

**Harmonized system of quality assessment
for electronic components**

Fixed capacitors for use in electronic equipment Sectional specification for fixed multilayer ceramic chip capacitors

Système harmonisé d'assurance de la qualité
des composants électroniques
Condensateurs fixes utilisés dans les
équipements électroniques
Spécification intermédiaire pour les
condensateurs fixes chipsets à diélectrique en
céramique multicouche

Harmonisiertes Gütebestätigungssystem für
Bauelemente der Elektronik
Festkondensatoren zur Verwendung in
Geräten der Elektronik
Bauartspezifikation für
Keramikmehrschichtkondensatoren

Committees responsible for this British Standard

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

British Telecommunications plc
EEA (the Association of Electronics, Telecommunications and Business Equipment Industries)
Electronic Components Industry Federation
Ministry of Defence
National Supervising Inspectorate
Society of British Aerospace Companies Ltd.

This British Standard, having been prepared under the direction of the Electronic Components Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 1 May 1992

© BSI 1992

The following BSI references relate to the work on this standard:
Committee reference ECL/4
Special announcement in *BSI News*, October 1991

ISBN 0 580 20378 6

Amendments issued since publication

Amd. No.	Date	Text affected

Contents

Committees responsible	Page Inside front cover
National foreword	ii
Specification	
1 General	1
1.1 Scope	1
1.2 Object	1
1.3 Related documents	1
1.4 Information to be given in a detail specification	2
1.5 Terminology	3
1.6 Marking	4
2 Preferred ratings and characteristics	5
2.1 Preferred characteristics	5
2.2 Preferred values of ratings	6
3 Quality assessment procedures	11
3.1 Primary stage of manufacture	11
3.2 Structurally similar components	11
3.3 Certified records of released lots	11
3.4 Qualification approval	11
3.5 Quality conformance inspection	11
4 Test and measurement procedures	21
4.1 Special preconditioning	21
4.2 Preliminary drying	21
4.3 Measuring conditions	21
4.4 Mounting	21
4.5 Visual examination and check of dimensions	21
4.6 Electrical tests	23
4.7 Variation of capacitance with temperature	26
4.8 Adhesion	28
4.9 Bond strength of the end face plating	28
4.10 Resistance to soldering heat	28
4.11 Solderability	29
4.12 Rapid change of temperature	29
4.13 Climatic sequence	30
4.14 Damp heat, steady state	32
4.15 Endurance	34
4.16 Robustness of terminations (only for capacitors with strip terminations)	35
4.17 Component solvent resistance	36
4.18 Solvent resistance of the marking	36
Appendices	
A Guide for the specification and coding of dimensions of multilayer ceramic chip capacitors	37
B Capacitance ageing of fixed capacitors of ceramic dielectric, Class 2	39

National foreword

This British Standard has been prepared under the direction of the Electronic Components Standards Policy Committee. It is identical with IEC 384-10 : 1989 (QC 301900) 'Fixed capacitors for use in electronic equipment. Part 10 : Sectional specification : Fixed multilayer ceramic chip capacitors' published by the International Electrotechnical Commission (IEC) and is a harmonized specification within the IECQ system of quality assessment for electronic components.

IEC 384-10 was prepared by IEC Technical Committee No. 40 'Capacitors and resistors for electronic equipment' and the United Kingdom participation in the drafting was provided by Technical Committee ECL/4 'Capacitors and resistors for electronic equipment'.

Cross-references

International standard	Corresponding British Standard
ISO 3 (1973)	BS 2045 : 1965 Preferred numbers (Technically equivalent)
IEC 62 : 1974	BS 1852 : 1975 Specification for 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 68-1 : 1988	BS 2011 Environmental testing Part 1.1 : 1989 General and guidance (Identical)
IEC 384-1 : 1982 (QC 300000)	BS 9930 Harmonized system of quality assessment for electronic components. Fixed capacitors for use in electronic equipment Part 0 : 1983 Generic specification (Identical)
IEC 384-10-1 : 1989	BS QC 301901 : 1992 ¹⁾ Harmonized system of quality assessment for electronic components. Fixed capacitors for use in electronic equipment. Blank detail specification : Fixed multilayer ceramic chip capacitors. Assessment level E (Identical)
IEC 410 : 1973	BS 6001 Sampling procedures for inspection by attributes Part 1 : 1991 Specification for sampling plans indexed by acceptable quality levels (AQL) for lot-by-lot inspection (Technically equivalent)
QC 001002 : 1986	BS QC 001002 : 1991 Rules of Procedure of the IEC Quality Assessment System for Electronic Components (IECQ) (Identical)

¹⁾ In preparation.

The British Standard which implements the IECQ Rules of Procedure 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'.

The Technical Committee has reviewed the provisions of QC 001001 to which reference is made in the text and has decided that they are acceptable for use in conjunction with this standard.

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

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT
PART 10: SECTIONAL SPECIFICATION:
FIXED MULTILAYER CERAMIC CHIP CAPACITORS

SECTION ONE - GENERAL

1. General

1.1 Scope

This standard is applicable to fixed unencapsulated multilayer chip capacitors of ceramic dielectric, Class 1 and Class 2, with a rated voltage normally not exceeding 200 V, for use in electronic equipment. For higher voltages changes may be necessary to some of the tests, and these shall be specified in the detail specification. These capacitors have metallized connecting pads or soldering strips and are intended to be mounted directly on to substrates for hybrid circuits or on to printed boards.

1.2 Object

The object of this standard is to prescribe preferred ratings and characteristics and to select from IEC Publication 384-1 (1982), the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of capacitor. Test severities and 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.

1.3 Related documents

IEC Publications:

Publication 62 (1974):	Marking Codes for Resistors and Capacitors.
Publication 63 (1963):	Preferred Number Series for Resistors and Capacitors. Amendment No. 1 (1967) Amendment No. 2 (1977)
Publication 68:	Basic Environmental Testing Procedures.
Publication 384-1 (1982):	Fixed Capacitors for Use in Electronic Equipment. Part 1: Generic Specification. Amendment No. 2 (1987) Amendment No. 3 (1989)
Publication 384-10-1 (1989):	Part 10: Blank Detail Specification. Fixed Multilayer Ceramic Chip Capacitors. Assessment Level E.
Publication 410 (1973):	Sampling Plans and Procedures for Inspection by Attributes.
Publication QC 001001 (1986):	Basic Rules of the IEC Quality Assessment System for Electronic Components (IECQ).
Publication QC 001002 (1986):	Rules of Procedure of the IEC Quality Assessment System for Electronic Components (IECQ).

ISO Publication:

ISO Standard 3 (1973): Preferred Numbers - Series of Preferred Numbers.

Note. -The above references apply to the current editions except for IEC Publication 68, for which the referenced edition in the applicable test clauses of the generic specification shall be used.

1.4 Information to be given in a detail specification

Detail specifications shall be derived from the relevant blank detail specification.

Detail specifications shall not specify requirements inferior to those of the generic, sectional or blank detail specification. When more severe requirements are included, they shall be listed in Sub-clause 1.9 of the detail specification and indicated in the test schedules, for example by an asterisk.

Note. -The information given in Sub-clause 1.4.1 may for convenience, be presented in tabular form.

The following information shall be given in each detail specification and the values quoted shall preferably be selected from those given in the appropriate clause of this sectional specification.

1.4.1 Outline drawing and dimensions

There shall be an illustration of the chip capacitor as an aid to easy recognition and for comparison of the chip capacitor with others. Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall preferably be stated in millimetres, however when the original dimensions are given in inches, the converted metric dimensions in millimetres shall be added.

Normally the numerical values shall be given for the length, width and height of the body. When necessary, for example when a number of items (sizes and capacitance/voltage ranges) are covered by a detail specification, the dimensions and their associated tolerances shall be placed in a table below the drawing.

When the configuration is other than described above, the detail specification shall state such dimensional information as will adequately describe the chip capacitor.

1.4.2 Mounting

The detail specification shall give guidance on methods of mounting for normal use. Mounting for test and measurement purposes (when required) shall be in accordance with Sub-clause 4.4 of this sectional specification.

1.4.3 Ratings and characteristics

The ratings and characteristics shall be in accordance with the relevant clauses of this specification, together with the following:

1.4.3.1 Rated capacitance range

See Sub-clause 2.2.4.1.

Note. -When products approved to the detail specification have different ranges, the following statement should be added:
"The range of values available in each voltage range is given in the qualified products list".

1.4.3.2 Particular characteristics

Additional characteristics may be listed, when they are considered necessary to specify adequately the component for design and application purposes.

1.4.3.3 Soldering

The detail specification shall prescribe the test methods, severities and requirements applicable for the solderability and the resistance to soldering heat tests.

1.4.4 Marking

The detail specification shall specify the content of the marking on the capacitor and on the package. Deviations from Sub-clause 1.6 of this sectional specification shall be specifically stated.

1.5 Terminology

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

1.5.1 Chip capacitor

A capacitor whose small dimensions and nature or shape of terminations make it suitable for surface mounting in hybrid circuits and on printed boards.

1.5.2 Fixed capacitors of ceramic dielectric, Class 1

1.5.2.1 A capacitor specially designed and suited for resonant circuit application where low losses and high stability of capacitance are essential or where a precisely defined temperature coefficient is required, e.g. for compensating temperature effects in the circuit.
The ceramic dielectric is defined by its rated temperature coefficient (α).

1.5.2.2 Sub-class

For a given rated temperature coefficient the sub-class is defined by the rated tolerance on the temperature coefficient (see Table III, Sub-clause 2.2.5.1).

Note. -The rated temperature coefficient value and its tolerance refer to the temperature interval of +20 °C to +85 °C, but because in practice TC curves are not strictly linear, it is necessary to define limiting capacitance deviations ($\Delta C/C$) for other temperatures (see Table IV, Sub-clause 2.2.5.2).

1.5.3 Fixed capacitors of ceramic dielectric, Class 2

1.5.3.1 A capacitor which has a dielectric with a high permittivity and is suitable for by-pass and coupling applications or for frequency discriminating circuits where low losses and high stability of capacitance are not of major importance. The ceramic dielectric is characterized by a non linear change of capacitance over the category temperature range (see Table V, Sub-clause 2.2.6).

1.5.3.2 Sub-class

The sub-class is defined by the maximum percentage change of capacitance within the category temperature range with respect to the capacitance at 20 °C.

The sub-class may be expressed in code form (see Table V in Sub-clause 2.2.6).

1.5.4 Rated voltage (U_R)

The rated voltage is the maximum d.c. voltage which may be applied continuously to a capacitor at the rated temperature.

Note. -The sum of the d.c. voltage and the peak a.c. voltage applied to the capacitor shall not exceed the rated voltage. The value of the peak a.c. voltage shall not exceed the value determined by the permissible reactive power.

1.6 Marking

Sub-clause 2.4 of IEC Publication 384-1, with the following details:

1.6.1 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) rated capacitance;
- b) rated voltage (d.c. voltage may be indicated by the symbol --- or ---);
- c) tolerance on rated capacitance;
- d) temperature coefficient and its tolerance (Class 1) or dielectric class (Class 2) as applicable (according to Sub-clauses 2.2.5 and 2.2.6);
- e) year and month (or week) of manufacture;
- f) manufacturer's name or trade mark;
- g) climatic category;
- h) manufacturer's type designation;
- i) reference to the detail specification.

1.6.2 Chip capacitors are generally not marked on the body. If some marking can be applied, they shall be clearly marked with as many as possible of the above items as is considered useful. Any duplication of information in the marking on the capacitor should be avoided.

- 1.6.3 Any marking shall be legible and not easily smeared or removed by rubbing with the finger.
- 1.6.4 The package containing the capacitor(s) shall be clearly marked with all the information listed in Sub-clause 1.6.1.
- 1.6.5 Any additional marking shall be so applied that no confusion can arise.

SECTION TWO - PREFERRED RATINGS AND CHARACTERISTICS

2. Preferred ratings and characteristics

2.1 Preferred characteristics

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

2.1.1 Preferred climatic categories

The chip capacitors covered by this specification 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 chosen from the following:

Lower category temperature: -55 °C, -40 °C, -25 °C, -10 °C and +10 °C.

Upper category temperature: +70 °C, +85 °C, +100 °C
and +125 °C.

Duration of the damp heat, steady state test: 4, 10, 21 and 56 days.

The severities for the cold and dry heat tests are the lower and upper category temperatures respectively.

Note. -The resistance to humidity resulting from the above climatic category is for the chip in its unmounted state. The climatic performance of the chip capacitor after mounting is greatly influenced by the mounting substrate, the mounting method (see Sub-clause 4.4) and the final coating.

2.2 Preferred values of ratings2.2.1 Rated temperature

For capacitors covered by this specification, the rated temperature is equal to the upper category temperature, unless the upper category temperature exceeds 125 °C.

2.2.2 Rated voltage (U_R)

The preferred values of rated voltage are the values of the R5 series of ISO Standard 3. If other values are needed they shall be chosen from the R10 series.

2.2.3 Category voltage (U_C)

When the rated temperature is defined as the upper category temperature, the category voltage is equal to the rated voltage as defined in IEC Publication 384-1, Sub-clause 2.2.17.

2.2.4 Preferred values of rated capacitance and associated tolerance values2.2.4.1 Preferred values of rated capacitance

Rated capacitance values shall be taken from the series of IEC Publication 63; the E3, E6, E12 and E24 series are preferred.

2.2.4.2 Preferred tolerances on rated capacitance for Class 1 capacitors

TABLE I

Preferred series	Tolerances			
	$C_R \geq 10 \text{ pF}$	Letter code	$C_R < 10 \text{ pF}$	Letter code
E 6	$\pm 20\%$	M	$\pm 2 \text{ pF}$	G
E 12	$\pm 10\%$	K	$\pm 1 \text{ pF}$	F
E 24	$\pm 5\%$	J	$\pm 0.5 \text{ pF}$	D
	$\pm 2\%$	G	$\pm 0.25 \text{ pF}$	C
	$\pm 1\%$	F	$\pm 0.1 \text{ pF}$	B

2.2.4.3 Preferred tolerances on rated capacitance for Class 2 capacitorsTABLE II

Preferred series	Tolerances (%)	Letter code
E3 and E6	-20/+80	Z
	-20/+50	S
E6	±20	M
E6 and E12	±10	K

2.2.5 Temperature coefficient (α)Class 1 capacitors

- 2.2.5.1 Table III shows the preferred rated temperature coefficients and the associated tolerances, expressed in parts per million per degree Celsius ($10^{-6}/^{\circ}\text{C}$), and the corresponding sub-classes and codes.

The detail specification shall specify for each temperature coefficient the minimum value of capacitance for which the given tolerance of temperature coefficient may be verified, considering the accuracy of the methods of capacitance measurement specified.

For values of capacitance lower than this minimum value:

- The detail specification shall specify a multiplying factor for the tolerance on α , as well as the permissible changes of capacitance at the lower and upper category temperature.
- Special methods of measurement may be necessary and if required shall be stated in the detail specification.

TABLE III

Rated temperature coefficient ($10^{-6}/^{\circ}\text{C}$)	Tolerance on temperature coefficient ($10^{-6}/^{\circ}\text{C}$)	Sub-class	Letter code for	
			α	Tolerance
+100	± 30	1B	A	G
<u>0</u>	± 30	1B	C	G
-33	± 30	1B	H	G
-75	± 30	1B	L	G
<u>-150</u>	± 30	1B	P	G
-220	± 30	1B	R	G
-330	± 60	1B	S	H
-470	± 60	1B	T	H
<u>-750</u>	± 120	1B	U	J
-1 000	± 250	1F	Q	K
-1 500	± 250	1F	V	K
$+140 \geq \alpha \geq -1\ 000$	4)	1C	SL	-
$+250 \geq \alpha \geq -1\ 750$	4)	1D	UM	-

Notes 1. -Preferred temperature coefficients (α) are underlined.

2. -The rated temperature coefficients and their tolerances are defined using the capacitance change between the temperatures 20°C and 85°C .

3. -A capacitor with a temperature coefficient $0.10^{-6}/^{\circ}\text{C}$ and a tolerance on T.C. of $\pm 30.10^{-6}/^{\circ}\text{C}$ is designated as a CG capacitor (Sub-class 1B).

4. -Those temperature coefficient values are not subject to inspection, since no limits for relative capacitance variation are specified in Table IV.

2.2.5.2 Table IV shows for each combination of temperature coefficient and tolerance the permissible relative variation of capacitance expressed in parts per thousand at each of the upper and lower category temperatures. Temperature coefficients and tolerances are expressed in parts per million per degree Celsius ($10^{-6}/^{\circ}\text{C}$).

TABLE IV

		Permissible relative variation in capacitance in parts per 1 000 between 20 °C and given temperature									
		Lower category temperature					Upper category temperature				
α 10 ⁻⁶ /°C	Tolerance 10 ⁻⁶ /°C	-55 °C	-40 °C	-25 °C	-10 °C	+70 °C	+85 °C	+100 °C	+125 °C		
+100	±30 (G)	-9.75/4.10	-7.80/-3.38	-5.85/-2.61	-3.90/-1.79	3.42/6.50	4.55/8.45	5.60/10.4	7.35/13.5		
<u>0</u>	±30 (G)	-2.25/4.05	-1.80/3.09	-1.35/2.20	-0.90/1.39	-1.63/1.50	-1.95/1.95	-2.40/2.42	-3.15/3.23		
-33	±30 (G)	0.225/7.05	0.180/5.44	0.135/3.93	0.090/2.52	-3.32/-0.15	-4.10/-0.195	-5.04/-0.233	-6.62/-0.29		
-75	±30 (G)	3.38/11.5	2.70/8.89	2.03/6.43	1.35/4.13	-5.51/-2.25	-6.83/-2.93	-8.40/-3.47	-11.0/-4.25		
<u>-150</u>	±30 (G)	9.00/18.2	7.20/14.1	5.40/10.3	3.60/6.66	-9.33/-6.0	-11.7/-7.80	-14.4/-9.29	-18.9/-11.5		
-220	±30 (G)	14.3/24.5	11.4/19.1	8.58/14.0	5.72/9.07	-12.9/-9.54	-16.2/-12.4	-20.0/-14.9	-26.3/-18.9		
-330	±60 (H)	20.3/38.3	16.2/29.9	12.2/21.8	8.12/14.2	-20.2/-13.5	-25.4/-17.6	-31.2/-21.2	-41.4/-26.7		
-470	±60 (H)	30.8/51.2	24.6/40.0	18.5/29.3	12.3/19.0	-27.4/-20.5	-34.5/-26.7	-42.4/-32.1	-55.7/-40.5		
<u>-750</u>	±120 (J)	47.3/82.4	37.8/64.5	28.4/47.3	18.9/30.8	-45.0/-31.5	-56.6/-41.0	-69.6/-50.3	-91.4/-65.6		
-1 000	±250 (K)	56.3/117	45.0/91.7	33.8/67.2	22.5/43.8	-64.2/-37.5	-81.3/-48.8	-100/-60.0	-131/-78.8		
-1 500	±250 (K)	93.8/161	75.0/126	56.3/92.8	37.5/60.6	-89.8/-62.5	-114/-81.3	-140/-100	-184/-131		

Notes 1. -Preferred temperature coefficient values (α) are underlined.

2. -When the upper category temperature is above 125 °C, the limits shall be given in the detail specification.