



1ZSC000563-ABF en

Bushings for power transformers

Product guide

Explanations

Type of application

The range of bushings for AC installations is designed for four different applications:

- Oil-to-air
- Oil-to-oil
- Oil-to-SF₆
- Air-to-air

For DC applications and air-to-air bushings, please contact ABB for further information.

Electrical requirements

The following electrical data must be known prior to beginning the selection process:

Referred standard

ABB bushings generally fulfil the electrical requirements according to the latest version of IEC (IEC 60137) and ANSI (IEEE C57.19.00 and IEEE C57.19.01). If any other standard is required, please contact ABB.

Highest voltage for equipment, U_m

Normally the highest RMS value of the phase-to-phase voltage for the system on which the bushing will be used.

Rated lightning impulse withstand voltage (dry), BIL

Normally the same lightning impulse level as for the transformer. The lightning impulse test is a routine test for bushings with a rated BIL level equal to or above 850 kV.

Rated switching impulse withstand voltage (wet), SIL

Normally the same switching impulse level as for the transformer. This is a type test and is performed under wet conditions for bushings for outdoor application.

Dry power frequency voltage withstand test (1 minute)

Normally 10% above the test level of the test for the transformer. This test is performed as a routine test on all bushings.

Wet power frequency voltage withstand test (1 minute)

This is a type test for bushings with a highest voltage for equipment less than or equal to 245 kV.

Rated phase-to-ground voltage

This is the actual continuous AC voltage that the bushing is subjected to.

Rated current

This is the maximum continuous AC current the bushing can carry at a certain air temperature and a certain oil temperature with the hot spot of the bushing at maximum 105°C (120°C for RIP). The following temperatures apply for IEC and ANSI:

	IEC	ANSI
Air temperature	30°C	40°C
Transformer oil temperature rise above ambient	60 K	65 K

Required maximum power factor limits if other than IEC or ANSI

This is performed as a routine test on all bushings. IEC requires the bushing to have a power factor below 0.7%. ABB has more stringent requirements depending on the rated voltage for the equipment and thus better reflects the actual dielectrical losses:

- ≤362 kV; 0.55%
- >362 kV and ≤550 kV; 0.5%
- >550 kV; 0.4%

Ambient conditions including mechanical requirements

Referenced standard

ABB bushings fully comply with IEC 60137 and the electrical requirements of IEEE C57.19.0. ANSI (IEEE C57.19.0) specifies certain dimensional requirements that deviate from ABB bushings. Please check with the transformer manufacturer or ABB for further information. If any other standard is required, please contact ABB.

Unified Specific Creepage Distance, USCD

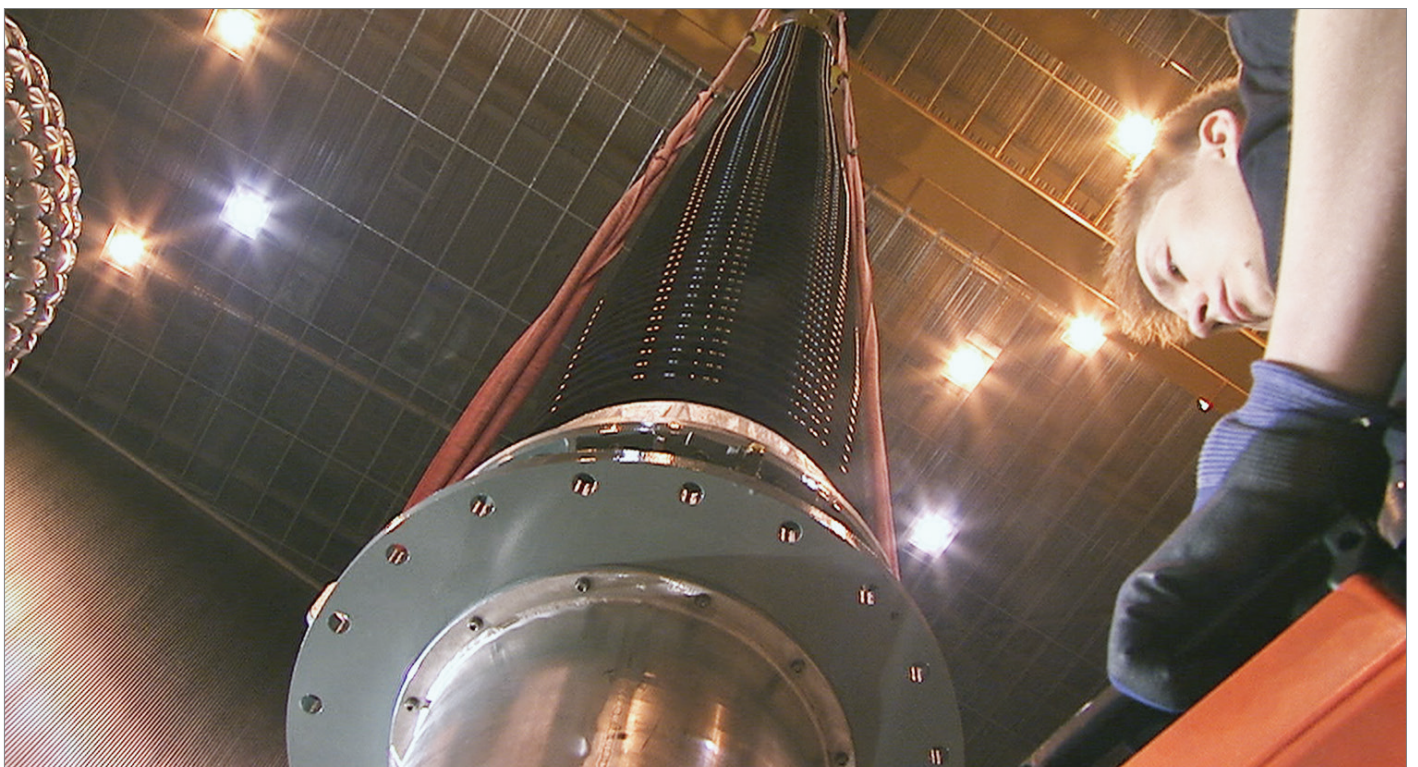
IEC 60815-3 defines five different classes depending on the degree of pollution in the area where the bushing is to be used. The Unified Specific Creepage Distance is the total creepage distance divided by the highest operating line-to-ground voltage across the bushing. Regarding the option of reducing the creepage distance when using polymeric instead of ceramic insulators, please refer to the above-mentioned document for advice.

- a Very light: 22 mm/kV
- b Light: 28 mm/kV
- c Medium: 35 mm/kV
- d Heavy: 43 mm/kV
- e Very heavy: 54 mm/kV

It should be noted that this definition differs from the previously used specific creepage distance with a factor of $\sqrt{3}$ where the line-to-line voltage was used.

Required cantilever operating load

Both IEC and ANSI have specified values for the required cantilever load. In IEC 60137 two different levels for the cantilever load are given: Level 1 for normal applications and Level 2 for special applications with severe mechanical loads.



Product philosophy

To assure reliability in operation, bushings must be designed in such a way that prevents moisture penetration. An effective ground connection must also be assured for the entire service life of the unit. This is accomplished by:

- Using a robust sealing system together with a professionally designed compressing system that provides an adequate sealing pressure during all operational conditions.
- Selecting design elements, materials and production methods that reduce the number of potential leakage points.
- Using a robust ground connection system between the bushing's condenser core and transformer tank.
- Verifying the tightness of all parts individually, as well as the complete system during final testing.

Bushings must be designed for full thermal stability at their highest voltage while considering both the ohmic and dielectric losses throughout the bushings' service life. For a properly designed bushing, a lower dissipation factor does not contribute to improved service life.

Testing

ABB has more stringent limiting values for acceptance during testing compared to those set out by the international IEC 60137 standard.

To verify the production process, each bushing is subjected to an electrical routine test sequence before being approved for delivery. Type tests are conducted on each product family to demonstrate compliance with specific requirements not covered by the routine tests.

In addition, ABB carries out comprehensive testing programs to verify certain characteristics that are not covered by the standards to ensure long-term performance or performance under extreme conditions. Some examples are various cyclic tests, arcing tests, fire tests, seismic tests, hydrophobicity tests and various ageing tests.



References

Hundreds of thousands of bushings have been manufactured since production started in 1908, and ABB currently produces a range of condenser bushings to suit all applications from 36 kV to 1200 kV AC, and 1100 kV DC. Both oil-impregnated and resin-impregnated variants are available and in operation on all continents. Bushings for 800 kV AC systems have been delivered since 1964.

Earthquakes are capable of causing serious damage and experience shows that incorrectly dimensioned electrical equipment is easily destroyed. The United States, Chile, China, Mexico, Korea, Greece and New Zealand are some of the countries that demand a high level of earthquake resilience. ABB bushings are in use in all these regions, in some cases for more than 40 years, with excellent operational performance.



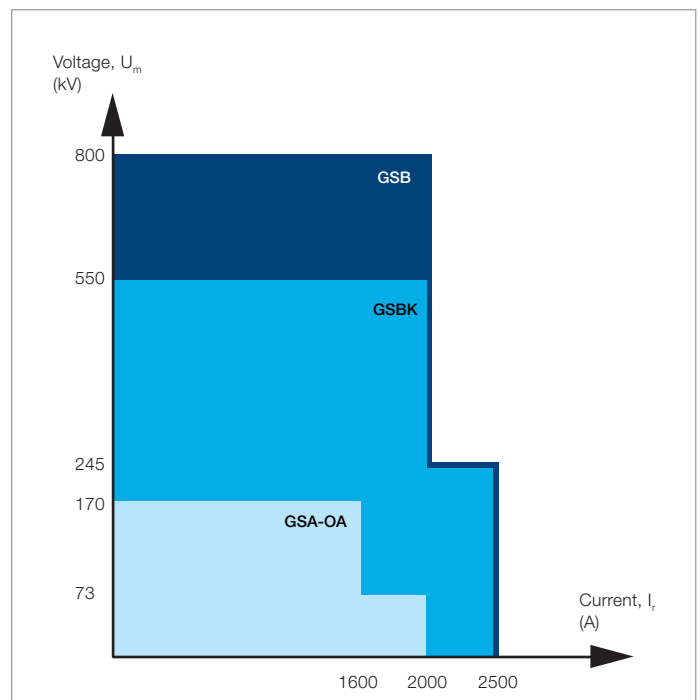
Resin-impregnated bushings

A web of crepe paper is wound onto a mandrel or a conductor to form the main insulation. Conduction inserts made of aluminum are placed at calculated and very precise axial and radial positions to create the grading of the electric field. The core is heated, vacuum dried and impregnated by using a curable epoxy resin to form the solid condenser core. After curing, the core is machined and the mounting flange and insulator are fitted. An assortment of terminal connections, shields and conductor configurations are available to suit all applications.

RIP bushings offer the following advantages:

- High mechanical strength and flexibility combined with reduced weight, clearly increasing the ability to withstand earthquakes.
- Because no oil is in the bushing, there is no need to have an expansion volume at its highest point. This entails that even if RIP bushings are stored horizontally, they can be energized immediately after installation.
- This eliminates the risk of bushing oil being sprayed over the equipment and causing a fire in the event of an explosive failure.
- The transformer is sealed, which means that the risk for moisture ingress to the transformer is reduced in the event of flashovers.
- Downtime in the event of major transformer failures is also reduced because no porcelain fragments are left inside the transformer.

GSA and GSB bushings use outer insulation based on silicone rubber. The consequences for the transformer and the rest of the substation will be minor in the event of a major failure. It also provide the necessary weight reduction and mechanical flexibility to ensure high seismic withstand. Outer insulation based on silicone rubber also provides excellent pollution performance and minimizes the risk for flashovers. Long service life is ensured by using erosion-resistant, high quality HTV rubber with a high content of ATH filler and proper shed profile geometry.



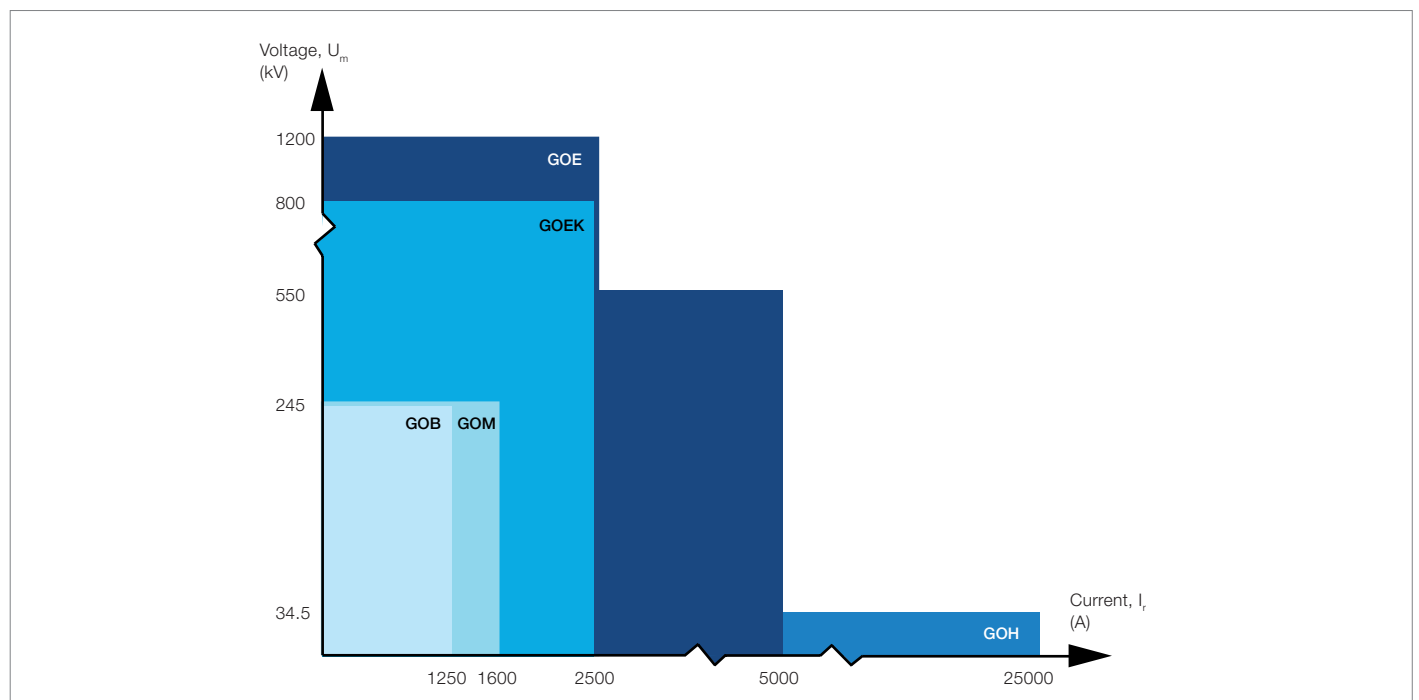
Oil-air bushings are designated GSA and GSB, and oil-SF₆ immersed bushings are designated GSBK.

Oil impregnated bushings

The bushings are built up around a center tube on which the condenser body is wound with craft paper. Conduction inserts made of aluminum are placed at calculated and very precise axial and radial positions to create the grading of the electric field. The ceramic insulators are made from one piece without gaskets, and are held between the end-plates with the center tube. Sealing is accomplished by oil-resistant rubber gaskets in grooves. The space between the condenser body and the insulators is filled with transformer oil, and a gas-filled expansion space is left at the top of the bushing. Several different product lines are available and details of the designs vary with voltage and current ratings.

OIP bushings offer the following advantages:

- Complete range and outstanding performance under the most demanding conditions
- We use a sealing system with 40 years of proven reliability on all the world's continents.
- State-of-the-art production facilities and 100 years of experience
- Our unique draw rod system facilitates easy field installation and removal without lowering the oil level,
- The world's most-used 800 kV bushing.



Bushings for immersed oil-SF₆ service are designated GOEK; all others are for oil-air applications.

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