IEC 60384-2

Edition 5.0 2021-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fixed capacitors for use in electronic equipment –
Part 2: Sectional specification – Fixed metallized polyethylene-terephthalate film dielectric DC capacitors

Condensateurs fixes utilisés dans les équipements électroniques –
Partie 2: Spécification intermédiaire – Condensateurs fixes pour courant continu à diélectrique en film de téréphtalate de polyéthylène métallisé

IEC 60384-2:2021-04(en-fr)

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FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 2: Sectional specification – Fixed metallized polyethylene-terephthalate film dielectric DC capacitors

FOREWORD

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International Standard IEC 60384-2 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This fifth edition cancels and replaces the fourth edition published in 2011. This edition constitutes a technical revision.

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

a) revision of all parts of the document based on the ISO/IEC Directives, Part 2:2018 and harmonization with other similar kinds of documents;
b) the document structure has been organized to follow the new sectional specification structure decided by TC 40;
c) revision of tables and Clause 5 so as to prevent duplications and contradictions.

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

FDIS	Report on voting
40/2821/FDIS	40/2830/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 in the IEC 60384 series, published under the general title *Fixed capacitors for use in electronic equipment*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "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- withdrawn,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.

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 2: Sectional specification – Fixed metallized polyethylene-terephthalate film dielectric DC capacitors

1 Scope

This part of IEC 60384 applies to fixed capacitors for direct current, with metallized electrodes and polyethylene-terephthalate dielectric for use in electronic equipment.

These capacitors have a possibility of "self-healing properties" depending on conditions of use. They are primarily intended for applications where the AC component is small with respect to the rated voltage. Two performance grades of capacitors are covered: grade 1 for long-life application and grade 2 for general application.

Capacitors for electromagnetic interference suppression and surface mount fixed metallized polyethylene-terephthalate film dielectric DC capacitors are not included, but are covered by IEC 60384-14 and IEC 60384-19, respectively.

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 are 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 60063:2015, *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*

ISO 3:1973, *Preferred numbers – Series of preferred numbers*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60384-1:2016 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
grade 1 capacitors
<long-life> capacitors intended for long-life applications with stringent requirements for the electrical parameters

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

3.3
rated voltage
U_R
maximum DC voltage that can be continuously applied to a capacitor at the rated temperature

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 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 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, +100 °C, +105 °C and +125 °C
– duration of the damp heat, steady-state test: 21 days and 56 days

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

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

4.2 Preferred values of ratings

4.2.1 Nominal capacitance (C_N)

Preferred values of nominal capacitance are values chosen from the E series of IEC 60063, which are given in Table 1, and their decimal multiples (× 10^n, where n is an integer).

4.2.2 Tolerance on nominal capacitance

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

4.2.3 Rated voltage (U_R)

The preferred values of rated voltages are: 40 V – 50 V – 63 V – 100 V – 160 V – 200 V – 250 V – 400 V – 630 V – 1 000 V – 1 600 V. These values conform to the basic series of preferred values R5 and R 10 given in ISO 3.

The sum of the DC voltage and the peak AC voltage applied to the capacitor shall not exceed the rated voltage. The value of the peak AC voltage shall not exceed the following percentages of the rated voltage at the frequencies stated and shall be not greater than 280 V:

– 50 Hz: 20 %
– 100 Hz: 15 %
– 1 000 Hz: 3 %
– 10 000 Hz: 1 %

unless otherwise specified in the detail specification.

4.2.4 Category voltage (U_C)

The category voltage is equal to the rated voltage for upper category temperatures up to 85 °C.

For the upper category temperature of 100 °C, the voltage is 0,8 U_R.

For the upper category temperature of 105 °C, the voltage is 0,75 U_R.

For the upper category temperature of 125 °C, the voltage is 0,5 U_R.

4.2.5 Rated temperature

The standard value of rated temperature is 85 °C.

5 Test and measurement procedures, and performance requirements

5.1 Visual examination and check of dimensions

See IEC 60384-1:2016, 4.4.

5.2 Electrical tests

5.2.1 Voltage proof

5.2.1.1 General

See IEC 60384-1:2016, 4.6, with the details of 5.2.1.2 to 5.2.1.4.

5.2.1.2 Test circuit

Delete the capacitor C_1.

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

R_1 includes the internal resistance of the power supply.

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

5.2.1.3 Test conditions

The voltages in Table 1 shall be applied between the measuring points of IEC 60384-1:2016, Table 3, for a period of 1 min for qualification approval testing and for a period of 1 s for the lot-by-lot quality conformance testing.

Table 1 – Test points and voltages

Test point	Test voltage
1 a)	Grade 1: 1,6 U_R Grade 2: 1,4 U_R
1 b), 1 c)	2 U_R with a minimum of 200 V

5.2.1.4 Requirements

See Table 9.

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

5.2.2 Capacitance

5.2.2.1 General

See IEC 60384-1:2016, 4.7, with the details of 5.2.2.2 and 5.2.2.3.

5.2.2.2 Measuring conditions

The capacitance shall be measured at, or corrected to, a frequency of 1 kHz.

For nominal capacitance values > 10 µF, 50 Hz to 120 Hz may be used, but 1 kHz shall be the reference frequency.

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

5.2.2.3 Requirements

The capacitance shall be within the specified tolerance. See Table 9.

5.2.3 Tangent of loss angle (tan δ)

5.2.3.1 General

See IEC 60384-1:2016, 4.8, with the details of 5.2.3.2 to 5.2.3.5.

5.2.3.2 Measuring conditions for measurements at 1 kHz

Tangent of loss angle shall be measured as follows:

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

5.2.3.3 Requirement for measurements at 1 kHz

Tangent of loss angle shall not exceed the applicable values shown in Table 2.

Table 2 – Tangent of loss angle requirements

Nominal capacitance	tan δ (absolute value)	
	Grade 1 capacitors	Grade 2 capacitors
≤ 1 µF	0,008	0,01
> 1 µF	0,01	0,01

5.2.3.4 Measuring conditions for measurements at 10 kHz

For capacitors with C_N ≤ 1 µF, tan δ shall be measured as follows:

– frequency: 10 kHz;
– voltage: ≤ 1 V RMS;
– inaccuracy: ≤ 10×10^{-4} (absolute value).

5.2.3.5 Requirement for measurements at 10 kHz

Tangent of loss angle shall be prescribed in the detail specification.

5.2.4 Insulation resistance

5.2.4.1 General

See IEC 60384-1:2016, 4.5, with the details of 5.2.4.2 to 5.2.4.5.

5.2.4.2 Preconditioning

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

5.2.4.3 Measuring conditions

The measuring voltage shall be in accordance with IEC 60384-1:2016, 4.5.2.

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

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

5.2.4.4 Requirements

The insulation resistance shall meet the requirements given in Table 3. However, in lot-by-lot quality conformance testing, the measuring may be interrupted when the limits stated in Table 3 are reached, which can happen in under 60 s.

Table 3 – Insulation resistance requirements

Measuring points [a]	Nominal capacitance	Rated voltage	Minimum RC product [b] s		Minimum insulation resistance between terminations MΩ		Minimum insulation resistance between terminations and case MΩ
			Grade 1	Grade 2	Grade 1	Grade 2	
1a)	> 0,33 µF	> 100 V	10 000	2 500	—	—	—
		≤ 100 V	5 000	1 250	—	—	—
	≤ 0,33 µF	> 100 V	—	—	30 000	7 500	—
		≤ 100 V	—	—	15 000	3 750	—
1b), 1c)	—	—	—	—	—		30 000

[a] Measuring points in accordance with Table 3 of IEC 60384-1:2016.

[b] R = insulation resistance between the terminations
C = nominal capacitance

5.2.4.5 Correction factors

When the test is carried out at a temperature other than 20 °C, the result shall, when necessary, be corrected to 20 °C by multiplying the result of the measurement by the appropriate correction factor. In case of doubt, measurement at 20 °C is decisive. The following correction factors (see Table 4) can be considered as an average for metallized polyethylene-terephthalate film capacitors:

Table 4 – Correction factors

Temperature °C	Correction factor	Temperature °C	Correction factor
15	0,79	26	1,32
16	0,83	27	1,38
17	0,87	28	1,45
18	0,91	29	1,52
19	0,95	30	1,59
20	1,00	31	1,66
21	1,05	32	1,74
22	1,10	33	1,82
23	1,15	34	1,91
24	1,20	35	2,00
25	1,26		

5.3 Robustness of terminations

5.3.1 General

See IEC 60384-1:2016, 4.13, with the details of 5.3.2 to 5.3.4.

5.3.2 Initial inspections

The capacitance shall be measured in accordance with 5.2.2.2.

The tangent of loss angle shall be measured in accordance with 5.2.3.2 or 5.2.3.4, as appropriate.

5.3.3 Test method

See IEC 60384-1:2016, 4.13.

5.3.4 Final inspections and requirements

See Table 9.

5.4 Resistance to soldering heat

5.4.1 General

See IEC 60384-1:2016, 4.14, with the details of 5.4.2 and 5.4.3.

5.4.2 Test conditions

No pre-drying.

Method 1 (solder bath) or Method 2 (soldering iron) of IEC 60384-1:2016, 4.14, unless otherwise specified in the detail specification.

If method 1 is applied,

– temperature of the solder bath: (260 ± 5) °C;
– immersion time: (5 ± 0,5) s or (10 ± 1) s, as specified in the detail specification.

If method 2 is applied,

– temperature of the soldering iron: (350 ± 10) °C;
– soldering iron size A;
– soldering duration time: (10 ± 1) s.

5.4.3 Final inspections and requirements

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

5.5 Solderability

5.5.1 General

See IEC 60384-1:2016, 4.15, with the details of 5.5.2 and 5.5.3.

5.5.2 Test conditions

No aging.

Temperature of the solder bath and process time for preferred solders:

– SnPb solder: (235 ± 3) °C for (2 ± 0,2) s;
– Sn96,5Ag3Cu,5 solder: (245 ± 3) °C for (3 ± 0,3) s;
– Sn99,3Cu,7 solder: (250 ± 3) °C for (3 ± 0,3) s.

The requirements for the globule test method shall be prescribed in the detail specification.