123 kV



PWO 245 kV

Packing - Transportation

PWO bushings are normally shipped in the horizontal position in cases of three for voltages up to 170 kV or in individual cases for a voltage of 245 kV.

Installation

PWO bushings can be installed in any position. The actual installation has to be defined on ordering to allow the proper orientation of the porcelain sheds.

Rated Voltage	"h" Discharge distance ± 10 %
kV	mm
52	320
72.5	450
100	600
123	750
145	900
170	1000
245	1450

Fig. 6: "h" Discharge distance

1. *Porcelain*
2. *Cement*
3. *Metal cemented ring*
4. *Flange*
5. *Silicone sealing*

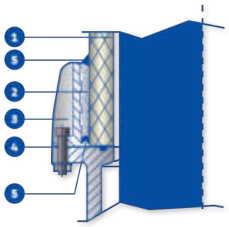


Fig. 3: Cemented porcelain

Insulating Fluid

The impregnation is made with a top quality inhibited super grade mineral oil, fully complying to standards IEC 60296 and ASTMD3487, with the following outstanding characteristics:

- High dielectric strength (> 70 kV / 2.5 mm)
- Very good low temperature properties (pour point typically
- <-60°C)
- Low viscosity even at the lowest temperatures
- Very good oxidation stability
- Extremely good heat transfer

For more information please contact
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Imagination at work

Assembling

The porcelain and metal parts (top of the heads and flange) are coupled by means of Belleville washer-type springs placed in the heads of the bushings. For special cantilever requirements, the bushings employ cemented porcelain (Fig. 3 and Fig. 5).

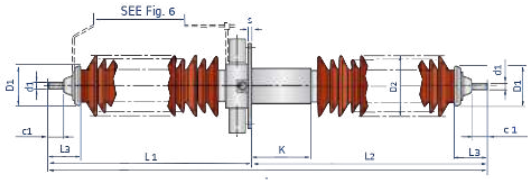

Fig. 4: Through wall bushing for normal cantilever load

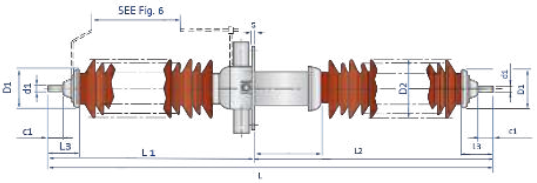

Fig. 5: Through wall bushing for heavy cantilever load

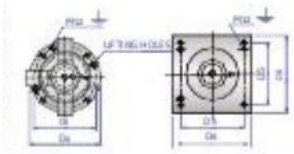

Fig. 7 *Fig. 8*

Name Plate

Each bushing is provided with a name plate containing complete electrical data and its serial number in accordance with IEC/IEEE requirements. The aluminium name plate is secured to the flange with rivets and carries the following information:

Fig. 9: Name plate

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