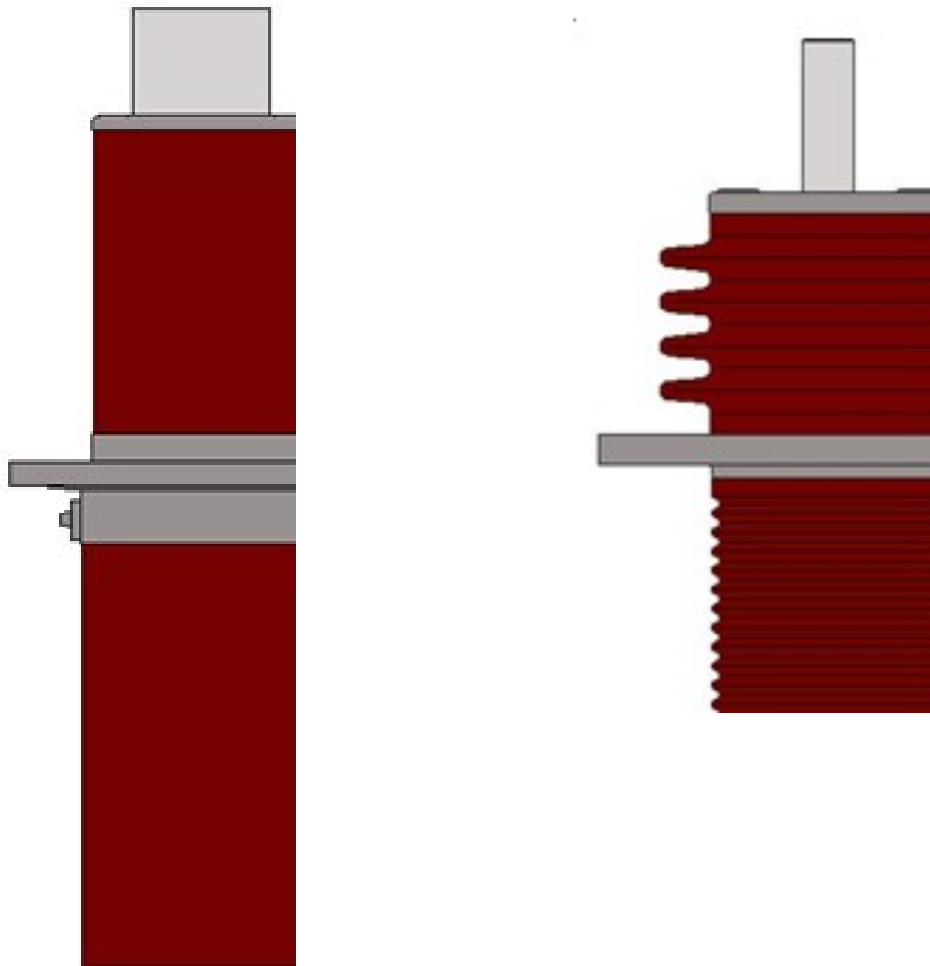




GRID SOLUTIONS


HIGH CURRENT BUSHINGS SERIES PGFR FOR AC GENERATORS

IS 2637




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national wherever located.

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2	Nameplate material	13/09/2022	Campana	Scuderi
1	Company and logo	13/03/2017	Campana	Scuderi
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	<p align="center">BUSHINGS PACKING</p>	<p align="center">IS 2637</p> <p align="center">PASSONI VILLA <small>ESPERTI IN TRUCCO VOLTAGGIO</small></p>
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1 INTRODUCTION

1.1 GENERAL

These instructions are applicable to the resin impregnated paper condenser type bushings series "PGFR"

- For rated voltages 24 and 36 kV
IEC 60137 -2008 Standard
- For insulation class 25 kV and 34,5 kV
IEEE C57.19.01 – 2000 Standard
IEEE C57.19.00 – 1991 Standard

and give all general information to be followed from the receipt of bushings until their installation on the transformer. Other information is given regarding their service and maintenance.

These bushings are manufactured and tested in compliance with Standards

- IEC 60137 – 2008 – “Insulated bushings for alternating voltages above 1000 V”;
- IEEE C57.19.01- 2000 - “Characteristics and dimensions for Outdoor Apparatus Bushings”;
- IEEE C57.19.00 – 2004 - “Requirements and Test Procedure for Outdoor Power Apparatus Bushings”.
- DIN 48124 part 1-2-3 – “Bushings for hydrogen cooled generators”

Design, components and manufacturing technology guarantee an average lifetime longer than 30 years in normal operation conditions.

The designation of the bushing is made as in the following example:

PGFR 24.150.15000

P Condenser bushing (“P” from Italian word “Passante”)
G Generator
F High current (from Italian word “Forte corrente”)
R Epoxy resin impregnated paper technology (RIP)
24 Rated voltage (in kV)
150 BIL – Basic Insulation Level (in kV)
15000 Rated current (in A)

1.2 SAFETY

This manual must be available to the personnel responsible of the installation, operation and maintenance of the bushings.

The installation, operation and maintenance of the bushings present conditions of no safety and it is necessary to follow carefully specific procedures and instructions. No compliance with these procedures and instructions can involve very severe and dangerous conditions for the personnel and the property.



1.3 TECHNICAL CHARACTERISTICS

These bushings are capacitance-graded type, resin impregnated paper, provided for operation with one side indoor or in a bus duct and with the other side inserted in the generator body (fig. 1).

The body of the bushing is of epoxy resin paper: the condenser-type design improves radial and longitudinal distribution of electric gradients.

Every bushing can be provided, on request, with an under-flange elongation – K – for CT accommodation in accordance with IEC Standard.

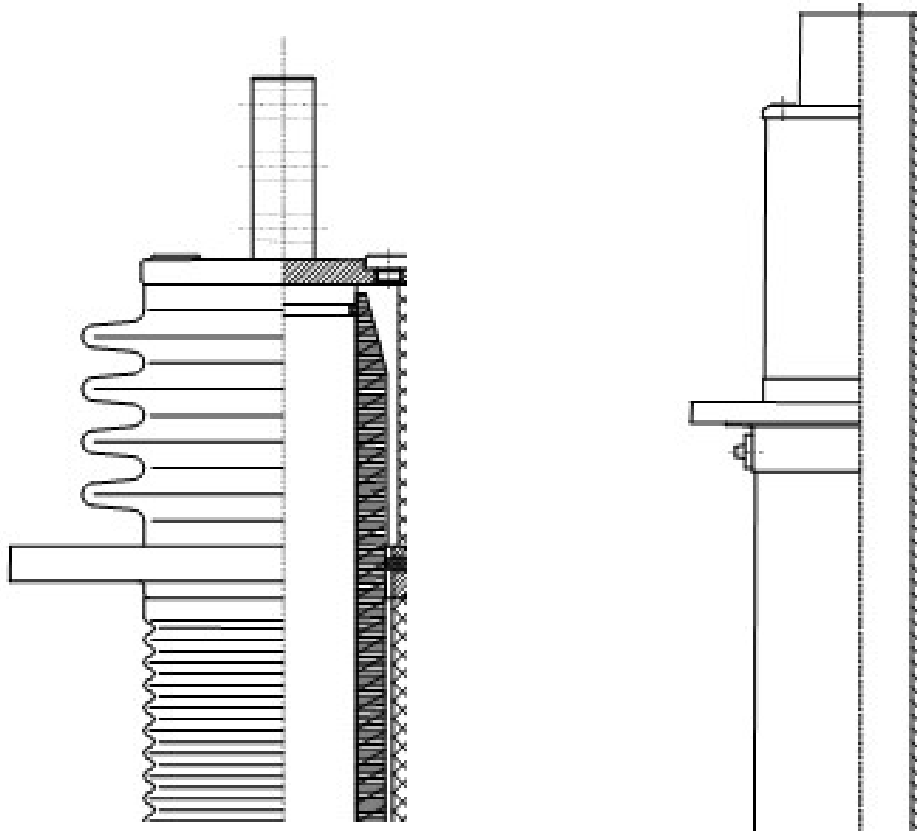


Fig. 1

On both sides the envelope is made of brown colour porcelain (grey on request).

The flange is made of stainless steel casting, low permeability; for low current ratings and natural cooling application the flange is made in aluminium.


Mechanical coupling is achieved by a spring system placed at the lower extremity of the bushing.

All the gaskets are O-ring type, in fluorinate elastomer.

Flat gaskets are also provided to prevent the contact between porcelain and metal parts.

The conductor is made by a copper tube.

The external connection surfaces are silver-plated, to assure a low contact resistance.

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1.3 TYPE OF DIELECTRIC

The internal condenser body of PGFR bushings is made of epoxy resin impregnated paper, which provides:

- High dielectric characteristics;
- Low dielectric losses also at high temperatures.

The space between the condenser core and the external envelope is filled with a dry polyurethane mass; with this solution, the bushing can be mounted in any position.

1.5 NAME PLATE

Each bushing is provided with a name plate, with serial number and all the electrical data, in accordance with the prescription of the Standards (fig. 2).

The plate is made of aluminium and is secured to the flange by means of rivets.

The plate includes the following information:

1 - Type of bushing	2 - Insulating voltages
3 - Rated current	4 - Max. mounting angle
5 - Weight	6 - Serial number
7 - Month and year of production	8 - (Available)

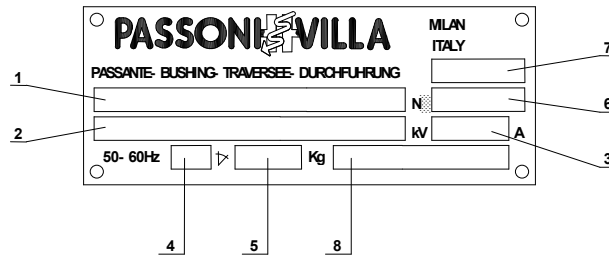


Fig. 2


The month is indicated by a code, as follows:

A = January	B = February	C = March	D = April	E = May	H = June
L = July	M = August	P = September	R = October	S = November	T = December

For space reason, the name plate can be made of two smaller ones.



Fig. 3

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2. MOUNTING INSTRUCTIONS

2.1 PACKING

PGFR bushings are shipped in horizontal position in cases of 1 or 3 pieces (fig.4).

Each bushing is protected with a polyethylene bag hermetically sealed and containing a silicagel bag; in such a way, the bushing is protected in dry air against the humidity of the ambient.

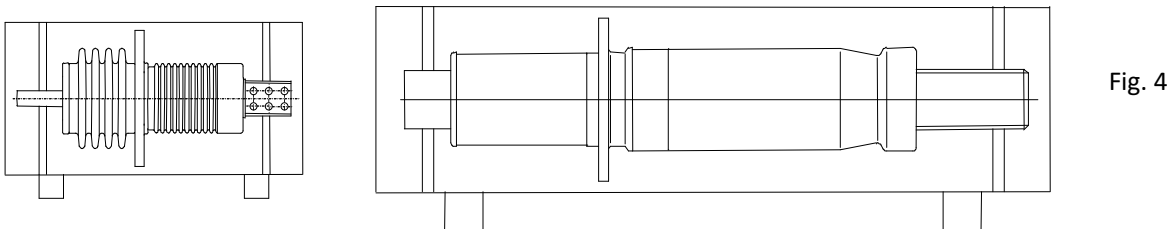


Fig. 4

2.2 ACCEPTANCE

Upon receipt of the goods the Customer should operate as follows:

- Check the external surfaces of the packing cases:
- No sign of damage must be found;
- The shock-watch indicator, placed in the external part of each packing case (fig. 5), must be white.



Fig. 5

If the shockwatch indicator is red (ACTIVATED) the shipment shall NOT be refused;

A notation on delivery receipt shall be made, and an inspection shall be made as follows:

- Open the packing case by removing its cover;
- Make sure that the anchoring elements are in order and securely fixed;
- Make sure that there are no breaks or broken parts.


In case any damage is found, leave the bushing in original packaging and request an immediate inspection from carrier within 15 days of delivery.

A written claim shall be given to the forwarding agent and a notification to GE Grid Solutions, with the details of the packing list, including the number of the case and the serial number of the bushing, to the following address:

GE Grid Solutions S.p.A.
Via Mario Villa, 210
20099 SESTO SAN GIOVANNI (MI) – ITALY
Phone +39 02 24105 231
e-mail maurizio.campana@ge.com

or

Grid Solutions Contact Centre
Tel: +44 1785 250070
contact.centre@ge.com

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2.3 STORAGE

Bushings shall be stored in a closed room, or at least in a covered room protected from rain.

They must be kept in their original packing, held in the polyethylene bag with silicagel.

Any damages of the packaging or plastic bag must be avoided.

Furthermore, it is advisable to protect the contact surfaces from atmospheric humidity and pollution, to prevent their deterioration.

The silver-plated fittings must be greased and protected against corrosion.

CAUTION
Until the installation on the generator, the bushing must be considered as an equipment of indoor installation

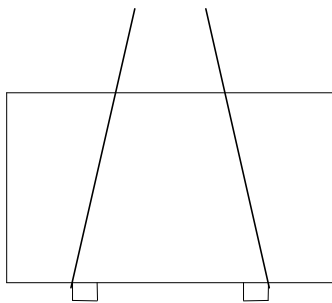
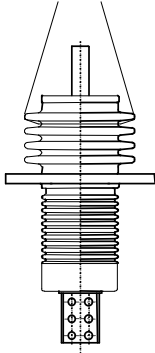
The storing temperature shall be between -25 and +50 °C.


When the bushing is taken out from the storage, a visual check shall be performed to verify the conditions of any part.

For extended indoor storage and/or for outdoor, a plastic rigid enclosure with silicagel dryers can be offered.

2.4 LIFTING AND TRANSPORTATION

The bushings type PGFR are sturdy, nevertheless, to avoid dangerous movements, it is mandatory to follow these instructions:

Packed bushings	Unpacked bushings
	
The case containing the bushings can be easily lifted with a tackle by applying the ropes on the points and with the inclination as shown on the packing case.	To take the bushing out of the case lift by round hemp ropes (or flat nylon ropes) fixed at loop under the first shed of the porcelain.
Fig. 6	Fig. 7

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2.5 SHIPMENT TO THE END USER

The shipment of the bushing made by the generator's manufacturer, after the generator factory tests. If bushings are dismantled from the generator, they shall be shipped either with the original packing or with an equivalent one.

If dehydrating cartridges are used, their status shall be checked; new cartridges are anyhow recommended.

2.6 INSTALLATION ON THE AC GENERATOR

This type of bushing can be installed in the generator in any angle, from vertical to horizontal.

Connection types to the external bars are:

- Plates;
- Rods;
- Threaded rods.

The connection to the plates must be made by bars placed on the two sides. The clamping must be made by non-magnetic steel bolts.

The status of the silvered surface of the contacts must be checked; dirt, light oxidation or black spots must be removed by cleaning with a light solvent (e.g. alcohol).

The effectiveness of the contacts shall be ensured to prevent overheating.

Details of contacts shall follow the prescriptions of the AC generator manufacturer.

2.7 COOLING SYSTEM

This type of bushings works with very high currents; in some cases, a cooling system is embedded.

Four different types of cooling are foreseen:



- Normal cooling: the external surface of the bushing cools the internal conductor.
- Natural cooling system: the bushing conductor is made of a cylindrical tube, where the generator's cooling fluid flows through, and removes the heat generated in the bushing.
- Forced cooling system: the bushing conductor made of a cylindrical tube, inside which a smaller tube is inserted by the generator's manufacturer. The generator's forced cooling fluid flows in the bushing through the smaller tube and removes the heat produced by the current. Fig. 8.
- Liquid cooled system: the system is like the previous one, with a double passage of the cooling fluid (a liquid in this case)

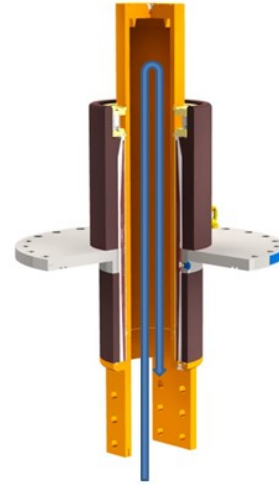


Fig. 8

3. SERVICE AND MAINTENANCE

3.1 CHECKS AFTER INSTALLATION

Before the installation on the generator, it is recommended to perform a check of the bushing capacitance and $\tan\delta$.

Reference values are given by the values reported on the bushing routine test report.

This type of bushing doesn't have an accessible power factor tap, so the measurement is done between the HV terminal and the flange.

The screw visible in figure 9, it is connected to the earthing device which grounds the condenser body, instead of the PF tap (Fig.9 – item 1).

Don't dismantle this device for any reason.




Fig. 9

WARNING

Screw item 1 fig. 9 that grounds the internal condenser body to the flange shall NOT be removed.

Disconnection of the screw results in missing the electrical contact between the internal condenser body and the flange; in this case the bushing may explode.

Not respecting this WARNING can result in personal injury, death or property damage.

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3.2 MAINTENANCE

The bushings are hermetically sealed and therefore an excellent preservation in time of the dielectric properties of the resin paper is ensured.

As for the preservation of the active part, these bushings require no maintenance.

Measurement of the dielectric losses ($\tan\delta$) every 10 years is recommended; instruction is in par. 5.

As for the preservation of the external surfaces, the following checks are recommended:

Visual inspection

The visual inspection includes the following checks.

Porcelain

Check for chips, cracks and contamination. Minor chips maybe painted with an insulating varnish to obtain a glossy finish which will prevent dirt and moisture attack.

Bushings with major chips or cracks which appreciably decrease the creepage distance should be removed from service and replaced.

The porcelain surfaces shall be periodically cleaned, since dust, combustion residual, dirt, and other deposits may collect and reduce consequently the voltage withstand capability.

HV terminals

Check the connections to avoid poor contacts and consequent overheating.

In case of very dirty and/or oxidised connections surfaces, they shall be cleaned with a light solvent (for example alcohol).

If necessary, a very fine sandpaper can be used, paying attention to not damage the silvered thin layer.

In case of damage of the silver coating, a light coat of silver conductive paint can be used.

4. DISASSEMBLY OF THE BUSHING

The bushing can be disassembled following the AC generator manufacturer's instructions.

- Remove completely the fixing contact of both connections;
- Remove the flange fixing bolts;
- Finally lift the bushing.

5. MEASUREMENT OF DIELECTRIC LOSSES


Dielectric loss max values for RIP bushings are the following:

IEC 60137 7×10^{-3}

IEEE C57.19.01-2000 8.5×10^{-3}

The GE internal acceptance criterion is 4×10^{-3} .

The measurement in GE Test Lab with calibrated equipment at the voltages requested by the Standards.

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All these values are shown in the Test Report.

Measurement at 10 kV is performed as a future reference value.


The bushing is tested with both sides in air, feeding the HV terminal and connecting the flange to the bridge.

This measurement can be repeated as follows:

- Disassemble the bushing from the AC generator (alternatively the bushing's flange must be insulated from the generator's body);
- Connect the flange to a measuring bridge;
- Apply a voltage of 10 kV to the HV terminal.
- Make the measurement.

The result is positive if the $\tan\delta$ is close to the original value shown in the Test Report.

If the difference between measured value and Test Report value exceeds 0.5×10^{-3} we recommend to contact the supplier.

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6. DISPOSAL AT THE END OF LIFETIME

The bushing consists of the following material:

Component	Material
Conductor	Copper
Terminals and bottom plates	Copper, aluminium alloy or brass; optional silver or tin coating
Winding	Epoxy resin impregnated paper with thin aluminium foils
Washers and springs	Stainless steel, carbon steel
Spring system rings	Brass
PF tap and cover	Nickel or tin coated brass, tin coated copper
Insulators	Porcelain acc. IEC60672
Filling mass	Polyurethane resin