

INTERNATIONAL STANDARD

IEC 60115-1

QC 40000

Third edition
1999-05

Fixed resistors for use in electronic equipment –

Part 1: Generic specification

*Résistances fixes utilisées dans les équipements
électroniques –*

*Partie 1:
Spécification générique*

[IEC 60115-1:1999](#)

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Terminology, graphical and letter symbols

For general terminology, readers are referred to IEC 60050: *International Electrotechnical Vocabulary* (IEV).

For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications IEC 60027: *Letter symbols to be used in electrical technology*, IEC 60417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets* and IEC 60617: *Graphical symbols for diagrams*.

* See web site address on title page.

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CONTENTS

	Page
FOREWORD	4
Clause	
1 General.....	5
1.1 Scope	5
1.2 Normative references	5
2 Technical data.....	7
2.1 Units and symbols.....	7
2.2 Definitions.....	7
2.3 Preferred values.....	10
2.4 Marking.....	10
2.5 Coding	11
3 Quality assessment procedures.....	11
3.1 General.....	11
3.2 Primary stage of manufacture.....	12
3.3 Subcontracting.....	12
3.4 Structurally similar components.....	12
3.5 Qualification approval procedures.....	12
3.6 Capability approval procedures.....	13
3.7 Rework and repair.....	19
3.8 Release for delivery	19
3.9 Certified test records of released lots	19
3.10 Delayed delivery.....	19
3.11 Alternative test methods.....	19
3.12 Manufacture outside the geographical limits of IECQ NSIs.....	20
3.13 Unchecked parameters.....	20
4 Test and measurement procedures	20
4.1 General.....	20
4.2 Standard atmospheric conditions.....	20
4.3 Drying.....	21
4.4 Visual examination and checking of dimensions	21
4.5 Resistance.....	22
4.6 Insulation resistance (insulated styles only)	22
4.7 Voltage proof	25
4.8 Variation of resistance with temperature.....	25
4.9 Reactance	27
4.10 Non-linear properties.....	28
4.11 Voltage coefficient.....	28
4.12 Noise	29
4.13 Overload.....	29
4.14 Temperature rise.....	29
4.15 Robustness of the resistor body	30
4.16 Robustness of terminations	30

Clause	Page
4.17 Solderability	32
4.18 Resistance to soldering heat	33
4.19 Rapid change of temperature	34
4.20 Bump	34
4.21 Shock	34
4.22 Vibration	34
4.23 Climatic sequence	35
4.24 Damp heat, steady state	36
4.25 Endurance	37
4.26 Accidental overload test (for low-power non-wire-wound resistors only)	42
4.27 Single-pulse high-voltage overload test	44
4.28 Periodic-pulse high-voltage overload test	47
4.29 Component solvent resistance	50
4.30 Solvent resistance of marking	50
4.31 Mounting (for surface mount resistors only)	50
4.32 Shear (adhesion) test	53
4.33 Substrate bending test (formerly bond strength of the end face plating)	53
Annex A (normative) Interpretation of sampling plans and procedures as described in IEC 60410 for use within the IEC quality assessment system for electronic components (IECQ)	54
Annex B (normative) Rules for the preparation of detail specifications for resistors and capacitors for electronic equipment	55
Annex C (informative) Example of test equipment for the periodic-pulse high-voltage overload test	56
Annex D (normative) Layout of the first page of a PCP/CQC specification	57

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED RESISTORS FOR USE IN ELECTRONIC EQUIPMENT -

Part 1: Generic specification

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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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- 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The 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: 999
 Capacitors and resistors for electronic equipment.

This third edition cancels and replaces the second edition published in 1982, amendment 2 (1987), amendment 3 (1989) and amendment 4 (1993).

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

FDIS	Report on voting
40/1087/FDIS	40/1109/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 QC number that appears on the front cover of this publication is the specification number in the IEC Quality Assessment System for Electronic Components (IECQ).

Annexes A, B and D form an integral part of this standard.

Annex C is for information only.

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

FIXED RESISTORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 1: Generic specification

1 General

1.1 Scope

This part of IEC 60115 is applicable to fixed resistors 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 normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60115. For dated references, subsequent amendments to, or revisions of any of these publications do not apply. However, parties to agreements based on this part of IEC 60115 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

NOTE – In the case of IEC 60068 standards, use the referenced edition.

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

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

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60060-2:1994, *High-voltage test techniques – Part 2: Measuring systems*

IEC 60062:1992, *Marking codes for resistors and capacitors*
Amendment 1 (1995)

IEC 60063:1963, *Preferred number series for resistors and capacitors*
Amendment 1 (1967)
Amendment 2 (1977)

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*
Amendment 1 (1992)

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests – Tests A: Cold*
Amendment 1 (1993)
Amendment 2 (1994)

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests – Tests B: Dry heat*
Amendment 1 (1993)
Amendment 2 (1994)

IEC 60068-2-3:1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*
Amendment 1 (1984)

.IEC 60068-2-6:1995, *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*
Amendment 1 (1986)

IEC 60068-2-20:1979, *Environmental testing – Part 2: Tests – Test T: Soldering*
Amendment 2 (1987)

IEC 60068-2-21:1983, *Environmental testing – Part 2: Tests – Test U: Robustness of terminations and integral mounting devices*
Amendment 2 (1991)
Amendment 3 (1992)

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

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

IEC 60068-2-30:1980, *Environmental testing – Part 2: Tests – Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle)*
Amendment 1 (1985)

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

IEC 60068-2-58:1989, *Environmental testing – Part 2: Tests – Test Td: Solderability, resistance to dissolution of metallization and to soldering heat of Surface Mounting Devices (SMD)*

IEC 60195:1965, *Method of measurement of current noise generated in fixed resistors*

IEC 60249-2-4:1987, *Base materials for printed circuits – Part 2: Specifications – Specification No. 4: Epoxide woven glass fabric copper-clad laminated sheet, general purpose grade*

IEC 60294:1969, *Measurement of the dimensions of a cylindrical component having two axial terminations*

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

IEC 60440:1973, *Method of measurement of non-linearity in resistors*

IEC QC 001002-3: 1998, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of procedure – Part 3: Approval procedures*

IEC QC 001003:1998, *IEC Quality Assessment System for Electronic Components (IECQ) – Guidance documents*

IEC QC 001005:1998, *Register of firms, products and services approved under the IECQ system, including ISO 9000*

ISO 1000:1992, *SI units and recommendations for the use of their multiples and of certain other units*

2 Technical data

2.1 Units and symbols

For the purposes of this part of IEC 60115, the following definitions apply. In addition, units, graphical symbols, letter symbols and terminology shall, whenever possible, be taken from the following publications:

- IEC 60027;
- IEC 60050;
- ISO 1000.

When further items are required they shall be derived in accordance with the principles of the documents listed above.

2.2 Definitions

For the purposes of this part of IEC 60115, the following definitions apply.

2.2.1

type

group of components having similar design features, the similarity of whose manufacturing techniques enables them to be grouped together either for qualification approval or for quality conformance inspection; they are generally covered by a single detail specification

NOTE 1 – Components described in several detail specifications, may, in some cases, be considered as belonging to the same type and may therefore be grouped for quality assessment purposes.

NOTE 2 – Mounting accessories are ignored, provided they have no significant effect on the test results.

NOTE 3 – Ratings cover the combination of

- electrical ratings,
- sizes,
- environmental category.

The limits of the range of ratings are to be given in the detail specification.

2.2.2

style

subdivision of a type, generally based on dimensional factors; a style may include several variants, generally of a mechanical order

2.2.3

grade

term indicating additional general characteristics concerning the intended application, for example long-life applications.

The term "grade" may be used only in combination with one or more words (for example, long-life grade) and not with a single letter or number.

The figures to be added after the term "grade" should be arabic numerals

2.2.4

family (of electronic components)

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

2.2.5

subfamily (of electronic components)

group of components within a family manufactured by similar technological methods

2.2.6**rated resistance**

resistance value for which the resistor has been designed, and which is generally indicated on the resistor

2.2.7**critical resistance**

resistance value at which the rated voltage is equal to the limiting element voltage (see 2.2.15 and 2.2.16)

NOTE – At an ambient temperature of 70 °C, the maximum voltage which may be applied across the terminations of a resistor is either the calculated rated voltage, if the resistance is less than the critical resistance, or the limiting element voltage, if the resistance is equal to or greater than the critical resistance. At temperatures other than 70 °C, it is important that account be taken of the derating curve and of the limiting element voltage in the calculation of any voltage to be applied.

2.2.8**category temperature range**

range of ambient temperatures for which the resistor has been designed to operate continuously, defined by the temperature limits of its appropriate category

2.2.9**upper category temperature**

the maximum ambient temperature for which a resistor has been designed to operate continuously at that portion of the rated dissipation which is indicated in the category dissipation

2.2.10**lower category temperature**

minimum ambient temperature at which a resistor has been designed to operate continuously

2.2.11**maximum surface temperature**

maximum temperature permitted on the surface for any resistor of that type when operated continuously at rated dissipation at an ambient temperature of 70 °C

2.2.12**rated temperature**

maximum ambient temperature at which the rated dissipation may be applied continuously under the conditions of the endurance test prescribed for this temperature. It has a value of 70 °C, unless otherwise prescribed in the relevant sectional specification

2.2.13**rated dissipation**

maximum allowable dissipation at an ambient temperature of 70 °C under the conditions of the endurance test at 70 °C and for which the permitted change in resistance for this endurance test is not exceeded

2.2.14**category dissipation**

fraction of the rated dissipation exactly defined in the detail specification, applicable at the upper category temperature, taking account of the derating curve prescribed in the detail specification

NOTE – The category dissipation may be zero.

2.2.15**rated voltage** (U_N or U_R)

d.c. or a.c. r.m.s. voltage calculated from the square root of the product of the rated resistance and the rated dissipation

NOTE – At high values of resistance, the rated voltage may not be applicable because of the size and the construction of the resistor (see 2.2.16).

2.2.16**limiting element voltage**

maximum d.c. or a.c. r.m.s. voltage that may be continuously applied to the terminations of a resistor (generally dependent upon size and manufacturing technology of the resistor).

Where the term "a.c. r.m.s. voltage" is used in this standard, the peak voltage shall not exceed 1,42 times the r.m.s. value

NOTE – This voltage can only be applied to resistors when the resistance value is equal to or higher than the critical resistance value.

2.2.17**insulation voltage** (applicable only to insulated resistors)

the maximum peak voltage which may be applied under continuous operating conditions between the resistor terminations and any conducting mounting surface

2.2.18**insulated resistor**

resistor which fulfils the voltage proof and insulation resistance test requirements and the damp-heat, steady-state test with a polarizing voltage applied when mounted on a metal plate

2.2.19**insulation resistance**

Under consideration

2.2.20**variation of resistance with temperature**

variation of resistance with temperature which can be expressed either as a temperature characteristic or as a temperature coefficient as defined below

2.2.20.1**temperature characteristic of resistance**

maximum reversible variation of resistance produced over a given temperature range within the category temperatures related to a reference temperature of 20 °C

2.2.20.2**temperature coefficient of resistance** (α)

relative variation of resistance between two given temperatures divided by the difference in the temperature producing it

NOTE – It should be noted that the use of the term does not imply any degree of linearity for this function, nor should any be assumed.

2.2.21**voltage coefficient of resistance**

reversible change in resistance caused by the applied voltage and expressed as a percentage change in resistance per applied volt

2.2.22**visible damage**

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

2.2.23

surface mount resistor

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

2.2.24

heat-sink resistor

resistor type designed for mounting on a separate heat-sink

2.2.25

rated dissipation (heat-sink resistors only)

maximum allowable dissipation of a heat-sink resistor at an ambient temperature of 25 °C, when mounted on the reference heat-sink, under the conditions of the endurance test at room temperature for heat-sink resistors, and which will result in a change in resistance not greater than that specified for this endurance test

2.2.26

maximum element temperature

maximum stated temperature at any point on or within the resistor, under any permissible operating condition

2.3 Preferred values

2.3.1 General

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

2.3.2 Preferred values of rated resistance

The preferred values of rated resistance shall be taken from the series specified in IEC 60063.

2.4 Marking

2.4.1 General

2.4.1.1 The information given in the marking is normally selected from the following list; the relative importance of each item is indicated by its position in the list:

- a) rated resistance;
- b) tolerance on rated resistance;
- c) temperature coefficient (if applicable);
- d) year and month (or week) of manufacture;
- e) number of the detail specification and style reference;
- f) manufacturer's name or trade mark.

2.4.1.2 The resistor shall be clearly marked with a) and b) above, and with as many of the remaining items as is practicable. Any duplication of information in the marking on the resistor should be avoided.

2.4.1.3 The package containing the resistor(s) shall be clearly marked with all the information listed above.

2.4.1.4 Any additional marking shall be so applied that no confusion can arise.

2.5 Coding

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

3 Quality assessment procedures

3.1 General

When this standard and any related standards are used for the purpose of a full quality assessment system such as the IEC quality assessment system for electronic components (IECQ), compliance to 3.5 or 3.6 is required.

When these standards are used outside such quality assessment systems for purposes such as design proving or type testing, the procedures and requirements of 3.5.1 and 3.5.3 b) may be used, but the tests and parts of tests shall be applied in the order given in the test schedules.

Before resistors can be qualified according to the procedures of this clause, the manufacturer shall obtain the approval of his organization, in accordance with the provisions of IEC QC 001002-3.

Two of the methods that are available for the approval of resistors of assessed quality, and which are covered by the following subclause are qualification approval according to the provisions of clause 3 of IEC QC 001002-3, and capability approval according to the provisions of clause 4 of IEC QC 001002-3. For a given subfamily of resistors, separate sectional specifications for qualification approval and capability approval are necessary, and capability approval is therefore available only when a relevant sectional specification has been published.

3.1.1 Applicability of qualification approval

Qualification approval is appropriate for a standard range of resistors manufactured to similar design and production processes, and conforming to a published detail specification.

The programme of tests defined in the detail specification for the appropriate assessment and performance levels applies directly to the resistor range to be qualified, as prescribed in 3.5 and the relevant sectional specification.

3.1.2 Applicability of capability approval

Capability approval is appropriate when resistors based on common design rules are fabricated by a group of common processes. It is particularly appropriate when resistors are manufactured to a user's specific requirements.

Under capability approval, detail specifications fall into the following three categories.

3.1.2.1 Capability qualifying components (CQCs), including process validation test vehicles

A detail specification shall be prepared for each CQC as agreed with the national supervising inspectorate (NSI). It shall identify the purpose of the CQC and include all relevant test severities and limits.

3.1.2.2 Standard catalogue components

When the manufacturer requires that a resistor approved under the capability approval procedure be listed in the IECQ register of approvals, a capability approval detail specification complying with the blank detail specification shall be written. Such specifications shall be registered by the IECQ and the component shall be listed in IEC QC 001005.

3.1.2.3 Customer specific components

The content of the detail specification (often known as a CDS (customer detail specification)) shall be by agreement between the manufacturer and the customer, in accordance with 4.4.3 of IEC QC 001002-3.

Further information on these detail specifications is given in the relevant sectional specification.

Approval is given to a manufacturing facility on the basis of validated design rules, processes and quality control procedures and the results of tests on capability qualifying components, including any process validation test vehicles. See 3.6 and the relevant sectional specification for further information.

3.2 Primary stage of manufacture

For fixed resistor specifications, the primary stage of manufacture is as follows:

- for film types:
deposition of the resistive film on the substrate;
- for carbon composition types:
process which produces the greatest change in polymerization of the binder;
- for wire-wound types:
winding of the resistance wire (or ribbon) on the former;
- for metal foil resistors:
fixing of the resistive foil on the substrate.

3.3 Subcontracting

If subcontracting of the primary stage of manufacture and/or subsequent stages is employed, it shall be in accordance with 4.2.2 of IEC QC 001002-3.

The sectional specification may restrict subcontracting, in accordance with 4.2.2.2 of IEC QC 001002-3.

3.4 Structurally similar components

The grouping of structurally similar components for qualification approval testing or for quality conformance testing under qualification approval or capability approval shall be prescribed in the relevant sectional specification.

3.5 Qualification approval procedures

3.5.1 Eligibility for qualification approval

The manufacturer shall comply with 3.1.1 of IEC QC 001002-3.

3.5.2 Application for qualification approval

The manufacturer shall comply with 3.1.3 of IEC QC 001002-3.