

INTERNATIONAL STANDARD

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**Fixed resistors for use in electronic equipment –
Part 8: Sectional specification: Fixed surface mount resistors**

**Résistances fixes utilisées dans les équipements électroniques –
Partie 8: Spécification intermédiaire: Résistances fixes pour montage en surface**



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FIXED RESISTORS FOR USE IN ELECTRONIC EQUIPMENT –**Part 8: Sectional specification: Fixed surface mount resistors****FOREWORD**

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This third edition cancels and replaces the second edition published in 2009. This edition constitutes a technical revision.

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

- a) definitions of product technologies and product classification levels of the generic specification, IEC 60115 1:2020, have been adopted;
- b) new style of transverse (RT) resistors has been added in 3.1.5 and 4.2.2 to cover resistors with wide terminals, which have become common in market;
- c) recommended test boards in 5.2.2 have been revised to fit the demands from the market for higher rated dissipation in resistors;

- d) test boards have been revised so that they can be set vertically instead of horizontally during specified tests to optimize the temperature rise stability, area and spacing inside the test chamber;
- e) 'Periodic-pulse high-voltage overload test' of IEC 60115-1:2020, 8.3 has been added to the default test method in 5.3.8, however, the legacy test 'periodic-pulse overload test' of IEC 60115-1:2020, 8.4 is still maintained for historical products;
- f) revised solderability test of IEC 60115-1:2020, 11.1 has been adopted in 5.3.21 and 5.3.22;
- g) combined solvent resistance test of IEC 60115-1:2020, 11.3 has been adopted in 5.3.24;
- h) 'Single-pulse high-voltage overload test' of IEC 60115-1:2020, 8.2, applied with the pulse shape 10/700 in 5.3.7, is complemented with the optional alternative provided by the pulse shape 1,2/50 in 5.4.1;
- i) climatic tests for 'operation at low temperature' of IEC 60115-1:2020, 10.2, and for 'damp heat, steady state, accelerated' of IEC 60115-1:2020, 10.5, have been adopted as optional tests in 5.4.3 and 5.4.4, respectively;
- j) new guidance is provided in 6.2 on the presentation of stability requirements with their permissible absolute and relative deviations;
- k) acceptance criteria for the visual examination have been added in 6.5 and in Annex B;
- l) visual examination for the primary and proximity packaging has been added in 6.5.3 and in 7.2;
- m) periodical evaluation of termination plating has been added as a new topic of quality assessment in 9.8;
- n) revised test clause numbering of IEC 60115-1:2020 has been applied;
- o) normative Annex A has been moved from Annex B of the old version to stay in line with other sectional specifications;
- p) normative Annex B has been added to show the criteria for general visual examinations;
- q) informative Annex C has been added to summarize workmanship requirements for the assembly;
- r) normative Annex D has been moved from Annex A of the old version to stay in line with other sectional specifications;
- s) informative Annex E has been added to show guidance for optional and/or additional tests;
- t) informative Annex F has been added to show typical temperature rise of recommended test boards in the endurance test at the rated temperature 70 °C;
- u) informative Annex G has been added to explain why some recommended test boards have extremely wide copper patterns;
- v) informative Annex X has been added to show the cross reference for the prior revision of this document.

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

Draft	Report on voting
40/2973/CDV	40/3031/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60115 series, published under the general title *Fixed resistors for use in electronic equipment*, can be found on the IEC website.

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FIXED RESISTORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 8: Sectional specification: Fixed surface mount resistors

1 Scope

This part of IEC 60115 is applicable to fixed surface mount resistors for use in electronic equipment.

These resistors are typically described according to types (different geometric shapes) and styles (different dimensions) and product technology. These resistors have metallized terminations and are primarily intended to be mounted directly onto a circuit board.

The object of this document is to specify preferred ratings and characteristics and to select from IEC 60115-1, the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of resistor.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60062:2016, *Marking codes for resistors and capacitors*

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-58:2015, *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)*

IEC 60115-1:2020, *Fixed resistors for use in electronic equipment – Part 1: Generic specification*

IEC 60286-3, *Packaging of components for automatic handling – Part 3: Packaging of surface mount components on continuous tapes*

IEC 61193-2:2007, *Quality assessment systems – Part 2: Selection and use of sampling plans for inspection of electronic components and packages*

IEC 61760-1:2020, *Surface mounting technology – Part 1: Standard method for the specification of surface mounting components (SMDs)*

IEC 60294:2012, *Measurement of the dimensions of a cylindrical component with axial terminations*

3 Terms, definitions, product technologies and product classification

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60115-1:2020, 3.1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1.1

cylindrical (RC) resistor

physical design of a component with metallic terminations to both sides along the longitudinal axis of the cylindrical component body

Note 1 to entry: This series of products is generally called MELF. However, MELF resistors are different and not related to MELF diodes.

3.1.2

load reduction curve

curve that shows the maximum allowable dissipation at terminal part temperatures between the upper and lower category temperatures

3.1.3

rectangular (RR) resistor

physical design of a component with metallic terminations to both sides along the longitudinal axis of the rectangular component body

3.1.4

terminal part temperature

θ_t

temperature that is measured on the terminal part, or the connection part of the resistor that is generally soldered to the printed circuit board

3.1.5

transverse (RT) resistor

physical design of a component with metallic terminations to both sides along the lateral axis of the rectangular component body

3.1.6

wire-wound (RW) resistor

component designed to use wire-wound elements inside the component body whose physical design can vary depending on the required specification

3.2 Product technologies

The definitions of product technologies intend to provide the reader with a guidance on the variety of technologies used for the making of resistors, and to aid their identification

For the purposes of this document, the following product technologies as described in IEC 60115-1:2020, 3.2 apply:

- metal film technology,
- metal glaze technology,
- carbon film technology,

- wire-wound technology,
- metal foil technology,
- metal strip technology.

3.3 Product classification

The introduction of a product classification permits the user to select performance requirements according to the conditions of the intended end-use application.

For the purposes of this document, the following product classification levels as defined in IEC 60115-1:2020, 3.4 apply:

- Level G – General electronic equipment,
- Level P – High-performance electronic equipment,
- Level R – High-performance and high-reliable electronic equipment.

4 Preferred characteristics

4.1 General

The values given in detail specifications shall be selected from the values given in 4.2 to 4.9.

4.2 Style and dimensions

4.2.1 Preferred styles and outline dimensions for rectangular (RR) resistors

The shape and dimensions of rectangular resistors is shown in Figure 1, with preferred styles and their respective dimensions given in Table 1. Style designators of rectangular resistors begin with RR.

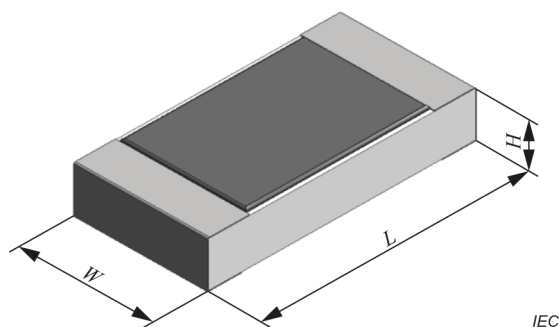


Figure 1 – Shape and dimension of rectangular (RR) resistors

Table 1 – Preferred styles of rectangular (RR) resistors

Style		Dimensions		
Metric	Imperial ^a	Length <i>L</i> mm	Width <i>W</i> mm	Height <i>H</i> mm
RR0402M	RR01005	0,4 ± 0,02	0,2 ± 0,02	0,13 ± 0,02
RR0603M	RR0201	0,6 ± 0,05	0,3 ± 0,05	0,23 ± 0,05
RR1005M	RR0402	1,0 ^{+0,1} _{-0,05}	0,5 ^{+0,1} _{-0,05}	0,35 ± 0,15
RR1608M	RR0603	1,6 ± 0,1	0,8 ± 0,15	0,45 ± 0,1
RR2012M	RR0805	2,0 ± 0,2	1,25 ± 0,15	0,5 ± 0,15
RR3216M	RR1206	3,2 ^{+0,2} _{-0,3}	1,6 ± 0,15	0,55 ± 0,15
RR3225M	RR1210	3,2 ± 0,2	2,5 ± 0,2	0,55 ^{+0,25} _{-0,2}
RR4532M	RR1812	4,6 ± 0,2	3,2 ± 0,2	0,55 ± 0,2
RR5025M	RR2010	5,0 ± 0,2	2,5 ± 0,2	0,55 ± 0,2
RR6332M	RR2512	6,3 ± 0,2	3,2 ± 0,2	0,55 ± 0,2
NOTE 1 RR3245M in the previous edition of this document is moved to Table 2, the new style being RT3245M.				
NOTE 2 Thickness <i>T</i> was used in the prior edition but is changed to height <i>H</i> for harmonization.				
^a Historical style codes, for information only.				

The detail specification shall present a realistic outline illustration of the resistors covered therein, which shall contain all relevant dimensions.

4.2.2 Preferred styles and outline dimensions for transverse (RT) resistors

The shape and dimensions of transverse resistors is shown in Figure 2, with preferred styles and their respective dimensions given in Table 2. Style designators of transverse resistors begin with RT.

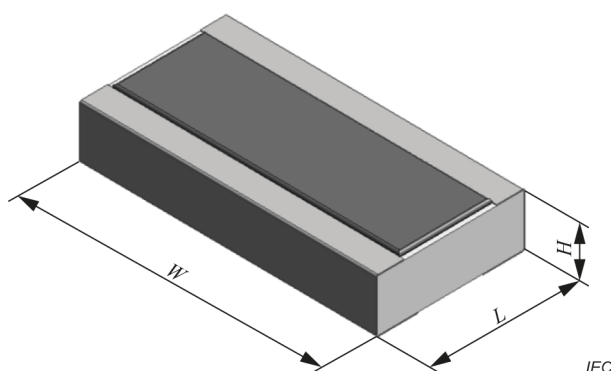
**Figure 2 – Shape and dimension of transverse (RT) resistors**

Table 2 – Preferred styles of transverse (RT) resistors

Style		Dimensions		
Metric	Imperial ^a	Length <i>L</i> mm	Width <i>W</i> mm	Height <i>H</i> mm
RT0510M	RT0204	0,5 ± 0,05	1,0 ± 0,05	0,35 ± 0,05
RT0816M	RT0306	0,8 ± 0,15	1,6 ± 0,15	0,45 ± 0,1
RT1016M	RT0406	1,0 ± 0,15	1,5 ± 0,15	0,35 ± 0,1
RT1220M	RT0508	1,25 ± 0,15	2,0 ± 0,15	0,55 ± 0,15
RT1632M	RT0612	1,6 ± 0,2	3,2 ± 0,3	0,5 ± 0,2
RT2550M	RT1020	2,5 ± 0,2	5,0 ± 0,2	0,55 ± 0,2
RT3245M	RT1218	3,2 ± 0,25	4,6 ± 0,2	0,55 ± 0,2
RT3263M	RT1225	3,2 ± 0,25	6,3 ± 0,3	0,6 ± 0,25

^a Historical style codes, for information only.

The detail specification shall present a realistic outline illustration of the resistors covered therein, which shall contain all relevant dimensions.

NOTE RR3245M and RR1218 which were in edition 2 of this document (IEC 60115-8:2009) have been revised to RT3245M and RT1218, since the new name for transverse (RT) resistors have been standardized.

4.2.3 Preferred styles and outline dimensions for cylindrical (RC) resistors

The shape and dimensions of cylindrical resistors is shown in Figure 3, with preferred styles and their respective dimensions given in Table 3. Style designators of cylindrical resistors begin with RC.

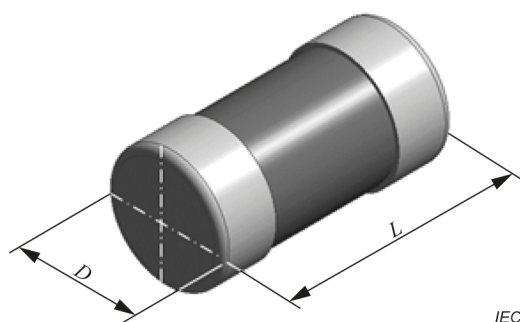
**Figure 3 – Shape and dimension of cylindrical (RC) resistors**

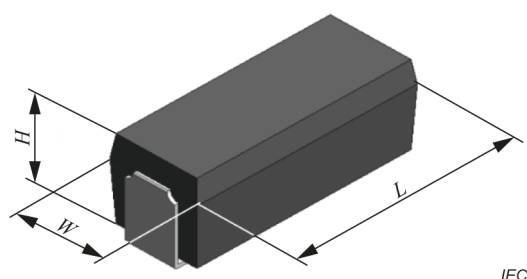
Table 3 – Preferred styles of cylindrical (RC) resistors

Style	Dimensions	
Metric	Length L mm	Diameter D mm
RC1610M	$1,6^{+0,10}_{-0,05}$	$1,0^{+0,15}_{-0,05}$
RC2012M	$2,0 \pm 0,1$	$1,25^{+0,2}_{-0,1}$
RC2211M	$2,2^{0}_{-0,3}$	$1,1^{0}_{-0,10}$
RC3514M	$3,5 \pm 0,2$	$1,4 \pm 0,2$
RC3715M	$3,7^{0}_{-0,4}$	$1,5^{+0,1}_{-0,3}$
RC5922M	$5,9 \pm 0,2$	$2,2 \pm 0,2$
RC6123M	$6,1^{0}_{-0,9}$	$2,3^{+0,2}_{-0,4}$

The detail specification shall present a realistic outline illustration of the resistors covered therein, which shall contain all relevant dimensions.

4.2.4 Preferred styles and outline dimensions for wire-wound (RW) resistors

The typical shape and dimensions of wire-wound (RW) resistors is shown in Figure 4, with preferred styles and their respective dimensions given in Table 4. Style designators of wire-wound resistors begin with RW.

**Figure 4 – Shape and dimension of wire-wound (RW) resistors****Table 4 – Preferred styles of wire-wound (RW) resistors**

Style		Dimensions		
Metric	Imperial ^a	Length L mm	Width W mm	Height H mm
RW0503M	RW2012	$5,0^{+0,6}_{-0,5}$	$3,0^{+0,6}_{-1,0}$	$3,0^{+0,6}_{-1,0}$
RW0704M	RW2515	$7,0^{+1,0}_{-1,3}$	$4,0^{+0,5}_{-1,0}$	$4,0^{+0,5}_{-1,6}$
RW1107M	RW4527	$11,0^{+1,5}_{-1,2}$	$7,0^{+0,5}_{-1,5}$	$5,0^{+1,0}_{-1,1}$
RW1607M	RW6927	$16,0^{+3,0}_{-2,5}$	$7,0^{+0,5}_{-1,5}$	$7,0^{+0,5}_{-1,5}$
^a Historical style codes, for information only.				

Further detail of wire-wound resistors (RW) shall be described in the detail specification.

4.3 Preferred climatic categories

The fixed surface mount resistors covered by this document are classified into climatic categories according to the general rules given in IEC 60068-1:2013, Annex A.

The lower and upper category temperatures and the duration of the damp heat, steady state test shall be chosen from the following:

Lower category temperature (LCT) –55 °C; –40 °C; –25 °C and –10 °C.

Upper category temperature (UCT) 85 °C; 100 °C; 125 °C; 155 °C; 175 °C
and 200 °C.

Duration of damp heat, steady state test: 10 days, 21 days and 56 days.

The severities for the cold and dry heat tests are the lower and upper category temperatures, respectively.

4.4 Resistance

See IEC 60115-1:2020, 4.2.2.

The series of resistance values should be selected according to the tolerance on resistance as recommended by IEC 60063:2015, Table 3.

4.5 Tolerances on resistance

The preferred tolerances for the resistance of fixed resistors are:

±10 %; ±5 %; ±2 %; ±1 %; ±0,5 %; ±0,25 %; ±0,1 %; ±0,05 %; ±0,02 % and ±0,01 %.

NOTE 1 Fixed resistors are trimmed to the desired resistance value, which is not intended to be altered.

The preferred tolerances on resistance for trimmable resistors are:

0/-30 %; 0/-20 % and 0/-10 %.

NOTE 2 Trimmable resistors provide an unstructured base resistance layer, which is suitable for trimming (e.g. increase of resistance by laser cutting) after assembly in its application. Hence the nominal resistance with +0 tolerance marks the lowest resistor achievable in the circuit.

4.6 Rated dissipation P_{70}

The preferred values of rated dissipation P_{70} for mounted resistors at 70 °C ambient temperature are: 0,016 W; 0,032 W; 0,05 W; 0,063 W; 0,1 W; 0,125 W; 0,25 W; 0,33 W; 0,4 W; 0,5 W; 0,75 W; 1 W; 2 W and 3 W.

The detail specification shall specify the conditions under which the rated dissipation applies.

Figure 5 shows the format of a typical derating curve, suitable for providing information on the required derating of the permissible dissipation for any ambient temperature above the rated temperature.

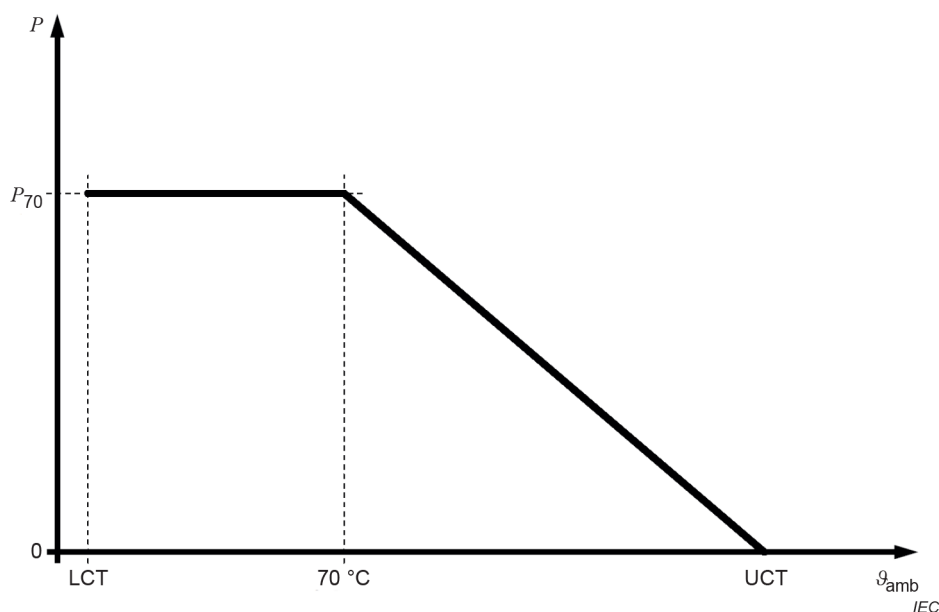


Figure 5 – Derating curve based on ambient temperature

The upper category temperature (UCT), which is used for test procedures, should be based on the maximum element temperature (MET).

All end points and break points on the derating curve shall be verified by tests implemented using the test boards defined in 5.2.2.2.

4.7 Limiting element voltage U_{max}

The preferred values of DC or AC RMS limiting element voltage U_{max} are taken from the R10 series of preferred numbers of ISO 3: 12,5 V; 15 V; 25 V; 50 V; 75 V; 100 V; 150 V; 200 V; 300 V and 500 V.

4.8 Insulation voltage U_{ins}

For insulated resistors, the preferred values of DC or AC peak insulation voltage U_{ins} are taken from the R10 series of preferred numbers of ISO 3: 75 V; 100 V; 200 V; 300 V and 500 V.

The insulation voltage U_{ins} shall not be specified lower than the AC voltage peak value that can be applied continuously and therefore shall not be rated less than $U_{ins} = 1,42 \cdot U_{max}$.

4.9 Insulation resistance R_{ins}

For insulated resistors, the insulation resistance R_{ins} shall be not less than 1 GΩ.

NOTE See 6.7 for requirements to the insulation resistance R_{ins} after tests.

5 Tests and test severities

5.1 General provisions for tests invoked by this document

Subclause 5.2 provides detailed specifications related to the preparation of specimens for tests, particularly on a preferred variety of mounting methods. Any deviation from these specifications, as can be required by the type of resistors covered by a particular detail specification under this sectional specification, shall be clearly specified by that same particular detail specification.

Subclause 5.3 provides detailed specifications of all the tests applied by the test schedules for qualification approval and for quality conformance inspection. The amount of information given here clearly exceeds any short overview information fitted into the conditions of test column of the respective test schedule and therefore shall take precedence over the overview information.

Subclause 5.4 provides detailed specifications of additional tests that are not contained in the test schedules for qualification approval and for quality conformance inspection. These tests are intended to be used as an alternative to tests contained in the test schedules, or as additions to the specified number of tests, in the drafting of a detail specification aiming to cover special requirements. Any specification of such additional tests shall be accompanied by the specification of suitable inspections, e.g. visual examination or assessment of the change of resistance. Furthermore, the respective detail specification shall present suitable performance requirements for any applied additional test. See Annex E for recommendations on the suitable implementation of these optional and/or additional tests into the test schedules.

The specified tests shall be conducted under standard atmospheric conditions for testing outlined in IEC 60115-1:2020, 5.2.3, unless specified otherwise.

Tolerances on specified test parameters shall be applied in accordance with IEC 60115-1:2020, 5.3, unless specified otherwise.

5.2 Preparation of specimens

5.2.1 Drying

Procedure 1 of IEC 60115-1:2020, 5.4 shall be used.

5.2.2 Mounting of components on test boards

5.2.2.1 General

Fixed surface mount resistors shall be mounted on a test board with a basic layout as specified in 5.2.2.2, applying the assembly provisions of 5.2.2.3.

The provisions of IEC 60115-1:2020, 5.5.2 shall be applied.

5.2.2.2 Specification of test boards

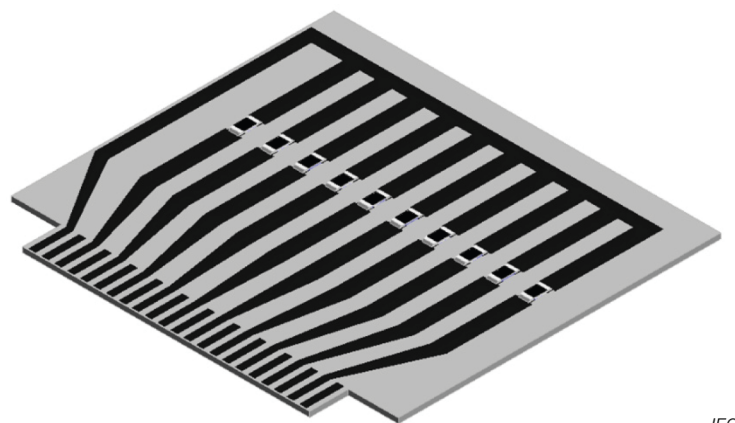
The recommended test boards are basically designed to be at 125 °C at the terminal part when the reference dissipation is applied to the specimen. This is indicated as "Target temperature" in Table 5, Table 6 and Table 7. For reference, an ideal number of specimens is also shown in the tables to consider the variation of temperature between the edge and the centre of the test board. See Annex F for details. The reason why the recommended test boards are based on the terminal part temperature and not the hotspot temperature is also explained in Annex F.

Unless specified otherwise, the test boards shall be an epoxide woven glass type with conductors made of un-tinned copper with the specified thickness.

The nominal thickness of the recommended test board shall be $(1,6 \pm 0,1)$ mm.

The nominal thickness of the copper trace (or copper pattern) shall be 35 µm (0,035 mm). However, copper trace thickness of 70 µm (0,07 mm) shall be used for RT2550M and RT3263M to suppress the excess temperature rise.

Unless specified otherwise, the central area of tests boards shall comply with the basic layout as shown in Figure 7 or Figure 9. Outside of the defined area, the conductor tracks should not be wider than those specified inside the defined area. The total board size, connector style, use of solder mask, and number of specimens on each board are at the discretion of the executor of the tests, and subject to approval of the responsible certification body. The basic appearance of the test board is shown in Figure 6.



IEC

Key

-  Conductor tracks (Copper trace)
-  Glass epoxy board

Figure 6 – Basic appearance of recommended test board

The detail specification can provide a different material specification and basic layout, as technically required for the scope of components covered therein.

When test boards other than the recommended test boards are used, see Annex F to manufacture a corresponding test board that forms a uniform baseline for testing.

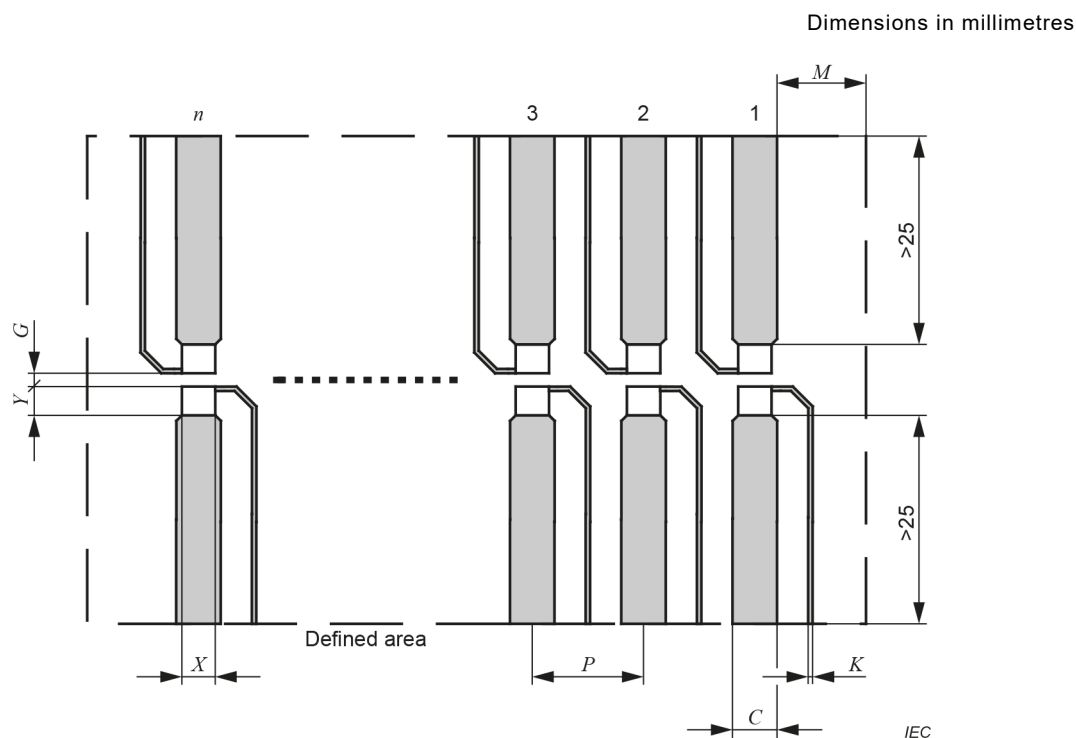
Test boards designed for resistors with higher rated dissipation may have different copper pattern widths compared to traditional test boards. This is because the temperature of the test boards can become extremely high depending on the heat dissipation characteristics of the test boards. See Annex G for reference.

When SMD resistors with the similar or approximate structure but different in size are newly developed, new test boards should be designed based on this document that is to be 125 °C at the terminal part when the rated dissipation is applied to the specimen at 70 °C ambient temperature.

Test boards with Kelvin (4-point) connections illustrated in Figure 7 shall be used.

Test boards that conform to Figure 9 may be used for tests when the resistance of the specimen is 100 Ω or higher, or for tests not requiring a measurement of the resistance value.

Further detail of wire-wound resistors (RW) shall be described in the detail specification. Test boards applicable to RW resistors shall be determined by a relevant specification.

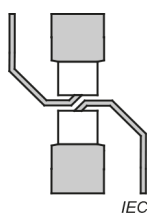
**Key**

- solderable area
- non solderable area, conductor covered with solder resist

NOTE 1 For dimensions, refer to Table 5, Table 6 and Table 7.

NOTE 2 For specimens with a nominal resistance value lower than 100 mΩ, the sense line should be attached to the solderable area as shown in Figure 8.

Figure 7 – Basic layout for mechanical, environmental and electrical tests, Kelvin (4 point) connections

**Key**

- solderable area
- non solderable area, conductor covered with solder resist

Figure 8 – Attachment of the sense line for Kelvin (4-point) connections for specimens with nominal resistance lower than 100 mΩ

Pad dimensions of X , Y and G shown in Figure 7 and Figure 9 and their corresponding values in Table 5, Table 6 and Table 7 are only for reference. The pad dimensions X , Y and G shall be adjusted to have the suitable size for the test specimen and are not limited to the values shown in the tables.

Table 5 – Test board dimensions for RR resistors

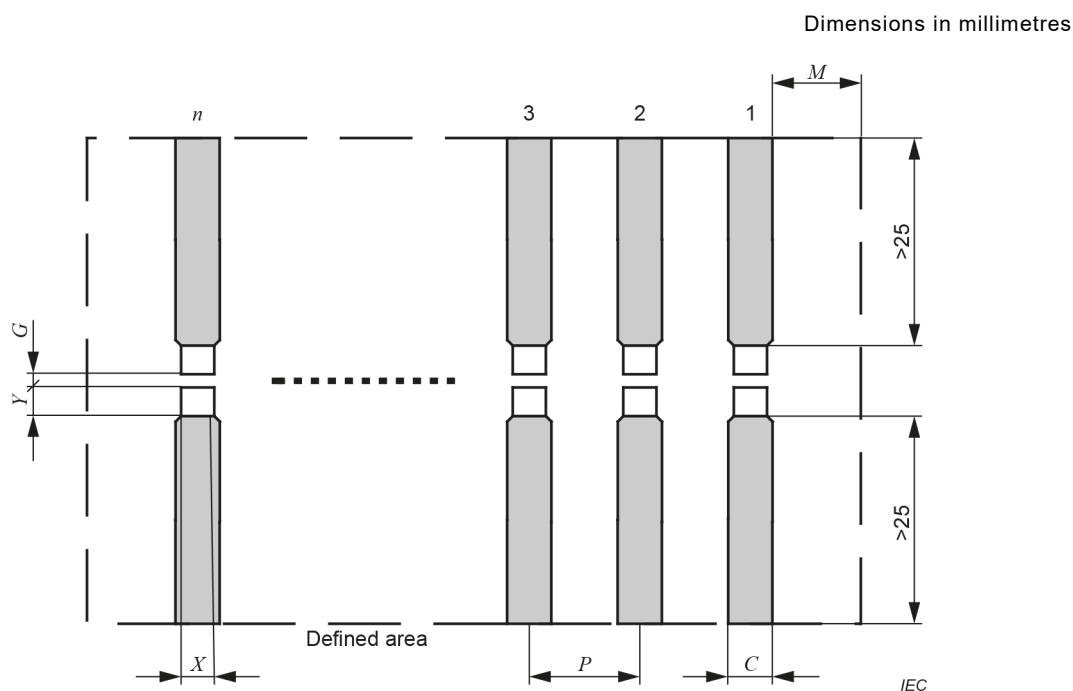
Style	Reference			Specified							Reference		
	X mm	Y mm	G mm	C mm	K mm	P mm	M mm	Board thickness mm	Pattern thickness ^a µm	Reference dissipation W	Number of specimens ^b pcs	Target temp. ^c °C	
RR0402M	0,3 ± 0,05	0,26 ± 0,05	0,18 ± 0,05	0,3 ± 0,05	0,15 ± 0,05	5,0 ± 0,05	P – C	1,6 ± 0,1	35	0,03	20	92	
RR0603M	0,4 ± 0,05	0,4 ± 0,05	0,3 ± 0,05	0,3 ± 0,05	0,15 ± 0,05	5,0 ± 0,05				0,05	20	104	
RR1005M	0,7 ± 0,05	0,6 ± 0,05	0,5 ± 0,05	0,35 ± 0,05	0,15 ± 0,05	5,0 ± 0,05				0,1	20	127	
RR1608M	1,0 ± 0,05	1,1 ± 0,05	0,95 ± 0,05	0,45 ± 0,05	0,2 ± 0,05	5,0 ± 0,05				0,125	20	129	
RR2012M	1,6 ± 0,1	1,3 ± 0,1	1,2 ± 0,1	2,2 ± 0,1	0,2 ± 0,1	5,5 ± 0,1				0,25	18	128	
RR3216M	2,0 ± 0,1	1,6 ± 0,1	1,5 ± 0,1	2,0 ± 0,1	0,2 ± 0,1	5,5 ± 0,1				0,25	18	126	
RR3225M	2,9 ± 0,1	1,6 ± 0,1	1,5 ± 0,1	5,5 ± 0,1	0,2 ± 0,1	10,0 ± 0,1				0,5	10	126	
RR4532M	3,6 ± 0,1	1,8 ± 0,1	2,3 ± 0,1	11,0 ± 0,1	0,2 ± 0,1	14,0 ± 0,1				0,75	7	128	
RR5025M	2,9 ± 0,1	1,8 ± 0,1	2,7 ± 0,1	11,0 ± 0,1	0,2 ± 0,1	15,0 ± 0,1	0,75	6	125				
RR6332M	3,6 ± 0,1	1,8 ± 0,1	3,8 ± 0,1	15,0 ± 0,1	0,2 ± 0,1	19,0 ± 0,1		4	129				
No metal area is permitted on the bottom side or on any inner layer under the defined area, except a single straight sense conductor with a maximum width of 0,3 mm for every Kelvin connection.													
If applicable, the test board layout may also allow for both sense conductors to run to the same edge of the defined area.													
NOTE Test board dimensions for RC resistors, which were in this table in the prior edition of this document, have been moved to Table 7. Test board dimensions for RR3245M were in this table in the prior edition, but the style name is changed to RT3245 and is moved to Table 6.													
^a Pattern thickness is set as design values. Tolerance may be determined by each test board manufacturer.													
^b The number of specimens determines the minimum number of specimens to be mounted on the recommended test board to achieve the target temperature by loading the designated reference dissipation. Detailed data are shown in Annex F.													
^c The lower target temperatures for RR0402M and RR0603M are given to fulfil market requests since they do not generate enough heat to reach 125 °C with the reference dissipation.													

Table 6 – Test board dimensions for RT resistors

Style	Reference			Specified						Reference		
	X mm	Y mm	G mm	C mm	K mm	P mm	M mm	Board thickness mm	Pattern thickness ^a µm	Reference dissipation W	Number of specimens ^b pcs	Target temp. °C
RT0510M	1,1 ± 0,05	0,55 ± 0,05	0,2 ± 0,05	4,5 ± 0,1	0,15 ± 0,05	8,0 ± 0,1	P – C	1,6 ± 0,1	35	0,33	12	126
RT0816M RT1016M	1,7 ± 0,1	0,75 ± 0,05	0,3 ± 0,05	8,0 ± 0,1	0,15 ± 0,05	12,0 ± 0,1				0,5	8	125
RT1220M	2,2 ± 0,1	0,9 ± 0,05	0,45 ± 0,05	17,0 ± 0,1	0,2 ± 0,05	20,0 ± 0,1				0,75	4	128
RT1632M	3,4 ± 0,1	1,0 ± 0,05	0,6 ± 0,1	13,0 ± 0,1	0,2 ± 0,1	18,0 ± 0,1				0,75	5	124
RT3245M	5,0 ± 0,1	1,6 ± 0,1	1,5 ± 0,1	19,0 ± 0,1	0,2 ± 0,1	22,0 ± 0,1				1,0	4	126
RT2550M	5,2 ± 0,1	1,4 ± 0,1	0,7 ± 0,1	21,0 ± 0,1	0,2 ± 0,1	24,0 ± 0,1				1,5	4	125
RT3263M	6,4 ± 0,1	2,125 ± 0,1	0,6 ± 0,1	32,0 ± 0,1	0,2 ± 0,1	35,0 ± 0,1			70	2,0	3	124
No metal area is permitted on the bottom side or on any inner layer under the defined area, except a single straight sense conductor with a maximum width of 0,3 mm for every Kelvin connection. If applicable, the test board layout may also allow for both sense conductors to run to the same edge of the defined area.												
NOTE Test board dimensions for RR3245M were given in the table for RR resistors in the prior edition of this document. The style name has been changed to RT3245 and has been moved to this table.												
^a Pattern thickness is set as design values. Tolerance may be determined by each test board manufacturer.												
^b The number of specimens determines the minimum number of specimens to be mounted on the recommended test board to achieve the target temperature by loading the designated reference dissipation. Detailed data are shown in Annex F.												

Table 7 – Test board dimensions for RC resistors

Style	Reference			Specified						Reference					
	X mm	Y mm	G mm	C mm	K mm	P mm	M mm	Board thickness mm	Pattern thickness ^a µm	Reference dissipation W	Number of specimens ^b pcs	Target temp. °C			
RC1610M	1,0 ± 0,05	1,1 ± 0,05	0,6 ± 0,05	0,45 ± 0,05	0,2 ± 0,05	5,0 ± 0,05	P – C	1,6 ± 0,1	35	0,125	20	125			
RC2012M	1,6 ± 0,1	1,3 ± 0,1	0,6 ± 0,1	3,3 ± 0,1	0,2 ± 0,1	6,5 ± 0,1				15	125				
RC2211M															
RC3514M	2,0 ± 0,1	1,6 ± 0,1	1,5 ± 0,1	4,5 ± 0,1	0,2 ± 0,1	7,5 ± 0,1				13	126				
RC3715M															
RC5922M	2,9 ± 0,1	1,8 ± 0,1	2,7 ± 0,1	20,0 ± 0,1	0,2 ± 0,1	24,0 ± 0,1				4	125				
RC6123M															
No metal area is permitted on the bottom side or on any inner layer under the defined area, except a single straight sense conductor with a maximum width of 0,3 mm for every Kelvin connection.															
If applicable, the test board layout may also allow for both sense conductors to run to the same edge of the defined area.															
NOTE Test board dimensions for RC resistors were given in the table for RR resistors in the prior edition of this document but are now given in a separate table.															
^a Pattern thickness is set as design values. Tolerance may be determined by each test board manufacturer.															
^b The number of specimens determines the minimum number of specimens to be mounted on the recommended test board to achieve the target temperature by loading the designated reference dissipation. Detailed data are shown in Annex F.															

**Key**

-  solderable area
-  non solderable area, conductor covered with solder resist

NOTE For the dimensions, refer to Table 5, Table 6 and Table 7.

Figure 9 – Basic layout for mechanical, environmental and electrical tests

5.2.2.3 Assembly on test boards

The workmanship requirements for general SMD resistors shown in Annex C shall be observed.

5.3 Tests

5.3.1 Resistance

See IEC 60115-1:2020, 6.1 and IEC 60115-1:2020, 5.6.

Unless otherwise specified, the points of measurement are determined by the solder joints for specimens mounted on a test board in accordance with 5.2.2.

5.3.2 Temperature coefficient of resistance

See IEC 60115-1:2020, 6.2 and IEC 60115-1:2020, 5.6.

Unless otherwise specified, the points of measurement are determined by the solder joints for specimens mounted on a test board in accordance with 5.2.2.

The sequence of temperatures, 20 °C / LCT / 20 °C / UCT / 20 °C, shall be applied consecutively.

5.3.3 Temperature rise

See IEC 60115-1:2020, 6.7, with the following details:

The specimen shall be mounted on a test board in accordance with 5.2.2 or as specified by the detail specification. The test board should be mounted vertically with the specimens positioned in a horizontal level and shall be in free air at the standard atmospheric conditions for testing given in IEC 60115-1:2020, 5.2.3 (e.g. ambient temperature 15 °C to 35 °C).

NOTE Vertical setting of the test board is likely to result a better harmonized temperature distribution of the test specimens.

5.3.4 Endurance at the rated temperature 70 °C

See IEC 60115-1:2020, 7.1, with the following details:

The specimen shall be mounted on a test board in accordance with 5.2.2, or as specified by the detail specification.

The test shall be performed with the rated voltage:

$$U_{\text{test}} = U_r = \sqrt{P_{70} \times R_n},$$

which shall be limited by

$$U_{\text{test}} \leq U_{\text{max}},$$

where

U_r is the rated voltage;

P_{70} is the rated dissipation;

R_n is the nominal resistance;

U_{max} is the limiting element voltage.

The duration of the endurance test shall be $t_{\text{test}} = 1000^{+24}_0$ h.

The extension of the endurance test to a total duration of $t_{\text{test}} = 8\,000^{+48}_0$ h, is mandatory only for resistors categorized as level P or R.

See 5.3.25 for the measurement of the insulation resistance of insulated resistors.

5.3.5 Endurance at a maximum temperature: UCT

See IEC 60115-1:2020, 7.3, with the following details:

The specimen should be tested mounted on a test board in accordance with 5.2.2, or as specified by the detail specification.

The duration of the endurance test shall be $t_{\text{test}} = 1000^{+24}_0$ h.

See 5.3.25 for the measurement of the insulation resistance of insulated resistors.

5.3.6 Short-term overload

See IEC 60115-1:2020, 8.1, with the following details:

The specimen shall be mounted on a test board in accordance with 5.2.2, or as specified by the detail specification. The test board shall be in free air at the standard atmospheric conditions for testing as given in IEC 60115-1:2020, 5.2.3 (e.g. ambient temperature 15 °C to 35 °C).

The preferred overload test voltage is

$$U_{\text{test}} = 2,5 \times U_r = \sqrt{6,25 \times P_{70} \times R_n},$$

which shall be limited by

$$U_{\text{test}} \leq 2 \times U_{\text{max}},$$

where

- U_r is the rated voltage;
- P_{70} is the rated dissipation;
- R_n is the nominal resistance;
- U_{max} is the limiting element voltage.

The overload duration is a function of the resistor style.

The detail specification shall specify the values for the overload duration t_{load} , preferably from the following preferred values: 0,5 s; 1 s; 2 s; 5 s and 10 s. A relative tolerance of +5 % shall apply to the overload duration.

5.3.7 Single-pulse high-voltage overload test

See IEC 60115-1:2020, 8.2.

The specimen should be mounted on a test board in accordance with 5.2.2, or as specified by the detail specification.

The test shall be performed with pulses defined by:

Pulse shape: 10/700

Pulse peak voltage: $\hat{U}_{\text{test}} = x \times \sqrt{P_{70} \times R_n}$, with $x \geq 10$,

which shall be limited by $\hat{U}_{\text{test}} \leq y \times U_{\text{max}}$, with $y \geq 2$.

The detail specification shall specify the values for x and y .

NOTE The given minimum values for multipliers, $x = 10$ and $y = 2$, establish the lowest severity No.4 as defined for pulses of shape 10/700 in IEC 60115-1:2020, 8.2.

This test is mandatory only for resistors categorized as level P or R.

5.3.8 Periodic-pulse high-voltage overload test

See IEC 60115-1:2020, 8.3, with the following details:

The specimen shall be mounted on a test board in accordance with 5.2.2, or as specified by the detail specification. The test board should be mounted vertically with the specimens positioned in a horizontal level and shall be in free air at the standard atmospheric conditions for testing as given in IEC 60115-1:2020, 5.2.3 (e.g. ambient temperature 15 °C to 35 °C).

NOTE Vertical setting of the test board is likely to result a better harmonized temperature distribution of the test specimens.

The preferred square pulse overload test voltage is, as specified as severity 3:

$$\hat{U}_{\text{test}} = \sqrt{25 \times P_{70} \times R_n},$$

which shall be limited by

$$\hat{U}_{\text{test}} \leq 3 \times U_{\text{max}}$$

where

P_{70} is the rated dissipation;

R_n is the nominal resistance;

U_{max} is the limiting element voltage.

Duration of the test: $t_{\text{test}} = 100^{+5}_0$ h;

Pulse duration: $t_{\text{pulse}} = 100$ µs;

Pulse frequency: $f_{\text{pulse}} = 400$ Hz.

The detail specification may specify a higher overload factor than the 25 given in severity 3. In such a case, the test duration of 100 h and the pulse duration of 100 µs shall be maintained and the pulse frequency shall be adjusted in order to establish a mean dissipation of the pulse sequence of 100 % of the rated dissipation P_{70} . See the preferred alternative overload conditions given in Table 8.

Table 8 – Preferred aggravated overload conditions

Severity	Peak load $\hat{P}$ W	Pulse voltage $\hat{U}_{\text{test}}$ V	Pulse duration t_{pulse} μs	Pulse frequency f_{pulse} Hz
3a	$40 \times P_r$	$\sqrt{40 \times P_r \times R_n}$	100	250
3b	$63 \times P_r$	$\sqrt{63 \times P_r \times R_n}$	100	160
3c	$100 \times P_r$	$\sqrt{100 \times P_r \times R_n}$	100	100
3d	$160 \times P_r$	$\sqrt{160 \times P_r \times R_n}$	100	63
3e	$250 \times P_r$	$\sqrt{250 \times P_r \times R_n}$	100	40
3f	$400 \times P_r$	$\sqrt{400 \times P_r \times R_n}$	100	25
3g	$630 \times P_r$	$\sqrt{630 \times P_r \times R_n}$	100	16
3h	$1\,000 \times P_r$	$\sqrt{1\,000 \times P_r \times R_n}$	100	10

This test is mandatory only for resistors categorized as level P or R.

5.3.9 Electrostatic discharge (ESD) test

See IEC 60115-1:2020, 8.5, with the following details:

The specimen should be tested mounted on a test board in accordance with 5.2.2, or as specified by the detail specification.

The ESD test voltage is a function of the resistor style. The detail specification shall specify the values for the test voltage U_{HBM} , preferably from the preferred values given in IEC 60115-1:2020, 8.5.4. A relative tolerance of $\pm 2\%$ shall apply to the test voltage.

An equal number of discharges with positive polarity, n_{pos} , and with negative polarity, n_{neg} , shall be applied to the specimens, where

$$n_{\text{pos}} = n_{\text{neg}} = 3 \quad \text{for all resistor category levels.}$$

The minimum time between any two discharges shall be 1 s.

5.3.10 Visual examination

See IEC 60115-1:2020, 9.1

The resistor body and its terminations shall undergo visual examination.

The items required to be marked on marked resistors in accordance with 7.1 shall be verified by visual examination.

5.3.11 Gauging of dimensions

See IEC 60115-1:2020, 9.2, with the following details:

The length, height and width (or diameter) of the resistor body and of the terminations shall be gauged.

The length of the resistor body shall be assessed in accordance with IEC 60294:2012, 3.1.

The diameter of the resistor body shall be gauged in accordance with IEC 60294:2012, Clause 5. A similar approach shall be used for a non-cylindrical resistor body.

5.3.12 Detail dimensions

See IEC 60115-1:2020, 9.3, with the following details:

All dimensions specified by the detail specification shall be measured.

For measurement of the length of the resistor body, a gauge plate in accordance with IEC 60294:2012, 3.1 shall be used.

5.3.13 Shear (adhesion) test

See IEC 60115-1:2020, 9.7, with the following details:

Unless otherwise specified in the relevant detail specification, the appropriate force given in Table 9 shall be applied to the surface mount resistor body.

This test is mandatory only for rectangular, transverse and cylindrical resistors (styles RR, RT, RC). The applicability of this test for wire-wound resistors (style RW) and the required test forces shall be determined by the relevant specification.

Table 9 – Shear test force

Style			Force ^a N
Rectangular resistors (styles RR)	Transverse resistors (styles RT)	Cylindrical resistors (styles RC)	
RR0402M	—	—	1
RR0603M	—	—	2
RR1005M	—	—	3
RR1608M	—	RC1610M	5
	RT0510M	—	7
RR2012M	—	RC2012M RC2211M	9
RR3216M RR3225M	RT0816M RT1220M	RC3514M RC3715M	25
RR4532M RR5025M RR6332M	—	—	45
—	RT3245M RT1632M RT2550M RT3263M	RC5922M RC6123M	90

^a A relative tolerance of 0/+10 % applies to the specified shear test forces.

5.3.14 Substrate bending test

See IEC 60115-1:2020, 9.8, with the following details:

Deflection: $d = (2 \pm 0,2) \text{ mm}$

Deflection holding time: $t_{\text{hold}} = (20 \pm 1) \text{ s}$

Number of deflections: $n = 3$

5.3.15 Shock

See IEC 60115-1:2020, 9.10, with the following details:

Pulse shape:	half-sine
Peak acceleration, d :	$50 g_n$ (500 m/s ²)
Duration of pulse, t_p :	11 ms
Number of pulses, n :	3 per axis and direction

This test is mandatory only for wire-wound resistors (style RW) unless otherwise stated in the detail specification.

5.3.16 Vibration

See IEC 60115-1:2020, 9.11, with the following details:

The method to be employed is endurance by sweeping in accordance with IEC 60068-2-6:2007, 8.3.1, with the specimens mounted in such a way that they are not exposed to resonances, and with the following details:

Frequency range:	$f_1 = 10$ Hz to $f_2 = 2\,000$ Hz;
Amplitude:	$\hat{a} = 200$ m/s ² , limited by $d = 1,5$ mm;
Duration:	$n = 10$ sweep cycles in each axis (x, y, z), resulting in a test duration $t_{load} = 2,5$ h per axis.

This test is mandatory only for resistors categorized as level P or R.

5.3.17 Rapid change of temperature

See IEC 60115-1:2020, 10.1, with the following details:

Lower temperature:	$\vartheta_{inf} = LCT$
Upper temperature:	$\vartheta_{sup} = UCT$
Number of cycles:	$n = 5$

5.3.18 Rapid change of temperature, ≥ 100 cycles

See IEC 60115-1:2020, 10.1, with the following details:

Lower temperature:	$\vartheta_{inf} = LCT$
Upper temperature:	$\vartheta_{sup} = UCT$
Number of cycles:	preferred values for n are 100; 200; 500 and 1 000

The detail specification may specify different values for n depending on the properties and capabilities of the individual style.

This test is mandatory only for resistors categorized as level P or R.

5.3.19 Climatic sequence

5.3.19.1 General

See IEC 60115-1:2020, 10.3

The specimen should be mounted on a test board in accordance with 5.2.2, or as specified by the detail specification.

5.3.19.2 Dry heat

IEC 60115-1:2020, 10.3.4.2

The test specimens may be introduced directly into the heated chamber at any temperature from laboratory temperature to the upper category temperature, and withdrawn directly from it, since the effects of the sudden change of temperature are not known to be detrimental to the test specimen.

5.3.19.3 Damp heat, cyclic, first cycle

See IEC 60115-1:2020, 10.3.4.3

5.3.19.4 Cold

See IEC 60115-1:2020, 10.3.4.4

The test specimens may be introduced directly into the cooled chamber at any temperature from the lower category temperature to laboratory temperature, and withdrawn directly from it, since the effects of the sudden change of temperature are not known to be detrimental to the test specimen.

Precaution against condensation of moisture on the test specimen is required if the specimens are inserted into the test chamber at a temperature below laboratory temperature.

5.3.19.5 Low air pressure

See IEC 60115-1:2020, 10.3.4.5, with the following details:

Air pressure: $p_{\text{amb}} = 8 \text{ kPa}$, for resistors categorized as level G, or
 $p_{\text{amb}} = 1 \text{ kPa}$, for resistors categorized as level P or R.

NOTE According to ISO 2533, the air pressure of 1 kPa represents an approximate altitude of 31 200 m above sea level, and the air pressure of 8 kPa represents an approximate altitude of 17 600 m above sea level.

5.3.19.6 Damp heat, cyclic, additional cycles

See IEC 60115-1:2020, 10.3.4.6.

The number of additional cycles is ruled by the climatic category and given in IEC 60115-1:2020, Table 20.

5.3.19.7 DC load

See IEC 60115-1:2020, 10.3.4.7.

5.3.19.8 Final measurements

See IEC 60115-1:2020, 10.3.5.

See 5.3.25 for the measurement of the insulation resistance of insulated resistors.

5.3.20 Damp heat, steady state

NOTE This test is also known as "40/93 test", or as "load humidity test" with no obvious discrimination from the "85/85 test" covered in 5.4.4

See IEC 60115-1:2020, 10.4, with the following details:

The specimen should be mounted on a test board in accordance with 5.2.2, or as specified by the detail specification.

The duration t_{exp} of this test is determined by the climatic category; see IEC 60115-1:2020, Table 21.

See 5.3.25 for the measurement of the insulation resistance of insulated resistors.

5.3.21 Solderability, with lead-free solder

See IEC 60115-1:2020, 11.1, with the following details:

The solderability test shall be preceded by an accelerated ageing. Unless specified different by the detail specification, ageing 3a (i.e. 4 h at 155 °C dry heat, see IEC 60115-1:2020, Table 27) shall be employed. After the accelerated ageing, the specimen shall be subjected to the standard atmospheric conditions for testing for a duration in the range of 2 h to 24 h.

A variety of lead-free solder alloys is applicable for the assembly of fixed surface mount resistors, with their own process temperature requirements and their typical soldering method, see IEC 60115-1:2020, 11.1.4.3.

Solderability testing for group 3 shall employ the solder bath method, see IEC 60115-1:2020, Table 29, Method 1, with the following details:

Solder alloy: Sn96,5Ag3,0Cu0,5;
Bath temperature: $\vartheta_{\text{bath}} = (245 \pm 3) ^\circ\text{C}$;
Immersion time: $t_{\text{imm}} = (3 \pm 0,3) \text{ s}$.

A thermal insulating screen may be used only if specified by the detail specification.

This test should not be applied if the relevant detail specification explicitly excludes compatibility of the components covered therein with any lead-free soldering process.

5.3.22 Solderability, with SnPb solder

See IEC 60115-1:2020, 11.1, with the following details:

The solderability test shall be preceded by an accelerated ageing. Unless specified different by the detail specification, Ageing 3a (i.e. 4 h at 155 °C dry heat, see IEC 60115-1:2020, Table 27) shall be employed. After the accelerated ageing, the specimen shall be subjected to the standard atmospheric conditions for testing for a duration in the range of 2 h to 24 h.

A variety of lead-free solder alloys is applicable for the assembly of fixed surface mount resistors, with their own process temperature requirements and their typical soldering method, see IEC 60115-1:2020, 11.1.4.3.

Solderability testing for group 2 shall employ the solder bath method, see IEC 60115-1:2020, Table 29, Method 1, with the following details:

Solder alloy: Sn60Pb40 or Sn63Pb37
Bath temperature: $\vartheta_{\text{bath}} = (235 \pm 3) ^\circ\text{C}$
Immersion time: $t_{\text{imm}} = (2 \pm 0,2) \text{ s}$

A thermal insulating screen may be used only if specified by the detail specification.

This test normally is applicable also to components with lead-free termination plating, since most of these platings are compatible with a lead-bearing solder process, too. This test however shall not be applied if the relevant detail specification explicitly excludes compatibility of the components covered therein with a traditional soldering process using lead-bearing solder (SnPb).

5.3.23 Resistance to soldering heat

See IEC 60115-1:2020, 11.2, with the following details:

Resistors shall be capable of withstanding the full variety of soldering processes described in IEC 61760-1, unless explicitly stated otherwise in the relevant detail specification:

- SnPb vapour phase reflow soldering;
- lead-free vapour phase reflow soldering;
- SnPb infrared or forced gas convection reflow soldering;
- lead-free infrared or forced gas convection reflow soldering;
- SnPb double wave soldering;
- lead-free double wave soldering.

Resistance to soldering heat for the combination of all soldering methods shall be tested with the worst-case condition from IEC 60068-2-58:2015, 8.2.1 and IEC 60068-2-58:2015, 8.1.1:

Solder alloy: any alloy, SnPb or SnCu or SnAgCu or SnAg

Bath temperature: $\vartheta_{\text{bath}} = (260 \pm 5) ^\circ\text{C}$

Immersion time: $t_{\text{imm}} = (10 \pm 1) \text{ s}$

5.3.24 Solvent resistance

See IEC 60115-1:2020, 11.3, with the following detail:

Method: Method 1: with rubbing

Solvent: Isopropyl alcohol (IPA)

Solvent temperature: $\vartheta_{\text{bath}} = (23 \pm 5) ^\circ\text{C}$ or $\left(50 \begin{smallmatrix} 0 \\ -5 \end{smallmatrix}\right) ^\circ\text{C}$.

Soak time: $t_{\text{imm}} = (5 \pm 0,5) \text{ min}$

Rubbing device: Wad of cotton wool, or toothbrush, as stated in the detail specification.

Number of strokes: $n = 10$.

NOTE The bath temperature of $23 ^\circ\text{C}$ is preferred in some regions owing to safety concerns about the bath at $50 ^\circ\text{C}$.

5.3.25 Insulation resistance

This test shall be applied only to insulated resistors.

See IEC 60115-1:2020, 12.1.

A suitable method given in IEC 60115-1:2020, 12.1 shall be applied for measurement of the insulation resistance, preferably the parallel clamp method of IEC 60115-1:2020, 12.1.3.5 for rectangular SMD resistors and V-clamp method of IEC 60115-1:2020, 12.1.3.6 for cylindrical SMD resistors.

5.3.26 Voltage proof

This test shall be applied only to insulated resistors.

See IEC 60115-1:2020, 12.2.

A suitable method given in IEC 60115-1:2020, 12.2 shall be applied for the voltage proof test, preferably the parallel clamp method given in IEC 60115-1:2020, 12.1.3.5 for rectangular SMD resistors and V-clamp method given in IEC 60115-1:2020, 12.1.3.6 for cylindrical SMD resistors.

5.3.27 Flammability test

The needle-flame test according to IEC 60115-1:2020, 12.4 shall be applied with the following detail:

Duration of flame application: $t_a = 10_{-1}^0$ s.

5.4 Optional and/or additional tests

5.4.1 Single-pulse high-voltage overload test

This test presents as an alternative set of severities for the single-pulse high-voltage overload test of 5.3.7, using the pulse shape 1,2/50.

See IEC 60115-1:2020, 8.2.

The specimen should be mounted on a test board in accordance with 5.2.2, or as specified by the detail specification. The test board shall be in free air at the standard atmospheric conditions for testing. The test shall be performed with pulses defined by:

Pulse shape: 1,2/50

Pulse peak voltage: $\hat{U}_{\text{test}} = x \times \sqrt{P_{70} \times R_n}$, with $x \geq 20$,

which shall be limited by $\hat{U}_{\text{test}} \leq y \times U_{\text{max}}$, with $y \geq 5$.

The detail specification shall specify the values for x and y .

The single-pulse high-voltage overload test of 5.4.1 is recommended only for resistors categorized as level P or R.

If this test is applied in an advanced test schedule, the specimens shall be inspected for visual defects and for the occurred change of resistance. The requirement for the permissible resistance change shall be stated in the clause on performance requirements of the detail specification, preferably added to the table on limits for the change of resistance during tests.

5.4.2 Periodic-pulse overload test

This test is a legacy test method which has been employed by traditional specifications of leaded fixed low-power non-wire-wound (i.e. film) resistors. This test should only be used in specifications that require a strict continuance of historical test requirements. In this case it should replace the periodic-pulse high-voltage overload test of 5.3.8.

The overall severity of this test is considered inadequate in light of the capabilities of current products and of typical application requirements. The deficiency is recognizable by the low peak load, the mean dissipation being lower than the specimens' rated dissipation, and the limited number of applied pulses.

See IEC 60115-1:2020, 8.4, with the following details:

The specimen should be mounted on a test board in accordance with 5.2.2, or as specified in the detail specification. The test board shall be in free air at the standard atmospheric conditions for testing as given in IEC 60115-1:2020, 5.2.3 (e.g. ambient temperature 15 °C to 35 °C).

The preferred pulse overload test voltage is

$$\hat{U}_{\text{test}} = \sqrt{15 \times P_{70} \times R_n},$$

which shall be limited by

$$\hat{U}_{\text{test}} \leq 2 \times U_{\text{max}}$$

where

P_{70} is the rated dissipation,

R_n is the nominal resistance,

U_{max} is the limiting element voltage.

The duration of the test is determined by the following details:

Number of pulse cycles: $n = 1\,000$,

On-state duration: $t_{\text{on}} = 0,1\text{ s}$, and

Off-state duration: $t_{\text{off}} = 2,5\text{ s}$ within each pulse cycle.

If this test is applied in an advanced test schedule, the specimens shall be inspected for visual defects and for the occurred change of resistance. The requirement for the permissible resistance change shall be stated in the clause on performance requirements of the detail specification, preferably added to the table on limits for the change of resistance during tests.

5.4.3 Operation at low temperature

This test is presented as a supplement to the passive cold test of the climatic sequence of 5.3.19 and IEC 60115-1:2020, 10.3, which remains a mandatory part of all test schedules under the scope of this document.

See IEC 60115-1:2020, 10.2, for the details of this test.

If this test is applied in an advanced test schedule, the specimens shall be inspected for visual defects and for the occurred change of resistance. The requirement for the permissible resistance change shall be stated in the clause on performance requirements of the detail specification, preferably added to the table on limits for the change of resistance during tests.

5.4.4 Damp heat, steady state, accelerated

NOTE This test is also known as "85/85 test", or as "load humidity test" with no obvious discrimination from the "40/93 test" covered in 5.3.20.

This test is presented as a supplement to the damp heat, steady state test of 5.3.20 and IEC 60115-1:2020, 10.4, which remains a mandatory part of all test schedules under the scope of this document.

See IEC 60115-1:2020, 10.5, with the following details:

In order to follow the recommendation for this test of IEC 60068-2-67:1995, B.2 a) about limiting the temperature increase to below 2 K, the test shall be performed with a bias of 10 % of the rated voltage U_r ; see DC bias voltage option a) of IEC 60115-1:2020, Table 23.

For practical simplification, the test may be performed with the grouped DC bias voltages as given in IEC 60115-1:2020, 10.5.4.2.

See 5.3.25 for the measurement of the insulation resistance of insulated resistors.

If this test is applied in an advanced test schedule, the specimens shall be inspected for visual defects, and for the occurred change of resistance. Insulated resistors shall also be inspected for the insulation resistance. The requirement for the permissible resistance change shall be stated in the clause on performance requirements of the detail specification, preferably added to the table on limits for the change of resistance during tests.

6 Performance requirements

6.1 General

Test severities and requirements specified by detail specifications referring to this sectional specification shall be of equal or superior performance level. Inferior performance levels are not permitted.

The severities for the tests shall be specified by the detail specifications, following the specifications of the generic specification IEC 60115-1 and Clause 5 of this sectional specification.

6.2 Limits for change of resistance at tests

Table 10 lists preferred limits for resistance change for all tests listed in the column headings. To classify the performance of resistors, the resistance change limits are assigned to stability classes. The performance requirements specified by the detail specification shall be based on a suitable selection of these stability classes and the assigned preferred limits.

Limits for resistance change are generally expressed as the sum of an absolute deviation, a , and a relative deviation, $p \times R$:

$$\Delta R = p \times R + a$$

where the dimensionless real number p typically is expressed as a percentage.

NOTE The sum of an absolute and a relative share reflects the nature of some resistance change mechanisms being linked with the actual resistance value, and some others being independent of it.

Another historic background of an absolute deviation is probably related to the uncertainty of low resistance measurements, for whatever low resistance was available then. The improvement of measurement capabilities over time suggests the absolute deviation has become redundant. These improvements, however, do not waive the absolute share of resistance change mechanisms.

An equal share of absolute and relative deviations applies for

$$R' = \frac{a}{p}$$

For low ohmic resistors with $R < R'$, the relative share loses significance versus the absolute share. For $R \ll R'$, the dominant absolute deviation reaches the same order of magnitude as the tested resistance R , or may even exceed R , which may render such stability requirement to appear mismatched with the general qualities of the resistor. Hence the writers of detail

specifications are advised to consider a reasonable absolute deviation for the range of low resistance to be covered, which may be less than any proposal presented in Table 10.

EXAMPLE 1 Applying a permitted resistance change of $\Delta R = \pm(0,5 \% R + 50 \text{ m}\Omega)$ to a resistance range extending down to $100 \text{ m}\Omega$ renders the permissible change to be $\pm 50,5 \%$ at the lower range limit. Component users will probably expect a much better stability; hence, the specification writers are advised to use a lower permitted absolute deviation for such cases.

For high ohmic resistors with $R > R'$, the absolute share loses significance versus the relative share; for example, at $R = 100 \times R'$, the absolute share amounts to only 1% of the relative share. For clarity of presentation, such insignificant absolute share should no longer be presented nor applied.

EXAMPLE 2 Applying a permitted resistance change of $\Delta R = \pm(0,5 \% R + 50 \text{ m}\Omega)$ results in an equal share of deviation for $R' = 10 \Omega$. At $1 \text{ k}\Omega$, the absolute share is only a mere $0,005 \% R$, which is 1% of the relative share, and which can hardly be essential for the quality assessment of the resistors. Therefore, it will only confuse the readers of specifications or related test reports if the absolute share is still presented and applied for any $R \geq 1 \text{ k}\Omega$.

Table 10 – Limits for the change of resistance at tests

Stability class	Limit of resistance change, ΔR Ω					
	Long term tests		Short term tests		Advanced stress tests	
	IEC 60115-1:2020, 7.3 Endurance at a maximum temperature: UCT	IEC 60115-1:2020, 7.1 Endurance at the rated temperature 70 °C, 1 000 h	Extended, 8 000 h ^a	IEC 60115-1:2020, 8.1 Short-term Overload	IEC 60115-1:2020, 10.1 Rapid change of temperature, ≥ 100 cycles ^a	IEC 60115-1:2020, 8.2 Single-pulse high-voltage overload test ^a
	10.3 Climatic sequence			9.8 Substrate bending test	8.5 Electrostatic discharge ^b	8.3 Periodic-pulse high-voltage overload test ^a
	10.4 Damp heat, steady state			9.10 Shock ^d		8.4 Periodic-pulse overload test ^c
				9.11 Vibration ^a		
				10.1 Rapid change of temperature, 5 cycles		
				11.2 Resistance to soldering heat		
5	$\pm(5\% R + 0,1 \Omega)$	$\pm(5\% R + 0,1 \Omega)$	$\pm(10\% R + 0,1 \Omega)$	$\pm(1\% R + 0,05 \Omega)$	$\pm(1\% R + 0,05 \Omega)$	$\pm(2\% R + 0,05 \Omega)$
2	$\pm(2\% R + 0,1 \Omega)$	$\pm(2\% R + 0,1 \Omega)$	$\pm(5\% R + 0,1 \Omega)$	$\pm(0,5\% R + 0,05 \Omega)$		
1	$\pm(1\% R + 0,05 \Omega)$	$\pm(1\% R + 0,05 \Omega)$	$\pm(2\% R + 0,05 \Omega)$	$\pm(0,25\% R + 0,05 \Omega)$	$\pm(0,5\% R + 0,05 \Omega)$	
0,5	$\pm(0,5\% R + 0,05 \Omega)$	$\pm(0,5\% R + 0,05 \Omega)$	$\pm(1\% R + 0,05 \Omega)$	$\pm(0,1\% R + 0,01 \Omega)$		
0,25	$\pm(0,25\% R + 0,05 \Omega)$	$\pm(0,25\% R + 0,05 \Omega)$	$\pm(0,5\% R + 0,05 \Omega)$	$\pm(0,05\% R + 0,01 \Omega)$		
0,1	$\pm(0,1\% R + 0,02 \Omega)$	$\pm(0,1\% R + 0,02 \Omega)$	$\pm(0,25\% R + 0,02 \Omega)$	$\pm(0,05\% R + 0,01 \Omega)$	$\pm(0,25\% R + 0,05 \Omega)$	$\pm(1\% R + 0,05 \Omega)$
0,05	$\pm(0,05\% R + 0,01 \Omega)$	$\pm(0,05\% R + 0,01 \Omega)$	$\pm(0,1\% R + 0,01 \Omega)$	$\pm(0,025\% R + 0,01 \Omega)$		
0,025	$\pm(0,025\% R + 0,01 \Omega)$	$\pm(0,025\% R + 0,01 \Omega)$		$\pm(0,01\% R + 0,01 \Omega)$		
^a This test is mandatory only for resistors categorized as level P or as level R.						
^b See 5.3.9 for the applicability of this test.						
^c This test is optional, see the respective subclause of 5.4.						
^d This test is optional and not applicable for general surface mount resistors (RR, RT and RC resistors) unless otherwise requested by the detail specification.						

6.3 Temperature coefficient of resistance

Table 11 lists preferred limits for the reversible resistance change at the temperature coefficient of resistance test according to IEC 60115-1:2020, 6.2, and 5.3.2 of this document. The performance requirements specified in the detail specification shall be based on a suitable selection of these preferred limits.

Each row of Table 11 presents a preferred temperature coefficient of resistance (TCR) with the limits for the change of resistance at the various category temperatures used within this document.

Table 11 – Permitted change of resistance due to the variation of temperature

Temperature coefficient ^a		Limit of resistance change $\Delta R/R$ %								
		Cold TCR				Hot TCR				
		Lower category temperature / Reference temperature				Reference temperature / Upper category temperature				
$10^{-6}/K$	Code ^b	$-55^{\circ}C / 20^{\circ}C$	$-40^{\circ}C / 20^{\circ}C$	$-25^{\circ}C / 20^{\circ}C$	$-10^{\circ}C / 20^{\circ}C$	$20^{\circ}C / 85^{\circ}C$	$20^{\circ}C / 125^{\circ}C$	$20^{\circ}C / 155^{\circ}C$	$20^{\circ}C / 175^{\circ}C$	$20^{\circ}C / 200^{\circ}C$
±1 000	W	±7,50	±6,00	±4,50	±3,00	±6,50	±10,50	±13,50	±15,50	±18,00
±500	V	±3,75	±3,00	±2,25	±1,50	±3,25	±5,25	±6,75	±7,75	±9,00
±250	U	±1,875	±1,500	±1,125	±0,750	±1,625	±2,625	±3,375	±3,875	±4,500
±100	S	±0,750	±0,600	±0,450	±0,300	±0,650	±1,050	±1,350	±1,550	±1,800
±50	R	±0,375	±0,300	±0,225	±0,150	±0,325	±0,525	±0,675	±0,775	±0,900
±25	Q	±0,188	±0,150	±0,113	±0,075	±0,163	±0,263	±0,338	±0,388	±0,450
±15	P	±0,113	±0,090	±0,068	±0,045	±0,098	±0,158	±0,203	±0,233	±0,270
±10	N	±0,075	±0,060	±0,045	±0,030	±0,065	±0,105	±0,135	±0,155	±0,180
±5	M	±0,038	±0,030	±0,023	±0,015	±0,033	±0,053	±0,068	±0,078	±0,090
±2	L	±0,015	±0,012	±0,009	±0,006	±0,013	±0,021	±0,027	±0,031	±0,036
±1	K	±0,008	±0,006	±0,005	±0,003	±0,007	±0,011	±0,014	±0,016	±0,018
^a If additional temperature coefficients are required, these shall be specified by the detail specification, where the applicable coding in accordance with IEC 60062 for the next larger TCR shall be applied. ^b Code letters in accordance with IEC 60062:2016, 7.2.										

6.4 Temperature rise

The permissible temperature rise $\Delta\vartheta_{\max}$ for the temperature rise test according to IEC 60115-1:2020, 6.7 and 5.3.3 of this document is determined by

$$\Delta\vartheta_{\max} = \text{MET} - 70^{\circ}C$$

where

MET is the maximum element temperature.

6.5 Visual examination

6.5.1 General visual criteria

The detail specification shall specify acceptance criteria for the visual examination of the resistor body and its terminations. These acceptance criteria shall consider the following information:

- the general criteria given in IEC 60115-1:2020, 9.1.3, list items a) through d); and
- the illustrated examples for specific criteria, applicable to resistors from the scope of this sectional specification, given in Annex B of this document.

The detail specification shall specify acceptance criteria for the visual examination of the marking of the items stated in 7.1 of this document. These acceptance criteria shall consider the following information:

- the general criteria given in IEC 60115-1:2020, 9.1.3, list item e); and
- the illustrated examples for specific criteria, applicable to resistors from the scope of this sectional specification, given in Annex B of this document.

6.5.2 Visual criteria after tests

Unless more specific requirements are specified in the relevant specification for the visual examination after tests, the following criteria shall apply:

- there shall not be any visible damage to the resistor body and to its terminations after the test, except for an acceptable discolouration after endurance tests; and
- the required marking of marked resistors shall be legible after the test, except after extended duration endurance tests.

6.5.3 Visual criteria for the packaging

Unless more specific requirements are specified in the relevant specification for the visual examination of the packaging, the following criteria shall apply:

- for the primary packaging,
 - the top and bottom tapes shall be properly aligned in order not to expose adhesive;
 - the adhesives of the top and bottom tapes shall not be attached to the resistors;
 - the resistors shall not protrude from the tapes (top, bottom and carrier);
 - the top and bottom tapes shall not cover the sprocket holes of the carrier tape;
 - the tapes shall not be spliced;
 - the resistor shall not be flipped over in the tape pockets;
- for the proximity packaging,
 - the inner width of the reel shall fit snugly around the outer tape width, however without jamming the tape at its extraction;
 - the marking applied to the box or reel shall present all details as required by 7.3 and shall not be blurred or crumpled.

6.6 Solderability

See IEC 60115-1:2020, 11.1.5 and 11.1.6.

The requirement for the visual examination for the assessment of good solderability shall be:

≥ 95 % of the surface shall be covered with new solder. The new solder shall show no more than small amounts of scattered imperfections, such as pinholes or non-wetted or dewetted areas. These imperfections shall not be concentrated in one area.

6.7 Insulation resistance

The requirements of this clause only apply to insulated resistors.

The insulation resistance R_{ins} shall be not less than 1 GΩ in the test IEC 60115-1:2020, 12.1 in group 3 of the test schedule for the qualification approval.

The insulation resistance R_{ins} shall be not less than 1 GΩ after any of the following tests:

- endurance at the rated temperature 70 °C test in accordance with IEC 60115-1:2020, 7.1; and
- endurance at a maximum temperature: UCT test in accordance with IEC 60115-1:2020, 7.3;

and not less than 100 MΩ after any of the following tests:

- climatic sequence test in accordance with IEC 60115-1:2020, 10.3; and
- damp heat, steady state test in accordance with IEC 60115-1:2020, 10.4; and
- damp heat, steady state, accelerated test in accordance with IEC 60115-1:2020, 10.5.

6.8 Flammability

See IEC 60115-1:2020, 12.4.5 and IEC 60115-1:2020, 12.4.6.

The duration of burning, t_b , shall not exceed 30 s.

7 Marking, packaging and ordering information

7.1 Marking of the component

Surface mount resistors are generally not marked on the body.

However, if some marking is applied to the body, the resistor shall be marked with the resistance in accordance with IEC 60062:2016, Clause 3, IEC 60062:2016, Clause 4 and as many as possible of the remaining items listed in IEC 60115-1:2020, 4.4.

All the required information shall be marked on the packaging.

7.2 Packaging

Wherever applicable, the resistors shall be taped for automatic handling in accordance with the provisions of IEC 60286-3.

The packaging shall undergo visual examination.

7.3 Marking of the packaging

The complete required information as listed in IEC 60115-1:2020, 4.5 shall be marked on the proximity packaging.

7.4 Ordering information

The detail specification should specify the following minimum information as required for the ordering of resistors:

- the number of the detail specification and style reference;
- resistance, the tolerance on resistance and, if applicable, the temperature coefficient of resistance. Wherever applicable, an alphanumeric coding given in IEC 60062 shall be used.

The detail specification should specify the special ordering information for 0 Ω resistors, if these parts are a supplementary part of the product family covered by it.

Special variants of the products covered by a detail specification may be identified by means of an optional suffix to the standard ordering information.

The packaging and form of delivery of the resistors are usually not an integral part of the ordering information, hence the packaging needs to be specified separately in an ordering process. This focuses the entries of the bills of material to the technically relevant specifications, separated from the mere logistical information.

The recommendations of this clause shall be applied as mandatory provisions for detail specifications covering products classified to level P or level R.

The ordering information used for electronic order processing shall not contain any spaces.

8 Detail specifications

8.1 General

Detail specifications shall be derived from the relevant blank detail specification.

Detail specifications shall not specify requirements inferior to those of the generic specification, sectional specification or blank detail specification. When more severe requirements are included, they shall be listed in a respective clause of the detail specification and indicated in the test schedules, for example by a note.

The information listed in 8.2 shall be given in each detail specification and the specified values shall be selected from those given in the appropriate clause of this sectional specification.

8.2 Information to be specified in a detail specification

8.2.1 Outline drawing or illustration

There shall be an outline drawing or illustration of the resistor as an aid to easy recognition and for comparison of the resistor with others.

8.2.2 Style and dimensions

See 4.2.

All dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification, using a dedicated outline and dimensions drawing.

A suitable measurement method shall be adequately specified, and the relevant maximum permissible dimension shall be specified in the table of dimensions.

The mass of the products may be given for information.

8.2.3 Climatic category

See 4.3.

8.2.4 Resistance range

See 4.4.

If products approved to the detail specification have different ranges, the following statement should be added: "The range of values available in each style, together with the associated tolerance and temperature coefficient, is given in the register of approvals, available for example on the website www.iecq.org".

8.2.5 Tolerances on resistance

See 4.5.

If products approved to the detail specification have different ranges, the following statement should be added: "The range of values available in each style, together with the associated tolerance and temperature coefficient, is given in the register of approvals, available for example on the website www.iecq.org".

8.2.6 Rated dissipation P_{70}

See 4.6.

The detail specification shall state the maximum allowable dissipation P_{70} at an ambient temperature of 70 °C (i.e. the rated temperature).

The detail specification shall state the maximum dissipation at temperatures other than 70 °C, i.e. the derating, either in a diagram or in the form of a statement.

8.2.7 Limiting element voltage $U_{\max}$

See 4.7 and the definition given in IEC 60115-1:2020, 3.1.

8.2.8 Insulation voltage U_{ins}

This information is required for insulated resistors only.

See 4.8 and the definition given in IEC 60115-1:2020, 3.1.

8.2.9 Insulation resistance R_{ins}

This information is required for insulated resistors only.

See 4.9 and 6.7.

8.2.10 Test severities

See 5.3. and, where applicable, 5.4.

8.2.11 Limits of resistance change after testing

See 6.2.

8.2.12 Temperature coefficient of resistance

See 6.3.

8.2.13 Marking

See 7.1 for the marking of the resistors.

See 7.3 for the marking of the packaging.

8.2.14 Ordering information

See 7.4.

8.2.15 Mounting

The detail specification shall give guidance on methods of mounting for normal use. Such guidance may be based on the specifications of assembly process conditions given in IEC 61760-1:2020, Clause 5, for the specification of SMD components.

Mounting required for test and measurement purposes should be in accordance with the provisions of 5.2.

8.2.16 Storage

See IEC 60115-1:2020, 4.9.

The detail specification shall specify the permissible duration of storage and, if required, periodicity, method and requirements of a re-examination to be applied.

8.2.17 Transportation

See IEC 60115-1:2020, 4.10

8.2.18 Additional information

The detail specification may include additional information (which is not normally required to be verified by the inspection procedure), such as circuit diagrams, curves, drawings and notes needed for the clarification of the detail specification.

8.2.19 Quality assessment procedures

The detail specification shall provide complete test schedules for the qualification approval and for the quality conformance inspection of the resistors covered therein.

8.2.20 0 Ω Resistors

The detail specification may provide all information required for the specification and for the quality assessment of 0 Ω resistors, see Annex D.

9 Quality assessment procedures

9.1 General

See IEC 60115-1:2020, Annex Q.

9.2 Definitions

9.2.1 Primary stage of manufacture

See IEC 60115-1:2020, Q.1.3.1

For fixed surface mount resistors, the primary stage of manufacture is the deposition of the resistive film on the substrate.

9.2.2 Structurally similar components

See IEC 60115-1:2020, Q.1.3.2

Fixed surface mount resistors are accepted as being structurally similar

- a) if they are manufactured at one or several manufacturing sites
 - within the same product technology; and
 - using the same specified raw-materials, manufacturing and quality inspection procedures; and
 - under the same leading manufacturing site's responsibility for product and quality.

In the case of several manufacturing sites, the manufacturer shall nominate the leading manufacturing site and the associated Designated Management Representative (DMR).
- b) if all manufacturing sites are supervised by the same Certification Body (for example, IECQ CB). Preferably it should be the Certification Body of that country in which the leading manufacturing site is located;
- c) if they have the same stability class and climatic category;
- d) if they are different in dimensions only; and
- e) if they have similar terminal types.

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

The concept of structural similarity may only be employed for resistors categorized as level R, and for the purpose of the evaluation and determination of a failure rate, see IEC 60115-1:2020, Annex R.

9.2.3 Assessment level EZ

See IEC 60115-1:2020, Q.1.3.3

Assessment level EZ shall be applied for the quality assessment of leaded fixed film resistors in a detail specification referring to this sectional specification.

9.3 Formation of inspection lots

An inspection lot shall consist of resistors of the same product technology, type and style.

Where a range of resistors is to be qualified, the distribution of resistance values within the sample shall be as follows:

- 1/3 with the lowest resistance within that range, $R_{\min}$,
to be collected from the range of $R_{\min}$ to $2 \times R_{\min}$,
or the lowest resistance produced within the approval range;

- 1/3 with the critical resistance, R_{crit} ,
to be collected from the range of $0,8 \times R_{crit}$ to R_{crit} ;
- 1/3 with the highest resistance within that range, R_{max} ,
to be collected from the range of $0,7 \times R_{max}$ to R_{max} ,
or the highest resistance produced within the approval range.

The range to be qualified may be a subset of the range covered by the detail specification. If the critical resistance is outside of the range to be qualified, resistors from the middle of the range (near the geometric mean between lowest and highest resistance, e.g. 1 kΩ for a range of 1 Ω to 1 MΩ) shall be used for substitution.

If approval is being sought for more than one temperature coefficient of resistance (TCR), the sample shall contain specimens representative of the different TCRs. In general, a superior TCR is considered representative of any inferior TCR. In a similar manner, the sample shall contain a proportion of specimens of the different resistances having the closest tolerance for which approval is being sought. The proportion of specimens having the different characteristics is subject to the approval of the Certification Body (for example, IECQ CB).

If required for a periodic inspection, an inspection lot should be representative of those extremes of the resistance range produced during the period. Styles of the same nominal dimensions but of different TCR produced during the period may be aggregated, except for the purposes of subgroups which contain a test for the TCR.

The low and high extreme resistances, or any critical resistance of the ranges of resistance and temperature characteristics of resistance for which qualification approval has been granted shall be inspected during a period which is approved by the Certification Body (for example, IECQ CB).

The specimens shall be collected over the last 13 weeks of the inspection period.

9.4 Approved component (IECQ AC) procedures

The provisions of IEC 60115-1:2020, Clause Q.2 shall apply.

9.5 Qualification approval (QA) procedures

9.5.1 General

The procedures for Qualification Approval testing are given and referenced in IEC 60115-1:2020, Clause Q.3.

The sample shall be established in accordance with 9.3.

One spare specimen per resistance and one spare specimen per each temperature coefficient may be used to replace specimens which are defective because of incidents not attributable to the manufacturer.

For mounted specimens, any specimen found defective after mounting shall not be taken into account when calculating the permissible nonconforming items for the succeeding test. They shall be replaced by spare specimens.

9.5.2 Qualification approval

The required total sample size is the sum of all sample sizes in the qualification approval test schedule of Table 6 identified as destructive. If additional groups with destructive tests are introduced into the qualification approval test schedule, the total sample size shall be increased by the number of specimens required for the additional groups.

The test schedule for the qualification approval of resistors is given in Table 12. The schedule offers advice on the applicability of individual tests, which shall be applied in the normative detailed test schedule given by the detail specification. The tests of each group shall be carried out in the given order.

The whole sample except the specimens required for group 4 shall be subjected to the tests of group 1 and group 2 and then be allocated to the other test groups. Specimens found nonconforming during the tests of group 1 or group 2 shall not be used for any other test group.

The qualification approval shall be granted after successful completion of 1 000 h of the test Endurance at 70 °C and all other tests of Table 12.

9.5.3 Quality conformance inspection

The schedule for the lot-by-lot and periodic tests for quality conformance inspection of resistors is given in Table 13.

The schedule offers advice on the applicability of individual tests, which shall be applied in the normative detailed test schedule given by the detail specification. The conditions of tests and the performance requirements shall be the same as those specified for the respective tests in the schedule for qualification approval. The tests of each group shall be carried out in the given order.

9.6 Capability certification (IECQ AC-C) procedures

This sectional specification does not cover the capability approval as described in IEC 60115-1:2020, Clause Q.4.

9.7 Technology certification (IECQ-AC-TC) procedures

The provisions of IEC 60115-1:2020, Clause Q.5 shall apply, and the test schedules of Table 12 and Table 13 shall be used.

9.8 Periodical evaluation of termination plating

The resistor manufacturer should establish a system for the periodical evaluation of the properties of their component's termination plating. A key aspect of these evaluations is the propensity of the solderable surface finishes to grow whiskers.

Such evaluation system should employ suitable test methods for the assessment of the whisker propensity, preferably those of IEC 60068-2-82, as proposed by IEC 60115-1:2020, 10.7.

9.9 Delayed delivery

The provisions of IEC 60115-1:2020, Clause Q.1.8 shall apply, except that the inspection level shall be reduced to S-2.

9.10 Certified test records

Certified test records according to IEC 60115-1:2020, Clause Q.1.6 can be supplied, if agreed between the manufacturer and the customer.

9.11 Certificate of conformity (CoC)

The conformity is declared by marking the packing in accordance with the relevant system rules if components are qualified to this document by a certification body of a quality assessment system (e.g. IECQ, successor of CECC).

An additional certificate of conformity (CoC) is not required for qualified components.