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1 General Design

The test tap is an accessory for capacitance graded bushings which makes it possible to access a control layer insulated from the flange from the outside and thus to divide the total capacitance of the bushing into 2 sub-capacitances $C_1$ (high-voltage conductor-test layer) and $C_2$ (test layer-flange).

The test tap is designed, that a connection between the test layer and the flange is automatically established, when the test tap is not in use. This connection can only be opened by completely inserting a 4 mm plug coupler or by connecting a plug converter (see figs. 2/3 in HLJM090044). For normal operation of the bushing the test tap should always be closed with the supplied cover for protection.

2 Purpose

The normal purpose of the test tap is to measure the capacitance $C_1$ and its loss factor $\tan \delta$. The most common test circuit for this purpose is shown in the enclosed drawing HLJM 118034.

The test tap can also be used to carry out a permanent voltage measurement or partial discharge monitoring. The maximum permissible permanent voltage between the test layer and the flange is 1.5 kV. Depending on the rated voltage and the capacitance of the bushing it can be taken 5..10 VA power from the test tap. There must be always connected an impedance parallel to $C_2$ to limit the voltage to $\leq 1.5$ kV. This impedance is mostly a capacitance $C_z$ which must have a minimum value

$$U = \frac{U_N}{\sqrt{3}} \sqrt{\frac{1}{a^2 + b^2}} \leq 1.5kV$$

The values of $C_1$ and $C_2$ can be taken from the test report for the particular bushing. To get a specified voltage $U$ it is necessary to use a capacitance $C_z$

$$C_z = C_1 \left( \frac{U_N}{\sqrt{3} \cdot U} - 1 \right) - C_2 \geq C_{z \text{ min}}$$

To take reactive power from the test tap an ohmic resistor must be put in parallel to $C_2$. The possible power $P$ which can be taken from the test tap is

$$P = \frac{(U_N / \sqrt{3})^2}{R_z} \cdot \frac{1}{a^2 + b^2} \quad \text{with} \quad a = 1 + \frac{C_z}{C_1} \quad b = \frac{1}{\alpha C_1 \cdot R_z}$$

However it is a requirement the $U$ remains $\leq 1.5$ kV. This can be checked with

$$U = \frac{U_N}{\sqrt{3}} \sqrt{\frac{1}{a^2 + b^2}} \leq 1.5kV$$
**Caution:** Without addition of an external impedance, the voltage resulting by \(C_1\) and \(C_2\) is always higher than 1.5 kV at the test tap. With live bushings either the test tap must be connected conductively with the flange or the divider voltage produced must be limited to 1.5 kV by addition of an additional impedance. **Otherwise the bushing will be damaged and can cause an explosion!**

The obtainable measurement accuracy depends on the changes of \(C_1\) and \(C_2\) as a function of the temperature of the bushing. It can be calculated with < 5%.

3 **Connection**

3.1 **Capacitance- and power factor measurements**
After inserting a 4 mm plug coupler, the connection to a measuring bridge can be performed with a line with standard 4 mm banana plugs.

3.2 **Permanent measurements**
After insertion of a plug coupler, available at MICAFIL AG, a shielded cable with an UHF- or a N-type connector can be attached to the coupler (see fig. 3 in HLJM 090044). The cable used is depending on the voltage and the shielding properties needed.

4 **Insulation tests**
The insulation strength of the test tap of each bushing is checked with 3 kV for 1 min. at the routine test of the bushing acc. to IEC 60137.

5 **Appendices**

5.1 **Drawing measuring tap**
HLJM 090044

5.2 **Drawing measuring circuit**
HLJM 118034
Fig.1
Betriebzustand geerdet
Standard application, grounded
Service normal, mise à la terre

Fig.2
Feder nicht mit Hilfsmitteln bewegen
Do not move the spring with any instruments
Ne pas enlever le ressort avec des instruments
ian delta & C-Messung, Erdung offen
ian delta & C measurements, grounding open
ian delta & C mesure, mise à la terre ouverte

Fig.3
Übergangstecker
Adapter
Pièce intermédiaire
C1 = C_N \cdot R_4 / R_3 ; \quad \tan \delta = R_4 \cdot 2\pi f \cdot C_4
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 its 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 (\(\tan \delta \approx 0.35\%\))
- 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

Dimension drawing

4 x M12
25 deep

Aluminium, silver plated

Sealing area
Ra = 1.6 (N7)

Grounded length

Copper, thickness 30 mm

De-aeration of transformer opposite to test tap

Shields removable

Types 123 kV - 245 kV
Types 362 kV - 525 kV

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

View A: SF6 side

View B: Oil side

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

De-aeration of transformer opposite to test tap

Sealing area
Ra = 3.2 (N8)

22.5°
15°
30°

22.5°
11.5°
22.5°
11.5°
22.5°

22.5°
11.5°

M12 (2 x 180°)
M12 (2 x 180°)
M12 (2 x 180°)
M12 (2 x 180°)
M12 (2 x 180°)
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 RTKG</th>
<th>AC test voltage (kV)</th>
<th>A (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>185 230 310</td>
<td>130 145</td>
</tr>
<tr>
<td>145</td>
<td>275 305 365</td>
<td>170 200</td>
</tr>
<tr>
<td>170</td>
<td>325 365 400</td>
<td>210 230</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>630 680</td>
<td>450 500</td>
</tr>
<tr>
<td>525</td>
<td>750 790</td>
<td>550 600</td>
</tr>
</tbody>
</table>

GIS
Observe the minimum enclosure diameter DGIS as well as the minimum operating SF6–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 = SF6–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>HLJM 154484</td>
</tr>
<tr>
<td>GARIP RTKG 72.5-350 / 2500</td>
<td>HLJM 154964</td>
</tr>
<tr>
<td>GARIP RTKG 123-550 / 2000</td>
<td>HLJM 154504</td>
</tr>
<tr>
<td>GARIP RTKG 123-550 / 2500</td>
<td>HLJM 154514</td>
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<td>GARIP RTKG 145-650 / 2000</td>
<td>HLJM 154524</td>
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<td>GARIP RTKG 170-750 / 2000</td>
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<tr>
<td>GARIP RTKG 170-750 / 2500</td>
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<td>GARIP RTKG 245-1050 / 2000</td>
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<tr>
<td>GARIP RTKG 525-1800 / 2000</td>
<td>HLJM 154594</td>
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