

This is a preview of "IEC 60384-1 Ed. 4.0 ...". Click here to purchase the full version from the ANSI store.



Edition 4.0 2008-07

# INTERNATIONAL STANDARD

QC 300000

---

**Fixed capacitors for use in electronic equipment –  
Part 1: Generic specification**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

PRICE CODE **XC**

---

ICS 31.060

ISBN 2-8318-9907-9

## CONTENTS

FOREWORD.....	7
1 General.....	9
1.1 Scope.....	9
1.2 Normative references.....	9
2 Technical data.....	10
2.1 Units and symbols.....	10
2.2 Terms and definitions.....	11
2.3 Preferred values.....	17
2.3.1 General.....	17
2.3.2 Preferred values of nominal capacitance.....	17
2.3.3 Preferred values of rated voltage.....	17
2.4 Marking.....	17
2.4.1 General.....	17
2.4.2 Coding.....	17
3 Quality assessment procedures.....	17
4 Tests and measurement procedures.....	18
4.1 General.....	19
4.2 Standard atmospheric conditions.....	19
4.2.1 Standard atmospheric conditions for testing.....	19
4.2.2 Recovery conditions.....	19
4.2.3 Referee conditions.....	20
4.2.4 Reference conditions.....	20
4.3 Drying.....	20
4.4 Visual examination and check of dimensions.....	20
4.4.1 Visual examination.....	20
4.4.2 Dimensions (gauging).....	20
4.4.3 Dimensions (detail).....	20
4.5 Insulation resistance.....	21
4.5.1 Preconditioning.....	21
4.5.2 Measuring conditions.....	21
4.5.3 Test points.....	21
4.5.4 Test methods.....	21
4.5.5 Temperature compensation.....	22
4.5.6 The relevant specification shall prescribe:.....	22
4.6 Voltage proof.....	23
4.6.1 Test circuit (for the test between terminations).....	23
4.6.2 Test.....	24
4.6.3 Requirements.....	26
4.6.4 Conditions to be prescribed in the relevant specification.....	26
4.7 Capacitance.....	26
4.7.1 Measuring frequency and measuring voltage.....	26
4.7.2 Measuring equipment.....	26
4.7.3 Conditions to be prescribed in the relevant specification.....	26
4.8 Tangent of loss angle and equivalent series resistance (ESR).....	27
4.8.1 Tangent of loss angle.....	27
4.8.2 Equivalent series resistance (ESR).....	27

4.9	Leakage current .....	27
4.9.1	Preconditioning.....	27
4.9.2	Test method .....	28
4.9.3	Power source .....	28
4.9.4	Measuring accuracy.....	28
4.9.5	Test circuit .....	28
4.9.6	Conditions to be prescribed in the relevant specification.....	28
4.10	Impedance .....	28
4.11	Self-resonant frequency and inductance.....	29
4.11.1	Self-resonant frequency ( $f_r$ ) .....	29
4.11.2	Inductance.....	32
4.11.3	Conditions to be prescribed in the relevant specification.....	32
4.12	Outer foil termination.....	32
4.13	Robustness of terminations .....	33
4.13.1	Test $U_{a1}$ – Tensile.....	33
4.13.2	Test $U_b$ – Bending (half of the sample).....	33
4.13.3	Test $U_c$ – Torsion (remaining sample) .....	33
4.13.4	Test $U_d$ – Torque (for terminations with threaded studs or screws and for integral mounting devices).....	33
4.13.5	Visual examination .....	34
4.14	Resistance to soldering heat .....	34
4.14.1	Preconditioning.....	34
4.14.2	Test procedure .....	34
4.14.3	Recovery.....	34
4.14.4	Final inspection, measurement and requirements .....	34
4.15	Solderability .....	34
4.15.1	Preconditioning.....	34
4.15.2	Test procedure .....	35
4.15.3	Final inspection, measurements and requirements .....	35
4.16	Rapid change of temperature .....	35
4.16.1	Initial measurement .....	35
4.16.2	Test procedure .....	35
4.16.3	Final inspection, measurements and requirements .....	35
4.17	Vibration.....	36
4.17.1	Initial measurement .....	36
4.17.2	Test procedure .....	36
4.17.3	Electrical test.....	36
4.17.4	Final inspection, measurements and requirements .....	36
4.18	Bump .....	36
4.18.1	Initial measurement .....	36
4.18.2	Test procedure .....	36
4.18.3	Final inspection, measurements and requirements .....	36
4.19	Shock.....	36
4.19.1	Initial measurement .....	36
4.19.2	Test procedure .....	36
4.19.3	Final inspection, measurements and requirements .....	37
4.20	Container sealing .....	37
4.21	Climatic sequence .....	37
4.21.1	Initial measurements .....	37

4.21.2	Dry heat .....	37
4.21.3	Damp heat, cyclic, test Db, first cycle .....	37
4.21.4	Cold .....	37
4.21.5	Low air pressure .....	38
4.21.6	Damp heat, cyclic, test Db, remaining cycles .....	38
4.21.7	Final measurements .....	38
4.22	Damp heat, steady state .....	38
4.22.1	Initial measurement .....	38
4.22.2	Test procedure .....	38
4.22.3	Final inspection, measurements and requirements .....	39
4.23	Endurance .....	39
4.23.1	Initial measurements .....	39
4.23.2	Test procedure .....	39
4.23.3	Conditions to be prescribed in the relevant specification .....	39
4.23.4	Test voltage .....	39
4.23.5	Placement in the test chamber .....	40
4.23.6	Recovery .....	40
4.23.7	Final inspection, measurements and requirements .....	40
4.24	Variation of capacitance with temperature .....	41
4.24.1	Static method .....	41
4.24.2	Dynamic method .....	41
4.24.3	Methods of calculation .....	42
4.25	Storage .....	43
4.25.1	Storage at high temperature .....	43
4.25.2	Storage at low temperature .....	43
4.26	Surge .....	43
4.26.1	Initial measurement .....	43
4.26.2	Test procedure .....	43
4.26.3	Final inspection, measurements and requirements .....	45
4.26.4	Information to be given in the relevant detail specification .....	45
4.27	Charge and discharge tests and inrush current test .....	45
4.27.1	Initial measurement .....	45
4.27.2	Test procedure .....	45
4.27.3	Charge and discharge .....	47
4.27.4	Inrush current .....	47
4.27.5	Final inspection, measurements and requirements .....	47
4.28	Pressure relief (for aluminium electrolytic capacitors) .....	47
4.28.1	a.c. test .....	47
4.28.2	d.c. test .....	47
4.28.3	Pneumatic test .....	47
4.28.4	Final inspection, measurements and requirements .....	48
4.29	Characteristics at high and low temperature .....	48
4.29.1	Test procedure .....	48
4.29.2	Requirements .....	48
4.30	Thermal stability test .....	48
4.31	Component solvent resistance .....	48
4.31.1	Initial measurements .....	48
4.31.2	Test procedure .....	48
4.31.3	Final inspection, measurements and requirements .....	49

4.32	Solvent resistance of marking.....	49
4.32.1	Test procedure .....	49
4.32.2	Final inspection, measurements and requirements .....	49
4.33	Mounting (for surface mount capacitors only) .....	49
4.33.1	Substrate.....	49
4.34	Shear test .....	52
4.34.1	Test procedure .....	52
4.34.2	Final inspection, measurements and requirements .....	52
4.35	Substrate bending test .....	52
4.35.1	Test procedure .....	52
4.35.2	Recovery.....	52
4.35.3	Final inspection and requirements .....	52
4.36	Dielectric absorption.....	52
4.36.1	Test procedure .....	52
4.36.2	Requirement.....	53
4.37	Accelerated damp heat, steady state (for multilayer ceramic capacitors only).....	53
4.37.1	Mounting of capacitors .....	53
4.37.2	Initial measurement .....	53
4.37.3	Test procedure .....	53
4.37.4	Recovery.....	54
4.37.5	Final inspection, measurements and requirements .....	54
4.38	Passive flammability.....	54
4.38.1	Test procedure .....	54
4.38.2	Final inspection, measurements and requirements .....	54
4.39	High surge current test.....	55
4.39.1	Initial measurements .....	55
4.39.2	Test procedure .....	55
4.39.3	Requirements for the charging circuit .....	55
4.39.4	Nonconforming items.....	56
4.40	Voltage transient overload (for aluminium electrolytic capacitors with non-solid electrolyte).....	56
4.40.1	Initial measurement .....	56
4.40.2	Test procedure .....	56
4.40.3	Final inspection, measurements and requirements .....	57
4.40.4	Conditions to be prescribed in the relevant specification.....	57
Annex A	(normative) Interpretation of sampling plans and procedures as described in IEC 60410 for use within the IECQ system.....	58
Annex B	(normative) Rules for the preparation of detail specifications for capacitors and resistors for electronic equipment for use within the IECQ system.....	59
Annex C	(normative) Layout of the first page of a PCP/CQC specification.....	60
Annex D	(normative) Requirements for capability approval test report .....	61
Annex E	(informative) Guide for pulse testing of capacitors .....	62
Annex F	(informative) Guidance for the extension of endurance tests on fixed capacitors.....	65
Annex G	(normative) Damp heat, steady state with voltage applied, for metallized film capacitors only .....	66
Annex Q	(normative) Quality assessment procedures .....	67
Figure 1	– Reactive power against frequency.....	13

Figure 2 – Relation between category temperature range and applied voltage .....	16
Figure 3 – Voltage-proof test circuit .....	24
Figure 4 – Schematic diagram of the impedance measuring circuit .....	28
Figure 5 – Capacitor mounting arrangement .....	30
Figure 6 – Capacitor mounting arrangement .....	30
Figure 7 – Typical diagram of an absorption oscillator-wavemeter .....	31
Figure 8 – Schematic diagram of the measuring circuit .....	31
Figure 9 – Test circuit .....	32
Figure 10 – Test circuit for electrolytic capacitors .....	40
Figure 11 – Relay circuit .....	44
Figure 12 – Thyristor circuit .....	44
Figure 13 – Voltage waveform across capacitor .....	45
Figure 14 – Voltage and current waveform .....	46
Figure 15 – Suitable substrate for mechanical tests (may not be suitable for impedance measurements) .....	51
Figure 16 – Suitable substrate for electrical tests .....	51
Figure 17 – High surge current test .....	55
Figure 18 – Voltage transient overload test circuit .....	56
Figure 19 – Voltage waveform .....	57
Figure Q.1 – General scheme for capability approval .....	70
Table 1 – Referee conditions .....	20
Table 2 – Measurement of insulation resistance .....	21
Table 3 – Measuring points .....	23
Table 4 – Tensile force .....	33
Table 5 – Torque .....	33
Table 6 – Number of cycles .....	38
Table 7 – Severities and requirements .....	54

## 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.
- 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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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 60384-1 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment

This fourth edition cancels and replaces the third edition issued in 1999 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:

- implementation of Annex Q which replaces Clause 3.

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

FDIS	Report on voting
40/1915/FDIS	40/1924/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 is a preview of "IEC 60384-1 Ed. 4.0 ...". [Click here to purchase the full version from the ANSI store.](#)

The QC number that appears on the front cover of this publication is the specification number in the IECQ Quality Assessment System for Electronic Components (IECQ).

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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

A bilingual version of this publication may be issued at a later stage.

The contents of the corrigendum of November 2008 have been included in this copy.

## 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 referenced documents are indispensable for the application 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 60027, *Letter symbols to be used in electrical technology*

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

IEC 60062, *Marking codes for resistors and capacitors*

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

IEC 60068-1:1988, *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: Tests – Test Fc: Vibration (sinusoidal)*

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

IEC 60068-2-14:1984, *Environmental testing – Part 2: Tests – Test N: Change of temperature*

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

IEC 60068-2-20:1979, *Environmental testing – Part 2-20: Tests – Test T: Soldering*

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 60068-2-29:1987, *Environmental testing – Part 2-29: Tests – Test Eb and guidance: Bump*

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

IEC 60068-2-58:2004, *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 60068-2-69:2007, *Environmental testing – Part 2: Tests – Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method*

IEC 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

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 packaging<sup>1</sup>*

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*

IEC QC 001002-3, *Rules of Procedure – Part 3: Approval procedures*

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

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units*

ISO 9000, *Quality management systems – Fundamentals and vocabulary*

## **2 Technical data**

### **2.1 Units and symbols**

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

---

<sup>1</sup> To be published.