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(JEITA/JSA)

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

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In the event of any doubts arising as to the contents,
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Contents

	Page
Introduction	1
1 General	1
1.1 Scope	1
1.2 Normative references	1
2 Technical data	6
2.1 Units and symbols	6
2.2 Terms and definitions	6
2.3 Preferred values	11
2.4 Marking	11
2.5 Coding	12
2.6 Packaging	12
2.7 Storage	12
2.8 Transportation	12
3 Quality assessment procedures	12
4 Test and measurement procedures	12
4.1 General	12
4.2 Standard atmospheric conditions	13
4.3 Drying	14
4.4 Visual examination and checking of dimensions	14
4.5 Resistance	15
4.6 Insulation resistance	16
4.7 Voltage proof	19
4.8 Variation of resistance with temperature	19
4.9 Reactance	21
4.10 Non-linear properties	23
4.11 Voltage coefficient	23
4.12 Noise	23
4.13 Short time overload	23
4.14 Temperature rise	24
4.15 Robustness of the resistor body	25
4.16 Robustness of terminations	26
4.17 Solderability	27
4.18 Resistance to soldering heat	28
4.19 Rapid change of temperature	29
4.20 Bump	29
4.21 Shock	30
4.22 Vibration	30
4.23 Climatic sequence	31
4.24 Damp heat, steady state	33

4.25	Endurance	34
4.26	Accidental overload test.....	38
4.27	Single-pulse high-voltage overload test.....	40
4.28	Periodic-pulse high-voltage overload test.....	43
4.29	Component solvent resistance	46
4.30	Solvent resistance of marking	46
4.31	Mounting of surface mount resistors.....	47
4.32	Shear test	50
4.33	Substrate bending test.....	50
4.34	Corrosion	51
4.35	Flammability	51
4.36	Operation at low temperature	51
4.37	Damp heat, steady state, accelerated.....	52
4.38	Electrostatic discharge.....	52
4.39	Periodic-pulse overload test.....	53
4.40	Whisker growth test.....	54
4.41	Hydrogen sulphide test.....	55
Annex A (normative)	Interpretation of sampling plans and procedures as described in IEC 60410 for use within the IECQ system.....	56
Annex B (normative)	Rules for the preparation of detail specifications for resistors and capacitors for electronic equipment for use within the IECQ system	58
Annex C (informative)	Example of test equipment for the periodic-pulse high-voltage overload test.....	59
Annex D (normative)	Layout of the first page of a PCP/CQC specification for use within the IECQ system	60
Annex E (normative)	Requirements for capability approval test report for use within the IECQ system	61
Annex F (informative)	Letter symbols and abbreviations	62
Annex G (informative)	Index table for test and measurement procedures.....	64
Annex Q (informative)	Quality assessment procedures for use within the IECQ system	66
Annex JA (informative)	Type designation and marking.....	79
Annex JB (informative)	Method of measurement of non-linearity in fixed resistors.....	89
Annex JC (informative)	Method of measurement of current noise generated in fixed resistors.....	100
Annex JD (informative)	Comparison table between JIS and corresponding International Standard	109

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Electronics and Information Technology Industries Association (JEITA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS C 5201-1: 1998** is replaced with this Standard.

This **JIS** document is protected by the Copyright Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public, or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public and utility model rights.

JIS C 5201 series consists of the following 18 parts under the general title “*Fixed resistors for use in electronic equipment*”

JIS C 5201-1 : *Generic specification*

JIS C 5201-2 : *Sectional specification: Fixed low-power non-wirewound resistors*

JIS C 5201-2-1 : *Blank detail specification: Fixed low-power non-wirewound resistors Assessment level E*

JIS C 5201-2-2 : *Blank detail specification: Fixed low-power non-wirewound resistors Assessment level F*

JIS C 5201-4 : *Sectional specification: Fixed power resistors*

JIS C 5201-4-1 : *Blank detail specification: Fixed power resistors Assessment level E*

JIS C 5201-4-2 : *Blank detail specification: Fixed power resistors Assessment level F*

JIS C 5201-4-3 : *Blank detail specification: Fixed power resistors, heat-sink types Assessment level H*

JIS C 5201-5 : *Sectional specification: Fixed precision resistors*

- JIS C 5201-5-1 : *Blank detail specification: Fixed precision resistors
Assessment level E*
- JIS C 5201-5-2 : *Blank detail specification: Fixed precision resistors
Assessment level F*
- JIS C 5201-6 : *Sectional specification: Fixed resistor networks with
individually measurable resistors*
- JIS C 5201-6-1 : *Blank detail specification: Fixed resistor networks
with individually measurable resistors, all of equal
value and equal dissipation Assessment level E*
- JIS C 5201-6-2 : *Blank detail specification: Fixed resistor networks
with individually measurable resistors, of either
different resistance values or different rated dissipa-
tions Assessment level E*
- JIS C 5201-8 : *Sectional specification: Fixed chip resistors*
- JIS C 5201-8-1 : *Blank detail specification: Fixed chip resistors As-
sessment level E*
- JIS C 5201-9 : *Sectional specification: Fixed surface mount resistor
networks with individually measurable resistors*
- JIS C 5201-9-1 : *Blank detail specification: Fixed surface mount re-
sistor networks with individually measurable resis-
tors—Assessment level EZ*

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

Introduction

This Japanese Industrial Standard has been prepared based on the fourth edition of IEC 60115-1 published in 2008 with some modifications of the technical contents in order to correspond to the latest edition of IEC 60068-2-1 and IEC 60068-2-2.

The portions with dotted underlines in this Standard are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with explanations is given in Annex JD. Annex JA to Annex JC are specified in the corresponding International Standard.

1 General

1.1 Scope

This Standard is a generic specification and is applicable to fixed resistors for use in electronic equipment (hereafter referred to as “resistors”).

This Standard 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.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

IEC 60115-1 : 2008 *Fixed resistors for use in electronic equipment—
Part 1: Generic specification* (MOD)

In addition, symbols, which denote the degree of correspondence in the contents between the relevant International Standard and JIS, are IDT (identical), MOD (modified), and NEQ (not equivalent) according to ISO/IEC Guide 21-1.

1.2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the edition of the indicated year shall apply but the revisions (including amendments) made thereafter shall not apply. The normative references without the indication of the year shall apply only to the most recent editions (including amendments).

JIS C 0025:1998 *Basic environmental testing procedure, Part 2 : Tests—Test N: Change of temperature*

NOTE : Corresponding International Standard: IEC 60068-2-14:1984 *Environmental testing—Part 2: Tests—Test N: Change of temperature* and Amendment 1:1986, and IEC 60068-2-33:1971 *Environmental testing—Part 2: Tests. Guidance on change of temperature tests* and Amendment 1:1978 (MOD)

JIS C 0617 (series) *Graphical symbols for diagrams*

NOTE : Corresponding International Standard: **IEC 60617** (all parts) *Graphical symbols for diagrams* (MOD)

JIS C 0806 (series) *Packaging of components for automatic handling*

NOTE : Corresponding International Standard: **IEC 60286** (all parts) *Packaging of components for automatic handling* (MOD)

JIS C 5005-2 *Quality assessment systems—Part 2: Selection and use of sampling plans for inspection of electronic components and packages*

NOTE : Corresponding International Standard: **IEC 61193-2:2007** *Quality assessment systems—Part 2: Selection and use of sampling plans for inspection of electronic components and packages* (IDT)

JIS C 5062 *Marking codes for resistors and capacitors*

NOTE : Corresponding International Standard: **IEC 60062:2004** *Marking codes for resistors and capacitors* (MOD)

JIS C 5063 *Preferred number series for resistors and capacitors*

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

JIS C 6484:2005 *Base materials for printed circuits—Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test)*

NOTE : Corresponding International Standard: **IEC 61249-2-7:2002** *Materials for printed boards and other interconnecting structures—Part 2-7: Reinforced base materials clad and unclad—Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test)*, copper-clad and **IEC 61249-2-8:2003** *Materials for printed boards and other interconnecting structures—Part 2-8: Reinforced base materials clad and unclad—Modified brominated epoxide woven fibreglass reinforced laminated sheets of defined flammability (vertical burning test)*, copper-clad (MOD)

JIS C 60068-1:1993 *Environmental testing Part 1: General and guidance*

NOTE : Corresponding International Standard: **IEC 60068-1:1988** *Environmental testing Part 1: General and guidance* and Amendment 1:1992 (IDT)

JIS C 60068-2-1 *Environmental testing—Part 2-1: Tests—Test A: Cold*

NOTE : Corresponding International Standard: **IEC 60068-2-1:2007** *Environmental testing—Part 2-1: Tests—Test A: Cold* (IDT)

IEC 60068-2-1:1994 is referred to in the corresponding International Standard IEC 60115-1, but in this Standard the latest edition is quoted.

JIS C 60068-2-2 *Environmental testing—Part 2-2: Tests—Test B: Dry heat*

NOTE : Corresponding International Standard: **IEC 60068-2-2:2007** *Environmental testing—Part 2-2: Tests—Test B: Dry heat* (IDT)

IEC 60068-2-2:1994 is referred to in the corresponding International Standard IEC 60115-1, but in this Standard the latest edition is quoted.

JIS C 60068-2-6 *Environmental testing—Part 2-6: Tests—Test Fc: Vibration (sinusoidal)*

NOTE : Corresponding International Standard : IEC 60068-2-6:2007 *Environmental testing—Part 2-6: Tests—Test Fc: Vibration (sinusoidal)* (IDT)

JIS C 60068-2-11:1989 *Basic environmental testing procedures Part 2: Tests—Test Ka: Salt mist*

NOTE : Corresponding International Standard : IEC 60068-2-11:1981 *Environmental testing—Part 2: Tests—Test Ka: Salt mist* (IDT)

JIS C 60068-2-13 : 1989 *Basic environmental testing procedures Part 2: Tests, Test M: Low air pressure*

NOTE : Corresponding International Standard : IEC 60068-2-13:1983 *Environmental testing—Part 2: Tests—Test M: Low air pressure* (IDT)

JIS C 60068-2-20 *Environmental testing—Part 2-20: Tests—Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

NOTE : Corresponding International Standard : IEC 60068-2-20:2008 *Environmental testing—Part 2-20: Tests—Test T: Test methods for solderability and resistance to soldering heat of devices with leads* (IDT)

IEC 60068-2-20:1987 is referred to in the corresponding International Standard IEC 60115-1, but in this Standard the latest edition is quoted.

JIS C 60068-2-21 *Environmental testing—Part 2-21: Tests—Test U: Robustness of terminations and integral mounting devices*

NOTE : Corresponding International Standard: IEC 60068-2-21:2006 *Environmental testing—Part 2-21: Tests—Test U: Robustness of terminations and integral mounting devices* (IDT)

JIS C 60068-2-27 *Environmental testing—Part 2-27: Tests—Test Ea: Shock*

NOTE : Corresponding International Standard: IEC 60068-2-27:2008 *Environmental testing—Part 2-27: Tests—Test Ea and guidance: Shock* (IDT)

JIS C 60068-2-29:1995 *Basic environmental testing procedures Part 2: Tests Test Eb and guidance: Bump*

NOTE : Corresponding International Standard: IEC 60068-2-29:1987 *Environmental testing—Part 2: Tests—Test Eb and guidance: Bump* (IDT)

JIS C 60068-2-30 *Environmental testing—Part 2-30: Tests—Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

NOTE : Corresponding International Standard : IEC 60068-2-30:2005 *Environmental testing—Part 2-30: Tests—Test Db: Damp heat, cyclic (12 h+12 h cycle)* (IDT)

JIS C 60068-2-45:1995 *Environmental testing procedures of electronic and electrical resistance to solvents (immersion in cleaning solvents)*

NOTE : Corresponding International Standard : **IEC 60068-2-45:1980** *Environmental testing—Part 2: Tests—Test XA and guidance: Immersion in cleaning solvents* and Amendment 1:1993 (IDT)

JIS C 60068-2-54:2009 *Environmental testing—Part 2-54: Tests—Test Ta: Solderability testing of electronic components by the wetting balance method*

NOTE : Corresponding International Standard : **IEC 60068-2-54:2006** *Environmental testing—Part 2-54: Tests—Test Ta: Solderability testing of electronic components by the wetting balance method* (MOD)

JIS C 60068-2-58:2006 *Environmental testing—Part 2: Tests—Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

NOTE : Corresponding International Standard : **IEC 60068-2-58:2004** *Environmental testing—Part 2-58: Tests—Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)* (MOD)

JIS C 60068-2-67:2001 *Environmental testing—Part 2: Tests—Test Cy: Damp heat, steady state, accelerated test primarily intended for components*

NOTE : Corresponding International Standard : **IEC 60068-2-67:1995** *Environmental testing—Part 2: Tests—Test Cy: Damp heat, steady state, accelerated test primarily intended for components* (IDT)

JIS C 60068-2-69 *Environmental testing—Part 2-69: Tests—Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method*

NOTE : Corresponding International Standard : **IEC 60068-2-69** *Environmental testing—Part 2-69: Tests—Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method* (IDT)

JIS C 60068-2-78:2004 *Environmental testing—Part 2-78: Tests—Test Cab: Damp heat, steady state*

NOTE : Corresponding International Standard : **IEC 60068-2-78:2001** *Environmental testing—Part 2-78: Tests—Test Cab: Damp heat, steady state* (IDT)

JIS C 60068-2-82 *Environmental testing—Part 2-82: Tests—Test XW1: Whisker test methods for electronic and electric components*

NOTE : Corresponding International Standard : **IEC 60068-2-82:2007** *Environmental testing—Part 2-82: Tests—Test XW1: Whisker test methods for electronic and electric components* (IDT)

JIS C 60695-11-5:2007 *Fire hazard testing—Part 11-5: Test flames—Needle-flame test method—Apparatus, confirmatory test arrangement and guidance*

NOTE : Corresponding International Standard : **IEC 60695-11-5:2004** *Fire hazard testing—Part 11-5: Test flames—Needle-flame test method—Apparatus, confirmatory test arrangement and guidance* (IDT)

JIS C 61340-3-1 *Electrostatics—Part 3-1: Methods for simulation of electrostatic effects—Human body model (HBM) electrostatic discharge test waveforms*

NOTE : Corresponding International Standard : **IEC 61340-3-1:2006** *Electrostatics—Part 3-1: Methods for simulation of electrostatic effects—Human body model (HBM) electrostatic discharge test waveforms* (IDT)

JIS Z 8115 *Glossary of terms used in dependability*

JIS Z 8203 *SI units and recommendations for the use of their multiples and of certain other units*

NOTE : Corresponding International Standard : **ISO 1000:1992** *SI units and recommendations for the use of their multiples and of certain other units* (IDT)

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

IEC 60050 (all parts) *International Electrotechnical Vocabulary*

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

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

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*

NOTE : Corresponding Japanese Industrial Standard : **JIS Z 9015-1** *Sampling procedures for inspection by attributes—Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection* (MOD)

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

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

2 Technical data

2.1 Units and symbols

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

- JIS C 0617 (series)
- JIS Z 8203
- IEC 60027 (series)
- IEC 60050 (series) or JIS Z 8115

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

2.2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE : The terms described below are listed in alphabetical order.

2.2.1 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 1 For resistors the category dissipation is zero, where the upper category temperature is the maximum element temperature.

NOTE 2 Related terminology: rated dissipation, upper category temperature, derating curve

2.2.2 category temperature range

range of ambient temperatures for which the resistor has been designed to operate continuously; this is given by the lower and upper category temperature

NOTE : Related terminology: lower category temperature, upper category temperature

2.2.3 critical resistance

resistance value at which the rated voltage is equal to the limiting element voltage (see 2.2.18 and 2.2.11)

NOTE 1 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.

NOTE 2 Related terminology: Rated voltage, limiting element voltage

2.2.4 derating curve

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

NOTE 1 In the range between lower category temperature and rated temperature, it shows the rated dissipation, and between rated temperature and maximum element temperature it shows a linear slope down to zero dissipation at the maximum element temperature. The slope depends on the thermal properties of the resistor, i.e. its capability to abduct the dissipation to the environment.

NOTE 2 Related terminology: rated dissipation, rated temperature, maximum element temperature

2.2.5 family (of electronic components)

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

NOTE : Related terminology: subfamily

2.2.6 grade

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

NOTE 1 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.

NOTE 2 Related terminology: stability class

2.2.7 heat-sink resistor

resistor type designed for mounting on a separate heat-sink

NOTE : Related terminology: insulated resistor

2.2.8 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

NOTE : Related terminology: heat-sink resistor

2.2.9 insulation resistance

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

NOTE : Related terminology: insulated resistor

2.2.10 insulation voltage

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

NOTE : Related terminology: insulated resistor

2.2.11 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)

NOTE 1 Where the term “a.c. r.m.s.” voltage is used in this Standard, the peak voltage is not exceed 1.42 times the r.m.s. value.

NOTE 2 This voltage can only be applied to resistors when the resistance value is equal to or higher than the critical resistance value.

NOTE 3 Related terminology: rated voltage, critical resistance

2.2.12 lower category temperature (LCT)

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

NOTE : Related terminology: upper category temperature, category temperature range

2.2.13 maximum element temperature

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

NOTE 1 The maximum element temperature is the sum of the rated temperature and the temperature rise generated by the rated dissipation. For ambient temperature above the rated temperature, the maximum element temperature is the sum of the ambient temperature and the related permissible dissipation as specified by the derating curve.

NOTE 2 Related terminology: maximum surface temperature

2.2.14 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

NOTE : Related terminology: maximum element temperature

2.2.15 nominal resistance

designated resistance value usually indicated on the resistor

2.2.16 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

NOTE 1 If the rated dissipation depends on special means supporting the abduction of the dissipation to the environment, for example, special circuit board material, special conductor dimensions, heat-sink, such means have to be identified whenever the rated dissipation is mentioned.

NOTE 2 The term for heat-sink resistors is defined as maximum allowable dissipation 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.

NOTE 3 Related terminology: rated temperature, rated voltage

2.2.17 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.

NOTE : Related terminology: rated dissipation

2.2.18 rated voltage (U_r)

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

NOTE 1 At high values of resistance, the rated voltage may not be applicable because of the size and the construction of the resistor (see 2.2.11).

NOTE 2 Related terminology: rated dissipation, limiting element voltage

2.2.19 stability class

term representing a predefined set of stability requirements. i.e. specific limits of permissible resistance change assigned to individual tests

NOTE 1 The term 'stability class' may be used only in combination with a plain number representing the typical stability requirement for long term test, for example, endurance at upper category temperature or 1 000 h endurance at 70 °C. Stability requirements for short term tests will typically be lower than indicated by the stability class number.

NOTE 2 Related terminology: grade

2.2.20 style

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

NOTE : Related terminology: type

2.2.21 subfamily (of electronic components)

group of components within a family manufactured by similar technological methods

NOTE : Related terminology: family

2.2.22 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

NOTE : Related terminology: type, style

2.2.23 temperature coefficient of resistance (α)

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

NOTE 1 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.

NOTE 2 Related terminology: variation of resistance with temperature

2.2.24 temperature rise (T_r)

increase of temperature on or within a resistor generated by application of a dissipation and depending on the thermal properties of the resistor, i.e. its capability to abduct the dissipation to the environment

2.2.25 type

group of resistors having similar design features and manufacturing techniques, enabling them to be considered together either for qualification approval or for quality conformance inspection, which 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 Related terminology: style

2.2.26 upper category temperature (UCT)

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

NOTE 1 For resistors with a linear derating down to zero category dissipation, the upper category temperature is equal to the maximum element temperature.

NOTE 2 Related terminology: lower category temperature, category temperature range

2.2.27 variation of resistance with temperature

variation of resistance with temperature expressed as the temperature coefficient of resistance

NOTE : Related terminology: temperature coefficient of resistance

2.2.28 visible damage

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

2.2.29 voltage coefficient of resistance

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

2.3 Preferred values

2.3.1 General

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

2.3.2 Preferred values of nominal resistance

The preferred values of nominal resistance shall be taken from the series specified in JIS C 5063.

2.4 Marking

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) nominal resistance;
- b) tolerance on nominal 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.

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.

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

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

Small resistor styles are generally not marked on the body. However, if some marking is applied to the body, the resistor shall as a minimum be marked with the nominal resistance according to clause 3 of JIS C 5062. Specific requirements shall be prescribed in the detail specifications.

2.5 Coding

When coding is used for resistance value, tolerance or date of manufacture, the method shall be selected from those given in **JIS C 5062**.

NOTE : For symbols and marking of styles, the symbols described in Annex JA may apply.

2.6 Packaging

Where applicable, the sectional specification shall provide information about packaging, preferably selected from **JIS C 0806** series.

2.7 Storage

Unless otherwise specified, storage conditions shall not exceed the following limits.

Maximum temperature: + 40 °C

Maximum relative humidity: 75 %

The resistor shall be stored in original package.

Further requirements shall be prescribed by the detail specification.

2.8 Transportation

Environmental conditions under transportation may exceed the limits of storage conditions described in 2.7 for a limited duration. The detail specification may specify suitable conditions.

3 Quality assessment procedures

When this Standard, and relevant specifications are used for the purpose of a full quality assessment system such as **IEC Quality Assessment System for Electronic Components (IECQ)**, the relevant clauses of Annex Q apply.

NOTE : Clause 3 has been moved to Annex Q. To maintain reference to previous editions of this Standard, the clause numbers of clause 3 have been converted into the clause numbers of Annex Q as shown by following example:

Subclause 3.1 → Clause **Q1**

Subclause 3.1.2 → Subclause **Q.1.2**

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 which are to be made before and after each test or subgroup of tests, and the sequence in which the tests shall be performed. 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 of taking measurement uncertainty into account shall be applied (see IEC QC 001002-3, Annex C to clause 2).

4.2 Standard atmospheric conditions

4.2.1 Standard atmospheric conditions for testing (standard conditions)

Unless otherwise specified in the sectional specification, blank detailed specification or detailed specification which is under this Standard (hereafter referred to as “relevant specifications”), all tests and measurements shall be made under standard atmospheric conditions for testing, as given in 5.3 of JIS C 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 (see 4.2.3) and such other conditions as are prescribed in this Standard.

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 in the relevant specification, recovery shall take place under the standard atmospheric conditions for testing (see 4.2.1).

If recovery under closely controlled conditions is necessary, the controlled recovery conditions of 5.4.1 of JIS C 60068-1 shall be used.

4.2.3 Standard atmospheric conditions for referee testing (referee conditions)

For referee purposes, one of the standard atmospheric conditions for referee tests taken from 5.2 of JIS C 60068-1 shall be chosen (see table 1).

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 Standard reference atmospheric conditions (reference conditions)

For reference purposes, the standard atmospheric conditions for reference given in 5.1 of JIS C 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.

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.

Distortions of the component's shape shall be checked with an optical equipment, and shall comply with the dimensions prescribed in the detail specification.

The optical equipment shall provide sufficient magnification and geometrical resolution to ensure an accuracy of 10 % of the permitted dimensional tolerance.

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 Test methods

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 Ω	Measuring voltage $U^a)$ V
$R < 10$	0.1
$10 \leq R < 100$	0.3
$100 \leq R < 1 \text{ k}$	1
$1 \text{ k} \leq R < 10 \text{ k}$	3
$10 \text{ k} \leq R < 100 \text{ k}$	10
$100 \text{ k} \leq R < 1 \text{ M}$	25
$1 \text{ M} \leq R$	50
NOTE 1 When the nominal resistance is less than 10 Ω , the measuring voltage should be so chosen that the resistor dissipates less than 10 % of its rated dissipation, but does not exceed 0.1 V.	
NOTE 2 Not to exceed the limiting element voltage.	
Note ^{a)} The tolerance shall be -10 % to 0 %.	

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.

In addition to the provisions for reference purposes, the points of measurement for resistors shall be specified in the respective sectional specifications.

For leaded resistors, a suitable definition should be based on a defined distance from the resistor body.

For SMD, resistors a suitable definition should be based on a reference to the component side on which the resistance is to be measured.

Reproducibility of the measurement is the most critical issue, therefore the definition may exclude the influence of the mounting of the specimen, for example, the influence of attached solder.

4.5.2 Requirements

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

4.6 Insulation resistance

This test is applicable only to insulated resistors.

4.6.1 Test methods

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:

- 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;
- 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

This is an 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 1.

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.

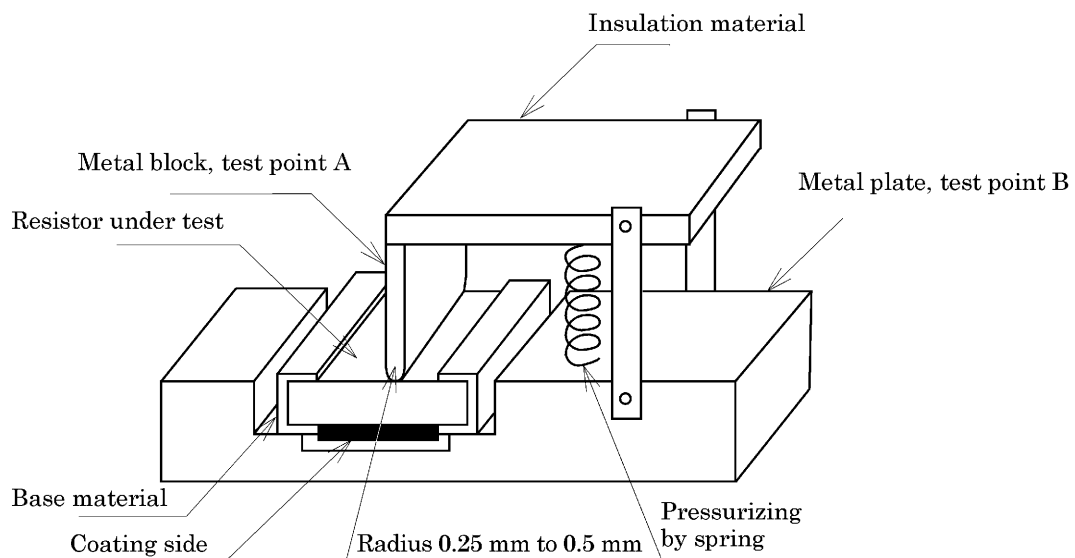


**Figure 1 Insulation resistance and voltage proof test jig
for rectangular surface mount resistors**

4.6.1.5 Method for cylindrical types

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

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.

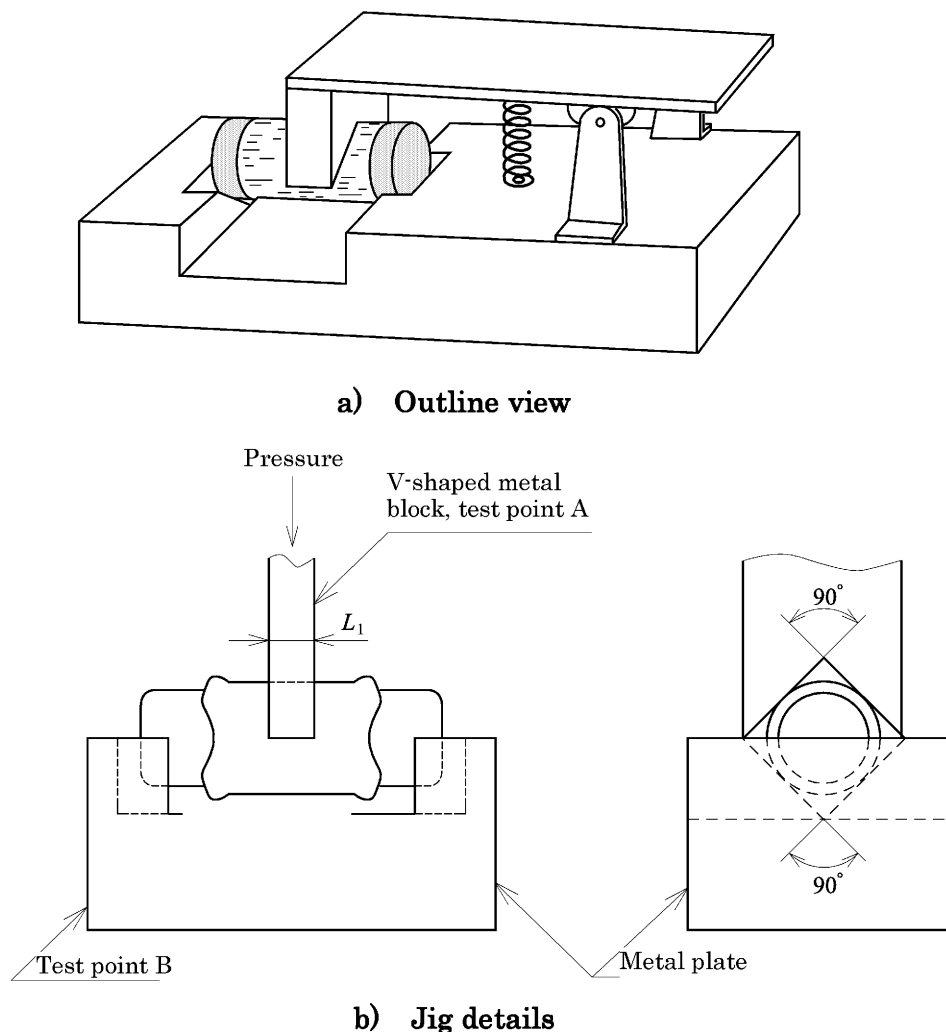


**Figure 2 Insulation resistance and voltage proof test jig
for cylindrical surface mount resistors**

4.6.2 Measuring conditions

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 to 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 1 and figure 2 (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.

4.6.3 Requirements

The insulation resistance shall be not less than the value prescribed in the relevant specification.

4.7 Voltage proof

4.7.1 Test methods

The test shall be performed using one of the methods specified in 4.6.1, as prescribed in the detail specification.

The V-block method is the preferred method for resistors without mounting devices.

4.7.2 Test conditions

For all resistors except surface mount resistors, the test voltage shall be applied between the terminations of the resistor connected together as one pole, and the V-block or metal foil or mounting plate(s) as the other pole. The test voltage shall be alternating (40 Hz to 60 Hz) and shall be increased, at a rate of about 100 V/s, from zero to a peak value of 1.42 times the value of the insulation voltage specified in the detail specification.

After the specified voltage has been reached, the voltage shall continue to be applied for $60 \text{ s} \pm 5 \text{ s}$.

For surface mount resistors, an alternating voltage of 40 Hz to 60 Hz, with a peak value of 1.42 times the insulation voltage, shall be applied for a period of $60 \text{ s} \pm 5 \text{ s}$ between test points A and B as shown in figures 1 and 2. The voltage shall be applied gradually at a rate of approximately 100 V/s.

4.7.3 Requirements

There shall be no breakdown (e.g. a leakage current equal to or greater than 10 μA) or flashover.

4.8 Variation of resistance with temperature

4.8.1 Preconditioning

The resistor shall be dried using either procedure I or procedure II of 4.3, as prescribed in the relevant specification.

4.8.2 Measuring temperatures

The resistor shall be maintained at each of the following temperatures in turn or at other temperatures specified in the relevant specification:

- a) $20^{+5}_{-1} \text{ }^{\circ}\text{C}$;
- b) lower category temperature $\pm 3 \text{ }^{\circ}\text{C}$;
- c) $20^{+5}_{-1} \text{ }^{\circ}\text{C}$;
- d) upper category temperature $\pm 2 \text{ }^{\circ}\text{C}$;
- e) $20^{+5}_{-1} \text{ }^{\circ}\text{C}$.

4.8.3 Measuring procedures

Resistance measurements shall be made at each of the temperatures specified in 4.8.2, after the resistor has reached thermal stability.

The condition of thermal stability is deemed to be reached when two readings of resistance taken at an interval of not less than 5 min do not differ by an amount greater than that which can be attributed to the measuring apparatus.

The temperature of the resistor at the time of measurement shall be recorded. The error of measurement of temperature shall not exceed 1 °C.

4.8.4 Calculation of temperature coefficient of resistance α

The temperature coefficient of resistance (α) between 20 °C and each of the other temperatures specified in 4.8.2 shall be calculated from the following formula:

$$\alpha = \frac{\Delta R}{R \times \Delta T} \times 10^6$$

where, α : The temperature coefficient of resistance is expressed in parts per million per kelvin ($10^{-6}/K$).
 ΔT : The algebraic difference, in kelvins, between the specified ambient temperature and the reference temperature (k)
 ΔR : The change in resistance between the two specified ambient temperatures (Ω)
 R : The resistance value at the reference temperature (Ω)

If the resistances recorded in 4.8.3 are designated, R_a , R_b , R_c , R_d , and R_e , R and ΔR shall be calculated as shown in table 3.

Table 3 Calculation of resistance value (R) and an change in resistance (ΔR)

	Lower category temperature	Upper category temperature
R	$\frac{R_a + R_c}{2}$	$\frac{R_c + R_e}{2}$
ΔR	$R_b - R$	$R_d - R$

If the temperatures recorded in 4.8.3 are designated T_a , T_b , T_c , T_d and T_e , the temperature differences (ΔT) between the recorded temperatures shall be calculated as shown in table 4.

Table 4 Calculation of temperature differences (ΔT)

	Lower category temperature	Upper category temperature
ΔT	$T_b - \frac{T_a + T_c}{2}$	$T_d - \frac{T_c + T_e}{2}$

4.8.5 Requirements

The temperature coefficient of resistance (α), ascertained as described in 4.8.4, shall be within the limits prescribed in the detail specification for the appropriate category temperature.

When the resistance value is greater than 5 Ω but less than 10 Ω , the temperature coefficient shall not exceed the limits prescribed in the detail specification for values equal to or above 10 Ω by more than a factor of 2.

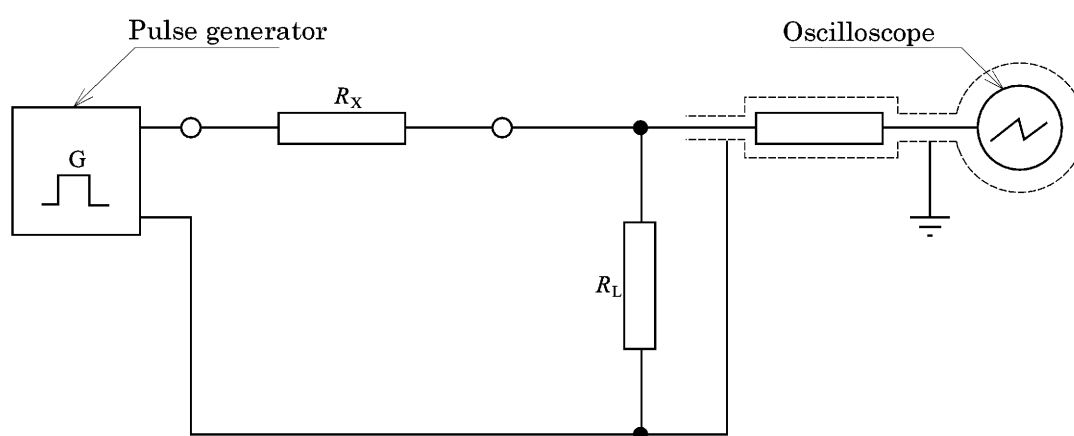
NOTE : The temperature coefficient of resistance is not specified for resistance values of less than 5 Ω owing to difficulty of accurate measurement.

4.9 Reactance

4.9.1 Test procedures

The reactance test is applicable only to resistors for which a low reactance is required and is specified in the detail specification. It is a suitable test for inductance in the range exhibited by wire-wound resistors. The instrumentation shown in figure 3 can be used for resistors with a L/R time constant greater than 20 ns. The resistance range which can be tested is from 100 Ω to 1 M Ω .

A suitable impedance analyzer may be used as an alternative to the test circuit shown in figure 3 (see 4.9.5).



R_X : resistor under test

R_L : non-inductive resistor with resistance approximately equal to 0.1 times the resistance of R_X

NOTE : The length of the connecting leads between the generator and resistor R_X should not exceed 50 mm.

Figure 3 Test circuit

4.9.2 Pulse generator specification

The pulse generator shall have the following characteristics.

- a) Pulse width: sufficient to cover three times L/R period

- b) Rise time on load (10 % to 90 %): less than 3 ns
- c) Repetition rate: greater than 10 kHz, or that required to obtain good oscilloscope readability

4.9.3 Oscilloscope specification

The oscilloscope shall have the following characteristics.

- a) Rise time (10 % to 90 %): less than 3.7 ns (frequency response: 100 MHz or better)
- b) Time base: 2 ns per mm or faster
- c) Input capacitance at R_L should be 25 pF or less
- d) Amplification shall be sufficient to obtain good readability with the pulse voltage used.

4.9.4 Measurements

The L/R time constant is determined by measuring the time between the start of the pulse and the time when the voltage attains 63.2 % of the maximum (see figure 4). If there is noise or distortion at the start of the rise, the zero voltage point can be determined by extension of the curve. If there is no overshoot or oscillation and the L/R time constant is greater than 20 ns, then the formula below can be used with sufficient accuracy:

$$\text{effective inductance } (H) = \frac{L}{R} (s) \times R (\Omega)$$

NOTE : A specification limit could be set either as a maximum L/R time or, resulting from use of the calculation, as a maximum inductance.

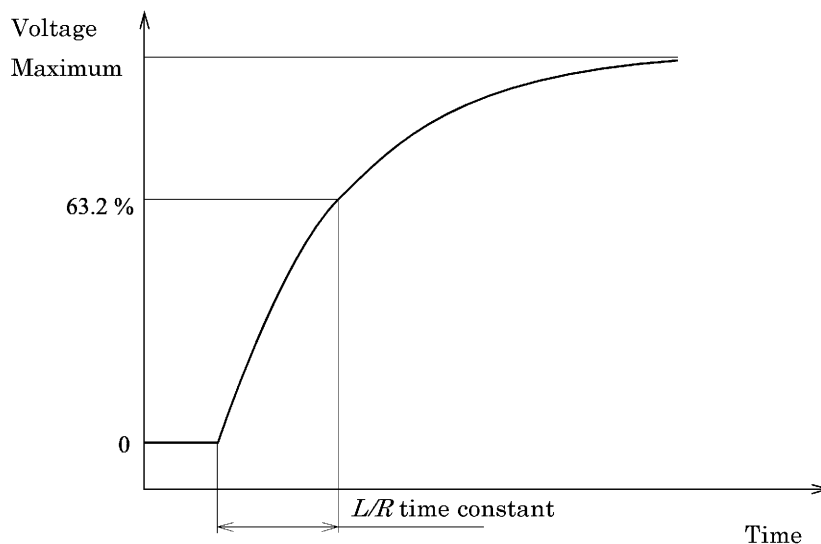


Figure 4 Oscilloscope trace

4.9.5 Impedance analyzer

High frequency impedance analyzer or equivalent test equipment may be used.

The measuring frequency shall be taken from the relevant specification.

4.10 Non-linear properties

The resistors shall be measured for non-linearity in accordance with IEC/TR 60440. The voltage to be applied shall be the rated voltage or the limiting element voltage, whichever is the less severe. When there are specific requirements for non-linearity, such requirements shall be specified in the detail specification.

NOTE : The brief summary of IEC/TR 60440 is described in Annex JB.

4.11 Voltage coefficient

4.11.1 Preconditioning

The resistor shall be dried using either procedure I or procedure II of 4.3, as prescribed in the relevant specification.

4.11.2 Measuring methods

The resistance shall then be measured at 10 % and at 100 % of either the rated voltage or the limiting element voltage, whichever is the smaller. The 100 % voltage shall be applied for not more than 0.5 s in every 5 s; the 10 % voltage shall be applied for 4.5 s. Care shall be taken that there is no appreciable temperature rise of the resistor.

4.11.3 Calculation of voltage coefficient

The voltage coefficient is normally expressed in per cent per volt (%/V) and shall be calculated from the following formula:

$$\frac{(R_2 - R_1)}{0.9 \times U \times R_1} \times 100$$

Where, U : the applied voltage of 100 % (V)
 R_1 : the resistance measured at 10 % voltage (Ω)
 R_2 : the resistance measured at 100 % voltage (Ω)

4.11.4 Requirements

The value of the voltage coefficient shall not exceed that prescribed in the relevant specification.

4.12 Noise

The resistors shall be subjected to the procedure given in IEC 60195.

NOTE : The procedure given in IEC 60195 is described in Annex JC.

4.13 Short time overload

4.13.1 Initial measurements

The resistance shall be measured as specified in 4.5.

4.13.2 Test procedures

The resistor shall be mounted horizontally. For wire-wound resistors, the axis of the winding shall be horizontal. The resistor shall be in free air at an ambient temperature between 15 °C and 35 °C. A voltage shall then be applied to the terminations of the resistor. The value of the voltage and the duration of its application shall be as prescribed in the relevant specification. Connections shall be made in the usual manner. For resistors with soldering tags, copper wire of approximately 1.0 mm diameter shall be used for connecting the resistors. The relevant specification shall prescribe any special mounting arrangements.

4.13.3 Final inspection, measurements and requirements

After a recovery of not less than 1 h and not more than 2 h, the resistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The resistance shall then be measured as specified in 4.5. The change of resistance, with respect to the value measured in 4.13.1, shall not exceed the value prescribed in the detail specification.

4.14 Temperature rise

4.14.1 Object

Resistors having a nominal resistance less than the critical resistance shall be subjected to the following test.

4.14.2 Mounting

The resistor shall be mounted horizontally. For wire-wound resistors, the axis of the winding shall be horizontal. Connections shall be made in the usual manner. For resistors with soldering tags, copper wire of approximately 1.0 mm diameter shall be used for connecting the resistors. The relevant specification shall prescribe any special mounting arrangements.

Surface mounting (SMD) resistors shall be mounted normally on a 1.6 mm thick copper clad epoxide woven E-glass laminated circuit board as defined, for example, in **JIS C 6484**. A 0.635 mm thick alumina substrate may be used if explicitly specified in the detail specification for resistors which are typically assembled and operated on such substrates.

4.14.3 Test procedures

The ambient temperature for the test shall be 15 °C to 35 °C. There shall be no air circulation other than that produced by natural convection caused by the heated resistor.

The rated voltage shall be applied.

The temperature at the hottest point on the surface of the resistor shall be measured after temperature equilibrium has been attained. The temperature measuring device shall be of such dimensions as not to affect the result of the measurement.

4.14.4 Requirements

The temperature rise shall not exceed the value prescribed in the detail specification.

If applicable, infrared thermometer, that is properly calibrated, shall be used for measurement of temperature.

4.15 Robustness of the resistor body

4.15.1 Object

Resistors having a body length not less than 25 mm shall be subjected to the following test.

4.15.2 Test procedure

The body of the resistor is supported at both ends, the distance of the supports from the end faces being not more than 5 mm. The support shall have a radius of not less than 6 mm. A thrust as prescribed in the detail specification is applied gradually to the centre of the body in a direction perpendicular to the axis, for a period of 10 s. The load shall be applied through a device having a radius of not less than 6 mm (see figure 5).

4.15.3 Requirements

At the conclusion of the test, the body of the resistor shall not be cracked or broken.

Unit : mm

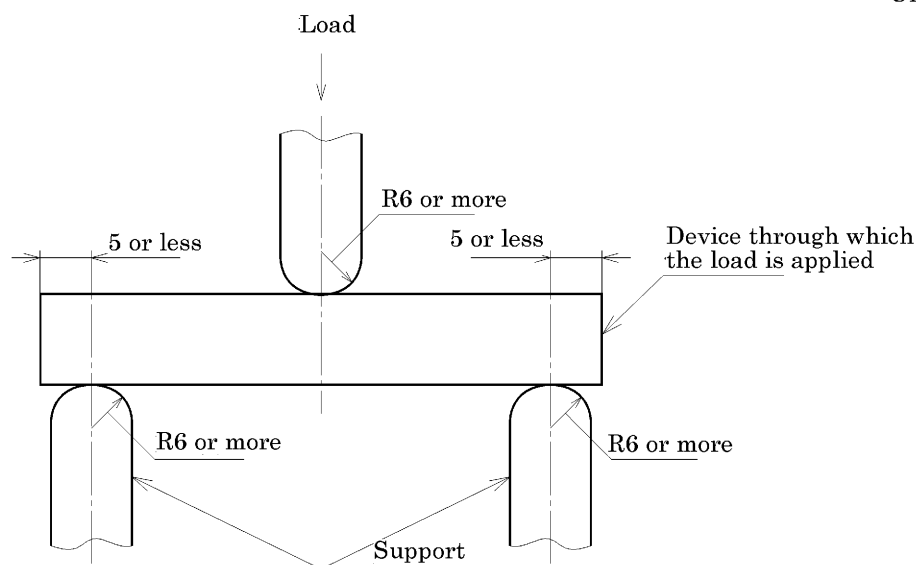


Figure 5 Testing of resistor body robustness

4.16 Robustness of terminations

4.16.1 Test methods

The resistors shall be subjected to tests U_{a1} , U_b , U_c and U_d specified in JIS C 60068-2-21, as applicable.

The resistors shall be measured as specified in the detail specification.

4.16.2 Test U_{a1} -Tensile

The force applied shall be as follows:

- for terminations other than wire terminations: 20 N;
- for wire terminations: see table 5.

Table 5 Tensile force for wire terminations

Nominal cross-sectional area S mm ²	Corresponding diameter for circular-section wires d mm	Force N
$S \leq 0.05$	$d \leq 0.25$	1
$0.05 < S \leq 0.1$	$0.25 < d \leq 0.35$	2.5
$0.1 < S \leq 0.2$	$0.35 < d \leq 0.5$	5
$0.2 < S \leq 0.5$	$0.5 < d \leq 0.8$	10
$0.5 < S \leq 1.2$	$0.8 < d \leq 1.25$	20
$1.2 < S$	$1.25 < d$	40
NOTE : For circular-section wires, strips or pins: the nominal cross-sectional area is equal to the value calculated from the nominal dimension(s) given in the detail specification. For stranded wires, the nominal cross-sectional area is obtained by taking the sum of the cross-sectional areas of the individual strands of the conductor specified in the detail specification.		

4.16.3 Test U_b —Bending

Method 1: two consecutive bends shall be applied in each direction. This test shall not apply if, in the detail specification, the terminations are described as rigid.

4.16.4 Test U_c —Torsion

Method 1, severity 2 (two successive rotations of 180°) shall be used.

This test shall not apply if, in the detail specification, the terminations are described as rigid, and it shall not apply to components with unidirectional terminations designed for printed wiring applications.

4.16.5 Test U_d —Torque

This test shall be applicable for terminations with threaded studs or screws and for integral mounting devices.

Table 6 Torque

Nominal thread diameter mm		2.6	3	3.5	4	5	6
Torque Nm	Severity 1	0.4	0.5	0.8	1.2	2.0	2.5
	Severity 2	0.2	0.25	0.4	0.6	1.0	1.25

4.16.6 Final measurements

The following procedure shall be applied.

- a) After each of these tests, the resistors shall be visually examined, There shall be no visible damage.
- b) At the conclusion of the last of these tests, the resistance shall be measured as specified in 4.5. The change of resistance with respect to the value measured in 4.16.1 shall not exceed the value prescribed in the detail specification.

4.17 Solderability

NOTE : Not applicable to those terminations which the detail specification describes as not designed for soldering.

4.17.1 Preconditioning

The relevant specification shall prescribe whether ageing is to be applied. If accelerated ageing is required, one of the ageing procedures given in JIS C 60068-2-20 shall be applied.

Unless otherwise stated in the relevant specification, the test shall be carried out with non-activated flux.

4.17.2 Test procedures

Unless otherwise stated in the relevant specification, one of the following tests as set out in the same specification shall be applied.

The test conditions shall be defined in the relevant specification.

- a) For all resistors except those of item b) and c) below:

- 1) JIS C 60068-2-20, Test Ta, method 1 (solder bath)

Depth of immersion (from the seating plane or component body): $2.0 \text{ mm}^{0}_{-0.5}$
mm, using a thermal insulating screen of $1.5 \text{ mm} \pm 0.5 \text{ mm}$ thickness;

- 2) JIS C 60068-2-20, Test Ta, method 2 (soldering iron);

- 3) JIS C 60068-2-54, solder bath wetting balance method.

NOTE : JIS C 60068-2-54 is applicable only when prescribed in the detail specification or when agreed upon between manufacturer and customer.

b) **For resistors not designed for use in printed boards, but with connections intended for soldering as indicated by the detail specification:**

- 1) **JISC 60068-2-20** Test Ta, method 1 (solder bath) Depth of immersion (from the seating plane or component body): $3.5 \text{ mm} \begin{smallmatrix} 0 \\ -0.5 \end{smallmatrix} \text{ mm}$
- 2) **JIS C 60068-2-20**, Test Ta, method 2 (soldering iron).

c) **For surface mounting resistors:**

- 1) **JIS C 60068-2-58**, reflow or solder bath method;
- 2) **JIS C 60068-2-69**, solder bath wetting balance or solder globule wetting balance method.

NOTE : **JIS C 60068-2-69** is applicable only when prescribed in the detail specification or when agreed upon between manufacturer and customer.

4.17.3 Final inspection, measurements and requirements

The terminations shall be examined for good tinning as evidenced by free flowing of the solder with wetting of the terminations.

The resistors shall meet the requirements as prescribed in the detail specification.

4.18 Resistance to soldering heat

4.18.1 Preconditioning

When prescribed by the relevant specification, the resistors shall be dried using the method of 4.3.

The resistors shall be measured as prescribed in the relevant specification.

4.18.2 Test procedures

Unless otherwise stated in the relevant specification, one of the following tests as set out in the same specification shall be applied.

The test conditions shall be defined in the relevant specification.

- a) **For all resistors except those of item b) and c) below:** **JIS C 60068-2-20**, Test Tb, method 1 (solder bath).
- b) **For resistors not designed for use in printed boards, but with connections intended for soldering as indicated by the detail specification:**
 - 1) **JIS C 60068-2-20**, Test Tb, method 1 (solder bath);
 - 2) **JIS C 60068-2-20**, Test Tb, method 2 (soldering iron).

c) **For surface mounting resistors:** **JIS C 60068-2-58**, reflow or solder bath method.

4.18.3 Recovery

The period of recovery shall, unless otherwise specified by the detail specification, be not less than 1 h nor more than 2 h, except for surface mount resistors, for which the period of recovery shall be $24 \text{ h} \pm 2 \text{ h}$.

4.18.4 Final inspection, measurements and requirements

For all resistors, except surface mount resistors, the following shall apply:

- when the test has been carried out, the resistors shall be visually examined;
- there shall be no visible damage and the marking shall be legible;
- the resistors shall then be measured as prescribed in the relevant specification.

Surface mount resistors shall be visually examined and measured and shall meet the requirements as prescribed in the relevant specification.

4.19 Rapid change of temperature

4.19.1 Initial measurements

The resistance shall be measured as specified in 4.5.

4.19.2 Test procedures

The resistors shall be subjected to test Na of **JIS C 0025**. Preferred numbers of cycles are 5, 100, 200, 500 and 1 000, to be specified in the relevant specification. Unless otherwise specified in the relevant specification, the duration of the exposure at each of the extremes of temperature shall be 30 min. Unless otherwise specified the transition time, t_2 between the temperatures shall be less than 30 s.

The resistors shall then remain under standard atmospheric conditions for recovery for not less than 1 h and not more than 2 h.

For this test, only the number of cycles is counted. During interruptions, the resistors shall be stored under standard atmospheric conditions.

4.19.3 Final inspection, measurements and requirements

After recovery, the resistors shall be visually examined. There shall be no visible damage.

The resistance shall be measured as specified in 4.5. The change of resistance with respect to the value measured in 4.19.1 shall not exceed the limit prescribed in the detail specification.

4.20 Bump

4.20.1 Mounting

The resistor shall be mounted as indicated in the relevant specification.

4.20.2 Initial measurements

The resistance shall be measured as specified in 4.5.

4.20.3 Test procedures

The resistors shall be subjected to test Eb of **JIS C 60068-2-29**, using the degree of severity prescribed in the relevant specification.