In modern metal enclosed switchgear SF₆-gas is used as an extinguishing and insulating medium, ensuring highest security standard for operating staff and residents, especially in most confined and dense populated areas. 

As a result, today’s space saving design requires excellent mechanical and electrical performance of all components involved. Micafil’s contribution to this world-wide development is it’s new product range of GARIP 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 kV up to 550 kV.

Since more than 40 years Micafil AG produces high voltage bushings made with Vacuum Resin Impregnated Paper Technology (RIP).

We are proud of our leading position in this field, making available to our customers profound expertise in the latest state of the art technology, which is based upon more than 50000 RIP-bushings successful in operation.

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

The basic procedure for this new kind of manufacture was originally developed by Micafil AG in Switzerland already in 1958 and continuously improved in the course of four decades.

Advanced standardisation, highly skilled craftsmanship and computer-aided engineering guarantee today’s most reliable and advanced insulation system for every voltage level.

Main advantages of Micafil’s RIP-technology

- Short delivery times
- Low dielectric losses (tan δ ~ 0.35%)
- Partial discharge free up to double service voltage
- Fully dry, maintenance free
- Oil-free and environmental friendly
- Highest mechanical and thermal properties
- Robust design and vandalism resistant
- Option for any operating position
- Gas and oil tight
- Easy handling
Technical Data and Dimensions

Flange dimensions for:
- RTKG 72.5-350 / 2000
- RTKG 72.5-350 / 2500
- RTKG 123-550 / 2000
- RTKG 123-550 / 2500
- RTKG 145-650 / 2000
- RTKG 170-750 / 2000
- RTKG 170-750 / 2500

View A: SF₆ side
- De-aeration of transformer opposite to test tap

View B: Oil side
- Shields removable
- Sealing area Ra = 1.6 (N7)
- Sealing area Ra = 3.2 (N8)
- Grounded length
- Copper, thickness 30 mm
- De-aeration of transformer opposite to test tap

Flange dimensions for:
- RTKG 170-750 / 2500
- RTKG 245-1050 / 2000
- RTKG 245-1050 / 2500
- RTKG 362-1300 / 2000
- RTKG 362-1300 / 2000
- RTKG 420-1550 / 2000
- RTKG 420-1550 / 2500
- RTKG 525-1800 / 2000
- RTKG 525-1800 / 2000

View A: SF₆ side
- De-aeration of transformer opposite to test tap

View B: Oil side
- Shields removable
- Sealing area Ra = 1.6 (N7)
- Sealing area Ra = 3.2 (N8)
- Grounded length
- Copper, thickness 30 mm
- De-aeration of transformer opposite to test tap
General Informations

Conductor loading
Rated current dependent on the bushing lower length (see "Technical Data" page 5 & 6, column 12). 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>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>185</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>230</td>
<td>145</td>
</tr>
<tr>
<td>145</td>
<td>275</td>
<td>170</td>
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<tr>
<td></td>
<td>310</td>
<td>200</td>
</tr>
<tr>
<td>170</td>
<td>325</td>
<td>210</td>
</tr>
<tr>
<td></td>
<td>365</td>
<td>230</td>
</tr>
<tr>
<td>245</td>
<td>460</td>
<td>300</td>
</tr>
<tr>
<td>362</td>
<td>570</td>
<td>400</td>
</tr>
<tr>
<td>420</td>
<td>630</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td>680</td>
<td>500</td>
</tr>
<tr>
<td>525</td>
<td>750</td>
<td>550</td>
</tr>
<tr>
<td></td>
<td>790</td>
<td>600</td>
</tr>
</tbody>
</table>

GIS
Observe the minimum enclosure diameter $D_{GIS}$ as well as the minimum operating SF$_6$ gas pressure (see "Technical Data" page 5 & 6, columns 17 & 18). Adjacent conductor parts should be well adapted to the bushing terminal.

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

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

GARIP RTKG 245-1050 / 2000

- Nominal current (A)
- Lightning impulse voltage (kV)
- Rated voltage (kV)
- R = RIP Insulation
- T = Transformer application
- K = Short oil side part
- G = SF$_6$-gas application
- Bushing series

Testing of the bushing
Each bushing undergoes routine testing before leaving the factory, either according to IEC 60137 or IEEE C57.19.00.

The standard tests include:
- Tan δ, capacitance and partial discharge measurement
- Power frequency test
- Lightning impulse test (if applicable)
- Leakage test

Ordering particulars
When ordering please state:
- Type and catalogue no. see the table below
- CT space L6, see "Technical Data" page 5 & 6, column 20
- For 170 kV / 2000 A respective 245 kV / 2000 A only: choose the size of oil side shield depending on the transformer current; see "Technical Data" page 5 & 6, columns 26 & 27

<table>
<thead>
<tr>
<th>Bushing type</th>
<th>Catalogue no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>GARIP RTKG 72.5-350 / 2000</td>
<td>HLJMJ 154484</td>
</tr>
<tr>
<td>GARIP RTKG 72.5-350 / 2500</td>
<td>HLJMJ 154964</td>
</tr>
<tr>
<td>GARIP RTKG 123-550 / 2000</td>
<td>HLJMJ 154504</td>
</tr>
<tr>
<td>GARIP RTKG 123-550 / 2500</td>
<td>HLJMJ 154514</td>
</tr>
<tr>
<td>GARIP RTKG 145-650 / 2000</td>
<td>HLJMJ 154524</td>
</tr>
<tr>
<td>GARIP RTKG 170-750 / 2000</td>
<td>HLJMJ 154534</td>
</tr>
<tr>
<td>GARIP RTKG 170-750 / 2500</td>
<td>HLJMJ 154544</td>
</tr>
<tr>
<td>GARIP RTKG 245-1050 / 2000</td>
<td>HLJMJ 154554</td>
</tr>
<tr>
<td>GARIP RTKG 245-1050 / 2500</td>
<td>HLJMJ 154564</td>
</tr>
<tr>
<td>GARIP RTKG 362-1300 / 2000</td>
<td>HLJMJ 154574</td>
</tr>
<tr>
<td>GARIP RTKG 420-1550 / 2000</td>
<td>HLJMJ 154584</td>
</tr>
<tr>
<td>GARIP RTKG 525-1800 / 2000</td>
<td>HLJMJ 154594</td>
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  2.2 Transport box 2
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  6.2 HLAB 200 203E Operating instructions for bushing test tap 5

All information in this document is subject to change without notice.
1 Structural Design

The type RTKG bushing is intended for the direct connection between power transformers and gas-insulated metal-enclosed high voltage switchgears (GIS).

The dimensions of the SF₆ side of the bushing as well as the physical features completely correspond to the data of IEC Publ. 61639.

HLJM 155644 (Appendix 6.1) illustrates the structural design of Oil-SF₆ bushings.

Webs of crepe paper are wound onto the stem conductor by an automated winding machine to form the insulating core. Aluminium layers are inserted in the windings at precisely calculated positions for field control. This insulating core is vacuum dried, impregnated under vacuum with epoxy resin and cured. The result is a high quality insulation system. The RIP core including the non removable conductor is compact, oil and gas-tight.

The bushing core is fixed in the flange. The space between the two O-ring tightened flange sections is accessible via two M12 tapped holes. For normal operation these threaded holes are closed gastight. They can, however, also be used for leakage rate measurement purposes.

All bushings are provided with a self-grounding test tap and 4 threads M12 at the transformer side flange plate which can be used either for grounding the flange or as forcing threads.

On the transformer side part there are different CT spaces L6 available. Details see order specific drawing.

Because the bushing is completely dry, it can be transported, stored and installed vertically or horizontally or in any position.

Details of the construction of the bushing can be extracted from the order specific drawing.

2 Packing

2.1 Bushing supply conditions

For protection against damages the bushings are dispatched in wooden transport boxes. Both bushing ends are protected against humidity by a plastic sack with a desiccant bag. The flange plate at the SF₆ switchgear end is protected from damage by a cover.

2.2 Transport box

Gross- and netweight, also the dimensions are given in the shipping documents.

2.3 Lifting of the bushing / handling

The smaller types can be lifted by hand. The larger types require rope and lifting tackle. For this purpose the rope must be fixed to both ends of the insulating core, but not using the terminals.

2.4 Repacking for further transport

It is necessary to ensure that the quality of packing, the protection against humidity and damages is as good as on delivery.
3 Storage

Concerning the storage of the bushing, the location (outdoors, rain protected or indoors) and the duration of storage (short, medium or long term) must be taken into account. If necessary a storage container can be ordered from Micafil AG.

Caution: Generally the moisture protection of the bushing must be mounted at all time.

<table>
<thead>
<tr>
<th></th>
<th>Outdoor, protected from rain</th>
<th>Indoor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term</td>
<td>In original transportation box, covered with plastic. Recommended: Additional moisture protection with a second plastic bag and desiccant cartridge.</td>
<td>In original transportation box or unpacked.</td>
</tr>
<tr>
<td>max. 1 year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium term</td>
<td>Not recommended</td>
<td>In original transportation box or unpacked.</td>
</tr>
<tr>
<td>max. 2 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long term</td>
<td>Not recommended</td>
<td>- SF₆ side part in a storage container, filled with dry nitrogen.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- lower part of the bushing in a storage container, filled with oil or dry nitrogen.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In original transportation box or unpacked. Only in dry rooms, temperature as constant as possible. The desiccant cartridge should be checked regularly.</td>
</tr>
</tbody>
</table>

Note

Bushings which have been stored in storage containers can be used even after long term storage without any further testing of the bushing.

3.1 Proceedings after inexperted storage

If it is suspicious whether the storage conditions are conform to the table above, it is possible, that humidity has entered into the insulation by a diffusion process. This must be verified by capacitance and dielectric dissipation factor tanδ measurement at about 10 kV between head and measuring tap. If the increase of the dielectric dissipation factor tanδ is more than 0,2%, please contact Micafil AG for further information about the drying procedure.

Example: Initial tanδ: 0,35%, measured tanδ: 0,55%.

4 Installation and commissioning

4.1 Checks

- take away all packing materials from the bushing,
- check the bushing for visible damages.

4.2 Release for installation

Release only when:

- there are no visible damages,
- the humidity indicator is active.

In case of deficiencies contact Micafil AG.
4.3 Shielding
For a better handling at the terminal the oil side shield is dismountable. See 4.7.

4.4 Erection into vertical position
The smaller types can be erected by hand, larger types require ropes and lifting tackle. When setting bushings upright with the aid of lifting tackle, they should be slung from the flange and secured against tipping over by hand or with a rope slung round the hook of the lifting tackle while slowly raising them to the vertical position.

**Caution:** Do not place the bushing onto the terminals or shields!

4.5 Installation of the bushing
The connection between bushing flange and transformer should be corrosion resistant. To tighten the system, O-rings or flat sealings are suitable. Attention must be paid to the de-aeration hole at the flange plate, which should not be covered by the sealing.

The screw connection should be designed for not deforming the flange. Sealing and screw connection on SF6-side according to order.

4.6 Connection to bottom contact and mounting of shield
- Remove the shield by unscrewing the 3 screws, using a hexagon socket screw key.
- Move the shield temporarily upwards or downwards
- Connect the cable lugs to the bottom contact. When connecting the usual procedure with respect to contact resistance and corrosion should be taken.
- Place the shield onto its initial location. Ensure that the screws are precisely positioned. Tighten the screws and check that the screws are sunk by about 12 mm.

**CAUTION:**
Do not remove the two fixing rings at the bushing bottom end!

4.7 Cleaning, de-aeration, resting time
If the bushing is colder than ambient temperature at site, the bushing should be brought to ambient temperature before installation, this in order to prevent condensation. The insulating core should then be thoroughly cleaned using a clean, dry and non-fluffy rag.

If the bushing is to be fitted inside a dome, this can be de-aerated by means of the de-aeration screw provided on the flange.

If the filling of a transformer to its final oil level is not made under vacuum it is necessary to apply a resting time of 12 h prior to the application of voltage higher than \( \text{Un}/\sqrt{3} \). However, if the filling is made under vacuum no resting time is required.

4.8 Evacuating the transformer
It is permissible to evacuate the transformer with bushings installed.
4.9 Test tap
See instruction HLAB 200203 E.

**Caution:** For connection use only the plug according to HLJM090044 fig.2 or an adapter plug according to fig.3. Never force the grounding spring with a tool!

4.10 Measurement of tanδ and capacitance
Before putting the bushing into service, carry out a measurement of dielectric dissipation factor tanδ and capacitance C1 between high voltage lead and test tap at a voltage up to 10 kV in order to have a reference for later checks.

4.11 Connection to SF6 side terminal

**Caution:** Prior to assembly into the SF6-Switchgear housing the SF6 side of the bushing is to be protected against absorption of moisture by means of suitable packing and desiccant.

The SF6 side terminal is an integral part of the bushing design, therefore an additional shield is not needed. Its outer surface is epoxy coated. The contact area of the connection interface is silver plated. Tightening torque 48Nm (thread M12)

Adjacents conductor parts of the GIS main circuit shall be well adapted to the terminal.

**Caution:** Do not damage the outside surface of the terminal!

4.12 Maintenance
Apart from a visual check together with the transformer in intervals the bushing requires no maintenance.

5 Spare parts and repairs

5.1 Spare parts
When ordering spare parts please always indicate the serial number and type designation of the bushing, which can be found on the name plate.

5.2 Repairs
Repair only according to the instruction of Micafil AG. For this, give the serial number and type designation of the bushing, as well as an exact description of the damage.

6 Appendices

6.1 HLJM 155644 E Structural design of RTKG bushing

6.2 HLAB 200203 E Operating instructions for bushing test tap
**SF₆ side**
Dimensions and physical features acc. IEC 61639

**SF₆ side terminal**
Contact area silver plated

**RIP Insulating core with condenser layers for field control**

**Flange**
De-areation of transformer

**Gas outlet for leakage check**
Test tap

**Grounded length L₆ for CT**

**Non removable current conductor**

**Transformer side**

**Terminal**

**Shield, removable**

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**GARIP**
Condenser Bushing, Oil to SF₆, for Transformers
Type RTKG Ur: 72.5 – 300 kV

<table>
<thead>
<tr>
<th>Edition:</th>
<th>Revision:</th>
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</tr>
</tbody>
</table>

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</thead>
<tbody>
<tr>
<td>D. Vilano</td>
<td>K. Frei</td>
</tr>
</tbody>
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HLJM 155644 E
Document-No.

HLJM155644aE.doc