IEC 60384-26

Edition 2.0 2018-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fixed capacitors for use in electronic equipment – Part 26: Sectional specification – Fixed aluminium electrolytic capacitors with conductive polymer solid electrolyte

Condensateurs fixes utilisés dans les équipements électroniques – Partie 26: Spécification intermédiaire – Condensateurs fixes électrolytiques en aluminium à électrolyte solide en polymère conducteur

IEC 60384-26:2018-05(en-fr)

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 26: Sectional specification – Fixed aluminium electrolytic capacitors with conductive polymer solid electrolyte

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International Standard IEC 60384-26 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

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

a) revision of the structure in accordance with ISO/IEC Directives, Part 2:2016 to the extent practicable, and harmonization between other similar kinds of documents;
b) in addition, Clause 4 and all the tables have been reviewed in order to prevent duplications and contradictions.

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

FDIS	Report on voting
40/2599/FDIS	40/2605/RVD

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

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

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

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

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- withdrawn,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

The contents of the corrigendum of April 2020 have been included in this copy.

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 26: Sectional specification – Fixed aluminium electrolytic capacitors with conductive polymer solid electrolyte

1 General

1.1 Scope

This part of IEC 60384 applies to fixed aluminium electrolytic capacitors with conductive polymer solid electrolyte primarily intended for d.c. applications for use in electronic equipment.

Fixed aluminium electrolytic capacitors with solid (MnO_2) electrolyte are covered by IEC 60384-4. Fixed aluminium electrolytic surface mount capacitors with conductive polymer solid electrolyte are covered by IEC 60384-25.

1.2 Object

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

1.3 Normative references

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

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

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

IEC 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T – Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60384-1:2016, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*

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

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

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

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1.4 Information to be given in a detail specification

1.4.1 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 1.4.2 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.

1.4.2 Outline drawings 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:

– general case: width, length and height;
– for cylindrical body: diameter and length.

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

– for leaded terminals: diameter, 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.

1.4.3 Mounting

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

1.4.4 Rating and characteristics

1.4.4.1 General

The ratings and characteristics shall be given in accordance with the relevant subclauses of this sectional specification, including the items specified in 1.4.4.2 to 1.4.4.4.

1.4.4.2 Nominal capacitance range

See 2.2.1.

When products approved to the detail specification have different nominal capacitance ranges, the following statement should be added:

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"The nominal capacitance range available in each voltage range is given in the register of approvals, available for example on the website www.iecq.org".

1.4.4.3 Particular characteristics

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

1.4.4.4 Soldering

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

1.4.5 Marking

The detail specification shall specify the content of the marking on the capacitor and on the packaging. Any deviations from 1.6 shall be stated in the detail specification.

1.5 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

1.5.1
capacitance
<electrolytic capacitor> capacitance of an equivalent circuit having capacitance and resistance in series measured with alternating current approximately sinusoidal waveform at a specified frequency

1.6 Marking

1.6.1 General

See IEC 60384-1:2016, 2.4, with 1.6.2, 1.6.3 and 1.6.4 of this document.

1.6.2 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;

b) nominal capacitance;

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

d) year and month (or, year and week) of manufacture;

e) manufacturer's name and/or trade mark;

f) tolerance on nominal capacitance;

g) category temperature;

h) manufacturer's type designation;

i) reference to the detail specification.

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1.6.3 Marking on capacitors

Polarity of the terminations shall be marked. The other information listed in 1.6.2 is marked as necessary.

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

1.6.4 Marking on packaging

The packaging containing the capacitors should be clearly marked with the information listed in 1.6.2 as necessary.

2 Preferred ratings and characteristics

2.1 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 temperatures 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.

2.2 Preferred values of ratings

2.2.1 Nominal capacitance (C_N)

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

Preferred values of nominal capacitance shall be taken from the E12 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).

2.2.2 Tolerance on nominal capacitance

Preferred values of tolerance on nominal capacitance are:

± 10 % and ± 20 %.

2.2.3 Rated voltage (U_R)

Preferred values of rated d.c. voltages taken from the R10 and R20 series of ISO 3 are:

– from R10: 1,0 – 1,25 – 1,6 – 2,0 – 2,5 – 3,15 – 4,0 – 5,0 – 6,3 – 8,0;
– from R20: 3,5[1] – 4,5;

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

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

2.2.4 Category voltage (U_C)

The category voltage is equal to the rated voltage.

2.2.5 Surge voltage

The surge voltage shall be 1,15 times the rated voltage rounded off (significant digit of 2) to the nearest volt (see Table 1).

Table 1 – Surge voltages

Values in volts

Rated voltage	2,0	2,5	4,0	5,0	6,3	8,0	10	12,5	16	20	25	35	50
Surge voltage	2,3	2,9	4,6	5,8	7,2	9,2	12	14	18	23	29	40	58

2.2.6 Rated temperature

The value of the rated temperature shall be upper category temperature.

3 Quality assessment procedures

3.1 Primary stage of manufacture

The primary stage of manufacture is the capacitor manufacturer's evaluation of the formed anode foil.

3.2 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.

3.3 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 or equivalent series resistance, and leakage current.

3.4 Qualification approval (QA) procedures

3.4.1 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 3.5. The procedure using a fixed sample size schedule is given in 3.4.2 and 3.4.3.

3.4.2 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 sample shall be representative of the range of capacitors for which approval is sought. The sample may be the whole or the part of the range given in the detail specification.

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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 either four or six values. Where 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 non-conforming because of incidents not attributable to the manufacturer.

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

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

Table 2 gives the number of samples to be tested in each group or subgroup together with the number of permissible non-conformances for qualification approval test.

3.4.3 Tests

The complete series of tests specified in Table 2 and Table 3 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 2 and Table 3 together form the fixed sample size test schedule for the qualification approval on the basis of the fixed sample size procedure. Table 2 gives the number of the samples and permissible non-conforming items for each test or test group. Table 3 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 inspection given in the detail specification.

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Table 2 – Sampling plan for qualification approval, assessment level EZ

Group no.	Test	Subclause	Number of specimens n [b]	Permissible number of non-conforming items c [c]
0	High surge current [a]	4.22	120 + 12 [d]	0
	Visual examination	4.3		
	Dimensions	4.3		
	Leakage current	4.4.1		
	Capacitance	4.4.2		
	Tangent of loss angle (tan δ)	4.4.3		
	Equivalent series resistance (ESR)	4.4.4		
	Spare specimens			
1A	Robustness of terminations	4.5	12	0
	Resistance to soldering heat	4.6		
	Component solvent resistance [a]	4.17		
1B	Solderability	4.7	24	0
	Solvent resistance of the marking [a]	4.18		
	Rapid change of temperature	4.8		
	Vibration	4.9		
	Shock or bump (Specify in the detail specification)	4.10 or 4.11		
1	Climatic sequence	4.12	36	0
2	Damp heat, steady state	4.13	24	0
3	Endurance	4.14	36	0
4	Storage at high temperature	4.19	12	0
	Surge	4.15		
	Reverse voltage [a]	4.16		
5	Characteristics at high and low temperature	4.20	12	0
	Charge and discharge [a]	4.21		

[a] If required.

[b] For case size/voltage combinations, see 3.4.2.

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

[d] Spare specimens.

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Table 3 – Test schedule for qualification approval (1 of 6)

Subclause number, test and inspection items [a]	D or ND [b]	Conditions of test and measurements [a]	Number of specimens (n) and number of permissible non-conforming items (c) [c]	Performance requirements [a]
Group 0	**ND**		See Table 2	
4.22 High surge current [e]		See 4.22.1		
4.3 Visual examination		See 4.3.1		No visible damage Legible marking and as specified in the detail specification
4.3 Dimension (detail)		See 4.3.1		See detail specification
4.4.1 Leakage current		See 4.4.1		≤ 0,2 $C_N U_R$ or 500 µA, whichever is greater (at 20 °C ± 2 °C)
4.4.2 Capacitance		See 4.4.2		within the specified tolerance
4.4.3 Tangent of loss angle (tan δ)		See 4.4.3		See detail specification
4.4.4 Equivalent series resistance (ESR)		See 4.4.4		See detail specification
Group 1A	**D**		See Table 2	
4.5 Robustness of terminations		See 4.5.1		
4.5.2 Initial inspection				
Capacitance		See 4.4.2		
4.5.3 Final inspection				
Visual examination		See 4.3.1		No visible damage
4.6 Resistance to soldering heat		See 4.6.1		
4.6.2 Initial inspection				
Capacitance		See 4.4.2		
4.6.4 Final inspection				
Visual examination		See 4.3.1		No visible damage No signs of damage such as cracks Legible marking and as specified in the detail specification
Leakage current [d]		See 4.4.1		≤ 0,2 $C_N U_R$ or 500 µA, whichever is greater (at 20 °C ± 2 °C)
Capacitance		See 4.4.2		See detail specification
Tangent of loss angle		See 4.4.3		See detail specification
Equivalent series resistance		See 4.4.4		See detail specification
4.17 Component solvent resistance [e]		See 4.17		See detail specification

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Subclause number, test and inspection items [a]	D or ND [b]	Conditions of test and measurements [a]	Number of specimens (n) and number of permissible non-conforming items (c) [c]	Performance requirements [a]
Group 1B	**D**		See Table 2	
4.7 Solderability		See 4.7.1		
4.7.3 Final inspection				
Visual examination		See 4.3.1		No signs of damage. Area to be soldered shall be covered with a new solder coating with no more than a small amount of scattered imperfections such as pinholes or un-wetted or de-wetted areas. These imperfections shall not be concentrated in one area. Area in which plating does not exist such as tip of the terminal shall not be evaluated.
4.18 Solvent resistance of the marking [e]		See IEC 60384-1:2016, 4.32		See IEC 60384-1:2016, 4.32
4.8 Rapid change of temperature		See 4.8.1		
4.8.2 Initial inspection				
Capacitance		See 4.4.2		
4.8.4 Recovery		See 4.8.4		
4.8.5 Final inspection				
Visual examination		See 4.3.1		No visible damage Legible marking and as specified in the detail specification
Leakage current [d]		See 4.4.1		$\leq 0{,}2\ C_N U_R$ or 500 µA, whichever is greater (at 20 °C ± 2 °C)
Capacitance		See 4.4.2		$\lvert \Delta C/C \rvert \leq 10$ % of value measured in 4.8.2
Tangent of loss angle		See 4.4.3		See detail specification
4.9 Vibration		See 4.9.1		
4.9.3 Final inspections				
Visual examination		See 4.3.1		No visible damage Legible marking
Capacitance		See 4.4.2		$\lvert \Delta C/C \rvert \leq 10$ % of value measured in 4.8.2
4.10 Shock (or Bump, see 4.11)		See 4.10.1		
4.10.3 Final inspections				
Visual examination		See 4.3.1		No visible damage Legible marking
Capacitance		See 4.4.2		$\lvert \Delta C/C \rvert \leq 10$ % of value measured in 4.8.2

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Table 3 (3 of 6)

Subclause number, test and inspection items [a]	D or ND [b]	Conditions of test and measurements [a]	Number of specimens (n) and number of permissible non-conforming items (c) [c]	Performance requirements [a]
Group 1B (continued)	**D**		See Table 2	
4.11 Bump (or shock, see 4.10)		See 4.11.1		
4.11.3 Final inspections				
Visual examination		See 4.3.1		No visible damage Legible marking
Capacitance		See 4.4.2		$\lvert\Delta C/C\rvert \leq 10$ % of value measured in 4.8.2
Group 1	**D**		See Table 2	
4.12 Climatic sequence		See 4.12.1		
4.12.2 Initial inspection				
Capacitance		See 4.4.2		
4.12.3 Dry heat		See 4.12.3		
4.12.4 Damp heat, cyclic, Test Db, first cycle		See 4.12.4		
4.12.5 Cold		See 4.12.5		
4.12.6 Damp heat, cyclic, Test Db, remaining cycles		See 4.12.6		
4.12.7 Recovery		See 4.12.7		
4.12.8 Final inspections				
Visual examination		See 4.3.1		No visible damage Legible marking
Leakage current [d]		See 4.4.1		$\leq 0{,}2\ C_N U_R$ or 500 µA, whichever is greater (at 20 °C ± 2 °C)
Capacitance		See 4.4.2		$\lvert\Delta C/C\rvert \leq 20$ % of value measured in 4.12.2
Tangent of loss angle		See 4.4.3		≤ 1,5 times of the limit in the detail specification
Group 2	**D**		See Table 2	
4.13 Damp heat, steady state		See 4.13.1		
4.13.2 Initial inspection				
Capacitance		See 4.4.2		
4.13.4 Recovery		See 4.13.4		
4.13.5 Final inspections				
Visual examination		See 4.3.1		No visible damage Legible marking
Leakage current		See 4.4.1		≤ 5 times the limit in 4.4.1.3
Capacitance		See 4.4.2		See detail specification
Tangent of loss angle		See 4.4.3		≤ 1,5 times of the limit in the detail specification

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Table 3 (4 of 6)

Subclause number, test and inspection items [a]	D or ND [b]	Conditions of test and measurements [a]	Number of specimens (n) and number of permissible non-conforming items (c) [c]	Performance requirements [a]
Group 3	**D**		See Table 2	
4.14 Endurance		See 4.14.1		
4.14.2 Initial inspection				
Capacitance		See 4.4.2		
4.14.4 Recovery		See 4.14.4		
4.14.5 Final inspections				
Visual examination		See 4.3.1		No visible damage Legible marking
Leakage current		See 4.4.1		≤ 0,2 $C_N U_R$ or 500 µA, whichever is greater (at 20 °C ± 2 °C)
Capacitance		See 4.4.2		$\lvert\Delta C/C\rvert$ ≤ 20 % of value measured in 4.14.2
Tangent of loss angle		See 4.4.3		≤ 1,5 times the limit specified in the detail specification
Equivalent series resistance		See 4.4.4		≤ 2 times the limit specified in the detail specification
Group 4	**D**		See Table 2	
4.19 Storage at high temperature		See 4.19.1		
4.19.2 Initial inspection				
Capacitance		See 4.4.2		
4.19.4 Recovery		See 4.19.4		
4.19.5 Final inspections				
Visual examination		See 4.3.1		No visible damage Legible marking
Leakage current [d]		See 4.4.1		≤ 0,2 $C_N U_R$ or 500 µA, whichever is greater (at 20 °C ± 2 °C)
Capacitance		See 4.4.2		$\lvert\Delta C/C\rvert$ ≤ 5 % of value measured in 4.19.2
Tangent of loss angle		See 4.4.3		See detail specification
4.15 Surge		See 4.15.1		
4.15.2 Initial inspection				
Capacitance		See 4.4.2		
4.15.4 Recovery		See 4.15.4		
4.15.5 Final inspections				
Visual examination		See 4.3.1		No visible damage
Leakage current		See 4.4.1		≤ 0,2 $C_N U_R$ or 500 µA, whichever is greater (at 20 °C ± 2 °C)
Capacitance		See 4.4.2		$\lvert\Delta C/C\rvert$ ≤ 15 % of value measured in 4.15.2
Tangent of loss angle		See 4.4.3		See detail specification

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Subclause number, test and inspection items [a]	D or ND [b]	Conditions of test and measurements [a]	Number of specimens (n) and number of permissible non-conforming items (c) [c]	Performance requirements [a]
Group 4 (continued)	**D**		See Table 2	
4.16 Reverse voltage [e]		See 4.16		
4.16.1 Initial inspection				
Capacitance		See 4.4.2		
4.16.3 Recovery		See 4.16.3		
4.16.4 Final inspections				
Leakage current		See 4.4.1		≤ 0,2 $C_N U_R$ or 500 µA, whichever is greater (at 20 °C ± 2 °C)
Capacitance		See 4.4.2		$\lvert \Delta C/C \rvert$ ≤ 10 % of value measured in 4.16.1
Tangent of loss angle		See 4.4.3		See detail specification
Group 5	**D**		See Table 2	
4.20 Characteristics at high and low temperature		See 4.20.1		
Step 1: 20 °C				
Capacitance [e f]		See 4.4.2		
Step 2: lower category temperature				
Capacitance [e]		See 4.4.2		$\lvert \Delta C/C \rvert$ ≤ 20 % of value measured in Step 1
Equivalent series resistance [e]		See 4.4.4		≤ 2 times the limit specified in the detail specification
Step 3: upper category temperature				
Leakage current		See 4.4.1		≤ 12,5 times the limit specified in 4.4.1.3
Capacitance [e]		See 4.4.2		$\lvert \Delta C/C \rvert$ ≤ 20 % of value measured in Step 1
Equivalent series resistance [e]		See 4.4.4		≤ 2 times the limit specified in the detail specification

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