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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fixed capacitors for use in electronic equipment – Part 21: Sectional specification – Fixed surface mount multilayer capacitors of ceramic dielectric, Class 1

Condensateurs fixes utilisés dans les équipements électroniques – Partie 21: Spécification intermédiaire – Condensateurs multicouches fixes à diélectriques en céramique pour montage en surface, de Classe 1

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 21: Sectional specification – Fixed surface mount multilayer capacitors of ceramic dielectric, Class 1

FOREWORD

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9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60384-21 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This third edition cancels and replaces the second edition published in 2011. This edition constitutes a technical revision.

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

a) revision of the structure in accordance with ISO/IEC Directives, Part 2:2016 to the extent practicable, and for harmonizing with IEC 60384-22;

b) deletion of the description on the permissible reactive power in 6.2.2 because it is not appropriate for the purposes of this document;

c) the dimensions of 0201M in Annex A have been added.

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

FDIS	Report on voting
40/2639/FDIS	40/2651/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 21: Sectional specification – Fixed surface mount multilayer capacitors of ceramic dielectric, Class 1

1 Scope

This part of IEC 60384 is applicable to fixed unencapsulated surface mount multilayer capacitors of ceramic dielectric, Class 1, 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 prescribe preferred ratings and characteristics and to select from IEC 60384-1 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 are of equal or higher performance levels; lower performance levels are not permitted.

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 60063, *Preferred number series for resistors and capacitors*

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-58:2015, *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 60068-2-58:2015/AMD1:2017

IEC 60384-1:2016, *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*

ISO 3:1973, *Preferred numbers – Series of preferred numbers*

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 terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://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 1
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, for example for compensating temperature effects in the circuit

Note 1 to entry: The ceramic dielectric is defined by its nominal temperature coefficient (α).

3.3
subclass
for a given nominal temperature coefficient, the subclass is defined by the tolerance on the temperature coefficient

Note 1 to entry: See Table 2.

Note 2 to entry: The nominal 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 deviation ($\Delta C/C$) for other temperatures (see Table 3).

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.

3.5
rated temperature
T_R
maximum ambient temperature at which the rated voltage may be continuously applied

3.6
rated voltage
U_R
maximum DC voltage that may 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 Information to be given in a detail specification

4.1 General

The detail specification 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 1.9 of the detail specification and indicated in the test schedules, for example by an asterisk.

The information given in 4.2 may be presented in tabular form if more convenient.

The information in 4.2 to 4.5 shall be given in each detail specification and the values quoted should be selected from those given in the appropriate clause of this sectional specification.

4.2 Outline drawing and dimensions

There shall be an illustration of the capacitors as an aid to easy recognition and for comparison of the capacitors with others.

Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall 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 capacitors.

4.3 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 8.4 of this sectional specification.

4.4 Rating and characteristics

4.4.1 General

The ratings and characteristics shall be in accordance with the relevant clauses of this sectional specification, together with 4.4.2, 4.4.3 and 4.4.4.

4.4.2 Nominal capacitance range

See 6.2.4.1.

When products approved to the detail specification have different ranges, the following statement should be added: "The range of capacitance values available in each voltage range is given in the register of approvals, available for example on the IECQ on-line certificate system website: www.iecq.org".

4.4.3 Particular characteristics

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

4.4.4 Soldering

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

4.5 Marking

The detail specification shall specify the content of the marking on the capacitor and on the packaging. Deviations from Clause 5 of this sectional specification shall be specifically stated.

5 Marking

5.1 General

See IEC 60384-1:2016, 2.4, with the details of 5.2 to 5.6.

5.2 Information for marking

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:

– nominal capacitance;
– rated voltage (DC voltage may be indicated by the symbol: ⎓ [IEC 60417-5031(2002-10)] or ⎓);
– tolerance on nominal capacitance;
– temperature coefficient and its tolerance as applicable (in accordance with 6.2.5);
– year and month (or week) of manufacture;
– manufacturer's name or trade mark;
– climatic category;
– manufacturer's type designation;
– reference to the detail specification.

5.3 Marking on the body

These 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 items stated in 5.2 as is considered useful. Any duplication of information in the marking on the capacitor should be avoided.

5.4 Requirements for marking

Any marking shall be legible and not easily smeared or removed by rubbing with fingers.

5.5 Marking of the packaging

The packaging containing the capacitor(s) shall be clearly marked with all the information listed in 5.2.

5.6 Additional marking

Any additional marking shall be so applied that no confusion can arise.

6 Preferred ratings and characteristics

6.1 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.

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.

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 8.4) and the final coating.

6.2 Preferred values of ratings

6.2.1 Rated temperature (T_R)

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

6.2.2 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.

6.2.3 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 60384-1:2016, 2.2.5. If the upper category temperature exceeds 125 °C, or the rated voltages exceed 500 V, the category voltage shall be given in the detail specification.

6.2.4 Preferred values of nominal capacitance and associated tolerance values

6.2.4.1 Preferred values of nominal capacitance

Nominal capacitance values shall be taken from the number series of IEC 60063; the E6, E12 and E24 series are preferred.

6.2.4.2 Preferred tolerances on nominal capacitance

See Table 1.

Table 1 – Preferred tolerances on nominal capacitance

Preferred series	Tolerance			
	$C_N \geq 10$ pF	Letter code	$C_N < 10$ pF	Letter code
E6	±20 %	M	±2 pF	G
E12	±10 %	K	±1 pF	F
E24	±5 %	J	±0,5 pF	D
	±2 %	G	±0,25 pF	C
	±1 %	F	±0,1 pF	B

6.2.5 Temperature coefficient (α)

6.2.5.1 Nominal temperature coefficient and tolerance

Table 2 shows the preferred nominal temperature coefficients and the associated tolerances, expressed in parts per million per Kelvin (10^{-6}/K), and the corresponding subclasses and codes.

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

For values of capacitance lower than this minimum value:

a) 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;

b) special methods of measurement may be necessary and, if required, shall be stated in the detail specification.

Table 2 – Nominal temperature coefficient and tolerance

Nominal temperature coefficient(10^{-6}/K)	Tolerance on temperature coefficient(10^{-6}/K)	Subclass	Letter code for	
			α	Tolerance
+100	±30	1B	A	G
0	±30	1B	C	G
−33	±30	1B	H	G
−75	±30	1B	L	G
−150	±30	1B	P	G
−220	±30	1B	R	G
−330	±60	1B	S	H
−470	±60	1B	T	H
−750	±120	1B	U	J
−1 000	±250	1F	Q	K
−1 500	±250	1F	V	K
+140 ≥ α ≥ −1 000	[a]	1C	SL	-

NOTE 1 Preferred temperature coefficients values (α) are underlined.

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

NOTE 3 A capacitor with a temperature coefficient 0 × 10^{-6}/K and a tolerance on temperature coefficient of ±30 × 10^{-6}/K is designated as a CG capacitor (subclass 1B).

[a] This temperature coefficient value is not subject to inspection, since no limits for relative capacitance variation are specified in Table 3.

NOTE See Annex B for the reference temperature of 25 °C as an informative guidance.

6.2.5.2 Permissible relative variation of capacitance

Table 3 shows for each combination of temperature coefficient and tolerance the permissible relative variation of capacitance expressed in parts per thousand at both the upper and lower category temperatures. Temperature coefficients and tolerances are expressed in parts per million per Kelvin (10^{-6}/K).