

# 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 © 2020 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 l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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

Tel.: +41 22 919 02 11  
[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 corrigendum or an amendment might have been published.

#### IEC publications search - [webstore.iec.ch/advsearchform](http://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 It also gives information on projects, replaced and withdrawn publications.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](http://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](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: [sales@iec.ch](mailto:sales@iec.ch).

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

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) 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 IEC

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

#### Recherche de publications IEC -

[webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

La recherche avancée permet de trouver des publications IEC 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.

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

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

#### 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: [sales@iec.ch](mailto:sales@iec.ch).

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

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

#### Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.



IEC 60115-1

Edition 5.0 2020-03

# 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

---

ICS 31.040.10

ISBN 978-2-8322-7904-5

**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 .....	6
INTRODUCTION .....	9
1 Scope .....	11
2 Normative references .....	11
3 Terms, definitions, product technologies and product classifications .....	13
3.1 Terms and definitions .....	13
3.2 Product technologies .....	20
3.3 Resistor encapsulations .....	23
3.4 Product classification .....	24
4 General requirements .....	25
4.1 Units and symbols .....	25
4.2 Preferred values .....	25
4.3 Coding .....	26
4.4 Marking of the resistors .....	26
4.5 Marking of the packaging .....	26
4.6 Ordering designation .....	27
4.7 Permissible substitutions .....	27
4.8 Packaging .....	28
4.9 Storage .....	29
4.10 Transportation .....	29
5 General provisions for measurements and test methods .....	30
5.1 General .....	30
5.2 Standard atmospheric conditions .....	30
5.3 Tolerances on test severity parameters .....	32
5.4 Drying .....	33
5.5 Mounting of specimens .....	33
5.6 Measurement of resistance .....	35
6 Electrical measurements and tests .....	37
6.1 Resistance .....	37
6.2 Temperature coefficient of resistance .....	39
6.3 Inductance .....	42
6.4 Voltage coefficient of resistance .....	44
6.5 Non-linearity .....	45
6.6 Current noise .....	46
6.7 Temperature rise .....	47
7 Endurance tests .....	48
7.1 Endurance at the rated temperature 70 °C .....	48
7.2 Endurance at room temperature .....	50
7.3 Endurance at a maximum temperature .....	55
8 Electrical overload tests .....	59
8.1 Short-term overload .....	59
8.2 Single-pulse high-voltage overload test .....	61
8.3 Periodic-pulse high-voltage overload test .....	66
8.4 Periodic-pulse overload test .....	68
8.5 Electrostatic discharge .....	70

9	Mechanical measurements and tests .....	71
9.1	Visual examination.....	71
9.2	Gauging of dimensions .....	72
9.3	Detail dimensions .....	73
9.4	Robustness of the resistor body.....	74
9.5	Robustness of terminations.....	75
9.6	Robustness of threaded stud or screw terminations .....	78
9.7	Shear test.....	79
9.8	Substrate bending test .....	81
9.9	Bump .....	83
9.10	Shock .....	84
9.11	Vibration .....	85
10	Environmental and climatic tests .....	87
10.1	Rapid change of temperature.....	87
10.2	Operation at low temperature.....	88
10.3	Climatic sequence.....	89
10.4	Damp heat, steady state .....	92
10.5	Damp heat, steady state, accelerated .....	95
10.6	Corrosion .....	97
10.7	Whisker growth test .....	99
10.8	Hydrogen sulphide test .....	100
11	Tests related to component assembly.....	101
11.1	Solderability.....	101
11.2	Resistance to soldering heat.....	105
11.3	Solvent resistance .....	107
12	Tests related to safety .....	109
12.1	Insulation resistance .....	109
12.2	Voltage proof .....	114
12.3	Accidental overload test.....	115
12.4	Flammability .....	120
13	Quality assessment procedures .....	121
	Annex A (normative) Symbols and abbreviated terms .....	123
	A.1 Symbols.....	123
	A.2 Abbreviated terms.....	126
	Annex B (normative) Rules for the preparation of detail specifications for resistors and capacitors for electronic equipment for use within the IECQ system .....	129
	Annex C (informative) Example of a certified test record .....	130
	Annex Q (informative) Quality assessment procedures .....	132
	Q.1 General.....	132
	Q.2 IECQ Approved Component (IECQ AC) procedures .....	136
	Q.3 IECQ Qualification Approval (QA) procedures.....	137
	Q.4 IECQ Approved Component – Capability Certification (IECQ AC-C) procedures.....	138
	Q.5 IECQ Approved Component – Technology Certification (IECQ AC-TC) procedure .....	140
	Annex R (informative) Failure rate level evaluation, determination and qualification.....	143
	R.1 General.....	143
	R.2 Certification and determination of a failure rate level.....	144

R.3	Non-conformances .....	146
R.4	Extension of a qualification to a higher failure rate level .....	146
R.5	Maintenance of a failure rate level .....	146
R.6	Deliveries .....	147
R.7	Determination of a component failure rate .....	148
Annex X (informative) Cross-references for references to the prior revision of this document .....		151
Bibliography .....		155
Figure 1	– Hierarchical system of specifications .....	10
Figure 2	– Voltage and dissipation on a resistor below and above its critical resistance .....	14
Figure 3	– Standard measurement points on a leaded resistor .....	36
Figure 4	– Standard measurement points on an SMD resistor .....	36
Figure 5	– Measurement points on an assembled SMD resistor .....	37
Figure 6	– Permissible resistance range due to tolerance .....	38
Figure 7	– Permissible resistance range due to tolerance and TCR .....	39
Figure 8	– Variation of resistance with temperature (example) .....	39
Figure 9	– Test circuit for measurement of the inductance .....	43
Figure 10	– Exponential voltage rise caused by inductance .....	44
Figure 11	– Standard derating curve for the rated dissipation $P_{70}$ .....	49
Figure 12	– Derating curve with specification of a suitable test dissipation .....	53
Figure 13	– Derating curve without specification of a suitable test dissipation .....	53
Figure 14	– Derating curve for $UCT \geq MET$ .....	57
Figure 15	– Derating curve for $UCT < MET$ .....	57
Figure 16	– Parameters of an open-circuit lightning impulse voltage .....	62
Figure 17	– Circuit for generation of 1,2/50 pulses .....	63
Figure 18	– Circuit for generation of 10/700 pulses .....	64
Figure 19	– Testing of resistor body robustness .....	75
Figure 20	– Shear test for SMD resistors .....	80
Figure 21	– Substrate bending test for SMD resistors .....	82
Figure 22	– V-block fixture .....	110
Figure 23	– Foil method applied to a resistor specimen .....	111
Figure 24	– Mounting method applied to a resistor specimen .....	111
Figure 25	– Parallel clamp fixture for rectangular SMD resistors .....	112
Figure 26	– V-clamp test fixture for cylindrical SMD resistors .....	113
Figure 27	– Gauze fixture for axial cylindrical specimens .....	117
Figure 28	– Gauze fixture dimensions for cylindrical specimens .....	118
Figure 29	– Gauze fixture dimensions for non-cylindrical specimens .....	119
Table 1	– Reference atmospheric conditions .....	30
Table 2	– Referee atmospheric conditions .....	31
Table 3	– Standard atmospheric conditions for testing .....	31
Table 4	– Controlled atmospheric conditions for recovery .....	32
Table 5	– Default tolerances on temperature specifications .....	32

Table 6 – Default tolerances on voltage specifications .....	32
Table 7 – Default tolerances on duration specifications.....	33
Table 8 – Specimen drying procedures .....	33
Table 9 – Voltages for resistance measurement.....	35
Table 10 – Sequence of temperatures and measurements .....	40
Table 11 – Severities for the single-pulse high-voltage overload test .....	65
Table 12 – Severities for the periodic-pulse high-voltage overload test .....	68
Table 13 – Tensile test force for wire terminations .....	76
Table 14 – Test torque for threaded studs, screws and integral mounting devices .....	78
Table 15 – Recommended parameters for the substrate bending test .....	81
Table 16 – Recommended parameters for the bump test .....	84
Table 17 – Recommended parameters for the shock test.....	85
Table 18 – Recommended parameters for the vibration test.....	86
Table 19 – Recommended parameters for the rapid change of temperature test .....	88
Table 20 – Number of additional damp heat cycles .....	91
Table 21 – Severity parameters for the damp heat, steady state test .....	93
Table 22 – Bias voltage for the damp heat, steady state test .....	94
Table 23 – Severity parameters for the accelerated damp heat, steady state test .....	96
Table 24 – Grouped DC bias voltages for < 25 % deviation.....	97
Table 25 – Recommended parameters for the corrosion test.....	98
Table 26 – Test methods and parameters for the whisker growth test .....	100
Table 27 – Selection of accelerated ageing methods of IEC 60068-2-20 .....	101
Table 28 – Process temperatures for selected solder alloy examples.....	102
Table 29 – Solderability test parameters for SMD resistors .....	103
Table 30 – Solderability test parameters for resistors with wire or tag terminations .....	104
Table 31 – Resistance to soldering heat test parameters for SMD resistors .....	106
Table 32 – RSH test parameters for resistors with wire or tag terminations .....	106
Table 33 – Recommended parameters for the solvent resistance test .....	109
Table 34 – Insulation resistance measuring voltage .....	114
Table 35 – Recommended parameters for the accidental overload test.....	120
Table R.1 – Requirements for the qualification of a failure rate level.....	145
Table R.2 – Requirements for the maintenance of a failure rate level qualification .....	147
Table R.3 – Environmental factor $\pi_E$ for determination of the component failure rate .....	150
Table R.4 – Quality factor $\pi_Q$ for determination of the component failure rate .....	150
Table X.1 – Cross-references for references to clauses (1 of 3) .....	151
Table X.2 – Cross-references for references to figures .....	153
Table X.3 – Cross reference for references to tables .....	154

# 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 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 60115-1 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. This edition constitutes a technical revision.

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

- a) this 5<sup>th</sup> edition employs a new document structure, where the tests of prior Clause 4 are given in Clauses 6 to 12 now, with an informative Annex X providing cross-references for references to the prior revision of this standard;
- b) the terms and definitions have been revised and amended, supplemented by a new section on resistor technologies and a new section on product classification levels;
- c) a new Subclause 4.7 on recommendations for permissible substitutions has been added;

- d) the provisions for packaging, storage and transportation in Subclauses 4.8, 4.9 and 4.10 have been completely revised;
- e) a new Subclause 5.3 on default tolerances for the most common test parameters has been added;
- f) the generic method of measuring resistance, now Subclause 5.6, has been separated from the test for compliance with a prescribed resistance value in 6.1, as a revision of the prior 4.5;
- g) the test for the temperature coefficient of resistance of Subclause 6.2 is a revision of the prior test 4.8, variation of resistance with temperature, where the special concessions for resistors below 10  $\Omega$  have been waived;
- h) the test methods for endurance testing of Subclauses 7.1 to 7.3 (prior 4.25.1 to 4.25.3) have been completely revised;
- i) the single-pulse high-voltage overload test of Subclause 8.2 (prior 4.27) has been completely revised, and now offers adjustable severities for the 1,2/50 and for the 10/700 pulse shape for the benefit of detail specifications with improved significance;
- j) the periodic-pulse high-voltage overload test of Subclause 8.3 (prior 4.28) has been revised and a corrected table of severities provided;
- k) the period-pulse overload test of Subclause 8.4 (prior 4.39) has been deprecated and streamlined to only offer the severity historically applied in subordinate specifications;
- l) the Subclauses 9.1 on visual inspection, 9.2 on the gauging of dimensions, and 9.3 on the assessment of detail dimensions (all parts of prior 4.4) have been completely revised;
- m) the tests for robustness of terminations (prior 4.16) have been revised and separated into tests for the robustness of solderable terminations, Subclause 9.5, and tests for the robustness of threaded stud or screw terminations, Subclause 9.6;
- n) the bump test of Subclause 9.9 (prior 4.20) and the shock test of Subclause 9.10 (prior 4.21) have been revised to reflect the merged relevant test standard IEC 60068-2-29;
- o) the dry heat and cold test of the climatic sequence of Subclause 10.3 (prior 4.23) have been revised to reflect the changes of the relevant test standards IEC 60068-2-2 and IEC 60068-2-1;
- p) the accelerated damp heat, steady state test of Subclause 10.5 (prior 4.37) has been amended with an option for a reduced number of bias voltages;
- q) the corrosion test of Subclause 10.6 has been completely revised in order to employ the better suitable test method of IEC 60068-2-52 instead of the prior used IEC 60068-2-11;
- r) the whisker growth test of Subclause 10.7 has been revised to reflect the changes of the new revision of the test methods of IEC 60068-2-82;
- s) the test methods for solderability of Subclause 11.1 (prior 4.17) and for resistance to soldering heat of Subclause 11.2 (prior 4.18) have been completely revised to incorporate the necessary option for the variety of lead-bearing and lead-free solder alloys and respective process conditions;
- t) the solvent resistance test of Subclause 11.3 combines the prior tests 4.29, component solvent resistance, and 4.30, solvent resistance of marking, in one test;
- u) the accidental overload test of Subclause 12.3 (prior 4.26) has been completely revised;
- v) the Annex Q on quality assessment procedures has been completely revised;
- w) a new Annex R on failure rate evaluation, determination and qualification has been added.

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

FDIS	Report on voting
40/2717/FDIS	40/2733/RVD

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

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

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.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

## INTRODUCTION

The specification system for fixed resistors for use in electronic equipment is structured in a hierarchical system as shown in Figure 1, consisting of the following specification types.

### **Generic specification**

The generic specification covers all subjects mainly common to the family of fixed resistors 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 sub-family or type of fixed resistor, such prescriptions are required to be given by one of the subordinate specifications.

For the scope of fixed resistors, the numeric reference to the generic specification is IEC 60115-1.

### **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 resistors. 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 resistors, the numeric references to the sectional specifications reach from IEC 60115-2 for leaded fixed low power film resistors to currently IEC 60115-9 for fixed surface mount resistor networks with individually measurable resistors. The variety of sectional specifications may be adapted to the portfolio of different technologies of fixed resistors.

### **Detail specification**

Detail specifications give directly, or by making reference to other documents, all information necessary to completely describe a given type and range of fixed resistors, 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 resistors 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 resistors, the numeric references to detail specifications are e.g. IEC 60115-2-101; if related to the sectional specification, IEC 60115-2; and if related to the ancillary blank detail specification, IEC 60115-2-1.

### **Blank detail specification**

The hierarchical system of specifications is supplemented by one or more blank detail specification 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.

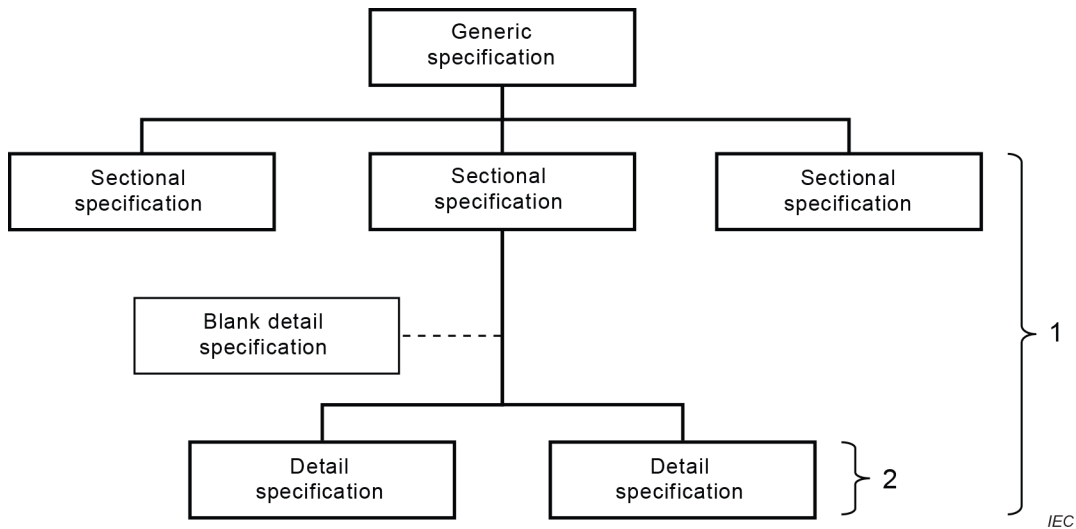
The presence of an established hierarchical specification system with blank detail specifications permits the preparation of detail specifications even outside of the relevant IEC technical committee.

For the scope of fixed resistors, the numeric references to blank detail specifications are e.g. IEC 60115-2-1: if related to the sectional specification, IEC 60115-2.

### 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.

**Figure 1 – Hierarchical system of specifications**