Micafil transformer oil-SF₆ bushings
GARIP / RTKG 72.5 – 550 kV
Design and accessories

The design of the main RIP insulating body includes a solid, non-removable conductor, resulting in a perfectly reliable structure which meets today’s stringent electrical, thermal and mechanical requirements.

Main features of the SF₆ interface
The dimensions and physical properties of GARIP type bushings fully comply with all standard requirements according to the latest IEC Publication 61639. This ensures complete compatibility of the interface for manufacturers of transformers and GIS (gas insulated switchgear). The specially shaped head acts as both a silver-coated terminal with tapped holes and an epoxy-coated high-voltage electrode. Additional shields are therefore not necessary. Only adjacent conductor parts must be designed to suit the bushing terminal.

Intended for the entire range of rated voltages from 72.5 to 550 kV, Micafil's GARIP bushings are specified for working pressure up to 750 kPa of SF₆ in the GIS. Our series of GARIP bushings require minimum functional SF₆ gas pressures of 350 kPa (72.5 – 420 kV) or 390 kPa (550 kV).

Flange design
All flanges are made of corrosion-proof aluminum alloys. Standard equipment includes a test tap, four threads at the transformer side flange plate either for grounding or as forcing threads plus a deaeration screw on the transformer side. Very advanced seals between the main insulating RIP body and the flange guarantee permanent gas and oil tightness during operation.

Test tap
All GARIP bushings include a self-grounded test tap connected to the outer control layer of the RIP body for on-site measurement of capacitance and tan δ.

Main features of the transformer interface
The range of GARIP bushings offers CT spaces of 0, 300 and 600 mm as standard (note: dimension L₆ min. = 100 mm for 170 kV types). Special shields, which are removable for better handling, are supplied for all bushings with a rated voltage greater than 72.5 kV.

Customized designs for every oil/SF₆ application are available on request.
Micafil is the worldwide leader in RIP (Resin Impregnated Paper) technology for oil-free, dry bushings. These are extremely safe, protect the environment and lead to noticeable cost reductions.

RIP technology in detail
RIP technology is the core element of a Micafil bushing: resin impregnated paper insulation with capacitor inserts for electrical field control. Our materials meet today's requirements for a high-grade insulating system as concerns free from partial discharge. Through a complex production process, a compact, liquid- and gas-tight insulation core is manufactured.

1. RIP condenser core with inserted aluminum layers
2. Flange with test tap
3. SF₆ interface (GIS)
4. Oil interface (transformer)

RIP bushing technology
In modern metal-enclosed switchgear, SF₆ gas is used as an extinguishing and insulating medium, ensuring the highest level of safety for operating staff and residents, especially in very confined and densely populated areas.

To meet this requirement, today’s space-saving designs require excellent mechanical and electrical performance of all the components involved.

Micafil’s contribution to this worldwide development is its GARIP line of bushings. These have been designed for the direct single-phase connection between power transformers and gas insulated switchgear (GIS) for rated voltages of 72.5 up to 550 kV.

We are proud of our leading position in this field. Our customers benefit from our extensive expertise in state-of-the-art technology, which is based upon more than 100,000 RIP bushings successfully in operation.

The insulation body of the GARIP condenser bushing consists of a robust and solid core. It is made of wound crepe paper with inserted aluminum foils for field control, carefully vacuum dried and subsequently impregnated with a special epoxy resin.

Main advantages of Micafil RIP technology
- Free of partial discharge up to double service voltage
- High thermal strength (class E, 120 °C)
- Low dielectric losses (tan δ < 0.35 %)
- Adaptable to different transformer and installation designs
- Compact, space-saving configuration
- Installation, transportation and operation in any position allowed
- Low weight
- Gas tight (in oil-gas bushings, the transformer is not threatened by penetrating gas)
- No explosion risk for outdoor SF₆ bushings (pressure-free bushings)
- Free of maintenance and monitoring
Technical data and dimensions

**Dimension drawings**

- **Aluminium, silver plated**
- **Copper, thickness 30 mm**
- **Grounded length**
- **Sealing area, Ra = 1.6 (N7)**
- **Sealing area, Ra = 3.2 (N8)**
- **Removable shields**
  - Types 123 kV – 245 kV
  - Types 362 kV – 550 kV

**Flange dimensions**

<table>
<thead>
<tr>
<th>Flange dimensions</th>
<th>RTKG 72.5 – 350 / 2000</th>
<th>RTKG 123 – 550 / 2500</th>
</tr>
</thead>
</table>

**View A: SF₆ side**

- Deaeration of transformer opposite the test tap

**View B: Oil side**

- Deaeration of transformer opposite the test tap

RTKG 170 – 750 / 2500
## Table: Dielectric data for transformers

<table>
<thead>
<tr>
<th>Type</th>
<th>Condenser bushing, oil – SF&lt;sub&gt;6&lt;/sub&gt; for transformers</th>
</tr>
</thead>
<tbody>
<tr>
<td>GARIP RTKG</td>
<td></td>
</tr>
<tr>
<td><strong>Variante 1:</strong></td>
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<td><strong>Variante 2:</strong></td>
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<tr>
<td><strong>RTKG 72.5−350/2000</strong></td>
<td>72.5 42 140 325 – 69 44 160 350 – 2400 2200 1900 1450 1100 700 – 770 1070 1370 - 0 300 600 175 475 775</td>
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<tr>
<td><strong>RTKG 72.5−350/2500</strong></td>
<td>72.5 42 140 325 – 69 44 160 350 – 3000 2700 2450 2200 1650 1300 900 700 – 700 1070 1370 - 0 300 600 175 475 775</td>
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<td><strong>RTKG 123−550/2000</strong></td>
<td>123 71 230 550 – 92 73 185 450 – 2200 2040 1900 1750 1500 1250 1000 700 – 1180 1480 1780 - 0 300 600 310 610 910</td>
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<td>123 71 230 550 – 92 73 185 450 – 2550 2450 2200 2000 1750 1500 1250 1000 – 1180 1480 1780 - 0 300 600 310 610 910</td>
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<td><strong>RTKG 145−650/2000</strong></td>
<td>145 84 275 650 – 138 88 310 650 – 2100 1900 1700 1500 1300 1100 900 700 – 1250 1530 1830 - 0 300 600 360 660 960</td>
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<td>170 98 325 750 – 161 102 365 750 – 2650 2450 2250 2050 1850 1650 1450 1250 – 1390 1590 1890 1200 1000 1020 172</td>
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<td>245 141 460 1050 850 230 146 425 900 – 2000 1900 1700 1500 1300 1100 900 700 – 1740 2040 2340 1200 1100 690</td>
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</tr>
<tr>
<td><strong>RTKG 362−1300/2000</strong></td>
<td>362 209 570 1300 1050 345 220 520 1175 825 2100 1900 1700 1500 1300 1100 900 700 – 2110 2410 2710 1200 1100 690 282</td>
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<tr>
<td><strong>RTKG 550−1800/2000</strong></td>
<td>550 318 790 1800 1300 500 318 750 1675 1175 2000 1900 1800 1700 1600 1500 1400 1300 1200 1100 1000 900 800 700 – 2310 2610 2910 1300 1200 690 342</td>
</tr>
</tbody>
</table>

### Explanation of the columns:

5. Lightning impulse withstand voltage according to IEC 60137
6. Switching impulse withstand voltage according to IEC 60137
10. Lightning impulse withstand voltage according to IEE C57.19.01
11. Switching impulse withstand voltage according to IEE C57.19.01
12. Conductor loading according to IEC 60137 & IEEE C57.19.01
13. Short-time current after operation with rated current
20. CT extension L6 as standard, other lengths on request.

Note: L<sub>6,ns</sub> = 100 mm for 170 kV types
<table>
<thead>
<tr>
<th>D7</th>
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<th>d6</th>
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<th>s1</th>
<th>s2</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
<th>Ø6</th>
<th>n x Ø6</th>
<th>D9</th>
<th>D10</th>
<th>D11</th>
<th>D12</th>
<th>Ø1 x Ø16</th>
<th>L2</th>
<th>D8</th>
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<td>8 x Ø16</td>
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</tbody>
</table>

25 The copper terminal is flat with two holes, Ø18 mm
26 Bushings Ur > 72.5 kV are equipped with an oil-end shield that is epoxy-coated
27 For better handling, the shield is removable.

Note: For the 170 kV / 2000 A and 245 kV / 2000 A types, two different shield sizes are available depending on the transformer current

Subject to change
1 automated winding machine | 2 final curing vessel | 3 machining of condenser body
**Conductor loading**

The rated current depends on the bushing lower length (see the section «Technical data and dimensions» on pages 5 and 6, column 12 and 20). Bushings selected with Ir not less than 120% of the rated current of the transformer are considered to be able to withstand the overload conditions according to IEC Publication 60354 (loading guide).

**Recommendations for bushing installation**

**Transformer**

The field strength in the oil on the surface of the shield insulation must be limited to values normal for insulated components. As a guideline, minimum distances A to grounded transformer parts are given below:

<table>
<thead>
<tr>
<th>Type</th>
<th>AC test voltage [kV]</th>
<th>A [mm]</th>
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<tbody>
<tr>
<td>123</td>
<td>185</td>
<td>130</td>
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<td>790</td>
<td>600</td>
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</tbody>
</table>

**GIS**

Observe the minimum enclosure diameter DGIS as well as the minimum operating SF6 gas pressure (see the section «Technical data and dimensions» on pages 5 and 6, columns 17 and 18). Adjacent conductor parts should be designed to suit the bushing terminal.

**General**

Because the bushing is completely dry, it can be operated vertically, horizontally or in any other position.

**Bushing testing**

Before leaving the factory, each bushing undergoes routine testing according to either IEC 60137 or IEEE C57.19.01.

**The standard tests include:**

- Measurement of tan δ, capacitance and partial discharge
- Power frequency test
- Lightning impulse test (if applicable)
- Leakage test

**Ordering details**

When ordering, please state:

- Type and catalog no. (see the table below)
- CT extension (see the section «Technical data and dimensions» on pages 5 and 6, column 20)
- For 170 kV / 2000 A or 245 kV / 2000 A only: choose the size of oil-side shield depending on transformer current (see the section «Technical data and dimensions» on pages 5 and 6, columns 26 and 27)

**Type Designation**

The type designation is included in an overall system. An example of nomenclature used to designate our GARIP bushings:

**RTKG 245 – 1050 / 2000**

- Nominal current (A)
- Lightning impulse voltage (kV)
- Rated voltage (kV)
- R = RIP insulation
- T = Transformer application
- K (Kurz in German) = short oil-side part
- G (Gas in German) = SF6 gas application

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8 Micafil transformer oil-SF6 bushings
Other Micafil bushings
In addition to the transformer high current bushings described here, Micafil offers other transformer bushings, GIS bushings, wall bushings and railway bushings, as well as customer tailored bushings. Our bushings are developed and approved for mineral oil applications.

Transformer bushings

Oil-air bushings
- 24 – 550 kV up to 5000 A
- SeismicRIP® bushing according to IEEE 693-2005
  69 – 550 kV up to 5000 A

Oil-SF₆ bushings
- 36 – 550 kV up to 4000 A

Oil-oil bushings
- 24 – 550 kV up to 4000 A

GIS bushings
- SF₆-air bushings
- 245 – 550 kV up to 4000 A

Wall bushings
- 24 – 362 kV up to 4000 A

Railway bushings
- 12 – 52 kV up to 2000 A

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