

INTERNATIONAL STANDARD

CONSOLIDATED VERSION

Fixed capacitors for use in electronic equipment
Part 14: Sectional specification - Fixed capacitors for electromagnetic
interference suppression and connection to the supply mains



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2025 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.

IEC Secretariat
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 It also gives information on projects, replaced and withdrawn publications.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.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will also have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) Online.

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	7
1 Scope.....	9
2 Normative references	9
3 Terms and definitions and classification	10
3.1 Terms and definitions.....	10
3.2 Classifications	15
3.2.1 Classification of X capacitors	15
3.2.2 Classification of Y capacitors.....	15
4 Preferred ratings and characteristics	16
4.1 Preferred climatic categories.....	16
4.2 Preferred values of ratings	17
4.2.1 Nominal capacitance (C_N)	17
4.2.2 Tolerance on nominal capacitance.....	17
4.2.3 Selection of rated voltages (U_R).....	17
4.2.4 Nominal resistance (R_N).....	17
4.2.5 Rated temperature.....	17
4.2.6 Passive flammability	17
4.3 Requirements for sleeving, tape, tubing and wire insulation	17
5 Test and measurement procedures, and performance requirements	18
5.1 General.....	18
5.2 Visual examination and check of dimensions	18
5.2.1 General	18
5.2.2 Creepage distances and clearances	18
5.3 Electrical tests	19
5.3.1 Voltage proof.....	19
5.3.2 Capacitance	21
5.3.3 Tangent of loss angle	21
5.3.4 Resistance (Equivalent Series Resistance (ESR)) (for RC units only)	21
5.3.5 Insulation resistance.....	22
5.4 Robustness of terminations.....	23
5.5 Resistance to soldering heat.....	23
5.5.1 General	23
5.5.2 Test conditions	23
5.5.3 Final inspection, measurements, and requirements	24
5.6 Solderability.....	24
5.6.1 General	24
5.6.2 Test conditions	24
5.6.3 Requirements	24
5.7 Rapid change of temperature	24
5.7.1 General	24
5.7.2 Final inspection	25
5.8 Vibration	25
5.8.1 General	25
5.8.2 Test conditions	25
5.8.3 Final inspection	25
5.9 Repetitive shock (bump)	25

5.9.1	General	25
5.9.2	Test conditions	25
5.9.3	Final inspection, measurements, and requirements	25
5.10	Shock	26
5.10.1	General	26
5.10.2	Test conditions	26
5.10.3	Final inspection, measurements, and requirements	26
5.11	Container sealing	27
5.11.1	General	27
5.11.2	Test conditions	27
5.11.3	Requirements	27
5.12	Climatic sequence	27
5.12.1	General	27
5.12.2	Initial measurements	27
5.12.3	Dry heat	27
5.12.4	Damp heat, cyclic, test Db, first cycle	27
5.12.5	Cold	27
5.12.6	Damp heat, cyclic, test Db, remaining cycles	27
5.12.7	Final inspection, measurements, and requirements	27
5.13	Damp heat, steady state (DHSS)	28
5.13.1	General	28
5.13.2	Initial measurements	28
5.13.3	Test conditions	28
5.13.4	Final inspection, measurements, and requirements	29
5.13.5	Sample size summary for humidity tests	30
5.14	Impulse voltage	30
5.14.1	General	30
5.14.2	Initial measurements	30
5.14.3	Test conditions	31
5.14.4	Requirements	31
5.15	Endurance	32
5.15.1	General	32
5.15.2	Test conditions	32
5.15.3	Sampling	32
5.15.4	Initial measurements	32
5.15.5	Endurance for Class X capacitors and RC units containing Class X capacitors	32
5.15.6	Endurance for Class Y capacitors and RC units containing Class Y capacitors	33
5.15.7	Endurance for the lead-through arrangements	33
5.15.8	Test conditions – Combined voltage/current tests	34
5.15.9	Final inspection, measurements, and requirements	34
5.16	Charge and discharge	34
5.16.1	General	34
5.16.2	Initial measurements	34
5.16.3	Test conditions	35
5.16.4	Final measurements and requirements	35
5.17	Radiofrequency characteristics	36
5.18	Passive flammability test	36

5.18.1	Testing according to IEC 60384-1	36
5.18.2	Alternative passive flammability test	36
5.19	Active flammability test	37
5.19.1	Test condition	37
5.19.2	Adjustment of U_i	39
5.19.3	Requirements	39
5.20	Component solvent resistance (if applicable)	39
5.21	Solvent resistance of the marking	39
6	Marking	39
6.1	General	39
6.2	Information for marking	39
6.3	Marking of capacitors	40
6.4	Marking of packaging	40
6.5	Additional marking	40
7	Information to be given in a detail specification	40
7.1	General	40
7.2	Outline drawing and dimensions	40
7.3	Mounting	41
7.4	Ratings and characteristics	41
7.4.1	General	41
7.4.2	Nominal capacitance range	41
7.4.3	Nominal resistance range (if applicable)	41
7.4.4	Particular characteristics	41
8	Assessment procedures	41
8.1	Primary stage of manufacture	41
8.2	Structurally similar components	42
8.3	Certified records of released lot	42
8.4	Approval testing	42
8.4.1	Safety tests only qualification approval	42
8.4.2	Qualification approval based on safety and performance testing	42
8.4.3	Qualification approval based on the fixed sample size procedure	42
8.5	Quality conformance inspection	47
8.5.1	General	47
8.5.2	Formation of inspection lots	48
8.5.3	Test schedule for safety tests only approval	49
8.5.4	Delayed delivery	49
8.5.5	Assessment level	49
Annex A	(normative) Circuit for the impulse voltage test	51
Annex B	(normative) Circuit for the endurance test	53
Annex C	(normative) Circuit for the charge and discharge test	54
Annex D	(normative) Declaration of design (confidential to the manufacturer and the certification body)	55
Annex E	(informative) Pulse test circuits	56
E.1	General	56
E.2	Test circuits	56
E.3	Charging of the capacitor	56
E.4	Discharging of the capacitor	57
E.4.1	Discharging in resistive circuit	57

E.4.2	Discharging in inductive circuit	57
Annex F (normative)	Particular requirements for safety test of surface mount capacitors	59
F.1	General.....	59
F.2	Test and measurement procedures	59
Annex G (informative)	Capacitance ageing of fixed capacitors of ceramic dielectric, Class 2	62
G.1	Overview	62
G.2	Law of capacitance ageing.....	62
G.3	Capacitance measurements and capacitance tolerance	63
G.4	Special preconditioning	63
Annex H (normative)	Use of safety approved AC rated capacitors in DC applications	65
H.1	Overview	65
H.2	Background	65
H.3	Additional requirement for use of X- and Y-capacitors in DC applications.....	65
H.4	Creepage and clearance distances	66
Annex I (normative)	Humidity robustness grades for applications, where high stability under high humidity operating conditions is required.....	67
I.1	Overview	67
I.2	Humidity robustness grades	67
I.2.1	General	67
I.2.2	Grade (I) robustness under humidity	67
I.2.3	Grade (II) robustness under high humidity	67
I.2.4	Grade (III) high robustness under high humidity.....	67
I.3	Test description	68
I.4	Indication of humidity robustness grades	68
Annex J (normative)	Description of creepage /clearance distance measurement for cased and conformal coated capacitors	69
J.1	Measurement of creepage distances and clearance – general	69
J.1.1	General	69
J.1.2	Capacitor styles.....	69
J.1.3	Capacitor body and terminal insulation	69
J.1.4	Measurement principle	70
J.2	Measurement	71
J.2.1	Creepage distance between terminals	71
J.2.2	Clearance between terminals.....	72
J.2.3	Clearance in mounted stage	72
J.2.4	Conductors between terminals.....	74
J.3	Precautions in handling.....	74
Annex K (normative)	Safety and performance tests qualification approval.....	75
K.1	Overview	75
K.2	Qualification approval	75
K.3	Quality conformance inspection	81
K.3.1	General	81
K.3.2	Groups A and B inspection	81
K.3.3	Group C inspection	81
K.3.4	Test schedule for qualification approval.....	81
Annex X (informative)	Cross-references to the previous edition of this document.....	83
Bibliography	87

Figure 1 – Two-terminal EMI suppression capacitor	10
Figure 2 – RC unit	11
Figure 3 – Lead-through capacitor (coaxial)	11
Figure 4 – Lead-through capacitors	12
Figure 5 – By-pass capacitors	13
Figure 6 – Impulse wave form	31
Figure 7 – Typical circuit for pulse loading of capacitors under AC voltage	38
Figure 8 – Fundamental AC wave with randomly, not synchronized, superimposed high-voltage pulse	38
Figure 9 – Increased voltage for tests below 2 seconds	48
Figure A.1 – Impulse voltage test circuit	51
Figure B.1 – Endurance test circuit	53
Figure C.1 – Charge and discharge test circuit	54
Figure E.1 – Resistive pulse test circuit	56
Figure E.2 – Inductive pulse test circuit	56
Figure E.3 – Charge waveform for both circuits	57
Figure E.4 – Discharge waveform for resistive circuit	57
Figure E.5 – Discharge waveform for inductive circuit	58
Figure F.1 – Example of test substrate for safety test according to Table F.1	61
Figure J.1 – Example of a cased capacitor	69
Figure J.2 – Example of a conformal coated capacitor	69
Figure J.3 – Cased and conformal coated types	70
Figure J.4 – Description	71
Figure J.5 – Creepage distance – cased style	71
Figure J.6 – Creepage distance – conformal coated style	72
Figure J.7 – Clearance between terminals	72
Figure J.8 – Clearance in mounted state – cased style	73
Figure J.9 – Clearance – capacitor body larger than lead pitch	73
Figure J.10 – Clearance – capacitor body smaller than lead pitch	73
Table 1 – Classification of Class X capacitors	15
Table 2 – Classification of Class Y capacitors	16
Table 3 – Creepage distances and clearances	19
Table 4 – Voltage proof	20
Table 5 – Insulation resistance – Safety tests only	22
Table 6 – Insulation resistance – Safety and performance tests	23
Table 7 – Resistance to soldering heat – Requirements	24
Table 8 – Shock test preferred severities	26
Table 9 – Climatic sequence – Requirements	28
Table 10 – Damp heat, steady state – Requirements for samples tested without voltage applied	29
Table 11 – Damp heat, steady state – Requirements for samples tested with voltage applied	30
Table 12 – Sample sizes for humidity tests	30

Table 13 – Endurance – Requirements	34
Table 14 – Charge and discharge – Requirements	35
Table 15 – Sampling plan – Tests concerning safety requirements only	44
Table 16 – Test schedule and sampling plan for lot-by-lot tests	45
Table 17 – Test schedule for safety tests only	45
Table 18 – Assessment level	50
Table A.1 – Values of C_X , C_T , R_P , R_S , C_p	51
Table A.2 – Values and tolerances of C_X , t_r , t_d	52
Table F.1 – Test schedule and sampling plan for safety test of surface mount capacitors	60
Table H.1 – Additional test conditions Test conditions for the additional samples	66
Table I.1 – Requirements	68
Table K.1 – Sampling plan – Safety and performance tests qualification approval – Assessment level DZ	75
Table K.2 – Test schedule and sampling plan for lot-by-lot tests	77
Table K.3 – Test schedule for safety and performance tests qualification approval – Assessment level DZ	77
Table K.4 – Assessment level	82
Table X.1 – Reference to IEC 60384-14 for clause/subclause or annex	83
Table X.2 – Reference to IEC 60384-14 for figure/table	86

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Fixed capacitors for use in electronic equipment -
Part 14: Sectional specification - Fixed capacitors for electromagnetic
interference suppression and connection to the supply mains**

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 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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60384-14 edition 5.1 contains the fifth edition (2023-01) [documents 40/2985/FDIS and 40/3227/RVD], its corrigendum 1 (2024-10), and its amendment 1 (2025-07) [documents 40/3220/FDIS and 40/3234/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

IEC 60384-14 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2013 and Amendment 1:2016. This edition constitutes a technical revision.

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

- a) in damp heat steady state test, all capacitor types are tested both with and without rated voltage; the number of test pieces has been increased;
- b) tangent of loss angle is added in Group 0 tests, in safety tests only;
- c) qualification approval based on safety and performance tests has been removed from the main text to a normative annex;
- d) the range of rated voltages is given instead of exact rated voltage values;
- e) normative annex for description of capacitor styles and of creepage/clearance distance measurement has been added;
- f) the importance of mechanical failures (cracks) in component encapsulation as a safety feature is highlighted in handling instructions and requirements after all relevant tests.

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

Draft	Report on voting
40/2985/FDIS	40/302/RVL

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

The language used for the development of this International Standard is English.

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_e/projects/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

- reconfirmed,
- withdrawn, or
- revised.

1 Scope

This part of IEC 60384 applies to capacitors and resistor-capacitor combinations intended to be connected to AC mains or other supply with a nominal voltage not exceeding 1 000 V AC (RMS), and with a nominal frequency not exceeding 100 Hz. This document includes also additional specific conditions and requirements for the connection to DC supplies with a rated voltage not exceeding 1 500 V DC.

The principal object of this part of IEC 60384 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; lower performance levels are not permitted.

This document also provides a schedule of safety tests to be used by national testing stations in countries where approval by such stations is required.

The overvoltage categories in combination with the AC mains voltages for the capacitors classified in this document are to be taken from IEC 60664-1.

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 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

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

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

IEC 60068-2-17, *Basic environmental testing procedures – Part 2-17: Tests – Test Q: Sealing*

IEC 60384-1:2021, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements, and tests*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

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

IEC 61210, *Connecting devices – Flat quick-connect terminations for electrical copper conductors – Safety requirements*

CISPR 17, *Methods of measurement of the suppression characteristics of passive EMC filtering devices*