

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fixed capacitors for use in electronic equipment –
Part 11: Sectional specification – Fixed polyethylene-terephthalate film
dielectric metal foil DC capacitors

Condensateurs fixes utilisés dans les équipements électroniques –
Partie 11: Spécification intermédiaire – Condensateurs fixes pour courant
continu à diélectrique en film de polytéréphtalate d'éthylène à armatures
en feuilles métalliques



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 IEC 60384-11:2019

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –**Part 11: Sectional specification – Fixed polyethylene-terephthalate film dielectric metal foil DC capacitors**

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International Standard IEC 60384-11 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This fourth edition cancels and replaces the third edition published in 2008. 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 new sectional specification structure decided in TC 40;
- c) revised tables and Clause 5 so as to prevent duplications and contradictions.

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

FDIS	Report on voting
40/2679/FDIS	40/2689/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 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 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

- 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- withdrawn,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 11: Sectional specification – Fixed polyethylene-terephthalate film dielectric metal foil DC capacitors

1 Scope

This part of IEC 60384 is applicable to fixed direct current capacitors, for rated voltages not exceeding 6 300 V, using as dielectric a polyethylene-terephthalate film and electrodes of thin metal foils. For capacitors with rated voltages exceeding 1 000 V, additional tests and requirements may be specified in the detail specification.

The capacitors covered by this document are intended for use in electronic equipment.

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

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 are of an equal or higher performance level. Lower performance levels are not permitted.

2 Normative references

[IEC 60384-11:2019](https://standards.iteh.ai/catalog/standards/sist/024cef00-533e-4d95-bb69-b2b5a82ca98a/iec-60384-11-2019)

<https://standards.iteh.ai/catalog/standards/sist/024cef00-533e-4d95-bb69-b2b5a82ca98a/iec-60384-11-2019>

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

IEC 60062, *Marking codes for resistors and capacitors*

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

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

IEC 60384-1:2016, *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 of 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

rated DC voltage

maximum DC voltage that may be applied continuously to a capacitor at the rated temperature

4 Preferred ratings and characteristics

4.1 Preferred climatic categories

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

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 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: 4, 10, 21 and 56 days.

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

4.2 Preferred values of ratings

[IEC 60384-11:2019](http://standards.iteh.ai/catalog/standards/sist/024cef00-533e-4d95-bb69-b2b5a82ca98a/iec-60384-11-2019)

4.2.1 Nominal capacitance (C_N)

<http://standards.iteh.ai/catalog/standards/sist/024cef00-533e-4d95-bb69-b2b5a82ca98a/iec-60384-11-2019>

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 ($\times 10^n$, where n is an integer).

4.2.2 Tolerance on nominal capacitance

The preferred tolerances on the nominal capacitance are $\pm 20\%$; $\pm 10\%$; $\pm 5\%$; $\pm 2\%$; $\pm 1\%$.

4.2.3 Nominal capacitance with associated tolerance values

For preferred combinations of capacitance series and tolerances, see Table 1.

Table 1 – Preferred combinations of capacitance series and tolerance

Preferred combinations	
Series	Tolerances
E 6	$\pm 20\%$
E 12	$\pm 10\%$
E 24	$\pm 5\%$
E 48	$\pm 2\%$
E 96	$\pm 1\%$

4.2.4 Rated voltage (U_R)

The preferred values of rated voltages taken from the R5 series of ISO 3 are:

40 V – 63 V – 100 V – 160 V – 250 V – 400 V – 630 V – 1 000 V – 1 600 V – 2 500 V.

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.

4.2.5 Category voltage (U_C)

The category voltage is:

U_R	for upper category temperature 85 °C;
$0,8 U_R$	for upper category temperature 100 °C;
$0,75 U_R$	for upper category temperature 105 °C; and
$0,5 U_R$	for upper category temperature 125 °C.

4.2.6 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

5.1.1 General

See IEC 60384-1:2016, 4.4, with the details in 5.1.2 and 5.1.3.

5.1.2 Examination methods

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.

5.1.3 Requirements

See Table 10.

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

5.2 Electrical tests

5.2.1 Voltage proof

5.2.1.1 General

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

5.2.1.2 Test circuit

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

R_1 includes the internal resistance of the power supply.

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

5.2.1.3 Test conditions

The voltages given in Table 2 shall be applied between the measuring points (from IEC 60384-1:2016, Table 3) for a period of 1 min for qualification approval testing and between measuring point 1a) for a period of 1 s for the lot-by-lot quality conformance testing.

Table 2 – Test voltages

Test point	Test voltage
1a)	$2U_R$
1b) and 1c)	$2U_R$ with a minimum of 200 V

5.2.1.4 Requirement

[IEC 60384-11:2019](https://standards.iteh.ai/catalog/standards/sist/024cef00-533e-4d95-bb69-b2b5a82ca98a/iec-60384-11-2019)

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There shall be no breakdown or flashover during the test.

5.2.2 Capacitance

5.2.2.1 General

See IEC 60384-1:2016, 4.7, with the details in 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 10.

5.2.3 Tangent of loss angle (tan δ)

5.2.3.1 General

See IEC 60384-1:2016, 4.8, with the details in 5.2.3.2 and 5.2.3.3.

5.2.3.2 Measuring conditions for measurements at 1 kHz

Test conditions are as follows:

- Frequency: 1 kHz.
- Peak voltage: $\leq 3\%$ of the rated voltage.
- Inaccuracy: $\leq 10 \times 10^{-4}$ (absolute value).

5.2.3.3 Requirement for measurements at 1 kHz

Tan δ shall not exceed 100×10^{-4} . See Table 10.

5.2.4 Insulation resistance

5.2.4.1 General

See IEC 60384-1:2016, 4.5, with the details in 5.2.4.2 to 5.2.4.4.

5.2.4.2 Preconditioning

Prior to the test, capacitors shall be carefully cleaned to remove any contamination. Care shall be taken to maintain cleanliness in the test chambers and during post-test measurements.

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 $\geq 0,01$ s or any other value prescribed in the detail specification.

5.2.4.3 Measuring conditions IEC 60384-11:2019

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

The measuring points shall be in accordance with IEC 60384-1:2016, Table 3.

The voltage shall be applied immediately at the correct value through the internal resistance of the voltage source. The product of the internal resistance and the nominal capacitance of the capacitor shall be smaller than 1 s or any other value prescribed in the detail specification.

5.2.4.4 Requirements

The insulation resistance shall meet the requirements in Table 3.

Table 3 – Insulation resistance

Measuring points in accordance with IEC 60384-1:2016, Table 3	Requirements		
	Minimum RC product (R = insulation resistance between the terminations C_N = nominal capacitance) s	Minimum insulation resistance between the terminations M Ω	Minimum insulation resistance between terminations and case M Ω
	$C_N > 0,33 \mu\text{F}$	$C_N \leq 0,33 \mu\text{F}$	
1a)	10 000	30 000	-
1b) and 1c)	-	-	30 000

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 correction factors in Table 4 can be considered as an average for polyethylene-terephthalate film dielectric metal foil capacitors.

Table 4 – Correction factor dependent on test temperature

Temperature °C	Correction factor
15	0,79
20	1,00
25	1,26
30	1,59
35	2,00

5.2.5 Characteristics depending on temperature (if required in the detail specification)

5.2.5.1 General

See IEC 60384-1:2016, 4.24.1, with the details in 5.2.5.2 and 5.2.5.3.

5.2.5.2 Measurement conditions

The capacitance measurements shall be carried out at points b) (lower category temperature), d) (20 °C = comparison temperature) and f) (upper category voltage).

5.2.5.3 Requirements

The requirements in lower category temperatures and upper category temperatures are given in Table 5 and Table 6, respectively.

Table 5 – Characteristics at lower category temperature

Test temperature at point b)	Temperature characteristic of capacitance
-10 °C and -25 °C	$-5 \% \leq \frac{\Delta C}{C} \leq 0 \%$
-40 °C	$-7 \% \leq \frac{\Delta C}{C} \leq 0 \%$
-55 °C	$-10 \% \leq \frac{\Delta C}{C} \leq 0 \%$

Table 6 – Characteristics at upper category temperature

Test temperature at point f)	Temperature characteristic of capacitance
85 °C	$0 \% \leq \frac{\Delta C}{C} \leq 5 \%$
100 °C	$0 \% \leq \frac{\Delta C}{C} \leq 10 \%$
105 °C	$0 \% \leq \frac{\Delta C}{C} \leq 13 \%$
125 °C	$0 \% \leq \frac{\Delta C}{C} \leq 20 \%$

5.3 Robustness of terminations

5.3.1 General

See IEC 60384-1:2016, 4.13, with the details in 5.3.2 and 5.3.3.

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.

5.3.3 Final inspections and requirements

No visible damage. See Table 10.

5.4 Resistance to soldering heat

5.4.1 General

See IEC 60384-1:2016, 4.14, with the details 5.4.2 to 5.4.5.

5.4.2 Initial inspections

See 5.3.2.

5.4.3 Preconditioning

No pre-drying.

5.4.4 Test Conditions

- method 1 (solder bath) or 2 (soldering iron) of IEC 60384-1:2016, 4.14, unless otherwise specified in the detail specification
- duration: $5 \text{ s} \pm 0,5 \text{ s}$ or $10 \text{ s} \pm 1 \text{ s}$, unless otherwise specified in the detail specification

If method 1 is applied, immersion and withdrawal speed shall be $25 \text{ mm/s} \pm 2,5 \text{ mm/s}$.

5.4.5 Final inspections, measurements and requirements

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

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

The capacitance and tangent of loss angle shall be measured in accordance with 5.3.2 and shall meet the requirements given in Table 10.

5.5 Solderability

5.5.1 General

See IEC 60384-1:2016, 4.15, with the details in 5.5.2 to 5.5.4.

5.5.2 Preconditioning

No ageing.

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