GE

Grid Solutions

PNR Porcelain

Condenser Bushing 24kV-300kV
Oil-to-Air Applications
Resin Impregnated Paper Bushing

PNR Bushings are capacitance graded bushings with Resin Impregnated Paper core. Design, Components and manufacturing technology of RIP Bushings promote an average lifetime in excess of 30 years under normal operating conditions.

GE Bushings – your Partner of choice

GE, a company you can trust to harness your power. Following the acquisition of Passoni and Villa in 2008, former Alstom Grid now GE Grid Solutions offers a wide range of condenser bushings for AC and DC applications. Our partner acknowledges us as one of the most reputable and reliable Bushing manufacturers in the world.

A Wealth of Benefits

- We have pioneered in Bushing Technology with our combined experience and expertise over nine decades.
- RIP Bushings offer multiple benefits over conventional Bushings (OIP).
- RIP Bushings suitable for all transformers types are available.

Flexibility

Ease of transport, handling, storage and installation. Flexibility in angle of installation.

Seismic Solutions

Seismic solutions can be provided on request against specific site requirement.

Bushings to suit specific requirements

- Bushings in accordance to IEEE C57.19.01 with special flag dimensions available on request.
- Bushings in accordance to NF C52-062 including special power factor tap , flags available on request.
- Bushings for replacement with adaptation and interchangeability available on request. Specific terminals , lugs and counter flange can be provided.

Key Benefits

- Compact, Robust and Reliable design.
- Partial discharge-free up to rated nominal voltage
- Excellent mechanical strength
- High thermal strength (Class E, 120°C)
- Low dielectric losses (tanδ ≤ 0.4%)
- Suitable for Ester Oil immersion media.
- Suitable for low temperature of -50DegC

Safety – Our priority

- Personnel, Substation and Environment protection
- RIP bushings are fire and explosion-proof
- Oil and SF6 free means no environmental costs on end-of-life disposal
- Free from leakage issues

Minimal Maintenance

- RIP Bushings are 100% oil and pressure- free, hence no specific maintenance or on-site verification are required.
- Measurement of tan| and capacitance is recommended as part of maintenance check

Test Standards

- Bushings conform to IEC-60137
- Bushings conforming to IEEE C57.19.01 / NF C52-062 standard are also available.
- Very High Cantilever Solution available on request.
- Tailor made Design available on request.

PNR Bushings Main Features

Resin Impregnated Paper Bushing

Oil-to-air

- Resin Impregnated Paper
- Installation in any position
- Dimensions of flange terminals in accordance with IEC 60137 standards
- Partial discharges < 5pC at 1.5 Um/V3
- Power factor tap grounded through the cap
- Flange made of corrosion-free aluminum
- Execution with fixed and solid conductor

1. *HV terminal*
2. *Conductor*
3. *RIP condenser core*
4. *Polyurethane filling*
5. *Porcelain insulator*
6. *Power factory/ test tap*
7. *Main flange*
8. *Stress shield (detachable type for 245kV and above)*
9. *Air outlet screw*
10. *Lifting eyes*

Fig. 4: PNR Bushing Typical Cross Section

Bushing Designation PNR.145.650.1250

CODE	DESCRIPTION
P	Condenser bushings ('P' from the Italian word 'Passante')
N	Normal
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.

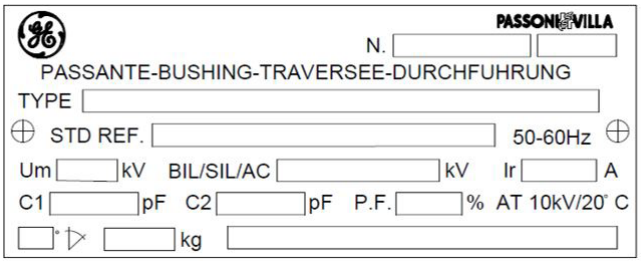


Fig. 5: Nameplate

Fig.6 : Electrical test

Key Features

RIP Condenser Core

The main insulation of the bushing comprises of resin Impregnated paper. The condenser core is manufactured with crepe paper wound on central tube or rod. Winding is done under heat on a state of art winding machine. Series of Aluminum foils are inserted between the paper layers at predetermined positions to achieve the optimum distribution of radial and longitudinal electrical gradients between central tube and flange. The condenser core is then processed under heat, vacuum and resin impregnated under highly controlled conditions.

Air side insulator

The air side insulator is of porcelain insulator.

Flange

The flange is made of corrosion free aluminum and is equipped with lifting holes , air vent screw and a power factor tap (tested at 3 kV for 60 s). Special coating up to CH5 class on request. Voltage tap can be provided on request.

Polyurethane Filling

The space between RIP core and the housing is dry- filled with polyurethane. Dry filling eliminates the risk of pollution (as in SF6 filling) and is leak proof should any damage exceptionally occur. Polyurethane has been specially selected for its high mechanical and electrical properties. High compressibility polyurethane makes the bushings more resistant to mechanical stress caused by thermal variation.

Assembling

The RIP condenser core and main flange are assembled in high controlled environment to avoid moisture and contamination of the RIP surface during the production.

Power Factor Tap

The PF tap is the connection to outer conducting layer of a capacitance-graded bushing. It is accessible from outside the bushing, insulated from the flange or other fixing devices, 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.

Top Terminal

Bushings top terminal is made of aluminum or copper terminals. Tinned or silver-plated copper terminal can be supplied on request. Draw-lead or draw-rod type bushings (rated current up to 1600A) have a removable top terminal. This terminal is connected to the copper inner terminal lug or the draw rod by means of multi-contact and is screwed to the bushing head. In bottom-connected bushings, the inner non- removable rod extends as top terminal.

Fig.7/8: Lifting of the Bushings

Fig. 9: Air outlet screw

Fig. 10: Voltage tap (On request)

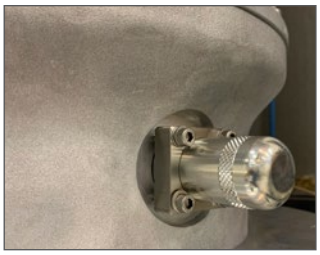


Fig. 11/12: Power factor tap

Fig. 13: Removable top terminal

Fig. 14: top terminal conductor

Key Features

Metal Surface Treatment

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

Power factor tap and voltage tap surface finish avoids any corrosion throughout lifetime and allows for easy fixing and unscrewing in service. Further finishing or final painting are the customer's option.

Electrical test

The bushings are tested according to latest edition of IEC 60137 – "Insulated bushings for alternating voltage above 1000 V". Upon request it is possible to carry-out electrical test according to other relevant standards.

Packing & Transportation

Bushings are thoroughly cleaned after testing before packing. Bushings are packed in vacuum sealed bag along with silica gel to avoid moisture ingress. For long term storage (for spares bushings) oil side is inserted in a metallic container and sealed with Nitrogen or Oil.

Oil Side shield

The oil end is provided with a carefully designed shield to reduce the electric field stress in transformer oil. The shield is epoxy painted. The shield is integrated part of the bushing up to 170kV. Bushings rated 245kV and above are detachable type of shield. Special type of coating available on request.

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 and humidity. The crate can be equipped with shock indicator as well.

Fig. 15: Cantilever Test

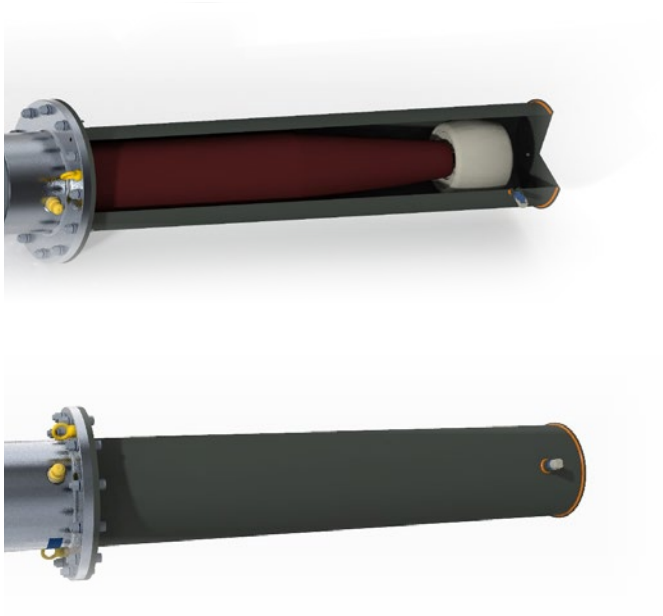
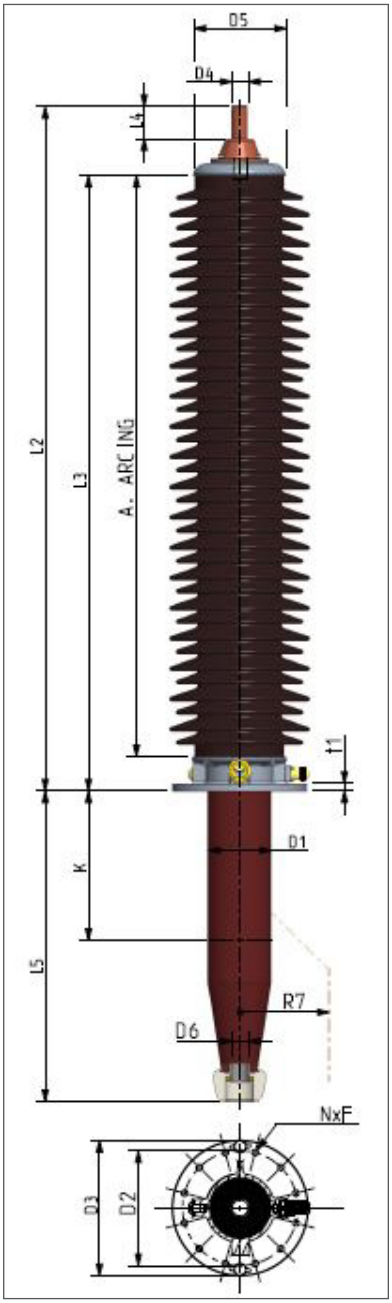


Fig. 16: Long term storage RIP bushings

Fig. 17: Packaging - transportation

PNR Range from 24 to 300 kV:

Ratings/Dimension



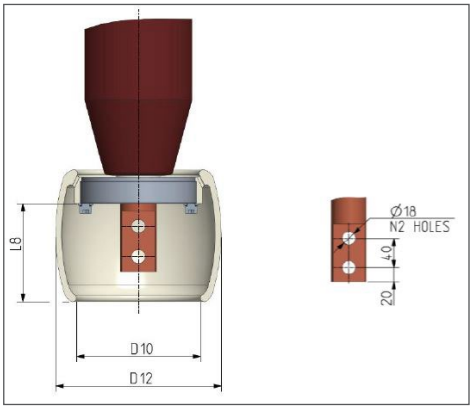


Fig. 1

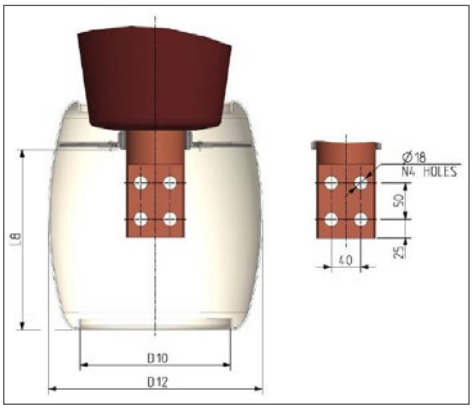


Fig. 2

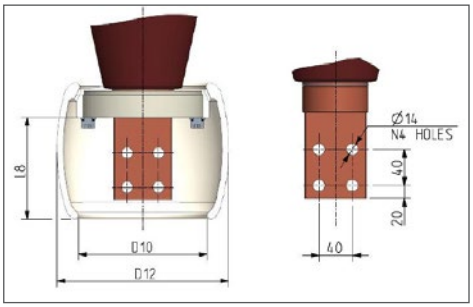
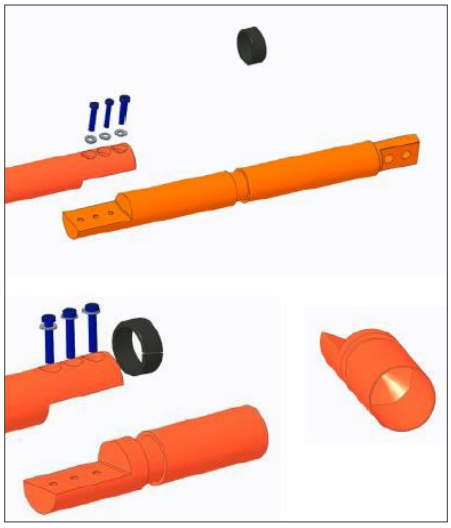


Fig. 3 Transformer side



Draw-rod connections

PNR Bushing 24kV to 300kV With Porcelain Insulator

Condenser bushing, oil – air, 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/Wet	Wet Switching Impulse withstand	Draw Lead connnection	Draw Rod connection	Bottom connection	Minimum Nominal Creepage Distance	Minimum Arcing distance	Cantilever withstand load	Max Operating Altitude	Short time rating for 2s (As per IEC 60137)	Short time rating for 1s / 3s
TYPE/Voltage[kV]/ Current Range [A]	kV	kV	kVp	A	kV	kV				mm	mm	N	Meter	kA	kA
24.125	24	14	125	1000	55/50	-	x			900	251	1250	1000	25	35/20
1600				1600				x						40	57/33
2000				2000					x			2000		50	71/41
3150				3150					x			3150		78,75	111/64
36.170	36	20	170	1000	77/70	-	x			1185	321	1250	1000	25	35/20
2000				2000					x			2000		50	71/41
2500				2500					x					62,5	88/51
3500				3500					x			3150		87,5	124/71
52.250	52	30	250	1000	105/95	-	x			1700	480	1250	1000	25	35/20
2000				2000					x			2500		50	71/41
2500				2500					x					62,5	88/51
3150				3150					x			3150		78,75	111/64
72,5.325	72,5	42	325	800	155/140	-	x			2300	700	2000	1600	20	28/16
1250				1250				x						31,25	44/26
1600				1600				x						40	57/33
2000				2000					x			3150		50	71/41
3150				3150					x					78,75	111/64
123.550	123	71	550	800	255/230	-	X			3840	1040	3150	1000	20	28/16
1250				1250			X							31,25	44/26
1600				1600				x						40	57/33
2000				2000					x					50	71/41
3150				3150					x	3860	1060	4000		78,75	111/64
145.650	145	84	650	800	305/275	-	x			4590	1260	3150	1000	20	28/16
1250				1250			x							31,25	44/26
1600				1600				x						40	57/33
2000				2000					x					50	71/41
3150				3150					x					78,75	111/64
170750	170	98	750	800	355/325	-	x			5330	1440	4000	1000	20	28/16
1250				1250			x							31,25	44/26
1600				1600				x						40	57/33
2000				2000					x			5000		50	71/41
3150				3150					x					78,75	111/64
245.1050	245	141	1050	1250	505/460	850	x			8940	2370	4000	1000	31,25	44/26
1600				1600				x						40	57/33
2000				2000					x			5000		50	71/41
2500				2500					x					62,5	88/51
300.1050	300	173	1050	1250	505/460	850	x			8940	2370	4000	1000	31,25	44/26
1600				1600				x						40	57/33
2000				2000					x			5000		50	71/41
2500				2500					x					62,5	88/51

Note : For ratings not listed, please contact us

PNR Bushing 24k to 300 kV: dimensions with Porcelain Insulator

Dimensions		Type of Connection	A	D1	D2	D3	D4	D5	D6	R7 (Min)	D10	D12	L2	L3	L4	L5		L8	Weight	t1	No. of Holes	F	Bottom terminal
TYPE/Voltage[kV]/ Current Range [A]			mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm		mm	kg	mm	N	mm	
24.125	1000	Draw Lead	251	92	185	225	40	170	38	100	67	95	501	336	80	202 502 702	22	0 300 500	30 34 37	14	6	16	-
	1600	Draw Rod	251	92	185	225	40	170	38	100	67	95	501	336	80	202 502 702	22	0 300 500	35 39 42	14	6	16	-
	2000	Bottom Connection	251	92	185	225	40	170	NA	100	NA	NA	546	336	125	230 530 730	NA	0 300 500	31 34 36	14	6	16	Fig. 1
	3150	Bottom Connection	251	92	185	225	60	170	NA	100	NA	NA	546	336	125	230 530 730	NA	0 300 500	51 60 68	14	6	16	Fig. 1
36.170	1000	Draw Lead	321	92	185	225	40	170	38	100	67	95	571	406	80	202 502 702	22	0 300 500	30 33 35	14	6	16	-
	2000	Bottom Connection	321	92	185	225	40	170	NA	100	NA	95	616	406	125	255 555 755	NA	0 300 500	37 40 42	14	6	16	Fig. 1
	2500	Bottom Connection	321	92	185	225	50	170	NA	100	NA	95	616	406	125	255 555 755	NA	0 300 500	50 58 63	14	6	16	Fig. 1
	3500	Bottom Connection	480	140	250	290	60	205	NA	100	NA	NA	821	566	125	282 582 782	NA	0 300 500	90 105 115	14	8	16	Fig. 3
52.250	1000	Draw Lead	480	92	185	225	40	170	38	100	67	95	730	565	80	225 525 725	22	0 300 500	43 45 47	14	6	16	-
	2000	Bottom Connection	480	92	185	225	40	170	NA	100	NA	95	775	565	125	282 582 782	NA	0 300 500	40 43 45	14	6	16	Fig. 1
	2500	Bottom Connection	480	92	185	225	50	170	NA	100	NA	95	775	565	125	282 582 782	NA	0 300 500	55 63 68	14	6	16	Fig. 1
	3150	Bottom Connection	481	140	250	290	60	205	NA	100	NA	NA	821	566	125	282 582 782	NA	0 300 500	90 105 115	14	8	16	Fig. 2
72,5.325	800	Draw Lead	700	92	185	225	40	170	38	140	67	95	950	785	80	222 522 722	22	0 300 500	86 95 102	14	6	16	-
	1250	Draw Rod	700	92	185	225	40	170	38	140	67	95	950	785	80	222 522 722	22	0 300 500	86 95 102	14	6	16	-
	1600	Draw Rod	700	92	185	225	40	170	38	140	67	95	950	785	80	222 522 722	22	0 300 500	87 96 103	14	6	16	-
	2000	Bottom Connection	700	92	185	225	40	170	NA	140	NA	95	1023	785	125	322 622 822	NA	0 300 500	90 95 105	14	6	16	Fig. 1
	3150	Bottom Connection	701	140	250	290	60	205	NA	140	NA	NA	1041	786	125	300 600 800	NA	0 300 500	130 145 155	14	8	16	Fig. 2

PNR Bushing 24k to 300 kV: dimensions with Porcelain Insulator

Dimensions	Type of Connection	A	D1	D2	D3	D4	D5	D6	R7 (Min)	D10	D12	L2	L3	L4	L5	L8	Weight	t1	No. of Holes	F	Bottom terminal
TYPE/Voltage[kV]/ Current Range [A]		mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	kg	mm	N	mm	
123.550	800	Draw Lead	1040	135	250	290	40	205	40	200	70	130	1295	1125	80	375 675 875	0 50 300 500	112 118 122	16	8	16	-
	1250	Draw Lead	1040	135	250	290	40	205	50	200	70	130	1295	1125	80	375 675 875	0 50 300 500	113 119 123	16	8	16	-
	1600	Draw Rod	1040	135	250	290	40	205	50	200	70	130	1295	1125	80	375 675 875	0 50 300 500	138 149 156	16	8	16	-
	2000	Bottom Connection	1040	135	250	290	40	205	NA	230	145	200	1340	1125	125	450 750 950	0 110 300 500	121 129 134	16	8	16	Fig. 1
	3150	Bottom Connection	1060	143	290	335	50	280	NA	230	165	220	1613	1303	125	477 777 977	0 130 300 500	250 265 280	18	12	16	Fig. 2
145.650	800	Draw Lead	1260	143	290	335	40	280	50	225	80	130	1768	1503	80	435 735 935	0 38 300 500	195 200 210	18	12	16	-
	1250	Draw Lead	1260	143	290	335	40	280	50	225	80	130	1768	1503	80	435 735 935	0 38 300 500	195 200 210	18	12	16	-
	1600	Draw Rod	1260	143	290	335	40	280	50	225	80	130	1768	1503	80	435 735 935	0 38 300 500	240 235 245	18	12	16	-
	2000	Bottom Connection	1260	143	290	335	50	280	NA	230	165	220	1813	1503	125	527 827 1027	0 130 300 500	235 240 250	18	12	16	Fig. 1
	3150	Bottom Connection	1260	143	290	335	50	280	NA	230	165	220	1813	1503	125	527 827 1027	0 130 300 500	292 300 305	18	12	16	Fig. 2
170.750	800	Draw Lead	1440	143	290	335	40	280	50	260	80	130	1948	1683	80	495 795 995	0 38 300 500	215 220 230	18	12	16	-
	1250	Draw Lead	1440	143	290	335	40	280	50	260	80	130	1948	1683	80	495 795 995	0 38 300 500	215 220 230	18	12	16	-
	1600	Draw Rod	1440	143	290	335	40	280	50	260	80	130	1948	1683	80	495 795 995	0 38 300 500	255 265 275	18	12	16	-
	2000	Bottom Connection	1440	143	290	335	50	280	NA	260	165	220	1993	1683	125	587 887 1087	0 130 300 500	265 270 280	18	12	16	Fig. 1
	3150	Bottom Connection	1440	178	400	450	50	305	NA	260	165	220	2012	1697	125	587 887 1087	0 130 300 500	330 338 344	22	12	23	Fig. 2
245.1050	1250	Draw Lead	2370	178	400	450	40	305	55	350	165	220	2897	2627	80	757 1057 1357	0 130 300 600	400 410 420	22	12	23	-
	1600	Draw Rod	2370	178	400	450	40	305	55	350	165	220	2897	2627	80	757 1057 1357	0 130 300 600	470 480 490	22	12	23	-
	2000	Bottom Connection	2370	178	400	450	50	305	NA	350	165	220	2942	2627	125	757 1057 1357	0 130 300 600	470 480 490	22	12	23	Fig. 1
	2500	Bottom Connection	2370	178	400	450	50	305	NA	350	165	220	2942 2902	2627	125	757 1057 1357	0 130 300 600	470 520 535	22	12	23	Fig. 2
300.1050	1250	Draw Lead	2370	178	400	450	40	305	55	350	165	220	2897	2627	80	1057 1357	130 300 600	410 420	22	12	23	-
	1600	Draw Rod	2370	178	400	450	40	305	55	350	165	220	2897	2627	80	1057 1357	130 300 600	480 490				
	2000	Bottom Connection	2370	178	400	450	50	305	NA	350	165	220	2942	2627	125	1057 1357	130 300 600	480 490	22	12	23	Fig. 1
	2500	Bottom Connection	2370	178	400	450	50	305	NA	350	165	220	2902	2627	125	1057 1357	130 300 600	520 535				

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