Grid Solutions

# PTFR

## High Current Condenser Bushing 24-36 kV Oil-to-Air - Resin-Impregnated Paper

PTFR are capacitance-graded bushings with resin-impregnated paper (RIP) insulation. They are designed for use on power transformers, installed in any position, in compliance with the latest edition of IEC 60137. Design, components, and manufacturing technology guarantee an average lifetime longer than 30 years under normal operating conditions.

### Manufacturing of Capacitance-Graded Bushings

The main electrical component is the condenser body that is manufactured using RIP technology. This technology utilizes a continuous sheet of pure crepe paper, wound around a support tube. During the winding process, the first step is to reduce its water content to 1% maximum by drying the paper with heated cylinders and infrared rays. During winding, a series of aluminum foils are coaxially inserted between the layers of the paper in order to grade the best possible distribution of radial and longitudinal electrical gradients between the central conductor and the grounded flanges. The winding and foil placement is made by computer-controlled machines. After winding, each condenser core is placed into an autoclave for resin impregnation under vacuum. Each core is then machined to achieve the final shape.

### Standards

- IEC 60137

### Key Benefits

- Bushings have longer lifetime and higher reliability
- Possibility to use bushings under extreme weather conditions
- No performance decline with age
- Free of partial discharge
- Installation possible in any position

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# Main Features of PTFR Bushings

RIP High Current IEC Standards

- Rated voltages: 24 and 36 kV
- Air side: porcelain insulator
- Oil side: RIP winding
- Inner conductor made of cast aluminum
- Dry filling of the interspace between porcelain and condenser body
- Installation in any position
- Flange of aluminum alloy casting
- Maximum current rating up to 24,000 A
- Flange provided with power factor tap and Buchholz relay connection

# Bushing Designation PTFR.24.125.12000

| | |
|---|---|
| PTFR | Condenser bushings, transformer (for use on), high current, RIP technology |
| 24 | Insulation class in kV |
| 125 | BIL in kV |
| 12000 | Rated current in A |

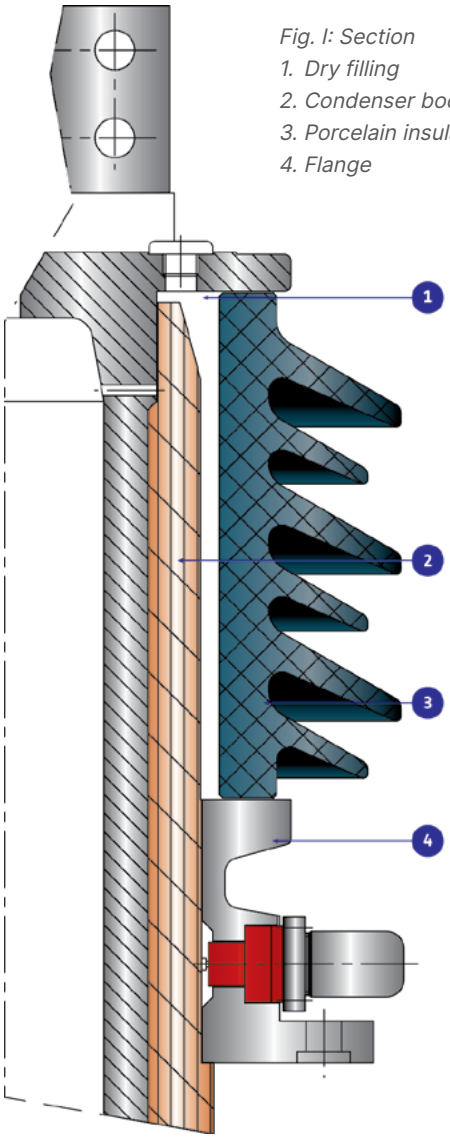


*Fig. I: Section*
*1. Dry filling*
*2. Condenser body*
*3. Porcelain insulator*
*4. Flange*

## Air Side

The air side envelope is made of brown-colored porcelain. The creepage distance is for a very high polluted atmosphere (VhP) equivalent to 31 mm/kV. The shed configuration is alternate-type (small-large sheds). This is the most effective solution, proven by salt tests and the profile of sheds complies with the recommendations of IEC 60815.

The air extremity of the bushing inner conductor is provided by two or more palms for the connections of the bus bars, which are normally enclosed in a metal-clad duct.

## Oil Side

The condenser body is immersed in the transformer oil and is hermetically sealed to the flange. The springs, located on the oil side, are used for mechanical coupling of all bushing parts and to avoid shifting due to the thermal variations. The oil extremity of the inner conductor is provided with one or more palms for the connection to the transformer windings.

## Current Ratings

The acceptable operating currents versus oil temperatures and bus duct air compared to the conductor can be calculated using the following formula:

$$Ina = In \times \alpha \times \beta$$

where:

| | |
|---|---|
| *Ina* | continuous admissible current [A] |
| *In* | nominal bushing current [A] |
| α | temperature coefficient |
| β | CT space coefficient |

α and ß can be determined using the tables below, where:

| | |
|---|---|
| Tc | admissible conductor temperature (120°C) |
| Ta | ambient (bus duct) air temperature (°C) |
| To | transformer oil temperature (°C) |
| K | CT space (mm) |

| Tc - Ta (°C) | COEFFICIENT (24 kV TYPE) | | | | |
|---|---|---|---|---|---|
| 90 | 0.83 | 0.91 | 1.01 | 1.09 | 1.16 |
| 80 | 0.80 | 0.87 | 0.97 | 1.05 | 1.13 |
| 70 | 0.74 | 0.83 | 0.93 | 1.02 | 1.11 |
| 60 | 0.69 | 0.80 | 0.90 | 1.00 | 1.10 |
| 50 | 0.65 | 0.77 | 0.87 | 0.98 | 1.09 |
| 40 | 0.61 | 0.73 | 0.84 | 0.96 | 1.08 |
| 30 | 0.57 | 0.70 | 0.82 | 0.94 | 1.07 |
| 20 | 0.53 | 0.66 | 0.79 | 0.92 | 1.06 |
| 10 | 0.50 | 0.63 | 0.76 | 0.90 | 1.05 |
| **Tc - To (°C)** | 10 | 20 | 30 | 40 | 50 |

| Tc - Ta (°C) | COEFFICIENT α (36 kV TYPE) | | | | |
|---|---|---|---|---|---|
| 90 | 0.76 | 0.83 | 0.92 | 0.99 | 1.06 |
| 80 | 0.72 | 0.79 | 0.88 | 0.96 | 1.03 |
| 70 | 0.67 | 0.76 | 0.85 | 0.93 | 1.01 |
| 60 | 0.63 | 0.73 | 0.82 | 0.91 | 1.00 |
| 50 | 0.59 | 0.70 | 0.79 | 0.89 | 0.99 |
| 40 | 0.55 | 0.66 | 0.76 | 0.86 | 0.96 |
| 30 | 0.50 | 0.63 | 0.73 | 0.84 | 0.95 |
| 20 | 0.46 | 0.59 | 0.70 | 0.81 | 0.93 |
| 10 | 0.43 | 0.56 | 0.67 | 0.79 | 0.91 |
| **Tc - To (°C)** | 10 | 20 | 30 | 40 | 50 |

| CT SPACE | COEFFICIENT β | | | |
|---|---|---|---|---|
| K (mm) | 24 kV Type | | 36 kV Type | |
| | Ta = 40°C | Ta = 80°C | Ta = 40°C | Ta = 80°C |
| 0 | 1.00 | 1.00 | 1.00 | 1.00 |
| 100 | 0.94 | 0.99 | 0.97 | 0.99 |
| 200 | 0.87 | 0.97 | 0.90 | 0.95 |
| 300 | 0.81 | 0.95 | 0.84 | 0.91 |
| 400 | 0.75 | 0.91 | 0.79 | 0.87 |
| 500 | 0.68 | 0.87 | 0.75 | 0.83 |
| 600 | 0.61 | 0.81 | ... | ... |
| 700 | 0.55 | 0.75 | ... | ... |

## Conductor and Terminals

Both sides of the conductor and terminals are made from a unique cast aluminum alloy, which has an IACs 55% conductivity. Terminal surfaces are not treated. It is possible to provide them with 10 micron silver plating, upon request.

## Flange

The flange is made from cast aluminum, and is equipped with lifting holes, a power factor tap (tested at 2 kV for 60 s) (Fig. 2) and Buchholz relay connection (1/2" gas outlet plug) (Fig. 6).

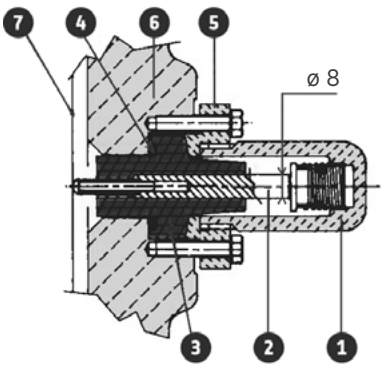


*Fig. 2: Power Factor Tap*
*1. Closing and grounding cap*
*2. Measurement electrode*
*3. Insulation tap*
*4. Gasket*
*5. Tap flange*
*6. Bushing flange*
*7. Last layer*

# Assembling

The coupling between the porcelain and metal parts (flange and inner conductor) is achieved with helicoidal springs, placed in the oil side of the bushings.

# Gaskets

Made of Viton® a fluorocarbon rubber elastomer (FPM), o-ring type. They are compatible with all the fluids they are in contact with (transformer mineral oil). 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.

# Dry filling

PTFR bushings can be installed in any position because the interspace between the porcelain and the condenser body is filled with a dry mass (polyol-isocyanate).

This material offers:

- Low dielectric losses
- Good level of partial discharges
- Good thermal resistance
- Constant characteristics versus time

Dry filling improves reliability in comparison with oil filled type and makes installation simpler: no oil leakage and, if horizontal installation, no oil reservoir.

# Tests

All bushings have electrical characteristics that are tested in compliance with the last edition of IEC 60137-Publication insulated bushings for alternating voltages above 1000 V, and Main National standards.

*Fig. 3 Cross-section*

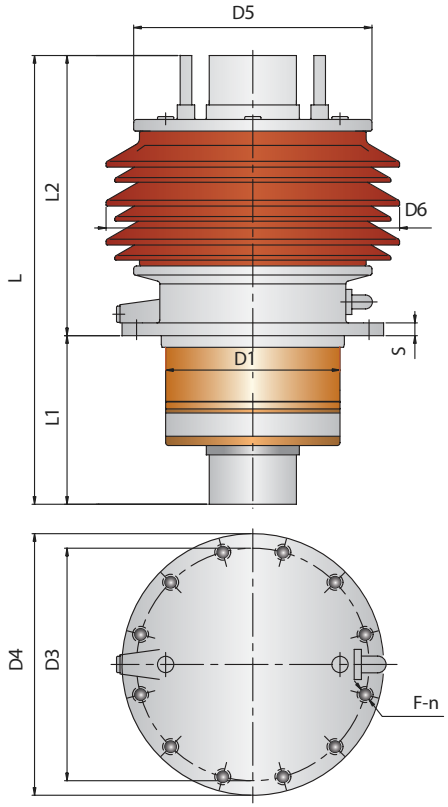


*Fig. 4 Dimensions*

# PTFR Range - 24 / 36 kV: Ratings / Dimensions

| | | Rated Voltage | Rated phase-to-earth voltage | Dry and wet power frequency withstand voltage (60') | Dry lightning impulse withstand voltage | Rated current | Free insulation length in air | Min. nominal creepage distance | Pair of sheds (small + large) | Cantilever load | Weight | Max. operating altitude |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ITEM | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| **Type** | | **kV** | **kV** | **kV** | **kV** | **A** | **mm** | **mm** | **n°** | **N** | **kg** | **m** |
| 1 | 24.125.7500 | 24 | 14 | 50 | 125 | 7,500 | 230 | 828 | 3 | 3150 | 60 | 1,000 |
| 2 | 24.125.9000 | 24 | 14 | 50 | 125 | 9,000 | 230 | 828 | 3 | 3150 | 60 | 1,000 |
| 3 | 24.125.12000 | 24 | 14 | 50 | 125 | 12,000 | 230 | 828 | 3 | 3150 | 60 | 1,000 |
| 4 | 24.125.15000 | 24 | 14 | 50 | 125 | 15,000 | 230 | 828 | 3 | 3150 | 60 | 1,000 |
| 5 | 24.125.19000 | 24 | 14 | 50 | 125 | 19,000 | 230 | 828 | 3 | 3150 | 60 | 1,000 |
| 6 | 24.125.24000 | 24 | 14 | 50 | 125 | 24,000 | 230 | 1205 | 4,5 | 3150 | 210 | 3,000 |
| 7 | 36.170.7500 | 36 | 21 | 70 | 170 | 7,500 | 460 | 1650 | 6 | 3150 | 80 | 3,000 |
| 8 | 36.170.9000 | 36 | 21 | 70 | 170 | 9,000 | 460 | 1650 | 6 | 3150 | 100 | 3,000 |
| 9 | 36.170.12000 | 36 | 21 | 70 | 170 | 12,000 | 460 | 1650 | 6 | 3150 | 110 | 1,000 |
| 10 | 36.170.15000 | 36 | 21 | 70 | 170 | 15,000 | 460 | 1205 | 4,5 | 3150 | 145 | 1,000 |
| 11 | 36.170.19000 | 36 | 21 | 70 | 170 | 19,000 | 460 | 1650 | 6 | 3150 | 230 | 3,000 |
| 12 | 36.170.24000 | 36 | 21 | 70 | 170 | 24,000 | 460 | 1205 | 4,5 | 3150 | 220 | 1,000 |

| Dimensions | | L | L1 | L2 | D1 | D3 | D4 | D5 | D6 | NR | F | S | Top Palm | Bottom Palm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ITEM | | 12 | 13 | 14 | 15 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| **Type** | | **mm** | **mm** | **mm** | **mm** | **mm** | **mm** | **mm** | **mm** | **N°** | **mm** | **mm** | **Fig.** | **Fig.** |
| 1 | 24.125.7500 | 770 | 290 | 480 | 190 | 290 | 335 | 260 | 360 | 12 | 16 | 19 | 7 | 8 |
| 2 | 24.125.900 | 770 | 290 | 480 | 218 | 290 | 335 | 345 | 445 | 12 | 16 | 19 | 9 | 10 |
| 3 | 24.125.12000 | 770 | 290 | 480 | 255 | 350 | 400 | 345 | 445 | 12 | 20 | 21 | 11 | 12 |
| 4 | 24.125.15000 | 770 | 290 | 480 | 300 | 400 | 450 | 410 | 505 | 12 | 20 | 22 | 13 | 14 |
| 5 | 24.125.19000 | 770 | 290 | 480 | 360 | 450 | 500 | 460 | 555 | 12 | 20 | 22 | 15 | 16 |
| 6 | 24.125.24000 | 860 | 290 | 570 | 435 | 535 | 590 | 530 | 625 | 16 | 22 | 23 | 17 | 18 |
| 7 | 36.170.7500 | 1,030 | 320 | 710 | 190 | 290 | 335 | 260 | 360 | 12 | 16 | 19 | 7 | 8 |
| 8 | 36.170.9000 | 1,030 | 320 | 710 | 218 | 290 | 335 | 345 | 445 | 12 | 16 | 19 | 9 | 10 |
| 9 | 36.170.12000 | 1,030 | 320 | 710 | 255 | 350 | 400 | 345 | 445 | 12 | 20 | 21 | 11 | 12 |
| 10 | 36.170.15000 | 890 | 320 | 570 | 300 | 400 | 450 | 410 | 505 | 12 | 20 | 22 | 13 | 14 |
| 11 | 36.170.19000 | 1,030 | 320 | 710 | 360 | 450 | 500 | 460 | 555 | 12 | 20 | 22 | 15 | 16 |
| 12 | 36.170.24000 | 890 | 320 | 570 | 435 | 535 | 590 | 530 | 625 | 16 | 22 | 23 | 17 | 18 |

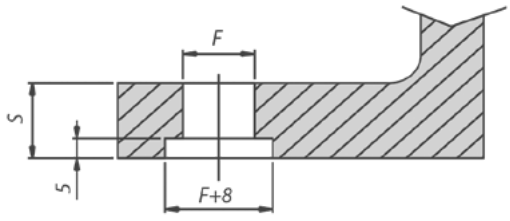


*Fig. 5 Flange fixing holes*

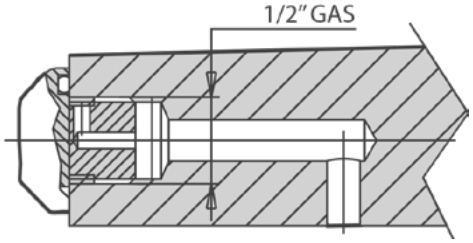


*Fig. 6 Buchholz relay connection*

# Top Palms

### 7500 A

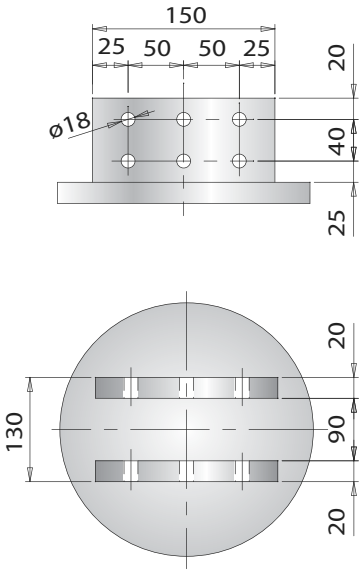


*Fig. 7*

### 9000 A

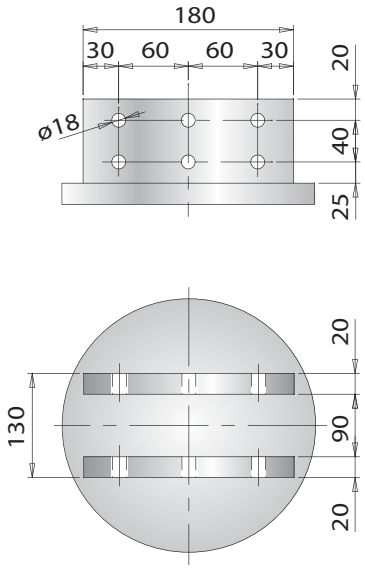


*Fig. 9*

### 12000 A

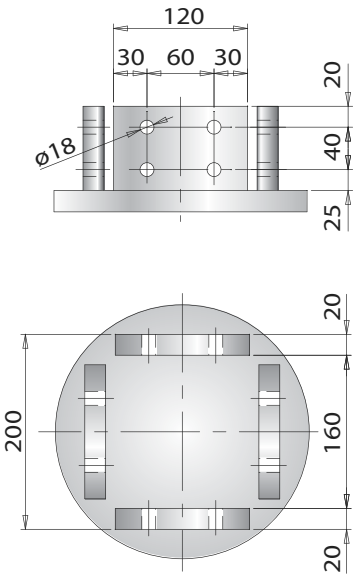


*Fig. 11*

# Bottom Palms

### 7500 A

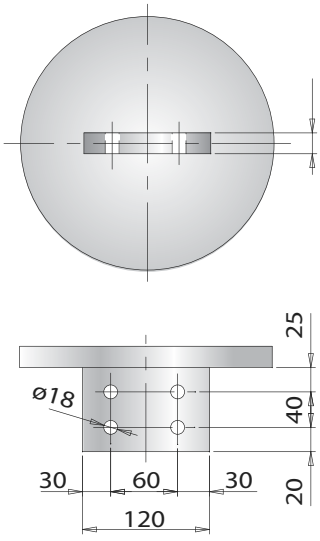


*Fig. 8*

### 9000 A

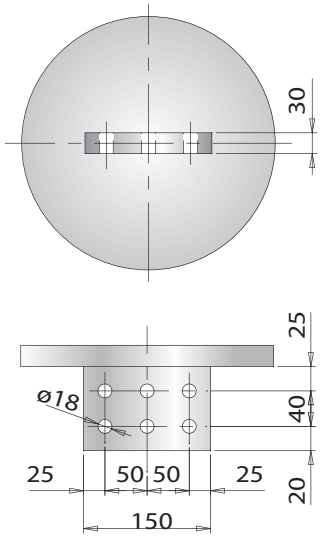


*Fig. 10*

### 12000 A

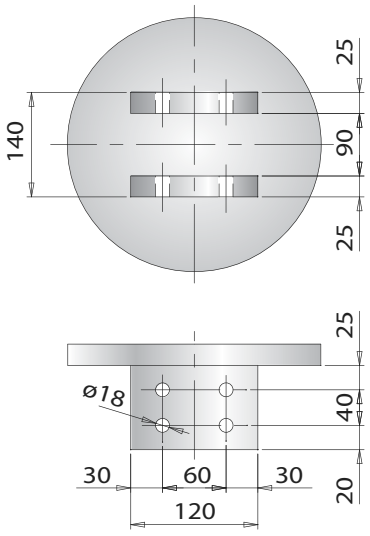


*Fig. 12*

# Top Palms

### 15000 A

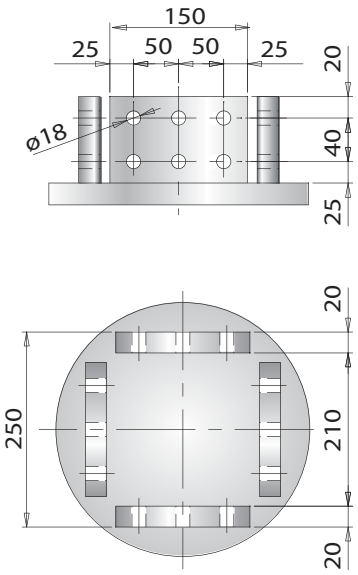


*Fig. 13*

### 19000 A

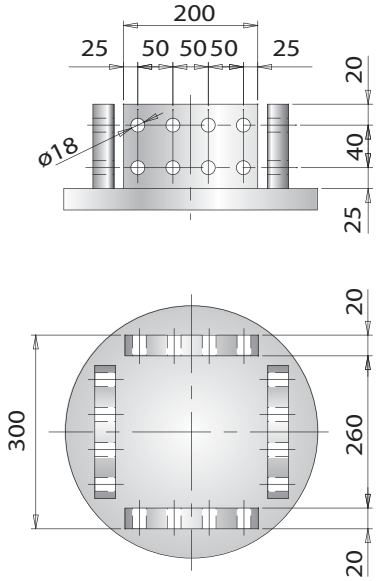


*Fig. 15*

### 24000 A

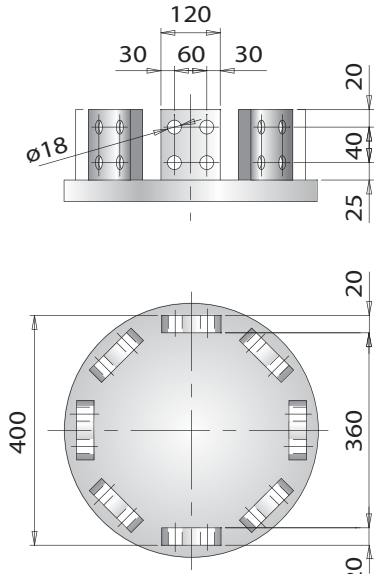


*Fig. 17*

# Bottom Palms

### 15000 A

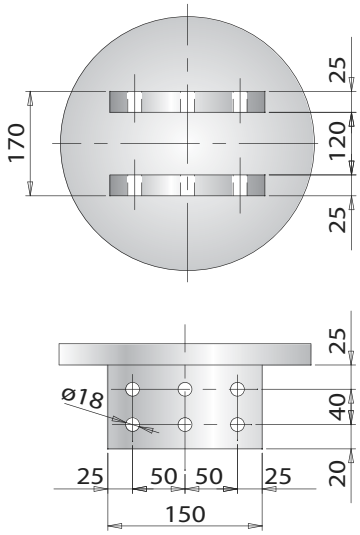


*Fig. 14*

### 19000 A

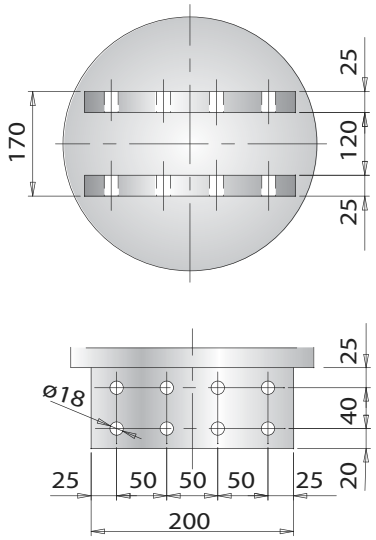


*Fig. 16*

### 24000 A

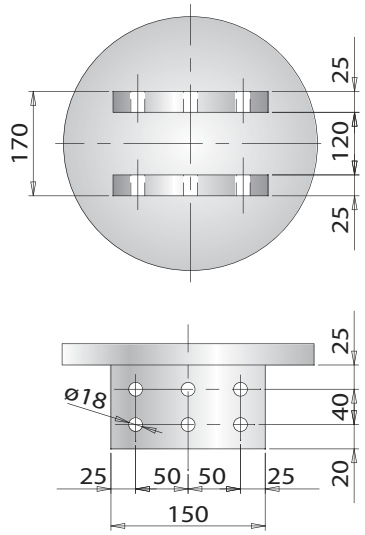


*Fig. 18*

# Nameplate

Each bushing is provided with a nameplate, (Fig. 19) with all the electrical data and serial number, in accordance with the prescription of IEC standards. The aluminium plate is placed on the flange by rivets.

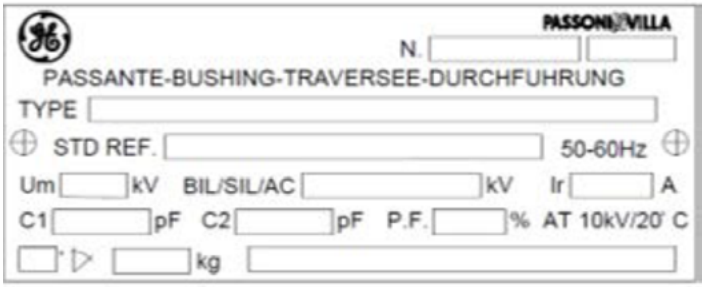


*Fig. 19: Nameplate*

## For more information visit gevernova.com/grid-solutions



GEA-33261-(E)
English
240605