

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Fixed capacitors for use in electronic equipment –
Part 16: Sectional specification – Fixed metallized polypropylene film dielectric
DC capacitors**

**Condensateurs fixes utilisés dans les équipements électroniques –
Partie 16: Spécification intermédiaire – Condensateurs fixes pour courant
continu à diélectrique en film de polypropylène métallisé**





THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Fixed capacitors for use in electronic equipment –
Part 16: Sectional specification – Fixed metallized polypropylene film dielectric
DC capacitors**

**Condensateurs fixes utilisés dans les équipements électroniques –
Partie 16: Spécification intermédiaire – Condensateurs fixes pour courant
continu à diélectrique en film de polypropylène métallisé**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.060.30

ISBN 978-2-8322-7334-0

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	6
1 General	8
1.1 Scope	8
1.2 Object.....	8
1.3 Normative references.....	8
1.4 Information to be given in a detail specification.....	9
1.4.1 General	9
1.4.2 Outline drawing and dimensions	9
1.4.3 Mounting	9
1.4.4 Ratings and characteristics.....	10
1.4.5 Marking	10
1.5 Terms and definitions.....	10
1.6 Marking.....	11
1.6.1 General	11
1.6.2 Information for marking.....	11
1.6.3 Marking on capacitors.....	11
1.6.4 Marking on packaging.....	11
2 Preferred ratings and characteristics	12
2.1 Preferred characteristics	12
2.2 Preferred values of ratings.....	12
2.2.1 Nominal capacitance (C_N).....	12
2.2.2 Tolerances on nominal capacitance	12
2.2.3 Nominal capacitance with associated tolerance values	12
2.2.4 Rated voltage (U_R)	12
2.2.5 Category voltage (U_C).....	13
2.2.6 Rated temperature.....	13
3 Quality assessment procedures	13
3.1 Primary stage of manufacture	13
3.2 Structurally similar components	13
3.3 Certified records of released lots	13
3.4 Qualification approval procedures.....	13
3.4.1 General	13
3.4.2 Qualification approval on the basis of the fixed sample size procedures	13
3.5 Quality conformance inspection	20
3.5.1 Formation of inspection lots.....	20
3.5.2 Test schedule	21
3.5.3 Delayed delivery.....	21
3.5.4 Assessment levels	21
4 Test and measurement procedures.....	22
4.1 Visual examination and check of dimensions	22
4.1.1 General	22
4.1.2 Test conditions	22
4.1.3 Requirements	22
4.2 Electrical tests	22
4.2.1 Voltage proof.....	22
4.2.2 Capacitance	23
4.2.3 Tangent of loss angle ($\tan \delta$)	23

4.2.4	Insulation resistance	24
4.2.5	Inductance (if required).....	26
4.2.6	Characteristics depending on temperature (if required).....	26
4.3	Robustness of terminations	27
4.3.1	General	27
4.3.2	Initial inspections	27
4.3.3	Test method	27
4.3.4	Final inspections.....	27
4.4	Resistance to soldering heat	27
4.4.1	General	27
4.4.2	Preconditioning.....	27
4.4.3	Test conditions	27
4.4.4	Final inspections.....	27
4.5	Solderability	27
4.5.1	General	27
4.5.2	Preconditioning.....	28
4.5.3	Test conditions	28
4.5.4	Final inspections.....	28
4.6	Rapid change of temperature	28
4.6.1	General	28
4.6.2	Initial inspections.....	28
4.6.3	Test conditions	28
4.6.4	Recovery (if required)	28
4.6.5	Final inspections.....	28
4.7	Vibration	28
4.7.1	General	28
4.7.2	Mounting	28
4.7.3	Test conditions	28
4.7.4	Final inspections.....	29
4.8	Bump (if required).....	29
4.8.1	General	29
4.8.2	Mounting	29
4.8.3	Initial inspections.....	29
4.8.4	Test conditions	29
4.8.5	Final inspections.....	29
4.9	Shock (if required)	29
4.9.1	General	29
4.9.2	Mounting	29
4.9.3	Initial inspections.....	30
4.9.4	Test conditions	30
4.9.5	Final inspections.....	30
4.10	Climatic sequence.....	30
4.10.1	General	30
4.10.2	Initial inspections.....	30
4.10.3	Dry heat	30
4.10.4	Damp heat, cyclic, Test Db, first cycle	30
4.10.5	Cold.....	30
4.10.6	Low air pressure (if required).....	30
4.10.7	Damp heat, cyclic, Test Db, remaining cycles	31

4.11	Damp heat, steady state	31
4.11.1	General	31
4.11.2	Initial inspections	31
4.11.3	Test conditions	31
4.11.4	Recovery (if required)	31
4.11.5	Final inspections.....	32
4.11.6	Humidity robustness grades.....	32
4.12	Endurance	32
4.12.1	General	32
4.12.2	Initial inspections.....	32
4.12.3	Test conditions	32
4.12.4	Recovery	32
4.12.5	Final inspections.....	32
4.13	Charge and discharge.....	32
4.13.1	General	32
4.13.2	Initial inspections.....	32
4.13.3	Test conditions	33
4.13.4	Recovery (if required)	34
4.13.5	Final inspections.....	34
4.14	Component solvent resistance	34
4.15	Solvent resistance of the marking	34
4.16	Sealing	34
Annex A (normative)	Humidity robustness grades for applications, where high stability under high humidity operating conditions is required.....	35
A.1	Scope	35
A.2	Humidity robustness grades	35
A.2.1	Standard.....	35
A.2.2	Grade (I) robustness under humidity	35
A.2.3	Grade (II) robustness under high humidity	35
A.2.4	Grade (III) high robustness under high humidity.....	35
A.3	Indication of humidity robustness grades	36
Bibliography	37
Table 1	– Preferred values.....	11
Table 2	– Preferred combinations of capacitance value series and tolerances	12
Table 3	– Sampling plan for qualification approval tests, assessment level EZ.....	15
Table 4	– Test schedule for qualification approval.....	16
Table 5	– Lot-by-lot inspection.....	21
Table 6	– Periodic inspection	22
Table 7	– Combinations of test point and test voltage	23
Table 8	– Tangent of loss angle limits, 1 kHz	24
Table 9	– Tangent of loss angle limits, 10 kHz	24
Table 10	– Insulation resistance requirements	25

Table 11 – Temperature coefficient factors 25

Table 12 – Characteristics at lower category temperature 26

Table 13 – Characteristics at upper category temperature 27

Table 14 – Preferred severities 30

Table 15 – Test conditions 32

Table 16 – Lead spacing 33

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –**Part 16: Sectional specification –
Fixed metallized polypropylene film dielectric DC capacitors**

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60384-16 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 2005. 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.

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

FDIS	Report on voting
40/2686/FDIS	40/2691/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.

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 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 16: Sectional specification – Fixed metallized polypropylene film dielectric DC capacitors

1 General

1.1 Scope

This part of IEC 60384 applies to fixed capacitors with metallized electrodes and polypropylene dielectric for use in electronic equipment.

These capacitors can have "self-healing properties" depending on conditions of use. They are mainly intended for use with direct voltage.

The maximum power to be applied is 500 var at 50 Hz and the maximum peak voltage is 2 500 V.

The following two grades are covered;

- a) Grade 1: for long-life application;
- b) Grade 2: for general application.

Capacitors for alternating voltage and pulse applications are not included, but are covered by IEC 60384-17.

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

Capacitors for electrical shock hazard protection (covered by IEC 60065) and fluorescent lamp and motor capacitors are also excluded.

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

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

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

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 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 drawing and dimensions

There shall be an illustration of the capacitors 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.

Normally, the numerical values shall be given for the length of the body, the width and height of the body and the wire spacing, or for cylindrical types, the body diameter, and the length and diameter of the terminals. When necessary, for example, when a number of items (capacitance values/voltage ranges) are covered by a detail specification, the dimensions and their associated tolerances shall be placed in a table below the drawing.

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

- width, length and height, or for cylindrical types, diameter and length.

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

- width or 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 Ratings and characteristics

1.4.4.1 General

The ratings and characteristics shall be given in accordance with the relevant clauses of this sectional specification, including the items as specified below.

1.4.4.2 Nominal capacitance range

See 2.2.1.

When products approved in accordance with the detail specification have different 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".

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 prescribe the test methods, severities and requirements applicable for the solderability and the resistance to the soldering heat test.

1.4.5 Marking

The detail specification shall specify the content of the marking on the capacitor and on the packaging. When there are deviations from 1.6, these shall be stated in the detail specification.

1.5 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>

1.5.1

performance grade 1 capacitors

<long-life> capacitors intended 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 are not necessary

1.5.3

stability grade

capacitance drift after climatic and mechanical tests and after endurance tests

Note 1 to entry: The performance grade and the stability grade shall be noted in the detail specification.

1.5.4

performance grade and stability grade combinations

designation for combined performance grade and stability grade

SEE: Table 1

Table 1 – Preferred values

Performance grade	Stability grade	Combination designation
1	1	1.1
	2	1.2
2	–	2

Note 1 to entry: The three combinations of performance grades and stability grades concern capacitance stability and $\tan \delta$ values. Distinction in performance of the three combinations is shown in Table 4.

1.5.5

rated voltage

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

Note 1 to entry: 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 allowed at different frequencies is under consideration.

1.6 Marking

1.6.1 General

See IEC 60384-1:2016, 2.4, with the following details.

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) nominal capacitance;
- b) rated voltage (DC voltage may be indicated by the symbol $\overline{\text{---}}$ (IEC 60417-5031-2002-10) or ---);
- c) tolerance on rated capacitance;
- d) year and month (or, year and week) of manufacture;
- e) manufacturer's name and/or trademark;
- f) climatic category;
- g) manufacturer's type designation;
- h) reference to the detail specification.

1.6.3 Marking on capacitors

The capacitor shall be clearly marked with a), b) and c) above and with as many as possible of the remaining items as is considered necessary. Any duplication of information in the marking on the capacitor should be avoided.

1.6.4 Marking on packaging

The packaging containing the 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

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 and the duration of the damp heat, steady-state test shall be chosen from the following:

Lower category temperature:	-55 °C, -40 °C, -25 °C and -10 °C;
Upper category temperature:	+70 °C, +85 °C, +100 °C and +105 °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.

2.2 Preferred values of ratings

2.2.1 Nominal capacitance (C_N)

Preferred values of nominal capacitance shall be taken from the E series of IEC 60063.

2.2.2 Tolerances on nominal capacitance

Preferred tolerances on the nominal capacitance are;

±20 %, ±10 %, ±5 %, ±2 % and ±1 %.

2.2.3 Nominal capacitance with associated tolerance values

For preferred combinations of capacitance, series and tolerances are shown in Table 2.

Table 2 – Preferred combinations of capacitance value series and tolerances

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

2.2.4 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.