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Fixed Capacitors for Use in Electronic Equipment - Part 1: Generic Specification

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October 2017



Electronic Components Industry Association

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This document is the EIA Standard EIA-60384-1-2017: *Fixed Capacitors for use in Electronic Equipment – Part 1: Generic Specification*.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 1: Generic specification

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.
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International Standard IEC 60384-1 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 2008 and constitutes a technical revision, including minor revisions related to tables, figures and references.

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

- INTRODUCTION added;
- 4.41 Whisker growth test added;
- Annex Q completely restructured.

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

FDIS	Report on voting
40/2420/FDIS	40/2444/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.

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

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

INTRODUCTION

The specification system for fixed capacitors for use in electronic equipment is structured in a hierarchical system consisting of the following specification types.

Generic specification

The generic specification covers all subjects mainly common to the family of fixed capacitors for use in electronic equipment, such as terminology, methods of measurement and tests. Where the individual subjects require the prescription conditions or parameters specific to the particular subfamily or type of fixed capacitor, such prescriptions are required to be given by one of the subordinate specifications.

For the scope of fixed capacitors, the numeric reference to the generic specification is IEC 60384-1.

Sectional specification

Sectional specifications cover all subjects additional to those given in the generic specification, which are specific to a defined sub-group of fixed capacitors. These subjects normally are preferred values for dimensions and characteristics, additional test methods and relevant prescriptions for test methods given in the generic specification, prescriptions for sampling and for the preparation of specimen, recommended test severities and preferred acceptance criteria. The sectional specification also outlines the structure and scope of the test schedules which are to be applied in all subordinate detail specifications.

For the scope of fixed capacitors, the numeric references to the sectional specifications reach from IEC 60384-2 for polyester film capacitors to currently IEC 60384-26 for aluminium electrolytic capacitors with conductive polymer solid electrolyte. The variety of sectional specifications may be adapted to the portfolio of different technologies of fixed capacitors.

Detail specification

Detail specifications give directly, or by making reference to other specifications, all information necessary to completely describe a given type and range of fixed capacitors, including prescriptions of all values for dimensions and characteristics. They also give all information required for the quality assessment of the covered type and range of fixed capacitors within a suitable quality assessment system, including prescriptions for all applied test severities and acceptance criteria, and the completed test schedules.

Detail specifications can be either specifications within the IEC system, another specification system linked to IEC, or specified by the manufacturer or user. For the scope of fixed capacitors, the numeric references to detail specifications are for example IEC 60384-3-101, if related to the sectional specification IEC 60384-3 and to the ancillary blank detail specification IEC 60384-3-1.

Blank detail specification

The hierarchical system of specifications is supplemented by one or more blank detail specifications to a sectional specification, which are used to ensure a uniform presentation of detail specifications. The blank detail specifications provide the specification writer with a template on the layout to be adopted and on the information to be given and with guidance for the preparation of detail specifications in line with the requirements of the superior generic or sectional specifications. Blank detail specifications are not considered as relevant specifications since they do not themselves describe any particular component.

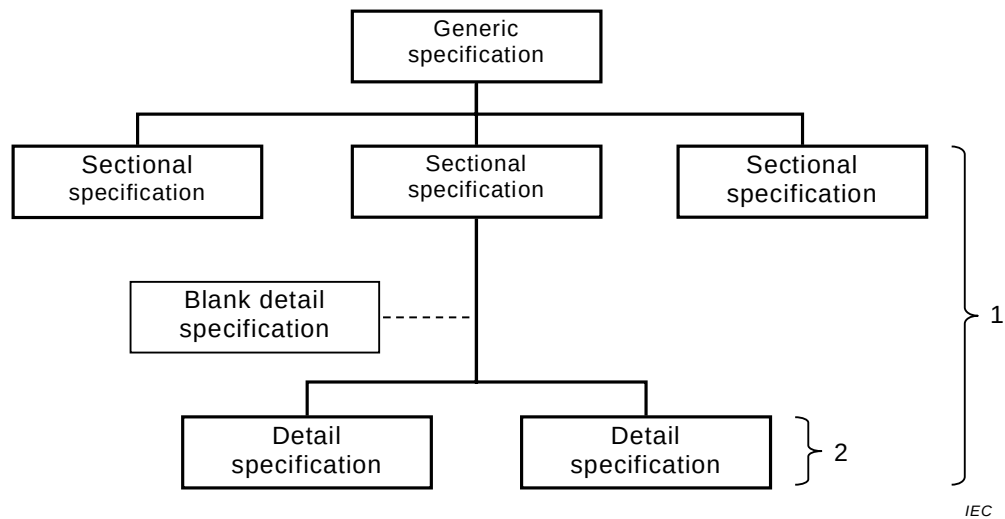
The presence of an established hierarchical specification system with blank detail specifications permits the preparation of detail specifications even outside of the relevant IEC technical committee.

For the scope of fixed capacitors, the numeric references to blank detail specifications are, for example, IEC 60384-3-1, if related to the sectional specification IEC 60384-3.

Relevant specification

In this system the term “relevant specification” addresses subordinate specifications containing specific requirements, where applicable.

Any generic or sectional specification may use abstract and universal references to subordinate specifications of either hierarchical level by use of the expression “relevant specification”.



Key

- 1 Indicates the range of “*Relevant specifications*” to the superior generic specification, where applicable.
- 2 Indicates the range of “*Relevant specifications*” to the superior sectional specification, where applicable.

FIXED CAPACITORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 1: Generic specification

1 General

1.1 Scope

This part of IEC 60384 is a generic specification and is applicable to fixed capacitors for use in electronic equipment.

It establishes standard terms, inspection procedures and methods of test for use in sectional and detail specifications of electronic components for quality assessment or any other purpose.

1.2 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 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050 (all parts), *International Electrotechnical Vocabulary*¹

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 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Tests A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Tests B: Dry heat*

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-13:1983, *Environmental testing – Part 2-13: Tests – Test M: Low air pressure*

IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-17:1994, *Environmental testing – Part 2-17: Tests – Test Q: Sealing*

IEC 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

¹ www.electropedia.org

IEC 60068-2-21:2006, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-45:1980, *Environmental testing – Part 2-45: Tests – Test XA and guidance: Immersion in cleaning solvents*

IEC 60068-2-45:1980/AMD1:1993

IEC 60068-2-54:2006, *Environmental testing – Part 2-54: Tests – Test Ta: Solderability testing of electronic components by the wetting balance method*

IEC 60068-2-58:2015, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60068-2-67:1995, *Environmental testing – Part 2-67: Tests – Test Cy: Damp heat, steady state, accelerated test primarily intended for components*

IEC 60068-2-69:2007, *Environmental testing – Part 2-69: Tests – Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method*

IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60068-2-82:2007, *Environmental testing – Part 2-82: Tests – Test XW1: Whisker test methods for electronic and electric components*

IEC 60294, *Measurement of the dimensions of a cylindrical component with axial terminations*

IEC 60617, *Graphical symbols for diagrams*

IEC 60695-11-5:2004, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60717, *Method for the determination of the space required by capacitors and resistors with unidirectional terminations*

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

IEC 61249-2-7:2002, *Materials for printed boards and other interconnecting structures – Part 2-7: Reinforced base materials clad and unclad – Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test), copper-clad*

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

ISO 80000-1, *Quantities and units – Part 1: General*



2 Technical data

2.1 Symbols, units and abbreviated terms

2.1.1 General

Units, graphical symbols and letter symbols should, whenever possible, be taken from the following publications:

- IEC 60027 (series);
- IEC 60050 (series);
- IEC 60617;
- ISO 80000-1.

When further items are required, they should be derived in accordance with the principles of the publications listed above.

2.1.2 Letter symbols

C_N	Nominal capacitance
DA	Dielectric Absorption
du/dt	Pulse handling capability
f_r	Self-resonant frequency
I_{leak}	leakage current
k_0	Maximum permissible pulse characteristics
L	Self-inductance
R_{INS}	Insulation resistance
T_A	Lower category temperature
$\tan \delta$	Tangent of loss angle
T_B	Upper category temperature
T_C	Category temperature
T_{op}	Operating temperature
T_R	Rated temperature
U_C	Category voltage
U_{op}	Operating voltage
U_R	Rated voltage

U_{RS} Surge voltage

Z Impedance

α Temperature coefficient of capacitance

$\tau = C_N \times R_{INS}$ Time constant

2.1.3 Abbreviations

CA Capability Approval

CB Certification Body

CQC Capability Qualifying Components

DMR Designated Management Representative

ESR Equivalent Series Resistance

IPA Isopropyl alcohol

PCP Process Control Plan

QA Qualifying Approval

SMD Surface Mount Device

TA Technology Approval

TADD Technology Approval Declaration Document

2.2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE They have been listed in alphabetical order.

2.2.1

a.c. capacitor

capacitor designed essentially for application with alternating voltages

2.2.2

bipolar capacitor

<electrolytic capacitor> capacitor designed to withstand an alternating voltage and/or reversal of the applied direct voltage

2.2.3

category of passive flammability

category indicating the maximum burning time after a specified time of flame application

2.2.4

category temperature range

ambient temperature range for which the capacitor has been designed to operate continuously



Note 1 to entry: The temperature range is limited by the lower and upper category temperature (see 2.2.10 and 2.2.41).

2.2.5

category voltage

U_C

maximum voltage that can be applied continuously to a capacitor at its upper category temperature (2.2.41)

2.2.6

d.c. capacitor

capacitor designed essentially for application with direct voltage

Note 1 to entry: It may not be suitable for use on a.c. supplies.

2.2.7

family

<electronic components> group of components which predominantly displays a particular physical attribute and/or fulfils a defined function

2.2.8

grade

term to indicate an additional general characteristic concerning the intended application of the component

2.2.9

insulated capacitor

capacitor in which all terminations of a section may be raised to a potential different (but not less than the rated voltage) from that of any conducting surface with which the case is liable to come into contact in normal use

2.2.10

lower category temperature

minimum ambient temperature for which a capacitor has been designed to operate continuously

2.2.11

maximum storage temperature

maximum ambient temperature which the capacitor withstands in the non-operating condition without damage

2.2.12

maximum temperature of a capacitor

temperature at the hottest point of its external surface

Note 1 to entry: The terminations are considered to be part of the external surface.

2.2.13

minimum storage temperature

minimum ambient temperature which the capacitor withstands in the non-operating condition without damage

2.2.14

minimum temperature of a capacitor

temperature at the coldest point of the external surface

Note 1 to entry: The terminations are considered to be part of the external surface.

2.2.15
nominal capacitance

C_N
designated capacitance value, usually indicated on the capacitor

2.2.16
passive flammability

ability of a capacitor to burn with a flame as a consequence of the application of an external source of heat

2.2.17
polar capacitor

<electrolytic capacitor> capacitor intended for use with a unidirectional voltage connected according to the polarity indication

2.2.18
pulse capacitor

capacitor for use with pulses of current or voltage

Note 1 to entry: The definitions of IEC 60469 apply.

2.2.19
pulse equivalent circuit of a capacitor

equivalent circuit consisting of an ideal capacitor in series with its residual inductance and the equivalent series resistance (ESR)

Note 1 to entry: For pulse operation the equivalent series resistance will be similar to, but not identical with, the ESR measured with a sinusoidal voltage. The pulse ESR depends on the series of harmonics in the pulse and the variation of the losses with frequency.

2.2.20
rated a.c. load

maximum sinusoidal a.c. load which may be applied continuously to the terminations of a capacitor at any temperature between the lower category temperature (2.2.10) and the rated temperature (2.2.24)

2.2.21
rated pulse load

maximum pulse load which may be applied at a certain pulse repetition frequency to the terminations of a capacitor at any temperature between the lower category temperature (2.2.10) and the rated temperature (2.2.24)

2.2.22
rated ripple current

r.m.s. value of the maximum allowable alternating current of a specified frequency, at which the capacitor can be operated continuously at a specified temperature

Note 1 to entry: As the ripple current will generate a ripple voltage across the capacitor, the sum of the direct voltage and the peak value of the alternating voltage applied to the capacitor should not exceed the rated voltage or temperature derated voltage, as applicable.

2.2.23
rated ripple voltage

r.m.s. value of the maximum allowable alternating voltage at a specified frequency superimposed on the d.c. voltage at which the capacitor may be operated continuously at a specified temperature

Note 1 to entry: The sum of the direct voltage and the peak value of the alternating voltage applied to the capacitor should not exceed the rated voltage or temperature derated voltage, as applicable.



2.2.24**rated temperature**

maximum ambient temperature at which the rated voltage may be continuously applied

2.2.25**rated voltage**

U_R

2.2.25.1**rated d.c. voltage**

maximum d.c. voltage which may be applied continuously to a capacitor at the rated temperature (2.2.24)

Note 1 to entry: The maximum d.c. voltage is the sum of the d.c. voltage and peak a.c. voltage or peak pulse voltage applied to the capacitor.

2.2.25.2**rated a.c. voltage**

maximum r.m.s. alternating voltage which may be applied continuously to a capacitor at the rated temperature (2.2.24) and at a given frequency

2.2.25.3**rated pulse voltage**

peak value of the pulse voltage within a given pulse wave form which may be applied continuously to a capacitor at the rated temperature (2.2.24)

2.2.26**reverse voltage**

<polar capacitor> voltage applied to the capacitor terminations in the reverse polarity direction

Note 1 to entry: Reverse voltage applies to polar capacitors only.

2.2.27**self-healing**

process by which the electrical properties of the capacitor, after a local breakdown of the dielectric, are rapidly and essentially restored to the values before the breakdown

2.2.28**style**

subdivision of a type (2.2.39), generally based on dimensional factors, which may include several variants, generally of a mechanical order

2.2.29**subfamily**

<electronic components> group of components within a family (2.2.7) manufactured by similar technological methods

2.2.30**surface mount capacitor**

fixed capacitor whose small dimensions and nature or shape of terminations make it suitable for use in hybrid circuits and on printed boards

2.2.31**surge voltage ratio**

quotient of the maximum instantaneous voltage which can be applied to the terminations of the capacitor for a specified time at any temperature within the category temperature range

(2.2.4) and the rated voltage (2.2.25) or the temperature derated voltage (2.2.36), as appropriate

2.2.32

tangent of loss angle

$\tan \delta$

power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage at a specified frequency

2.2.33

temperature characteristics of capacitance

maximum variation of capacitance produced over a given temperature range within the category temperature range (2.2.4)

Note 1 to entry: The term characterizing this property applies mainly to capacitors of which the variations of capacitance as a function of temperature, linear or non-linear, cannot be expressed with precision and certainty.

Note 2 to entry: This characteristic is normally expressed as a percentage of the capacitance related to a reference temperature of 20 °C.

2.2.34

temperature coefficient of capacitance

α

rate of change of capacitance with temperature measured over a specified range of temperature

Note 1 to entry: The term characterizing this property applies to capacitors of which the variations of capacitance as a function of temperature are linear or approximately linear and can be expressed with a certain precision.

Note 2 to entry: This coefficient is normally expressed in parts per million per Kelvin ($10^{-6}/K$).

2.2.35

temperature cyclic drift of capacitance

maximum irreversible variation of capacitance observed at room temperature during or after the completion of a number of specified temperature cycles

Note 1 to entry: The term characterizing this property applies to capacitors of which the variations of capacitance as a function of temperature are linear or approximately linear and can be expressed with a certain precision.

Note 2 to entry: This drift is normally expressed as a percentage of the capacitance related to a reference temperature, usually 20 °C.

2.2.36

temperature derated voltage

maximum voltage that may be applied continuously to a capacitor, when it is at any temperature between the rated temperature (2.2.24) and the upper category temperature (2.2.41)

Note 1 to entry: Refer to 2.3.6.

2.2.37

temperature rise

temperature rise of the capacitor relative to the ambient temperature resulting from the losses in the capacitor due to operation under a.c., pulse or charge/discharge conditions

2.2.38

time constant

τ

product of the insulation resistance and the capacitance

Note 1 to entry: The time constant is normally expressed in seconds.

2.2.39

type

group of components having similar design features and manufacturing techniques, enabling them to be considered together, either for qualification approval or for quality conformance inspection

Note 1 to entry: These components are generally covered by a single detail specification.

Note 2 to entry: Components described in several detail specifications, may, in some cases, be considered as belonging to the same type.

2.2.40

uninsulated capacitor

capacitor in which one or more of the terminations of a section cannot be raised to a potential different (but not less than the rated voltage) from that of any conducting surface with which the case is liable to come into contact in normal use

2.2.41

upper category temperature

maximum ambient temperature for which a capacitor has been designed to operate continuously

2.2.42

visible damage

visible damage which reduces the usability of the capacitor for its intended purpose

2.3 Preferred values and additional technical requirements

2.3.1 General

Each sectional specification shall prescribe the preferred values appropriate to the subfamily; for nominal capacitance, see also 2.3.2.

2.3.2 Preferred values of nominal capacitance

The preferred values of nominal capacitance shall be taken from the series specified in IEC 60063.

2.3.3 Preferred values of rated voltage

The preferred values of the rated voltage are the values of the R10 series of ISO 3: 1,0 – 1,25 – 1,6 – 2,0 – 2,5 – 3,15 – 4,0 – 5,0 – 6,3 – 8,0 and their decimal multiples ($\times 10^n$, n : integer).

2.3.4 Rated a.c. load

The rated a.c. load may be expressed:

- a) at low frequencies as a rated a.c. voltage;
- b) at high frequencies as a rated a.c. current;
- c) at intermediate frequencies as a rated reactive power (var).

This is shown in Figure 1.

For a particular type of capacitor, it may be necessary to specify one or more of the above characteristics.

Capacitors within the scope of this standard are normally less than 500 var at 50 Hz to 60 Hz. Low frequencies may be 50 Hz to 60 Hz, 100 Hz to 120 Hz, or 400 Hz. Voltages may be up to 600 V r.m.s. at 50 Hz to 60 Hz. However, capacitors for filters, transmitter or converter circuits may be required to operate under power over a wide range of frequencies and up to 10 kvar at the higher frequencies with voltages up to 1 000 V r.m.s.

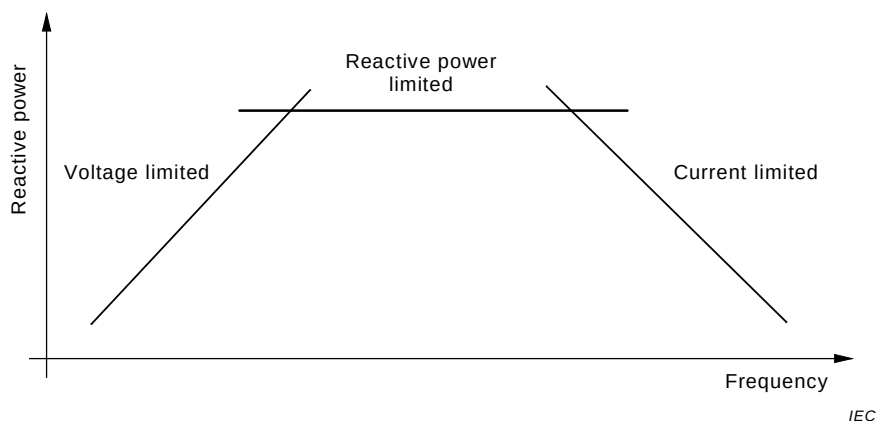


Figure 1 – Reactive power against frequency

2.3.5 Rated pulse load

The rated pulse load may be expressed as a) and b) and any of the remaining items:

- a) peak current per μF or du/dt ($\text{V}/\mu\text{s}$);
- b) relative duration of charge and discharge periods;
- c) current;
- d) peak voltage;
- e) peak reverse voltage;
- f) pulse repetition frequency;
- g) maximum active power.

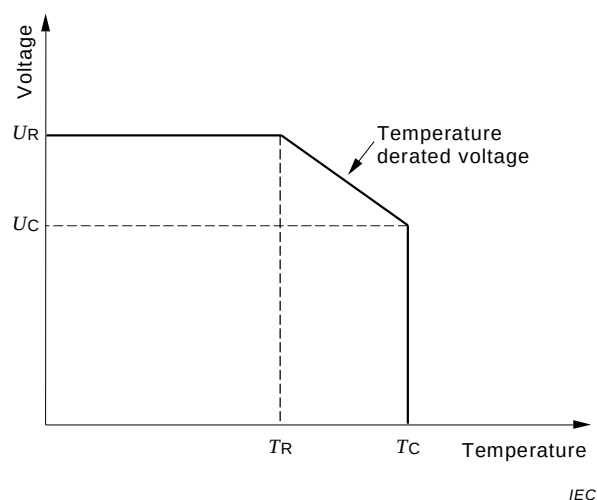
These parameters are fixed for periodic pulses.

In the case of intermittent pulses, the duty cycle should be specified. In the case of random pulses, the total number expected over a given time period should be stated.

The r.m.s. pulse current should be calculated in accordance with IEC 60469:2013, 3.2.17.5. In the case of intermittent or random pulses, the time interval should be chosen to correspond to the maximum temperature rise.

2.3.6 Temperature derated voltage

Information on the voltage/temperature dependence at temperatures between the rated temperature and the upper category temperature should, if applicable, be given in the relevant specification (see Figure 2).

**Key**

- U_R is the rated voltage
 U_C is the category voltage
 T_R is the rated temperature
 T_C is the category temperature

Figure 2 – Relation between category temperature range and applied voltage

2.4 Marking

2.4.1 General

The sectional specification shall indicate the identification criteria and other information to be shown on the capacitor and/or packaging.

The order of priority for marking small capacitors shall be specified.

2.4.2 Coding

When coding is used for capacitance value, tolerance or date of manufacture, the method shall be selected from those given in IEC 60062.

3 Quality assessment procedures

See Annex Q.

4 Tests and measurement procedures

General information on test and measurement procedures	Subclause
General	4.1
Standard atmospheric conditions	4.2
Drying	4.3
Storage	4.25
Mounting (for surface mount capacitors only)	4.33
Electrical tests and measurements	
Insulation resistance	4.5
Voltage proof	4.6
Capacitance	4.7
Tangent of loss angle and equivalent series resistance (ESR)	4.8
Leakage current	4.9
Impedance	4.10
Self-resonant frequency and inductance	4.11
Variation of capacitance with temperature	4.24
Surge	4.26
High surge current test	4.39
Charge and discharge tests and inrush current test	4.27
Dielectric absorption	4.36
Voltage transient overload (for aluminium electrolytic capacitors with non-solid electrolyte)	4.40
Mechanical tests and measurements	
Visual examination and check of dimensions	4.4
Outer foil termination	4.12
Robustness of terminations	4.13
Vibration	4.17
Bump (repetitive shock)	4.18
Shock	4.19
Container sealing	4.20
Shear test	4.34
Substrate bending test	4.35
Environmental and climatic tests	
Rapid change of temperature	4.16
Climatic sequence	4.21
Damp heat, steady state	4.22
Endurance	4.23
Characteristics at high and low temperature	4.29
Thermal stability test	4.30
Damp heat, steady state, accelerated	4.37
Tests related to component assembly	
Resistance to soldering heat	4.14
Solderability	4.15
Component solvent resistance	4.31
Solvent resistance of marking	4.32
Whisker growth test	4.41
Test related to safety	
Pressure relief (for aluminium electrolytic capacitors)	4.28
Passive flammability	4.38



4.1 General

The sectional and/or blank detail specification shall indicate the tests to be made, which measurements are to be made before and after each test or subgroup of tests, and the sequence in which they shall be made. The stages of each test shall be carried out in the order written. The measuring conditions shall be the same for initial and final measurements.

If national specifications within any quality assessment system include methods other than those specified in the above specifications, they shall be fully described.

Limits given in all specifications are absolute limits. The principle to take measurement uncertainty into account shall be applied.

4.2 Standard atmospheric conditions

4.2.1 Standard atmospheric conditions for testing

Unless otherwise specified, all tests and measurements shall be carried out under standard atmospheric conditions for testing as given in IEC 60068-1:2013, 4.3:

- temperature: 15 °C to 35 °C;
- relative humidity: 25 % to 75 %;
- air pressure: 86 kPa to 106 kPa.

Before the measurements are made, the capacitor shall be stored at the measuring temperature for a time sufficient to allow the entire capacitor to reach this temperature. The period as prescribed for recovery at the end of a test is normally sufficient for this purpose.

When measurements are made at a temperature other than the specified temperature, the results shall, where necessary, be corrected to the specified temperature. The ambient temperature during the measurements shall be stated in the test report. In the event of a dispute, the measurements shall be repeated using one of the referee temperatures (as given in 4.2.3) and such other conditions as are prescribed in this standard.

When tests are conducted in a sequence, the final measurements of one test may be taken as the initial measurements for the succeeding test.

During measurements the capacitor shall not be exposed to draughts, direct sunlight or other influences likely to cause error.

4.2.2 Recovery conditions

Unless otherwise specified recovery shall take place under the standard atmospheric conditions for testing (4.2.1).

If recovery under closely controlled conditions is necessary, the controlled recovery conditions of IEC 60068-1:2013, 4.4.2, shall be used.

Unless otherwise specified in the relevant specification, a duration of 1 h to 2 h shall be used.

The definition of recovery is as given in IEC 60068-1:2013, 3.4, being further restricted for capacitors as follows:

When a recovery period is specified as, for example, 1 h to 2 h, this means that measurement (or other subsequent action) on a batch of capacitors may start after 1 h and shall be completed before 2 h from the beginning of the recovery period.

The preferred method of specifying a recovery period is in the form "x h to y h".

4.2.3 Referee conditions

For referee purposes, one of the standard atmospheric conditions for referee tests taken from IEC 60068-1:2013, 4.2, as given in Table 1 below, shall be selected.

Table 1 – Referee conditions

Temperature	Relative humidity	Air pressure
°C	%	kPa
20 ± 1	63 to 67	86 to 106
23 ± 1	48 to 52	86 to 106
25 ± 1	48 to 52	86 to 106
27 ± 1	63 to 67	86 to 106

4.2.4 Reference conditions

For reference purposes, the standard atmospheric conditions for reference given in IEC 60068-1:2013, 4.1, apply:

- temperature: 20 °C;
- air pressure: 101,3 kPa.

4.3 Drying

Unless otherwise specified in the relevant specification, the capacitor shall be conditioned for 96 h ± 4 h by heating in a circulating air oven at a temperature of 55 °C ± 2 °C and a relative humidity not exceeding 20 %.

The capacitor shall then be allowed to cool in a desiccator using a suitable desiccant, such as activated alumina or silica gel, and shall be kept therein from the time of removal from the oven to the beginning of the specified tests.

4.4 Visual examination and check of dimensions

4.4.1 Visual examination

The condition, workmanship and finish shall be satisfactory, as checked by visual examination (see 2.2.42).

Marking shall be legible, as checked by visual examination and shall conform with the requirements of the detail specification.

4.4.2 Dimensions (gauging)

The dimensions indicated in the detail specification as being suitable for gauging shall be checked, and shall comply with the values prescribed in the detail specification.

When applicable, measurements shall be made in accordance with IEC 60294 or IEC 60717.

