IEC 60384-24

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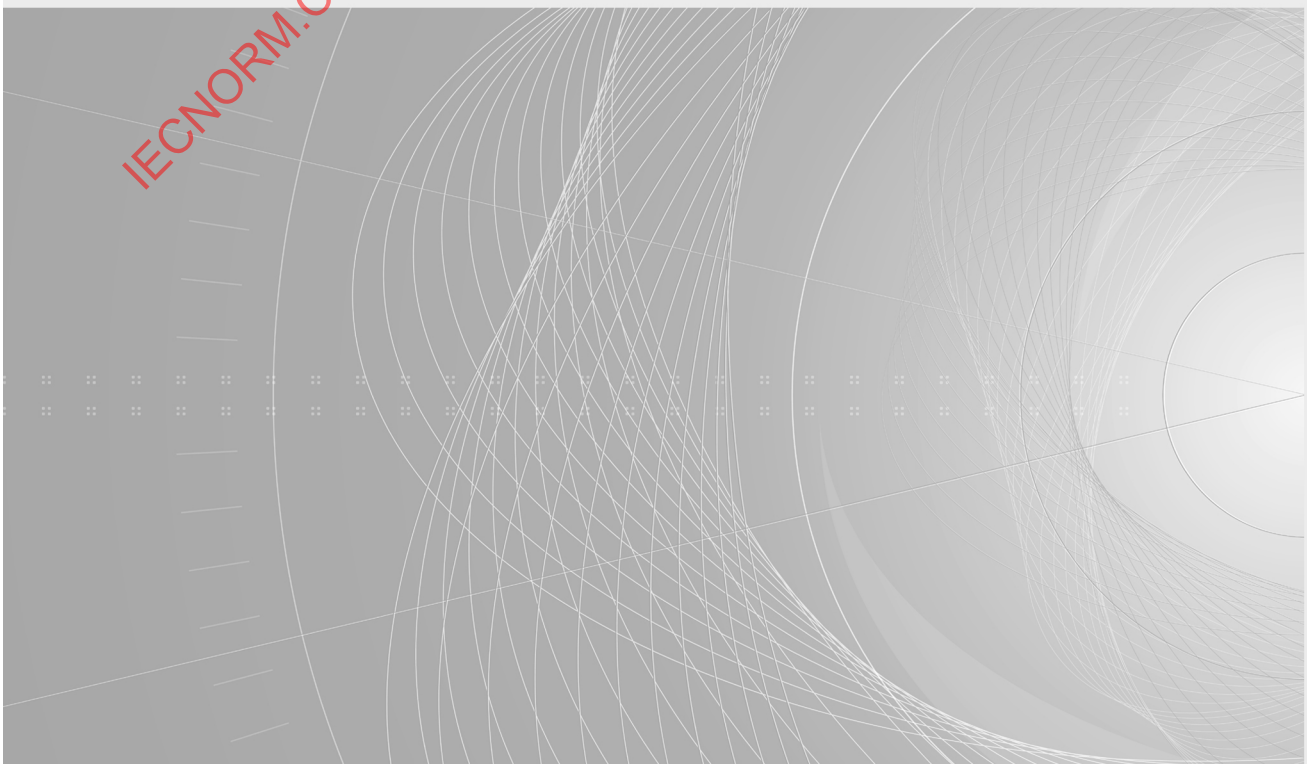
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Fixed capacitors for use in electronic equipment –
Part 24: Sectional specification – Fixed tantalum electrolytic surface mount capacitors with conductive polymer solid electrolyte



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 24: Sectional specification – Fixed tantalum electrolytic surface mount capacitors with conductive polymer solid electrolyte

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 60384-24:2015. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60384-24 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This third edition cancels and replaces the second edition published in 2015. This edition constitutes a technical revision.

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

a) Revision of the structure in accordance with ISO/IEC Directives, Part 2:2018, to the extent practicable, and harmonization between other similar kinds of documents.
b) In addition, Clause 5 and all the tables have been reviewed in order to prevent duplications and contradictions.

The text of this standard is based on the following documents:

FDIS	Report on voting
40/2849/FDIS	40/2860/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.

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.

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 http://www.iec.ch/standardsdev/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

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- withdrawn,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

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 24: Sectional specification – Fixed tantalum electrolytic surface mount capacitors with conductive polymer solid electrolyte

~~1 General~~

1 Scope

This part of IEC 60384 applies to fixed tantalum electrolytic surface mount capacitors with conductive polymer solid electrolyte, which are primarily intended for DC applications for use in electronic equipment.

Fixed tantalum electrolytic surface mount capacitors with solid (MnO_2) electrolyte are not included but are covered by IEC 60384-3.

These capacitors are primarily intended for use in electronic equipment to be mounted directly on substrates for hybrid circuits or to printed boards.

Capacitors for special-purpose applications ~~may~~ can need additional requirements.

~~1.2 Object~~

The object of this document is to prescribe preferred ratings and characteristics and to select from IEC 60384-1:2016 the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of capacitor. ~~Test severities and requirements prescribed in detail specifications referring to this sectional specification shall be of equal or higher performance level, because lower performance levels are not permitted.~~

2 Normative references

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

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

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

IEC 60384-1:~~2008~~2016, *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*~~

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60384-1:~~2008~~2016 and the following apply.

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

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

3.1
capacitance
<electrolytic capacitor> capacitance of an equivalent circuit whose capacitance and resistance in series is measured with an alternating current having an approximately sinusoidal waveform at a specified frequency

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 sectional specification are classified into climatic categories in accordance with the general rules given in IEC 60068-1:2013, Annex A.

The lower and upper category temperature shall be taken from the following:

- lower category temperature: −55 °C;
- upper category temperature: +105 °C and +125 °C.

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

The upper category temperature shall be 105 °C or 125 °C for a rated temperature of 85 °C.

The upper category temperature shall be 125 °C for a rated temperature of 105 °C.

4.2 Preferred values of ratings

4.2.1 Nominal capacitance (C_N)

Preferred values of nominal capacitance are indicated in microfarad (µF).

Preferred values of nominal capacitance shall be taken from the E 12 series of IEC 60063 as follows:

1,0 – 1,2 – 1,5 – 1,8 – 2,2 – 2,7 – 3,3 – 3,9 – 4,7 – 5,6 – 6,8 – 8,2;

and their decimal multiples (× 10^n, n: integer).

4.2.2 Tolerance on nominal capacitance

Preferred value of tolerance on nominal capacitance is:

±20 %.

4.2.3 Rated voltage (U_R)

Preferred values of rated ~~direct~~ DC voltages taken from R10 and R20 series of ISO 3 are:

– from R10: 1,0 – 1,25 – 1,6 – 2,0 – 2,5 – 4,0 – 5,0 – 6,3 – 8,0;

– from R20: 3,5[1] ;

– and their decimal multiples (× 10^n, n: integer).

4.2.4 Category voltage (U_C)

The category voltage for capacitors is given in Table 1 and Table 2.

4.2.5 Surge voltage (U_{RS} or U_{CS})

The surge voltage shall be 1,15 times the rated or category voltage rounded off to the nearest volt (two significant digits) (see Table 1 and Table 2).

NOTE U_{RS} is the surge voltage to rated voltage;
U_{CS} is the surge voltage to category voltage.

4.2.6 Rated temperature

The value of the rated temperature is +85 °C and +105 °C (see Table 1 and Table 2).

Table 1 – Category and surge voltages

Values in volts

	Upper category temperature 125 °C / rated temperature 85 °C											
U_R	2,0	2,5	4,0	5,0	6,3	8,0	10	12,5	16	20	25	35
U_C = 0,80 U_R	1,6	2,0	3,2	4,0	5,0	6,4	8,0	10	13	16	20	28
U_{RS}	2,3	2,9	4,6	5,8	7,2	9,2	12	14	18	23	29	40
U_{CS}	1,8	2,3	3,7	4,6	5,8	7,4	9,2	12	15	18	23	32

Table 2 – Category and surge voltages

Values in volts

	Upper category temperature 125 °C / rated temperature 105 °C or upper category temperature 105 °C / rated temperature 85 °C											
U_R	2,0	2,5	4,0	5,0	6,3	8,0	10	12,5	16	20	25	35
U_C = 0,90 U_R	1,8	2,3	3,6	4,5	5,7	7,2	9,0	11	14	18	23	32
U_{RS}	2,3	2,9	4,6	5,8	7,2	9,2	12	14	18	23	29	40
U_{CS}	2,0	2,6	4,1	5,2	6,5	8,2	10	13	16	20	26	36

1 ISO 3 indicates the value 3,55 for R20.

5 Test and measurement procedures

5.1 General

Test severities and requirements prescribed in detail specifications referring to this sectional specification are of equal or higher performance level, because lower performance levels are not permitted.

This clause supplements the information given in IEC 60384-1:~~2008~~2016, Clause 4.

5.2 Preliminary drying

See IEC 60384-1:~~2008~~2016, 4.3.

5.3 Measuring conditions

See IEC 60384-1:~~2008~~2016, 4.2.1.

5.4 Mounting

5.4.1 General

See IEC 60384-1:~~2008~~2016, 4.33, with 5.4.2, 5.4.3 and 5.4.4 of this document.

5.4.2 Initial inspections

See Table 4.

5.4.3 Test conditions

The test method shall be the reflow method and reflow temperature profile specified in the detail specification.

5.4.4 Final inspections and requirements

See Table 4.

5.5 Visual examination and check of dimensions

5.5.1 General

See IEC 60384-1:~~2008~~2016, 4.4, with 5.5.2 and 5.5.3 of this document.

5.5.2 Visual examination and check of dimensions

Visual examination shall be carried out with suitable equipment with approximately 10× magnification and lighting appropriate to the specimen under test and the quality level required. The operator should have available facilities for incident or transmitted illumination, as well as an appropriate measuring facility. The capacitors shall be examined to verify that the materials, design, construction, and physical dimensions are appropriate.

5.5.3 Requirements

The workmanship shall be in accordance with the applicable requirements given in the detail specification.

5.6 Electrical tests

5.6.1 Leakage current

5.6.1.1 General

See IEC 60384-1:~~2008~~2016, 4.9, with 5.6.1.2 and 5.6.1.3 of this document.

5.6.1.2 Measuring conditions

The rated voltage shall be applied across the capacitor and its protective resistor placed in series with the capacitor to limit the charging current.

The protective resistor shall have a value of 1 000 Ω.

5.6.1.3 Requirements

See Table 4.

5.6.2 Capacitance

5.6.2.1 General

See IEC 60384-1:~~2008~~2016, 4.7, with 5.6.2.2 and 5.6.2.3 of this document.

5.6.2.2 Measuring conditions

Unless otherwise specified in the detail specifications, the capacitance shall be measured at a frequency of 100 Hz or 120 Hz.

The peak alternating voltage actually applied across the capacitor terminations shall not exceed 0,5 V (RMS).

A DC bias voltage of 0,7 V to 1,0 V may be applied during the measurement to avoid negative voltage application to the capacitor by the applied AC voltage.

The inaccuracy of the measuring instruments shall not exceed ±2 % of the limit specified in the detail specification, whether this is given as an absolute value or as a change of capacitance.

5.6.2.3 Requirements

See Table 4.

5.6.3 Tangent of loss angle (tan δ)

5.6.3.1 General

See IEC 60384-1:~~2008~~2016, 4.8.1, with 5.6.3.2 and 5.6.3.3 of this document.

5.6.3.2 Measuring conditions

The measurement shall be under the conditions as specified in 5.6.2.2.

The inaccuracy of the measuring equipment shall not exceed 0,01 in absolute value.

5.6.3.3 Requirements

See Table 4.

5.6.4 Equivalent series resistance (ESR) (if required)

5.6.4.1 General

See IEC 60384-1:~~2008~~2016, 4.8.2, with 5.6.4.2 and 5.6.4.3 of this document.

5.6.4.2 Measuring conditions

Unless otherwise specified in the detail specifications, test conditions are as follows:

– temperature: 20 °C ± 2 °C;
– applied voltage: peak AC value ≤ 0,5 V (RMS);
– voltage frequency: 100 kHz ± 10 kHz.

The error of measurement shall not exceed 5 % of the requirement, or 0,02 Ω, whichever is the greater.

5.6.4.3 Requirements

See Table 4.

5.7 Resistance to soldering heat

5.7.1 General

See IEC 60384-1:~~2008~~2016, 4.14, with 5.7.2 to 5.7.5 of this document.

5.7.2 Initial inspections

See Table 4.

5.7.3 Test conditions

The test method shall be the reflow method, and the reflow temperature profile shall be specified in the detail specification.

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 under normal lighting and approximately 10× magnification and measured electrical characteristics given in Table 4.

5.8 Solderability

5.8.1 General

See IEC 60384-1:~~2008~~2016, 4.15, with 5.8.2 of this document.

5.8.2 Final inspections and requirements

See Table 4.

5.9 Shear test

See IEC 60384-1:~~2008~~2016, 4.34.

5.10 Substrate bending test (if required)

5.10.1 General

See IEC 60384-1:~~2008~~2016, 4.35, with 5.10.2 to 5.10.4 of this document.

5.10.2 Initial inspections

See Table 4.

5.10.3 Test conditions

Deflection D and the number of bends shall be specified in the detail specification.

5.10.4 Final inspections and requirements

See Table 4.

5.11 Rapid change of temperature

5.11.1 General

See IEC 60384-1:~~2008~~2016, 4.16, with 5.11.2 to 5.11.5 of this document.

The capacitors shall be mounted in accordance with 5.4.

5.11.2 Initial inspections

See Table 4.

5.11.3 Test conditions

Test conditions are as follows:

– T_A = lower category temperature;
– T_B = upper category temperature;
– the capacitors shall be tested for 5 cycles;
– the duration of the exposure at each temperature limit shall be 30 min.

5.11.4 Recovery

The recovery period shall be 1 h to 2 h.

5.11.5 Final inspections and requirements

See Table 4.

5.12 Climatic sequence

5.12.1 General

See IEC 60384-1:~~2008~~2016, 4.21, with 5.12.2 to 5.12.8 of this document.

5.12.2 Initial inspections

See Table 4.

5.12.3 Dry heat

See IEC 60384-1:~~2008~~2016, 4.21.3, with the following details:

– temperature: upper category temperature;
– duration: 16 h.

5.12.4 Damp heat, cyclic, test Db, first cycle

See IEC 60384-1:~~2008~~2016, 4.21.4.

5.12.5 Cold

See IEC 60384-1:~~2008~~2016, 4.21.5, with the following details:

– temperature: lower category temperature;
– duration: 2 h.

5.12.6 Damp heat, cyclic, test Db, remaining cycles

See IEC 60384-1:~~2008~~2016, 4.21.7.

5.12.7 Recovery

The recovery period shall be 1 h to 2 h.

5.12.8 Final inspections and requirements

See Table 4.

5.13 Damp heat, steady state

5.13.1 General

See IEC 60384-1:~~2008~~2016, 4.22, with 5.13.2 to 5.13.5 of this document:

The capacitors shall be mounted in accordance with 5.4.

5.13.2 Initial inspections

See Table 4.

5.13.3 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.

5.13.4 Recovery

The recovery period shall be 1 h to 2 h.

5.13.5 Final inspections and requirements

See Table 4.

5.14 Characteristics at high and low temperature

5.14.1 General

See IEC 60384-1:~~2008~~2016, 4.29, with 5.14.2 of this document:

The capacitors shall be mounted in accordance with 5.4.

5.14.2 Initial inspections and requirements

The capacitors shall be measured at each temperature step and shall meet the requirements given in Table 4.

5.15 Surge voltage

5.15.1 General

See IEC 60384-1:~~2008~~2016, 4.26, with 5.15.2 to 5.15.5 of this document.

5.15.2 Initial inspections

See Table 4.

5.15.3 Test conditions

Test conditions are as follows:

– number of cycles: 1 000;

– temperature: 15 °C to upper category temperature with the applicable requirements given in the detail specification;

– voltage: 1,15 U_R or 1,15 U_C;

– ~~Protective~~ charge resistor:1 000 Ω ± 100 Ω or a value calculated by Formula (1);

$$RC = 0{,}1 \pm 0{,}05 \text{ (s)} \quad (1)$$

where

If the internal resistance of the power supply is negligibly smaller than 1 000 Ω, R is equal to the resistance of the charging circuit. If the internal resistance of the power supply affects the charging resistance of the circuit, the current value possibly gets too small to measure correctly. On the other hand, if the time constant is 0,1 s and the capacitance is 1 000 µF, the R value is 100 Ω. Since an excessive inrush current then flows depending on the applied voltage, it is not possible to distinguish whether a defect, even if it occurs, is caused by the inrush current or the surge. Therefore, either of the two conditions above should be selectable depending on the situation at measurement.

R is the ~~value of charge resistor~~ sum of the internal resistance of the power supply and resistance of the charge circuit (Ω)

C is the value of nominal capacitance (F)

– duration of charge: 30 s;

– duration of no-load: 5 min 30 s.

5.15.4 Recovery

The recovery period shall be 1 h to 2 h.

5.15.5 Final inspections and requirements

See Table 4.

5.16 Endurance

5.16.1 General

See IEC 60384-1:~~2008~~2016, 4.23, with 5.16.2 to 5.16.5 of this document:

The capacitors shall be mounted in accordance with 5.4.

5.16.2 Initial inspections

See Table 4.

5.16.3 Test conditions

Test conditions are as follows:

– applied voltage: category voltage, unless otherwise specified in the detail specification;
– temperature: upper category temperature;
– duration: 1 000 h.

NOTE When the category voltage is different from the rated voltage, the sample tested is divided into two parts and submitted to the rated temperature and the category voltage respectively.

5.16.4 Recovery

The recovery period shall be 1 h to 2 h.

5.16.5 Final inspections and requirements

See Table 4.

5.17 Component solvent resistance (if required)

See IEC 60384-1:~~2008~~2016, 4.31.

5.18 Solvent resistance of marking (if required)

See IEC 60384-1:~~2008~~2016, 4.32.

5.19 High surge current (if required)

See IEC 60384-1:~~2008~~2016, 4.39.

5.20 Storage at high temperature

5.20.1 General

See IEC 60384-1:~~2008~~2016, 4.25.1, with 5.20.2 to 5.20.5 of this document.

5.20.2 Initial inspections

See Table 4.

5.20.3 Test conditions

Test conditions are as follows:

– temperature: upper category temperature;
– duration: 96 h ± 4 h.

5.20.4 Recovery

The minimum recovery period shall be 16 h.

5.20.5 Final inspections and requirements

See Table 4.

6 Marking

6.1 General

See IEC 60384-1:~~2008~~2016, 2.4, with 6.2 to 6.4 of this document.

6.2 Information for marking

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) polarity of the terminations (unless identified by the construction);
b) nominal capacitance;
c) rated voltage (DC voltage may be indicated by the symbol: ⎓ (IEC 60417-5031-2002-10) or ⎓);
d) category temperature;
e) tolerance on nominal capacitance;
f) year and month (or, year and week) of manufacture;
g) manufacturer's name and/or trademark;
h) manufacturer's type designation;
i) reference to the detail specification.

6.3 Marking on capacitors

Polarity of the terminations shall be marked. Other elements are marked, as necessary.

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

6.4 Marking on packaging

The packaging containing the capacitors should be clearly marked with 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 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 7.27.2 may, for convenience, be presented in tabular form.

The following information shall be given in each detail specification and the values quoted shall preferably 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 capacitors as an aid to easy recognition and for comparison of the capacitors with others.

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

– for general: width, length and height.

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

– for terminals: width, length and spacing.

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 method of mounting for tests and measurements are given in 5.4. The detail specification shall specify the methods of mounting for normal use.

7.4 Ratings and characteristics

7.4.1 General

The ratings and characteristics shall be given in accordance with the relevant subclauses of this sectional specification, including the items specified in 7.4.2 to 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 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 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.

When there are deviations from Clause 6, these shall be given in the detail specification.

8 Quality assessment procedures

8.1 Primary stage of manufacture

The primary stage of manufacture is the forming of the oxide layer.

8.2 Structurally similar components

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

8.3 Certified test records of released lots

The information required in IEC 60384-1:~~2008~~2016, Q.1.5 shall be made available when prescribed in the detail specification and when requested by a purchaser. After the endurance test, the required parameters are the capacitance change, tangent of loss angle, equivalent series resistance, and leakage current.

8.4 Qualification approval (QA) procedures

8.4.1 General

The procedures for qualification approval testing are given in IEC 60384-1:~~2008~~2016, 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 8.5. 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:~~2008~~2016, Q.2.4. The ~~sample~~ range of approval shall be representative of the range of capacitors for which approval is sought. The ~~sample~~ range of approval may be the whole or the 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 case size. When there are more than four case sizes, an intermediate case size shall also be tested. In each of these case size/voltage combinations (values), the maximum capacitance shall be chosen. Thus, for the approval of a range, testing is required ~~of~~ for either four or six values. When the range consists of fewer than four values, the number of specimens to be tested shall be that required for four values.

Two (for 6 values) or three (for 4 values) specimens per value may be used as replacements for specimens, that are nonconforming 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 3 gives the number of samples to be tested in each group or subgroup together with the permissible number of ~~non-conforming items~~ non-conformances for qualification approval tests.

8.4.3 Tests

The complete series of tests specified in Table 3 and Table 4 are required for the approval of capacitors covered by a 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.

Specimens found to be non-conforming in the tests of Group 0 shall not be used for the other groups.

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

Table 3 and Table 4 together form the fixed sample size test schedule for the qualification approval on the basis of the fixed sample size procedure.

Table 3 gives the number of the samples or permissible non-conforming items for each test or test group.

Table 4 gives a summary of the test conditions and performance requirements, and ~~choices of the test conditions and performance requirements~~ when a choice shall be made in the detail specification.

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

Table 3 – Sampling plan for qualification approval, assessment level EZ

Group no.	Test	Subclause	Number of specimens n [d]	Permissible number of non-conforming items c [g]
0	High surge current [c]	5.19	120+12 [f]	0
	Visual examination	5.5		
	Dimensions	5.5		
	Leakage current	5.6.1		
	Capacitance	5.6.2		
	Tangent of loss angle	5.6.3		
	Equivalent series resistance [c]	5.6.4		
	Spare specimens			
1A	Resistance to soldering heat	5.7	12	0
	Component solvent resistance [c]	5.17		
1B	Solderability	5.8	12	0
	Solvent resistance of marking [c]	5.18		
2	Substrate bending test [e]	5.10	12	0
3 [a]	Mounting	5.4	84	0 [b]
	Visual examination	5.5.2		
	Leakage current	5.6.1		
	Capacitance	5.6.2		
	Tangent of loss angle	5.6.3		
	Equivalent series resistance [c]	5.6.4		
3.1	Shear test [c]	5.9	12	0
	Rapid change of temperature	5.11		
	Climatic sequence	5.12		
3.2	Damp heat, steady state	5.13	12	0
3.3	Characteristics at high and low temperature	5.14	12	0
	Surge voltage	5.15		
3.4	Endurance	5.16	36	0
3.5	Storage at high temperature	5.20	12	0

[a] The values of these inspections serve as initial inspections for the tests of Group 3.

[b] The capacitors found non-conforming after mounting shall not be taken into account when calculating the non-conforming items for the following tests. They shall be replaced by spare capacitors.

[c] If required.

[d] For case size/voltage combinations, see 8.4.2.

[e] Not applicable to capacitors, which shall be mounted on alumina substrates only, according to their detail specification.

[f] Spare specimens.

[g] This is the acceptance number, which is not to be exceeded for acceptance.

Table 4 – Test schedule for qualification approval *(1 of 6)*

Subclause number and test[a], inspection items		D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
GROUP 0		ND		See Table 3	
5.19	High surge current[e]		See IEC 60384-1:~~2008~~2016, 4.39		See detail specification
5.5	Dimension (detail)		See 5.5.2		See detail specification
5.5.2	Visual examination		See 5.5.2		Legible marking and as specified in the detail specification
5.6.1	Leakage current		See 5.6.1.2		≤ 0,1 $C_N U_R$ or 10 µA, whichever is the greater (at 20 °C ± 2 °C) [d]
5.6.2	Capacitance		See 5.6.2.2		Within specified tolerance
5.6.3	Tangent of loss angle (tan δ)		See 5.6.3.2		See detail specification
5.6.4	Equivalent series resistance [e]		See 5.6.4.2		See detail specification
GROUP 1A		D		See Table 3	
5.7	Resistance to soldering heat		See 5.7.3		
5.7.2	Initial inspections				
	Capacitance		See 5.6.2.2		
5.7.4	Recovery		See 5.7.4		
5.7.5	Final inspections				
	Visual examination		See 5.7.5		There shall be no signs of remarkable damage Dissolution of the end face plating (leaching) shall not exceed 25 % of the length of the edge concerned
	Capacitance		See 5.6.2.2		See detail specification
	Tangent of loss angle		See 5.6.3.2		See detail specification
	Leakage current		See 5.6.1.2		See detail specification
5.17	Component solvent resistance [e]		See IEC 60384-1:~~2008~~2016, 4.31		See IEC 60384-1:~~2008~~2016, 4.31

Table 4 *(2 of 6)*

Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
GROUP 1B	D		See Table 3	
5.8 Solderability		See IEC 60384-1:~~2008~~2016, 4.15		
5.8.2 Final inspections				
Visual examination		See 5.5.2		~~There shall be~~ No signs of damage. Areas to be soldered shall be covered with a new 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. Areas in which plating does not exist, such as the tip of the terminal, shall not be evaluated.
5.18 Solvent resistance of the marking [c,e]		See IEC 60384-1:~~2008~~2016, 4.32		See IEC 60384-1:~~2008~~2016, 4.32
GROUP 2	D		See Table 3	
5.10 Substrate bending test [e]		See 5.10.3		
5.10.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.10.4 Final inspections				
Visual examination		See 5.5.2		No visible damage
Capacitance (with printed board in bent position)		See 5.6.2.2		See detail specification
GROUP 3	D		See Table 3	
5.4 Mounting		See 5.4.3		
5.4.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.4.4 Final inspections				
Visual examination		See 5.5.2		No visible damage
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert$ < 8 % of value measured in 5.4.2
Tangent of loss angle		See 5.6.3.2		See detail specification
Equivalent series resistance [e]		See 5.6.4.2		See detail specification

Table 4 *(3 of 6)*

Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
GROUP 3.1	D		See Table 3	
5.9 Shear test		See IEC 60384-1:~~2008~~2016, 4.34		
5.11 Rapid change of temperature		See 5.11.3		
5.11.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.11.4 Recovery		See 5.11.4		
5.11.5 Final inspections				
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		$\|\Delta C/C\|$ ≤ 10 % of the value measured in 5.11.2
Tangent of loss angle		See 5.6.3.2		See detail specification
5.12 Climatic sequence		See IEC 60384-1:~~2008~~2016, 4.21		
5.12.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.12.3 Dry heat		See 5.12.3		
5.12.4 Damp heat, cyclic, test Db, first cycle		See IEC 60384-1:~~2008~~2016, 4.21.4		
5.12.5 Cold		See 5.12.5		
5.12.6 Damp heat, cyclic, test Db, remaining cycles		See IEC 60384-1:~~2008~~2016, 4.21.7		
5.12.7 Recovery		See 5.12.7		
5.12.8 Final inspections				
Visual examination		See 5.5.2		No visible damage Legible marking
Capacitance		See 5.6.2.2		$\|\Delta C/C\|$ ≤ 20 % of the value measured in 5.12.2
Tangent of loss angle		See 5.6.3.2		See detail specification

Table 4 *(4 of 6)*

Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
GROUP 3.2	D		See Table 3	
5.13 Damp heat, steady state		See 5.13.3		
5.13.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.13.4 Recovery		See 5.13.4		
5.13.5 Final inspections				
Visual examination		See 5.5.2		No visible damage Legible marking
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		$-20\ \% < \lvert\Delta C/C\rvert < +40\ \%$ of the value measured in 5.13.2
Tangent of loss angle		See 5.6.3.2		See detail specification
GROUP 3.3	D		See Table 3	
5.14 Characteristics at high and low temperature		See IEC 60384-1:~~2008~~2016, 4.29		
Step 1: 20 °C				
Leakage current		See 5.6.1.2		
Capacitance		See 5.6.2.2		
Tangent of loss angle		See 5.6.3.2		
Step 2: −55 °C (lower category temperature)				
Capacitance		See 5.6.2.2		See detail specification
Tangent of loss angle		See 5.6.3.2		See detail specification
Step 3: 20 °C				
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert \leq 5\ \%$ of the value measured in step 1
Tangent of loss angle		See 5.6.3.2		See detail specification
Step 4: 85 °C				
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		See detail specification
Step 5: upper category temperature				
Leakage current (with U_R)		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		See detail specification
Tangent of loss angle		See 5.6.3.2		See detail specification
Step 6: 20 °C				
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert \leq 5\ \%$ of the value measured in step 1
Tangent of loss angle		See 5.6.3.2		See detail specification

Table 4 *(5 of 6)*

Subclause number and test[a], inspection items		D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
5.15	Surge voltage	D	See 5.15.3	See Table 3	
5.15.2	Initial inspections				
	Capacitance		See 5.6.2.2		
5.15.4	Recovery		See 5.15.4		
5.15.5	Final inspections				
	Leakage current		See 5.6.1.2		See detail specification
	Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert$ ≤ 10 % of the value measured in 5.15.2
	Tangent of loss angle		See 5.6.3.2		See detail specification
GROUP 3.4		D		See Table 3	
5.16	Endurance		See 5.16.3		
5.16.2	Initial inspections				
	Capacitance		See 5.6.2.2		
5.16.4	Recovery		See 5.16.4		
5.16.5	Final inspections				
	Visual examination		See 5.5.2		No visible damage
					Legible marking
	Leakage current		See 5.6.1.2		≤ 2 times the value in 5.6.1
	Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert$ ≤ 20 % of the value measured in 5.16.2
	Tangent of loss angle		See 5.6.3.2		≤ 1,5 times the value in 5.6.3
	Equivalent series resistance [e]		See 5.6.4.2		See detail specification

Table 4 *(6 of 6)*

Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
GROUP 3.5	D		See Table 3	
5.20 Storage at high temperature		See 5.20.3		
5.20.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.20.4 Recovery		See 5.20.4		
5.20.5 Final inspections				
Visual examination		See 5.5.2		No visible damage Legible marking
Leakage current		See 5.6.1.2		≤ 5 times the value in 5.6.1
Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert$ ≤ 10 % of the value measured in 5.20.2
Tangent of loss angle		See 5.6.3.2		See 5.6.3.3

[a] Subclause numbers of test and performance requirements refer to Clause 5.

[b] In this table: D = destructive, ND = non-destructive.

[c] This test may be carried out on surface mount capacitors mounted on a substrate.

[d] C_N = nominal capacitance in microfarad; U_R = rated voltage in volt.

[e] If required.

8.5 Quality conformance inspections

8.5.1 Formation of inspection lots

8.5.1.1 Groups A and B inspections

These tests shall be carried out on a lot-by-lot basis.

A manufacturer may aggregate the current production into inspection lots subject to the following safeguards:

a) The inspection lot shall consist of structurally similar capacitors (see 8.2).

b) The sample tested shall be representative of the values (rated voltage and nominal capacitance) and dimensions contained in the inspection lot:
   - in relation to their number;
   - with a minimum of five of any one value.

c) If there are fewer than five of any one value in the sample, the basis for the drawing of samples shall be agreed between the manufacturer and the certification body (CB).

8.5.1.2 Group C inspections

These tests shall be carried out on a periodic basis.

Samples shall be representative of the current production of the specified periods and shall be divided into high-, medium- and low-voltage ratings. In order to cover the range of approvals in any period, one case size shall be tested from each voltage group. In subsequent periods, other case sizes and/or voltage ratings in production shall be tested with the aim of covering the whole range.

8.5.2 Test schedule

The test schedule for the lot-by-lot and periodic tests for quality conformance inspection is given in the blank detail specification.

8.5.3 Delayed delivery

When, in accordance with the procedures of IEC 60384-1:~~2008~~2016, Clause Q.1.7, re-inspection should be made, capacitance, tangent of loss angle, leakage current and solderability shall be checked as specified in Groups A and B inspections.

8.5.4 Assessment levels

The assessment levels given in the blank detail specification shall ~~preferably~~ be selected from Table 5 and Table 6 as assessment level EZ.

Table 5 – Lot-by-lot inspection

Inspection subgroup[a]	EZ		
	IL[b]	n[b]	c[b]
A0	100 %[c]		
A1	S-3	[d]	0
A2	S-3	[d]	0
B1	S-3	[d]	0

[a] The content of the inspection subgroup is described in Clause 2 of the blank detail specification.

[b] IL = inspection level

n = sample size

c = permissible number of non-conforming items

[c] After removal of nonconforming items by 100 % testing during the manufacturing process, sampling inspection shall be performed in order to monitor outgoing quality level by nonconforming items per million ($\times 10^{-6}$). The sampling level shall be established by the manufacturer~~, preferably~~ in accordance with IEC 61193-2:2007 Annex A. In the case where one or more nonconforming items occur in a sample, this lot shall be rejected, but the whole sample shall be inspected and all nonconforming items shall be counted for the calculation of quality level values. Outgoing quality level by nonconforming items per million ($\times 10^{-6}$) values shall be calculated by accumulating inspection data in accordance with the method given in IEC 61193-2:2007, 6.2.

[d] Number to be tested: Sample size shall be determined in accordance with IEC 61193-2:2007, 4.3.2.

Table 6 – Periodic inspection

Inspection subgroup[a]	EZ		
	p[b]	n[b]	c[b]
C1A	6	12	0
C1B	6	12	0
C1	6	24	0
C2	6	24	0
C3	3	36	0
C4	6	12	0
C5	6	12	0

[a] The content of the inspection subgroup is described in Clause 2 of the blank detail specification.

[b] p = periodicity in months

n = sample size

c = permissible number of non-conforming items

Annex X
(informative)

Cross-references to the prior edition of this document

The revision of this sectional specification has resulted in a new structure. Table X.1 provides a cross-reference to specific elements of the prior edition of this sectional specification.

Table X.1 – Reference to IEC 60384-24 for clauses/subclauses and tables

IEC 60384-24:2015 (Edition 2.0) Clause/subclause	IEC 60384-24:2021 (Edition 3.0) Clause/subclause	Notes
1	-	This is covered by Clauses 1, 2, 3, 4, 6, 7.
1.1 1.2	1	The prior scope and object are merged into Clause 1.
1.3	2	-
1.4	7	-
1.4.1	7.1	-
1.4.2	7.2	-
1.4.3	7.3	-
1.4.4	7.4	
1.4.4.1	7.4.1	-
1.4.4.2	7.4.2	-
1.4.4.3	7.4.3	-
1.4.4.4	7.4.4	-
1.4.5	7.5	-
1.5	3	
1.6	6	
1.6.1	6.1	
1.6.2	6.2	
1.6.3	6.3	
1.6.4	6.4	
2	4	Clause 2 is transferred to become Clause 4. Otherwise numbering kept unchanged.
3	8	Clause 3 is transferred to become Clause 8. Otherwise numbering kept unchanged.
4	5	Clause 4 is transferred to become Clause 5. Otherwise numbering kept unchanged.
Table 1	Table 1	-
Table 2	Table 2	-
Table 3	Table 3	-
Table 4	Table 4	-
Table 5	Table 5	-
Table 6	Table 6	-

Bibliography

IEC 60068-2-58:~~2004~~2015, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60384-3, *Fixed capacitors for use in electronic equipment – Part 3: Sectional specification: Surface mount fixed tantalum electrolytic capacitors with manganese dioxide solid electrolyte*

IEC 60417, *Graphical symbols for use on equipment* (available at http://www.graphical-symbols.info/equipment)

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

IEC 60384-24

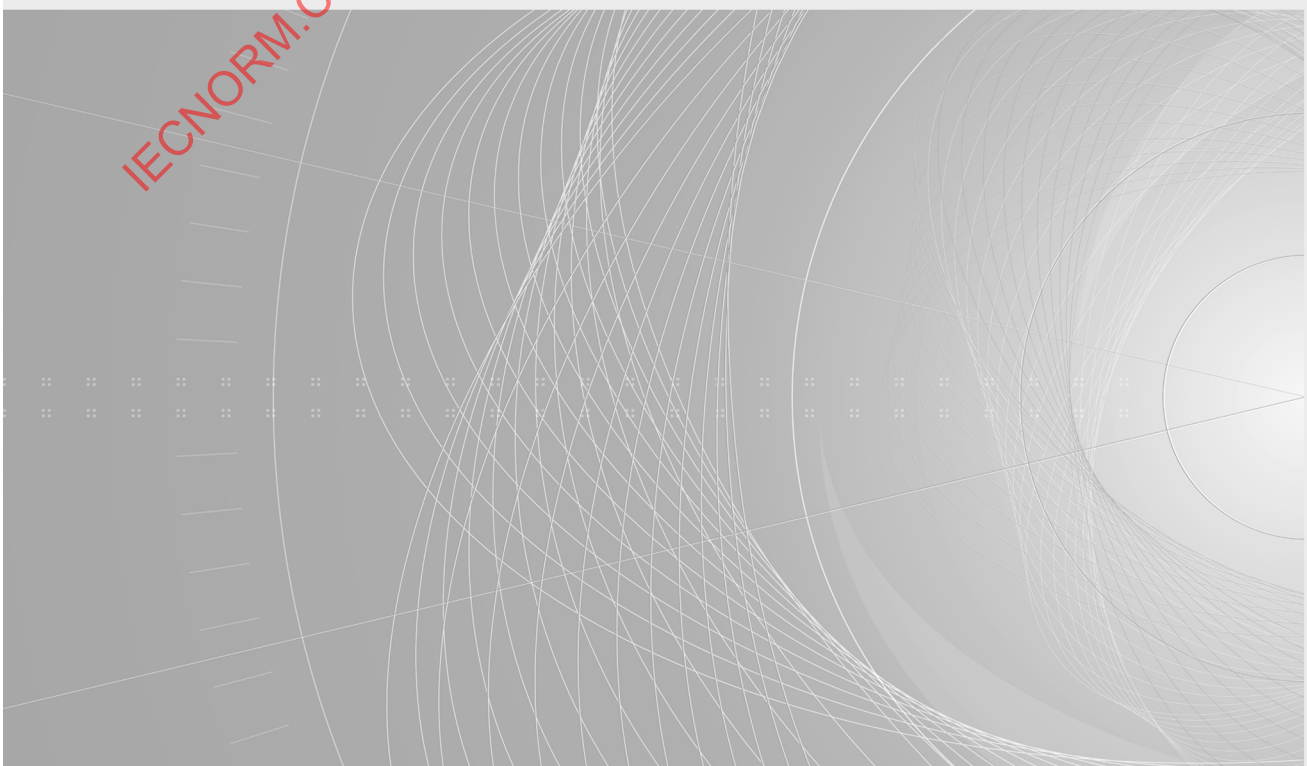
Edition 3.0 2021-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fixed capacitors for use in electronic equipment –
Part 24: Sectional specification – Fixed tantalum electrolytic surface mount capacitors with conductive polymer solid electrolyte

Condensateurs fixes utilisés dans les équipements électroniques –
Partie 24: Spécification intermédiaire – Condensateurs fixes électrolytiques au tantale pour montage en surface à électrolyte solide en polymère conducteur



IEC 60384-24:2021-07(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 24: Sectional specification – Fixed tantalum electrolytic surface mount capacitors with conductive polymer solid electrolyte

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60384-24 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This third edition cancels and replaces the second edition published in 2015. This edition constitutes a technical revision.

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

a) Revision of the structure in accordance with ISO/IEC Directives, Part 2:2018, to the extent practicable, and harmonization between other similar kinds of documents.
b) In addition, Clause 5 and all the tables have been reviewed in order to prevent duplications and contradictions.

The text of this standard is based on the following documents:

FDIS	Report on voting
40/2849/FDIS	40/2860/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.

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.

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 http://www.iec.ch/standardsdev/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

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

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 24: Sectional specification – Fixed tantalum electrolytic surface mount capacitors with conductive polymer solid electrolyte

1 Scope

This part of IEC 60384 applies to fixed tantalum electrolytic surface mount capacitors with conductive polymer solid electrolyte, which are primarily intended for DC applications for use in electronic equipment.

Fixed tantalum electrolytic surface mount capacitors with solid (MnO_2) electrolyte are not included but are covered by IEC 60384-3.

These capacitors are primarily intended for use in electronic equipment to be mounted directly on substrates for hybrid circuits or to printed boards.

Capacitors for special-purpose applications can need additional requirements.

The object of this document is to prescribe preferred ratings and characteristics and to select from IEC 60384-1:2016 the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of capacitor.

2 Normative references

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

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

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

IEC 60384-1:2016, *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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60384-1:2016 and the following apply.

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

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

3.1
capacitance
<electrolytic capacitor> capacitance of an equivalent circuit whose capacitance and resistance in series is measured with an alternating current having an approximately sinusoidal waveform at a specified frequency

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 sectional specification are classified into climatic categories in accordance with the general rules given in IEC 60068-1:2013, Annex A.

The lower and upper category temperature shall be taken from the following:

- lower category temperature: −55 °C;
- upper category temperature: +105 °C and +125 °C.

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

The upper category temperature shall be 105 °C or 125 °C for a rated temperature of 85 °C.

The upper category temperature shall be 125 °C for a rated temperature of 105 °C.

4.2 Preferred values of ratings

4.2.1 Nominal capacitance (C_N)

Preferred values of nominal capacitance are indicated in microfarad (µF).

Preferred values of nominal capacitance shall be taken from the E 12 series of IEC 60063 as follows:

1,0 – 1,2 – 1,5 – 1,8 – 2,2 – 2,7 – 3,3 – 3,9 – 4,7 – 5,6 – 6,8 – 8,2;

and their decimal multiples (× 10^n, n: integer).

4.2.2 Tolerance on nominal capacitance

Preferred value of tolerance on nominal capacitance is:

±20 %.

4.2.3 Rated voltage (U_R)

Preferred values of rated DC voltages taken from R10 and R20 series of ISO 3 are:

– from R10: 1,0 – 1,25 – 1,6 – 2,0 – 2,5 – 4,0 – 5,0 – 6,3 – 8,0;
– from R20: 3,5[1];
– and their decimal multiples (× 10^n, n: integer).

[1] ISO 3 indicates the value 3,55 for R20.

4.2.4 Category voltage (U_C)

The category voltage for capacitors is given in Table 1 and Table 2.

4.2.5 Surge voltage (U_{RS} or U_{CS})

The surge voltage shall be 1,15 times the rated or category voltage rounded off to the nearest volt (two significant digits) (see Table 1 and Table 2).

NOTE U_{RS} is the surge voltage to rated voltage;
U_{CS} is the surge voltage to category voltage.

4.2.6 Rated temperature

The value of the rated temperature is +85 °C and +105 °C (see Table 1 and Table 2).

Table 1 – Category and surge voltages

Values in volts

	Upper category temperature 125 °C / rated temperature 85 °C											
U_R	2,0	2,5	4,0	5,0	6,3	8,0	10	12,5	16	20	25	35
U_C = 0,80 U_R	1,6	2,0	3,2	4,0	5,0	6,4	8,0	10	13	16	20	28
U_{RS}	2,3	2,9	4,6	5,8	7,2	9,2	12	14	18	23	29	40
U_{CS}	1,8	2,3	3,7	4,6	5,8	7,4	9,2	12	15	18	23	32

Table 2 – Category and surge voltages

Values in volts

	Upper category temperature 125 °C / rated temperature 105 °C or upper category temperature 105 °C / rated temperature 85 °C											
U_R	2,0	2,5	4,0	5,0	6,3	8,0	10	12,5	16	20	25	35
U_C = 0,90 U_R	1,8	2,3	3,6	4,5	5,7	7,2	9,0	11	14	18	23	32
U_{RS}	2,3	2,9	4,6	5,8	7,2	9,2	12	14	18	23	29	40
U_{CS}	2,0	2,6	4,1	5,2	6,5	8,2	10	13	16	20	26	36

5 Test and measurement procedures

5.1 General

Test severities and requirements prescribed in detail specifications referring to this sectional specification are of equal or higher performance level, because lower performance levels are not permitted.

This clause supplements the information given in IEC 60384-1:2016, Clause 4.

5.2 Preliminary drying

See IEC 60384-1:2016, 4.3.

5.3 Measuring conditions

See IEC 60384-1:2016, 4.2.1.

5.4 Mounting

5.4.1 General

See IEC 60384-1:2016, 4.33, with 5.4.2, 5.4.3 and 5.4.4 of this document.

5.4.2 Initial inspections

See Table 4.

5.4.3 Test conditions

The test method shall be the reflow method and reflow temperature profile specified in the detail specification.

5.4.4 Final inspections and requirements

See Table 4.

5.5 Visual examination and check of dimensions

5.5.1 General

See IEC 60384-1:2016, 4.4, with 5.5.2 and 5.5.3 of this document.

5.5.2 Visual examination and check of dimensions

Visual examination shall be carried out with suitable equipment with approximately 10× magnification and lighting appropriate to the specimen under test and the quality level required. The operator should have available facilities for incident or transmitted illumination, as well as an appropriate measuring facility. The capacitors shall be examined to verify that the materials, design, construction, and physical dimensions are appropriate.

5.5.3 Requirements

The workmanship shall be in accordance with the applicable requirements given in the detail specification.

5.6 Electrical tests

5.6.1 Leakage current

5.6.1.1 General

See IEC 60384-1:2016, 4.9, with 5.6.1.2 and 5.6.1.3 of this document.

5.6.1.2 Measuring conditions

The rated voltage shall be applied across the capacitor and its protective resistor placed in series with the capacitor to limit the charging current.

The protective resistor shall have a value of 1 000 Ω.

5.6.1.3 Requirements

See Table 4.

5.6.2 Capacitance

5.6.2.1 General

See IEC 60384-1:2016, 4.7, with 5.6.2.2 and 5.6.2.3 of this document.

5.6.2.2 Measuring conditions

Unless otherwise specified in the detail specifications, the capacitance shall be measured at a frequency of 100 Hz or 120 Hz.

The peak alternating voltage actually applied across the capacitor terminations shall not exceed 0,5 V (RMS).

A DC bias voltage of 0,7 V to 1,0 V may be applied during the measurement to avoid negative voltage application to the capacitor by the applied AC voltage.

The inaccuracy of the measuring instruments shall not exceed ±2 % of the limit specified in the detail specification, whether this is given as an absolute value or as a change of capacitance.

5.6.2.3 Requirements

See Table 4.

5.6.3 Tangent of loss angle (tan δ)

5.6.3.1 General

See IEC 60384-1:2016, 4.8.1, with 5.6.3.2 and 5.6.3.3 of this document.

5.6.3.2 Measuring conditions

The measurement shall be under the conditions as specified in 5.6.2.2.

The inaccuracy of the measuring equipment shall not exceed 0,01 in absolute value.

5.6.3.3 Requirements

See Table 4.

5.6.4 Equivalent series resistance (ESR) (if required)

5.6.4.1 General

See IEC 60384-1:2016, 4.8.2, with 5.6.4.2 and 5.6.4.3 of this document.

5.6.4.2 Measuring conditions

Unless otherwise specified in the detail specifications, test conditions are as follows:

– temperature: 20 °C ± 2 °C;
– applied voltage: peak AC value ≤ 0,5 V (RMS);
– voltage frequency: 100 kHz ± 10 kHz.

The error of measurement shall not exceed 5 % of the requirement, or 0,02 Ω, whichever is the greater.

5.6.4.3 Requirements

See Table 4.

5.7 Resistance to soldering heat

5.7.1 General

See IEC 60384-1:2016, 4.14, with 5.7.2 to 5.7.5 of this document.

5.7.2 Initial inspections

See Table 4.

5.7.3 Test conditions

The test method shall be the reflow method, and the reflow temperature profile shall be specified in the detail specification.

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 under normal lighting and approximately 10× magnification and measured electrical characteristics given in Table 4.

5.8 Solderability

5.8.1 General

See IEC 60384-1:2016, 4.15, with 5.8.2 of this document.

5.8.2 Final inspections and requirements

See Table 4.

5.9 Shear test

See IEC 60384-1:2016, 4.34.

5.10 Substrate bending test (if required)

5.10.1 General

See IEC 60384-1:2016, 4.35, with 5.10.2 to 5.10.4 of this document.

5.10.2 Initial inspections

See Table 4.

5.10.3 Test conditions

Deflection D and the number of bends shall be specified in the detail specification.

5.10.4 Final inspections and requirements

See Table 4.

5.11 Rapid change of temperature

5.11.1 General

See IEC 60384-1:2016, 4.16, with 5.11.2 to 5.11.5 of this document.

The capacitors shall be mounted in accordance with 5.4.

5.11.2 Initial inspections

See Table 4.

5.11.3 Test conditions

Test conditions are as follows:

– T_A = lower category temperature;
– T_B = upper category temperature;
– the capacitors shall be tested for 5 cycles;
– the duration of the exposure at each temperature limit shall be 30 min.

5.11.4 Recovery

The recovery period shall be 1 h to 2 h.

5.11.5 Final inspections and requirements

See Table 4.

5.12 Climatic sequence

5.12.1 General

See IEC 60384-1:2016, 4.21, with 5.12.2 to 5.12.8 of this document.

5.12.2 Initial inspections

See Table 4.

5.12.3 Dry heat

See IEC 60384-1:2016, 4.21.3, with the following details:

– temperature: upper category temperature;
– duration: 16 h.

5.12.4 Damp heat, cyclic, test Db, first cycle

See IEC 60384-1:2016, 4.21.4.

5.12.5 Cold

See IEC 60384-1:2016, 4.21.5, with the following details:

– temperature: lower category temperature;
– duration: 2 h.

5.12.6 Damp heat, cyclic, test Db, remaining cycles

See IEC 60384-1:2016, 4.21.7.

5.12.7 Recovery

The recovery period shall be 1 h to 2 h.

5.12.8 Final inspections and requirements

See Table 4.

5.13 Damp heat, steady state

5.13.1 General

See IEC 60384-1:2016, 4.22, with 5.13.2 to 5.13.5 of this document:

The capacitors shall be mounted in accordance with 5.4.

5.13.2 Initial inspections

See Table 4.

5.13.3 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.

5.13.4 Recovery

The recovery period shall be 1 h to 2 h.

5.13.5 Final inspections and requirements

See Table 4.

5.14 Characteristics at high and low temperature

5.14.1 General

See IEC 60384-1:2016, 4.29, with 5.14.2 of this document:

The capacitors shall be mounted in accordance with 5.4.

5.14.2 Initial inspections and requirements

The capacitors shall be measured at each temperature step and shall meet the requirements given in Table 4.

5.15 Surge voltage

5.15.1 General

See IEC 60384-1:2016, 4.26, with 5.15.2 to 5.15.5 of this document.

5.15.2 Initial inspections

See Table 4.

5.15.3 Test conditions

Test conditions are as follows:

– number of cycles: 1 000;
– temperature: 15 °C to upper category temperature with the applicable requirements given in the detail specification;
– voltage: 1,15 U_R or 1,15 U_C;
– charge resistor: 1 000 Ω ± 100 Ω or a value calculated by Formula (1);

$$RC = 0{,}1 \pm 0{,}05 \text{ (s)} \quad (1)$$

where

If the internal resistance of the power supply is negligibly smaller than 1 000 Ω, R is equal to the resistance of the charging circuit. If the internal resistance of the power supply affects the charging resistance of the circuit, the current value possibly gets too small to measure correctly. On the other hand, if the time constant is 0,1 s and the capacitance is 1 000 µF, the R value is 100 Ω. Since an excessive inrush current then flows depending on the applied voltage, it is not possible to distinguish whether a defect, even if it occurs, is caused by the inrush current or the surge. Therefore, either of the two conditions above should be selectable depending on the situation at measurement.

R is the sum of the internal resistance of the power supply and resistance of the charge circuit (Ω)

C is the value of nominal capacitance (F)

– duration of charge: 30 s;
– duration of no-load: 5 min 30 s.

5.15.4 Recovery

The recovery period shall be 1 h to 2 h.

5.15.5 Final inspections and requirements

See Table 4.

5.16 Endurance

5.16.1 General

See IEC 60384-1:2016, 4.23, with 5.16.2 to 5.16.5 of this document:

The capacitors shall be mounted in accordance with 5.4.

5.16.2 Initial inspections

See Table 4.

5.16.3 Test conditions

Test conditions are as follows:

– applied voltage: category voltage, unless otherwise specified in the detail specification;
– temperature: upper category temperature;
– duration: 1 000 h.

NOTE When the category voltage is different from the rated voltage, the sample tested is divided into two parts and submitted to the rated temperature and the category voltage respectively.

5.16.4 Recovery

The recovery period shall be 1 h to 2 h.

5.16.5 Final inspections and requirements

See Table 4.

5.17 Component solvent resistance (if required)

See IEC 60384-1:2016, 4.31.

5.18 Solvent resistance of marking (if required)

See IEC 60384-1:2016, 4.32.

5.19 High surge current (if required)

See IEC 60384-1:2016, 4.39.

5.20 Storage at high temperature

5.20.1 General

See IEC 60384-1:2016, 4.25.1, with 5.20.2 to 5.20.5 of this document.

5.20.2 Initial inspections

See Table 4.

5.20.3 Test conditions

Test conditions are as follows:

– temperature: upper category temperature;
– duration: 96 h ± 4 h.

5.20.4 Recovery

The minimum recovery period shall be 16 h.

5.20.5 Final inspections and requirements

See Table 4.

6 Marking

6.1 General

See IEC 60384-1:2016, 2.4, with 6.2 to 6.4 of this document.

6.2 Information for marking

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) polarity of the terminations (unless identified by the construction);
b) nominal capacitance;
c) rated voltage (DC voltage may be indicated by the symbol: ⎓ (IEC 60417-5031-2002-10) or ———);
d) category temperature;
e) tolerance on nominal capacitance;
f) year and month (or, year and week) of manufacture;
g) manufacturer's name and/or trademark;
h) manufacturer's type designation;
i) reference to the detail specification.

6.3 Marking on capacitors

Polarity of the terminations shall be marked. Other elements are marked, as necessary.

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

6.4 Marking on packaging

The packaging containing the capacitors should be clearly marked with 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 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 7.27.2 may, for convenience, be presented in tabular form.

The following information shall be given in each detail specification and the values quoted shall preferably 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 capacitors as an aid to easy recognition and for comparison of the capacitors with others.

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

– for general: width, length and height.

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

– for terminals: width, length and spacing.

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 method of mounting for tests and measurements are given in 5.4. The detail specification shall specify the methods of mounting for normal use.

7.4 Ratings and characteristics

7.4.1 General

The ratings and characteristics shall be given in accordance with the relevant subclauses of this sectional specification, including the items specified in 7.4.2 to 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 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 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.

When there are deviations from Clause 6, these shall be given in the detail specification.

8 Quality assessment procedures

8.1 Primary stage of manufacture

The primary stage of manufacture is the forming of the oxide layer.

8.2 Structurally similar components

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

8.3 Certified test records of released lots

The information required in IEC 60384-1:2016, Q.1.5 shall be made available when prescribed in the detail specification and when requested by a purchaser. After the endurance test, the required parameters are the capacitance change, tangent of loss angle, equivalent series resistance, and leakage current.

8.4 Qualification approval (QA) procedures

8.4.1 General

The procedures for qualification approval testing are given in IEC 60384-1:2016, 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 8.5. 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 60384-1:2016, Q.2.4. The range of approval shall be representative of the range of capacitors for which approval is sought. The range of approval may be the whole or the 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 case size. When there are more than four case sizes, an intermediate case size shall also be tested. In each of these case size/voltage combinations (values), the maximum capacitance shall be chosen. Thus, for the approval of a range, testing is required for either four or six values. When the range consists of fewer than four values, the number of specimens to be tested shall be that required for four values.

Two (for 6 values) or three (for 4 values) specimens per value may be used as replacements for specimens, that are nonconforming 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 3 gives the number of samples to be tested in each group or subgroup together with the permissible number of non-conformances for qualification approval tests.

8.4.3 Tests

The complete series of tests specified in Table 3 and Table 4 are required for the approval of capacitors covered by a 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.

Specimens found to be non-conforming in the tests of Group 0 shall not be used for the other groups.

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

Table 3 and Table 4 together form the fixed sample size test schedule for the qualification approval on the basis of the fixed sample size procedure.

Table 3 gives the number of the samples or permissible non-conforming items for each test or test group.

Table 4 gives a summary of the test conditions and performance requirements, and when a choice shall be made in the detail specification.

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

Table 3 – Sampling plan for qualification approval, assessment level EZ

Group no.	Test	Subclause	Number of specimens n [d]	Permissible number of non-conforming items c [g]
0	High surge current [c]	5.19	120+12[f]	0
	Visual examination	5.5		
	Dimensions	5.5		
	Leakage current	5.6.1		
	Capacitance	5.6.2		
	Tangent of loss angle	5.6.3		
	Equivalent series resistance [c]	5.6.4		
	Spare specimens			
1A	Resistance to soldering heat	5.7	12	0
	Component solvent resistance [c]	5.17		
1B	Solderability	5.8	12	0
	Solvent resistance of marking [c]	5.18		
2	Substrate bending test [e]	5.10	12	0
3[a]	Mounting	5.4	84	0[b]
	Visual examination	5.5.2		
	Leakage current	5.6.1		
	Capacitance	5.6.2		
	Tangent of loss angle	5.6.3		
	Equivalent series resistance [c]	5.6.4		
3.1	Shear test [c]	5.9	12	0
	Rapid change of temperature	5.11		
	Climatic sequence	5.12		
3.2	Damp heat, steady state	5.13	12	0
3.3	Characteristics at high and low temperature	5.14	12	0
	Surge voltage	5.15		
3.4	Endurance	5.16	36	0
3.5	Storage at high temperature	5.20	12	0

[a] The values of these inspections serve as initial inspections for the tests of Group 3.

[b] The capacitors found non-conforming after mounting shall not be taken into account when calculating the non-conforming items for the following tests. They shall be replaced by spare capacitors.

[c] If required.

[d] For case size/voltage combinations, see 8.4.2.

[e] Not applicable to capacitors, which shall be mounted on alumina substrates only, according to their detail specification.

[f] Spare specimens.

[g] This is the acceptance number, which is not to be exceeded for acceptance.

Table 4 – Test schedule for qualification approval *(1 of 6)*

Subclause number and test[a], inspection items		D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
GROUP 0		ND		See Table 3	
5.19	High surge current[e]		See IEC 60384-1:2016, 4.39		See detail specification
5.5	Dimension (detail)		See 5.5.2		See detail specification
5.5.2	Visual examination		See 5.5.2		Legible marking and as specified in the detail specification
5.6.1	Leakage current		See 5.6.1.2		≤ 0,1 $C_N U_R$ or 10 µA, whichever is the greater (at 20 °C ± 2 °C) [d]
5.6.2	Capacitance		See 5.6.2.2		Within specified tolerance
5.6.3	Tangent of loss angle (tan δ)		See 5.6.3.2		See detail specification
5.6.4	Equivalent series resistance [e]		See 5.6.4.2		See detail specification
GROUP 1A		D		See Table 3	
5.7	Resistance to soldering heat		See 5.7.3		
5.7.2	Initial inspections				
	Capacitance		See 5.6.2.2		
5.7.4	Recovery		See 5.7.4		
5.7.5	Final inspections				
	Visual examination		See 5.7.5		There shall be no signs of remarkable damage Dissolution of the end face plating (leaching) shall not exceed 25 % of the length of the edge concerned
	Capacitance		See 5.6.2.2		See detail specification
	Tangent of loss angle		See 5.6.3.2		See detail specification
	Leakage current		See 5.6.1.2		See detail specification
5.17	Component solvent resistance [e]		See IEC 60384-1:2016, 4.31		See IEC 60384-1:2016, 4.31

Table 4 *(2 of 6)*

Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
GROUP 1B	D		See Table 3	
5.8 Solderability		See IEC 60384-1:2016, 4.15		
5.8.2 Final inspections				
Visual examination		See 5.5.2		No signs of damage. Areas to be soldered shall be covered with a new 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. Areas in which plating does not exist, such as the tip of the terminal, shall not be evaluated.
5.18 Solvent resistance of the marking [c,e]		See IEC 60384-1:2016, 4.32		See IEC 60384-1:2016, 4.32
GROUP 2	D		See Table 3	
5.10 Substrate bending test [e]		See 5.10.3		
5.10.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.10.4 Final inspections				
Visual examination		See 5.5.2		No visible damage
Capacitance (with printed board in bent position)		See 5.6.2.2		See detail specification
GROUP 3	D		See Table 3	
5.4 Mounting		See 5.4.3		
5.4.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.4.4 Final inspections				
Visual examination		See 5.5.2		No visible damage
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		$\|\Delta C/C\|$ < 8 % of value measured in 5.4.2
Tangent of loss angle		See 5.6.3.2		See detail specification
Equivalent series resistance [e]		See 5.6.4.2		See detail specification

Table 4 *(3 of 6)*

Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
GROUP 3.1	D		See Table 3	
5.9 Shear test		See IEC 60384-1:2016, 4.34		
5.11 Rapid change of temperature		See 5.11.3		
5.11.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.11.4 Recovery		See 5.11.4		
5.11.5 Final inspections				
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert$ ≤ 10 % of the value measured in 5.11.2
Tangent of loss angle		See 5.6.3.2		See detail specification
5.12 Climatic sequence		See IEC 60384-1:2016, 4.21		
5.12.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.12.3 Dry heat		See 5.12.3		
5.12.4 Damp heat, cyclic, test Db, first cycle		See IEC 60384-1:2016, 4.21.4		
5.12.5 Cold		See 5.12.5		
5.12.6 Damp heat, cyclic, test Db, remaining cycles		See IEC 60384-1:2016, 4.21.7		
5.12.7 Recovery		See 5.12.7		
5.12.8 Final inspections				
Visual examination		See 5.5.2		No visible damage Legible marking
Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert$ ≤ 20 % of the value measured in 5.12.2
Tangent of loss angle		See 5.6.3.2		See detail specification

Table 4 *(4 of 6)*

Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
GROUP 3.2	D		See Table 3	
5.13 Damp heat, steady state		See 5.13.3		
5.13.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.13.4 Recovery		See 5.13.4		
5.13.5 Final inspections				
Visual examination		See 5.5.2		No visible damage Legible marking
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		$-20\ \% < \lvert\Delta C/C\rvert < +40\ \%$ of the value measured in 5.13.2
Tangent of loss angle		See 5.6.3.2		See detail specification
GROUP 3.3	D		See Table 3	
5.14 Characteristics at high and low temperature		See IEC 60384-1:2016, 4.29		
Step 1: 20 °C				
Leakage current		See 5.6.1.2		
Capacitance		See 5.6.2.2		
Tangent of loss angle		See 5.6.3.2		
Step 2: −55 °C (lower category temperature)				
Capacitance		See 5.6.2.2		See detail specification
Tangent of loss angle		See 5.6.3.2		See detail specification
Step 3: 20 °C				
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert \leq 5\ \%$ of the value measured in step 1
Tangent of loss angle		See 5.6.3.2		See detail specification
Step 4: 85 °C				
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		See detail specification
Step 5: upper category temperature				
Leakage current (with U_R)		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		See detail specification
Tangent of loss angle		See 5.6.3.2		See detail specification
Step 6: 20 °C				
Leakage current		See 5.6.1.2		See detail specification
Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert \leq 5\ \%$ of the value measured in step 1
Tangent of loss angle		See 5.6.3.2		See detail specification

Table 4 *(5 of 6)*

Subclause number and test[a], inspection items		D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
5.15	Surge voltage	D	See 5.15.3	See Table 3	
5.15.2	Initial inspections				
	Capacitance		See 5.6.2.2		
5.15.4	Recovery		See 5.15.4		
5.15.5	Final inspections				
	Leakage current		See 5.6.1.2		See detail specification
	Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert$ ≤ 10 % of the value measured in 5.15.2
	Tangent of loss angle		See 5.6.3.2		See detail specification
GROUP 3.4		D		See Table 3	
5.16	Endurance		See 5.16.3		
5.16.2	Initial inspections				
	Capacitance		See 5.6.2.2		
5.16.4	Recovery		See 5.16.4		
5.16.5	Final inspections				
	Visual examination		See 5.5.2		No visible damage Legible marking
	Leakage current		See 5.6.1.2		≤ 2 times the value in 5.6.1
	Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert$ ≤ 20 % of the value measured in 5.16.2
	Tangent of loss angle		See 5.6.3.2		≤ 1,5 times the value in 5.6.3
	Equivalent series resistance [e]		See 5.6.4.2		See detail specification

Table 4 *(6 of 6)*

Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and permissible number of non-conforming items (c)	Performance requirements[a]
GROUP 3.5	D		See Table 3	
5.20 Storage at high temperature		See 5.20.3		
5.20.2 Initial inspections				
Capacitance		See 5.6.2.2		
5.20.4 Recovery		See 5.20.4		
5.20.5 Final inspections				
Visual examination		See 5.5.2		No visible damage Legible marking
Leakage current		See 5.6.1.2		≤ 5 times the value in 5.6.1
Capacitance		See 5.6.2.2		$\lvert\Delta C/C\rvert$ ≤ 10 % of the value measured in 5.20.2
Tangent of loss angle		See 5.6.3.2		See 5.6.3.3

[a] Subclause numbers of test and performance requirements refer to Clause 5.

[b] In this table: D = destructive, ND = non-destructive.

[c] This test may be carried out on surface mount capacitors mounted on a substrate.

[d] C_N = nominal capacitance in microfarad; U_R = rated voltage in volt.

[e] If required.

8.5 Quality conformance inspections

8.5.1 Formation of inspection lots

8.5.1.1 Groups A and B inspections

These tests shall be carried out on a lot-by-lot basis.

A manufacturer may aggregate the current production into inspection lots subject to the following safeguards:

a) The inspection lot shall consist of structurally similar capacitors (see 8.2).

b) The sample tested shall be representative of the values (rated voltage and nominal capacitance) and dimensions contained in the inspection lot:
   - in relation to their number;
   - with a minimum of five of any one value.

c) If there are fewer than five of any one value in the sample, the basis for the drawing of samples shall be agreed between the manufacturer and the certification body (CB).

8.5.1.2 Group C inspections

These tests shall be carried out on a periodic basis.

Samples shall be representative of the current production of the specified periods and shall be divided into high-, medium- and low-voltage ratings. In order to cover the range of approvals in any period, one case size shall be tested from each voltage group. In subsequent periods, other case sizes and/or voltage ratings in production shall be tested with the aim of covering the whole range.

8.5.2 Test schedule

The test schedule for the lot-by-lot and periodic tests for quality conformance inspection is given in the blank detail specification.

8.5.3 Delayed delivery

When, in accordance with the procedures of IEC 60384-1:2016, Clause Q.1.7, re-inspection should be made, capacitance, tangent of loss angle, leakage current and solderability shall be checked as specified in Groups A and B inspections.

8.5.4 Assessment levels

The assessment levels given in the blank detail specification shall be selected from Table 5 and Table 6 as assessment level EZ.

Table 5 – Lot-by-lot inspection

Inspection subgroup[a]	EZ		
	IL[b]	n[b]	c[b]
A0	100 %[c]		
A1	S-3	[d]	0
A2	S-3	[d]	0
B1	S-3	[d]	0

[a] The content of the inspection subgroup is described in Clause 2 of the blank detail specification.

[b] IL = inspection level

n = sample size

c = permissible number of non-conforming items

[c] After removal of nonconforming items by 100 % testing during the manufacturing process, sampling inspection shall be performed in order to monitor outgoing quality level by nonconforming items per million ($\times 10^{-6}$). The sampling level shall be established by the manufacturer in accordance with IEC 61193-2:2007, Annex A. In the case where one or more nonconforming items occur in a sample, this lot shall be rejected, but the whole sample shall be inspected and all nonconforming items shall be counted for the calculation of quality level values. Outgoing quality level by nonconforming items per million ($\times 10^{-6}$) values shall be calculated by accumulating inspection data in accordance with the method given in IEC 61193-2:2007, 6.2.

[d] Number to be tested: Sample size shall be determined in accordance with IEC 61193-2:2007, 4.3.2.

Table 6 – Periodic inspection

Inspection subgroup[a]	EZ		
	p[b]	n[b]	c[b]
C1A	6	12	0
C1B	6	12	0
C1	6	24	0
C2	6	24	0
C3	3	36	0
C4	6	12	0
C5	6	12	0

[a] The content of the inspection subgroup is described in Clause 2 of the blank detail specification.

[b] p = periodicity in months

n = sample size

c = permissible number of non-conforming items

Annex X
(informative)

Cross-references to the prior edition of this document

The revision of this sectional specification has resulted in a new structure. Table X.1 provides a cross-reference to specific elements of the prior edition of this sectional specification.

Table X.1 – Reference to IEC 60384-24 for clauses/subclauses and tables

IEC 60384-24:2015 (Edition 2.0) Clause/subclause	IEC 60384-24:2021 (Edition 3.0) Clause/subclause	Notes
1	-	This is covered by Clauses 1, 2, 3, 4, 6, 7.
1.1 1.2	1	The prior scope and object are merged into Clause 1.
1.3	2	-
1.4	7	-
1.4.1	7.1	-
1.4.2	7.2	-
1.4.3	7.3	-
1.4.4	7.4	
1.4.4.1	7.4.1	-
1.4.4.2	7.4.2	-
1.4.4.3	7.4.3	-
1.4.4.4	7.4.4	-
1.4.5	7.5	-
1.5	3	
1.6	6	
1.6.1	6.1	
1.6.2	6.2	
1.6.3	6.3	
1.6.4	6.4	
2	4	Clause 2 is transferred to become Clause 4. Otherwise numbering kept unchanged.
3	8	Clause 3 is transferred to become Clause 8. Otherwise numbering kept unchanged.
4	5	Clause 4 is transferred to become Clause 5. Otherwise numbering kept unchanged.
Table 1	Table 1	-
Table 2	Table 2	-
Table 3	Table 3	-
Table 4	Table 4	-
Table 5	Table 5	-
Table 6	Table 6	-

Bibliography

IEC 60068-2-58:2015, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60384-3, *Fixed capacitors for use in electronic equipment – Part 3: Sectional specification: Surface mount fixed tantalum electrolytic capacitors with manganese dioxide solid electrolyte*

IEC 60417, *Graphical symbols for use on equipment* (available at http://www.graphical-symbols.info/equipment)

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

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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CONDENSATEURS FIXES UTILISÉS DANS LES ÉQUIPEMENTS ÉLECTRONIQUES –

Partie 24: Spécification intermédiaire – Condensateurs fixes électrolytiques au tantale pour montage en surface à électrolyte solide en polymère conducteur

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La Norme internationale IEC 60384-24 a été établie par le comité d'études 40 de l'IEC: Condensateurs et résistances pour équipements électroniques.

Cette troisième édition annule et remplace la deuxième édition parue en 2015. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) révision de la structure fondée sur les Directives ISO/IEC, Partie 2:2018 dans la mesure du possible, et harmonisation avec d'autres types de documents similaires;

b) en outre, révision de l'Article 5 et des tableaux pour éviter les redondances et les contradictions.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
40/2849/FDIS	40/2860/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Une liste de toutes les parties de la série IEC 60384, publiées sous le titre général *Condensateurs fixes utilisés dans les équipements électroniques*, peut être consultée sur le site web de l'IEC.

Le présent document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous http://www.iec.ch/standardsdev/publications.

Le comité a décidé que le contenu du présent document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

CONDENSATEURS FIXES UTILISÉS DANS LES ÉQUIPEMENTS ÉLECTRONIQUES –

Partie 24: Spécification intermédiaire – Condensateurs fixes électrolytiques au tantale pour montage en surface à électrolyte solide en polymère conducteur

1 Domaine d'application

La présente partie de l'IEC 60384 s'applique aux condensateurs fixes électrolytiques au tantale pour montage en surface à électrolyte solide en polymère conducteur principalement destinés à des applications en courant continu pour être utilisés dans des équipements électroniques.

Les condensateurs fixes électrolytiques au tantale pour montage en surface à électrolyte solide (MnO_2) ne sont pas inclus, mais ils sont couverts par l'IEC 60384-3.

Ces condensateurs sont principalement destinés à être utilisés dans des équipements électroniques et montés directement sur des substrats pour circuits hybrides ou sur des cartes imprimées.

Les condensateurs destinés à un usage spécial peuvent nécessiter des exigences supplémentaires.

Le présent document a pour objet de spécifier les valeurs assignées et caractéristiques préférentielles, de sélectionner, en se référant à l'IEC 60384-1:2016, les procédures d'assurance de la qualité, les essais et les méthodes de mesure appropriés et de donner les exigences de performance générales pour ce type de condensateur.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60063, *Séries de valeurs normales pour résistances et condensateurs*

IEC 60068-1:2013, *Essais d'environnement – Partie 1: Généralités et lignes directrices*

IEC 60384-1:2016, *Condensateurs fixes utilisés dans les équipements électroniques – Partie 1: Spécification générique*

IEC 61193-2:2007, *Quality assessment systems – Part 2: Selection and use of sampling plans for inspection of electronic components and packages* (disponible en anglais seulement)

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'IEC 60384-1:2016 et les suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
capacité
<condensateur électrolytique> capacité d'un circuit équivalent dont la capacité et la résistance en série sont mesurées avec un courant alternatif de forme d'onde approximativement sinusoïdale à une fréquence spécifiée

4 Valeurs assignées et caractéristiques préférentielles

4.1 Caractéristiques préférentielles

Les catégories climatiques préférentielles doivent être indiquées uniquement dans les caractéristiques préférentielles.

Les condensateurs couverts par la présente spécification intermédiaire sont classés en catégories climatiques selon les règles générales données dans l'Annexe A de l'IEC 60068-1:2013.

La température de catégorie inférieure et supérieure doit être choisie parmi les valeurs suivantes:

- température de catégorie inférieure: −55 °C;
- température de catégorie supérieure: +105 °C et +125 °C.

Les sévérités pour les essais au froid et en chaleur sèche sont les températures des catégories inférieure et supérieure respectivement.

La température de catégorie supérieure doit être de 105 °C ou 125 °C pour une température assignée de 85 °C.

La température de catégorie supérieure doit être de 125 °C pour une température assignée de 105 °C.

4.2 Valeurs préférentielles des caractéristiques assignées

4.2.1 Capacité nominale (C_N)

Les valeurs préférentielles de capacité nominale sont exprimées en microfarad (µF).

Les valeurs préférentielles de capacité nominale doivent être choisies dans la série E 12 de l'IEC 60063 comme suit:

1,0 – 1,2 – 1,5 – 1,8 – 2,2 – 2,7 – 3,3 – 3,9 – 4,7 – 5,6 – 6,8 – 8,2;

et leurs multiples décimaux (× 10^n, n: entier).

4.2.2 Tolérance sur la capacité nominale

La valeur préférentielle de tolérance sur la capacité nominale est:

±20 %.

4.2.3 Tension assignée (U_R)

Les valeurs préférentielles des tensions continues assignées choisies dans les séries R10 et R20 de l'ISO 3 sont:

– de R10: 1,0 – 1,25 – 1,6 – 2,0 – 2,5 – 4,0 – 5,0 – 6,3 – 8,0;

– de R20: 3,5[1];

– et leurs multiples décimaux (× 10^n, n: entier).

4.2.4 Tension de catégorie (U_C)

La tension de catégorie pour les condensateurs est indiquée dans le Tableau 1 et le Tableau 2.

4.2.5 Surtension (U_{RS} ou U_{CS})

La surtension doit être 1,15 fois la tension assignée ou la tension de catégorie, arrondie (deux chiffres significatifs) au volt le plus proche (voir le Tableau 1 et le Tableau 2).

NOTE U_{RS} est la surtension par rapport à la tension assignée;
U_{CS} est la surtension par rapport à la tension de catégorie.

4.2.6 Température assignée

La valeur de la température assignée est de +85 °C et +105 °C (voir le Tableau 1 et le Tableau 2).

Tableau 1 – Tensions de catégorie et surtensions

Valeurs en volts

	Température de catégorie supérieure 125 °C / température assignée 85 °C											
U_R	2,0	2,5	4,0	5,0	6,3	8,0	10	12,5	16	20	25	35
U_C = 0,80 U_R	1,6	2,0	3,2	4,0	5,0	6,4	8,0	10	13	16	20	28
U_{RS}	2,3	2,9	4,6	5,8	7,2	9,2	12	14	18	23	29	40
U_{CS}	1,8	2,3	3,7	4,6	5,8	7,4	9,2	12	15	18	23	32

Tableau 2 – Tensions de catégorie et surtensions

Valeurs en volts

	Température de catégorie supérieure 125 °C / température assignée 105 °C ou Température de catégorie supérieure 105 °C / température assignée 85 °C											
U_R	2,0	2,5	4,0	5,0	6,3	8,0	10	12,5	16	20	25	35
U_C = 0,90 U_R	1,8	2,3	3,6	4,5	5,7	7,2	9,0	11	14	18	23	32
U_{RS}	2,3	2,9	4,6	5,8	7,2	9,2	12	14	18	23	29	40
U_{CS}	2,0	2,6	4,1	5,2	6,5	8,2	10	13	16	20	26	36

[1] Pour R20, l'ISO 3 donne la valeur 3,55.

5 Procédures d'essai et de mesure

5.1 Généralités

Les sévérités et les exigences d'essai précisées dans les spécifications particulières se rapportant à la présente spécification intermédiaire présentent des niveaux de performance supérieurs ou égaux parce que les niveaux de performance inférieurs ne sont pas admis.

Le présent article complète les informations données dans l'Article 4 de l'IEC 60384-1:2016.

5.2 Préséchage

Voir 4.3 de l'IEC 60384-1:2016.

5.3 Conditions de mesure

Voir 4.2.1 de l'IEC 60384-1:2016.

5.4 Montage

5.4.1 Généralités

Voir 4.33 de l'IEC 60384-1:2016, ainsi que 5.4.2, 5.4.3 et 5.4.4 du présent document.

5.4.2 Inspections initiales

Voir le Tableau 4.

5.4.3 Conditions d'essai

La méthode d'essai doit être la méthode de refusion et le profil de la température de refusion doit être précisé dans la spécification particulière.

5.4.4 Inspections finales et exigences

Voir le Tableau 4.

5.5 Examen visuel et contrôle des dimensions

5.5.1 Généralités

Voir 4.4 de l'IEC 60384-1:2016, ainsi que 5.5.2 et 5.5.3 du présent document.

5.5.2 Examen visuel et contrôle des dimensions

L'équipement utilisé pour l'examen visuel doit être approprié avec un grossissement d'environ 10, un éclairage approprié de l'éprouvette en essai et le niveau de qualité exigé. Il convient que l'opérateur dispose d'équipements adaptés pour l'éclairage incident ou transmis ainsi que d'équipements de mesure appropriés. Les condensateurs doivent être examinés pour vérifier que les matériaux, la conception, la fabrication et les dimensions physiques sont appropriés.

5.5.3 Exigences

La qualité d'exécution doit être conforme aux exigences applicables données dans la spécification particulière.

5.6 Essais électriques

5.6.1 Courant de fuite

5.6.1.1 Généralités

Voir 4.9 de l'IEC 60384-1:2016, ainsi que 5.6.1.2 et 5.6.1.3 du présent document.

5.6.1.2 Conditions de mesure

La tension assignée doit être appliquée aux bornes du condensateur et de sa résistance de protection placée en série avec le condensateur pour limiter le courant de charge.

La valeur de la résistance de protection doit être 1 000 Ω.

5.6.1.3 Exigences

Voir le Tableau 4.

5.6.2 Capacité

5.6.2.1 Généralités

Voir 4.7 de l'IEC 60384-1:2016, ainsi que 5.6.2.2 et 5.6.2.3 du présent document.

5.6.2.2 Conditions de mesure

Sauf indication contraire dans les spécifications particulières, la capacité doit être mesurée à une fréquence de 100 Hz ou 120 Hz.

La tension alternative de crête réellement appliquée aux connexions de sortie du condensateur ne doit pas dépasser la valeur efficace de 0,5 V.

Une tension de polarisation continue de 0,7 V à 1,0 V peut être appliquée pendant le mesurage pour éviter une application de tension négative sur le condensateur par la tension alternative appliquée.

L'inexactitude des instruments de mesure ne doit pas dépasser ±2 % de la limite indiquée dans la spécification particulière, qu'il s'agisse d'une valeur absolue ou d'une variation de capacité.

5.6.2.3 Exigences

Voir le Tableau 4.

5.6.3 Tangente de l'angle de perte (tan δ)

5.6.3.1 Généralités

Voir 4.8.1 de l'IEC 60384-1:2016, ainsi que 5.6.3.2 et 5.6.3.3 du présent document.

5.6.3.2 Conditions de mesure

Le mesurage doit respecter les conditions spécifiées en 5.6.2.2.

L'inexactitude de l'équipement de mesure ne doit pas dépasser 0,01 en valeur absolue.

5.6.3.3 Exigences

Voir le Tableau 4.

5.6.4 Résistance-série équivalente (RSE) (si cela est exigé)

5.6.4.1 Généralités

Voir 4.8.2 de l'IEC 60384-1:2016, ainsi que 5.6.4.2 et 5.6.4.3 du présent document.

5.6.4.2 Conditions de mesure

Sauf indication contraire dans les spécifications particulières, les conditions d'essai sont les suivantes:

– température: 20 °C ± 2 °C;
– tension appliquée: valeur de crête en courant alternatif ≤ 0,5 V (valeur efficace);
– fréquence de tension: 100 kHz ± 10 kHz.

L'erreur de mesure ne doit pas dépasser la valeur exigée de 5 % ou 0,02 Ω, selon la valeur la plus élevée.

5.6.4.3 Exigences

Voir le Tableau 4.

5.7 Résistance à la chaleur de brasage

5.7.1 Généralités

Voir 4.14 de l'IEC 60384-1:2016, ainsi que 5.7.2 à 5.7.5 du présent document.

5.7.2 Inspections initiales

Voir le Tableau 4.

5.7.3 Conditions d'essai

La méthode d'essai doit être la méthode de refusion et le profil de la température de refusion doit être précisé dans la spécification particulière.

5.7.4 Reprise

La période de reprise doit être de 24 h ± 2 h.

5.7.5 Inspections finales et exigences

Après reprise, les condensateurs doivent être soumis à un examen visuel sous un éclairage normal et avec un grossissement d'environ 10 et selon les caractéristiques électriques mesurées du Tableau 4.

5.8 Brasabilité

5.8.1 Généralités

Voir 4.15 de l'IEC 60384-1:2016 et 5.8.2 du présent document.

5.8.2 Inspections finales et exigences

Voir le Tableau 4.

5.9 Essai de cisaillement

Voir 4.34 de l'IEC 60384-1:2016.

5.10 Essai de pliage du substrat (si cela est exigé)

5.10.1 Généralités

Voir 4.35 de l'IEC 60384-1:2016, ainsi que 5.10.2 à 5.10.4 du présent document.

5.10.2 Inspections initiales

Voir le Tableau 4.

5.10.3 Conditions d'essai

La déviation D et le nombre de pliages doivent être précisés dans la spécification particulière.

5.10.4 Inspections finales et exigences

Voir le Tableau 4.

5.11 Variations rapides de température

5.11.1 Généralités

Voir 4.16 de l'IEC 60384-1:2016, ainsi que 5.11.2 à 5.11.5 du présent document.

Les condensateurs doivent être montés conformément au 5.4.

5.11.2 Inspections initiales

Voir le Tableau 4.

5.11.3 Conditions d'essai

Les conditions d'essai sont les suivantes:

– T_A = température de catégorie inférieure;
– T_B = température de catégorie supérieure;
– les condensateurs doivent être soumis à l'essai pendant 5 cycles;
– la durée d'exposition à chaque limite de température doit être de 30 min.

5.11.4 Reprise

La période de reprise doit être comprise entre 1 h et 2 h.

5.11.5 Inspections finales et exigences

Voir le Tableau 4.

5.12 Séquence climatique

5.12.1 Généralités

Voir 4.21 de l'IEC 60384-1:2016, ainsi que 5.12.2 à 5.12.8 du présent document.

5.12.2 Inspections initiales

Voir le Tableau 4.