

Specification for harmonized system of quality assessment for electronic components — Fixed capacitors for use in electronic equipment — Generic specification

UDC 621.319.4:621.38

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW



Document Sharing Hub

Committees responsible for this standard

The preparation of this British Standard was entrusted by the Electronic Components Standards Committee (ECL/-) to Technical Committee ECL/4 upon which the following bodies were represented:

- British Telecommunications
- Electronic Components Industry Federation
- Electronic Engineering Association
- Ministry of Defence
- National Supervising Inspectorate
- Society of British Aerospace Companies Limited
- Telecommunication Engineering and Manufacturing Association (TEMA)

This British Standard, having been prepared under the direction of the Electronic Components Standards Committee, was published under the authority of the Board of BSI and comes into effect on 31 October 1983

© BSI 04-2000

The following BSI references relate to the work on this standard:
Committee reference ECL/4
Draft for comment 79/24918 DC

ISBN 0 580 13408 3

Amendments issued since publication

Amd. No.	Date of issue	Comments
5955	August 1992	Indicated by a sideline in the margin

Contents

	Page
Committees responsible	Inside front cover
National foreword	iii
Section 1. Scope	1
Section 2. General	
2.1 Related documents	1
2.2 Units, symbols and terminology	2
2.3 Preferred values	6
2.4 Marking	6
Section 3. Quality assessment procedures	
3.1 Qualification Approval/Quality Assessment Systems	6
3.2 Primary Stage of Manufacture	6
3.3 Structurally Similar Components	6
3.4 Qualification Approval Procedures	6
3.5 Quality Conformance Inspection	7
3.6 Alternative test methods	8
3.7 Unchecked parameters	8
Section 4. Test and measurement procedures	
4.1 General	8
4.2 Standard atmospheric conditions	8
4.3 Drying	9
4.4 Visual examination and check of dimensions	9
4.5 Insulation resistance	9
4.6 Voltage proof	12
4.7 Capacitance	14
4.8 Tangent of loss angle	14
4.9 Leakage current	14
4.10 Impedance (under consideration)	15
4.11 Inductance (under consideration)	15
4.12 Outer foil termination	18
4.13 Robustness of terminations	18
4.14 Resistance to soldering heat	19
4.15 Solderability	19
4.16 Rapid change of temperature	20
4.17 Vibration	20
4.18 Bump	20
4.19 Shock	20
4.20 Container sealing	21
4.21 Climatic sequence	21
4.22 Damp heat, steady state	22
4.23 Endurance	22
4.24 Variation of capacitance with temperature	23
4.25 Storage	25
4.26 Surge	25
4.27 Charge and discharge test	27
4.28 Pressure relief (for electrolytic capacitors)	28
4.29 Characteristics at high and low temperature	28
4.30 Thermal stability test	28
4.31 Component solvent resistance	29
4.32 Solvent resistance of the marking	29

	Page
Appendix A Interpretation of sampling plans and procedures as described in IEC Publication 410 for use within the IEC Quality Assessment System for Electronic Components	30
Appendix B Rules for the preparation of detail specifications for capacitors and resistors for electronic equipment	30
Appendix C Guide for pulse testing of capacitors	31
Figure 1 — Schematic diagram of the measuring circuit	15
Figure 2	16
Figure 3	16
Figure 5	17
Figure 6 — Schematic diagram of the measuring circuit	17
Figure 2 — Test circuit	18
Figure 3a — Relay circuit	25
Figure 3b — Thyristor circuit	26
Figure 4	26
Figure 5	27
Table I — Measuring points	11
Publications referred to	Inside back cover

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 384-1 [QC 300000] *“Fixed capacitors for use in electronic equipment. Part 1: Generic specification”*, published in 1982 by the International Electrotechnical Commission (IEC).

This standard is a harmonized specification within the IECQ system of quality assessment for electronic components.

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.

Cross references

The British Standard which implements QC 001001:1986 and QC 001002:1986 is BS 9000: *“General requirements for a system for electronic components of assessed quality”*: Part 3:1991 *“Specification for the national implementation of the IECQ system”*.

International Standard

ISO 3:1973	}	BS 2045:1965 <i>Preferred numbers</i>
ISO 497:1973		(Technically equivalent)
ISO 1000:1981		BS 5555:1981 <i>Specification for SI units and recommendations for the use of their multiples and of certain other units</i>
		(Identical)
IEC 62:1974		BS 1852:1975 <i>Marking codes for resistors and capacitors</i>
		(Identical)
IEC 63:1963		BS 2488:1966 <i>Schedule of preferred numbers for the resistance of resistors and the capacitance of capacitors for telecommunication equipment</i>
		(Technically equivalent)
IEC 68		BS 2011 <i>Basic environmental testing procedures</i>
IEC 68-1:1978 ^a		Part 1.1:1980 <i>General</i>
		(Identical)
IEC 68-2-1:1974		Part 2.1A:1977 <i>Test A. Cold</i>
		(Identical)
IEC 68-2-2:1974		Part 2.1B:1977 <i>Test B. Dry heat</i>
		(Identical)
IEC 68-2-3:1969		Part 2.1Ca:1977 <i>Test Ca. Damp heat, steady state</i>
		(Identical)
IEC 68-2-6:1982		Part 2.1Fc:1983 <i>Test Fc. Vibration (sinusoidal)</i>
		(Identical)
IEC 68-2-13:1966 ^b		Part 2.1M:1977 <i>Test M. Low air pressure</i>
		(Identical)
IEC 68-2-14:1974 ^c		Part 2.1N:1977 <i>Test N. Change of temperature</i>
		(Identical)
IEC 68-2-17:1978		Part 2.1Q:1981 <i>Test Q. Sealing</i>
		(Identical)
IEC 68-2-20:1979		Part 2.1T:1981 <i>Test T. Soldering</i>
		(Identical)

^a Now superseded by IEC 68-1:1982, the corresponding identical British Standard for which is BS 2011:-1.1:1983 *“General and guidance”*.

^b Now superseded by IEC 68-2-13:1983, the corresponding identical British Standard for which is BS 2011-2.1M:1984. Test M. *“Low air pressure”*.

^c Now superseded by IEC 68-2-14:1984, the corresponding identical British Standard for which is BS 2011-2.1N:1985. Test N. *“Change of temperature”*.

International Standard

IEC 68-2-21:1975 ^a	Part 2.1U:1977 <i>Test U. Robustness of terminations and integral mounting devices</i>
IEC 68-2-27:1972 ^b	Part 2.1Ea:1977 <i>Test Ea. Shock</i> (Identical)
IEC 68-2-29:1968 ^c	Part 2.1Eb:1977 <i>Test Eb. Bump</i> (Identical)
IEC 68-2-30:1980	Part 2.1Db:1981 <i>Tests Db and guidance. Damp heat cyclic (12 + 12 hour cycle)</i> (Identical)
IEC 68-2-45:1980	Part 2.1XA:1981 <i>Test XA and guidance. Immersion in cleaning solvents</i> (Identical)
IEC 294:1969	BS 5692:1979 <i>Method for measurement of the dimensions of a cylindrical electronic component having two axial terminations</i> (Identical)
IEC 410:1973	BS 6001 <i>Sampling procedures and tables for inspection by attributes</i> Part 1:1991 <i>Specification for sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection</i> (Technically equivalent)
IEC 469-1:1974	BS 5698 <i>Guide to pulse techniques and apparatus</i> Part 1:1979 <i>Pulse terms and definitions</i> (Identical)
IEC 469-2:1974	Part 2:1979 <i>Pulse measurement and analysis, general considerations</i> (Identical)

^a Now superseded by IEC 68-2-21:1983, the corresponding identical British Standard for which is BS 2011-2.1U:1984. Test U. “*Robustness of terminations and integral mounting devices*”.

^b Now superseded by IEC 68-2-27:1987, the corresponding identical British Standard for which is BS 2011-2.1Ea:1988. Test Ea. “*Shock*”.

^c Now superseded by IEC 68-2-29:1987, the corresponding identical British Standard for which is BS 2011-2.1Eb:1987. Test Eb. “*Bump*”.

There are no corresponding British Standards for IEC 27-1:1971, IEC 50 and IEC 117¹⁾, which are all referred to in clause 2. As the standards are referred to for information only, the validity of this British Standard is not affected.

British Standards related to IEC 27-1:1971, IEC 50 and IEC 617 are, respectively, BS 5775 “*Specification for quantities, units and symbols*”; BS 4727 “*Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms*”; and BS 3939 “*Guide for graphical symbols for electrical power, telecommunications and electronics diagrams*”.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 32, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

¹⁾ IEC 117 has been superseded by IEC 617.

Section 1. Scope

This standard is applicable to fixed capacitors for use in electronic equipment.

It establishes standard terms, inspection procedures and methods of test for use in sectional and detail specifications for Qualification Approval and for Quality Assessment Systems for electronic components.

Section 2. General

2.1 Related documents

IEC publications:

Publication 27-1:1971	<i>Letter Symbols to be Used in Electrical Technology, Part 1: General.</i>
Publication 50:	<i>International Electrotechnical Vocabulary (I.E.V.).</i>
Publication 62:1974	<i>Marking Codes for Resistors and Capacitors.</i>
Publication 63:1963	<i>Preferred Number Series for Resistors and Capacitors.</i>
	Amendment No. 1 (1967).
	Amendment No. 2 (1977).
Publication 68:	<i>Basic Environmental Testing Procedures.</i>
Publication 68-1:1978	<i>Part 1: General.</i>
Publication 68-2-1:1974	<i>Tests A: Cold.</i>
Publication 68-2-1A:1976	<i>First supplement.</i>
Publication 68-2-2:1974	<i>Tests B: Dry Heat.</i>
Publication 68-2-2A:1976	<i>First supplement.</i>
Publication 68-2-3:1969	<i>Test Ca: Damp Heat, Steady State.</i>
Publication 68-2-6:1970	<i>Test Fc: Vibration (Sinusoidal).</i>
	Amendment No. 1 (1972).
Publication 68-2-13:1966	<i>Test M: Low Air Pressure.</i>
Publication 68-2-14:1974	<i>Test N: Change of Temperature.</i>
Publication 68-2-17:1978	<i>Test Q: Sealing.</i>
Publication 68-2-20:1979	<i>Test T: Soldering.</i>
Publication 68-2-21:1975	<i>Test U: Robustness of Terminations and Integral Mounting Devices.</i>
	Amendment No. 1 (1979).
Publication 68-2-27:1972	<i>Test Ea: Shock.</i>
Publication 68-2-29:1968	<i>Test Eb: Bump.</i>
Publication 68-2-30:1969	<i>Test Db: Damp Heat, Cyclic (12 + 12-hour cycle).</i>
Publication 117:	<i>Recommended Graphical Symbols.</i>
Publication 294:1969	<i>Measurement of the Dimensions of a Cylindrical Component having Two Axial Terminations.</i>
Publication 410:1973	<i>Sampling Plans and Procedures for Inspection by Attributes.</i>
Publication QC 001001:1981:	<i>Basic Rules of the IEC Quality Assessment System for Electronic Components (IECQ).</i>
Publication QC 001002:1981:	<i>Rules of Procedure of the IEC Quality Assessment System for Electronic Components (IECQ).</i>

ISO publications:

ISO Standard 3:1973	<i>Preferred Numbers — Series of Preferred Numbers.</i>
ISO Standard 497:1973	<i>Guide to the Choice of Series of Preferred Numbers and of Series Containing more Rounded Values of Preferred Numbers.</i>
ISO Standard 1000:1973	<i>SI Units and Recommendations for the Use of their Multiples and of Certain Other Units.</i>

NOTE The above references apply to the current editions, except for IEC Publication 68 for which the referenced edition must be used.

2.2 Units, symbols and terminology

2.2.1 General

Units, graphical symbols, letter symbols and terminology shall, whenever possible, be taken from the following publications:

- ISO Standard 1000
- IEC Publication 27
- IEC Publication 117
- IEC Publication 50

When further items are required they shall be derived in accordance with the principles of the documents listed above.

2.2.2 Type

A group of components having similar design features and the similarity of whose manufacturing techniques enables them to be grouped together either for qualification approval or for quality conformance inspection.

They are generally covered by a single detail specification.

NOTE Components described in several detail specifications, may, in some cases, be considered as belonging to the same type and may therefore be grouped together for qualification approval and quality conformance inspection.

2.2.3 Style

A sub-division of a type, generally based on dimensional factors.

A style may include several variants, generally of a mechanical order.

2.2.4 Grade

A term to indicate additional general characteristics concerning the intended application, e.g. long life applications.

The term "Grade" may only be used in combination with one or more words (e.g. long life grade) and not by a single letter or number.

Figures to be added after the term "Grade" should be arabic numerals.

2.2.5 Family (of electronic components)

A group of, electronic components which predominantly displays a particular physical attribute and/or fulfils a defined function.

2.2.6 Sub-family (of electronic components)

A group of components within a family manufactured by similar technological methods.

2.2.7 D.C. capacitor

A capacitor designed essentially for application with direct voltage.

NOTE A d.c. capacitor may not be suitable for use on a.c. supplies.

2.2.8 Polar capacitor (for electrolytic capacitors)

A capacitor intended for use with a unidirectional voltage connected according to the polarity indication.

2.2.9 Bipolar capacitor (for electrolytic capacitors)

An electrolytic capacitor designed to withstand an alternating voltage and/or reversal of the applied direct voltage.

2.2.10 A.C. capacitor

A capacitor designed essentially for application with alternating voltages.

2.2.11 Pulse capacitor

A capacitor for use with pulses of current or voltage.

NOTE The definitions of IEC Publications 469-1 and 469-2 apply.

2.2.12 Rated capacitance (C_R)

The capacitance value for which the capacitor has been designed and which is usually indicated upon it.

2.2.13 Category temperature range

The range of ambient temperatures for which the capacitor has been designed to operate continuously; this is defined by the temperature limits of the appropriate category.

2.2.14 Upper category temperature

The maximum ambient temperature for which a capacitor has been designed to operate continuously.

2.2.15 Lower category temperature

The minimum ambient temperature for which a capacitor has been designed to operate continuously.

2.2.16 Rated temperature

The maximum ambient temperature at which the rated voltage may be continuously applied.

2.2.17 Rated voltage (d.c.) (U_R)

The maximum direct voltage or peak value of pulse voltage which may be applied continuously to a capacitor at any temperature between the lower category temperature and the rated temperature (see Sub-clause 2.2.16)

2.2.18 Category voltage (U_C)

The maximum voltage which may be applied continuously to a capacitor at its upper category temperature (see Sub-clause 2.2.14).

2.2.19 Temperature derated voltage

For any temperature between the rated temperature and the upper category temperature, the temperature derated voltage is the maximum voltage that may be applied continuously to a capacitor.

NOTE Information on the voltage/temperature dependence at temperatures between the rated temperature and the upper category temperature should, if applicable, be given in the relevant specification.

2.2.20 Surge voltage ratio

The quotient of the maximum instantaneous voltage which may be applied to the terminations of the capacitor for a specified time at any temperature within the category temperature range and the rated voltage or the temperature derated voltage, as appropriate.

The number of times per hour that this voltage may be applied shall be specified.

2.2.21 Rated ripple voltage

The r.m.s. value of the maximum allowable alternating voltage of a specified frequency superimposed on the d.c. voltage at which the capacitor may be operated continuously at a specified temperature. The sum of the direct voltage and the peak value of the alternating voltage applied to the capacitor shall not exceed the rated voltage or temperature derated voltage as applicable.

2.2.22 Reverse voltage (for polar capacitors only)

A voltage applied to the capacitor terminations in the reverse polarity direction.

2.2.23 Rated ripple current

The r.m.s. value of the maximum allowable alternating current of a specified frequency, at which the capacitor may be operated continuously at a specified temperature.

2.2.24 Time constant

The product of the insulation resistance and the capacitance. It is normally expressed in seconds.

2.2.25 Tangent of loss angle ($\tan \delta$)

The power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of specified frequency.

2.2.26 Self-healing

The process by which the electrical properties of the capacitor, after a local breakdown of the dielectric, are rapidly and essentially restored to the values before the breakdown.

2.2.27 Maximum temperature of a capacitor

The temperature at the hottest point of its external surface.

NOTE The terminations are considered to be part of the external surface.

2.2.28 Minimum temperature of a capacitor

The temperature at the coldest point of its external surface.

NOTE The terminations are considered to be part of the external surface.

2.2.29 Minimum storage temperature

The minimum permissible ambient temperature which the capacitor shall withstand in the non-operating condition without damage.

NOTE The maximum permissible storage temperature is equal to the upper category temperature.

2.2.30 Variation of capacitance with temperature

The variation of capacitance with temperature can be expressed in two ways:

- a) Temperature characteristic of capacitance.
- b) Temperature coefficient of capacitance.

2.2.30.1 *Temperature characteristic of capacitance*

The term characterizing this property applies mainly to capacitors of which the variations of capacitance as a function of temperature, linear or non-linear, cannot be expressed with precision and certainty.

The temperature characteristic of capacitance is the maximum reversible variation of capacitance produced over a given temperature range within the category temperature range. It is expressed normally as a percentage of the capacitance related to a reference temperature of 20 °C.

2.2.30.2 *Temperature coefficient of capacitance and temperature cyclic drift of capacitance*

The terms characterizing these two properties apply to capacitors of which the variations of capacitance as a function of temperature are linear or approximately linear and can be expressed with a certain precision.

For these capacitors, the variation of capacitance for any temperature, within the category temperature range, can be analysed into two components:

Temperature coefficient of capacitance (α)

The rate of change of capacitance with temperature measured over a specified range of temperature. It is normally expressed in parts per million per degree Celsius ($10^{-6}/^{\circ}\text{C}$).

Temperature cyclic drift of capacitance

The maximum irreversible variation of capacitance observed at room temperature during or after the completion of a number of specified temperature cycles. It is expressed normally as a percentage of the capacitance related to a reference temperature. This is normally 20 °C.

The conditions of measurement, during or after temperature cycling, a description of the temperature cycle and the number of cycles, shall be stated.

2.2.31 Visible damage

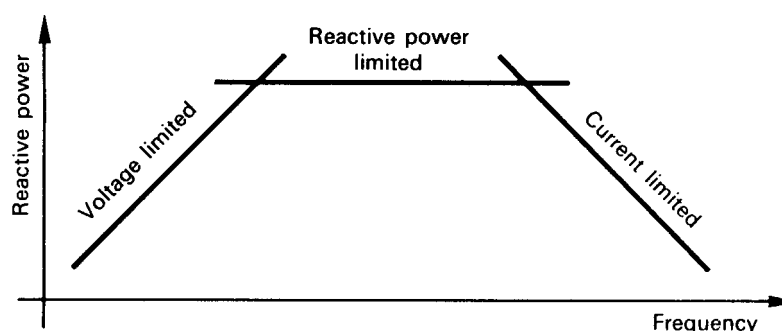
Visible damage which reduces the usability of the capacitor for its intended purpose.

2.2.32 Rated a.c. load

The rated load (a.c.) is the maximum sinusoidal a.c. load which may be applied continuously to the terminations of a capacitor at any temperature between the lower category temperature and the rated temperature (see Sub-clause 2.2.16). It may be expressed:

- at low frequencies as a rated a.c. voltage;
- at high frequencies as a rated a.c. current;
- at intermediate frequencies as a rated reactive power.

This is shown in the following figure:



NOTE 1 For a particular type of capacitor it may be necessary to specify one or more of the above characteristics.

NOTE 2 Capacitors within the scope of this specification are normally less than 500 var at 50–60 Hz. Low frequencies may be 50–60 Hz, 100–120 Hz, or 400 Hz. Voltages may be up to 600 V r.m.s. at 50–60 Hz. However, capacitors for filters, transmitter or converter circuits may be required to operate under power over a wide range of frequencies and up to 10 kvar at the higher frequencies with voltages up to 1 000 V r.m.s.

2.2.33 Rated pulse load

The rated pulse load is the maximum pulse load which may be applied at a certain pulse repetition frequency to the terminations of a capacitor at any temperature between the lower category temperature and the rated temperature (see Sub-clause 2.2.16). It may be expressed as a) and b) and any of the remaining items:

- peak current per μF or $\frac{dv}{dt}$ (V/ μs);
- relative duration of charge and discharge periods;
- r.m.s. current;
- peak voltage;
- peak reverse voltage;
- pulse repetition frequency (see note);
- maximum active power.

These parameters are fixed for periodic pulses.

NOTE In the case of intermittent pulses the duty cycle shall be specified. In the case of random pulses the total number expected over a given time period shall be stated.

2.2.34 R.M.S. pulse current

This shall be calculated in accordance with Sub-clause 2.5.2.4 of IEC Publication 469-1. In the case of intermittent or random pulses the time interval shall be chosen to correspond with the maximum temperature rise.

2.2.35 Pulse equivalent circuit of a capacitor

The equivalent circuit of a capacitor consists of an ideal capacitor in series with the residual inductance and the equivalent series resistance (ESR).

NOTE For pulse operation the equivalent series resistance will be similar to but not identical with the ESR measured with a sinusoidal voltage. The pulse ESR shall take into account the series of harmonics in the pulse and the variation of the losses with frequency.

2.2.36 Temperature rise

The temperature rise of the capacitor relative to the ambient temperature resulting from the losses in the capacitor due to operation under a.c. or pulse conditions.

2.2.37 Insulated capacitor

A capacitor in which all terminations of a section may be raised to a potential different (but not less than the rated voltage) from that of any conducting surface with which the case is liable to come into contact in normal use.

2.2.38 Uninsulated capacitor

A capacitor in which one or more of the terminations of a section cannot be raised to a potential different (but not less than the rated voltage) from that of any conducting surface with which the case is liable to come into contact in normal use.

2.3 Preferred values

2.3.1 General

Each sectional specification shall prescribe the preferred values appropriate to the sub-family; for rated capacitance see also Sub-clause **2.3.2**.

2.3.2 Preferred values of rated capacitance

The preferred values of rated capacitance shall be taken from the series specified in IEC Publication 63.

2.4 Marking

2.4.1 General

The sectional specification shall indicate the identification criteria and other information to be shown on the capacitor and/or packing.

The order of priority for marking small capacitors shall be specified.

2.4.2 Coding

When coding is used for capacitance value, tolerance or date of manufacture, the method shall be selected from those given in IEC Publication 62.

Section 3. Quality assessment procedures

3.1 Qualification Approval/Quality Assessment Systems

3.1.1 For a full Quality Assessment System the procedures of Sub-clauses **3.4** and **3.5** shall be followed.

3.1.2 For Qualification Approval without Quality Conformance Inspection (type testing only) the procedures and requirements of Sub-clauses **3.4.1** and **3.4.2 b)** may be used as appropriate, but, in any case, tests and parts of tests shall be applied in the order given in the test schedules.

3.2 Primary Stage of Manufacture

For fixed capacitor specifications, the primary stage shall be defined in the sectional specification.

3.3 Structurally Similar Components

The grouping of structurally similar components for the purpose of qualification approval and quality conformance inspection shall be prescribed in the sectional specification.

3.4 Qualification Approval Procedures

3.4.1 The manufacturer shall comply with:

- the general requirements of the rules of procedure governing qualification approval;
- the requirements for the primary stage of manufacture contained in Sub-clause **3.2** of this standard.