Contents

originated from:	replaced by:	Amendments:
written by:	Approved by:	

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 plu 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 δ. 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 ≤ 1.5 kV. This impedance is mostly a capacitance C_z which must hav a minimum value

$$U = \frac{U_N / \sqrt{3}}{a^2 + b^2} \cdot \sqrt{a^2 + b^2} \leq 1{,}5kV$$

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

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

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

$$P = \frac{\left(U_N / \sqrt{3}\right)^2}{R_z} \cdot \frac{1}{a^2 + b^2} \quad \text{with} \quad a = 1 + \frac{C_2}{C_1} \quad b = \frac{1}{\omega C_1 \cdot R_z}$$

However it is a requirement the U remains ≤ 1,5 kV. This can be checked with

$$U = \frac{U_N / \sqrt{3}}{a^2 + b^2} \cdot \sqrt{a^2 + b^2} \leq 1{,}5kV$$

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 wiht 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**

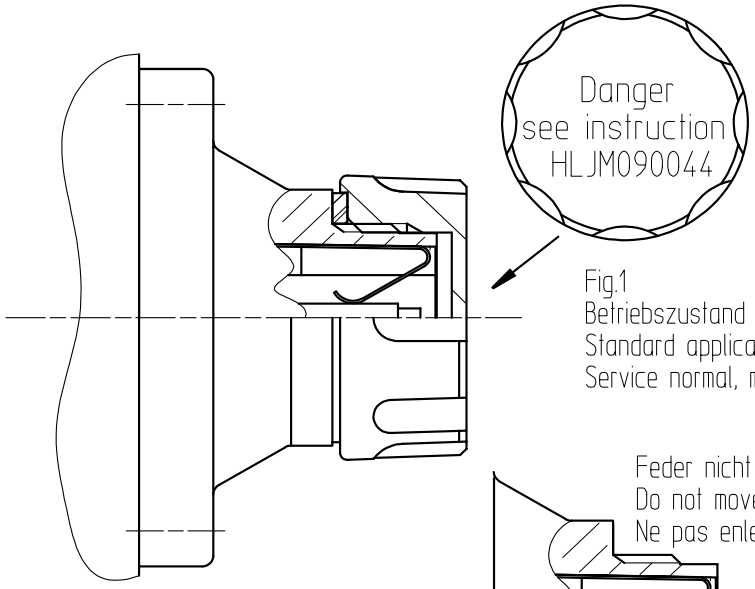


Fig.1
Betriebszustand geerdet
Standard application, grounded
Service normal, mise à la terre

Feder nicht mit Hilfsmitteln bewegen
Do not move the spring with any instruments
Ne pas enlever le ressort avec des instruments

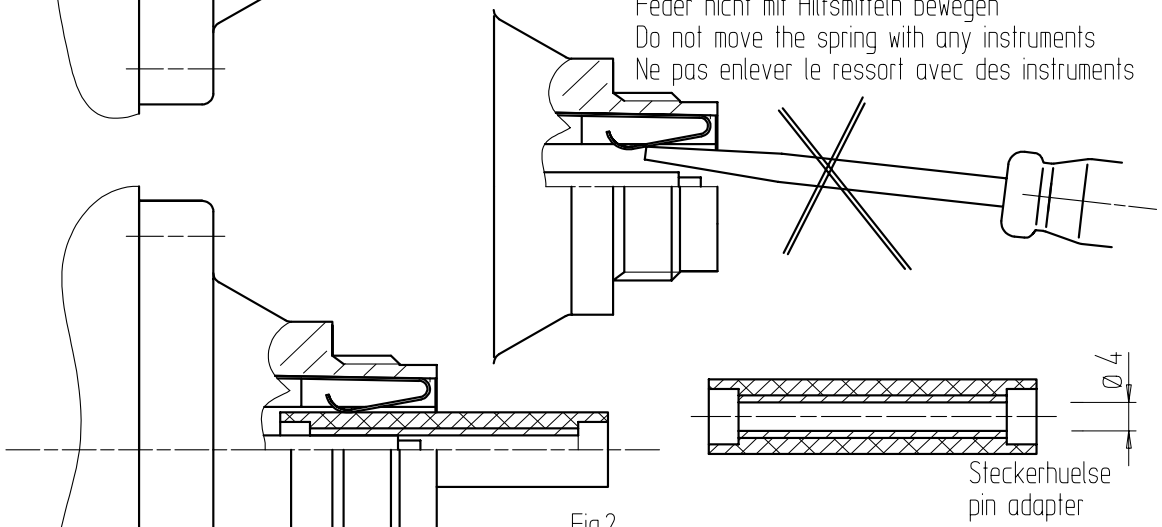


Fig.2
tan delta & C-Messung, Erdung offen
tan delta & C measurements, grounding open
tan delta & C mesure, mise à la terre ouverte

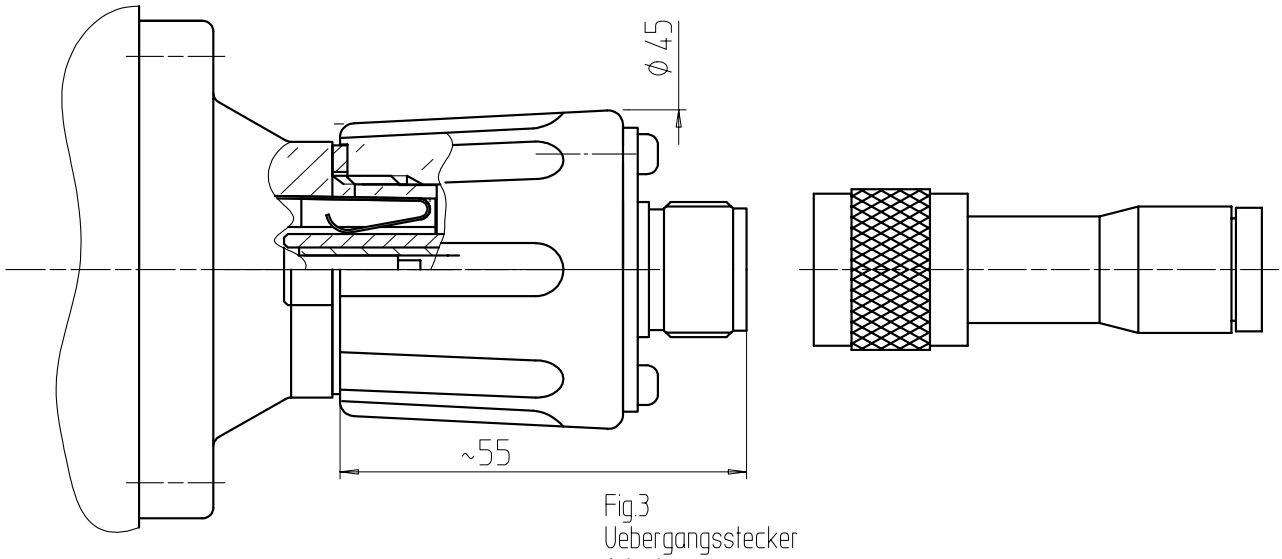


Fig.3
Uebergangsstecker
Adapter
Pièce intermédiaire

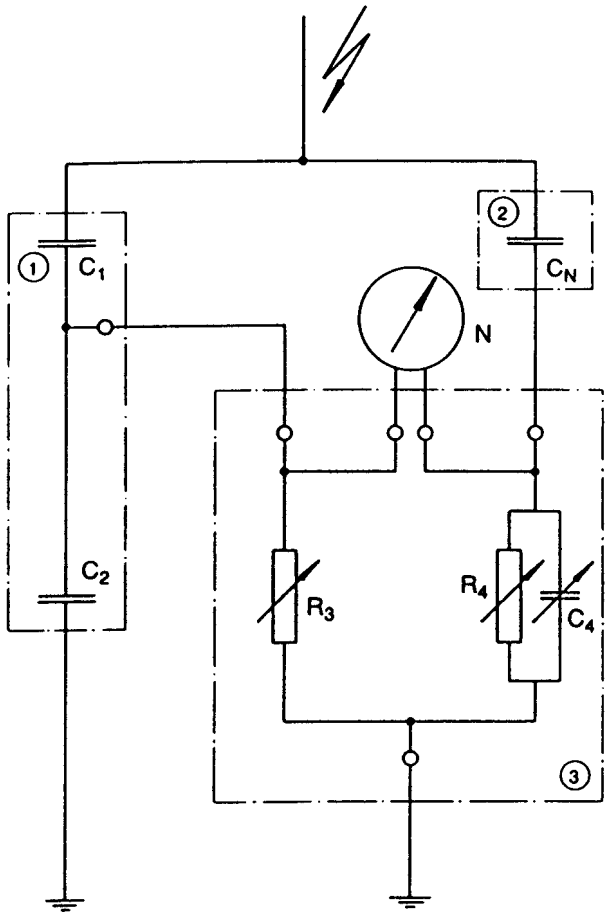
b)8.5.96 Koller
b)15.1.99 Koller Pin war banana

MICAFIL

Messanschluss-Instruktion
Measuring-Tap, instruction
Prise de mesure, instruction

HLJM090044 C

Messschaltung
Measuring circuit
Circuit de mesurement



① Durchführung
Bushing
Traversée

C_1: Kapazität Hochspannungsleiter-Messbelag
Capacity high voltage lead – test tap
Capacité conducteur haute tension – prise de mesure

C_2: Kapazität Messbelag - Flansch
Capacity test tap - flange
Capacité prise de mesure - bride

② Normalkondensator
Standardcapacitor C_N
Condensateur étalon

③ Schering Brücke
Schering bridge
Pont du mesure Schering

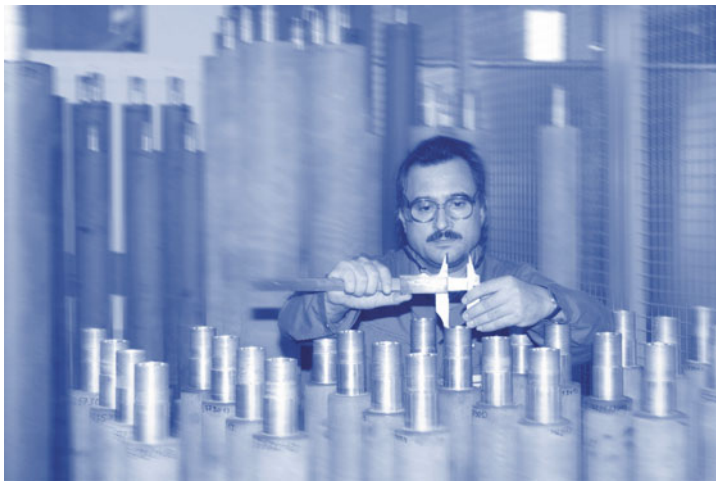
R_3, R_4, C_4: Brückenelemente
Bridge elements
Élements du pont de mesure

N: Nullindikator
Null indicator
Indicateur de zéro

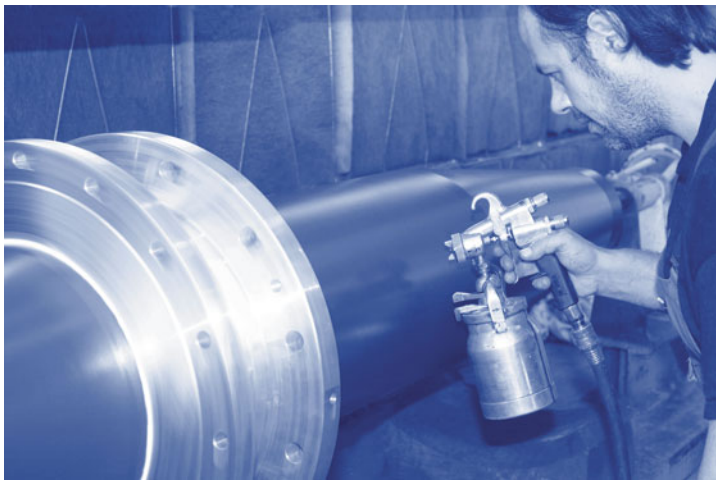
$$C_1 = C_N \cdot R_4 / R_3 ; \qquad \tan \delta = R_4 \cdot 2\pi f \cdot C_4$$

RIP - Technology for SF_6 / Oil - Bushings

In modern metal enclosed switchgear SF_6-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.



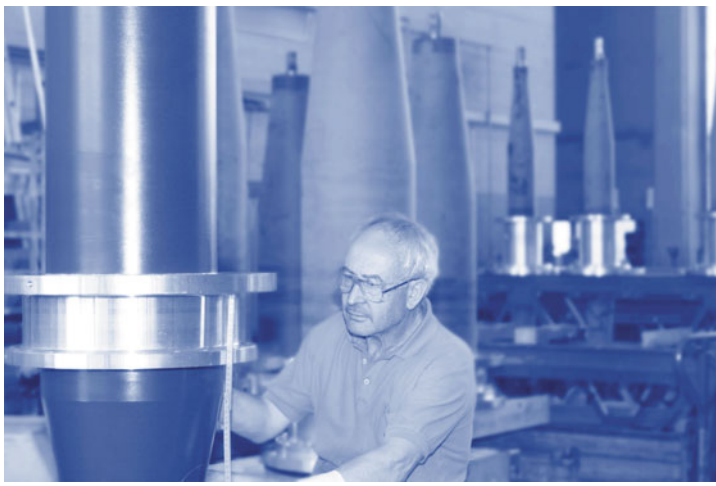
The insulation body of the GARIP condenser bushing series consists of a robust and solid core, made of wound crepe paper and inserted aluminium foils for field control, carefully vacuum dried and subsequently impregnated with special epoxy resin.

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.

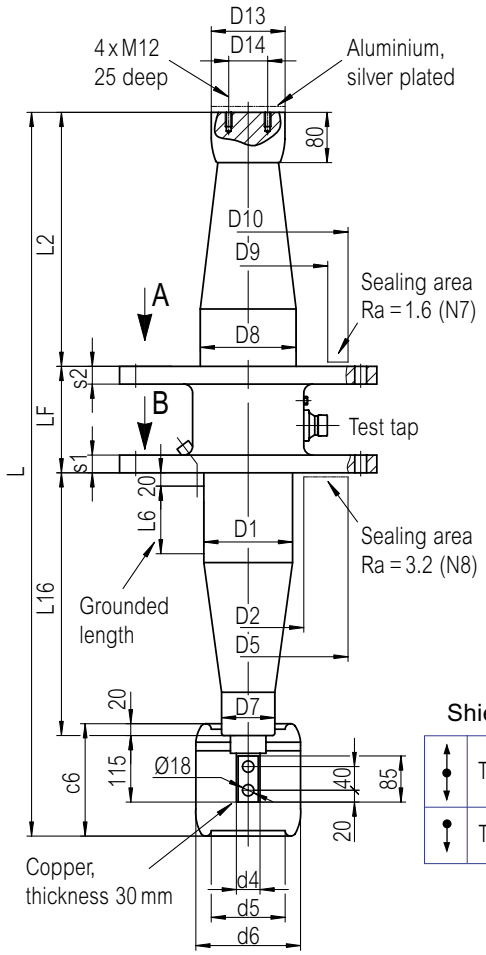
Main advantages of Micafil's RIP-technology

- 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

Dimension drawing



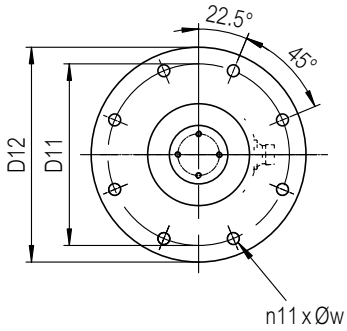
Shields removable

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

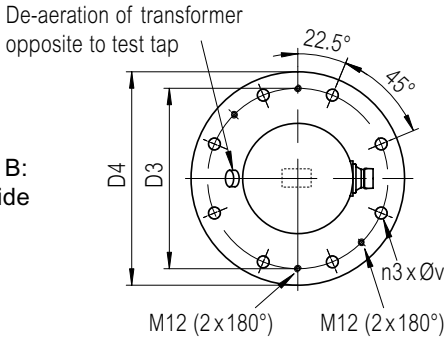
Flange dimensions for:

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

View A: SF_6 side



View B: Oil side



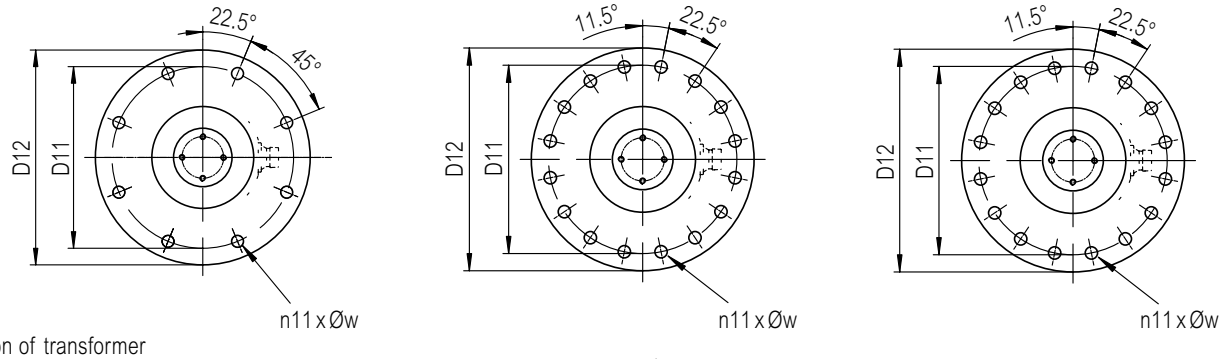
Flange dimensions for:

RTKG 170-750 / 2500

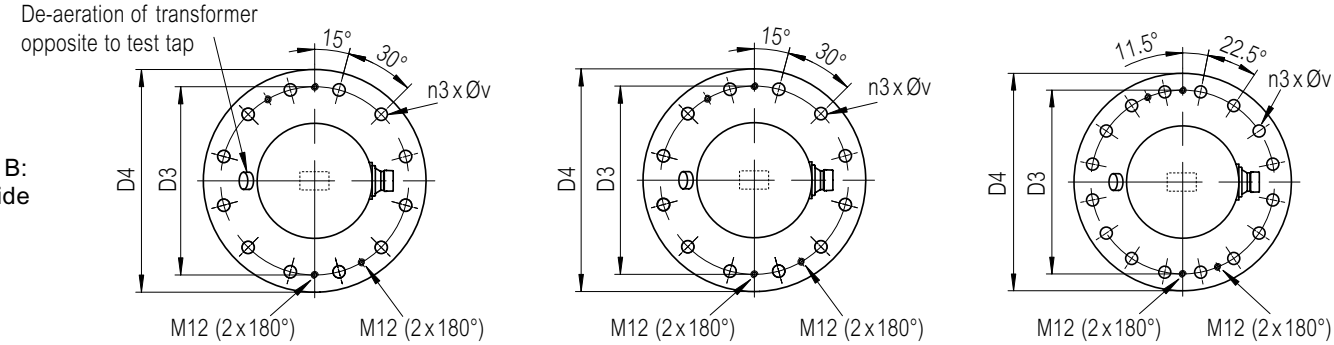
RTKG 245-1050 / 2000
RTKG 245-1050 / 2500

RTKG 362-1300 / 2000
RTKG 420-1550 / 2000
RTKG 525-1800 / 2000

View A: SF_6 side



View B: Oil side



General Informations

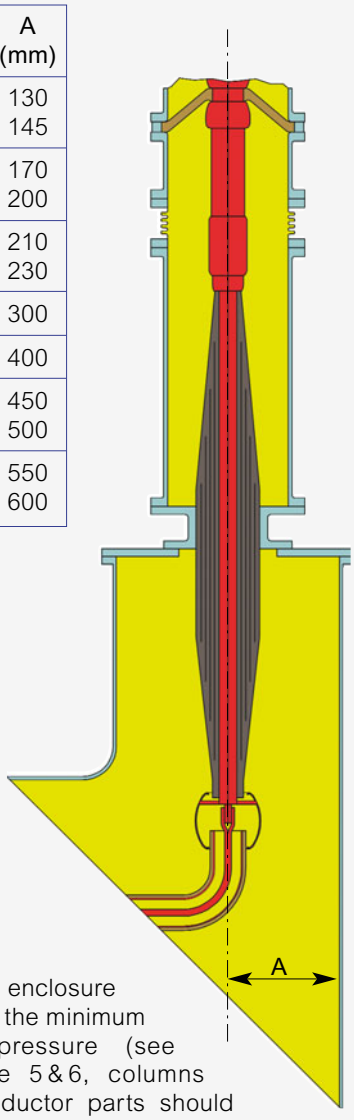
Conductor loading

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:

Type RTKG	AC test voltage (kV)	A (mm)
123	185 230	130 145
145	275 310	170 200
170	325 365	210 230
245	460	300
362	570	400
420	630 680	450 500
525	750 790	550 600



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

Bushing type	Catalogue no.
GARIP RTKG 72.5-350 / 2000	HLJM 154484
GARIP RTKG 72.5-350 / 2500	HLJM 154964
GARIP RTKG 123-550 / 2000	HLJM 154504
GARIP RTKG 123-550 / 2500	HLJM 154514
GARIP RTKG 145-650 / 2000	HLJM 154524
GARIP RTKG 170-750 / 2000	HLJM 154534
GARIP RTKG 170-750 / 2500	HLJM 154544
GARIP RTKG 245-1050 / 2000	HLJM 154554
GARIP RTKG 245-1050 / 2500	HLJM 154564
GARIP RTKG 362-1300 / 2000	HLJM 154574
GARIP RTKG 420-1550 / 2000	HLJM 154584
GARIP RTKG 525-1800 / 2000	HLJM 154594