
British Standard

Harmonized system of quality assessment for electronic components. Fixed resistors for use in electronic equipment: generic specification

Système harmonisé d'assurance de la qualité des composants électroniques.

Résistances fixes utilisés dans les équipements électroniques: spécification générique

Harmonisiertes Gütebestätigungssystem für Bauelemente der Elektronik.

Spezifikation für Festwiderstände für die Anwendung in elektronischen Geräten: Fachgrundspezifikation

National foreword

This British Standard has been prepared under the direction of the Electronic Components Standards Policy Committee (ECL/-). It is identical with IEC Publication 115-1 [QC 400000] 'Fixed resistors for use in electronic equipment. Part 1 : Generic specification', published in 1982 by the International Electrotechnical Commission (IEC) and incorporates Amendment Nos. 1, 2 and 3, published in 1983, 1987 and 1989 respectively. This British Standard supersedes BS 9940 : Part 0 : 1983, which is withdrawn. It is a harmonized specification within the IECQ system of quality assessment for electronic components.

Cross-references. The British Standard harmonized with QC 001001 and QC 001002 is BS 9000 'General requirements for a system for electronic components of assessed quality' Part 3 : 1987 'Specification for national implementation of IECQ basic rules and rules of procedure'.

International standard	Corresponding British Standard
ISO 3 : 1973 } ISO 497 : 1973 }	BS 2045 : 1965 Preferred numbers (Technically equivalent)
ISO 1000 : 1981	BS 5555 : 1981 Specification for SI units and recommendations for the use of their multiples and of certain other units (Identical)
IEC 60 IEC 60-1 : 1973	BS 923 Guide on high-voltage testing techniques Part 1 : 1980 General (Identical)
IEC 60-2 : 1973	Part 2 : 1980 Test procedures (Identical)
IEC 62 : 1974	BS 1852 : 1975 Specification for marking codes for resistors and capacitors (Identical)
IEC 63 : 1963	BS 2488 : 1966 Schedule of preferred numbers for the resistance of resistors and the capacitance of capacitors for telecommunication equipment (Technically equivalent)
IEC 68 IEC 68-1 : 1978	BS 2011 Basic environmental testing procedures Part 1.1 : 1980 General and guidance (Identical)
IEC 68-2-1 : 1974	Part 2.1A : 1977 Test A. Cold (Identical)
IEC 68-2-2 : 1974	Part 2.1B : 1977 Test B. Dry heat (Identical)
IEC 68-2-3 : 1969	Part 2.1Ca : 1977 Test Ca. Damp heat, steady state (Identical)
IEC 68-2-6 : 1982	Part 2.1Fc : 1983 Test Fc. Vibration (sinusoidal) (Identical)
IEC 68-2-13 : 1983	Part 2.1M : 1977 Test M. Low air pressure (Identical)
IEC 68-2-14 : 1984	Part 2.1N : 1977 Test N. Change of temperature (Identical)
IEC 68-2-20 : 1979	Part 2.1T : 1981 Test T. Soldering (Identical)
IEC 68-2-21 : 1983	Part 2.1U : 1977 Test U. Robustness of terminations and integral mounting devices
IEC 68-2-27 : 1987	Part 2.1Ea : 1977 Test Ea. Shock (Identical)
IEC 68-2-29 : 1968	Part 2.1Eb : 1977 Test Eb. Bump (Identical)
IEC 68-2-30 : 1987	Part 2.1Db : 1981 Test Db and guidance: Damp heat, cyclic (12+12 hour cycle) (Identical)
IEC 195 : 1965	BS 4119 : 1967 Method of measurement of current noise generated in fixed resistors (Technically equivalent)
IEC 294 : 1969	BS 5692 : 1979 Method for measurement of the dimensions of a cylindrical electronic component having two axial terminations (Identical)
IEC 410 : 1973	BS 6001 : 1972 Sampling procedures for inspection by attributes (Technically equivalent)
IEC 440 : 1973	BS 5694 : 1979 Method for measurement of non-linearity in resistors (Identical)

There are no corresponding British Standards for IEC 27-1 : 1971, IEC 50 and IEC 117, which are all referred to in clause 2. As the standards are referred to for information only, the validity of this British Standard is not affected. British Standards related to IEC 50 and IEC 117 are, respectively, BS 4727 'Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms' and BS 3939 'Guide for graphical symbols for electrical power, telecommunications and electronics diagrams'.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

CONTENTS

National foreword	Page
Committees responsible	Inside front cover
	Back cover
SECTION ONE – SCOPE	
Clause	
1. Scope	1
SECTION TWO – GENERAL	
2. General	1
2.1 Related documents	1
2.2 Units, symbols and terminology	3
2.3 Preferred values	6
2.4 Marking	6
SECTION THREE – QUALITY ASSESSMENT PROCEDURES	
3. Quality assessment procedures	7
3.1 Qualification Approval/Quality Assessment Systems	7
3.2 Primary Stage of Manufacture	7
3.3 Structurally Similar Components	7
3.4 Qualification Approval Procedures	7
3.5 Quality Conformance Inspection	8
3.6 Alternative test methods	10
3.7 Unchecked parameters	10
SECTION FOUR – TEST AND MEASUREMENT PROCEDURES	
4. Test and measurement procedures	10
4.1 General	10
4.2 Standard atmospheric conditions	11
4.3 Drying	12
4.4 Visual examination and check of dimensions	12
4.5 Resistance	12
4.6 Insulation resistance (insulated styles only)	13
4.7 Voltage proof	15
4.8 Variation of resistance with temperature	15
4.9 Reactance	17
4.10 Non-linear properties	18
4.11 Voltage coefficient	18
4.12 Noise	19
4.13 Overload	19
4.14 Temperature rise	19
4.15 Robustness of the resistor body	20
4.16 Robustness of terminations	20
4.17 Solderability	21
4.18 Resistance to soldering heat	23
4.19 Rapid change of temperature	24
4.20 Bump	25
4.21 Shock	25
4.22 Vibration	25
4.23 Climatic sequence	26
4.24 Damp heat, steady state	27
4.25 Endurance	28
4.26 Accidental overload test (for low power non-wirewound resistors only)	32
4.27 Single-pulse high-voltage overload test	35
4.28 Periodic pulse high-voltage overload test	37
4.29 Component solvent resistance	40
4.30 Solvent resistance of marking	40
4.31 Mounting (for chip resistors only)	41
4.32 Adhesion	43
4.33 Bond strength of the end face plating	43
APPENDIX A. – Interpretation of sampling plans and procedures as described in IEC Publication 410 for use within the IEC Quality Assessment System for Electronic Components	45
APPENDIX B. – Rules for the preparation of detail specifications for capacitors and resistors for electronic equipment	46
APPENDIX C. – Example of a test equipment for the periodic pulse high-voltage overload test	47

British Standard

Harmonized system of quality assessment for electronic components. Fixed resistors for use in electronic equipment: generic specification

SECTION ONE — SCOPE

1. Scope

This standard 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 for qualification approval and for quality assessment systems for electronic components.

SECTION TWO — GENERAL

2. General

2.1 *Related documents*

IEC Publications

Publication 27-1: (1971)	Letter Symbols to be Used in Electrical Technology. Part 1: General.
Publication 50:	International Electrotechnical Vocabulary (I.E.V.).
Publication 60:	High voltage test techniques
Publication 60-1: (1973)	Part 1: General definitions and test requirements
Publication 60-2: (1973)	Part 2: Test procedures
Publication 62: (1974)	Marking Codes for Resistors and Capacitors.
Publication 63: (1963)	Preferred Number Series for Resistors and Capacitors. Amendment No. 1: (1967) Amendment No. 2: (1977)
Publication 68:	Basic Environmental Testing Procedures.
Publication 68-1: (1978)	Part 1: General.
Publication 68-2-1: (1974)	Tests A: Cold.
Publication 68-2-1A: (1976)	First supplement.

Publication 68-2-2: (1974)	Tests B: Dry Heat.
Publication 68-2-2A: (1976)	First supplement.
Publication 68-2-3: (1969)	Test Ca: Damp Heat, Steady State.
Publication 68-2-6: (1970)	Test Fc: Vibration (Sinusoidal).
	Amendment No. 1: (1972)
Publication 68-2-13: (1966)	Test M: Low Air Pressure.
Publication 68-2-14: (1974)	Test N: Change of Temperature.
Publication 68-2-20: (1968)	Test T: Soldering.
Publication 68-2-20A: (1970)	First Supplement: Test Tb: Resistance to Soldering Heat, Method 1.
Publication 68-2-21: (1975)	Test U: Robustness of Terminations and Integral Mounting Devices.
	Amendment No. 1: (1979)
Publication 68-2-27: (1972)	Test Ea: Shock.
Publication 68-2-29: (1968)	Test Eb: Bump.
Publication 68-2-30: (1969)	Test Db: Damp Heat, Cyclic (12 + 12-hour Cycle).
Publication 117:	Recommended Graphical Symbols.
Publication 195: (1965)	Method of Measurement of Current Noise Generated in Fixed Resistors.
Publication 294: (1969)	Measurement of the Dimensions of a Cylindrical Component having Two Axial Terminations.
Publication 410: (1973)	Sampling Plans and Procedures for Inspection by Attributes.
Publication 440: (1973)	Method of Measurement of Non-linearity in Resistors.

Publication QC 001001 (1981): Basic Rules of the IEC Quality Assessment System for Components (IECQ).

Publication QC 001002 (1981): Rules of Procedure of the IEC Quality Assessment System for Electronic Components (IECQ).

ISO publications

ISO Standard 3: (1973)	Preferred Numbers — Series of Preferred Numbers.
ISO Standard 497: (1973)	Guide to the Choice of Series of Preferred Numbers and of Series Containing more Rounded Values of Preferred Numbers.
ISO Standard 1000: (1973)	SI Units and Recommendations for the Use of their Multiples and of Certain Other Units.

Note. — The above references apply to the current editions, except for IEC Publication 68 for which the referenced edition must be used.

2.2 *Units, symbols and terminology*

2.2.1 *General*

Units, graphical symbols, letter symbols and terminology shall, whenever possible be taken from the following publications:

IEC Publication 27
 IEC Publication 117
 IEC Publication 50
 ISO Standard 1000

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

2.2.2 *Type*

A group of components having similar design features and 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. — Components described in several detail specifications may, in some cases, be considered as belonging to the same type and may therefore be grouped together for qualification approval and quality conformance inspection.

2.2.3 *Style*

A sub-division of a type, generally based on dimensional factors.

A style may include several variants, generally of a mechanical order.

2.2.4 *Grade*

A term to indicate additional general characteristics concerning the intended application e.g. long life applications.

The term “grade” may be used only in combination with one or more words (e.g. long life grade) and not by a single letter or number.

Figures to be added after the term “grade” should be arabic numerals.

2.2.5 *Family (of electronic components)*

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

2.2.6 *Sub-family (of electronic components)*

A group of components within a family manufactured by similar technological methods.

2.2.7 *Rated resistance*

The resistance value for which the resistor has been designed, and which is generally indicated upon the resistor.

2.2.8 *Critical resistance*

The resistance value at which the rated voltage is equal to the limiting element voltage (see Sub-clauses 2.2.15 and 2.2.16).

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, account shall be taken of the derating curve and the limiting element voltage in the calculation of any voltage to be applied.

2.2.9 *Category temperature range*

The range of ambient temperatures for which the resistor is designed to operate continuously; this is defined by the temperature limits of its appropriate category.

2.2.10 *Upper category temperature*

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

2.2.11 *Lower category temperature*

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

2.2.12 *Maximum surface temperature*

The 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.

2.2.13 *Rated dissipation*

The 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*

A 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)*

The 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 Sub-clause 2.2.16).

2.2.16 *Limiting element voltage*

The maximum d.c. or a.c. r.m.s. voltage that may be continuously applied to the terminations of a resistor (it is 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 shall only be applied to resistors when the resistance value is equal to or higher than the critical resistance value.

2.2.17 *Isolation 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*

A 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 can be expressed either as temperature characteristic or as temperature coefficient as defined below:

2.2.20.1 *Temperature characteristic of resistance*

The maximum reversible variation of resistance produced over a given temperature range within the category temperatures. It is normally expressed as a percentage of the resistance related to a reference temperature of 20 °C.

Temperature characteristic of resistance = $\frac{\Delta R}{R}$, where:

ΔR is the change in resistance between the two specified ambient temperatures.

R is the resistance value at the reference temperature.

2.2.20.2 *Temperature coefficient of resistance (α)*

The relative variation of resistance between two given temperatures (mean coefficient), divided by the difference in temperature producing it. It is normally expressed in parts per million per degree Celsius ($10^{-6}/^{\circ}\text{C}$).

$$\alpha = \frac{R_2 - R_1}{R_1 \cdot \Delta\theta}$$

where:

$\Delta\theta$ is the algebraic difference, in degrees Celsius, between the specified ambient temperature and the reference temperature (for calculation see Sub-clause 4.8.4).

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

2.2.21 *Visible damage*

Visible damage which reduces the usability of the resistor for its intended purpose.

2.2.22 *Chip resistor*

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

2.3 *Preferred values*

2.3.1 *General*

Each sectional specification shall prescribe the preferred values appropriate to the sub-family; for rated resistance see also Sub-clause 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 Publication 63.

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) year and month (or week) of manufacture.
- d) number of the detail specification and style reference.
- e) 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.

2.4.2 *Coding*

When coding is used for resistance value, tolerance or date of manufacture, the method shall be selected from those given in IEC Publication 62.

SECTION THREE — QUALITY ASSESSMENT PROCEDURES

3. **Quality assessment procedures**3.1 *Qualification Approval/Quality Assessment Systems*

3.1.1 When these documents are being used for the purpose of a full quality assessment system such as the IEC Quality Assessment System for Electronic Components (IECQ), with Qualification Approval and Quality Conformance Inspection, the procedures of Sub-clauses 3.4 and 3.5 shall be complied with.

3.1.2 When these documents are used outside such quality assessment systems as the IECQ system for purposes such as design proving or type testing, the procedures and requirements of Sub-clauses 3.4.1 and 3.4.2 b) may be used, but the tests and parts of tests shall be applied in the order given in the test schedules.

3.2 *Primary Stage of Manufacture*

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

- For film types: the deposition of the resistive film on the substrate.
- For carbon composition types: the process which produces the greatest change in polymerization of the binder.
- For wirewound 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 *Structurally Similar Components*

Resistors considered as being structurally similar are resistors produced with similar processes and materials, though they may be of different sizes and values. The grouping of structurally similar components for the purpose of qualification approval and quality conformance inspection shall be prescribed in the sectional specification.

3.4 *Qualification Approval Procedures*

3.4.1 The manufacturer shall comply with:

- the general requirements of the rules of procedure governing qualification approval;
- the requirements for the primary stage of manufacture which is defined in Sub-clause 3.2 of this standard.

3.4.2 In addition to the requirements of Sub-clause 3.4.1 procedures *a)* or *b)* below shall apply:

- a)* 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 Publication 410 (see Appendix A). The sample shall contain the highest and lowest resistance values represented in the lot and a critical value when this value falls between such high and low values. The highest and lowest resistance values so selected shall define the resistance range for which qualification approval is granted.

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

- b) 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 from the sample shall be selected at random from current production or as agreed with the National Supervising Inspectorate.

- 3.4.3 Qualification Approval obtained as part of a Quality Assessment System shall be maintained by regular demonstration of compliance with the requirements for Quality Conformance (see Sub-clause 3.5). Otherwise this qualification approval must be verified by the rules for the maintenance of Qualification Approval given in the Rules of Procedure for the IEC Quality Assessment System for Electronic Components (IECQ) (IEC Publication QC 001002, Sub-clauses 11.5.2 and 11.5.3).

3.5 *Quality Conformance Inspection*

The blank detail specification(s) associated with a 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.

Inspection Levels and AQL's shall be selected from those given in IEC Publication 410.

If required, more than one schedule may be specified.

3.5.1 *Certified Records of Released Lots*

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

- attributes information (i.e. number of components tested and numbers of defective components) for tests in the sub-groups covered by periodic inspection without reference to the parameter(s) for which rejection was made.
- variables information for the change in resistance after the 1000 h endurance test.

3.5.1.1 *Attributes information*

When the relevant detail specification requires that attributes information shall be recorded, the following procedures shall be used:

- 1) When a sub-group comprises a single conditioning test, the total number of rejected resistors shall be recorded together with the test in which the failures occurred but without reference to the parameters for which the rejection was made.
- 2) When a sub-group comprises a number of conditioning tests, the relevant detail specification shall state whether the results shall be recorded for the individual conditioning tests or for a number of them as a group. For the purposes of this specification, the climatic sequence shall be deemed to form a single conditioning test.

3.5.1.2 Measurements information

The relevant detail specification shall state which tests are to be reported in the Certified Record of Released Lots as measurements information. It shall also state whether results may be aggregated, e.g. by rated dissipation, ranges of rated resistance, etc.

As a minimum, the results of all electrical endurance tests shall be presented as measurements information. To assist a standard presentation, measurements information for endurance tests and current noise shall preferably be given in the following manner:

- a) For the endurance tests, the intervals for the parametric change, expressed as a percentage, shall be $\Delta R/R$: 0.05; 0.1; 0.2; 0.5; 1.0; 2.0; 3.0; 5.0; 10.0; 15.0 and 20.0 and the time intervals shall be 48 h, 500 h and 1000 h. Separate intervals for positive and negative changes shall be recorded.

When the duration of an endurance test exceeds 1000 h, the additional time intervals of 2000 h, 4000 h and 8000 h shall be used.

If the number of results to be presented is 20 or less, the actual values shall be stated but the identity of the measurements need not be retained. See the Rules of Procedure for the IEC Quality Assessment System for Electronic Components (IECQ) (IEC Publication QC 001002, Clause 14) for the general requirements governing the contents of Certified Records of Released Lots.

- b) The results of the measurement of current noise of film and carbon composition resistors shall be presented in the following manner:

Noise in μV per volt	Quantity
> 6.4	
> 3.2 but ≤ 6.4	
> 1.6 but ≤ 3.2	
> 0.8 but ≤ 1.6	
> 0.4 but ≤ 0.8	
> 0.2 but ≤ 0.4	
> 0.1 but ≤ 0.2	
> 0.05 but ≤ 0.1	
≤ 0.05	

Note. — The contents of the Certified Records of Released Lots shall comply with the requirements given in the Rules of Procedure for the IEC Quality Assessment System for Electronic Components (IECQ) (IEC Publication QC 001002, Sub-clause 14.3).

3.5.2 Delayed delivery

Fixed 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 B Inspection of the detail specification.

The re-examination procedure adopted by the manufacturer's Chief Inspector shall be approved by the National Supervising Inspectorate.

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

3.5.3 *Release for delivery before the completion of Group B tests*

When the conditions of I E C Publication 410 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.

3.6 *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 National Supervising Inspectorate 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.

3.7 *Unchecked parameters*

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

It should not be assumed that any parameter not specified will remain unchanged from one component to another. Should, for any reason, it be necessary for (a) further parameter(s) to be controlled, then a new, more extensive, specification should be used.

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

SECTION FOUR — TEST AND MEASUREMENT PROCEDURES

4. **Test and measurement procedures**

4.1 *General*

The sectional and/or blank detail specification shall contain tables showing the tests to be made, which measurements are to be made before and after each test or sub-group of tests, and the sequence in which they shall be carried out. 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, they shall be fully described.

The issue and amendment status of any I E C Publication 68 test in this section is given in Sub-clause 2.1.

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 Sub-clause 5.3 of IEC Publication 68-1:

Temperature: 15 °C-35 °C
 Relative humidity: 45%-75%
 Air pressure: 86 kPa-106 kPa (860 mbar-1 060 mbar)

Before the 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 same period as is 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, when 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 Sub-clause 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.

Note. — During measurements, the resistor shall not be exposed to draughts, direct sun-rays 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 (Sub-clause 4.2.1). If recovery has to be made under closely controlled conditions, the controlled recovery conditions of Sub-clause 5.4.1 of IEC Publication 68-1 shall be used.

4.2.3 *Referee conditions*

For referee purposes, one of the standard atmospheric conditions for referee tests taken from Sub-clause 5.2 of IEC Publication 68-1, as given below, shall be chosen:

<i>Temperature</i>	<i>Relative humidity</i>	<i>Air pressure</i>
20 ± 1 °C	63%-67%	86 kPa-106 kPa (860 mbar-1 060 mbar)
23 ± 1 °C	48%-52%	86 kPa-106 kPa (860 mbar-1 060 mbar)
25 ± 1 °C	48%-52%	86 kPa-106 kPa (860 mbar-1 060 mbar)
27 ± 1 °C	63%-67%	86 kPa-106 kPa (860 mbar-1 060 mbar)

4.2.4 *Reference conditions*

For reference purposes the standard atmospheric conditions for reference given in Sub-clause 5.1 of IEC Publication 68-1 apply:

Temperature: 20 °C
 Air pressure: 101.3 kPa (1 013 mbar)

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 ± 4 h in an oven at a temperature of 55 ± 2 °C and at a relative humidity not exceeding 20%.

Procedure II: for 96 ± 4 h in an oven at 100 ± 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 shall be kept therein from the time of removal from the oven to the beginning of the specified tests.

4.4 Visual examination and check of dimensions

4.4.1 Visual examination

The condition, workmanship and finish shall be satisfactory as checked by visual examination (see Sub-clause 2.2.21).

Marking shall be legible, as checked by visual examination. It shall conform 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 Publication 294.

4.4.3 Dimensions (detail)

All dimensions prescribed in the detail specification shall be checked and they shall comply with the values prescribed.

4.5 Resistance

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

Rated resistance (<i>R</i>)	Measuring voltage $V^{+0}_{-10\%}$
$R < 10 \Omega$	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 is dissipating less than 10% of its rated dissipation, but shall not exceed 0.1 V.