

INTERNATIONAL STANDARD



**Fixed capacitors for use in electronic equipment –
Part 8: Sectional specification – Fixed capacitors of ceramic dielectric, Class 1**



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**Fixed capacitors for use in electronic equipment –
Part 8: Sectional specification – Fixed capacitors of ceramic dielectric, Class 1**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

**Part 8: Sectional specification –
Fixed capacitors of ceramic dielectric, Class 1**

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60384-8:2015. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60384-8 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2015. 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 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- b) The terms have been replaced by the letter symbols in Table 3.
- c) Code of temperature coefficient and tolerance of C0G, U2J have been added in Table 4, Table 6, Table 8, Table 9, Table 11, Table 13, Table 16 and Annex B.
- d) Annex B has been changed from informative to normative.
- e) Clause C.5 (Test schedule for quality conformance inspection) has been newly added to withdraw the blank detail specification: IEC 60384-8-1.

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

Draft	Report on voting
40/3144/FDIS	40/3161/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.

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 8: Sectional specification – Fixed capacitors of ceramic dielectric, Class 1

~~1~~ **General**

~~1.1~~ **Scope**

This part of IEC 60384 is applicable to fixed capacitors of ceramic dielectric with a defined temperature coefficient (dielectric Class 1), intended for use in electronic equipment, including leadless capacitors but excluding fixed surface mount multilayer capacitors of ceramic dielectric, which are covered by IEC 60384-21 (Class 1).

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

~~1.2~~ **Object**

The object of this document is to ~~prescribe~~ specify preferred ratings and characteristics and to select from IEC 60384-1:20082021, 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~~ specified in detail specifications referring to ~~this sectional specification shall be of equal or higher performance level because lower performance levels are not permitted~~ 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 60063:1963, Preferred number series for resistors and capacitors–
IEC 60063:1963/AMD1:1967–
IEC 60063:1963/AMD2:1977~~

~~IEC 60068-1:2013, Environmental testing — Part 1: General and guidance~~

IEC 60384-1:20082021, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*

IEC 61193-2:2007, *Quality assessment systems – 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 ~~applicable~~ 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

~~fixed capacitors~~, 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).

3.2

subclass

~~for a given nominal temperature coefficient ; it is defined by the tolerance on the temperature coefficient (see Table 2)~~ <Class 1> tolerance on the temperature coefficient for a given nominal temperature coefficient (see Table 2)

Note 1 to entry: The nominal temperature coefficient value and its tolerance refer to the temperature interval of +20 °C or +25 °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 3 and Annex B). The same information is expressed in graphical form in Figure A.1 to Figure A.15.

Figure A.1 to Figure A.15 enable the user to form an estimate of the value and tolerance of $1/C \times (dC/dT)_T$, the incremental temperature coefficient at a given temperature T , though this quantity is not required specifically to be measured in the test.

3.3

rated voltage

U_R

maximum DC voltage that ~~may~~ can be applied continuously to the terminations of a capacitor at the rated temperature

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

~~[SOURCE: IEC 60384-1:2008, 2.2.25, modified (addition of "the terminations of")]~~

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 of 20 °C or 25 °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 and –10 °C
- upper category temperature: +70 °C, +85 °C, +100 °C and +125 °C

- duration of the damp heat, steady state test (40 °C, 93 % RH): 4 days, 10 days, 21 days and 56 days

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

4.2 Preferred values of ratings

4.2.1 Rated temperature

For capacitors covered by this document, the rated temperature is equal to the upper category temperature.

4.2.2 Rated voltage (U_R)

The preferred values of rated voltage are: (25, 40, 63, 100, 160, 250, 400, 630, 1 000, 1 600, 2 500, 4 000 and 6 300) V. These values conform to the basic series of preferred values R5 given in 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 applied to the capacitor ~~should~~ shall not exceed the rated voltage. ~~The value of the peak alternating voltage should not exceed the value determined by the permissible reactive power.~~

4.2.3 Category voltage (U_C)

Since the rated temperature is defined as the upper category temperature, the category voltage is equal to the rated voltage, as defined in IEC 60384-1:20082021, 3.5.

4.2.4 Preferred values of nominal capacitance and associated tolerance values

4.2.4.1 Preferred values of ~~rated~~ nominal capacitance

Nominal capacitance values ~~shall~~ should be taken from the E6, E12 and E24 series given in IEC 60063 ~~preferably~~.

4.2.4.2 Preferred tolerances on nominal capacitance

Table 1 denotes the preferred values of tolerance on nominal capacitance.

Table 1 – Preferred tolerances on nominal capacitance

Preferred series	$C_N \geq 10 \text{ pF}$		$C_N < 10 \text{ pF}$	
	Tolerances	Letter code	Tolerances	Letter code
E 6	$\pm 20 \%$	M	$\pm 2 \text{ pF}$	G
E 12	$\pm 10 \%$	K	$\pm 1 \text{ pF}$	F
	$\pm 5 \%$	J	$\pm 0,5 \text{ pF}$	D
E 24	$\pm 2 \%$	G	$\pm 0,25 \text{ pF}$	C
	$\pm 1 \%$	F	$\pm 0,1 \text{ pF}$	B

4.2.5 Temperature coefficient (α)

4.2.5.1 Nominal temperature coefficient and tolerance

Table 2 shows the ~~preferred~~ nominal temperature coefficients for the reference temperature 20 °C and the associated tolerances, expressed in parts per million per Kelvin ($10^{-6}/\text{K}$), and the

corresponding subclasses and codes. Annex B contains the most used temperature coefficients for the reference temperature 25 °C.

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 these minimum values:

- 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~~ can be necessary and, if required, shall be stated in the detail specification.

**Table 2 – Nominal temperature coefficient and tolerance
for reference temperature 20 °C**

Nominal temperature coefficient (α) 10 ⁻⁶ /K	Tolerance on temperature coefficient 10 ⁻⁶ /K	Subclass	Letter code		Colour code for temperature coefficient
			α	Tolerance	
+100	±15 ±30	1A 1B	A	F G	Red +and Violet
0	±15 ±30 ±60	1A 1B 1F	C	F G H	Black
-33	±15 ±30	1A 1B	H	F G	Brown
-75	±15 ±30	1A 1B	L	F G	Red
-150	±15 ±30 ±60	1A 1B 1F	P	F G H	Orange
-220	±15 ±30 ±60	1A 1B 1F	R	F G H	Yellow
-330	±30 ±60	1A 1B	S	G H	Green
-470	±30 ±60	1A 1B	T	G H	Blue
-750	±60 ±120 ±250	1A 1B 1F	U	H J K	Violet
-1 000	±60 ±120 ±250	1A 1B 1F	Q	H J K	Red and Yellow
-1 500	±250	1F	V	K	Orange and Orange
-2 200	±500	1F	K	L	Yellow and Orange
-3 300	±500	1F	D	L	Green and Orange
-4 700	±1 000	1F	E	M	Blue and Orange

–5 600	±1 000	1F	F	M	Black and Orange
$+140 \geq \alpha \geq -1\,000$	^a	1C	SL	-	Grey
$+250 \geq \alpha \geq -1\,750$	^a	1D	UM	-	White

NOTE 1—~~Preferred temperature coefficient values (α) are underlined.~~

NOTE 2— α values $+33 \times 10^{-6}/\text{K}$ and $-47 \times 10^{-6}/\text{K}$ are also obtained on request.

NOTE 3—The nominal temperature coefficients and their tolerances are defined using the capacitance change between the temperatures 20 °C and 85 °C.

NOTE 4—A capacitor with a temperature coefficient of $0 \times 10^{-6}/\text{K}$ and a tolerance on temperature coefficient of $\pm 30 \times 10^{-6}/\text{K}$ is designated as a CG capacitor (subclass 1B).

^a Those temperature coefficient values are not subject to inspection, since no limits for relative capacitance variation are specified in Table 3.

4.2.5.2 ~~Limits of~~ 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 ($10^{-6}/\text{K}$). In the case of reference temperature 25 °C, see Table B.1 for an explanation of the permissible relative variation of capacitance.

Figure A.1 to Figure A.15 show the limits of variation of capacitance with temperature for the temperature coefficients and subclasses listed in Table 3.

Table 3 – Combination of temperature coefficient and tolerance

Temperature coefficients		Permissible relative variation in capacitance in parts per 1 000 between 20 °C and a given temperature									
α 10 ⁻⁶ /K	Tol. ^a 10 ⁻⁶ /K	Lower category temperatures					Upper category temperatures				
		-55 °C	-40 °C	-25 °C	-10 °C	+70 °C	+85 °C	+100 °C	+125 °C		
+100	±15 (F)	-8,63/-5,08	-6,90/-4,06	-5,18/-3,05	-3,45/-2,03	4,25/5,75	5,53/7,48	6,80/9,20	8,93/12,1		
	±30 (G)	-9,75/-3,71	-7,80/-2,96	-5,85/-2,22	-3,90/-1,48	3,50/6,50	4,55/8,45	5,60/10,4	7,35/13,7		
0	±15 (F)	-1,13/4,07	-0,900/3,26	-0,675/2,44	-0,450/1,63	-0,750/0,750	-0,975/0,975	-1,20/1,20	-1,58/1,58		
	±30 (G)	-2,25/5,45	-1,80/4,36	-1,35/3,27	-0,900/2,18	-1,50/1,50	-1,95/1,95	-2,40/2,40	-3,15/3,15		
-33	±60 (H)	-4,50/8,19	-3,60/6,55	-2,70/4,91	-1,80/3,28	-3,00/3,00	-3,90/3,90	-4,80/4,80	-6,30/6,30		
	±15 (F)	1,35/7,09	1,08/5,67	0,810/4,26	0,540/2,84	-2,40/-0,900	-3,12/-1,17	-3,84/-1,44	-5,04/-1,89		
-75	±30 (G)	0,225/8,46	0,180/6,77	0,135/5,08	0,090/3,39	-3,15/-0,150	-4,10/-0,195	-5,04/0,240	-6,62/-0,315		
	±15 (F)	4,50/10,9	3,60/8,75	2,70/6,56	1,80/4,37	-4,50/-3,00	-5,85/-3,90	-7,20/-4,80	-9,45/-6,30		
-150	±30 (G)	3,38/12,3	2,70/9,85	2,03/7,38	1,35/4,92	-5,25/-2,25	-6,83/-2,93	-8,40/-3,60	-11,0/-4,73		
	±15 (F)	10,1/17,8	8,10/14,2	6,08/10,7	4,05/7,12	-8,25/-6,75	-10,7/-8,78	-13,2/-10,8	-17,3/-14,2		
-220	±30 (G)	9,00/19,2	7,20/15,3	5,40/11,5	3,60/7,67	-9,00/-6,00	-11,7/-7,80	-14,4/-9,60	-18,9/-12,6		
	±60 (H)	6,75/21,9	5,40/17,5	4,05/13,1	2,70/8,77	-10,5/-4,50	-13,7/-5,85	-16,8/-7,20	-22,1/-9,45		
-330	±15 (F)	15,4/24,2	12,3/19,4	9,23/14,5	6,15/9,68	-11,8/-10,3	-15,3/-13,3	-18,8/-16,4	-24,7/-21,5		
	±30 (G)	14,3/25,6	11,4/20,5	8,55/15,3	5,70/10,2	-12,5/-9,50	-16,3/-12,4	-20,0/-15,2	-26,3/-20,0		
-470	±60 (H)	12,0/28,3	9,60/22,7	7,20/17,0	4,80/11,3	-14,0/-8,00	-18,2/-10,4	-22,4/-12,8	-29,4/-16,8		
	±30 (G)	22,5/35,6	18,0/28,5	13,5/21,4	9,00/14,3	-18,0/-15,0	-23,4/-19,5	-28,8/-24,0	-37,8/-31,5		
-750	±60 (H)	20,3/38,4	16,2/30,7	12,2/23,0	8,10/15,4	-19,5/-13,5	-25,4/-17,6	-31,2/-21,6	-41,0/-28,4		
	±30 (G)	33,0/48,5	26,4/38,8	19,8/29,1	13,2/19,4	-25,0/-22,0	-32,5/-28,6	-40,0/-35,2	-52,5/-46,2		
	±60 (H)	30,8/51,2	24,6/41,0	18,5/30,7	12,3/20,5	-26,5/-20,5	-34,5/-26,7	-42,4/-32,8	-55,7/-43,1		
	±60 (H)	51,8/76,8	41,4/61,5	31,1/46,1	20,7/30,7	-40,5/-34,5	-52,7/-44,9	-64,8/-55,2	-85,1/-72,5		
	±120 (J)	47,3/82,3	37,8/65,8	28,4/49,4	18,9/32,9	-43,5/-31,5	-56,6/-41,0	-69,6/-50,4	-91,4/-66,2		
	±250 (K)	37,5/94,2	30,0/75,4	22,5/56,5	15,0/37,7	-50,0/-25,0	-65,0/-32,5	-80,0/-40,0	-105/-52,5		

Temperature coefficients		Permissible relative variation in capacitance in parts per 1 000 between 20 °C and a given temperature									
		Lower category temperatures					Upper category temperatures				
α 10 ⁻⁶ /K	Tol. ^a 10 ⁻⁶ /K	-55 °C	-40 °C	-25 °C	-10 °C	+70 °C	+85 °C	+100 °C	+125 °C		
-1 000	±60 (H) ±120 (J) ±250 (K)	70,5/99,7 66,0/105 56,3/117	56,4/79,8 52,8/84,1 45,0/93,7	42,3/59,8 39,6/63,1 33,8/70,2	28,2/39,9 26,4/42,1 22,5/46,8	-53,0/-47,0 -56,0/-44,0 -62,5/-37,5	-68,9/-61,1 -72,8/-57,2 -81,3/-48,8	-84,8/-75,2 -89,6/-70,4 -100/-60,0	-111/-98,7 -118/-92,4 -131/-78,8		
-1 500	±250 (K)	93,8/163	75,0/130	56,3/97,7	37,5/65,1	-87,5/-62,5	-114/-81,3	-140/-100	-184/-131		
-2 200	±500 (L)	128/250	102/200	76,5/150	51,0/99,9	-135/-85,0	-176/-111	-216/-136	-284/-179		
-3 300	±500 (L)	210/350	168/280	126/210	84,0/140	-190/-140	-247/-182	-304/-224	-399/-294		
-4 700	±1 000 (M)	278/524	222/419	167/315	111/210	-285/-185	-371/-241	-456/-296	-599/-389		
-5 600	±1 000 (M)	345/607	276/485	207/364	138/243	-330/-230	-429/-299	-528/-368	-693/-483		

Temperature coefficients		Permissible relative variation in capacitance in parts per 1 000 between 20 °C and a given temperature					
		Lower category temperatures			Upper category temperatures		
α 10 ⁻⁶ /K	Tol. ^a 10 ⁻⁶ /K	-55 °C	-40 °C	-25 °C	-10 °C	+70 °C	+85 °C +100 °C +125 °C

NOTE 1 — Preferred temperature coefficient (α) values are underlined.

NOTE 2 — The temperature coefficient limits at the temperature range from 20 °C to the upper category temperature are calculated by the nominal temperature coefficients and their tolerances (see NOTE 3, a)).
The temperature coefficient limits at the temperature range from 20 °C to -55 °C are calculated by NOTE 3, b) and c).

NOTE 3 — The capacitance deviation at the lower category temperature are obtained by using the following formula:

a) Upper and lower permissible relative variation in capacitance under upper category temperature:
 $\Delta C/C(10^{-3}) = (\text{nominal temperature coefficient} \pm \text{tolerance on temperature coefficient}) \times (\text{upper category temperature} - 20)/1\,000$

b) Lower permissible relative variation in capacitance under lower category temperature:
 $\Delta C/C(10^{-3}) = (\text{nominal temperature coefficient} + \text{tolerance on temperature coefficient}) \times (\text{lower category temperature} - 20)/1\,000$

c) Upper permissible relative variation in capacitance under lower category temperature:
 $\Delta C/C(10^{-3}) = [(-36) - (1,22 \times \text{tolerance on temp. coefficient}) + (0,22 \times \text{nominal temp. coefficient}) + \text{nominal temp. coefficient}]$
 $\times (\text{lower category temperature} - 20)/1\,000$

where “tolerance on temperature coefficient” is an absolute value.

Formulas for calculation of the permissible relative variation in capacitance:

Permissible relative variation in the temperature range from 20 °C to the upper category temperature:

$$\Delta C/C(10^{-3}) = (\alpha \pm |\delta|) \times (UCT - 20) / 1\,000 \tag{1}$$

Permissible relative variation in the temperature range from 20 °C to the lower category temperature:

a) lower permissible relative variation in capacitance from 20 °C to lower category temperature:

$$\Delta C/C(10^{-3}) = (\alpha \pm |\delta|) \times (LCT - 20) / 1\,000 \tag{2}$$

b) upper permissible relative variation in capacitance from 20 °C to lower category temperature:

$$\Delta C/C(10^{-3}) = [(-36) - (1,22 \times |\delta|) + (0,22 \times \alpha) + \alpha] \times (LCT - 20) / 1\,000 \tag{3}$$

α Temperature coefficient

δ Tolerance of α

LCT Lower category temperature

UCT Upper category temperature

5 Test and measurement procedures

5.1 General

This Clause 5 supplements the information given in IEC 60384-1:20082021, Clause ~~4~~ 5 to Clause 10.

5.2 Visual examination and check of dimensions

See IEC 60384-1:20082021, 7.1.

5.3 Electrical tests

5.3.1 Capacitance

5.3.1.1 General

See IEC 60384-1:20082021, 6.3, with the details of 5.3.1.2 and 5.3.1.3.

5.3.1.2 Measuring conditions

The capacitance shall be measured in accordance with the following details:

- Measuring voltage: ≤ 5 V RMS, unless otherwise specified in the detail specification;
- Frequency: $C_N \leq 1\,000$ pF, 1 MHz (± 20 %) or 100 kHz (± 20 %)
(referee frequency 1 MHz);
 $C_N > 1\,000$ pF, 1 kHz (± 20 %) or 100 kHz (± 20 %)
(referee frequency 1 kHz).

5.3.1.3 Requirements

The capacitance value shall correspond with the ~~rated~~ nominal value taking into account the specified tolerance.

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

5.3.2.1 General

See IEC 60384-1:20082021, 6.4, with the details of 5.3.2.2 and 5.3.2.3.

5.3.2.2 Measuring conditions

See 5.3.1.

5.3.2.3 Requirements

The tangent of loss angle shall not exceed the limits given in Table 4.

Table 4 – Tangent of loss angle

Nominal capacitance pF	Tangent of loss angle ($\tan \delta$) $\times 10^{-4}$				
	$+100 \geq \alpha > -750$ and SL (1C) C0G	$-750 \geq \alpha > -1\,500$ and UM (1D) U2J	$-1\,500 \geq \alpha > -3\,300$	$-3\,300 \geq \alpha > -5\,600$	$\alpha \leq -5\,600$
$C_N \geq 50$	15	20	30	40	50
$5 \leq C_N < 50$	$1,5 \times (150 / C_N + 7)$	$2 \times (150 / C_N + 7)$	$3 \times (150 / C_N + 7)$	$4 \times (150 / C_N + 7)$	$5 \times (150 / C_N + 7)$
$C_N < 5$	When the measurement is required by the user, the detail specification shall specify the limit.				

5.3.3 Insulation resistance (R_i)

5.3.3.1 General

See IEC 60384-1:2008/2021, 6.1, with the details of 5.3.3.2 and 5.3.3.3.

5.3.3.2 Measuring conditions

See IEC 60384-1:2008/2021, 6.1.2, with the following details:

For $U_R < 100$ V, the measuring voltage may be of any value not greater than U_R , the reference voltage being U_R .

The voltage shall be applied immediately at the specified value for $60 \text{ s} \pm 5 \text{ s}$ for qualification approval testing and periodic tests (Group C). For lot-by-lot testing (Group A), the test may be terminated in a shorter time, if the required value of insulation resistance is reached. The product of the internal resistance of the voltage source and the nominal capacitance of the capacitor shall not exceed 1 s unless otherwise ~~prescribed~~ specified in the detail specification.

The charge current shall not exceed 0,05 A.

The insulation resistance (R_i) shall be measured at the end of the 1 min period.

5.3.3.3 Requirements

The insulation resistance (R_i) shall meet the requirements given in Table 5.

Table 5 – Insulation resistance requirements

Style	Measuring points	$C_N \leq 10 \text{ nF}$	$C_N > 10 \text{ nF}$
		R_i	$R_i \times C_N$
Insulated	1a and 1c	$\geq 10\,000 \text{ M}\Omega$	$\geq 100 \text{ s}$
Non-insulated	1a		

5.3.4 Voltage proof

5.3.4.1 General

See IEC 60384-1:2008/2021, 6.2, with the details of 5.3.4.2 and 5.3.4.3.

5.3.4.2 Test conditions

The product of R_i and the nominal capacitance C_x shall be smaller than or equal to 1 s.

The charge current shall not exceed 0,05 A.

5.3.4.3 Test voltage

The test voltages in accordance with Table 6 and Table 7 shall be applied between the measuring points of IEC 60384-1:20082021, Table 3, for a period of 1 min for qualification approval testing and for a period of 1 s for the lot-by-lot quality conformance testing.

Table 6 – Test voltages for single layer ceramic capacitors

Rated voltage V	Test voltage V
≤ 500	$2,5 U_R$
> 500	$1,5 U_R + 500$
NOTE —The test voltage of $U_R > 500$ V in test C (external insulation) is $1,5 U_R + 500$ V or is in accordance with the requirements of the detail specification.	

Table 7 – Test voltages for leaded multilayer ceramic capacitors

Rated voltage V	Test voltage V
$U_R \leq 100$	$2,5 U_R$
$100 < U_R \leq 200$	$1,5 U_R + 100$
$200 < U_R \leq 500$	$1,3 U_R + 100$
$500 < U_R$	$1,3 U_R$

5.3.4.4 Requirement

There shall be no breakdown or flashover during the test.

5.4 Temperature coefficient (α) and temperature cyclic drift of capacitance

5.4.1 General

See IEC 60384-1:20082021, 6.8.3.2, with the details of 5.4.2 to 5.4.4.

5.4.2 Preliminary drying

The capacitors shall be dried in accordance with IEC 60384-1:20082021, 5.3, for 16 h to 24 h.

5.4.3 Measuring conditions

See IEC 60384-1:20082021, 6.8.1.2 and 6.8.1.3.

5.4.4 Requirements

The capacitance deviation at upper and lower category temperatures (and such other temperatures as may be specified in the detail specification) shall not exceed the limits given in Table 3.

The temperature cyclic drift shall not exceed the limits given in Table 8.

Table 8 – Temperature cyclic drift limits

α rated in $10^{-6}/K$	Requirements ^a
$+100 \geq \alpha > -150$ C0G	0,3 % or 0,05 pF
$-150 \geq \alpha > -1\ 500$ SL (1C) and UM (1D) U2J	1 % or 0,05 pF
$-1\ 500 \geq \alpha \geq -5\ 600$	2 % or 0,05 pF
^a Whichever is the greater.	

5.5 Robustness of terminations

See IEC 60384-1:20082021, 7.3.

5.6 Resistance to soldering heat

5.6.1 General

See IEC 60384-1:20082021, 9.1, with the details of 5.6.2 to 5.6.4.

5.6.2 Initial measurement

The capacitance shall be measured in accordance with 5.3.1.

5.6.3 Test conditions

There shall be no preliminary drying.

5.6.4 Final inspection, measurements and requirements

The capacitors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The capacitances shall be measured in accordance with 5.3.1, and the change shall not exceed the values in Table 9.

Table 9 – Requirements

α rated in $10^{-6}/K$	Requirements ^a
$+100 \geq \alpha \geq -750$ C0G and U2J	0,5 % or 0,5 pF
$-750 > \alpha \geq -1\ 500$ SL (1C) and UM (1D)	1 % or 1 pF
$\alpha < -1\ 500$	3 % or 1 pF
^a Whichever is the greater.	

5.7 Solderability

5.7.1 General

See IEC 60384-1:20082021, 9.2, with the details of 5.7.2 and 5.7.3.

5.7.2 Test conditions

There shall be no preliminary drying.

The requirements for the globule test method shall be ~~prescribed~~ specified in the detail specification. When neither the solder bath nor the solder globule method is appropriate, the soldering iron test shall be used with soldering iron size A.

5.7.3 Final inspection, measurements and requirements

The terminations shall be examined for good tinning as evidenced by free flowing of the solder with wetting of the terminations, or see the detail specification for the wetting balance method.

5.8 Rapid change of temperature (if required)

5.8.1 General

See IEC 60384-1:20082021, 8.1, with the details of 5.8.2 to 5.8.4.

5.8.2 Initial measurement

Initial measurements shall be carried out as ~~prescribed~~ specified in 5.3.1.

5.8.3 Test conditions

The number of cycles: 5.

Duration of exposure at the temperature limits: 30 min.

5.8.4 Recovery

The capacitors shall recover for 24 h $\pm$ 2 h.

5.9 Vibration

5.9.1 General

See IEC 60384-1:20082021, 7.4, with the details of 5.9.2 and 5.9.3.

5.9.2 Test conditions

The following degree of severity of test Fc applies:

- 0,75 mm displacement or 100 m/s², whichever is the lower amplitude, over one of the following frequency ranges: 10 Hz to 55 Hz, 10 Hz to 500 Hz, 10 Hz to 2 000 Hz.

The total duration of the test shall be 6 h.

The detail specification shall specify the frequency range and shall also ~~prescribe~~ specify the mounting method to be used. For capacitors with axial leads and intended to be mounted by the leads only, the distance between the body and the mounting point shall be 6 mm $\pm$ 1 mm.

5.9.3 Final inspection, measurements and requirements

The capacitors shall be visually examined. There shall be no visible damage.

5.10 Bump (repetitive shock)

5.10.1 General

See IEC 60384-1:20082021, 7.5, with the details of 5.10.2 to 5.10.4.

The detail specification shall state whether the bump (repetitive shock) or the non-repetitive shock test applies.

5.10.2 Initial measurements

Not required.

5.10.3 Test conditions

The detail specification shall state which of the following preferred severities applies:

Total number of bumps:	1 000	or	4 000
Acceleration:	400 m/s ²	or	100 m/s ²
Pulse duration:	6 ms		16 ms

The detail specification shall also ~~prescribe~~ specify the mounting method to be used. For capacitors with axial leads and intended to be mounted by the leads only, the distance between the body and the mounting point shall be 6 mm ± 1 mm.

5.10.4 Final inspection, measurements and requirements

The capacitors shall be visually examined and measured and shall meet the requirements given in 5.11.4.

5.11 Shock (non-repetitive shock)

5.11.1 General

See IEC 60384-1:20082021, 7.6, with the details of 5.11.2 to 5.11.4.

The detail specification shall state whether the bump (repetitive shock) or the non-repetitive shock test applies.

5.11.2 Initial measurements

Not required.

5.11.3 Test conditions

The detail specification shall state which of the preferred severities applies as stated in Table 10.

Pulse-shape: half-sine.

Table 10 – Preferred severities (of non-repetitive shock)

Peak acceleration m/s ²	Corresponding duration of the pulse ms
300	18
500	11
1 000	6

The detail specification shall also ~~prescribe~~ specify the mounting method to be used. For capacitors with axial leads and intended to be mounted by the leads only, the distance between the body and the mounting point shall be 6 mm ± 1 mm.

5.11.4 Final inspection, measurements and requirements

The capacitors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The capacitances shall be measured in accordance with 5.3.1, and the change shall not exceed the values in Table 11.

Table 11 – Maximum capacitance change

α rated in 10 ⁻⁶ /K	Requirements ^a
+100 ≥ α ≥ -750 C0G and U2J	0,5 % or 0,5 pF
-750 > α ≥ -1 500 SL (1C) and UM (1D)	1 % or 1 pF
α < -1 500	3 % or 1 pF
^a Whichever is the greater.	

5.12 Climatic sequence

5.12.1 General

See IEC 60384-1:20082021, 8.2, with the details of 5.12.2 to 5.12.6.

5.12.2 Initial measurements

Not required, see 5.6.4, 5.10.4, or 5.11.4 as applicable.

5.12.3 Dry heat

See IEC 60384-1:20082021, 8.2.3.

5.12.4 Damp heat, cyclic, Test Db, first cycle

See IEC 60384-1:20082021, 8.2.4.

5.12.5 Cold

See IEC 60384-1:20082021, 8.2.5, with the following details:

The capacitors shall be visually examined. There shall be no visible damage.

5.12.6 Low air pressure

5.12.6.1 General

See IEC 60384-1:20082021, 8.2.6, with the details of 5.12.6.2 to 5.12.6.4.

5.12.6.2 Test conditions

The test, if required in the detail specification, shall be made at a temperature of 15 °C to 35 °C and a pressure of 8 kPa. The duration of the test shall be 1 h.

5.12.6.3 Test procedures

Immediately after achieving the low pressure, U_R shall be applied for 1 min to 2 min.

5.12.6.4 Final inspection and requirements

The capacitors shall be visually examined. There shall be no visible damage.

5.12.7 Damp heat, cyclic, Test Db, remaining cycles

5.12.7.1 General

See IEC 60384-1:20082021, 8.2.7, with the details of 5.12.7.2 to 5.12.7.4.

5.12.7.2 Test conditions

The test conditions are shown in Table 12.

No voltage is applied.

Table 12 – Number of damp heat cycles

Category	Number of cycles of 24 h
-/-/56	5
-/-/21	1
-/-/10	1
-/-/04	0

5.12.7.3 Recovery

After 6 h to 24 h recovery, the capacitors shall be measured.

5.12.7.4 Final inspection, measurements and requirements

The capacitors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The capacitors shall be measured and shall meet the requirements in Table 13.

Table 13 – Final inspection, measurements and requirements

Measurement	Measuring conditions	α rated and (subclass)	Requirements
Capacitance	5.3.1	$+100 \geq \alpha \geq -750$ (1 A) C0G (1 B)	Capacitance change $\leq 2\%$ or 1 pF^a
		$+100 \geq \alpha \geq -750$ (1 F) SL (1 C) U2J	Capacitance change $\leq 3\%$ or 1 pF^a
		$-750 \geq \alpha \geq -1\,500$ (1 F) UM (1 D)	
		$-1\,500 > \alpha \geq -5\,600$ (1 F)	Capacitance change $\leq 5\%$ or 1 pF^a
Tangent of loss angle	5.3.2	All α s and subclasses	$\leq 2 \times$ value of 5.3.2.3
Insulation resistance	5.3.3	All α s and subclasses	$R_i \geq 2\,500\text{ M}\Omega$ or $R_i \times C_N \geq 25\text{ s}^b$
NOTE See 4.2.5 and Table B.1 for explanation of the subclass codes.			
^a Whichever is the greater.			
^b Whichever is the lesser.			

5.13 Damp heat, steady state

5.13.1 General

See IEC 60384-1:2008/2021, 8.3, with the details of 5.13.2 to 5.13.5.

5.13.2 Initial measurement

The capacitance shall be measured in accordance with 5.3.1.

5.13.3 Test conditions

No voltage is applied, unless otherwise specified in the detail specification.

The severity of the test should be selected from the test conditions as shown in Table 14 and as specified in the detail specification.

The duration time of the test should be selected in accordance with 4.1 and shall be specified in the detail specification.

Table 14 – Test conditions for damp heat, steady state

Severity	Temperature °C	Relative humidity %
1	$+85 \pm 2$	85 ± 3
2	$+60 \pm 2$	93 ± 3
3	$+40 \pm 2$	93 ± 3

When the application of voltage is ~~prescribed~~ specified, U_R shall be applied to one half of the sample and no voltage shall be applied to the other half of the sample.

Within 15 min after removal from the damp heat test, the voltage proof test in accordance with 5.3.4 shall be carried out, but with the rated voltage applied.

5.13.4 Recovery

After 6 h to 24 h recovery, the capacitors shall be measured. If they fail to meet the requirements, they may be measured again after a recovery period of 6 h to 24 h.

5.13.5 Final inspection, measurements and requirements

The capacitor shall be visually examined.

There shall be no visible damage and the marking shall be legible.

The capacitors shall be measured and shall meet the requirements in Table 15.

Table 15 – Final inspection, measurements and requirements

Measurement	Measuring conditions	α rated and (subclass)	Requirements
Capacitance	5.3.1	+100 $\geq \alpha \geq$ -750 (1 A) C0G (1 B)	Capacitance change $\leq 2\%$ or 1 pF ^a
		+100 $\geq \alpha \geq$ -750 (1 F) SL (1 C) U2J	Capacitance change $\leq 3\%$ or 1 pF ^a
		-750 $\geq \alpha \geq$ -1 500 (1 F) UM (1 D)	
		-1 500 $> \alpha \geq$ -5 600 (1 F)	Capacitance change $\leq 5\%$ or 1 pF ^a
Tangent of loss angle	5.3.2	All α s and subclasses	$\leq 2 \times$ value of 5.3.2.3
Insulation resistance	5.3.3	All α s and subclasses	$R_i \geq 2\,500\text{ M}\Omega$ or $R_i \times C_N \geq 25\text{ s}$ ^b
NOTE See 4.2.5 and Table B.1 for explanation of the subclass codes.			
^a Whichever is the greater.			
^b Whichever is the lesser.			

5.14 Endurance

5.14.1 General

See IEC 60384-1:2008/2021, 8.5, with the details of 5.14.2 to 5.14.5.

5.14.2 Initial measurement

The capacitance shall be measured in accordance with 5.3.1.

5.14.3 Test conditions

The capacitors shall be tested in accordance with Table 16.

Table 16 – Endurance test conditions

Type	Temperature	Rated voltage V	Test voltage V	Duration h
Leaded multilayer ceramic capacitors	Upper category temperature	$U_R \leq 200$	$1,5 U_R$	1 000
		$200 < U_R \leq 500$	$1,3 U_R$	1 500
		$500 < U_R$	$1,2 U_R$	2 000
Others	Upper category temperature	U_R	$1,5 U_R$	1 000

5.14.4 Recovery

The capacitors shall be subjected for 6 h to 24 h to the standard atmospheric conditions for testing.

5.14.5 Final inspection, measurements and requirements

The capacitor shall be visually examined. There shall be no visible damage and the marking shall be legible.

The capacitors shall be measured and shall meet the requirements in Table 17.

Table 17 – Final inspection, measurements and requirements

Measurement	Measuring conditions	α rated and (subclass)	Requirements
Capacitance	5.3.1	$+100 \geq \alpha \geq -750$ (1 A) C0G and U2J (1 B)	Capacitance change $\leq 3 \%$ or 1 pF^a
		$+100 \geq \alpha \geq -750$ (1 F) SL (1 C)	Capacitance change $\leq 5 \%$ or 1 pF^a
		$-750 \geq \alpha \geq -1\,500$ (1 F) UM (1 D)	
		$-1\,500 > \alpha \geq -5\,600$ (1 F)	Capacitance change $\leq 10 \%$ or 1 pF^a
Tangent of loss angle	5.3.2	All α s and subclasses	$\leq 1,5 \times$ value of 5.3.2.3
Insulation resistance	5.3.3	All α s and subclasses	$R_i \geq 4\,000 \text{ M}\Omega$ or $R_i \times C_N \geq 40 \text{ s}^b$
NOTE See 4.2.5 and Table B.1 for explanation of the subclass codes.			
^a Whichever is the greater.			
^b Whichever is the lesser.			

5.15 Component solvent resistance (if required)

See IEC 60384-1:2008/2021, 9.4.

5.16 Solvent resistance of the marking (if required)

See IEC 60384-1:2008/2021, 9.5.

6 Marking

6.1 General

See IEC 60384-1:20082021, 4.3, with the details of 6.2 to 6.6.

6.2 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:

- a) nominal capacitance;
- b) rated voltage (DC voltage may be indicated by the symbol: $\overline{\text{---}}$ [IEC 60417-5031(2002-10)] or ---);
- c) tolerance on nominal capacitance;
- d) temperature coefficient and, space permitting, its tolerance in code, see Table 2;
- 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.

Information required under item b) and d) may be given in code form under the manufacturer's, or national, type or style designation.

6.3 Marking for code of temperature coefficient

Coding of temperature coefficient is given in Table 2. In case of colour code spot, stripe or ring may be used; moreover, for temperature coefficients, where two colours are required, the second colour may be provided by the colour of the body or of the typographical marking.

6.4 Marking on the body

The capacitor shall be clearly marked with items a), b) and c) of 6.2 and with as many as possible of the remaining items as is considered necessary. Any duplication of information in the marking on the capacitor should be avoided.

6.5 Marking of the packaging

The packaging containing the capacitor(s) shall be clearly marked with all the information listed in 6.2.

6.6 Additional marking

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

7 Information to be given in a detail specification

7.1 General

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

The information given in 7.2 may for convenience, be presented in tabular form.

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

7.2 Outline drawing and dimensions

There shall be an illustration of the capacitor as an aid to easy recognition and for comparison of the 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 of the body, the width and height of the body and the wire spacing, or for cylindrical types, the body diameter, and the length and diameter of the terminations. When necessary, for example when a number of items (capacitance values/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. When the capacitor is not designed for use on printed boards, this shall be clearly stated in the detail specification.

7.3 Mounting

The detail specification shall specify the method of mounting to be applied for normal use and for the application of the vibration and the bump or shock tests. The design of the capacitor may be such that special mounting fixtures are required in its use. In this case, the detail specification shall describe the mounting fixtures and they shall be used in the application of the vibration and the bump or shock tests.

7.4 Ratings and characteristics

7.4.1 General

The ratings and characteristics shall be in accordance with the relevant clauses of this document, together with the provisions of 7.4.2 to 7.4.4.

7.4.2 Nominal capacitance range

~~See 2.2.4.1.~~

The nominal capacitance range shall be specified as described in 4.2.4.1.

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".

7.4.3 Particular characteristics

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

7.4.4 Soldering

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

7.5 Marking

The detail specification shall specify the content of the marking on the capacitor and on the packaging. Deviations from Clause 6 shall be specifically stated in the detail specification.

8 Quality assessment procedures

8.1 Primary stage of manufacture

For single layer capacitors, the primary stage of manufacture is the metallizing of the dielectric to form the electrode; for multilayer capacitors, it is the first common firing of the dielectric-electrode assembly.

8.2 Structurally similar components

Capacitors, considered as being structurally similar, are capacitors produced with similar processes and materials, though they ~~may~~ can be of different case sizes and values.

8.3 Certified test records of released lots

The information required in IEC 60384-1:20082021, Q.1.5, shall be made available when ~~prescribed~~ specified in the detail specification and when requested by a purchaser. After the endurance test the parameters for which variables information is required are the capacitance change, $\tan \delta$ and the insulation resistance.

8.4 Qualification approval

8.4.1 General

The procedures for qualification approval testing are given in IEC 60384-1:20082021, Clause Q.2.

The schedule to be used for qualification approval testing on the basis of lot-by-lot and periodic tests is given in Annex C. The procedure using a fixed sample size schedule is given in 8.4.2 and 8.4.3.

8.4.2 Qualification approval on the basis of the fixed sample size procedure

The fixed sample size procedure is described in IEC 60384-1:20082021, Q.2.4. The sample shall be representative of the range of capacitors for which approval is sought. This range may ~~or may not~~ be different from the complete range covered by the detail specification.

When approval is sought for one temperature coefficient only, the sample shall consist of specimens having the lowest and highest voltages, and for these voltages the lowest and highest capacitance values. When there are more than four rated voltages an intermediate voltage shall also be tested. Thus, for the approval of a range, testing is required of either four or six values (capacitance/voltage combinations) for each temperature coefficient. Where the total range consists of less than four values, the number of specimens to be tested shall be that required for four values. When approval is sought for more than one temperature coefficient, see 8.4.3.

Spare specimens are permitted as follows.

Two (for six values) or three (for four values) per value may be used as replacements for specimens which are non-conforming because of incidents not attributable to the manufacturer.

The numbers given in Group 0 assume that all groups are applicable. If this is not so, the numbers may be reduced accordingly.

When additional groups are introduced into the qualification approval test schedule, the number of specimens required for Group 0 shall be increased by the same number as that required for the additional groups.

Table 18 gives the number of samples to be tested in each group or subgroup together with the number of permissible non-conformances for qualification approval tests.

8.4.3 Tests

The complete series of tests specified in Table 18 and Table 19 are required for the approval of capacitors covered by one detail specification. The tests of each group shall be carried out in the order given.

The whole sample shall be subjected to the tests of Group 0 and then divided for the other groups.

Non-conforming specimens found during the tests of Group 0 shall not be used for the other groups.

"One non-conforming item" is counted when a capacitor has not satisfied the whole or a part of the tests of a group.

When approval is sought for more than one temperature coefficient at the same time, tests of Groups 1 and 2 shall be carried out on the smallest temperature coefficient, but the tests of Groups 3 and 4 shall be carried out on each individual temperature coefficient.

The approval is decided on an individual temperature coefficient basis in accordance with the permissible number of non-conforming items indicated in Table 18. In order to calculate the total actual non-conforming items for temperature coefficients other than the smallest, the non-conforming items in Group 1 and Group 2 for the smallest temperature coefficient are added to the non-conforming items in Group 3 and Group 4 for that particular temperature coefficient.

The approval is granted when the number of non-conforming items is zero.

Table 18 and Table 19 together form the fixed sample size test schedule. Table 18 includes the details for the sampling and permissible non-conforming items for the different tests or groups of tests. Table 19 together with the details of the test contained in Clause 5 gives a complete summary of test conditions and performance requirements and indicates where, for example for the test method or conditions of test, a choice ~~has to~~ shall be made in the detail specification.

The conditions of test and performance requirements for the fixed sample size test schedule shall be identical to those ~~prescribed~~ specified in the detail specification for quality conformance inspection.

Table 18 – Sampling plan together with numbers of permissible non-conforming items for qualification approval tests, assessment level EZ

Group No.	Test	Subclause of this document	Number of specimens n^b	Permissible number of non-conforming items c^d
0	Visual examination Dimensions Capacitance Tangent of loss angle Voltage proof Insulation resistance Spare specimens	5.2 5.2 5.3.1 5.3.2 5.3.4 5.3.3	108 8	0
1A	Robustness of terminations Resistance to soldering heat Component solvent resistance ^c	5.5 5.6 5.15	12	0
1B	Solderability Solvent resistance of the marking ^c Rapid change of temperature ^a Vibration Bump or shock ^a	5.7 5.16 5.8 5.9 5.10 or 5.11	24	0
1	Climatic sequence	5.12	36	0
2	Damp heat, steady state	5.13	24	0
3	Endurance	5.14	36	0
4	Temperature coefficient (α) and cyclic drift of capacitance	5.4	12	0
^a As required in the detail specification. ^b Capacitance/voltage combinations, see 8.4.2. ^c If required in the detail specification. ^d This is the acceptance number, and not exceeded for acceptance.				

Table 19 – Test schedule for qualification approval

Subclause number and test ^a	D or ND ^b	Conditions of test ^a	Number of specimens (n) and number of non-conforming items (c) ^c	Performance requirements ^a
Group 0 ~~4.2 — Visual examination~~ ~~4.2 — Dimensions (detail)~~ ~~4.3.1 — Capacitance~~ ~~4.3.2 — Tangent of loss angle (tan δ)~~ ~~4.3.3 — Insulation resistance~~ ~~4.3.4 — Voltage proof~~	ND	~~Frequency: ... MHz or kHz~~ ~~Frequency: ... MHz or kHz (see 4.3.1)~~ ~~See detail specification for the method~~ ~~See detail specification for the method~~	~~See Table 4~~ 	~~As in 4.2~~ ~~Legible marking and as specified in the detail specification~~ ~~See detail specification~~ ~~Within specified tolerance~~ ~~As in 4.3.2.3~~ ~~As in 4.3.3.3~~ ~~No breakdown or flashover~~
Group 1A ~~4.5 — Robustness of terminations~~ ~~4.6.2 — Initial measurements~~ ~~4.6 — Resistance to soldering heat~~ ~~4.6.4 — Final measurements~~ ~~4.15 — Component solvent resistance (if applicable)~~	D	~~Visual examination~~ ~~Capacitance~~ ~~No pre-drying~~ ~~See detail specification for the method~~ ~~Visual examination~~ ~~Capacitance~~ ~~Solvent: ...~~ ~~Solvent temp: ...~~ ~~Method 2~~ ~~Recovery: ...~~	~~See Table 4~~ 	~~No visible damage~~ ~~No visible damage~~ ~~Legible marking~~ ~~AC/C as in 4.6.4~~ ~~See detail specification~~

Table 5 (2 of 4)

Subclause number and test ^a	D or ND ^b	Conditions of test ^a	Number of specimens (<i>n</i>) and number of non-conforming items (<i>c</i>) ^c	Performance requirements ^a
Group 1B	D		See Table 4	
4.7 — Solderability		No pre-drying See detail specification for the method	↓	Good tinning as evidenced by free flowing of the solder with wetting of the terminations, or see the detail specification for wetting balance method
4.16 — Solvent resistance — of the marking (if applicable)		Solvent: ... Solvent temperature: ... Method 4 Rubbing material: cotton wool Recovery: ...		Legible marking
4.8.2 — Initial measurement		Capacitance		
4.8 — Rapid change of temperature		T_A = Lower category temperature T_B = Upper category temperature Five cycles Duration t_1 = 30 min Recovery: 24 h ± 2 h		
4.9 — Vibration		Visual examination For mounting method see detail specification Frequency range: from ... Hz to ... Hz Amplitude: 0,75 mm or acceleration 100 m/s ² (whichever is the less severe) Total duration: 6 h		No visible damage
4.9.3 — Intermediate inspection		Visual examination		No visible damage
4.10 — Bump (or shock, see 4.11)		For mounting method see detail specification Number of bumps: ... Acceleration: ... m/s ² Duration of pulse: ... ms		
4.11 — Shock (or bump, see 4.10)		For mounting method see detail specification Acceleration: ... m/s ² Duration of pulse: ... ms		
4.10.4 — Final measurements of 4.11.4		Visual examination		No visible damage Legible marking
		Capacitance		AC/C as in 4.11.4

Table 5 (3 of 4)

Subclause number and test ^a	D or ND ^b	Conditions of test ^a	Number of specimens (n) and number of non-conforming items (c) ^c	Performance requirements ^a
Group 1 ~~4.12 Climatic sequence~~ ~~4.12.3 Dry heat~~ ~~4.12.4 Damp heat, cyclic, Test Db, first cycle~~ ~~4.12.5 Cold~~ ~~4.12.6 Low air pressure (if required by the detail specification)~~ ~~4.12.6.4 Intermediate measurement~~ ~~4.12.7 Damp heat, cyclic, Test Db, remaining cycles~~ ~~4.12.7.4 Final measurements~~	D	~~Temperature: upper category temperature~~ ~~Duration: 16 h~~ ~~Temperature: lower category temperature~~ ~~Duration: 2 h~~ ~~Visual examination~~ ~~Air pressure: 8 kPa~~ ~~Visual examination~~ ~~Recovery: 6 h to 24 h~~ ~~Visual examination~~ ~~Capacitance~~ ~~Tangent of loss angle~~ ~~Insulation resistance~~	~~See Table 4~~ 	~~No visible damage~~ ~~No breakdown or flashover~~ ~~No visible damage~~ ~~Legible marking~~ ~~AC/C as in 4.12.7.4~~ ~~As in 4.12.7.4~~ ~~As in 4.12.7.4~~
Group 2 ~~4.13 Damp heat, steady state~~ ~~4.13.2 Initial measurements~~ ~~4.13.5 Final measurements~~	D	~~Capacitance~~ ~~Recovery: 6 h to 24 h~~ ~~Visual examination~~ ~~Capacitance~~ ~~Tangent of loss angle~~ ~~Insulation resistance~~	~~See Table 4~~ 	~~No visible damage~~ ~~Legible marking~~ ~~AC/C as in 4.13.5~~ ~~As in 4.13.5~~ ~~As in 4.13.5~~

Table 5 (4 of 4)

Subclause number and test ^a	D or ND ^b	Conditions of test ^a	Number of specimens (n) and number of non-conforming items (c) ^c	Performance requirements ^a
Group 3 ~~4.14 — Endurance~~ ~~4.14.2 — Initial measurements~~ ~~4.14.5 — Final measurements~~	D	~~Duration: — h~~ ~~Voltage: — V~~ ~~Capacitance~~ ~~Recovery: 6 h to 24 h~~ ~~Visual examination~~ ~~Capacitance~~ ~~Tangent of loss angle~~ ~~Insulation resistance~~	~~See Table 4~~ 	~~No visible damage~~ ~~Legible marking~~ ~~ΔC/C as in 4.14.5~~ ~~As in 4.14.5~~ ~~As in 4.14.5~~
Group 4 ~~4.4 — Temperature coefficient and cyclic drift~~	ND	~~Conditioning: pre-drying for 16 h to 24 h~~	~~See Table 4~~ 	~~ΔC/C as in 4.4.4~~
^a —Subclause numbers of test and performance requirements refer to Clause 4. ^b —In this table: D = destructive, ND = non-destructive. ^c —This is the acceptance number, and not exceeded for acceptance.				

Test ^a	Conditions of test ^a	D or ND ^b	<i>n</i> <i>c</i> (see Table 18)	Performance requirements ^a
GROUP 0		ND	See Table 18	
5.2 Visual examination				As in 5.2
5.2 Dimension (detail)				Legible marking and as specified in the detail specification See the detail specification
5.3.1 Capacitance	Frequency: ... Hz Measuring voltage: V RMS			Within specified tolerance
5.3.2 Tangent of loss angle ($\tan \delta$)	Frequency and measuring voltage same as in 5.3.1			As in 5.3.2.3
5.3.3 Insulation resistance	See detail specification for the method			As in 5.3.3.3
5.3.4 Voltage proof	See detail specification for the method			No breakdown or flashover
GROUP 1A		D	See Table 18	
5.5 Robustness of termination	Visual examination			No visible damage
5.6.2 Initial measurement	Capacitance			
5.6 Resistance to soldering heat	No pre-drying See detail specification for the method			
5.6.4 Final inspection, measurement and requirements	Visual examination			No visible damage Legible marking
5.15 Component solvent resistance (if applicable)	Capacitance Solvent: ... Solvent temperature: Method 2 Recovery: ...			$\Delta C/C$ as in 5.6.4 See detail specification

Test ^a	Conditions of test ^a	D or ND ^b	<i>n</i> <i>c</i> (see Table 18)	Performance requirements ^a
GROUP 1B		D	See Table 18	
5.7 Solderability	See detail specification for the method			Good tinning as evidenced by free flowing of the solder with wetting of the terminations, or see the detail specification for wetting balance method
5.16 Solvent resistance of the marking (if applicable)	Solvent: ... Solvent temperature... Method 1 Rubbing material: cotton wool Recovery: ...			Legible marking
5.8.2 Initial measurement	Capacitance			
5.8 Rapid change of temperature	T_A = Lower category temperature T_B = Upper category temperature Five cycles Duration t_1 = 30 min Recovery: 24 h $\pm$ 2 h Visual examination			No visible damage
5.9 Vibration	For mounting method see detail specification Frequency range: from ... Hz to ... Hz Amplitude: 0,75 mm or acceleration 100 m/s ² (whichever is the less severe) Total duration: 6 h			
5.9.3 Intermediate inspection	Visual examination			No visible damage
5.10 Bump (or shock, see 5.11)	For mounting method see detail specification Number of bumps: ... Acceleration: ... m/s ² Duration of pulse: ... ms			
5.11 Shock (or bump, see 5.10)	For mounting method see detail specification Acceleration: ... m/s ² Duration of pulse: ... ms			
5.10.4 or 5.11.4 Final inspection, measurements and requirements	Visual examination Capacitance			No visible damage Legible marking $\Delta C/C$ as in 5.11.4

Test ^a	Conditions of test ^a	D or ND ^b	<i>n</i> <i>c</i> (see Table 18)	Performance requirements ^a
GROUP 1		D	See Table 18	
5.12 Climatic sequence				
5.12.2 Initial measurement	Capacitance			
5.12.3 Dry heat	Temperature: upper category temperature Duration: 16 h			
5.12.4 Damp heat, cyclic, Test Db, first cycle				
5.12.5 Cold	Temperature: lower category temperature Duration: 2 h			
	Visual examination			No visible damage
5.12.6 Low air pressure (if required by the detail specification)	Air pressure: 8 kPa			
5.12.6.4 Final inspection and requirements	Visual examination			No breakdown or flashover
5.12.7 Damp heat, cyclic, Test Db, remaining cycles	Recovery: 6 h to 24 h			
5.12.7.4 Final inspection, measurement and requirements	Visual examination			No visible damage Legible marking
	Capacitance			$\Delta C/C$ as in 5.12.7.4
	Tangent of loss angle			As in 5.12.7.4
	Insulation resistance			As in 5.12.7.4
Group 2		D	See Table 18	
5.13 Damp heat, steady state				
5.13.2 Initial measurements	Capacitance Recovery: 6 h to 24 h			
5.13.5 Final inspection, measurements and requirements	Visual examination			No visible damage Legible marking
	Capacitance			$\Delta C/C$ as in 5.13.5
	Tangent of loss angle			As in 5.13.5
	Insulation resistance			As in 5.13.5
Group 3		D	See Table 18	
5.14 Endurance	Voltage: V Duration: h			
5.14.2 Initial measurement	Capacitance Recovery: 6 h to 24 h			
5.14.5 Final inspection, measurement and requirements	Visual examination			No visible damage Legible marking
	Capacitance			$\Delta C/C$ as in 5.14.5
	Tangent of loss angle			As in 5.14.5
	Insulation resistance			As in 5.14.5

Test ^a	Conditions of test ^a	D or ND ^b	<i>n</i> (see Table 18)	<i>c</i>	Performance requirements ^a
Group 4 5.4 Temperature coefficient (α) and cyclic drift	Conditioning pre-drying for 16 h to 24 h	ND	See Table 18		$\Delta C/C$ as in 5.4.4
^a Subclause numbers of test and performance requirements refer to Clause 5.					
^b In this table: D = destructive, ND= non-destructive.					

Annex A

(~~normative~~informative)

Figures with limits of variation of capacitance with temperature for certain temperature coefficients and classes

See Figure A.1 to Figure A.15.

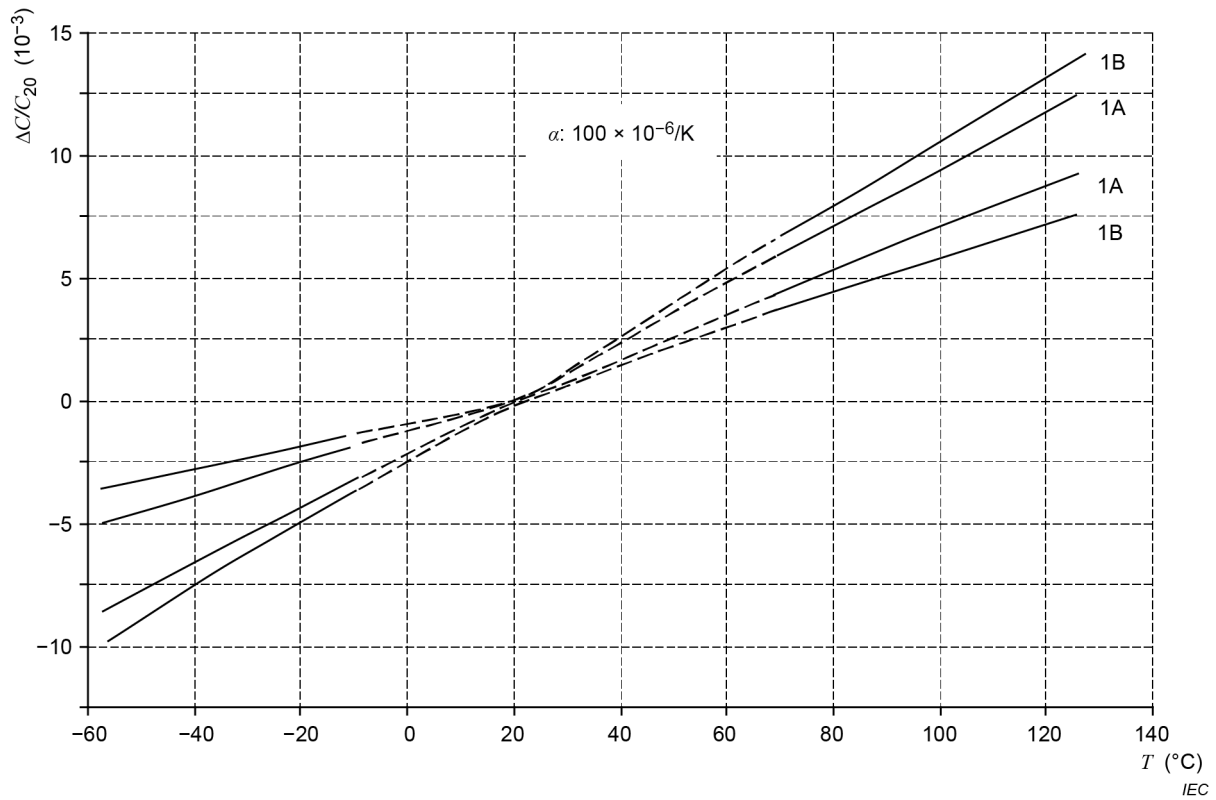
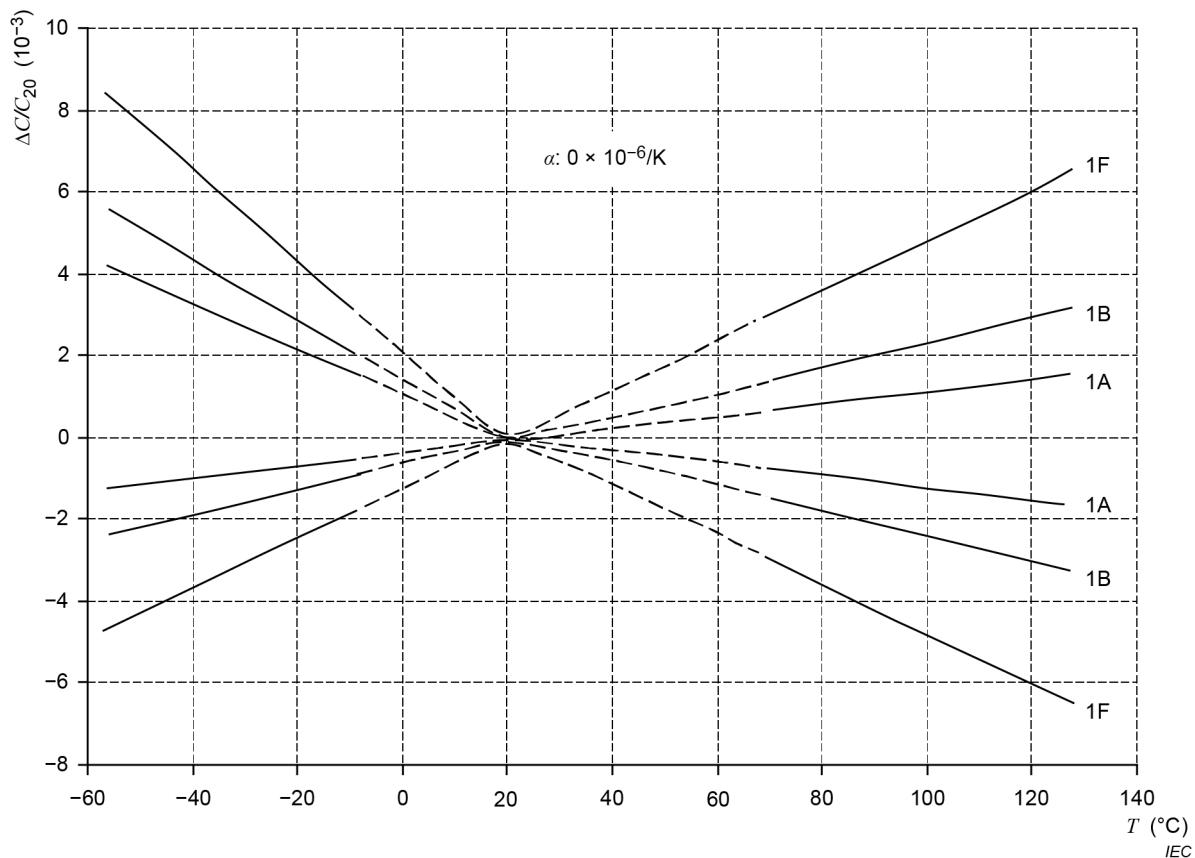
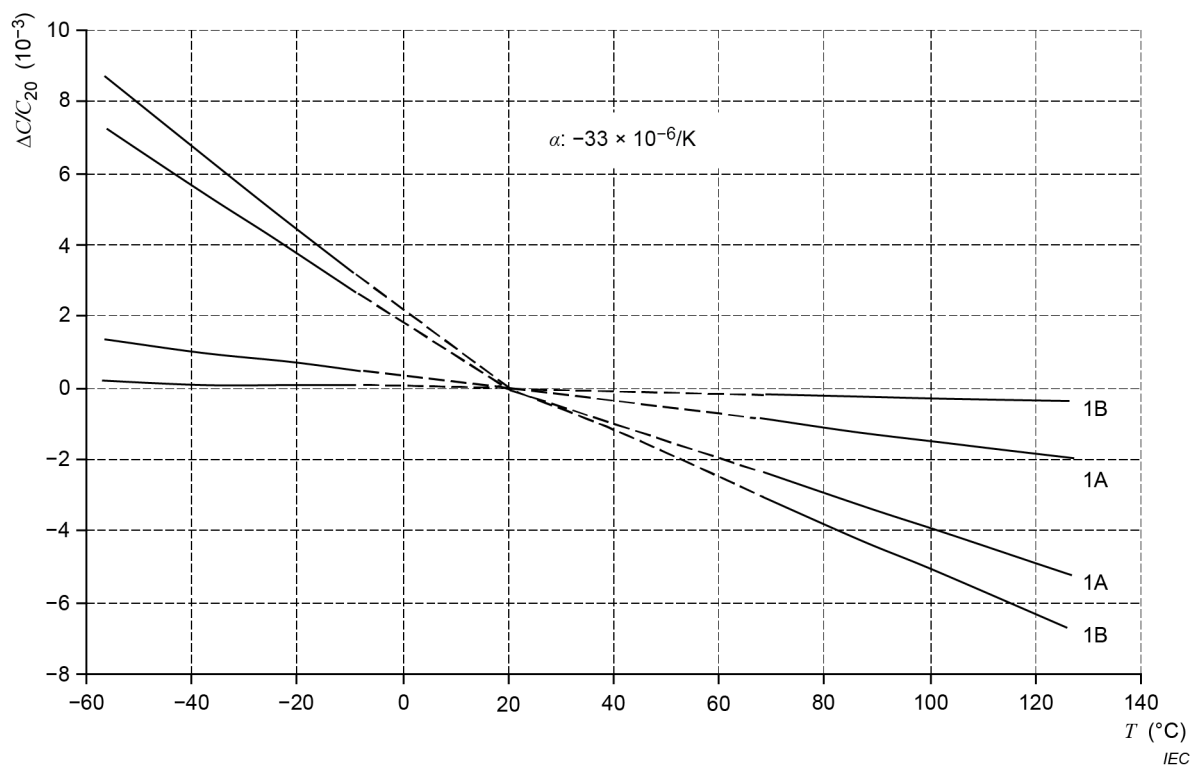


Figure A.1 – $\alpha: +100$ ($10^{-6}/\text{K}$)

Figure A.2 – $\alpha: 0$ ($10^{-6}/\text{K}$)Figure A.3 – $\alpha: -33$ ($10^{-6}/\text{K}$)

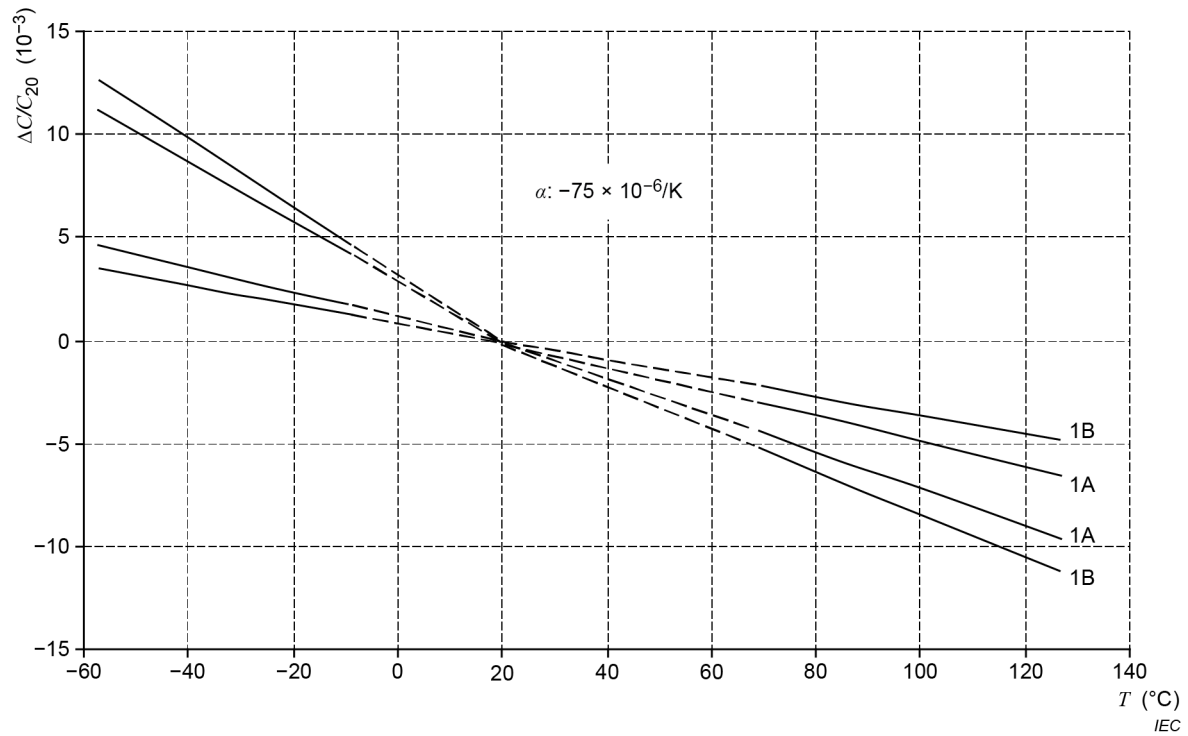


Figure A.4 – α : -75 ($10^{-6}/\text{K}$)

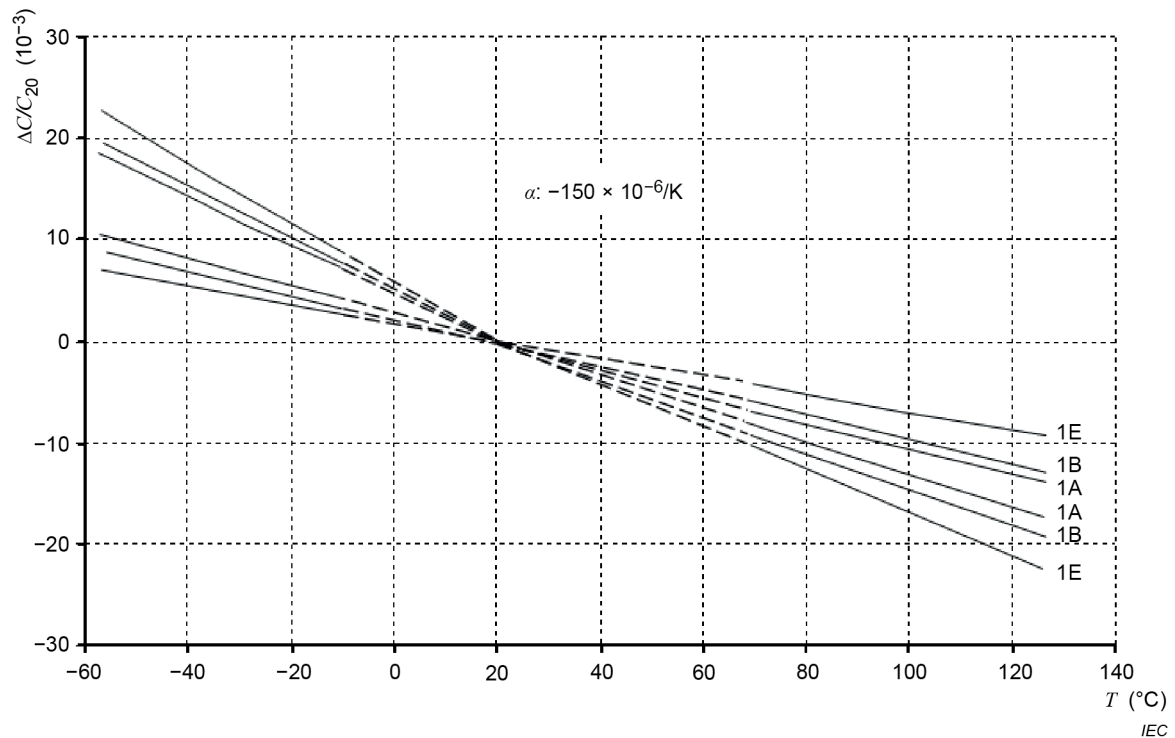


Figure A.5 – α : -150 ($10^{-6}/\text{K}$)

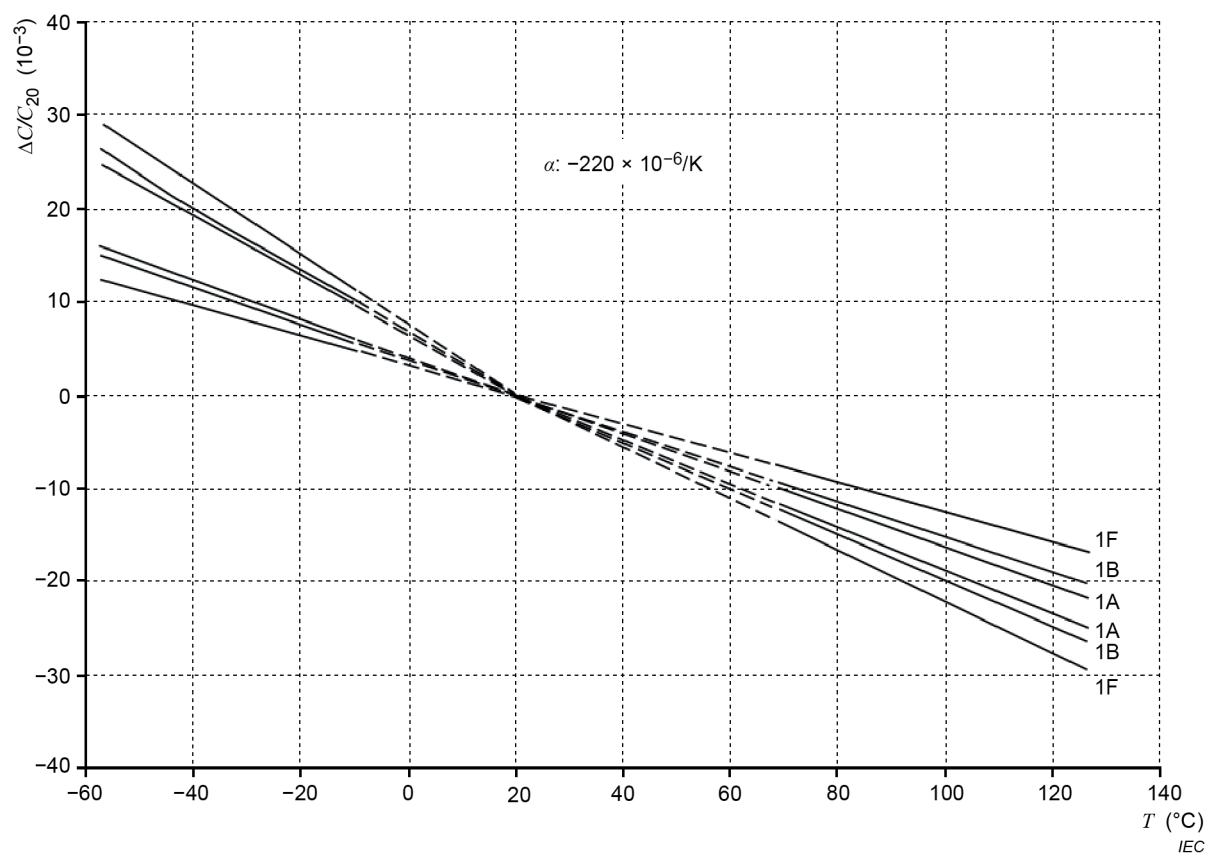


Figure A.6 – α : -220 ($10^{-6}/K$)

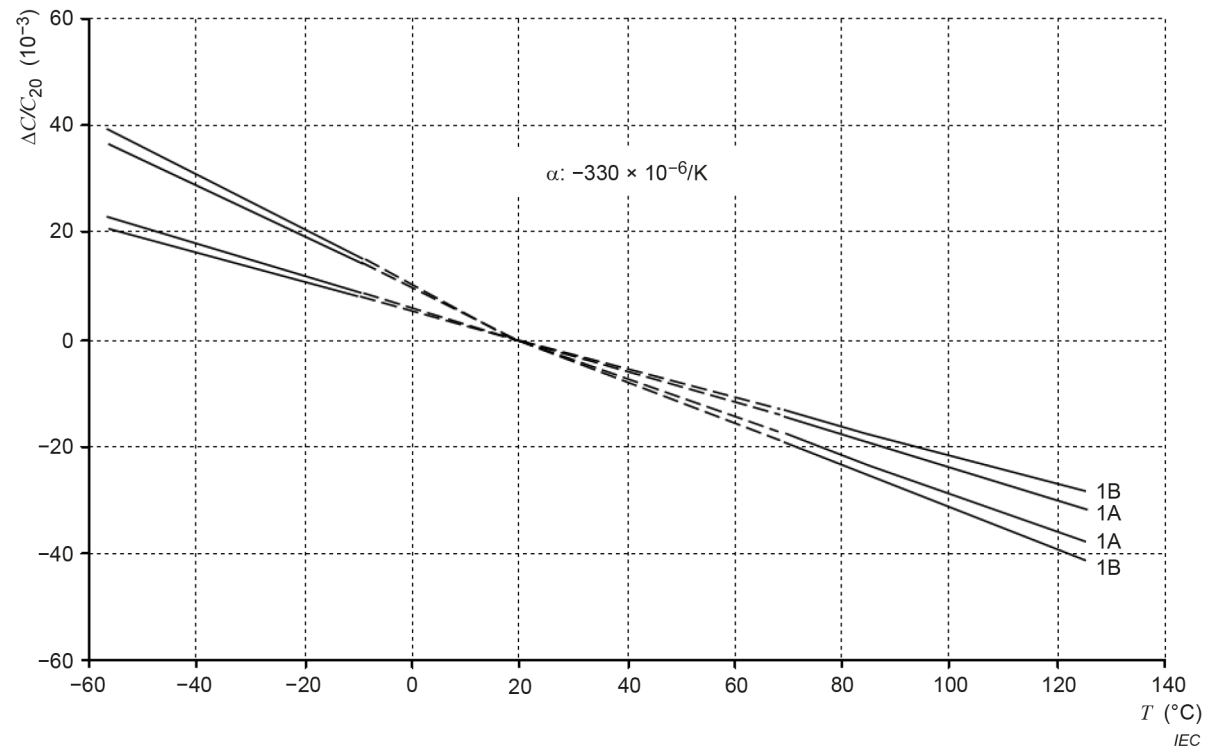


Figure A.7 – α : -330 ($10^{-6}/K$)

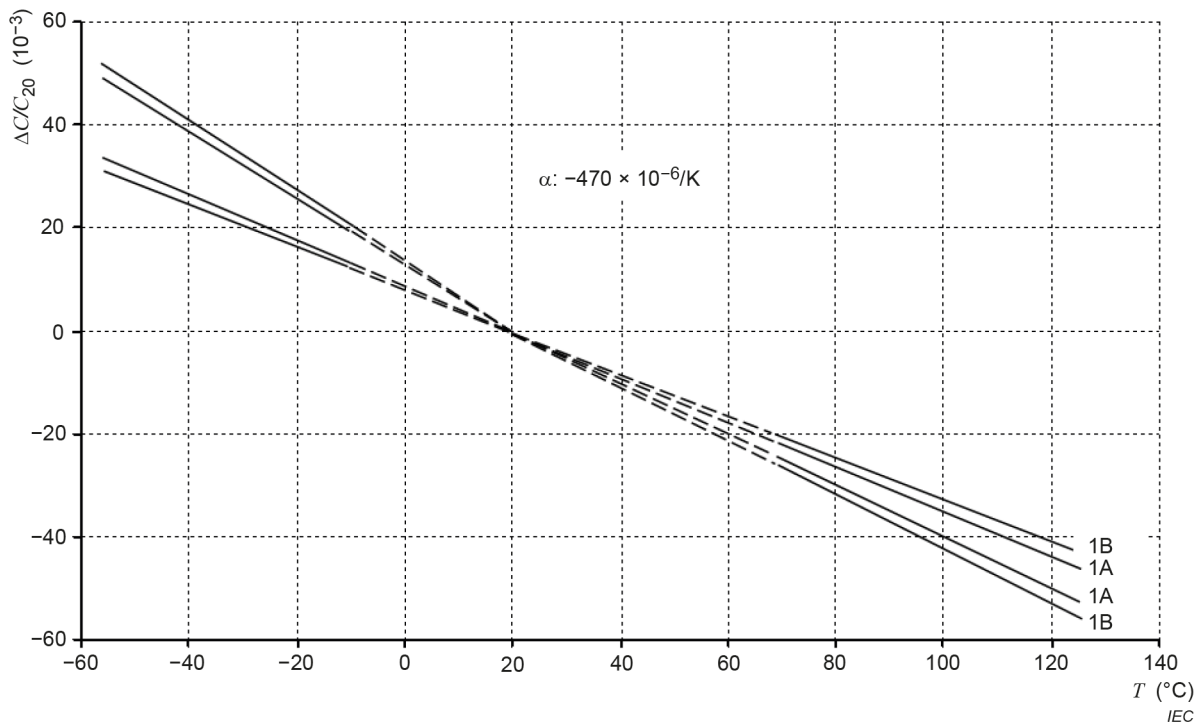


Figure A.8 – α : -470 ($10^{-6}/\text{K}$)

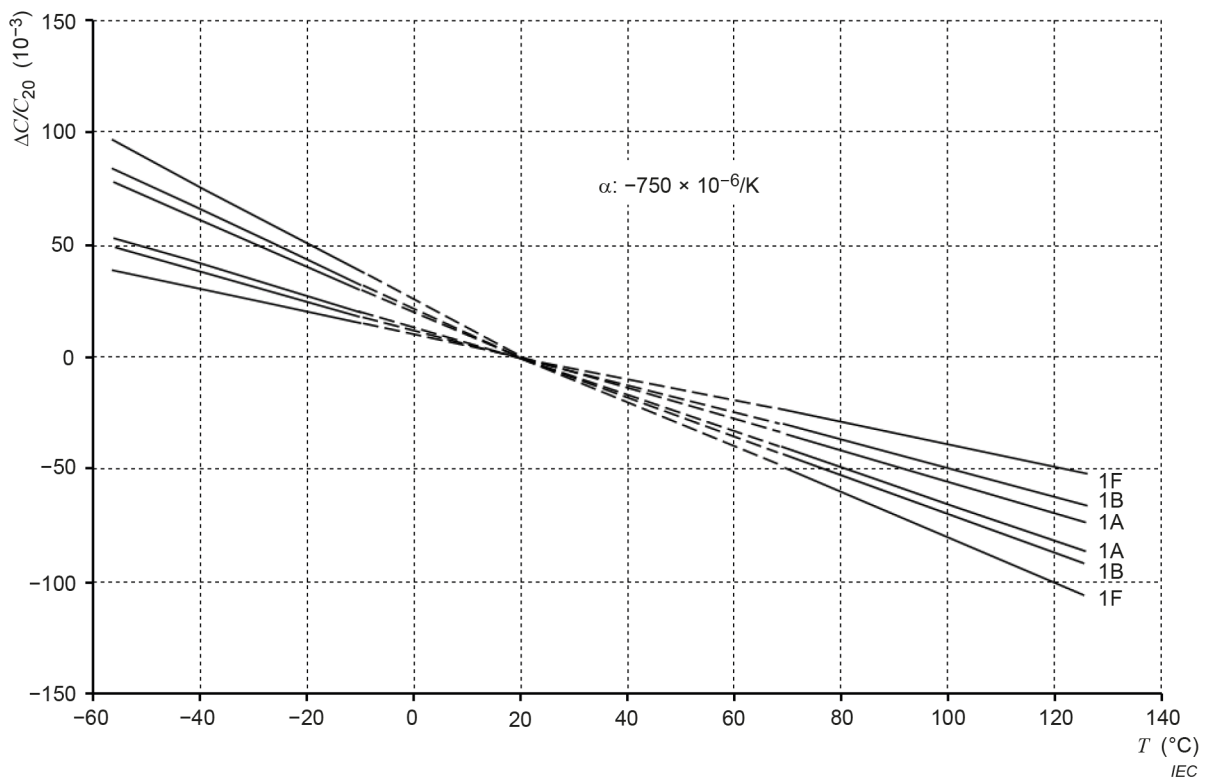


Figure A.9 – α : -750 ($10^{-6}/\text{K}$)

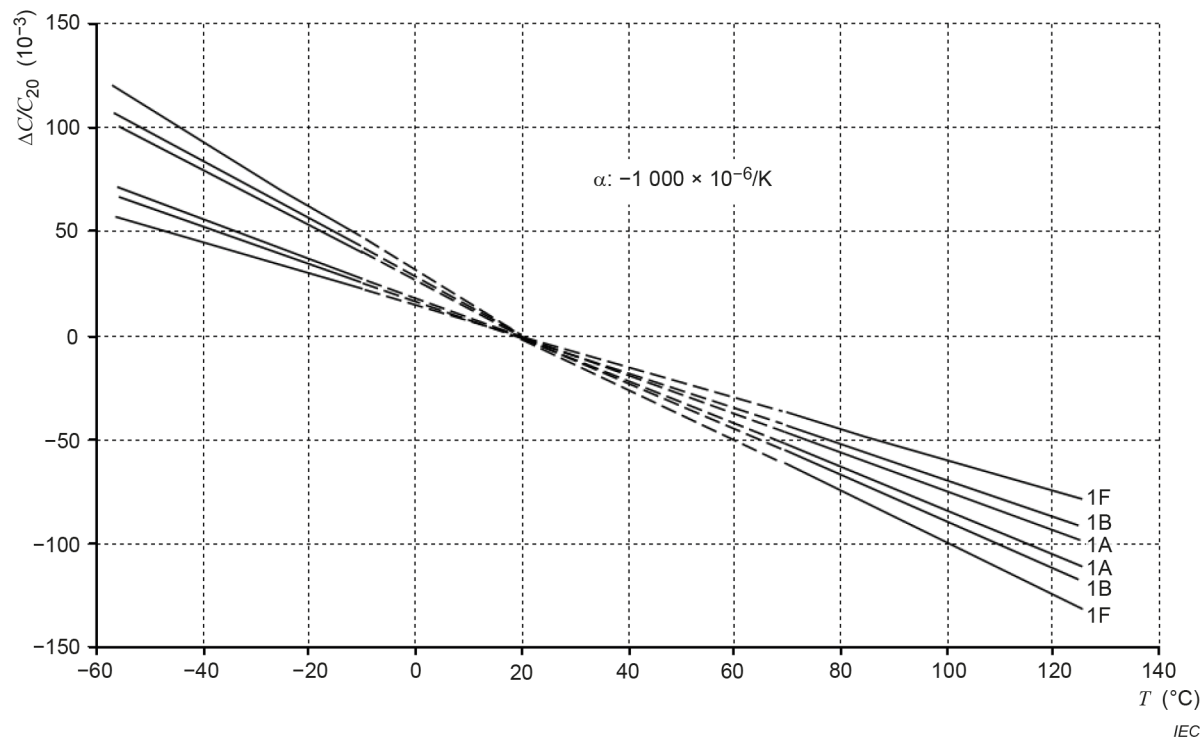


Figure A.10 – α : -1 000 ($10^{-6}/\text{K}$)

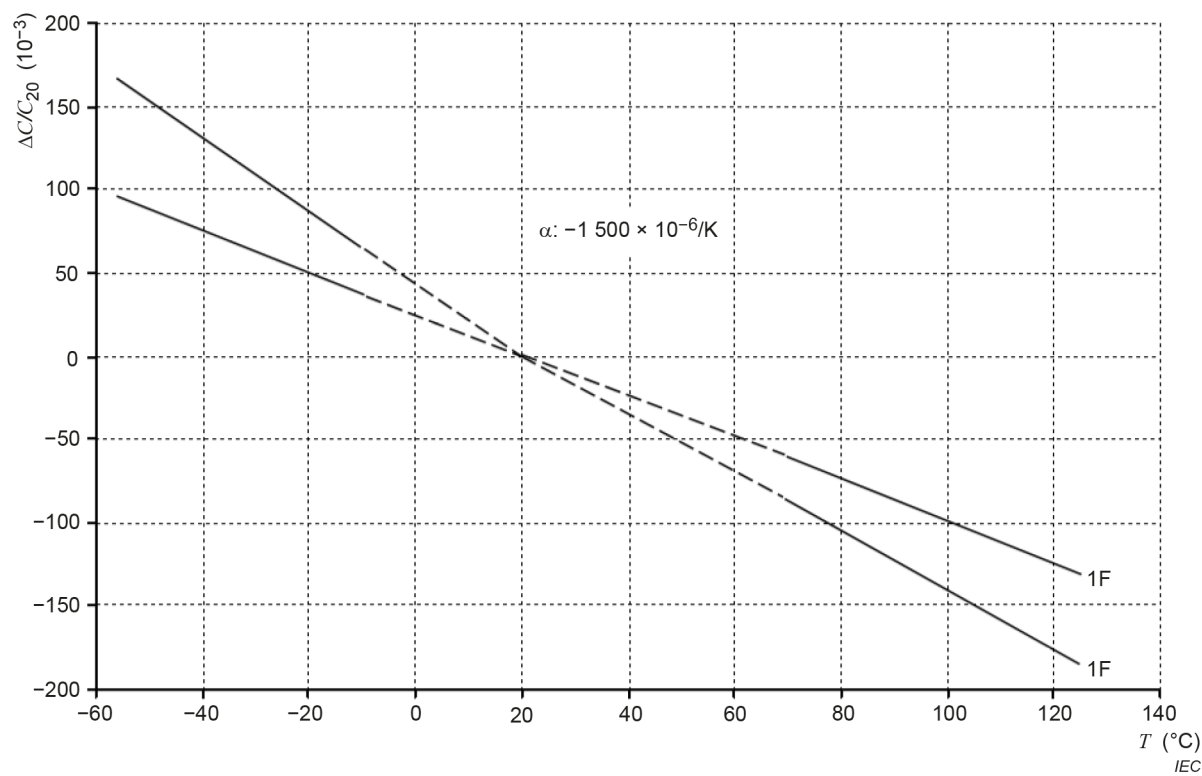


Figure A.11 – α : -1 500 ($10^{-6}/\text{K}$)

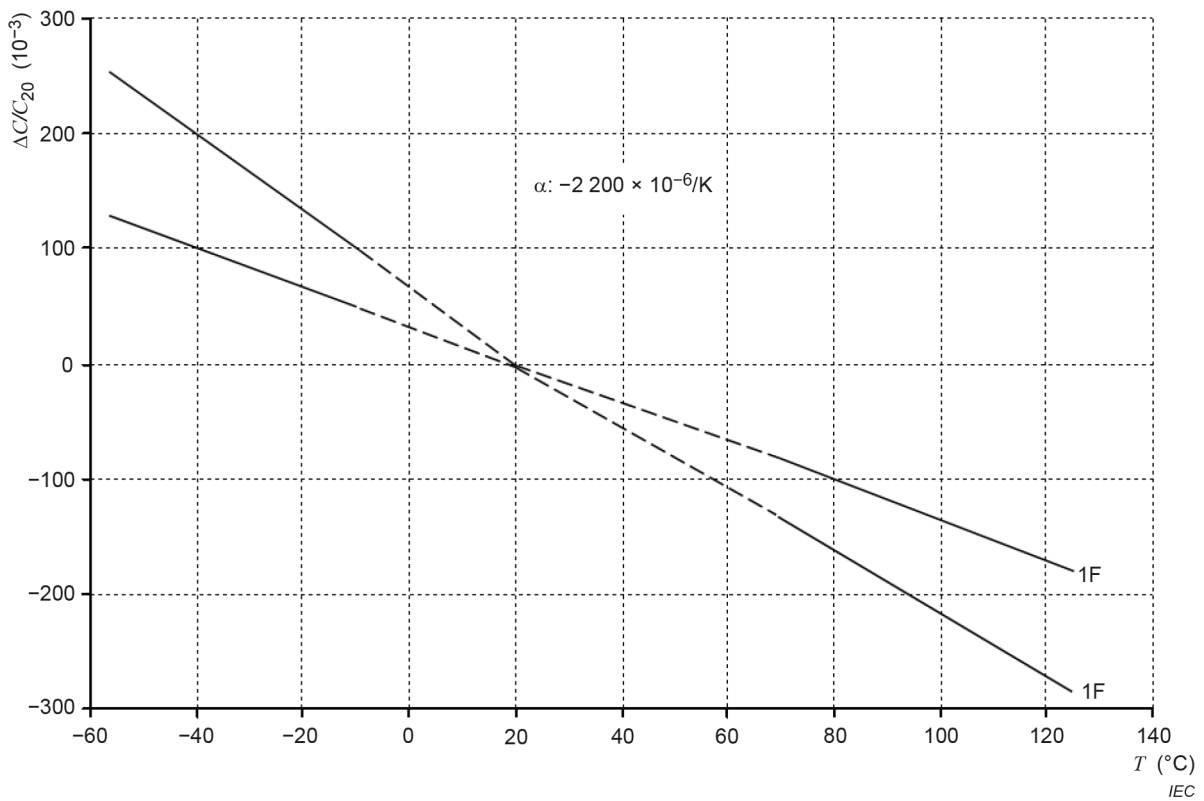


Figure A.12 – α : $-2\,200$ ($10^{-6}/\text{K}$)

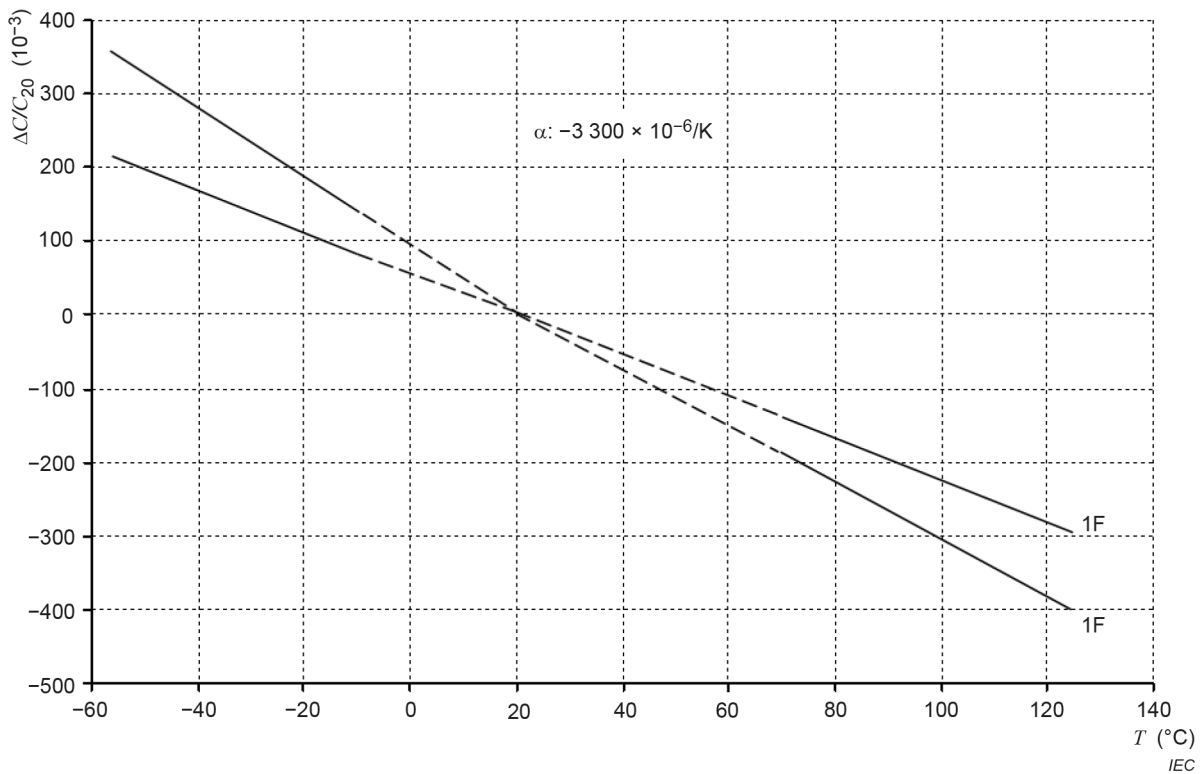


Figure A.13 – α : $-3\,300$ ($10^{-6}/\text{K}$)

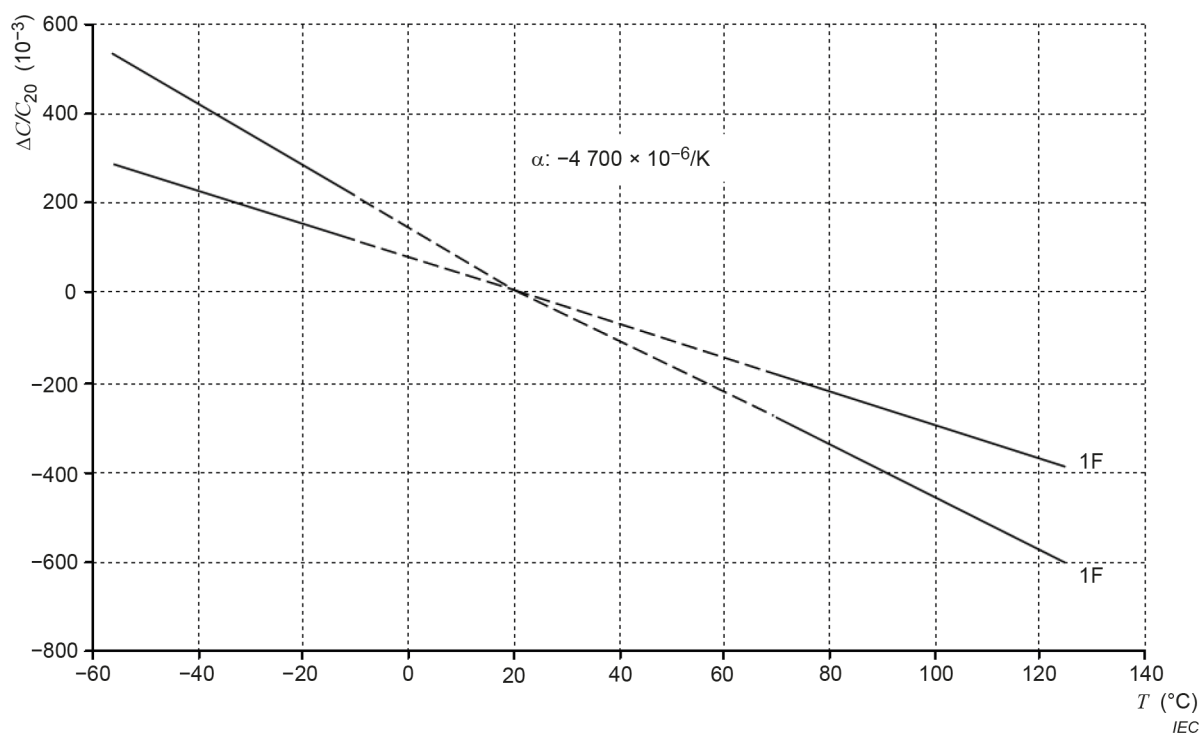


Figure A.14 – α : -4 700 ($10^{-6}/K$)

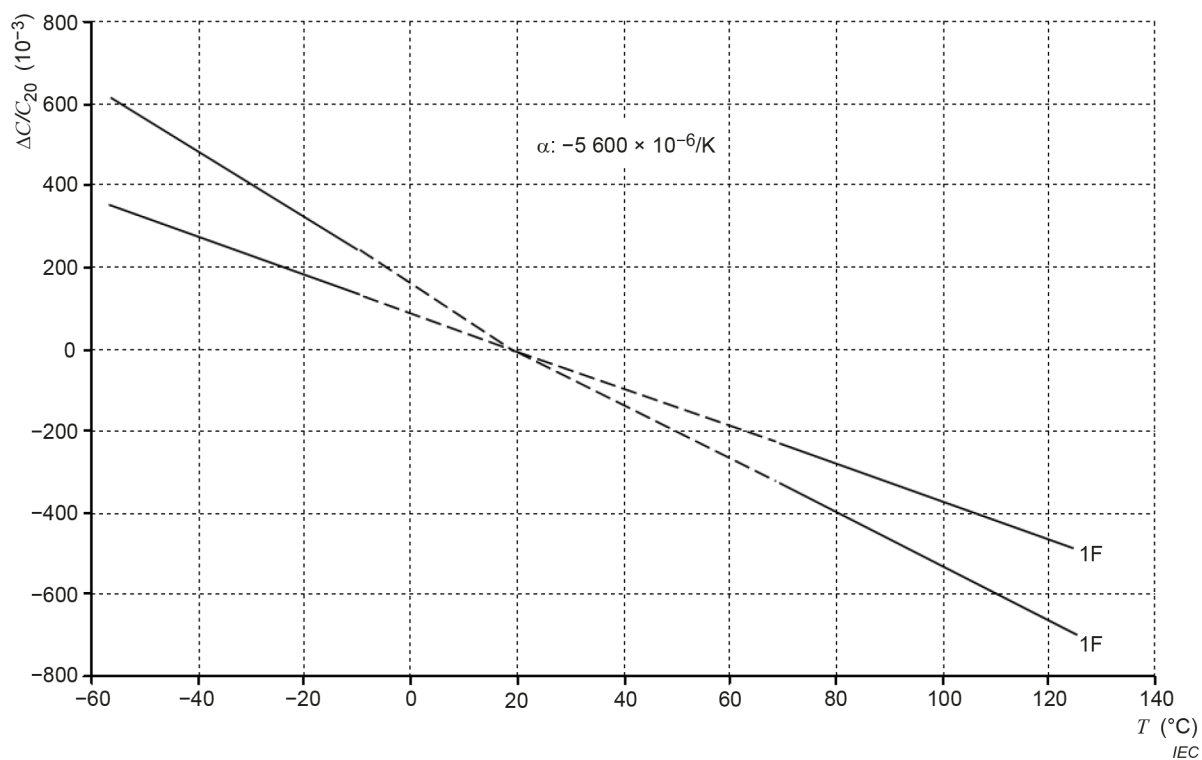


Figure A.15 – α : -5 600 ($10^{-6}/K$)

Annex B (normative)

Combination of temperature coefficients and tolerances for the reference temperature of 25 °C

Temperature coefficients of capacitance, tolerances and related codes are shown in Table B.1.

**Table B.1 – Combination of temperature coefficients and tolerances
for the reference temperature of 25 °C**

Code of temperature coefficient and tolerance	Temperature coefficient and the tolerance		Permissible relative variation in capacitance in parts per							
			1 000 between 25 °C and given temperature							
			Lower category temperature				Upper category temperature			
	α 10 ⁻⁶ /K	Tolerance 10 ⁻⁶ /K	-55 °C	-40 °C	-25 °C	-10 °C	+70 °C	+85 °C	+100 °C	+125 °C
C0G	0	± 30	-2,40/ 5,81	-1,95/ 4,72	-1,50/ 3,63	-1,05/ 2,54	-1,35/ 1,35	-1,80/ 1,80	-2,25/ 2,25	-3,00/ 3,00
U2J	-750	±120	50,4/ 87,8	41,0/ 71,3	31,5/ 54,9	22,1/ 38,4	-39,2/ -28,4	-52,2/ -37,8	-65,3/ -47,3	-87,0/ -63,0
α = nominal temperature coefficient										
NOTE C0G and U2J (Code of temperature coefficient and tolerance) quoted EIA198-1-F.										