IEC 60384-23

Edition 2.0 2015-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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

IEC 60384-23:2015-04(en-fr)

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 23: Sectional specification – Fixed metallized polyethylene naphthalate film dielectric surface mount d.c. capacitors

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International Standard IEC 60384-23 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 2005 and constitutes a technical revision.

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

a) Revised all parts of the document based on the ISO/IEC Directives, Part 2:2011 (sixth edition) and harmonization between other similar kinds of documents.
b) Revised tables and Clause 4 so as to prevent duplications and contradictions.

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

FDIS	Report on voting
40/2349/FDIS	40/2376/RVD

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

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

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

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

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 23: Sectional specification – Fixed metallized polyethylene naphthalate film dielectric surface mount d.c. capacitors

1 General

1.1 Scope

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

Capacitors for radio interference suppression are not included, they are covered by IEC 60384-14.

1.2 Object

The object of this standard 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, lower performance levels are not permitted.

1.3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60062, *Marking codes for resistors and capacitors*

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

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

IEC 60384-1:2008, *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*

1.4 Information to be given in a detail specification

1.4.1 General

Detail specifications shall be derived from the relevant blank detail specification.

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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 drawing and dimensions

There shall be an illustration of the capacitor as an aid to easy recognition and for comparison of the capacitor with others. Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall preferably be stated in millimetres, however, when the original dimensions are given in inches, the converted metric dimensions in millimetres shall be added.

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

– width, length and height.

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

– width, length and spacing.

When necessary, for example when a number of items (sizes and capacitance/voltage ranges) is covered by a detail specification, the dimensions and their associated tolerances shall be placed in a table below the drawing.

When the configuration is other than described above, the detail specification shall state such dimensional information as will adequately describe the capacitor.

1.4.3 Mounting

The detail specification shall give guidance on methods of mounting for normal use. Mounting for test and measurement purposes (when required) shall be in accordance with 4.1.

1.4.4 Ratings and characteristics

1.4.4.1 General

The ratings and characteristics shall be in accordance with the relevant clauses of this specification, together with the following.

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: "The nominal capacitance range available in each voltage range is given on the IEC online service, www.iecq.org/certificates."

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.

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1.4.4.4 Soldering

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

1.4.5 Marking

The detail specification shall specify the content of the marking on the capacitor and on the packaging. Deviations from 1.6 shall be specifically stated.

1.5 Terms and definitions

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

1.5.1
performance grade 1 capacitors
<long-life> capacitors for long-life applications with stringent requirements for the electrical parameters

1.5.2
performance grade 2 capacitors
<general purpose> capacitors for general application where the stringent requirements for grade 1 capacitors are not necessary

1.5.3
performance grade 3 capacitors
<low temperature, miniature type> miniature type capacitors having a rated temperature of 85 °C and for which less stringent requirements than for grade 2 capacitors are acceptable

1.6 Marking

1.6.1 General

See IEC 60384-1:2008, 2.4, with the following details.

1.6.2 Information for marking

The information given in the marking is normally selected from the following list. The relative importance of each item is indicated by its position in the list:

a) nominal capacitance (in clear or code according to IEC 60062);

b) rated voltage (d.c. voltage may be indicated by the symbol ⎓ or ⎯);

c) tolerance on nominal capacitance;

d) category voltage;

e) year and month (or week) of manufacture;

f) manufacturer's name or trade mark;

g) climatic category;

h) manufacturer's type designation;

i) reference to the detail specification.

NOTE In item b) the first symbol has been taken from IEC 60417-5031:2002-10, symbol for "Direct current".

1.6.3 Marking on capacitors

Marking on capacitors is made when necessary.

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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 capacitors should be clearly marked with all the information listed in 1.6.2 as necessary.

2 Preferred ratings and characteristics

2.1 Preferred characteristics

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

2.1.1 Preferred climatic categories

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

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

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

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

Duration of the damp heat, steady state test: 4, 10, 21 and 56 days.

With continuous operation at 125 °C in excess of the endurance test time, accelerated ageing has to be considered (see detail specification).

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 shall be taken from the E6 series of IEC 60063:

1,0 – 1,5 – 2,2 – 3,3 –, 4,7 and 6,8 and their decimal multiples ($\times 10^n$, n: integer).

If other values are required they shall preferably be chosen from the E12 series.

2.2.2 Tolerance on nominal capacitance

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

2.2.3 Rated voltage (U_R)

The preferred values of rated voltage taken from R 10 series of ISO 3 are:

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

The sum of the d.c. voltage and the peak a.c. voltage applied to the capacitor should not exceed the rated voltage.

The value of the peak a.c. voltage should not exceed the percentages of the rated voltage at the frequencies stated in Table 1, unless otherwise specified in the detail specification.

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Table 1 – Percentage limit of the rated voltage at a.c. voltage frequency

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

2.2.4 Category voltage (U_C)

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

– for upper category temperature 125 °C: 0,8 U_R;
– for upper category temperature 155 °C: 0,5 U_R;

and for Grade 3 capacitors is:

– for upper category temperature 100 °C: 0,8 U_R;
– for upper category temperature 125 °C: 0,5 U_R.

2.2.5 Rated temperature

Grade 1 and Grade 2 capacitors:

the standard value of rated temperature is 100 °C.

Grade 3 capacitors:

the standard value of rated temperature is 85 °C.

3 Quality assessment procedures

3.1 Primary stage of manufacture

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

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 capacitance and voltage values.

3.3 Certified test records of released lots

The information required in IEC 60384-1:2008, Q.9 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, tan δ and the insulation resistance.

3.4 Qualification approval procedures

3.4.1 General

The procedures for qualification approval testing are given in IEC 60384-1:2008, Q.5.

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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 below.

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

3.4.2.1 Sampling

The fixed sample size procedure is described in IEC 60384-1:2008, Q.5.3, list item b). The sample shall be representative of the range of capacitors for which approval is sought. The sample may be the whole or part of the range given in the detail specification.

The sample shall consist of four specimens having the maximum and minimum rated voltages, and, for these voltages, the maximum and minimum capacitances. When there are more than four rated voltages an intermediate voltage shall also be tested. Thus, for the approval of a range, testing is required of either four or six values (capacitance/voltage combinations). When the range consists of less than four values, the number of specimens to be tested shall be that required for four values.

Spare specimens are permitted as follows:

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

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

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

Table 2 gives the number of samples to be tested for each group with the permissible number of non-conforming items for qualification approval tests.

3.4.2.2 Tests

The complete series of tests specified in Table 2 and Table 3 are required for the approval of capacitors covered by one detail specification. The tests of each group shall be carried out in the order given.

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

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

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 and test group.

Table 3 gives a summary of the test conditions and performance requirements, and choices of the test conditions and performance requirements in the detail specification.

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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 2 – Test and sampling plan for qualification approval
Assessment level EZ

Group No.	Test	Subclause of this publication	Number of specimens n[a]	Permissible number of non-conforming items c
0	Visual examination	4.2	144	0
	Dimensions	4.2		
	Capacitance	4.3.2		
	Tangent of loss angle	4.3.3		
	Voltage proof	4.3.1		
	Insulation resistance	4.3.4		
	Spare specimens		12	
1A	Resistance to soldering heat	4.6	12	0
	Component solvent resistance [b]	4.13		
1B	Solderability	4.7	12	0
	Solvent resistance of the marking [b]	4.14		
2	Substrate bending test	4.5	12	0
3	Mounting	4.1	108	[c]
	Visual examination	4.2.1		
	Capacitance	4.3.2		
	Tangent of loss angle	4.3.3		
	Insulation resistance	4.3.4		
3.1	Shear test	4.4	24	0
	Rapid change of temperature	4.8		
	Climatic sequence	4.9		
3.2	Damp heat, steady state	4.10	24	0
3.3	Endurance	4.11	36	0
3.4	Charge and discharge	4.12	24	0

[a] Capacitance/voltage combinations, see 3.4.2.

[b] If required by the detail specification.

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

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Table 3 – 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 number of permissible non-conforming items (c)	Performance requirements[a]
Group 0	ND		See Table 2	
4.2.2 Visual examination		As in 4.2.2		As in 4.2.3
4.2 Dimensions (detail)				See detail specification
4.3.2 Capacitance		As in 4.3.2.2		Within specified tolerance
4.3.3 Tangent of loss angle		As in 4.3.3.2		As in 4.3.3.3
4.3.1 Voltage proof		As in 4.3.1.2 and 4.3.1.3		As in 4.3.1.4
4.3.4 Insulation resistance		As in 4.3.4.2		As in 4.3.4.3
Group 1A	D		See Table 2	
4.6 Resistance to soldering heat		As in 4.6.3		
4.6.2 Initial inspections		As in 4.6.2		
Capacitance				
4.6.4 Recovery		As in 4.6.4		
4.6.5 Final inspections				
Visual examination		As in 4.6.5		As in 4.6.5
Capacitance				$\lvert \Delta C/C \rvert$ ≤3 % for Grade 1 and Grade 2 ≤5 % for Grade 3 of the value measured in 4.6.2
4.13 Component solvent resistance [c, e]		As in 4.13 Method 2		As in 4.13

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Subclause number and test[a], inspection items	D or ND [b]	Conditions of test[a] and measurements	Number of specimens (n) and number of permissible non-conforming items (c)	Performance requirements[a]
Group 1B	D		See Table 2	
4.7 Solderability		As in 4.7.2		
4.7.3 Final inspections		As in 4.7.3		As in 4.7.3
Visual examination				
4.14 Solvent resistance of the marking [c, e]		As in 4.14 Method 1		Legible marking As in 4.14
Group 2	D		See Table 2	
4.5 Substrate bending test		See IEC 60384-1:2008,4.35		
4.5.2 Initial inspections		As in 4.5.2		
Capacitance				
4.5. Final inspections		As in 4.2.2		No visible damage
Visual examination				
Capacitance		As in 4.3.2.2		$\lvert \Delta C/C \rvert$ ≤2 % for Grade 1 and Grade 2 ≤5 % for Grade 3 of the value measured in 4.5.2.
Group 3	D		See Table 2	
4.1 Mounting		Substrate material: ...[d]		
4.2.2 Final inspections		As in 4.2.2		See detail specification
Visual examination				
Capacitance		As in 4.3.2.2		$\lvert \Delta C/C \rvert$ ≤2 % of value measured in 4.3.2.
Tangent of loss angle		As in 4.3.3.2		See detail specification.
Insulation resistance		As in 4.3.4.2		See detail specification.

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Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and number of permissible non-conforming items (c)	Performance requirements[a]
Group 3.1	D		See Table 2	
4.4 Shear test		As in 4.4		
4.8 Rapid change of temperature		As in 4.8.3 T_A = Lower category temperature T_B = Upper category temperature		
4.8.2 Initial inspections				
Capacitance		As in 4.8.2		
Tangent of loss angle				
4.8.4 Final inspections		As in 4.2.2		No visible damage
Visual examination				
Capacitance		As in 4.3.2.2		See detail specification
Tangent of loss angle		As in 4.3.3.2		See detail specification
4.9 Climatic sequence				
4.9.2 Initial inspections				
Capacitance		As in 4.9.2		
Tangent of loss angle				
4.9.3 Dry heat		As in 4.9.3 Temperature: upper category temperature Duration: 16 h		
4.9.4 Damp heat, cyclic, Test Db, first cycle		As in 4.9.4		
4.9.5 Cold		As in 4.9.5 Temperature: lower category temperature Duration: 2 h		
4.9.6 Damp heat, cyclic, Test Db, remaining cycles		As in 4.9.6		
4.9.7 Recovery		As in 4.9.7		

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Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and number of permissible non-conforming items (c)	Performance requirements[a]
4.9.8 Final inspections				
Visual examination		As in 4.2.2		No visible damage Legible marking
Capacitance		As in 4.3.2.2		$\lvert \Delta C/C \rvert$ ≤3 % for Grade 1and Grade 2 ≤5 % for Grade 3 of the value measured in 4.9.2
Tangent of loss angle:				
at 10 kHz for $C_N \leq 1$ µF		As in 4.3.3.4		Increase of tan δ: ≤0,002 5 for Grade 1 ≤0,004 for Grade 2 ≤0,007 for Grade 3 compared to values measured in 4.9.2
at 1 kHz for $C_N > 1$ µF		As in 4.3.3.2		≤0,003 for Grade 1 ≤0,005 for Grade 2 ≤0,007 for Grade 3 compared to values measured in 4.9.2
Insulation resistance		As in 4.3.4.2		≥50 % of values in 4.3.4.3 for Grade 1 and Grade 2 ≥25 % of values in 4.3.4.3 for Grade 3
Group 3.2	D		See Table 2	
4.10 Damp heat, steady state		As in 4.10.3		
4.10.2 Initial inspections				
Capacitance		As in 4.10.2		
Tangent of loss angle				
4.10.4 Recovery		As in 4.10.4		
4.10.5 Final inspections		As in 4.2.2		No visible damage
Visual examination				
Capacitance		As in 4.3.2.2		$\lvert \Delta C/C \rvert$ ≤7 % for Grade 1 and Grade 2 ≤10 % for Grade 3 of the values measured in 4.10.2

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Subclause number and test[a], inspection items	D or ND[b]	Conditions of test[a] and measurements	Number of specimens (n) and number of permissible non-conforming items (c)	Performance requirements[a]
Tangent of loss angle at 1 kHz	D	As in 4.3.3.2		Increase of tan δ: ≤0,005 for Grade 1 and Grade 2 ≤0,007 for Grade 3 compared to values measured in 4.10.2
Insulation resistance		As in 4.3.4.2		≥50 % of values in 4.3.4.3 for Grade 1 and Grade 2 ≥25 % of values in 4.3.4.3 for Grade 3
Group 3.3	D		See Table 2	
4.11 Endurance		As in 4.11.3		
4.11.2 Initial inspections		As in 4.11.2		
Capacitance				
Tangent of loss angle				
4.11.4 Final inspections		As in 4.2.2		No visible damage Legible marking
Visual examination				
Capacitance		As in 4.3.2.2		$\lvert \Delta C/C \rvert$ ≤5 % for Grade 1 ≤8 % for Grade 2 and Grade 3 of the values measured in 4.11.2
Tangent of loss angle:				
at 10 kHz for $C_N \leq 1$ µF		As in 4.3.3.4		Increase of tan δ: ≤0,003 for Grade 1 ≤0,005 for Grade 2 ≤0,007 for Grade 3 compared to values measured in 4.11.2.
at 1 kHz for $C_N > 1$ µF		As in 4.3.3.2		≤0,002 for Grade 1 ≤0,003 for Grade 2 ≤0,005 for Grade 3 compared to values measured in 4.11.2
Insulation resistance		As in 4.3.4.2		≥50 % of values in 4.3.4.3 for Grade 1 and Grade 2 ≥25 % of values in 4.3.4.3 for Grade 3
Group 3.4	D		See Table 2	
4.12 Charge and discharge		As in 4.12.3		
4.12.2 Initial inspections		As in 4.12.2		
Capacitance				
Tangent of loss angle				

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