

© British Standards Institution. No part of this publication may be photocopied or otherwise reproduced without the prior permission in writing of BSI.

British Standard

Fixed capacitors for use in electronic equipment

Part 3. Specification for fixed capacitors for radio interference suppression. Selection of methods of test and general requirements

[IEC title: Fixed capacitors for use in electronic equipment: Part 14. Sectional specification: Fixed capacitors for radio interference suppression. Selection of methods of test and general requirements]

Condensateurs fixes utilisés dans les équipements électroniques

Partie 3. Condensateurs fixes d'antiparasitage. Choix des méthodes d'essai et règles générales

Festkondensatoren für die Anwendung in elektronischen Geräten

Teil 3. Festkondensatoren zur Funkentstörung. Auswahl an Prüfverfahren und allgemeine Anforderungen

National foreword

This Part of this British Standard has been prepared under the direction of the Electronic Components Standards Committee. It is identical with IEC Publication 384-14 : 1981 'Fixed capacitors for use in electronic equipment: Part 14. Sectional specification: Fixed capacitors for radio interference suppression. Selection of methods of test and general requirements' published by the International Electrotechnical Commission (IEC).

Terminology and conventions. The text of the international standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards.

Wherever page numbers are quoted with reference to figures, these are IEC page numbers.

Cross references

International standard	Corresponding British Standard
IEC 60-1 : 1973	BS 923 Guide on high-voltage testing techniques Part 1 : 1980 General definitions and test requirements (Identical)
IEC 62 : 1974	BS 1852 : 1975 Marking codes for resistors and capacitors (Identical)
IEC 63 : 1963	BS 2488 : 1966 Schedule of preferred numbers for the resistance of resistors and the capacitance of capacitors for telecommunication equipment (Technically equivalent)
IEC 65 : 1976 (subclause 14.2)	BS 415 : 1979 Specification for safety requirements for mains-operated electronic and related apparatus for household and similar general use (Subclause 14.2 Identical)
IEC 68-1 : 1978	BS 2011 Basic environmental testing procedures Part 1.1 : 1980 General (Identical)
IEC 68-2-17 : 1978	Part 2.1Q : 1981 Test Q. Sealing (Identical)
IEC 68-2-20 : 1979 (including IEC 68-2-20A)	Part 2.1T : 1981 Test T. Soldering (Identical)
IEC 68-2-27 : 1972	Part 2.1Ea : 1977 Test Ea. Shock (Identical)
IEC 68-2-30 : 1980	Part 2.1Db : 1981 Test Db and guidance. Damp heat, cyclic (12 + 12 hour cycle) (Identical)
IEC 335-1 : 1976	BS 3456 Specification for safety of household and similar electrical appliances Part 101 : 1978 General requirements (Technically equivalent)
IEC 384-1 : 1972	BS 6201 Fixed capacitors for use in electronic equipment Part 1 : 1982 Methods of test (Identical)
IEC 384-9 : 1979	Part 2 : 1982 Specification for fixed capacitors of ceramic dielectric, Class 2. Selection of methods of test and general requirements (Identical)

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

CONTENTS

	Page
National foreword	Inside front cover
Cooperating organizations	Back cover

SECTION ONE — GENERAL

Clause

1. Scope	2
2. Object	2
3. Related documents	2
4. Terminology	3

SECTION TWO — PREFERRED RATINGS AND CHARACTERISTICS

5. Preferred ratings and characteristics	6
6. Marking	7

SECTION THREE — REQUIREMENTS FOR TESTS AND MEASURING METHODS

7. Qualification approval tests	8
8. Schedules for qualification approval tests	10
9. Standard atmospheric conditions for testing	12
10. Visual examination and check of dimensions	12
11. Electrical tests	13
11.1 Voltage proof	13
11.2 Capacitance	14
11.3 Insulation resistance	14
12. Environmental tests	16
12.1 Robustness of terminations	16
12.2 Resistance to soldering heat	16
12.3 Solderability (not applicable to terminations of snap-on contacts)	17
12.4 Rapid change of temperature	17
12.5 Vibration	17
12.6 Bump	17
12.7 Shock	18
12.8 Container sealing (when prescribed in the detail specification)	18
12.9 Climatic sequence	18
12.10 Damp heat, steady state	20
12.11 Endurance	20
12.12 Charge and discharge (applies only to metallized film or metallized paper capacitors) . . .	23
12.13 Radio-frequency characteristics	24
APPENDIX A — Example of a suitable circuit for the pulse test	25
APPENDIX B — Example of a suitable circuit for the endurance test for a.c. capacitors	26
APPENDIX C — Example of a suitable circuit for the charge and discharge test	27
APPENDIX D — Guide to the application of radio interference suppression capacitors (<i>under consideration</i>)	28

British Standard

Fixed capacitors for use in electronic equipment

Part 3. Specification for fixed capacitors for radio interference suppression.

Selection of methods of test and general requirements

SECTION ONE — GENERAL

1. Scope

This standard applies to fixed capacitors for radio interference suppression intended for apparatus and machines to be connected to a supply with a nominal voltage not exceeding 500 V d.c. or a.c. (r.m.s.) between conductors or 250 V d.c. or a.c. (r.m.s.) between any one conductor and earth and a frequency not exceeding 100 Hz. Capacitors for special environmental conditions (e.g. drip-proof, splash-proof etc.) have to fulfil additional requirements.

Combinations of two or more capacitors within one enclosure are also included in the scope of this standard.

This standard does not necessarily apply in its entirety to capacitor/resistor combinations, or to capacitors intended for use on motor vehicles, in aircraft or for marine applications. Individual recommendations for capacitor/resistor combinations, and capacitors for these other applications will indicate non-applicable clauses and extra requirements.

Notes 1. — For certain applications, U or Y capacitors, as described in this specification, may have to fulfil additional requirements as specified in IEC Publication 65: Safety Requirements for Mains Operated Electronic and Related Apparatus for Household and Similar General Use, Sub-clause 14.2.

2. — For notes on the application of radio interference suppression capacitors see Appendix D (under consideration).

2. Object

The object of this standard is to establish standard requirements for electrical shock hazard protection and to prescribe standard ratings and characteristics and to select from IEC Publication 384-1, the appropriate methods of test and to give general performance requirements for this type of capacitor. Test severities and performance requirements prescribed in detail specifications referring to this sectional specification shall be of equal or higher performance level, because lower performance levels are not permitted.

In addition the minimum requirements for electrical shock hazard protection specified herein always apply.

3. Related documents

IEC Publication 60-1: High-voltage Test Techniques,
(1973) Part 1: General Definitions and Test Requirements.

IEC Publication 62: Marking Codes for Resistors and Capacitors.
(1974)

IEC Publication 63: (1963)	Preferred Number Series for Resistors and Capacitors. Amendment No. 1 (1967). Amendment No. 2 (1977).
IEC Publication 68:	Basic Environmental Testing Procedures.
IEC Publication 335-1: (1970)	Safety of Household and Similar Electrical Appliances, Part 1: General Requirements.
IEC Publication 384-1: (1972)	Fixed Capacitors for Use in Electronic Equipment, Part 1: Terminology and Methods of Test. Amendment No. 1 (1979).
IEC Publication 384-1A: (1973)	First supplement.
IEC Publication 384-1B: (1975)	Second supplement.
IEC Publication 384-9: (1979)	Part 9: Sectional specification: Fixed Capacitors of Ceramic Dielectric, Class 2.

4. Terminology

Note. — Some definitions of IEC Publication 384-1 have been expanded and this is indicated in the definitions by reference to this note.

In addition to the applicable terms and definitions of IEC Publication 384-1, the following definitions apply:

4.1 A.C. capacitor

A capacitor designed essentially for application with a power-frequency alternating voltage (see note in Clause 4).

Note. — A.C. capacitors can be used on d.c. supplies, with the same rated voltages as the a.c. r.m.s. voltage.

Using ceramic capacitors of dielectric Class 2, in accordance with IEC Publication 384-9, the voltage characteristic of capacitance must be taken into consideration (see Sub-clauses 5.3 and 11.2*b*)).

4.2 Radio interference suppression capacitor

A capacitor to be used for the reduction of interference at radio frequencies caused by electrical appliances.

4.3 Capacitor of Class X

A capacitor of a type suitable for use in situations where failure of the capacitor would not lead to danger of electrical shock.

Class X capacitors are divided into two sub-classes (see Table I) according to the peak voltage of the pulses superimposed on the mains voltage to which they may be subjected in service. Such pulses may arise from lightning strikes on outside lines, from switching in neighbouring equipment, or switching in the equipment in which the capacitor is used.

TABLE I

Sub-class	Peak pulse voltage in service (kV)	Application*	Peak voltage applied during the endurance test (kV)
X1	> 1.2	High pulse application	$C \leq 0.33 \mu\text{F}$: 4 $C > 0.33 \mu\text{F}$: $4e^{(0.33 - C)}$
X2	≤ 1.2	General purpose	1.4

* Shorter or less severe tests for capacitors with a short accumulated life are under consideration.

4.4 Capacitor of Class U or Y

A capacitor of a type suitable for use in situations where failure of the capacitor could lead to danger of electric shock.

Differentiation of these classes is related to supply voltages on which they are used:

Class U: for normal insulation requirements for countries where mains voltages up to 125 V are standard.

Class Y: for normal insulation requirements for countries where mains voltages greater than 125 V and up to 250 V are standard.

4.5 Two-terminal capacitor

A normal radio interference suppression capacitor having two terminations (see Figure 1).

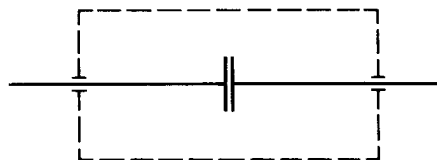


FIG. 1. — Two-terminal capacitor.

4.6 Lead-through capacitor (coaxial)

A capacitor with a central current-carrying conductor or a conductor connected with a current-carrying rod surrounded by a capacitor element which is symmetrically bonded to the centre conductor and to the outer electrode or casing to form a coaxial construction.

It should be mounted coaxially (see Figure 2).

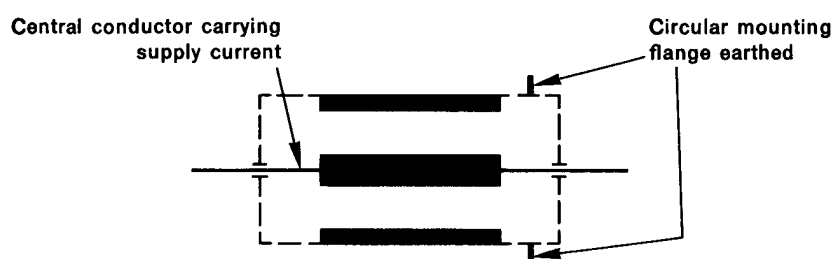


FIG. 2. — Lead-through capacitor (coaxial).

4.7 Lead-through capacitor (non-coaxial)

A capacitor in which the supply currents flow through or across the electrodes (see Figures 3a, 3b and 3c, page 13).

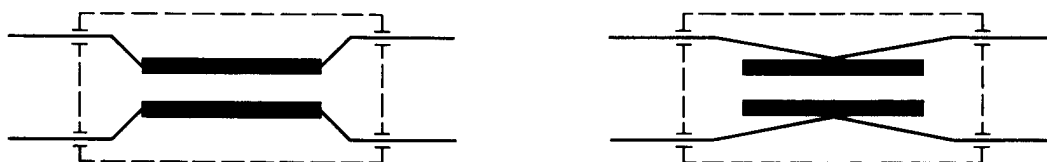


FIG. 3a. — Lead-through capacitor for symmetrical use (non-coaxial).

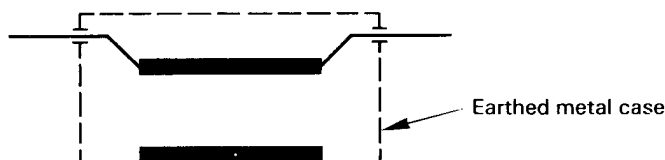


FIG. 3b. — Lead-through capacitor for asymmetrical use (non-coaxial).

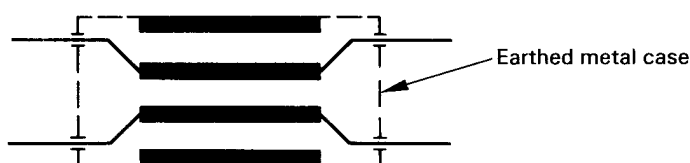


FIG. 3c. — Multiple unit lead-through capacitor (non-coaxial) for symmetrical and asymmetrical use.

4.8 *By-pass capacitor*

A capacitor where radio-frequency interference currents are by-passed to earth. There are two common forms, single and delta; the single capacitor employs a capacitor in an earthed metal case with one termination connected to the case as in Figure 4a; the delta form consists of an X-capacitor and two Y-capacitors arranged in a delta network as in Figure 4b, the junction of the two Y-capacitors either being connected to the earthed metal case or brought out as a separate termination.

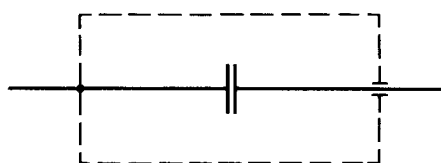


FIG. 4a. — Single by-pass capacitor.

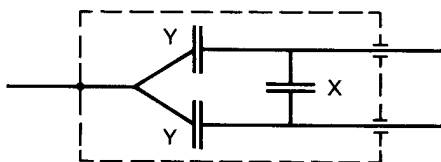


FIG. 4b. — Delta by-pass capacitor.

4.9 *Rated voltage (U_R)*

The rated voltage is either the r.m.s. operating voltage of rated frequency or the d.c. operating voltage, which may be applied continuously to the terminations of a capacitor at any temperature between the lower and the upper category temperatures.

This implies, for capacitors covered by this specification, that the category voltage is the same as the rated voltage.

4.10 *Upper category temperature*

The maximum external surface temperature for which the capacitor has been designed to operate continuously (see note in Clause 4).

Notes 1. — For lead-through capacitors, the external surface temperature can be affected by internal heating due to the lead-through current. The terminations of a test circuit are considered to be part of the external surface.

2. — This definition replaces that in IEC Publication 384-1, Sub-clause 4.8, because suppression capacitors are usually connected to the mains network and may have internal heat generation as a result.

4.11 *Lower category temperature*

The minimum external surface temperature for which the capacitor has been designed to operate continuously (see note in Clause 4).

Note. — This definition replaces that in IEC Publication 384-1, Sub-clause 4.9 (see Note 2 to Sub-clause 4.10 above).

4.12 *Rated temperature (of lead-through capacitor)*

The maximum ambient temperature at which a lead-through capacitor can carry its rated lead-through current.

Note. — This definition replaces that in IEC Publication 384-1, Sub-clause 4.11 (see Note 2 of Sub-clause 4.10 above)

4.13 *Insertion loss*

The ratio of the voltage before and after the insertion of the suppressor as measured at the terminations.

Note. — When expressed in decibels, the insertion loss is 20 times the logarithm of the ratio stated.

4.14 *Rated current of the conductors (lead-through capacitor)*

The maximum permissible current flowing through the conductors of the capacitor at the rated temperature during continuous operation.

4.15 *Main resonant frequency (two-terminal capacitor)*

The lowest frequency at which the impedance of the capacitor is a minimum when applying a sinusoidal voltage.

SECTION TWO — PREFERRED RATINGS AND CHARACTERISTICS

5. Preferred ratings and characteristics

The values given in detail specifications shall preferably be chosen from the following:

5.1 *Preferred climatic categories*

Radio interference suppression capacitors covered by this standard are classified into climatic categories according to the general rules given in IEC Publication 68-1.

The lower and upper category temperatures and the duration of the damp heat, steady-state test shall be within the following ranges:

Lower category temperature:	– 55 °C to – 10 °C
Upper category temperature:	+ 70 °C to + 125 °C

Duration of the damp heat, steady-state test: 10 to 56 days.

Values selected within these ranges shall be chosen from those listed in IEC Publication 68-2. The severities for the cold and dry heat tests are the lower and upper category temperatures respectively.

For guidance on the application of the categories described above, see Section Three.

5.2 Rated capacitance (C_R)

The preferred values of rated capacitance are:

1 — 1.5 — 2.2 — 3.3 — 4.7 and 6.8 and their decimal multiples.

These values conform to the E6 series of preferred values given in IEC Publication 63.

5.3 Tolerance on rated capacitance

The maximum tolerance on rated capacitance is $\pm 20\%$ except for ceramic capacitors of Class X which may have a maximum tolerance of $-20\%/+80\%$.

Note. — When the electrical shock hazard aspects of an equipment are considered in terms of leakage current, attention should be paid to the capacitance value and tolerance and, especially when ceramic capacitors with dielectric Class 2 are used, the temperature and voltage characteristic of the capacitance.

5.4 Rated voltage (U_R)

The preferred values of rated voltage are:

- for a.c. capacitors: 50 V, 125 V, 250 V, 380 V and 440 V;
- for d.c. capacitors: 50 V, 160 V, 250 V and 500 V.

Note. — Radio interference suppression capacitors shall be chosen to have a rated voltage equal to, or greater than, the nominal voltage of the supply system to which they are to be connected. It should, however, be borne in mind that the voltage of the system may rise by up to 10% above the nominal voltage.

5.5 Rated temperature

The rated temperature shall be specified in the detail specification, and for lead-through capacitors shall be not less than + 40 °C.

6. Marking

6.1 The information given in the marking is normally selected from the following list; the relative importance of each item is indicated by its position in the list:

- a) Manufacturer's name or trade mark.
- b) Manufacturer's type designation or the type designation given in the detail specification.
- c) Rated capacitance(s).
- d) Rated voltage and nature of supply (alternating voltage may be indicated by the symbol $\sim$ and direct voltage by the symbol $\equiv$ or —).
- e) Capacitor class and sub-class.
- f) The method of connection, if necessary.

- g)* Rated current of the conductor (in case of a lead-through capacitor).
- h)* Tolerance on rated capacitance if different from $\pm 20\%$ (may be indicated by the code given in IEC Publication 62).
- i)* The symbol (SH) if the capacitor, or a section of it, is a metallized film or metallized paper capacitor.
- j)* Climatic category.
- k)* The rated temperature (of a lead-through capacitor).
- l)* Year and month (or week) of manufacture (may be indicated by the code given in IEC Publication 62).
- m)* Reference to the detail specification.

- 6.2 The capacitor shall be clearly marked with *a)* and *b)* and as many as possible of the remaining items as is considered necessary. The marking shall be sufficient to enable a clear identification of the component to be made.

Any duplication of information in the marking on the capacitor shall be avoided.

- 6.3 The package containing the capacitor(s) shall be clearly marked with all the information listed above.
- 6.4 Any additional marking shall be so applied that no confusion can arise.

SECTION THREE — REQUIREMENTS FOR TESTS AND MEASURING METHODS

7. Qualification approval tests

- 7.1 This standard covers procedures for qualification approval tests only. Two alternative test procedures are given, namely the full test procedure covering both electrical shock hazard protection and performance requirements, and a restricted test procedure covering electrical shock hazard protection only.

The test schedule for qualification approval for electrical shock hazard protection tests only is given in Table II, and the full schedule for electrical shock hazard protection and performance is given Table III.

Capacitors of each rated voltage shall be separately qualified. The total number of capacitors of each rated voltage to be tested in each group is given in Tables II and III. For multi-section capacitors containing sections of different classes and for lead-through capacitors, larger numbers are required as indicated. For each rated voltage the sample shall contain equal numbers of specimens of the highest and lowest capacitance values in the range to be qualified. Where only one capacitance value is involved, the total number of capacitors as stated in Tables II and III shall be tested.

Spare specimens are permitted as follows:

- i)* One per capacitance value which may be used to replace the permitted defective in Group 0.
- ii)* One per capacitance value which may be used as replacements for specimens lost due to incidents not attributable to the manufacturer.