
British Standard Specification for

Bushings for alternating voltages above 1000 V

Traversées pour tensions alternatives supérieures à 1000 V – Spécifications

Durchführungen für Wechselspannungen über 1000 V

Foreword

This revision of BS 223 has been prepared under the direction of the Power Electrical Engineering Standards Committee and supersedes the 1956 edition of BS 223 which is withdrawn. It is identical with IEC Publication 137 : 1984 'Bushings for alternating voltages above 1000 V' published by the International Electrotechnical Commission (IEC), except that Note 1 to clause 32 has been altered because of established British practice.

NOTE. The text of the note in IEC 137 is as follows:

'On resin-bonded paper bushings with metallic layers, the discharge quantity at $1.05 U_N/\sqrt{3}$ should not exceed 300×10^{-12} C and at $1.5 U_N/\sqrt{3}$ it should be agreed upon between supplier and purchaser.'

For ease of reproduction the text of the IEC Publication has been used. Some terminology and certain conventions are not identical with those normally used in British Standards.

Cross-references

International standard	Corresponding British Standard
IEC 60-1 : 1973	BS 923 Guide on high voltage testing techniques Part 1 : 1980 General (Identical)
IEC 71-1 : 1976	BS 5622 Guide for insulation coordination Part 1 : 1979 Terms, definitions, principles and rules (Identical)
IEC 76-5 : 1976	BS 171 Power transformers Part 5 : 1978 Specification of ability to withstand short circuit (Identical)
IEC 216-2 : 1974	BS 5691 Guide for the determination of thermal endurance properties of electrical insulating materials Part 2 : 1979 Lists of materials and available tests (Identical)
IEC 233 : 1974	BS 4963 : 1973 Tests on hollow insulators for use in high voltage electrical equipment (Technically equivalent)
IEC 270 : 1981	BS 4828 : 1972 Guide to partial discharge measurements (Technically equivalent)
IEC 354 : 1972	CP 1010 : 1975 Loading guide for oil-immersed transformers (Identical)

The Technical Committee has reviewed the provisions of IEC 38 : 1983, IEC 56-2 : 1971, IEC 506 : 1975 and IEC 517 : 1975, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. A related British Standard for IEC 38 is BS 77 : 1958 'Voltages for a.c. transmission and distribution systems', for IEC 56-2 is BS 5311 'Specification for a.c. circuit-breakers of rated voltage above 1 kV' Part 2 : 1976 'Rating' and for IEC 517 is BS 5524 : 1978 'Specification for high-voltage metal-enclosed switchgear for rated voltages of 72.5 kV and above'.

There are no corresponding British Standards for IEC 59 : 1938 and IEC 505 : 1975. As these standards are referred to for information only, the validity of this British Standard is not affected.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

CONTENTS

	Page
Foreword	Inside front cover
Committees responsible	Back cover

SECTION ONE - GENERAL

Clause

1. Scope	3
--------------------	---

SECTION TWO - DEFINITIONS

2. Definitions	3
--------------------------	---

SECTION THREE - RATINGS

3. Standard values of nominal voltage (U_N)	7
4. Standard values of rated current (I_N)	7
5. Standard values of rated thermal short-time current (I_{th})	8
6. Standard value of rated dynamic current (I_d)	8
7. Minimum withstand values of cantilever load	8
8. Angle of mounting	9
9. Minimum nominal specific creepage distance	9
10. Temperature limits	9
11. Standard insulation levels	10
12. Maximum values of capacitance and dielectric dissipation factor of the test tap on transformer bushings	10

SECTION FOUR - INFORMATION TO BE FURNISHED WHEN ORDERING AND MARKINGS

13. Enumeration of characteristics	10
14. Markings	12

SECTION FIVE - OPERATING CONDITIONS

15. Temporary overvoltages	12
16. Altitude	13
17. Temperature of ambient air and immersion media	13

SECTION SIX - TEST REQUIREMENTS

18. General	14
19. Test classification	15
20. Condition of the bushings during the dielectric and thermal tests	16

SECTION SEVEN - TYPE TESTS

21. Wet power-frequency voltage withstand test	17
22. Dry lightning impulse voltage withstand test	17
23. Dry or wet switching impulse voltage withstand test	24
24. Thermal stability test	24
25. Temperature-rise test	19
26. Thermal short-time current withstand test	21
27. Dynamic current withstand test	22
28. Cantilever load withstand test	22
29. Tightness test on liquid-filled and liquid-insulated bushings	22

SECTION EIGHT - ROUTINE TESTS

Clause

30. Measurement of the dielectric dissipation factor ($\tan \delta$) and the capacitance at ambient temperature	23
31. Dry power-frequency voltage withstand test	24
32. Measurement of the partial discharge quantity	24
33. Tests of the tap insulation	25
34. Pressure test of gas-filled and gas-insulated bushings	26
35. Tightness test on liquid-filled and liquid-insulated bushings	26
36. Tightness test on gas-filled, gas-insulated and gas-immersed bushings	26
37. Tightness test at the flange or other fixing device	27

Tables

I. Standard insulation levels for nominal voltages lower than 300 kV	27
II. Standard insulation levels for nominal voltages equal to or higher than 300 kV	28
III. List of drypower-frequency withstand test voltages to be applied in the test according to clause 31 for nominal voltages higher than or equal to 300 kV	28

Figure

1. Arrangement for thermal and dynamic current withstand tests according to clauses 26 and 27	29
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British Standard Specification for

Bushings for alternating voltages above 1000 V

SECTION ONE — GENERAL

1. Scope

This standard is applicable to bushings, as defined in Section Two, which are supplied separately, intended for use in electrical apparatus, transformers, and installations, for three-phase alternating current systems, having rated voltages above 1000 V and frequencies between 15 Hz and 60 Hz.

This standard is not applicable to bushings for use with rectifiers, rotating machines, testing transformers, or to terminals for power cables (potheads). Such bushings shall be subject to special agreement between supplier and purchaser.

Moreover this standard is not applicable to insulating structures similar to bushings, which are used as support insulators inside metal-enclosed switchgear according to IEC Publication 517: High-voltage Metal-enclosed Switchgear for Rated Voltages of 72.5 kV and Above.

- Notes 1.* — The application of this standard to bushings for other than three-phase systems should be subject to special agreement between supplier and purchaser.
2. — If a bushing, due to its design or use, cannot be tested separately under the conditions specified in this standard, the test procedure should be subject to special agreement between supplier and purchaser.

SECTION TWO — DEFINITIONS

2. Definitions

For the purpose of this standard the following definitions shall apply:

2.1 *Bushing*

A structure carrying one or several conductors through a partition such as a wall or tank, etc., and insulating it or them therefrom, incorporating the means of attachment (flange or other fixing device) to the partition.

The conductor may form an integral part of the bushing or be drawn through.

2.2 *Liquid-filled bushing*

A bushing in which the space between the inside surface of the insulating envelope and the solid major insulation is filled with oil or another insulating liquid.

2.3 *Liquid-insulated bushing*

A bushing in which the major insulation consists of oil or another insulating liquid.

2.4 *Gas-filled bushing*

A bushing in which the space between the inside surface of the insulating envelope and the solid major insulation is filled with gas (other than ambient air) at atmospheric pressure or higher.

Note. — This definition includes bushings which are intended to form an integral part of gas-insulated equipment, the gas of the equipment being in communication with that of the bushing.

2.5 *Gas-insulated bushing*

A bushing in which the major insulation consists of gas (other than ambient air) at atmospheric pressure or higher.

Notes 1. — This definition includes bushings which are intended to form an integral part of gas-insulated equipment, the gas of the equipment being in communication with that of the bushing.

2. — A bushing which contains solid insulating materials other than the envelope containing the gas (e.g. support for conducting layers or insulating cylinder) is a composite bushing (see Sub-clause 2.11).

2.6 *Oil-impregnated paper bushing*

A bushing in which the major insulation consists of a core wound from untreated paper and subsequently impregnated with an insulating liquid, generally transformer oil. The core is contained in an insulating envelope, the space between the core and the insulating envelope being filled with the same insulating liquid as that used for impregnation.

2.7 *Resin-bonded paper bushing*

A bushing in which the major insulation consists of a core wound from resin-coated paper. During the winding process, each paper layer is bonded to the previous layer by its resin coating and the bonding achieved by curing the resin.

Note. — A resin-bonded paper bushing may be provided with an insulating envelope, in which case the intervening space may be filled with an insulating liquid or another insulating medium.

2.8 *Resin-impregnated paper bushing*

A bushing in which the major insulation consists of a core wound from untreated paper and subsequently impregnated with a curable resin.

Note. — A resin-impregnated paper bushing may be provided with an insulating envelope, in which case the intervening space may be filled with an insulating liquid or another insulating medium.

2.9 *Ceramic, glass or analogous inorganic material bushing*

A bushing in which the major insulation consists of a ceramic, glass or analogous inorganic material.

2.10 *Cast resin-insulated bushing*

A bushing in which the major insulation consists of a cast organic material with or without an inorganic filler.

2.11 *Composite bushing*

A bushing in which the major insulation consists of a combination of different insulating materials.

2.12 *Capacitance graded bushing*

A bushing in which metallic or non-metallic conducting layers are arranged within the insulating material for the purpose of controlling the distribution of the electric field of the bushing.

Notes 1. — The major insulation of a capacitance graded bushing generally consists of one of the following types:

- oil-impregnated paper,
- resin-bonded paper,
- resin-impregnated paper,
- cast resin,
- gas or other insulating fluid,
- composite.

2. — A capacitance graded bushing may be provided with an insulating envelope, in which case the intervening space may be filled with an insulating liquid or another insulating medium.

2.13 *Indoor bushing*

A bushing both ends of which are intended to be in ambient air but not exposed to external atmospheric conditions.

Notes 1. — In indoor installations, moisture condensation on the surface of the bushing is to be prevented, if necessary by ventilation or heating.

2. — This definition includes bushings operating in air at temperatures above ambient, such as occur with air-insulated ducting.

2.14 *Outdoor bushing*

A bushing both ends of which are intended to be in ambient air and exposed to external atmospheric conditions.

2.15 *Outdoor-indoor bushing*

A bushing both ends of which are intended to be in ambient air. One end is intended to be exposed to external atmospheric conditions and the other end is intended not to be so exposed.

Note. — See notes to Sub-clause 2.13.

2.16 *Indoor-immersed bushing*

A bushing one end of which is intended to be in ambient air but not exposed to external atmospheric conditions and the other end to be immersed in an insulating medium other than ambient air (e.g. oil or gas).

Note. — See notes to Sub-clause 2.13.

2.17 *Outdoor-immersed bushing*

A bushing one end of which is intended to be in ambient air and exposed to external atmospheric conditions and the other end to be immersed in an insulating medium other than ambient air (e.g. oil or gas).

2.18 *Completely immersed bushing*

A bushing the ends of which are intended to be immersed in insulating media other than ambient air (e.g. oil or gas).

2.19 *Nominal voltage (U_N)*

The voltage by which the bushing is designated.

2.20 Rated phase-to-earth voltage

The highest r.m.s. value of the voltage which the bushing can withstand continuously between the conductor and flange or other fixing device, under the operating conditions specified in Section Five.

2.21 Rated current (I_N)

The r.m.s. value of current which the bushing can carry continuously under the operating conditions specified in Section Five.

2.22 Rated thermal short-time current (I_{th})

The r.m.s. value of a symmetrical current which the bushing can withstand thermally for the rated duration (t_{th}) immediately following continuous operation at I_N with maximum temperatures of ambient air and immersion media in accordance with Clause 17.

2.23 Rated dynamic current (I_d)

The peak value of a current which the bushing shall withstand mechanically.

2.24 Temperature rise

The difference between the measured temperature of the hottest spot of the metal parts of the bushing which are in contact with insulating material and the ambient air temperature (see Clause 10).

2.25 Nominal frequency

The frequency by which the bushing is designated.

2.26 Rated density of insulating gas

The density assigned by the supplier at which the bushing is intended to be operated in service.

2.27 Minimum operating density of insulating gas

The density assigned by the supplier below which the rated values of insulating level no longer apply.

2.28 Maximum operating pressure

The maximum permissible pressure when the bushing is in operation carrying nominal current at the highest temperatures given in Clause 17.

2.29 Leakage rate of gas-filled and gas-insulated bushings

The permissible annual escape of gas, expressed as a percentage of the total gas quantity in the bushing.

2.30 Insulating envelope

An envelope of inorganic or organic material, such as ceramic or cast resin, placed round the whole or part of a bushing.

2.31 Creepage distance

The shortest distance (or the sum of the shortest distances) along the contour of the external insulating surface between the metal parts which normally have the operating voltage between them.

Note. — A semi-conducting layer of high resistance on the external surface of the insulating envelope should be included when measuring the creepage distance.

2.32 Arcing distance

The shortest distance (or the sum of the shortest distances) outside the bushing between metal parts which normally have the operating voltage between them.

2.33 Test tap

A connection, insulated from the flange or other fixing device, made to one of the outer conducting layers of a capacitance graded bushing in order to allow measurements whilst the flange of the bushing is earthed.

Note. — This connection is earthed directly when it is not being used to carry out measurements. The tap is accessible from outside the bushing.

2.34 Voltage tap

A connection, insulated from the flange or other fixing device, made to one of the outer conducting layers of a capacitance graded bushing in order to provide a voltage source whilst the bushing is in operation.

Note. — This connection is generally earthed directly when it is not being used to carry out measurements or as a voltage source. The tap is accessible from outside the bushing.

2.35 Rated voltage of the voltage tap

The highest voltage at which the tap is designed to supply the associated equipment, with the rated load connected thereto, when the rated phase-to-earth voltage of the bushing is applied to the bushing, at the nominal frequency.

SECTION THREE — RATINGS

3. Standard values of nominal voltage (U_N)

The values of U_N of a bushing shall be chosen from the standard values of the highest voltage for equipment, U_m defined in IEC Publication 38: IEC Standard Voltages, and IEC Publication 71-1: Insulation Co-ordination, Part 1: Terms, Definitions, Principles and Rules, as given below, in kilovolts:

3.6 – 7.2 – 12 – 17.5 – 24 – 36 – 52 – 72.5 – 123 – 145 – 170 – 245 – 300 – 362 – 420 – 525 – 765.

4. Standard values of rated current (I_N)

The values of I_N of a bushing shall be chosen from the standard values expressed in amperes given below:

100 – 250 – 315 – 400 – 500 – 630 – 800 – 1 000 – 1 250 – 1 600 – 2 000 – 2 500 – 3 150 – 4 000 – 5 000 – 6 300 – 8 000 – 10 000 – 12 500 – 16 000 – 20 000 – 25 000 – 31 500 – 40 000.

The above series of currents are in accordance with the values indicated in IEC Publication 59: IEC Standard Current Ratings.

- Notes* 1. — In the case of transformer bushings with the conductor drawn into the central tube, the supplier shall at least indicate the value of the cross-section, material of the conductor and the level of oil in the central tube which correspond to I_N .
2. — I_N of the bushing need not necessarily be identical to the rated current of the complete apparatus. It may be higher or lower, depending on how the actual operating conditions deviate from the standard test conditions for the bushing. The general rule for the permissible operating current should be that the temperature limits should be in accordance with Clause 10.
3. — Bushings for transformers selected with I_N not less than 120% of rated current of the transformer are considered to be able to withstand the overload conditions according to IEC Publication 354: Loading Guide for Oil-immersed Transformers, without further clarification or tests.

5. Standard values of rated thermal short-time current (I_{th})

Unless otherwise stated, the standard value of I_{th} shall be 25 times I_N , t_{th} being 1 s. For bushings with I_N greater than or equal to 4 000 A, I_{th} shall always be 100 kA.

Note. — In IEC Publication 56-2: High-voltage Alternating-current Circuit-breakers, Part 2: Rating, the maximum value of rated short-circuit breaking current is 100 kA.

With reference to IEC Publication 76-5: Power Transformers, Part 5: Ability to Withstand Short Circuit, t_{th} shall always be 2 s for transformer bushings.

6. Standard value of rated dynamic current (I_d)

The standard value of I_d shall have an amplitude of the first peak of 2.5 times the value of I_{th} according to Clause 5.

7. Minimum withstand values of cantilever load

Unless otherwise specified, the bushings shall withstand the following cantilever test load for 60 s, applied to the midpoint of the terminal or terminals, perpendicularly to the bushing axis:

U_N (kV)	I_N (A)			
	≤ 800	1 000 1 600	2 000 2 500	$\geq 3 150$
	Cantilever test load (N)			
≤ 52	1 000	1 250	2 000	3 150
72.5 ... 123	1 000	1 250	2 000	4 000
145 ... 300	1 250	1 600	2 500	4 000
≥ 362	2 500	2 500	3 150	5 000

The maximum permanent cantilever load in operation, including wind, which the bushing shall withstand in any direction should be limited to:

- 50% of the test values when the bushing is installed at any angle not exceeding 30° from the vertical;
- 30% of the test values when the bushing is installed at any angle exceeding 30° from the vertical.