

Fixed resistors for use in electronic equipment —

Part 1: Generic specification

ICS 31.040.10

National foreword

This British Standard is the UK implementation of EN 60115-1:2001+A1:2001, incorporating A11:2007. It is derived from IEC 60115-1:1999, incorporating amendment 1:2001. It supersedes BS EN 140000:1995 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by A1 A1.

The CENELEC common modifications have been implemented at the appropriate places in the text. The start and finish of each common modification is indicated in the text by tags C C.

The start and finish of text introduced or altered by CENELEC amendment is indicated in the text by tags. For example, the common modifications introduced by CENELEC amendment A11 are indicated by C11 C11.

The UK participation in its preparation was entrusted by Technical Committee EPL/40, Capacitors and resistors for electronic equipment, to Subcommittee EPL/40/2, Resistors.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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English version

Fixed resistors for use in electronic equipment
Part 1: Generic specification
(IEC 60115-1:1999, modified)

Résistances fixes utilisées dans les
équipements électroniques
Partie 1: Spécification générique
(CEI 60115-1:1999, modifiée)

Festwiderstände zur Verwendung in
Geräten der Elektronik
Teil 1: Fachgrundspezifikation
(IEC 60115-1:1999, modifiziert)

This European Standard was approved by CENELEC on 2001-03-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of the International Standard IEC 60115-1:1999, prepared by IEC TC 40, Capacitors and resistors for electronic equipment, together with the common modifications prepared by the Technical Committee CENELEC TC 40XB, Resistors, was submitted to the Unique Acceptance procedure and was approved by CENELEC as EN 60115-1 on 2001-03-01.

This European Standard supersedes EN 140000:1993.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2002-04-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2004-04-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A, B, D, ZB and ZC are normative and annexes C and ZA are informative.

Annexes ZA, ZB and ZC have been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60115-1:1999 was approved by CENELEC as a European Standard with agreed common modifications.

Foreword to amendment A1

The text of document 40/1184/FDIS, future amendment 1 to IEC 600115-1:1999, prepared by IEC TC 40, Capacitors and resistors for electronic equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60115-1 on 2001-03-01.

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- latest date by which the national standards conflicting
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Endorsement notice

The text of amendment 1:2001 to the International Standard IEC 60115-1:1999 was approved by CENELEC as an amendment to the European Standard without any modification.

Foreword

The text of the International Standard IEC 60115-1:1999, prepared by IEC TC 40, Capacitors and resistors for electronic equipment, together with the common modifications prepared by the Technical Committee CENELEC TC 40XB, Resistors, was submitted to the Unique Acceptance procedure and was approved by CENELEC as EN 60115-1 on 2001-03-01.

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Endorsement notice

The text of the International Standard IEC 60115-1:1999 was approved by CENELEC as a European Standard with agreed common modifications.

Foreword to amendment A11

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- latest date by which the national standards conflicting
with the amendment have to be withdrawn (dow) 2010-12-01

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EN 60115-1

NORME EUROPÉENNE

EUROPÄISCHE NORM

September 2001

ICS 31.040.10

Supersedes EN 140000:1993

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Central Secretariat: rue de Stassart 35, B - 1050 Brussels

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Cross reference list for clause numbers of EN 140000 and IEC 60115-1

The following cross reference list has been established to indicate the relation between the corresponding clauses in EN 140000 and IEC 60115-1. Technical deviations are indicated by "Y" in the third column. The clause numbers of common modifications for the harmonized EN 60115-1 refer to IEC 60115-1:1999. Related clause numbers for new clauses are indicated in column four.

Clause number		Modification	
EN 140000:1993	IEC 60115-1:1999	Yes/No	New clauses
	1	N	
1	1.1	N	
2.1	1.2	Y	
2	2	N	
2.2/2.2.1	2.1	N	
- - -	2.2	N	
2.2.2	2.2.1	N	
2.2.3	2.2.2	N	
2.2.4	2.2.3	N	
2.2.5	2.2.4	N	
2.2.6	2.2.5	N	
2.2.7	2.2.6	N	
2.2.8	2.2.7	N	
2.2.9	2.2.8	N	
2.2.10	2.2.9	N	
2.2.11	2.2.10	N	
2.2.12	2.2.11	N	
2.2.13	2.2.12	N	
2.2.13 Note	2.2.13	N	
	2.2.19	Y	
- - -	2.2.21	N	
2.2.21	2.2.22	N	
2.2.22	2.2.23	N	
2.2.23	2.2.24	N	
- - -	2.2.25	N	
2.2.24		Y	2.2.27
		Y	2.2.28
		Y	2.2.29

Clause number		Modification	
EN 140000:1993	IEC 60115-1:1999	Yes/No	New clauses
		Y	2.2.30
		Y	2.2.31
		Y	2.2.32
		Y	2.2.33
2.4.2	2.5	N	
		Y	2.6
		Y	2.7
3	3	Y	
4.5.3		Y	4.5.3
	4.10	Y	
4.14.2	4.14.2	Y	
4.14.4	4.14.4	Y	
4.14.6	4.14.6	Y	
4.17	4.17	Y	
	4.17.2	Y	
- - -	4.17.5	Y	
4.18	4.18.2 a, b, c	N	
4.19.2	4.19.2	Y	
4.25.4.2,3	4.25.4.2	N	
4.25.4.5	4.25.4.3	N	
4.25.4.6, 7, 8, 9	4.25.4.4	N	
4.25.4.10	4.25.4.5	N	
- - -	4.31	N	
4.31	4.32	Y	
- - -	4.32.2	Y	
4.31	4.33	N	
4.32		Y	4.34
4.33		Y	4.35
4.34		Y	4.36
		Y	4.37
		Y	4.38
		Y	4.39
		Y	4.40

Clause number		Modification	
EN 140000:1993	IEC 60115-1:1999	Yes/No	New clauses
- - -	Annex A	Y	
Annex E	Annex B	Y	
4.28.3.1 Diagram	Annex C	N	
- - -	Annex D	N	
Annex A	- - -	Y	Annex ZA
- - -	- - -	Y	Annex ZB
Annex B	- - -		
Annex C	- - -		
Annex D	- - -		

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 001002-3:2005, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of procedure – Part 3: Approval procedures*

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

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*

 Text deleted 

EN 60068-2-67:1996, *Environmental testing - Part 2: Tests - Test Cy: Damp heat, steady state, accelerated test primarily intended for components* (IEC 60068-2-67:1995)

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

EN 61340-3-1, *Electrostatics – Part 3-1: Methods for simulation of electrostatic effects – Human body model (HBM) – Component testing* (IEC 61340-3-1)

EN 61760-1, *Surface mounting technology - Part 1: Standard method for the specification of surface mounting components (SMDs)* (IEC 61760-1)

Text deleted

EN 100014:1991, *CECC Assessed Process Average Procedure (APA)*

Text deleted

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**

⌈C the resistance of the encapsulation of the insulated resistor measured between the resistor terminations connected together and any conducting mounting surface ⌈C

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

2.2.27

derating curve

a curve which shows the maximum allowable dissipation at ambient temperatures between the upper and lower category temperature

2.2.28

nonconformance

a characteristic or attribute of a product, that does not meet the specified requirement

2.2.29

defect

any nonconformance of a unit of product to specified requirements

2.2.30**defective**

a unit of product which contains one or more nonconformances

NOTE The terms defect and defective apply when using IEC 60410 (see annex A of this standard).

2.2.31**reject**

a unit of product that does not meet specified acceptance criteria due to one or more nonconformances

2.2.32**failure rate level**

accumulated number of non-conforming units under specified operating conditions and specified accumulated time, evaluated for a given confidence level

2.2.33**outgoing quality level**

ratio of the number of non-conforming units to the total number of inspected units of product at lot by lot inspections, evaluated for a given confidence level $\bar{C}_1$

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.

2.6 Packaging

Unless otherwise specified the method of packaging shall be selected from those given in IEC 60286

2.7 Storage

Unless otherwise specified, storage conditions shall be:

Storage temperature: - 25 °C to 45 °C

Relative humidity: ≤ 75 % yearly average
≤ 95 % for 30 days per year

Storage in the original package

3 Quality assessment procedures

3.1 General

Before resistors are qualified according to the procedures of this section the manufacturer shall obtain approval of his organisation following the provisions of QC 001002-3.

Two methods are available for the approval of resistors of assessed quality. These are Qualification Approval according to the provisions of QC 001002-3, Clause 3 and Capability Approval according to the provisions of QC 001002-3, Clause 4. For a given sub-family of resistors separate 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 CQC and include all relevant test severities and limits.

3.1.2.2 Components for listing in the Register of Approvals (Standard catalogue items)

When the manufacturer desires that a resistor covered by the capability approval procedure should be listed in the IECQ approvals database, 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 may be listed in the approvals section of the website www.iecq.org. See QC 001002-3, 4.4.3.

3.1.2.3 Customer specified resistors

The content of the detail specification (often known as a Customer Detail Specification CDS) shall be by agreement between the manufacturer and customer in accordance with [\[C11\]](#) QC 001002-3, 4.4.3 [\[C11\]](#).

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.

3.1.3 Applicability of technology approval

Technology approval is appropriate when the complete technological process (design, process realisation, product manufacture, test and shipment) is covering the qualification aspects common to all resistors determined by the technology.

3.2 Primary stage of manufacture

For fixed resistor specifications, the primary stage of manufacture is, if not specified otherwise in the sectional specification:

- for film types:
the deposition of the resistive film on the substrate;
- for carbon composition types:
the process which produces the greatest change in polymerisation of the binder;
- for wire wound types:
the winding of the resistance wire (or ribbon) on the former;
- for metal foil resistors:
the 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  QC 001002-3, 3.1.2 or QC 001002-3, 4.2.2.

The sectional specification may restrict subcontracting in accordance with QC 001002-3, 3.1.2.2 or QC 001002-3, 4.2.2.

3.4 Structurally similar components

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

3.4.2 For failure rate level evaluation and determination, fixed resistors are accepted as being structural similar

- a) when they are manufactured at one or at several manufacturing sites
- using the same specified raw-materials, manufacturing- and quality inspection-procedures and
 - under the same responsibility for the product and quality of the leading manufacturing site.

When there are several manufacturing sites, the manufacturer shall nominate the prime site and the associated Designated Management Representative (DMR).

- b) when all manufacturing sites are supervised by the same National Supervising Inspectorate (NSI). Preferably it should be the NSI of that country in which the leading manufacturing site is located,
- c) when they have the same stability class and climatic category,
- d) when they are different in dimensions only, and
- e) when they have similar terminal types.

Resistors which differ only in c) may be considered as structural similar if the different requirements of the stability class and/or the climatic category are judged separately in the final measurements.

3.5 Qualification approval procedures

3.5.1 Eligibility for qualification approval

The manufacturer shall comply with QC 001002-3, 3.1.1.

3.5.2 Application for qualification approval

The manufacturer shall comply with QC 001002-3, 3.1.3. 

3.5.3 Test procedure for qualification approval

One of the two following procedures shall be followed:

(1) The manufacturer shall produce test evidence of conformance to the specification requirements on three inspection lots for lot-by-lot inspection taken in as short a time as possible and one lot for periodic inspection. No major changes in the manufacturing process shall be made in the period during which the inspection lots are taken.

Samples shall be taken from the lots in accordance with IEC 60410 (see annex A). The resistance ranges for which approval is granted are defined by the sample taken in accordance with the sampling procedures prescribed by the sectional specification.

Normal inspection shall be used, but when the sample size would give acceptance on zero nonconformance, additional specimens shall be taken to meet the sample size requirements to give acceptance on one nonconformance.

(2) The manufacturer shall produce test evidence to show conformance to the specification requirements on the fixed sample size test schedule given in the sectional specification.

The specimens taken to form the sample shall be selected at random from current production or as agreed with the h NSI.

For the two procedures the sample sizes and the number of permissible nonconformances shall be of comparable order. The test conditions and requirements shall be the same.

3.5.4 Granting of qualification approval

Qualification approval shall be granted when the procedures in accordance with QC 001002-3, 3.1.5 have been completed satisfactorily.

3.5.5 Maintenance of qualification approval

Qualification approval shall be maintained by regular demonstration of compliance with the requirements for Quality Conformance (see 3.5.6).

3.5.6 Quality conformance inspection

The blank detail specification(s) associated with the sectional specification shall prescribe the test schedule for quality conformance inspection. This schedule shall also specify the grouping, sampling and periodicity for the lot-by-lot and periodic inspection.

Operation of the switching rule for reduced inspection in Group C given in QC 001002-3, 3.2.9 is permitted in all sub-groups except endurance.

Inspection Levels and AQL's shall be selected from those given in IEC 60410.

If required, more than one schedule may be specified.

3.6 Capability approval procedures

3.6.1 General

Capability approval in fixed resistor technology covers:

- the complete design, material preparation and manufacturing techniques, including control procedures and tests;
- the performance limits claimed for the processes and products, that is, those specified for the Capability Qualifying Components (CQCs) and Process Control Parameters (PCPs);
- the range of mechanical structures for which approval is granted.

3.6.2 Eligibility for capability approval

The manufacturer shall comply with QC 001002-3, 4.2.1. 

3.6.3 Application for capability approval

 The manufacturer shall comply with QC 001002-3, 4.2.4

3.6.4 Description of capability

The capability shall be described in a capability manual in accordance with QC 001002-3, 4.2.5 and the requirements of the relevant sectional specification.

The NSI shall treat the capability manual as a confidential document. The manufacturer may, if he so wishes, disclose part or all of it to a third party.

3.6.5 Demonstration and verification of capability

The manufacturer shall demonstrate and verify the capability in accordance with QC 001002-3, 4.2.6 and the requirements of the relevant sectional specification.

3.6.6 Granting of capability approval

(3.6.11 in IEC 60115-1)

Capability approval shall be granted when the procedures in accordance with QC 001002-3, 4.2.7 have been completed satisfactorily and the requirements of the relevant sectional specification have been met.

3.6.7 Maintenance of capability approval

(3.6.12 in IEC 60115-1)

Capability approval shall be maintained by complying with the requirements of QC 001002-3, 4.2.9 and 4.2.10 and the requirements declared in the capability manual following the schedule of maintenance given in the relevant sectional specification.

3.6.8 Quality conformance inspection

(3.6.14 in IEC 60115-1)

The quality conformance test requirements are given in the detail specification and shall be carried out in accordance with QC 001002-3, 4.3.1.

3.7 Rework and repair work

3.7.1 Rework

Rework is the rectification of processing errors prior to the release of a resistor. See QC 001002-3, 4.1.4 and 4.7.1.

It shall not be carried out if prohibited by the relevant sectional specification. The relevant sectional specification shall state if there is a restriction on the number of occasions that rework may take place on a specific component.

All rework shall be carried out prior to the formation of the inspection lot offered for inspection to the requirements of the detail specification.

Such rework procedures shall be fully described in the relevant documentation produced by the manufacturer and shall be carried out under the direct control of the Designated Management Representative (DMR). Subcontracting of rework is not permitted.

3.7.2 Repair

Repair is the making good of an approved resistor which has been damaged or has become non-conforming after release. See QC 001002-3, 4.1.5 and 4.7.2.

Resistors which have been repaired shall not be released under the IECQ System. 

3.8 Release for delivery

☐C11 Resistors shall be released for delivery according to QC 001002-3, 3.2 or QC 001002-3, 4.3 after the Quality Conformance Inspection prescribed in the detail specification has been carried out. ☐C11

3.8.1 Release for delivery under qualification approval before the completion of Group B tests

When the conditions of IEC 60410 for changing to reduced inspection have been satisfied for all Group B tests, the manufacturer is permitted to release components before the completion of such tests.

3.9 Certified test records of released lots

When certified test records are prescribed in the relevant specification and are requested by a purchaser, the following information shall be given as a minimum:

(1) attributes information (that is number of components tested and number of non-conforming components) for tests in the sub-groups covered by periodic inspection without reference to the parameter for which rejection was made.

(2) variables information (that is average and range for the change in resistance and number of tested components) for periodic tests specified in the relevant sectional specification.

NOTE For Capability Approval the Certified Test Records will refer only to tests carried out on Capability Qualifying Components.

3.10 Delayed delivery

Resistors held for a period exceeding two years (unless otherwise specified in the sectional specification), following the release of the lot shall, before delivery, be re-examined for solderability and resistance as specified in Group A and Group B of the detail specification.

☐C11 The re-examination procedure adopted by the manufacturers Designated Management Representative (DMR) shall be approved by the NSI.

Once a lot has been satisfactorily re-inspected, its quality is re-assured for the specified period.

3.11 Alternative test methods

The test and measurement methods given in the relevant specification are not necessarily the only methods which can be used. However, the manufacturer shall satisfy the NSI that any alternative methods which he may use will give results equivalent to those obtained by the methods specified. In case of dispute, for referee and reference purposes, the specified methods only shall be used.

3.12 Manufacture outside the geographical limits of IECQ supervising inspectorates

A manufacturer may have his approval extended to cover part or complete manufacture of resistors in a factory of his company located in a country which does not have an NSI for the technical area concerned, whether this country is an IECQ member country or not, provided that the requirements of QC 001002-3, 2.5.1.3 are met. ☐C11

3.13 Unchecked parameters

Only those parameters of a component which have been specified in a detail specification and which have been subjected to testing shall be assumed to be within the specified limits.

It cannot be assumed that any unspecified parameter will remain unchanged from one component to another. Should for any reason it be necessary for one or more additional further parameters to be controlled, then a new, more extensive specification shall be used.

The additional test method(s) shall be fully described and appropriate limits, sampling plans and inspection levels specified.

3.14 Technology approval procedures

3.14.1 General

Technology approval in fixed resistors covers the complete technological process. It extends the existing concepts -qualification- and capability approval- by adding as mandatory:

1. The use of in-process control methods, e.g. SPC.
2. Continuous quality improvement strategy.
3. Monitoring the overall technologies and operations.
4. Procedural flexibility due to the quality assurance management system and market sector requirements.
5. The acceptance of a manufacturers operational documentation to provide means for rapid approval or extension of approval.

3.14.2 Eligibility for technology approval

 The manufacturer shall comply with QC 001002-3, 6.2.1.

3.14.3 Application of technology approval

The manufacturer shall comply with QC 001002-3, 6.2.2.

3.14.4 Description of technology

The technology shall be described in a Technology Approval Declaration Document (TADD) and a Technology Approval Schedule (TAS) in accordance with QC 001002-3, 6.4.

3.14.5 Demonstration and verification of the technology

The manufacturer shall demonstrate and verify the technology in accordance with QC 001002-3, 6.5 and QC 001002-3, 6.6.

3.14.6 Granting of technology approval

Technology approval shall be granted when the procedures in accordance with QC 001002-3, 6.7.3 have been completely satisfied.

3.14.7 Maintenance of technology approval

Technology approval shall be maintained by complying with the requirements of QC 001002-3, 6.7.5. 

3.14.8 Quality conformance inspection

The quality conformance test and requirements shall be carried out in accordance with the relevant detail specification and technology approval schedules.

3.15 CECC Assessed Process Average Procedure (APA)

3.15.1 When on a voluntary basis, a manufacturer wishes to give information on the quality level within his production the procedure of the "CECC assessed process average (APA)" as described in EN 100014 shall be used. The calculation will be based on non-conforming items against the detail specification.

3.15.2 Accumulated results based on non-conforming items may be made available to the customer on his request. Alternative analysis of the non-conforming items more applicable to specific customer requirements is permitted and where used shall be documented.

3.16 Failure rate level determination

If failure rate level determination and certification is called for in the relevant specification, the procedure according annex ZB shall be applied.

3.17 Outgoing quality level

The definition shall be agreed between customer and manufacturer. 

4 Test and measurement procedures

4.1 General

The sectional and/or blank detail specification shall indicate the tests to be carried out, the measurements to be made before and after each test or subgroup of tests, and the sequence in which they shall be made. The stages of each test shall be carried out in the order written. The measuring conditions shall be the same for initial and final measurements.

If national specifications within any quality assessment system include methods other than those specified in the above documents, these methods shall be fully described.

The limits given in all specifications are absolute limits. The principle to take measurement uncertainty into account applies, see IEC QC 001002-3, annex C to clause 2.

4.2 Standard atmospheric conditions

4.2.1 Standard atmospheric conditions for testing

Unless otherwise specified, all tests and measurements shall be made under standard atmospheric conditions for testing, as given in 5.3 of IEC 60068-1:

- temperature: 15 °C to 35 °C;
- relative humidity: 25 % to 75 %;
- air pressure: 86 kPa to 106 kPa.

Before measurements are made, the resistor shall be stored at the measuring temperature for a time sufficient to allow the entire resistor to reach this temperature. The period as prescribed for recovery at the end of a test is normally sufficient for this purpose.

When measurements are made at a temperature other than the specified temperature, the results shall, where necessary, be corrected to the specified temperature. The ambient temperature during the measurements shall be stated in the test report. In the event of a dispute, the measurements shall be repeated using one of the referee temperatures (as given in 4.2.3) and such other conditions as are prescribed in this specification.

When tests are conducted in a sequence, the final measurements of one test may be taken as the initial measurements for the succeeding test.

During the measurements, the resistor shall not be exposed to draughts, direct sunlight or other influences likely to cause error.

4.2.2 Recovery conditions

Unless otherwise specified, recovery shall take place under the standard atmospheric conditions for testing (see 4.2.1).

If recovery has to be made under closely controlled conditions, the

conditions of 5.4.1 of IEC 60068-1 shall apply.

4.2.3 Referee conditions

For referee purposes, one of the standard atmospheric conditions for referee tests taken from 5.2 of IEC 60068-1, as given below, shall be chosen.

Table 1 – Referee conditions

Temperature °C	Relative humidity %	Air pressure kPa
20 ± 1	63 to 67	86 to 106
23 ± 1	48 to 52	86 to 106
25 ± 1	48 to 52	86 to 106
27 ± 1	63 to 67	86 to 106

4.2.4 Reference conditions

For reference purposes, the standard atmospheric conditions for reference given in 5.1 of IEC 60068-1 apply:

- temperature: 20 °C;
- air pressure: 101,3 kPa.

4.3 Drying

When drying is prescribed, the resistor shall be conditioned before measurement is made using procedure I or procedure II as prescribed in the detail specification.

Procedure I: for 24 h ± 4 h in an oven at a temperature of 55 °C ± 2 °C and at a relative humidity not exceeding 20 %

Procedure II: for 96 h ± 4 h in an oven at 100 °C ± 5 °C

The resistor shall then be allowed to cool in a desiccator using a suitable desiccant, such as activated alumina or silica gel, and it shall be kept therein from the time of removal from the oven to the beginning of the specified tests.

4.4 Visual examination and checking of dimensions

4.4.1 Visual examination

The condition, workmanship and finish shall be satisfactory, as checked by visual examination (see 2.2.22).

The marking shall be legible, as checked by visual examination. It shall be in accordance with the requirements of the detail specification.

4.4.2 Dimensions (gauging)

The dimensions indicated in the detail specification as being suitable for gauging shall be checked, and shall comply with the values prescribed in the detail specification.

When applicable, measurements shall be made in accordance with IEC 60294.

4.4.3 Dimensions (detail)

All the dimensions prescribed in the detail specification shall be checked and shall conform to

the values prescribed.

4.5 Resistance

4.5.1 Measurements of resistance shall be made by using a direct voltage of small magnitude for as short a time as is practicable, in order that the temperature of the resistance element does not rise appreciably during measurement. In the event of conflicting results attributable to such test voltages, the voltage specified in table 2 shall be used for referee purposes.

Table 2 – Measuring voltages

Rated resistance R	Measuring voltage U_{-10}^0 % V
$R < 10 \Omega$	0,1 (see note)
$10 \Omega \leq R < 100 \Omega$	0,3
$100 \Omega \leq R < 1 \text{ k}\Omega$	1
$1 \text{ k}\Omega \leq R < 10 \text{ k}\Omega$	3
$10 \text{ k}\Omega \leq R < 100 \text{ k}\Omega$	10
$100 \text{ k}\Omega \leq R < 1 \text{ M}\Omega$	25
$1 \text{ M}\Omega \leq R$	50
NOTE When the rated resistance is less than 10Ω , the measuring voltage shall be so chosen that the resistor dissipates less than 10 % of its rated dissipation, but does not exceed 0,1 V.	

The accuracy of the measuring method shall be such that the total error does not exceed 10 % of the tolerance. When the measurement forms part of a test sequence, it shall be possible to measure a change of resistance with an error not exceeding 10 % of the maximum change permitted for that test sequence.

4.5.2 The resistance value at 20 °C shall correspond with the rated resistance taking into account the specified tolerance.

4.5.3 In addition to the provisions stated in 4.5.1 and 4.5.2 for reference purposes, unless otherwise specified in the detail specification, the points of measurement for leaded fixed resistors shall be (6 ± 1) mm from the body. For surface mounting (SMD) resistors the points of measurement shall be on the terminations at the side of the resistive element.

4.6 Insulation resistance (insulated styles only)

4.6.1 The test shall be performed using one of the following four methods, as prescribed in the relevant detail specification. The V-block method is the preferred method for resistors without mounting devices.

4.6.1.1 V-block method

The resistor shall be clamped in the trough of a 90° metallic V-block of such size that the resistor body does not extend beyond the extremities of the block.

The clamping force shall be such as to guarantee adequate contact between the resistor and the block. The clamping force shall be chosen in such a way that no destruction or damage to the resistor occurs.

The resistor shall be positioned in accordance with the following:

- a) for cylindrical resistors: the resistor shall be positioned in the block so that the termination farthest from the axis of the resistor is nearest to one of the faces of the block;
- b) for rectangular resistors: the resistor shall be positioned in the block so that the termination nearest to the edge of the resistor is nearest to one of the faces of the block.

For cylindrical and rectangular resistors with axial leads, any out-of-centre positioning of the point of emergence of the terminations from the body shall be ignored.

4.6.1.2 Foil method (alternative method for resistors without mounting devices)

A metal foil shall be wrapped closely around the body of the resistor.

For resistors not having axial terminations, a space of 1 mm to 1,5 mm shall be left between the edge of the foil and each termination.

For resistors having axial terminations, the foil shall be wrapped around the whole body of the resistor protruding by at least 5 mm from each end, provided that a minimum space of 1 mm between the foil and the termination can be maintained. The ends of the foil shall not be folded over the ends of the resistor.

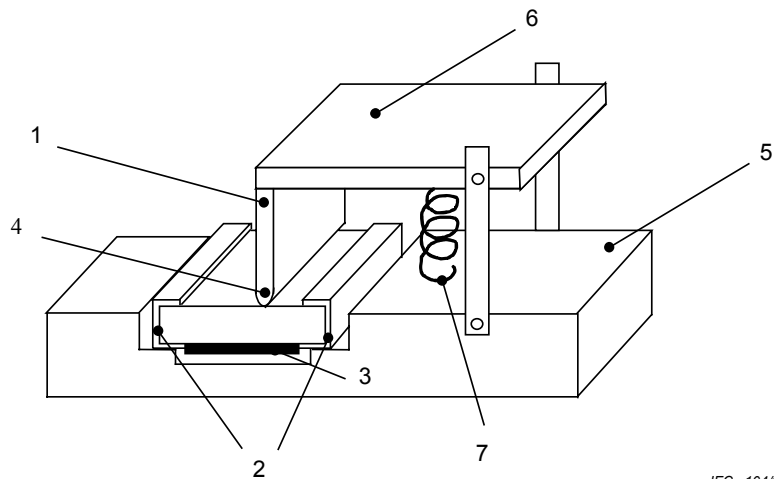
4.6.1.3 Method for resistors with mounting devices

The resistor shall be mounted in its normal manner on a metal plate (or between two metal plates) extending at least 12,7 mm in all directions beyond the mounting face of the resistor.

4.6.1.4 Method for rectangular surface mount resistors

The test shall be performed with the resistor mounted as shown in figure 2.

The clamping force of the spring shall be $1,0 \text{ N} \pm 0,2 \text{ N}$, unless otherwise specified in the detail specification. The point of contact of the metal block shall be centrally located to ensure good repeatability of the results.



IEC 104/01

Key

- | | |
|--------------------------------|-----------------------------|
| 1 Metal block, test point A | 5 Metal plate, test point B |
| 2 Terminations of the resistor | 6 Insulation material |
| 3 Coating side | 7 Spring |
| 4 Radius 0,25 mm to 0,5 mm | |

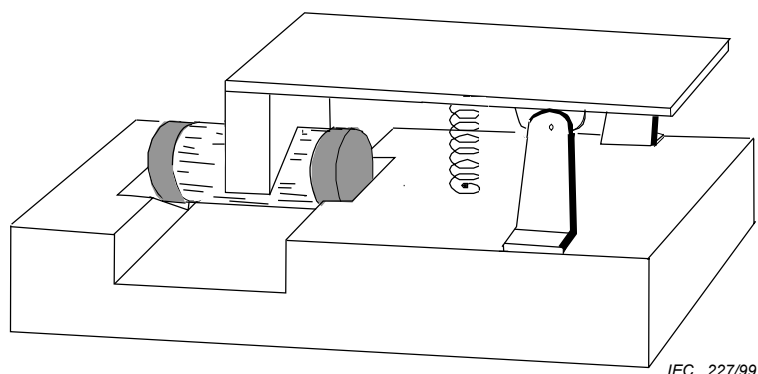
Figure 2 – Insulation resistance and voltage proof test jig for rectangular surface mount resistors

4.6.1.5 Method for cylindrical types

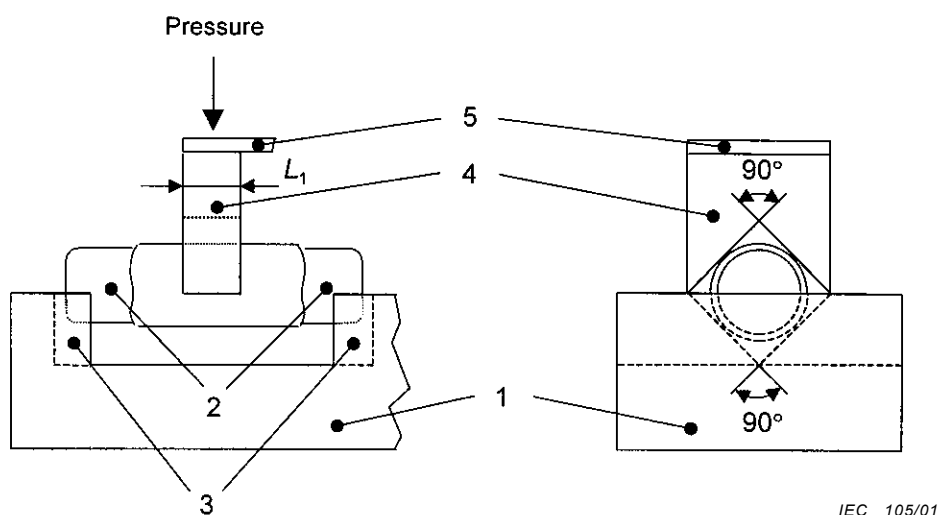
The test shall be performed with the resistor mounted as shown in figure 3.

The clamping force of the spring shall be $1,0 \text{ N} \pm 0,2 \text{ N}$, unless otherwise specified in the detail specification.

Dimension L_1 of the test block shall be chosen so that a minimum distance of 0,5 mm to the contact areas is maintained.



Jig details:



Key

- | | |
|--------------------------------|--------------------------------------|
| 1 Metal plate, test point B | 4 V-shaped metal block, test point A |
| 2 Terminations of the resistor | 5 Insulation material |
| 3 Grooves in the metal plate | |

Figure 3 – Insulation resistance and voltage proof test jig for cylindrical surface mount resistors

4.6.2 For all resistors except surface mount resistors, the insulation resistance shall be measured between both terminations of the resistor connected together as one pole and the V-block or the metal foil or the mounting device as the other pole. The measuring voltage shall be either $100\text{ V} \pm 15\text{ V}$ d.c. for resistors with an insulation voltage lower than 500 V or $500\text{ V} \pm 50\text{ V}$ d.c. for resistors with an insulation voltage equal or greater than 500 V.

For surface mount resistors, the insulation resistance shall be measured with a direct voltage of $100\text{ V} \pm 15\text{ V}$ or a voltage equal to the insulation voltage between test points A and B, as shown in figure 2 and figure 3 (test point A shall be positive).

The voltage shall be applied for 1 min or for such shorter time as is necessary to obtain a stable reading; the insulation resistance shall be read at the end of that period.