GE

Grid Solutions

PCTR

Condenser Bushing 72.5kV - 420kV
Oil-Oil Application
Resin Impregnated Paper Bushing

PCTR bushings are capacitance graded type (bushings made) manufactured with Resin Impregnated Paper insulation (RIP-dry type). They are designed for use on power transformers to connect two oil environments, in compliance with latest editions of IEC 60137.

Design, components and manufacturing technology of the RIP bushings can guarantee an average lifetime of 30 years under normal operating conditions. Being dry type RIP bushings, they offer benefits compared with conventional bushings (oil, gas, etc.) mainly in terms of the safety, environment protection and maintenance-free products.

Manufacturing of Capacitance-graded Bushings

The main electrical insulation consists of a condenser core made of a continuous sheet of pure dried crepe paper and aluminum foils wound around a conductor rod/tube made of aluminum or copper, designed according to customer specification.

The paper is pre-dried by heated cylinders and infra-red rays during winding process; the water content is reduced to less than 1%. During the winding stage, the aluminum foils are inserted coaxially between paper layers to create a co-centric cylindrical condenser core.

The graded bushing technology assures a uniform distribution of the electrical field between high voltage conductor and earthed parts (like) such as the main aluminum flange used for fitting on the transformer and the test tap used to earthing the last layer. The winding process is fully automated, and computer controlled.

The product range spans from 72.5kV up to 420kV.

The wound condenser core is placed in an autoclave to achieve the final drying phase and to be fully impregnated with resin under vacuum. The result is a solid core, mechanically robust and thermally class E (120°C) according to IEC standard. The manufacturing process such as the machining and shaping of the core is automatic and computer-controlled to ensure high quality level.

Standards

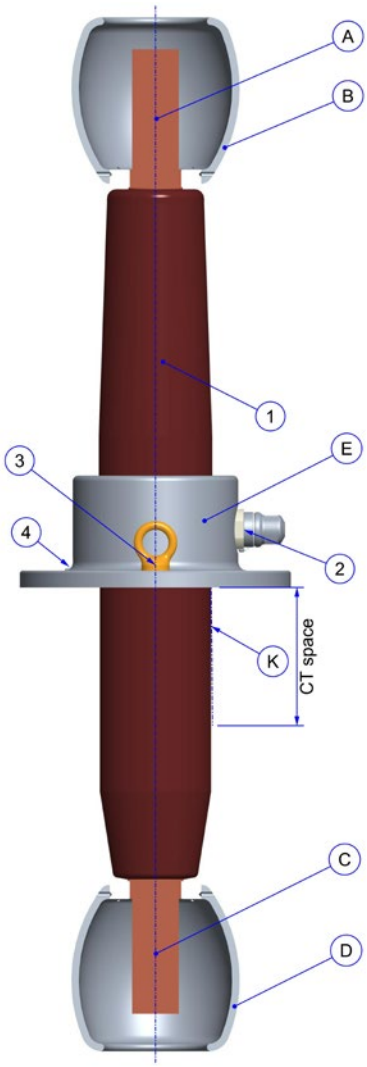
- Bushings conform to IEC-60137
- Bushings conforming to IEEE C57.19.01 electrical values also available

Key Benefits

- Partial discharge-free up to the rated voltage
- Low tan-δ < 0,4%
- Installation in any position
- Long lifetime and high reliability
- Maintenance-free
- High product flexibility
- Excellent mechanical strength
- High thermal strength (class E, 120°C)
- Suitable for Ester oil immersion media

PCTR Bushings Main Features

- Oil-to-Oil
- Resin Impregnated Paper
- Installation in any position
- Partial discharges < 5pC at 1.5 Um/V3
- Power factor tap grounded through the cap
- Flange made of corrosion-free aluminum
- Execution with draw-lead or bottom connection solid conductor



1. *RIP condenser core with inserted aluminum layers*
2. *Power factor/test tap*
3. *Lifting eyes*
4. *Air outlet screw ¼" gas*

CONFIGURABLE ITEMS

A. *Terminal - Cable side*
B. *Shield – Cable side*
C. *Terminal - Transformer side*
D. *Shield - Transformer side*
E. *Flange*
K. *Grounded zone for Current Transformer (CT) space*

Fig. 1: PCTR typical components

Bushing Designation PCTR.145.650.1250

CODE	DESCRIPTION
P	Condenser bushings ('P' from the Italian word 'Passante')
C	Cable
T	Transformer
R	Resin Impregnated Paper (RIP)
145	Rated voltage in kV
650	BIL in kV
1250	Rated current in A

Nameplate

Each bushing is provided with a nameplate, containing complete electrical data and the serial number, in accordance with the requirements of IEC/IEEE requirements.

The aluminum nameplate is secured to the flange with rivets and carries the following information as in Fig. 2.

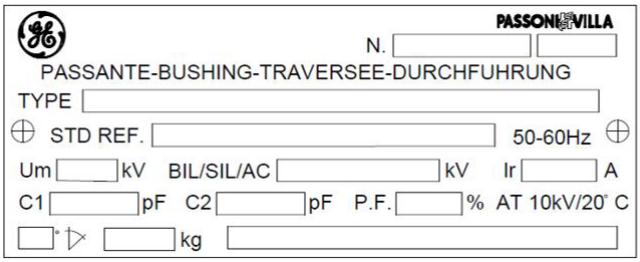


Fig. 2: Nameplate

Connection types and configurations

The bushing can be configured with two connections execution, depending on the current rating and preferred design of the transformer manufacturer.

The bushing platform enables to separate selection of shields and terminals of the both sides (oil and cable).

Draw Lead (DL)

Draw lead (DL) system (Fig.3) for greater ease of assembly, when the required current capacity is at a relative lower rate. The draw lead is the current path through the bushing. In this case the cable side terminal is made of copper as default (Fig.4) to easily weld the transformer lead to the bushing terminal directly. For the draw lead application, the bottom side shield is provided by default. The shield on the cable side is optional and if requested can be for axial connection only (Fig.5) and for lateral connection (Fig.6) with dedicated lateral hole and 360° orientable possibility.

Bottom connection (BC)

Bottom connection (BC) (Fig.7) for higher current capability and higher mechanical performance. The current is lead through a central conductor made of aluminum or copper depending on the current rating; the terminals, cable side and oil side, are made of copper or aluminum consequently. The terminals shapes can be round (Fig.8/9) or flag (Fig.10/11) type in cable and in transformer side independently.

Cable and oil side shields (Fig.12) are optional, and the transformer manufacturer can choose to guarantee to right insulation coordination with the insulation barriers. Additionally, the cable side shield can be provided for lateral connection option with dedicated lateral hole (Fig. 13).

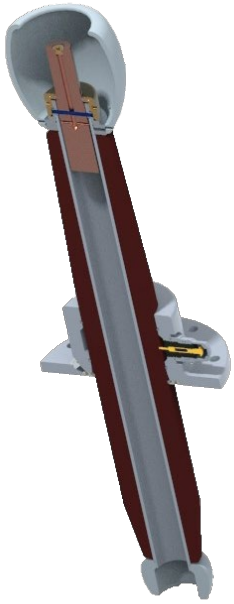


Fig. 3: Draw-Lead (DL) section type

Fig. 4: Terminals for DL – cable side

Fig. 5: Shields for DL – cable side

Fig. 6: Shields for DL – cable side

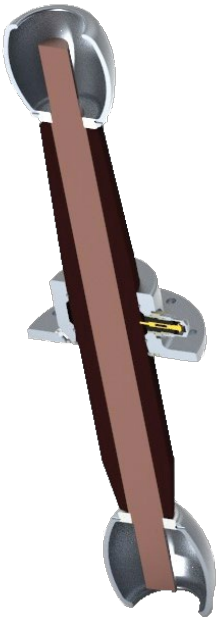


Fig. 7: Bottom Connection (BC) section type

Fig. 8/9: Round Terminals type for BC – cable side and transformer side

Fig. 10/11: Flag Terminals for BC – cable side and transformer side

Fig. 12/Fig. 13: Shields for BC – cable side and transformer side

Components and Accessories

Flange

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

- Power factor/test tap (tested at 2 kV for 60s)
- Air outlet screw (1/4” gas outlet plug)
- Lifting holes

Metal Surface Treatment

All metal bushing surfaces, made by aluminum alloy, have high resistance in industrial environment with high humidity content and aggressive atmosphere, like offshore with high salinity.

The tapping includes surface treatment to avoid corrosion throughout lifetime and to allow easy assembly and disassembly of its cover for service activities.

Any special finishing or final painting are customer’s option.

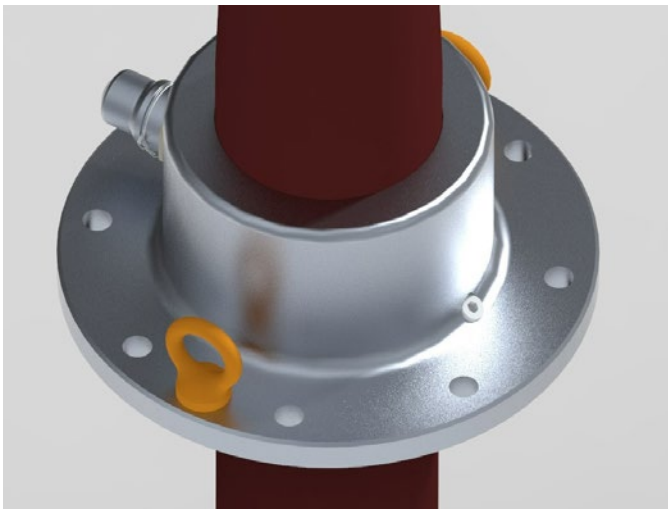


Fig. 14: Flange

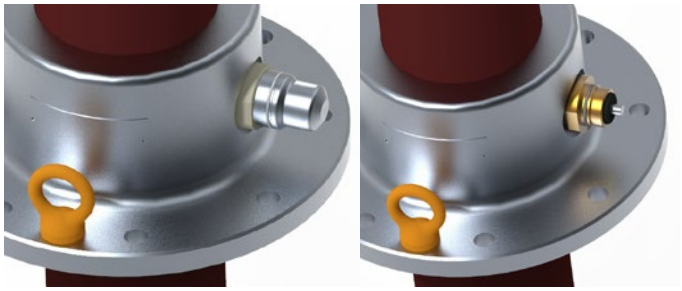


Fig. 15/16: Power factor tap

Power Factor Measuring Tap

The PF tap is the connection to the outer conducting/last layer of a capacitance graded bushing. It is accessible from outside the bushing, insulated from the flange or other fixing device and measures the dissipation factor, capacitance and partial discharge while the bushing flange is earthed. A suitable fully mounted PF measuring tap is supplied with all RIP bushings.

Special PF French type can be provided on request.

Power Factor Tap Extension

The test tap can be led out as insulated flexible wire and is equipped with a traction relief in the flange. If the bushing is dispatched, this flexible wire is screwed to the flange with a cable lug which is grounded.

Note 1: the cable is led outside of the transformer and fixed on a standard test tap.

Note 2: this device is an accessory and not part of the standard delivery.

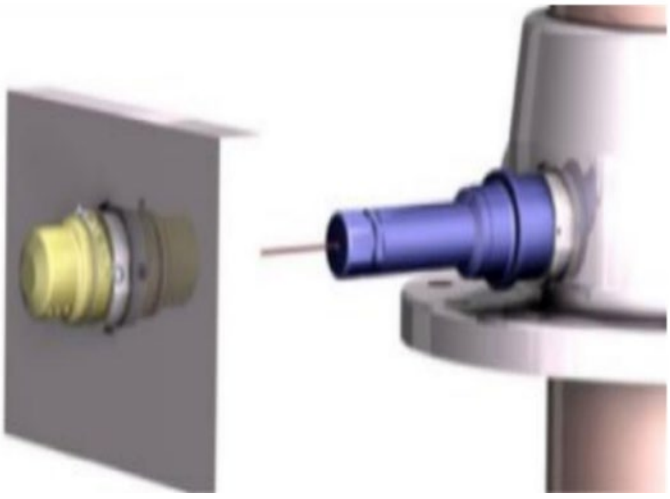


Fig 17: Mounting of remote PF tap with cable

Fig.18: Remote PF tap with cable

Components and Accessories

Tests

All bushings have electrical characteristics and are tested in compliance with the latest edition of IEC 60137 Standards.

Insulated bushing for alternating voltages above 1000 V and main

National Standards.

Type Tests

Measurement of dielectric dissipation factor (tan delta), capacitance and partial discharge quantity before and after the series of type tests:

- Tests of tap insulation
- Power-frequency voltage withstand test
- Lightning impulse voltage withstand test (BIL)
- Switching impulse voltage withstand test (SIL) for bushings rating 245kV and above
- Thermal stability test for bushings with Um greater than 300 kV
- Temperature rise test
- Verification of thermal short-time current withstand
- Cantilever load withstand test
- Tightness test
- Verification of dimensions

Routine Tests

- Tests of tap insulation
- Dielectric dissipation factor (tan delta), capacitance and partial discharge quantity measurement
- Lightning impulse voltage withstand test (BIL), when prescribed
- Power-frequency voltage withstand test
- Measurement of partial discharge quantity
- Test of tap insulation
- Tightness test
- Visual inspection and dimensional check

Packing & Transportation

After tests and before packing, the bushing is cleaned of any oil or dust. PCTR bushings are normally shipped in the horizontal position in cases of three (for voltages up to 170 kV). Terminals and exposed parts are wrapped in polyethylene bags to apply an additional protection from ambient contamination such as dust and moisture and any transport damage.

Long Term Storage Accessories

For long term storage and upon request the bushings are equipped with protective tank filled with nitrogen to protect the condenser core against any damage, moisture absorbing and humidity.

Fig. 19.1: Bushing under test

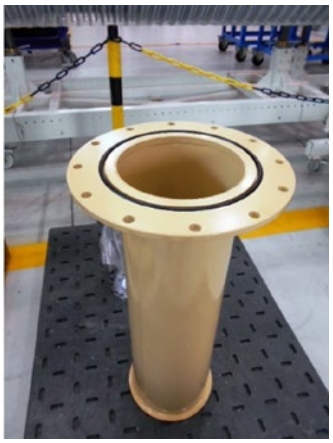


Fig. 19.2: Packaging and protective tank

PCTR Range from 72.5kV to 420kV: Ratings/Dimensions

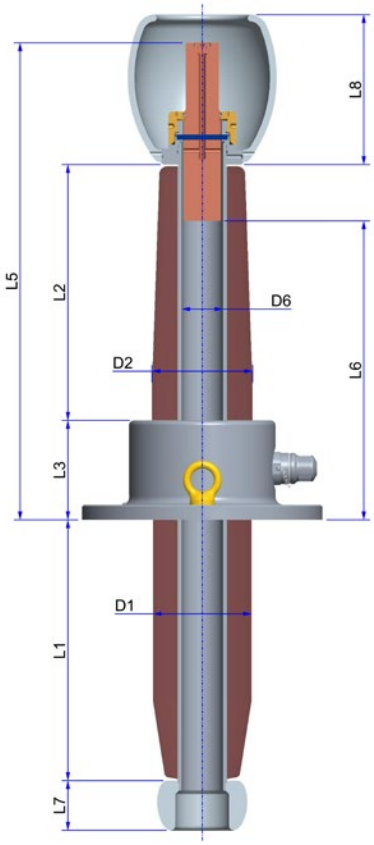


Fig.20: PCTR Draw-Lead (DL) type

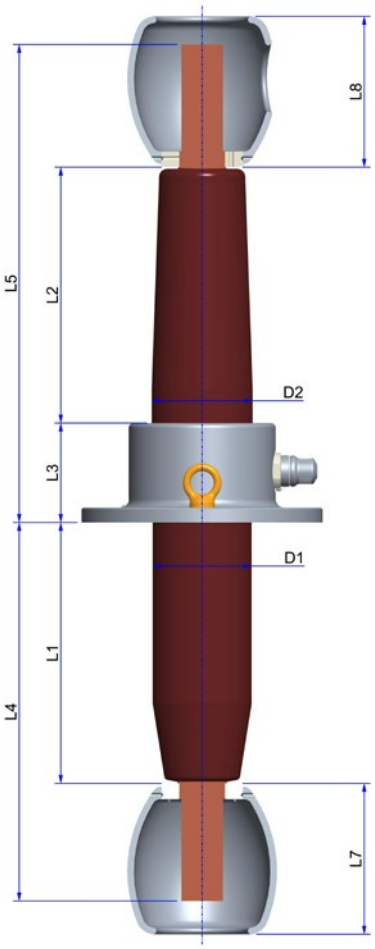


Fig.21: PCTR Bottom Connection (BC) type

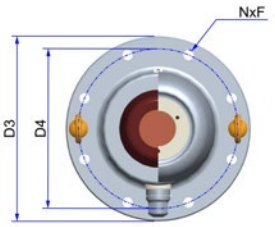


Fig.22: Flange

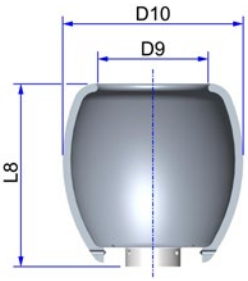


Fig.23: Shield cable side without lateral hole

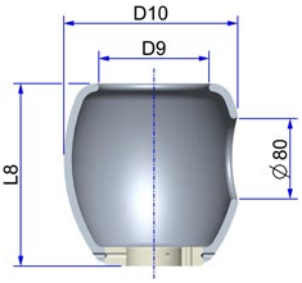


Fig.24: Shield cable side with lateral hole

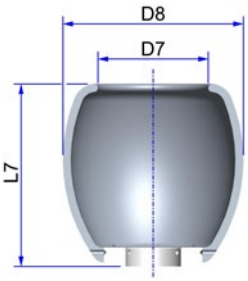


Fig.25: Shield trafo side

Terminal for DL type

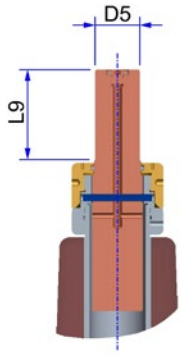


Fig.26: Terminal cable side round shape for DL type

Terminals for BC type in cable or transformer side

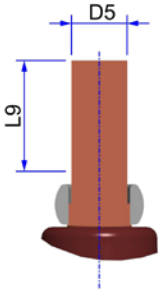


Fig.27: Terminal Round shape

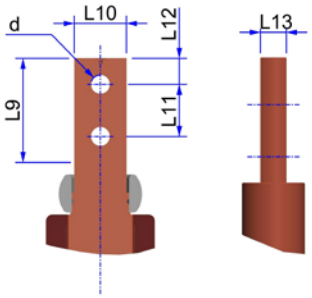


Fig.28: Terminal Flag shape

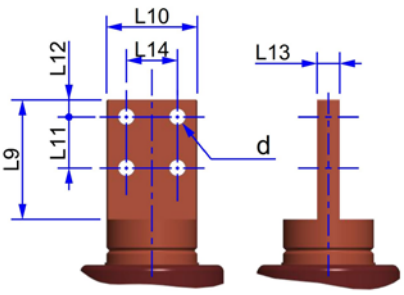


Fig.29: Terminal Flag shape for high currents

PCTR Bushings 72.5kV to 420kV

Condenser bushing oil-oil for Transformers	Nominal System Voltage	Rated line to earth Voltage	Dry lightning Impulse (BIL)	Rated continuous current	Power frequency withstand voltage (for 60 s) Dry	Draw Lead connnection (DL)	Bottom connection BC)	Cantilever withstand load	Short time rating for 2s (As per IEC 60137)	Short time rating for 1s / 3s	L1 (K can be 0, 100, 300, 500 or 600)	L2	L3	L4 (K can be 0, 100, 300, 500 or 600)	L5	L6
TYPE/Voltage[kV]/ Current Range [A]	kV	kV	kVp	A	kV			N	kA	kA	mm	mm	mm	mm	mm	mm
72.5.325	72.5	42	325	1250	155	x		1250	31	44/26	177 + K	177	120	-	445	229
				1600			x		40	57/33						
				2000			x	3150	50	71/41	177 + K			320 + K		-
				2500			x		63	88/51						
				3150			x	4000	79	111/64	200 + K			342 + K		-
123.550	123	71	550	1250	255	x		3150	31	44/26	310 + K	310	120	-	578	362
				1600			x		40	57/33						
				2000			x	4000	50	71/41	310 + K			452 + K		-
				2500			x		63	88/51						
				3150			x	4000	79	111/64	360 + K	360		503 + K	630	-
145.650	145	84	650	1000	305	x		3150	25	35/20	360 + K	360	120	-	630	412
				1250			x		31	44/26						
				1600			x	4000	40	57/33	360 + K			503 + K		-
				2000			x		50	71/41						
				2500			x	4000	63	88/51	360 + K			503 + K		-
				3150			x	4000	79	111/64						
170.750	170	98	750	1250	355	x		4000	31	44/26	410 + K	410	120	-	678	462
				1600			x		40	57/33						
				2000			x	5000	50	71/41	410 + K			552 + K		-
				2500			x		63	88/51						
				3150			x	5000	79	111/64	410 + K			552 + K		-
245.1050	245	142	1050	1250	505	x		4000	31	44/26	580 + K*	580	120	-	850	540
				1600		x			40	57/33						
				1600			x	5000	40	57/33				723 + K		-
				2000			x		50	71/41						
				2500			x	5000	63	88/51				723 + K*		-
				3150*			x		79	111/64						
420.1550	450	242	1550	1250	750		x	4000	31	44/26	815 + K*	815	180	980 + K*	1160	-
				1600			x		40	57/33						
				2000			x	5000	50	71/41						
				2500			x		63	88/51						

NOTES:

**PCTR 245.1050.3150 type available only for K>100*

K is the CT space length in the transformer side (standard dimensions are 0, 100, 300, 500 and 600mm)

For ratings or dimensions not listed, please contact us.

PCTR Bushings 72.5kV to 420kV

Condenser bushing oil-oil for Transformers		D1	D2	D3	D4	NxF	L7	D7	D8	L8	D9	D10	Shield - CABLE SIDE (B)	Shield - TRAFO SIDE (D)
TYPE/Voltage[kV]/ Current Range [A]		mm	mm	mm	mm	n°x mm	mm	mm	mm	mm	mm	mm		
72.5.325	1250	87	90	225	185	6x16	60	65	109	182	110	180	Fig.23/24	Fig.25
	1600 2000 2500						188	100	140	182	110	180	Fig.23/24	Fig.25
	3150	119	122	290	250	6X16	182	110	180	182	110	180	Fig.23	Fig.25
123.550	1250	119	122	290	250	6x16	60	65	109	182	110	180	Fig.23/24	Fig.25
	1600 2000 2500						182	110	180	182	110	180	Fig.23/24	Fig.25
	3150	159	162	335	290	12x16	182	110	180	182	110	180	Fig.23	Fig.25
145.650	1000	119	122	290	250	6x16	60	65	109	182	110	180	Fig.23/24	Fig.25
	1250 1600 2000						182	110	180	182	110	180	Fig.23/24	Fig.25
	2500 3150	159	162	335	290	12x16	182	110	180	182	110	180	Fig.23	Fig.25
170.750	1250	159	162	335	290	12x16	91	75	150	182	110	180	Fig.23/24	Fig.25
	1600 2000 2500						182	110	180	182	110	180	Fig.23/24	Fig.25
	3150	203	203	450	400	12x16	182	110	180	182	110	180	Fig.23	Fig.25
245.1050	1250 1600	203	203	450	400	12x16	182	110	180	182	110	180	Fig.23/24	Fig.25
	1600 2000	159	162	335	290	12x16	182	110	180	182	110	180	Fig.23/24	Fig.25
	2500 3150*	203	203	450	400	12x16	182	110	180	182	110	180	Fig.23	Fig.25
420.1550	1250 1600	285	285	500	450	12x23	225	166	291	225	166	291	Fig.23	Fig.25
	2000 2500	285	285	500	450	12x23	225	166	291	225	166	291	Fig.23	Fig.25

NOTES:

**PCTR 245.1050.3150 type available only for K>100*

K is the CT space length in the transformer side (standard dimensions are 0, 100, 300, 500 and 600mm)

For ratings or dimensions not listed, please contact us.

PCTR Bushings 72.5kV to 420kV

Condenser bushing oil-oil for Transformers		Terminal - CABLE SIDE (A)	Terminal - TRAFO SIDE (C)	D5	L9	L10	n x d	L11	L12	L13	L14
TYPE/Voltage[kV]/ Current Range [A]				mm	mm	mm	mm	mm	mm	mm	mm
72.5.325	1250	Fig.26	-	35	80	-	-	-	-	-	-
	1600 2000 2500	Fig.27/28	Fig.27/28	40	80	35	2 x 14	40	20	20	-
	3150	Fig.29	Fig.29	-	100	70	4 x 14	40	20	20	40
123.550	1250	Fig.26	-	40	80	-	-	-	-	-	-
	1600 2000 2500	Fig.27/28	Fig.27/28	50	100	45	2 x 14	40	20	20	-
	3150	Fig.29	Fig.29	-	105	75	4 x 14	45	15	20	45
145.650	1000	Fig.26	-	35	80	-	-	-	-	-	-
	1250 1600 2000	Fig.27/28	Fig.27/28	40	80	40	2 x 14	40	20	20	-
	2500 3150	Fig.29	Fig.29	-	105	75	4 x 14	45	15	20	45
170.750	1250	Fig.26	-	40	80	-	-	-	-	-	-
	1600 2000 2500	Fig.27/28	Fig.27/28	50	100	57	2 x 14	40	20	20	-
	3150	Fig.29	Fig.29	-	105	80	4 x 14	45	15	45	20
245.1050	1250 1600	Fig.26	-	40	80	-	-	-	-	-	-
	1600 2000	Fig.27/28	Fig.27/28	40	100	40	2 x 14	40	20	20	-
	2500 3150*	Fig.29	Fig.29	-	105	80	4 x 14	45	15	20	45
420.1550	1250 1600	Fig.27/28	Fig.27/28	50	80	80	2 x 18	40	20	20	-
	2000 2500	Fig.27/28	Fig.27/28	50	80	80	2 x 18	40	20	20	-

NOTES:

**PCTR 245.1050.3150 type available only for K>100*

K is the CT space length in the transformer side (standard dimensions are 0, 100, 300, 500 and 600mm)

For ratings or dimensions not listed, please contact us.

Bushing Selection Example

Electrical Data

First selection can be done according the electrical data required, then:

- Rated voltage.
- Rated current.
- The other system voltages for the dielectric coordination are driven by IEC 60137, cantilever value included.

This selection can identify if the bushing can be Draw-Lead (DL) or Bottom-Connection (BC) type.

Mechanical Data

A. Terminal – cable side among different types A1, A2...etc.

B. Shield – cable side among different types B1, B2...etc.

C. Shield – trafo side among different types C1, C2...etc.

D. Terminal – trafo side among different types D1, D2...etc

E. Flange among different types E1, E2...etc

K. CT space (under flange millimeters required for the current transformer installation in the transformer side

T. Min. ambient temperature of the place where the bushing/ transformer will be installed.

BUSHING CONFIGURATION SELECTION

Rated Voltage (kV)		Rated Current (A)		CT space (mm) K choice		TERMINAL - cable side A choice		SHIELD - cable side B choice		SHIELD - trafo side C choice		TERMINAL - trafo side D choice		Min. ambient air temperature (°C)		Main FLANGE type E choice	
145	x	1250		0		A1	X	B1 = no shield		C1 = no shield		D1		T1 = -25°C		E1	X
		1600	X	100		A2		B2		C2	X	D2	X	T2 = -40°C	X	E2	
		2000		300	X			B3	X								
				500													
				600													

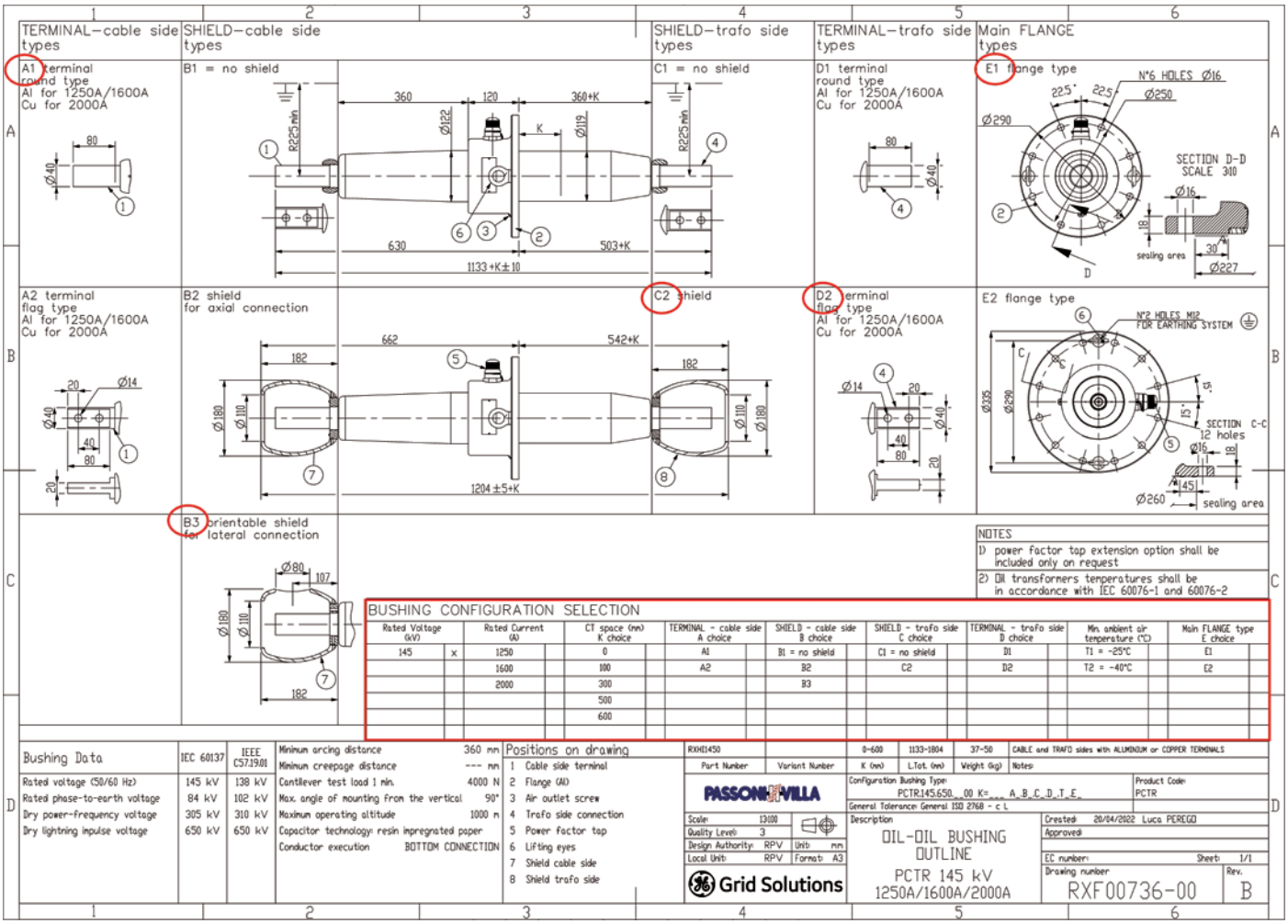


Fig.30: Detailed drawing example for bushing selection

Bushing Selection Example

Fig. 30 shows as example how the bushing was selected in particular:

- PCTR 145kV 1600A (BIL 650kV)
- K = 300mm (the length of the CT space)
- A1 - terminal – cable side that is round type 80x40 made of aluminum because for 1600A.
- B3 - shield – cable side that is for lateral connection.
- C2 - shield - trafo side.
- D2 terminal – trafo side that is a flag type made of aluminum because for 1600A.
- T2 min. ambient temperature = -40° where the substation is placed.
- E1 flange with the dimension indicated in the selected detail in Fig. 30.

Then the Configuration Bushing Type is:

PCTR.145.650.1600 K=300 A1.B3.C2.D2.T2.E1

Fig.31: Configured bushing

Bushings Manufacturing Site :

GE Grid Solutions Sesto San Giovanni,
Sesto San Giovanni
Milan, Italy

GEGridSolutions.com

GEA-33233-(E)
English
220505