IEC 60384-23

Edition 3.0 2023-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fixed capacitors for use in electronic equipment – Part 23: Sectional specification – Fixed metallized polyethylene naphthalate film dielectric surface mount DC capacitors

Condensateurs fixes utilisés dans les équipements électroniques – Partie 23: Spécification intermédiaire – Condensateurs fixes pour montage en surface pour courant continu à diélectrique en film de polynaphtalate d'éthylène métallisé

IEC 60384-23:2023-02(en-fr)

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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 23: Sectional specification – Fixed metallized polyethylene naphthalate film dielectric surface mount DC capacitors

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IEC 60384-23 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment. It is an International Standard.

This third edition cancels and replaces the second 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) this edition includes the following significant technical changes with respect to the previous edition: revision of all parts of the document based on the ISO/IEC Directives, Part 2:2021, and harmonization with other similar kinds of documents;
b) the document structure has been organized to follow new sectional specification structure decided in TC 40;
c) revised tables and Clause 5 so as to prevent duplications and contradictions;

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d) in Subclause 5.2 (Mounting), the Subclauses 5.2.1, 5.2.2 and 5.2.3 have been added;

e) in Subclause 5.5 (Shear test), the Subclauses 5.5.1 and 5.5.2 have been added;

f) in Subclause 5.14 (Component solvent resistance), the Subclauses 5.14.1 and 5.14.2 have been added. In Table 8 and Table A.2, test 5.14 has been moved before 5.7.5 (Final inspections and requirements) in Group 1A and in Subgroup C1;

g) In Subclause 5.15 (Solvent resistance of marking), the Subclauses 5.15.1 and 5.15.2 have been added;

h) tangent of loss angle measurement has been added to the resistance to soldering heat test;

i) lot-by-lot and periodical inspection tables including requirements have been moved to Annex A;

j) revised Inspection Level (IL) of A1 subgroup.

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

Draft	Report on voting
40/2983/FDIS	40/3019/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.

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

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.

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

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 23: Sectional specification – Fixed metallized polyethylene naphthalate film dielectric surface mount DC capacitors

1 Scope

This part of IEC 60384 is applicable to fixed surface mount capacitors for direct current, with metallized electrodes and polyethylene naphthalate dielectric for use in electronic equipment. These capacitors have metallized connecting pads or soldering strips and are intended to be mounted directly onto printed boards or onto substrates for hybrid circuits. These capacitors can have "self-healing properties" depending on conditions of use. They are primarily intended for applications where the AC component is small with respect to the rated voltage.

This part of IEC 60384 specifies preferred ratings and characteristics, selects from IEC 60384-1:2021 the appropriate quality assessment procedures, tests and measuring methods and gives general performance requirements for this type of capacitor. Test severities and requirements specified in detail specifications referring to this sectional specification are of an equal or higher performance level. Lower performance levels are not permitted.

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

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 60062, *Marking codes for resistors and capacitors*

IEC 60063, *Preferred number series for resistors and capacitors*

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

IEC 60384-1:2021, *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, *Preferred numbers – Series of preferred numbers*

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3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60384-1:2021,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
grade 1 capacitors
<long-life> capacitors for long-life applications with stringent requirements for the electrical parameters

3.2
grade 2 capacitors
<general purpose> capacitors for general applications for which the stringent requirements for grade 1 capacitors are not necessary

3.3
grade 3 capacitors
<low temperature, miniature type> miniature type capacitors having a rated temperature of 85°C and for which less stringent requirements than for grade 2 capacitors are acceptable

4 Preferred ratings and characteristics

4.1 Preferred climatic categories

The values given in detail specifications should be selected from the following.

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

The lower and upper category temperature and the duration of the damp heat, steady-state test shall be chosen from the following:

Lower category temperature: −55 °C, −40 °C and −25 °C.

Upper category temperature: +85 °C (only grade 3), +100 °C, +125 °C and +155 °C.

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

At continuous operation at 155 °C beyond the endurance test time, accelerated ageing shall be carried out (see detail specification).

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 Nominal capacitance (C_N)

Preferred values of nominal capacitance shall be taken from the E6 series of IEC 60063:

1,0 – 1,5 – 2,2 – 3,3 – 4,7 and 6,8 and their decimal multiples (× 10^n, n = integer).

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If other values are required, they should be chosen from the E12 series.

4.2.2 Tolerance on nominal capacitance

The preferred tolerances on the nominal capacitance are ±5 %, ±10 % and ±20 %.

4.2.3 Rated voltage (U_R)

The preferred values of rated voltage shall be taken from R10 series of ISO 3 are:

1,0 – 1,6 – 2,5 – 4,0 – 5,0 – 6,3 and their decimal multiples (× 10^n, n: integer).

The sum of the DC voltage and the peak AC voltage applied to the capacitor shall not exceed the rated voltage.

The value of the peak AC voltage shall not exceed the percentages of the rated voltage at the frequencies stated in Table 1 and should not be greater than 280 V, unless otherwise specified in the detail specification.

Table 1 – Percentage limit of the rated voltage at AC voltage frequency

AC voltage frequency Hz	Percentage limit of the rated voltage %
50	20
100	15
1 000	3
10 000	1

4.2.4 Category voltage (U_C)

The category voltage for Grade 1 and Grade 2 capacitors is:

– for upper category temperature 125 °C: 0,8 U_R;

– for upper category temperature 155 °C: 0,5 U_R.

The category voltage for Grade 3 capacitors is:

– for upper category temperature 100 °C: 0,8 U_R;

– for upper category temperature 125 °C: 0,5 U_R.

4.2.5 Rated temperature

Grade 1 and Grade 2 capacitors

The standard value of rated temperature is 100 °C.

Grade 3 capacitors

The standard value of rated temperature is 85 °C.

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5 Test and measurement procedures

5.1 General

This Clause 5 supplements the information given in the relevant clauses of IEC 60384-1:2021.

5.2 Mounting

5.2.1 Initial inspections

The capacitance shall be measured in accordance with 5.4.2.

The tangent of loss angle shall be measured in accordance with 5.4.3.

5.2.2 Mounting method

See IEC 60384-1:2021, 5.5.

5.2.3 Final inspections after mounting

After recovery, the capacitors shall be visually examined and measured and shall meet the requirements given in Table 9.

The measurement values are used as initial inspection values in subgroups 3.1, 3.2, 3.3 and 3.4 in Table 8 and in subgroups C3.1, C3.2, C3.3 and C3.4 in Table A.2.

5.3 Visual examination and check of dimensions

5.3.1 General

See IEC 60384-1:2021, 7.1 with the details of 5.3.2 and 5.3.3.

5.3.2 Visual examination and check of dimensions

Visual examination shall be carried out with equipment with approximately 10× magnification and lighting appropriate to the specimen under test and the quality level required.

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

5.3.3 Requirements

The capacitors shall be examined to verify that the materials, design, construction, physical dimensions and workmanship are in accordance with the applicable requirements given in the detail specification.

5.4 Electrical tests

5.4.1 Voltage proof

5.4.1.1 General

See IEC 60384-1:2021, 6.2 with the details of 5.4.1.2, 5.4.1.3 and 5.4.1.4.

5.4.1.2 Test circuit

Delete the capacitor C_1.

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The product of R_1 and the nominal capacitance of the capacitor under test (C_X) shall be smaller than or equal to 1 s and greater than 0,01 s.

R_1 includes the internal resistance of the power supply.

R_2 shall limit the discharge current to a value equal to or less than 1 A.

5.4.1.3 Test conditions

The voltages given in Table 2 shall be applied between terminals, the measuring points 1a) of IEC 60384-1:2021, Table 3, for a duration of 1 min for qualification approval testing and for a duration of 1 s for the lot-by-lot quality conformance testing.

Table 2 – Test voltages

Measuring point	Test voltage
1a)	Grade 1: 1,6 U_R Grade 2: 1,4 U_R Grade 3: 1,4 U_R

5.4.1.4 Requirements

There shall be no breakdown or flashover during the test.

NOTE The occurrence of self-healing breakdowns during the application of the test voltages is allowed.

5.4.2 Capacitance

5.4.2.1 General

See IEC 60384-1:2021, 6.3 with the details of 5.4.2.2 and 5.4.2.3.

5.4.2.2 Measuring conditions

The capacitance shall be measured at, or corrected to, a frequency of 1 kHz. For nominal capacitance values > 10 µF, 50 Hz to 120 Hz may be used.

The applied peak voltage at 1 kHz shall not exceed 3 % of the rated voltage, and the applied peak voltage at 50 Hz to 120 Hz shall not exceed 20 % of the rated voltage with a maximum of 100 V (70 V RMS).

5.4.2.3 Requirements

The capacitance shall be within the specified tolerance.

5.4.3 Tangent of loss angle (tan δ)

5.4.3.1 General

See IEC 60384-1:2021, 6.4 with the details of 5.4.3.2, 5.4.3.3, 5.4.3.4 and 5.4.3.5.

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5.4.3.2 Measuring conditions for measurements at 1 kHz

The test conditions are as follows:

– Frequency: 1 kHz;
– Peak voltage: ≤ 3 % of the rated voltage;
– Inaccuracy: ≤ 10 × 10^{-4} (absolute value).

5.4.3.3 Requirement for measurements at 1 kHz

Tan δ shall not exceed the applicable values shown in Table 3.

Table 3 – Tangent of loss angle limits

Nominal capacitance	Tan δ (absolute value)		
µF	Grade 1 capacitors	Grade 2 capacitors	Grade 3 capacitors
≤ 1	0,006	0,010	0,010
> 1	0,007	0,010	0,010

5.4.3.4 Measuring conditions for measurements at 10 kHz

For capacitors with C_N ≤ 1 µF, tan δ shall be in addition measured when required in Table 9 for certain tests.

– Frequency: 10 kHz;
– Voltage: 1 V RMS;
– Inaccuracy: ≤ 10 × 10^{-4} (absolute value).

5.4.3.5 Requirement for measurements at 10 kHz

Tangent of loss angle shall be as stated in the detail specification.

5.4.4 Insulation resistance

5.4.4.1 General

See IEC 60384-1:2021, 6.1 with the details of 5.4.4.2 and 5.4.4.3.

5.4.4.2 Measuring conditions

Prior to the test, capacitors shall be carefully cleaned to remove any contamination. Cleanliness shall be maintained in the test chambers and during post-test measurements.

Before the measurement, the capacitors shall be fully discharged. The product of the resistance of the discharge circuit and the nominal capacitance of the capacitor under test shall be ≥ 0,01 s or any other value stated in the detail specification.

The measuring conditions shall be in accordance with IEC 60384-1:2021, 6.1.2. The measuring points shall be in accordance with IEC 60384-1:2021, Table 3.

The voltage shall be applied immediately at the correct value through the internal resistance of the voltage source.

The product of the internal resistance and the nominal capacitance of the capacitor shall be smaller than 1 s or any other value stated in the detail specification.

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5.4.4.3 Requirements

The insulation resistance shall meet the requirements of Table 4. However, in lot-by-lot quality conformance testing, the measurement may be interrupted at the time when the limits of Table 4 have been reached, which can be within 60 s.

Table 4 – Requirements regarding insulation resistance

Minimal RC product (R = insulation resistance between the terminations) (C = nominal capacitance C_N) s				**Minimum insulation resistance between the terminations** MΩ			
C_N > 0,33 µF				**C_N ≤ 0,33 µF**			
Rated voltage							
> 100 V		**≤ 100 V**		**> 100 V**		**≤ 100 V**	
Grade:							
1	2,3	1	2,3	1	2,3	1	2,3
10 000	400	5 000	400	30 000	1 000	15 000	1 000
NOTE MΩ is used instead of the correct unit GΩ for the convenience of the user to calculate the time constant correctly, and from historical reasons.							

When the test is carried out at a temperature other than 20 °C, the result shall, when necessary, be corrected to 20 °C by multiplying the result of the measurement by the appropriate correction factor. In case of doubt, the measurement at 20 °C is decisive. The correction factors given in Table 5 can be considered as average values for metallized polyethylene naphthalate film capacitors.

Table 5 – Correction factor dependent on temperature

Temperature °C	**Correction factor**
15	0,75
20	1,00
23	1,15
27	1,35
30	1,50
35	1,75

5.5 Shear test

5.5.1 General

See IEC 60384-1:2021, 7.7.

5.5.2 Final inspections

The capacitors shall be visually examined and shall meet the requirements given in Table 9 or Table A.2.

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5.6 Substrate bending test

5.6.1 General

See IEC 60384-1:2021, 7.8.

5.6.2 Initial inspections

Capacitance shall be measured in accordance with 5.4.2.

5.6.3 Final inspections and requirements

The capacitance shall be measured in the board bending position.

The capacitance value and visual examination shall meet the requirements shown in Table 9 or Table A.2.

5.7 Resistance to soldering heat

5.7.1 General

See IEC 60384-1:2021, 9.1 with the details of 5.7.2 to 5.7.5.

5.7.2 Initial inspections

The capacitance shall be measured in accordance with 5.4.2.

The tangent of loss angle shall be measured in accordance with 5.4.3.

5.7.3 Test conditions

Test conditions are as follows:

– Method: Method 1 (solder bath), or Method 2 (reflow), unless otherwise specified in detail specification;

– Duration: 5 s ± 0,5 s or 10 s ± 1 s, unless otherwise specified in detail specification.

If Method 1 is applied, immersion and withdrawal speed shall be 20 mm/s to 25 mm/s.

5.7.4 Recovery

The recovery period shall be 24 h ± 2 h.

5.7.5 Final inspections and requirements

After recovery the capacitors shall be visually examined and measured and shall meet the following requirements:

Under normal lighting and approximately 10× magnification, there shall be no signs of damage such as cracks.

The capacitance and tangent of loss angle shall meet the requirements given in Table 9 or Table A.2.

5.8 Solderability

5.8.1 General

See IEC 60384-1:2021, 9.2 with the details of 5.8.2 and 5.8.3.

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5.8.2 Test conditions

The test conditions shall be specified in the detail specification. Preconditioning or ageing is not required unless otherwise specified in the detail specification.

5.8.3 Final inspections and requirements

The capacitor shall be visually examined under normal lighting and approximately 10× magnification. There shall be no signs of damage.

The areas to be soldered shall be covered with a smooth and bright solder coating with no more than a small number of scattered imperfections, such as pinholes or un-wetted or de-wetted areas. These imperfections shall not be concentrated in one area.

5.9 Rapid change of temperature

5.9.1 General

See IEC 60384-1:2021, 8.1 with the details of 5.9.2, 5.9.3 and 5.9.4.

The capacitors shall be mounted in accordance with 5.2.

5.9.2 Initial inspections

The capacitance shall be measured in accordance with 5.4.2.

The tangent of loss angle shall be measured in accordance with 5.4.3.

5.9.3 Test conditions

The test conditions are as follows:

The capacitors shall be tested for 5 cycles.

The duration of exposure at each temperature limit shall be 30 min.

5.9.4 Final inspections and requirements

The capacitors shall be visually examined and shall meet the requirements given in Table 9 or Table A.2.

5.10 Climatic sequence

5.10.1 General

See IEC 60384-1:2021, 8.2 with the details of 5.10.2 to 5.10.8.

The capacitors shall be mounted in accordance with 5.2.

5.10.2 Initial inspections

The capacitance shall be measured in accordance with 5.4.2.

The tangent of loss angle shall be measured in accordance with 5.4.3.

5.10.3 Dry heat

See IEC 60384-1:2021, 8.2.3.

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5.10.4 Damp heat, cyclic, test Db, first cycle

See IEC 60384-1:2021, 8.2.4.

5.10.5 Cold

See IEC 60384-1:2021, 8.2.5.

5.10.6 Damp heat, cyclic, test Db, remaining cycles

See IEC 60384-1:2021, 8.2.7 with the following detail:

Within 15 min after removal from the damp heat test, the rated voltage shall be applied for 1 min at measuring point 1a) using the test circuit conditions given in 5.4.1.2.

5.10.7 Recovery

The recovery period shall be 1 h to 2 h, unless otherwise specified in the detail specification.

5.10.8 Final inspections and requirements

After recovery, the surface mount capacitors shall be visually examined and measured and meet the requirements given in Table 9 or in Table A.2.

5.11 Damp heat, steady state

5.11.1 General

See IEC 60384-1:2021, 8.3 with the details of 5.11.2 to 5.11.5.

The capacitors shall be mounted in accordance with 5.2.

5.11.2 Initial inspections

The capacitance shall be measured in accordance with 5.4.2.

The tangent of loss angle shall be measured in accordance with 5.4.3.

5.11.3 Test conditions

Test conditions are as follows:

- Temperature: 40 °C ± 2 °C;
- Relative humidity: (93 ± 3) %;
- Applied voltage: No voltage shall be applied;
- Duration: 21 days or 56 days.

5.11.4 Recovery

The recovery period shall be 1 h to 2 h.

5.11.5 Final inspections and requirements

After recovery, the capacitors shall be visually examined and measured and shall meet the requirements given in Table 9 or in Table A.2.

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5.12 Endurance

5.12.1 General

See IEC 60384-1:2021, 8.5 with the details of 5.12.2, 5.12.3 and 5.12.4.

The capacitors shall be mounted in accordance with 5.2.

5.12.2 Initial inspections

The capacitance shall be measured in accordance with 5.4.2.

The tangent of loss angle shall be measured in accordance with 5.4.3.

5.12.3 Test conditions

Grade 1 capacitors shall be tested for 2 000 h, Grade 2 and Grade 3 capacitors for 1 000 h, as given in Table 6 and Table 7.

Table 6 – Endurance test conditions for Grade 1 and Grade 2 capacitors

Category	-/100/-	-/125/-		-/155/-	
Temperature	100 °C	125 °C	100 °C	155 °C	100 °C
Voltage (DC)	1,25 U_R	1,25 U_C	1,25 U_R	1,25 U_C	1,25 U_R
Sample part divided into	1 part	2 parts		2 parts	

Table 7 – Endurance test conditions for Grade 3 capacitors

Category	-/085/-	-/100/-		-/125/-	
Temperature	85 °C	100 °C	85 °C	125 °C	85 °C
Voltage (DC)	1,25 U_R	1,25 U_C	1,25 U_R	1,25 U_C	1,25 U_R
Sample part divided into	1 part	2 parts		2 parts	

The test voltage shall be applied to each capacitor individually through a resistor, the value R of which is equal to 0,022 / C_N (Ω), where C_N is the nominal capacitance in farad and R is the resistance in ohms and is to be within 30 % of the calculated value with a maximum of 2 MΩ.

After the specified period, the capacitors shall be allowed to recover and shall then be discharged across the same resistor R as defined in this subclause.

5.12.4 Final inspections and requirements

The capacitors shall be visually examined and measured and shall meet the requirements given in Table 9 or Table A.2.

5.13 Charge and discharge

5.13.1 General

See IEC 60384-1:2021, 6.11 with the details of 5.13.2 to 5.13.5.

The capacitors shall be mounted in accordance with 5.2.

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5.13.2 Initial inspections

The capacitance shall be measured in accordance with 5.4.2.

The tangent of loss angle shall be measured in accordance with 5.4.3.

5.13.3 Test conditions

The capacitors shall be subjected to 10 000 cycles of charge and discharge at a rate of approximately one cycle per second. Each cycle shall consist of charging and discharging the capacitor. Each capacitor shall be individually charged with the rated voltage through a resistor with a value $(220 \times 10^{-6}) / C_N$ (Ω), where C_N is the nominal capacitance in farad, or the value required to limit the charge current to 1 A (or to the higher current value given in the detail specification), whichever resistance value is the greater.

Each capacitor shall be individually discharged through a resistor with a value of $(10 \times 10^{-6}) / C_N$ (Ω), with a minimum of 20 Ω, or a lower value when stated in the detail specification.

5.13.4 Recovery

The recovery shall be 1 h to 2 h.

5.13.5 Final inspections and requirements

After recovery, the capacitors shall be measured and shall meet the requirements given in Table 9 or Table A.2.

5.14 Component solvent resistance (if required)

5.14.1 General

See IEC 60384-1:2021, 9.4.

5.14.2 Final inspections and requirements

See 5.7.5, if not specified differently in the detail specification.

5.15 Solvent resistance of marking (if applicable)

5.15.1 General

See IEC 60384-1:2021, 9.5.

5.15.2 Final inspections and requirements

The marking shall be visually examined, and it shall be legible.

6 Marking

6.1 General

See IEC 60384-1:2021, 4.3, with the following details.

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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 (in clear or code according to IEC 60062);

b) rated voltage (DC. voltage may be indicated by the symbol ⎓ (IEC 60417-5031:2002-10) or ⎓);

c) tolerance on nominal capacitance;

d) category voltage;

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.

6.3 Marking on capacitors

Marking on capacitors is made when necessary.

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

6.4 Marking on packaging

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

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 Clause 5 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 information outlined in 7.2 to 7.5 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.

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 should be stated in millimetres; however, when the original dimensions are given in inches, the converted metric dimensions in millimetres shall be added.

The numerical values of the body shall be given as follows:

– width, length and height.

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The numerical values of the terminals shall be given as follows:

– width, length and spacing.

When necessary, for example when a number of items (sizes and capacitance/voltage ranges) is 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 capacitor.

7.3 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 5.2.

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 content of 7.4.2, 7.4.3 and 7.4.4.

7.4.2 Nominal capacitance range

See 4.2.1.

When products approved to the detail specification have different nominal capacitance ranges, the following statement should be added: "The nominal capacitance range available in each voltage range is given on the IEC online service, www.iecq.org/certificates."

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 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.

8 Quality assessment procedures

8.1 Primary stage of manufacture

The primary stage of manufacture is the winding of the capacitor element or the equivalent operation.

8.2 Structurally similar components

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

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8.3 Certified test records of released lots

The information required in IEC 60384-1:2021, Q.1.5 shall be made available when stated in the detail specification and when requested by a purchaser. After the endurance test, the required parameters are the capacitance change, tan δ and the insulation resistance.

8.4 Qualification approval procedures

8.4.1 General

The procedures for qualification approval testing are given in IEC 60384-1:2021, 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 A. The procedure using a fixed sample size schedule is given in 8.4.2.

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

8.4.2.1 Sampling

The fixed sample size procedure is described in IEC 60384-1:2021, Q.2.4. The sample shall be representative of the range of capacitors for which approval is sought. The sample may be the whole or part of the range given in the detail specification.

The sample shall consist of four specimens having the maximum and minimum rated voltages, and for these voltages the maximum and minimum capacitances. 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 for either four or six values (capacitance/voltage combinations). When the range consists of fewer than four values, the number of specimens to be tested shall be that required for four values.

Spare specimens are permitted as follows:

Two (for six values) or three (for four values) per value, which 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 8 gives the number of samples to be tested for each group with the permissible number of non-conforming items for qualification approval tests.

8.4.2.2 Tests

The complete series of tests specified in Table 8 and Table 9 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.

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

Table 8 and Table 9 together form the fixed sample size test schedule for the qualification approval on the basis of the fixed sample size procedure.

Table 8 gives the number of the samples and permissible non-conforming items for each test and test group.

Table 9 gives a summary of the test conditions and performance requirements, and choices of the test conditions and performance requirements in the detail specification.

The test conditions and performance requirements for the qualification approval on the basis of the fixed sample size should be identical to those for quality conformance inspections given in the detail specification.

Table 8 – Test and sampling plan for qualification approval
Assessment level EZ

Group No.		Test	Subclause of this document	Number of specimens n[a]	Permissible number of non-conforming items c
0		Visual examination	5.3		
		Dimensions	5.3		
		Capacitance	5.4.2	144	0
		Tangent of loss angle	5.4.3		
		Voltage proof	5.4.1		
		Insulation resistance	5.4.4		
		Spare specimens		12	
1A		Resistance to soldering heat	5.7	12	0
		Component solvent resistance[b]	5.14		
1B		Solderability	5.8	12	0
		Solvent resistance of the marking[b]	5.15		
2		Substrate bending test (formerly bond strength of the end face plating)	5.6	12	0
3		Mounting	5.2	108	0 [c]
	3.1	Shear test	5.5	24	0
		Rapid change of temperature	5.9		
		Climatic sequence	5.10		
	3.2	Damp heat, steady state	5.11	24	0
	3.3	Endurance	5.12	36	0
	3.4	Charge and discharge	5.13	24	0

[a] Capacitance/voltage combinations, see 8.4.2.

[b] If required by the detail specification.

[c] Specimens found defective after mounting shall not be taken into account when calculating the permissible non-conforming items for the following tests. They shall be replaced by spare parts.

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