

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Fixed capacitors for use in electronic equipment –
Part 22: Sectional specification – Fixed surface mount multilayer capacitors of
ceramic dielectric, Class 2**

**Condensateurs fixes utilisés dans les équipements électroniques –
Partie 22: Spécification intermédiaire – Condensateurs multicouches fixes à
diélectriques en céramique pour montage en surface, de Classe 2**

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ceramic dielectric, Class 2**

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CONTENTS

FOREWORD.....	6
1 Scope.....	8
2 Normative references	8
3 Terms and definitions	8
4 Preferred ratings and characteristics	9
4.1 Preferred characteristics	9
4.2 Preferred values of ratings.....	10
4.2.1 Rated temperature (T_R).....	10
4.2.2 Rated voltage (U_R).....	10
4.2.3 Category voltage (U_C).....	10
4.2.4 Preferred values of nominal capacitance and associated tolerance values.....	10
4.2.5 Temperature characteristic of capacitance.....	11
4.2.6 Dimensions.....	11
5 Test and measurement procedures.....	12
5.1 General.....	12
5.2 Special preconditioning.....	12
5.3 Measuring conditions.....	12
5.4 Mounting.....	12
5.5 Visual examination and check of dimensions.....	12
5.5.1 General	12
5.5.2 Visual examination	12
5.5.3 Requirements	12
5.6 Electrical tests	14
5.6.1 Capacitance	14
5.6.2 Tangent of loss angle ($\tan \delta$)	15
5.6.3 Insulation resistance.....	15
5.6.4 Voltage proof.....	16
5.6.5 Impedance (if required by the detail specification)	17
5.6.6 Equivalent series resistance [ESR] (if required by the detail specification)	17
5.7 Temperature characteristic of capacitance (reference temperature 20 °C).....	17
5.7.1 Special preconditioning.....	17
5.7.2 Measuring conditions.....	17
5.7.3 Requirements	18
5.8 Shear test.....	18
5.9 Substrate bending test.....	18
5.9.1 General	18
5.9.2 Initial measurement	19
5.9.3 Final inspection	19
5.10 Resistance to soldering heat.....	19
5.10.1 General	19
5.10.2 Special preconditioning.....	19
5.10.3 Initial measurement	19
5.10.4 Test conditions	19
5.10.5 Recovery	20

5.10.6	Final inspection, measurements and requirements.....	20
5.11	Solderability.....	21
5.11.1	General.....	21
5.11.2	Test conditions.....	21
5.11.3	Recovery.....	22
5.11.4	Final inspection, measurements and requirements.....	22
5.12	Rapid change of temperature.....	22
5.12.1	General.....	22
5.12.2	Special preconditioning.....	22
5.12.3	Initial measurement.....	22
5.12.4	Number of cycles.....	22
5.12.5	Recovery.....	22
5.12.6	Final inspection, measurements and requirements.....	23
5.13	Climatic sequence.....	23
5.13.1	General.....	23
5.13.2	Special preconditioning.....	23
5.13.3	Initial measurement.....	23
5.13.4	Dry heat.....	23
5.13.5	Damp heat, cyclic, Test Db, first cycle.....	23
5.13.6	Cold.....	23
5.13.7	Damp heat, cyclic, Test Db, remaining cycles.....	24
5.13.8	Final inspection, measurements and requirements.....	24
5.14	Damp heat, steady state.....	25
5.14.1	General.....	25
5.14.2	Special preconditioning.....	25
5.14.3	Initial measurement.....	25
5.14.4	Test conditions.....	25
5.14.5	Recovery.....	26
5.14.6	Final inspection, measurements and requirements.....	26
5.15	Endurance.....	27
5.15.1	General.....	27
5.15.2	Special preconditioning.....	27
5.15.3	Initial measurement.....	27
5.15.4	Test conditions.....	27
5.15.5	Recovery.....	28
5.15.6	Final inspection, measurements and requirements.....	28
5.16	Robustness of terminations (only for capacitors with strip termination).....	28
5.16.1	General.....	28
5.16.2	Test conditions.....	28
5.16.3	Final inspection and requirements.....	28
5.17	Component solvent resistance (if required).....	29
5.18	Solvent resistance of the marking (if required).....	29
5.19	Accelerated damp heat, steady state (if required).....	29
5.19.1	General.....	29
5.19.2	Initial measurement.....	29
5.19.3	Conditioning.....	29
5.19.4	Recovery.....	30
5.19.5	Final measurements.....	30
6	Marking.....	30

6.1	General.....	30
6.2	Information for marking	30
6.3	Marking on the body	30
6.4	Requirements for marking	30
6.5	Marking of the packaging	30
6.6	Additional marking	30
7	Information to be given in a detail specification.....	31
7.1	General.....	31
7.2	Outline drawing and dimensions	31
7.3	Mounting.....	31
7.4	Rating and characteristics.....	31
7.4.1	General	31
7.4.2	Nominal capacitance range.....	31
7.4.3	Particular characteristics	32
7.4.4	Soldering	32
7.5	Marking.....	32
8	Quality assessment procedures	32
8.1	Primary stage of manufacture	32
8.2	Structurally similar components	32
8.3	Certified records of released lots	32
8.4	Qualification approval	32
8.4.1	General	32
8.4.2	Qualification approval on the basis of the fixed sample size procedures	32
8.4.3	Tests	33
Annex A (normative) Guidance for the specification and coding of dimensions of fixed surface mount multilayer capacitors of ceramic dielectric, Class 2		38
Annex B (normative) Capacitance ageing of fixed capacitors of ceramic dielectric, Class 2		39
B.1	General.....	39
B.2	Law of capacitance ageing.....	39
B.3	Capacitance measurements and capacitance tolerance	40
B.4	Special preconditioning (see 5.2)	40
Annex C (normative) Temperature characteristics of capacitance of 25 °C.....		42
Annex D (normative) Quality conformance inspection		44
D.1	Formation of inspection lots	44
D.1.1	Groups A and B inspection	44
D.1.2	Group C inspection	44
D.2	Test schedule	44
D.3	Delayed delivery	44
D.4	Assessment levels	44
D.5	test schedule for quality conformance inspection	45
Annex X (informative) Cross-reference for reference to IEC 60384-22:2019.....		51
Bibliography.....		52
Figure 1 – Fault: crack or fissure.....		13
Figure 2 – Fault: crack or fissure.....		13
Figure 3 – Separation or delamination		13

Figure 4 – Exposed electrodes.....	13
Figure 5 – Principal faces	14
Figure 6 – Reflow temperature profile	20
Figure A.1 – Dimensions.....	38
Table 1 – Preferred values of category voltages	10
Table 2 – Preferred tolerances.....	11
Table 3 – Temperature characteristic of capacitance	11
Table 4 – Measuring conditions	14
Table 5 – Tangent of loss angle limits.....	15
Table 6 – Test voltages.....	16
Table 7 – Details of measuring conditions.....	18
Table 8 – Reflow temperature profiles for Sn-Ag-Cu alloy	20
Table 9 – Maximum capacitance change.....	21
Table 10 – Maximum capacitance change.....	23
Table 11 – Number of damp heat cycles	24
Table 12 – Final inspection, measurements and requirements	25
Table 13 – Test conditions for damp heat, steady state.....	26
Table 14 – Final inspection, measurements and requirements	26
Table 15 – Endurance test conditions ($U_C = U_R$).....	27
Table 16 – Endurance test conditions ($U_C \neq U_R$).....	27
Table 17 – Final inspection, measurements and requirements of endurance test	28
Table 18 – Initial requirements.....	29
Table 19 – Conditioning.....	29
Table 20 – Fixed sample size test plan for qualification approval Assessment level EZ.....	34
Table 21 – Test schedule for qualification approval.....	35
Table A.1 – Dimensions	38
Table C.1 – Temperature characteristics of capacitance	42
Table C.2 – Preferred values of the temperature characteristic of capacitance with and without a DC voltage applied	43
Table C.3 – Measuring conditions of temperature characteristic of capacitance for the reference temperature 25 °C.....	43
Table D.1 – Lot-by-lot inspection	45
Table D.2 – Periodic test.....	45
Table D.3 – Test schedule for quality conformance inspection (lot by lot).....	46
Table D.4 – Test schedule for quality conformance inspection (Periodic test)	47
Table X.1 – Reference to IEC 60384-22 for clause/subclause	51
Table X.2 – Reference to IEC 60384-22 for figure/table	51

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –**Part 22: Sectional specification –
Fixed surface mount multilayer capacitors of ceramic dielectric, Class 2**

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IEC 60384-22 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2019. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the document has been completely restructured to comply with the ISO/IEC Directives, Part 2 and to make it more useable; tables, figures and references have been revised accordingly; Annex X contains all cross-references of changes in clause/subclause numbers;

- b) the requirements of reference temperature 25 °C has been added in Table 5, Table 9, Table 10, Table 12, Table 14 and Table 17;
- c) the table of temperature characteristics of capacitance for the reference temperature 25 °C have been added in Table C.1, Table C.2 and Table C.3;
- d) the requirement in 5.5.2 (visual examination) has been repeated in 5.9.3, 5.10.6, 5.11.4, 5.12.6, 5.13.8, 5.14.6 and 5.15.6;
- e) the deflection D in the very robust designs has been added in 5.9.1;
- f) Annex C has been changed informative into normative;
- g) Clause D.5 (Test schedule for quality conformance inspection) has been newly added to withdraw the blank detail specification: IEC 60384-22-1.

The text of this International Standard is based on the following documents:

Draft	Report on voting
40/3120/FDIS	40/3139/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60384 series, published under the general title *Fixed capacitors for use in electronic equipment*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 22: Sectional specification – Fixed surface mount multilayer capacitors of ceramic dielectric, Class 2

1 Scope

This part of IEC 60384 is applicable to fixed unencapsulated surface mount multilayer capacitors of ceramic dielectric, Class 2, for use in electronic equipment. These capacitors have metallized connecting pads or soldering strips and are intended to be mounted on printed boards, or directly onto substrates for hybrid circuits.

Capacitors for electromagnetic interference suppression are not included but are covered by IEC 60384-14.

The object of this document is to specify preferred ratings and characteristics and to select from IEC 60384-1:2021 the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of capacitor. Test severities and requirements specified in detail specifications referring to this document provide specific test severities and requirements of an equal or higher performance level. Further information on the conception of generic, sectional and detail specifications can be found in the Introduction of IEC 60384-1:2021.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-58, *Environmental testing – Part 2-58: Tests – Test Td – Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60384-1:2021, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*

IEC 61193-2:2007, *Quality assessment system – Part 2: Selection and use of sampling plans for inspection of electronic components and packages*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60384-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

surface mount multilayer capacitor

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

3.2

capacitor of ceramic dielectric, Class 2

capacitor that 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

Note 1 to entry: The ceramic dielectric is characterized by a non-linear change of capacitance over the category temperature range (see Table 3).

3.3

subclass

<Class 2> maximum percentage change of capacitance within the category temperature range with respect to the capacitance at the reference temperature 20 °C or 25 °C

Note 1 to entry: The subclass may be expressed in code form (see Table 3 and Annex C).

3.4

category temperature range

ambient temperature range for which the capacitor has been designed to operate continuously

Note 1 to entry: This is given by the lower and upper category temperature (see Table 3 and Annex C).

3.5

rated temperature

T_R

maximum ambient temperature at which the rated voltage can be continuously applied

3.6

rated voltage

U_R

maximum DC voltage that can be applied continuously to a capacitor at any temperature between the lower category temperature and the rated temperature

Note 1 to entry: The maximum DC voltage is the sum of the DC voltage and peak AC voltage or peak pulse voltage applied to the capacitor.

3.7

category voltage

U_C

maximum voltage that can be applied continuously to a capacitor at its upper category temperature

4 Preferred ratings and characteristics

4.1 Preferred characteristics

Preferred climatic categories only shall be given in the preferred characteristics.

The capacitors covered by this document are classified into climatic categories in accordance with the general rules given in IEC 60068-1:2013, Annex A.

For reference temperature 20 °C, 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, +125 °C and +150 °C;
- duration of the damp heat, steady state test (40 °C, 93 % RH): 4, 10, 21 and 56 days.

For reference temperature 25 °C, the lower and upper category temperatures shall be chosen from Table C.1 in Annex C.

The severities of 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 capacitors in their unmounted state. The climatic performance of the capacitors after mounting is greatly influenced by the mounting substrate, the mounting method (see 5.4) and the final coating.

4.2 Preferred values of ratings

4.2.1 Rated temperature (T_R)

The rated temperature is equal to the upper category temperature for capacitors with the upper category temperature not exceeding 125 °C, unless otherwise stated in the detail specification.

4.2.2 Rated voltage (U_R)

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

The sum of the DC voltage and the peak AC voltage or the peak-to-peak AC voltage, whichever is the greater, applied to the capacitor shall not exceed the rated voltage.

4.2.3 Category voltage (U_C)

The category voltage is equal to the rated voltage for capacitors with the upper category temperature not exceeding 125 °C. Any category voltages which are different from the rated voltage, for capacitors with the upper category temperature exceeding 125 °C or for high-voltage capacitors with rated voltages about 500 V, shall be given in the detail specification.

The preferred values of the category voltage at 125 °C upper category temperature for high volumetric capacitors with a rated voltage of 16 V and less and a rated temperature of 85 °C are given in Table 1.

Table 1 – Preferred values of category voltages

U_R V	2,5	4	6,3	10	16
U_C V	1,6	2,5	4	6,3	10
NOTE The numeric values of U_C are calculated by the following: $U_C = 0,63 \times U_R$					

4.2.4 Preferred values of nominal capacitance and associated tolerance values

4.2.4.1 Preferred values of nominal capacitance

Nominal capacitance values should be taken from the E3, E6 and E12 series given in IEC 60063.

4.2.4.2 Preferred tolerances on nominal capacitance

See Table 2.

Table 2 – Preferred tolerances

Preferred series	Tolerance %	Letter code
E3 and E6	–20/+80	Z
	–20/+50	S
E6	± 20	M
E6 and E12	± 10	K

4.2.5 Temperature characteristic of capacitance

Table 3 shows the temperature characteristic with and without DC voltage applied for the reference temperature 20 °C. The method of coding the subclass is also given; for example a dielectric with a percentage change of ±20 % without DC voltage applied over the temperature range from –55 °C to +125 °C will be defined as a dielectric of subclass 2C1. The temperature characteristics, category temperatures and corresponding codes for the reference temperature 25 °C are given in Annex C. The temperature range for which the temperature characteristic of the dielectric is defined is the same as the category temperature range.

Table 3 – Temperature characteristic of capacitance

Sub-class letter code	Maximum capacitance change within the category temperature range with respect to the capacitance at 20 °C measured with and without a DC voltage applied		Category temperature range and corresponding number code					
			–55/+150	–55/+125	–55/+85	–40/+85	–25/+85	+10/+85
	without DC voltage applied	with DC voltage applied ^a	°C	°C	°C	°C	°C	°C
2B	±10	Requirements specified in the detail specification	0	1	2	3	4	6
2C	±20							
2D	+20/–30							
2E	+22/–56							
2F	+30/–80							
2R	±15							
When the upper category temperature is above 125 °C, the limits of capacitance change, both with and without DC voltage applied, should be given in the detail specification.								
NOTE Annex C can be referred to for preferred values of the temperature characteristic for the reference temperature of 25 °C.								
^a DC voltage applied is either rated voltage or the voltage specified in the detail specification.								

4.2.6 Dimensions

Suggested rules for the specification and coding of dimensions are given in Annex A.

Specific dimensions shall be given in the detail specification.

5 Test and measurement procedures

5.1 General

This Clause 5 supplements the information given in IEC 60384-1:2021, Clause 5 to Clause 10.

5.2 Special preconditioning

Unless otherwise specified in the detail specification, the special preconditioning, when specified in this document before a test or a sequence of test, shall be carried out under the following conditions.

Exposure at upper category temperature or at such higher temperature as may be specified in the detail specification during 1 h, followed by recovery during (24 ± 1) h under standard atmospheric conditions for testing.

NOTE Capacitors lose capacitance continuously with time in accordance with a logarithmic law (this is called ageing). However, if the capacitor is heated to a temperature above the Curie point of its dielectric, then "de-ageing" takes place, i.e. the capacitance lost through "ageing" is regained, and "ageing" recommences from the time when the capacitor recools. The purpose of special preconditioning is to bring the capacitor to a defined state regardless of its previous history (see Clause B.4 for further information).

5.3 Measuring conditions

See IEC 60384-1:2021, 5.2.1.

5.4 Mounting

See IEC 60384-1:2021, 5.5.

5.5 Visual examination and check of dimensions

5.5.1 General

See IEC 60384-1:2021, 7.1, with the details of 5.5.2 and 5.5.3.

5.5.2 Visual examination

A visual examination shall be carried out with suitable equipment with approximately 10× magnification and lighting appropriate to the specimen under test and the quality level required. In case the specimen are very small components, the visual examination may be carried out with higher magnification.

The operator should have available facilities for incident or transmitted illumination as well as an appropriate measuring facility.

5.5.3 Requirements

5.5.3.1 General

Quantitative values for the requirements below may be given in the detail or in the manufacturer's specification.

5.5.3.2 Requirements for the ceramic

Requirements for the ceramic are as follows:

- a) Be free of cracks or fissures, except small damages on the surface, that do not deteriorate the performance of the capacitor (examples: see Figure 1 and Figure 2).