



INTERNATIONAL STANDARD



**Fixed electric double-layer capacitors for use in electric and electronic equipment –
Part 1: Generic specification**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.060.10

ISBN 978-2-8322-2956-9

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	10
4 General items	14
4.1 Unit and symbols	14
4.2 Preferred values and class.....	14
4.2.1 General	14
4.2.2 Preferred values of nominal capacitance	15
4.2.3 Class	15
4.3 Marking.....	15
4.3.1 General	15
4.3.2 Coding.....	15
4.4 Quality assessment procedures	15
5 Tests and measurement	15
5.1 General.....	15
5.2 Test and measurement requirements	15
5.2.1 Test conditions	15
5.2.2 Measurement conditions.....	15
5.2.3 Voltage treatment	16
5.2.4 Thermal treatment	16
5.3 Drying.....	16
5.4 Visual examination and check of dimensions	16
5.4.1 Visual examination	16
5.4.2 Dimensions (gauging).....	16
5.4.3 Dimensions (detail).....	16
5.5 Measurement method 1 for capacitance and internal resistance (constant current discharge).....	16
5.5.1 Basic circuit for measuring.....	16
5.5.2 Measuring equipment	17
5.5.3 Measuring procedure	18
5.5.4 Calculation methods for capacitance	20
5.5.5 Calculation methods for internal resistance.....	21
5.5.6 Conditions to be prescribed in the detail specification.....	22
5.6 Measurement method 2 for capacitance and internal resistance.....	22
5.6.1 Constant resistance charging method for capacitance measurement	22
5.6.2 AC internal resistance measuring method.....	23
5.7 Leakage current.....	23
5.7.1 Measuring method	23
5.7.2 Items to be specified in the detail specification	24
5.8 Maintain voltage.....	24
5.8.1 Measuring method	24
5.8.2 Calculation of voltage maintenance rate	25
5.8.3 Conditions to be prescribed in the detail specification.....	25
5.9 Robustness of terminations.....	25
5.9.1 Test Ua1 – Tensile	25

5.9.2	Test Ub – Bending (half of the sample)	25
5.9.3	Test Uc – Torsion (remaining sample)	26
5.9.4	Test Ud – Torque (for terminations with threaded studs or screws and for integral mounting devices).....	26
5.9.5	Visual examination	26
5.10	Resistance to soldering heat.....	26
5.10.1	Preconditioning and initial measurement.....	26
5.10.2	Test.....	26
5.10.3	Recovery	26
5.10.4	Final inspection, measurements and requirements.....	27
5.11	Solderability.....	27
5.11.1	General	27
5.11.2	Preconditioning.....	27
5.11.3	Capacitors with leads	27
5.11.4	Surface mount capacitors	28
5.12	Rapid change of temperature.....	28
5.12.1	Initial measurement	28
5.12.2	Test.....	28
5.12.3	Final inspection, measurements and requirements.....	28
5.13	Vibration	28
5.13.1	Initial measurement	28
5.13.2	Test.....	28
5.13.3	Final measurement and requirements	29
5.14	Damp heat, steady state	29
5.14.1	Initial measurement	29
5.14.2	Test.....	29
5.14.3	Final measurement	29
5.15	Endurance	29
5.15.1	Initial measurements	29
5.15.2	Test.....	29
5.15.3	Final measurement, inspection and requirements	29
5.16	Storage.....	30
5.16.1	Storage at high temperature	30
5.16.2	Storage at low temperature.....	30
5.17	Characteristics at high and low temperature.....	30
5.17.1	General	30
5.17.2	Test procedure	30
5.17.3	Dry heat	31
5.17.4	Cold.....	31
5.17.5	Final measurement and requirements	31
5.18	Component solvent resistance	31
5.18.1	Initial measurements	31
5.18.2	Test.....	31
5.18.3	Requirements	31
5.19	Solvent resistance of marking	31
5.19.1	Test.....	31
5.19.2	Requirements	32
5.20	Passive flammability	32
5.20.1	Test procedure	32

5.20.2	Requirements	32
5.21	Pressure relief (if applicable)	32
5.21.1	Test	32
5.21.2	Requirements	32
Annex A	(normative) Classification according to capacitance and internal resistance	33
A.1	General	33
A.2	Classification by capacitance and internal resistance	33
Annex B	(informative) Measuring method of capacitance and low resistance by low frequency a.c. method (reference)	35
B.1	General	35
B.2	Measuring system	35
B.3	Calculation of capacitance	35
B.4	Measuring conditions	36
Annex C	(informative) Thermal equilibrium time of capacitors	37
C.1	General	37
C.2	Thermal equilibrium time of capacitors	37
Annex D	(informative) Charging/discharging efficiency and measurement current	39
D.1	General	39
D.2	Charging efficiency, discharging efficiency, and current	39
Annex E	(informative) Procedures for setting the measurement current of capacitor with uncertain nominal internal resistance	41
E.1	General	41
E.2	Current setting procedures for measurement of capacitor	41
E.3	Example of setting current for determining capacitor characteristics	41
Annex F	(informative) Policy on uncertainty of measurement and inset limits	42
F.1	Objective	42
F.2	Terms and definitions	42
F.3	Calculation of measurement uncertainty	42
F.4	Policy	43
F.5	Calculation of inset and outset limits	43
F.6	Examples	43
F.6.1	General	43
F.6.2	Example 1: Resistor measurement	43
F.6.3	Example 2: Resistor measurement	44
F.6.4	Example 3: Transistor measurement (gain)	44
F.6.5	Example 4: Comparison between initial and final measurement results	44
Annex G	(informative) Reference to IEC 62391-1:2006	45
Annex Q	(normative) Quality assessment procedures	46
Q.1	General	46
Q.1.1	Overview	46
Q.1.2	Applicability of qualification approval	46
Q.1.3	Applicability of capability approval	46
Q.1.4	Applicability of technology approval	47
Q.2	Primary stage of manufacture	47
Q.3	Subcontracting	47
Q.4	Structurally similar components	47
Q.5	Qualification approval procedures	47
Q.5.1	Eligibility for qualification approval	47

Q.5.2	Application for qualification approval	48
Q.5.3	Test procedure for qualification approval	48
Q.5.4	Granting of qualification approval	48
Q.5.5	Maintenance of qualification approval	48
Q.5.6	Quality conformance inspection	48
Q.6	Capability approval procedures	48
Q.6.1	General	48
Q.6.2	Eligibility for capability approval.....	49
Q.6.3	Application for capability approval	49
Q.6.4	Description of capability.....	49
Q.6.5	Demonstration and verification of capability	50
Q.6.6	Programme for capability approval.....	50
Q.6.7	Capability approval test report	51
Q.6.8	Abstract of description of capability	51
Q.6.9	Modifications likely to affect the capability approval	51
Q.6.10	Initial capability approval	51
Q.6.11	Granting of capability approval	52
Q.6.12	Maintenance of capability approval	52
Q.6.13	Extension of capability approval	53
Q.6.14	Quality conformance inspection	53
Q.7	Rework and repair.....	53
Q.7.1	Rework	53
Q.7.2	Repair	54
Q.8	Release for delivery	54
Q.8.1	General	54
Q.8.2	Release for delivery under qualification approval before the completion of Group B tests	54
Q.9	Certified test records of released lots	54
Q.10	Delayed delivery	54
Q.11	Alternative test methods	54
Q.12	Manufacture outside the geographical limits of IECQ CBs	54
Q.13	Unchecked parameters	54
Q.14	Technology approval procedures	55
Q.14.1	General	55
Q.14.2	Eligibility for technology approval	55
Q.14.3	Application of technology approval	55
Q.14.4	Description of technology	55
Q.14.5	Demonstration and verification of the technology	55
Q.14.6	Granting of technology approval	55
Q.14.7	Maintenance of technology approval.....	55
Q.14.8	Quality conformance inspection	55
Q.14.9	Failure rate level determination.....	56
Q.14.10	Outgoing quality level	56
	Bibliography.....	57
	Figure 1 – Basic circuit for measuring	17
	Figure 2 – Voltage–time characteristics between capacitor terminals in capacitance and internal resistance measurement.....	18
	Figure 3 – Circuit for constant resistance charging method	22

Figure 4 – Circuit for a.c. resistance method.....	23
Figure 5 – Maintain voltage test diagram	24
Figure A.1 – Conceptual rendering orientated by characteristics in each classification.....	34
Figure B.1 – Capacitance measuring system by the low frequency a.c. method	35
Figure C.1 – Thermal equilibrium times of capacitors (from 85 °C to 25 °C)	37
Figure C.2 – Thermal equilibrium times of capacitors (from –40 °C to 25 °C)	38
Figure C.3 – Capacitor core temperature change with respect to time	38
Figure Q.1 – General scheme for capability approval	49
Table 1 – Measuring conditions for measuring method 1A	19
Table 2 – Measuring conditions for measuring method 1B	20
Table 3 – Tensile force	25
Table 4 – Torque	26
Table 5 – Severities and requirements	32
Table A.1 – Electrical performance and measuring method by class	34
Table E.1 – Example of setting current for measurement of capacitor	41

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED ELECTRIC DOUBLE-LAYER CAPACITORS FOR USE IN ELECTRIC AND 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 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 62391-1 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This second edition cancels and replaces the first edition published in 2006 and constitutes a technical revision.

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

- a) enhancement of the scope to include electric (high power) application;
- b) implementation of Annex Q, replacing Clause 3 in the first edition;
- c) in addition, minor revisions related to tables, figures and references.

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

FDIS	Report on voting
40/2393/FDIS	40/2415/RVD

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

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

A list of all parts of IEC 62391 under the general title *Fixed electric double-layer capacitors for use in electric and electronic equipment* can be found in the IEC website.

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.

The contents of the corrigenda of December 2016 and June 2019 have been included in this copy.

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

FIXED ELECTRIC DOUBLE-LAYER CAPACITORS FOR USE IN ELECTRIC AND ELECTRONIC EQUIPMENT –

Part 1: Generic specification

1 Scope

This part of IEC 62391 applies to fixed electric double-layer capacitors (hereafter referred to as capacitor(s)) mainly used in d.c. circuits of electric and electronic equipment.

This part of IEC 62391 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.

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*

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

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

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

IEC 60068-2-45:1980, *Environmental testing – Part 2-45: Tests – Test XA and guidance: Immersion in cleaning solvents*
Amendment 1:1993)

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 60068-2-69:2007, *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 60294:2012, *Measurement of the dimensions of a cylindrical component with axial terminations*

IEC 60617 (all parts), *Graphical symbols for diagrams*

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

IEC 60717:2012, *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*