

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

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

**Résistances fixes utilisées dans les équipements électroniques –  
Partie 1: Spécification générique**



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2008 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 la CEI ou du Comité national de la CEI du pays du demandeur.  
Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

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

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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 corrigenda or an amendment might have been published.

#### Useful links:

IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The advanced search enables you 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It also gives information on projects, replaced and withdrawn publications.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](http://webstore.iec.ch/justpublished)

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

Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - [webstore.iec.ch/csc](http://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: [csc@iec.ch](mailto:csc@iec.ch).

---

### A propos de la CEI

La Commission Electrotechnique Internationale (CEI) 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 CEI

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

#### Liens utiles:

Recherche de publications CEI - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

La recherche avancée vous permet de trouver des publications CEI 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.

Just Published CEI - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

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

Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

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

**Résistances fixes utilisées dans les équipements électroniques –  
Partie 1: Spécification générique**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE **XC**  
CODE PRIX

ICS 31.040.10

ISBN 978-2-8322-0880-9

**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.....	7
1 General .....	9
1.1 Scope.....	9
1.2 Normative references .....	9
2 Technical data .....	11
2.1 Units and symbols .....	11
2.2 Terms and definitions .....	11
2.3 Preferred values .....	15
2.3.1 General .....	15
2.3.2 Preferred values of nominal resistance.....	15
2.4 Marking .....	15
2.5 Coding.....	16
2.6 Packaging .....	16
2.7 Storage .....	16
2.8 Transportation .....	16
3 Quality assessment procedures .....	16
4 Test and measurement procedures .....	17
4.1 General .....	17
4.2 Standard atmospheric conditions .....	17
4.2.1 Standard atmospheric conditions for testing .....	17
4.2.2 Recovery conditions.....	17
4.2.3 Referee conditions.....	17
4.2.4 Reference conditions .....	18
4.3 Drying.....	18
4.4 Visual examination and checking of dimensions .....	18
4.4.1 Visual examination.....	18
4.4.2 Dimensions (gauging).....	18
4.4.3 Dimensions (detail).....	19
4.5 Resistance .....	19
4.5.1 Test methods.....	19
4.5.2 Requirements .....	20
4.6 Insulation resistance.....	20
4.6.1 Test methods.....	20
4.6.2 Measuring conditions .....	22
4.6.3 Requirements .....	23
4.7 Voltage proof.....	23
4.7.1 Test methods.....	23
4.7.2 Test conditions .....	23
4.7.3 Requirements .....	23
4.8 Variation of resistance with temperature .....	23
4.8.1 Preconditioning .....	23
4.8.2 Measuring temperatures .....	23
4.8.3 Measuring procedures .....	23
4.8.4 Calculation of temperature coefficient of resistance $\alpha$ .....	24
4.8.5 Requirements .....	24
4.9 Reactance .....	25
4.9.1 Test procedures.....	25

4.9.2	Pulse generator specification .....	25
4.9.3	Oscilloscope specification .....	25
4.9.4	Measurements .....	26
4.9.5	Impedance analyzer .....	26
4.10	Non-linear properties .....	26
4.11	Voltage coefficient .....	26
4.11.1	Preconditioning .....	26
4.11.2	Measuring methods .....	26
4.11.3	Calculation of voltage coefficient .....	27
4.11.4	Requirements .....	27
4.12	Noise .....	27
4.13	Short time overload .....	27
4.13.1	Initial measurements .....	27
4.13.2	Test procedures .....	27
4.13.3	Final inspection, measurements and requirements .....	27
4.14	Temperature rise .....	27
4.14.1	Object .....	27
4.14.2	Mounting .....	27
4.14.3	Test procedures .....	28
4.14.4	Requirements .....	28
4.15	Robustness of the resistor body .....	28
4.15.1	Object .....	28
4.15.2	Test procedure .....	28
4.15.3	Requirements .....	28
4.16	Robustness of terminations .....	29
4.16.1	Test methods .....	29
4.16.2	Test Ua <sub>1</sub> – Tensile .....	29
4.16.3	Test Ub – Bending .....	30
4.16.4	Test Uc – Torsion .....	30
4.16.5	Test Ud – Torque .....	30
4.16.6	Final measurements .....	30
4.17	Solderability .....	30
4.17.1	Preconditioning .....	31
4.17.2	Test procedures .....	31
4.17.3	Final inspection, measurements and requirements .....	31
4.18	Resistance to soldering heat .....	31
4.18.1	Preconditioning .....	31
4.18.2	Test procedures .....	32
4.18.3	Recovery .....	32
4.18.4	Final inspection, measurements and requirements .....	32
4.19	Rapid change of temperature .....	32
4.19.1	Initial measurements .....	32
4.19.2	Test procedures .....	32
4.19.3	Final inspection, measurements and requirements .....	32
4.20	Bump .....	33
4.20.1	Mounting .....	33
4.20.2	Initial measurements .....	33
4.20.3	Test procedures .....	33
4.20.4	Final inspection, measurements and requirements .....	33

4.21	Shock.....	33
4.21.1	Mounting.....	33
4.21.2	Initial measurements.....	33
4.21.3	Test procedures.....	33
4.21.4	Measurements under test.....	33
4.21.5	Final inspection, measurements and requirements .....	33
4.22	Vibration.....	33
4.22.1	Mounting.....	33
4.22.2	Initial measurements.....	34
4.22.3	Test procedures.....	34
4.22.4	Final inspection, measurements and requirements .....	34
4.23	Climatic sequence .....	34
4.23.1	Initial measurements.....	34
4.23.2	Dry heat.....	34
4.23.3	Damp heat, cyclic, test Db, first cycle.....	34
4.23.4	Cold.....	34
4.23.5	Low air pressure .....	34
4.23.6	Damp heat, cyclic, test Db, remaining cycles.....	35
4.23.7	DC load .....	35
4.23.8	Final inspection, measurements and requirements .....	35
4.24	Damp heat, steady state .....	35
4.24.1	Initial measurements.....	35
4.24.2	Test procedures.....	35
4.24.3	DC load .....	36
4.24.4	Final inspection, measurements and requirements .....	36
4.25	Endurance .....	36
4.25.1	Endurance at 70 °C.....	36
4.25.2	Endurance at room temperature.....	38
4.25.3	Endurance at upper category temperature.....	39
4.26	Accidental overload test.....	40
4.26.1	Object.....	40
4.26.2	Gauze cylinder test method.....	40
4.26.3	Conditions of test.....	41
4.26.4	Test procedure .....	42
4.26.5	Requirement.....	42
4.27	Single-pulse high-voltage overload test.....	42
4.27.1	Object.....	42
4.27.2	Terminology.....	42
4.27.3	Test procedure .....	42
4.28	Periodic-pulse high-voltage overload test .....	45
4.28.1	Object.....	45
4.28.2	Terminology.....	45
4.28.3	Test procedure .....	45
4.29	Component solvent resistance .....	47
4.29.1	Initial measurement .....	47
4.29.2	Test conditions .....	47
4.29.3	Requirements .....	47
4.30	Solvent resistance of marking.....	48
4.30.1	Test conditions .....	48

4.30.2	Requirements .....	48
4.31	Mounting of surface mount resistors .....	48
4.31.1	Substrate .....	48
4.31.2	Wave soldering .....	48
4.31.3	Reflow soldering .....	49
4.32	Shear test .....	51
4.32.1	Mounting .....	51
4.32.2	Severities .....	51
4.32.3	Requirements .....	51
4.33	Substrate bending test .....	51
4.33.1	Preparation .....	51
4.33.2	Initial measurements .....	51
4.33.3	Test procedures .....	51
4.33.4	Final inspection and requirements .....	51
4.34	Corrosion .....	52
4.34.1	Test method .....	52
4.34.2	Requirements .....	52
4.35	Flammability .....	52
4.35.1	Test conditions .....	52
4.35.2	Requirements .....	52
4.36	Operation at low temperature .....	52
4.36.1	Initial measurements .....	52
4.36.2	Test procedures .....	52
4.36.3	Final inspection, measurements and requirements .....	52
4.37	Damp heat, steady state, accelerated .....	52
4.37.1	Initial measurements .....	52
4.37.2	Test methods .....	52
4.37.3	Test procedures .....	53
4.37.4	Final inspection, measurements and requirements .....	53
4.38	Electrostatic discharge .....	53
4.38.1	Test methods .....	53
4.38.2	Initial measurements .....	53
4.38.3	Test procedures .....	53
4.38.4	Final inspection, measurements and requirements .....	53
4.39	Periodic-pulse overload test .....	53
4.39.1	Preconditioning .....	53
4.39.2	Mounting .....	53
4.39.3	Initial measurements .....	54
4.39.4	Severities .....	54
4.39.5	Recovery .....	54
4.39.6	Final inspection, measurements and requirements .....	54
4.40	Whisker growth test .....	54
4.40.1	General .....	54
4.40.2	Preparation of specimen .....	54
4.40.3	Initial measurement .....	54
4.40.4	Test procedures .....	55
4.40.5	Test severities .....	55
4.40.6	Final inspection, measurements and requirements .....	55
4.41	Hydrogen sulphide test .....	55

Annex A (normative) Interpretation of sampling plans and procedures as described in IEC 60410 for use within the IECQ system .....	56
Annex B (normative) Rules for the preparation of detail specifications for resistors and capacitors for electronic equipment for use within the IECQ system .....	57
Annex C (informative) Example of test equipment for the periodic-pulse high-voltage overload test .....	58
Annex D (normative) Layout of the first page of a PCP/CQC specification .....	60
Annex E (normative) Requirements for capability approval test report .....	61
Annex F (informative) Letter symbols and abbreviations .....	62
Annex G (informative) Index table for test and measurement procedures .....	64
Annex Q (normative) Quality assessment procedures .....	66
Figure 1 – Insulation resistance and voltage proof test jig for rectangular surface mount resistors .....	21
Figure 2 – Insulation resistance and voltage proof test jig for cylindrical surface mount resistors .....	22
Figure 3 – Test circuit .....	25
Figure 4 – Oscilloscope trace .....	26
Figure 5 – Testing of resistor body robustness .....	29
Figure 6 – Gauze cylinder fixture .....	41
Figure 7 – Pulse generator 1,2/50 .....	43
Figure 8 – Pulse generator 10/700 .....	43
Figure 9 – Suitable substrate for mechanical and electrical tests (may not be suitable for impedance measurements) .....	50
Figure 10 – Suitable substrate for electrical tests .....	50
Figure C.1 – Block diagram of test equipment .....	58
Figure C.2 – Tolerances on the pulse shape .....	59
Figure Q.1 – General scheme for capability approval .....	69
Table 1 – Referee conditions .....	18
Table 2 – Measuring voltages .....	19
Table 3 – Calculation of resistance value ( $R$ ) and change in resistance ( $\Delta R$ ) .....	24
Table 4 – Calculation of temperature differences ( $\Delta T$ ) .....	24
Table 5 – Tensile force for wire terminations .....	30
Table 6 – Torque .....	30
Table 7 – Number of cycles .....	35
Table 8 – Severities (see Note 2) .....	44
Table 9 – List of preferred severities .....	46
Table 10 – Periodic-pulse overload test condition .....	54

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## FIXED RESISTORS 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 60115-1 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 Amendment 1 (2001). It constitutes a technical revision.

This standard cancels and replaces IEC 61045-1 (1991), IEC 61045-2 (1991) and IEC 61045-2-1 (1991).

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

- a) implementation of Annex Q which replaces Clause 3;
- b) addition of new tests procedures in 4.34 through 4.38;
- c) removal of the property "temperature characteristics" from 4.8;

- d) introduction of a new system of test severities for the shear test in 4.32;
- e) introduction of new bias voltages for the damp heat steady-state test in 4.24;
- f) furthermore, this fourth edition cancels and replaces the third edition published in 1999 and constitutes minor revisions related to tables, figures and references.

This bilingual version (2013-07) corresponds to the monolingual English version, published in 2008-07.

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

FDIS	Report on voting
40/1907/FDIS	40/1922/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.

The French version of this standard has not been voted upon.

A list of all parts of the IEC 60115 series, under the general title *Fixed resistors for use in electronic equipment*, can be found on the IEC website.

All sectional specifications mentioned above do have one or more blank detail specifications being a supplementary document, containing requirements for style, layout and minimum content of detail specifications.

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.