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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



40/2910/CD

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IEC TC 40 : CAPACITORS AND RESISTORS FOR ELECTRONIC EQUIPMENT

SECRETARIAT:

Netherlands

SECRETARY:

Mr Ronald Drenthen

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

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TITLE:

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIXED RESISTORS FOR USE IN ELECTRONIC EQUIPMENT –

**Part 8: Sectional specification:
Fixed surface mount resistors**

FOREWORD

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International Standard IEC 60115-8 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

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

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

- a) the definitions of product technologies and product classification levels of the generic specification, IEC 60115 1:2020, have been adopted
- b) the new style of transverse (RT) resistors have been added in 3.1.5 and 4.2.2 to cover the resistors with wide terminals which has become common in market
- c) the recommended test boards in 5.2.2 has been revised to fit the demands from the market for higher rated power in resistors
- d) the test boards have been revised to be set vertically instead of horizontally during the specified tests to optimize the area and spacing inside the test chamber

- e) the 'period-pulse high-voltage overload test' of IEC 60115-1:2020, 8.3 has been adopted as default test method in 5.3.8, thereby replacing the legacy test 'periodic-pulse overload test' of IEC 60115-1:2020, 8.4
- f) the revised solderability test of IEC 60115-1:2020, 11.1 has been adopted in 5.3.21 and 5.3.22
- g) the combined solvent resistance test of IEC 60115-1:2020, 11.3 has been adopted in 5.3.24
- h) the 'endurance at room temperature test' of IEC 60115-1:2020, 7.2 has been adopted as an optional test in 5.4.1
- i) the '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 5.4.2
- j) 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 5.4.4. and 5.4.5, respectively
- k) new guidance is provided in 6.2 on the presentation of stability requirements with their permissible absolute and relative deviations
- l) acceptance criteria for the visual inspection have been added in 6.5 and in Annex B;
- m) visual inspection for the primary and proximity packaging has been added in 6.5.3 and in 7.2
- n) the periodical evaluation of termination plating has been added as a new topic of quality assessment in 9.8
- o) the revised test clause numbering of IEC 60115 1:2020 has been applied
- p) a normative Annex A has been moved from Annex B of the old version to stay in line with other sectional specifications
- q) an informative Annex C has been added to summarize workmanship requirements for the assembly. However, it is not applicable for general fixed surface mount resistors, so they are omitted but reserved in this document
- r) a normative Annex D has been moved from Annex A of the old version to stay in line with other sectional specifications
- s) an informative Annex E has been added to show a guide for optional and/or additional tests
- t) an 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) an informative Annex G has been added to explain why some recommended test boards have extremely wide copper patterns
- v) an informative Annex X has been added to show the cross reference for the prior revision of this document

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

FDIS	Report on voting
40/XX/FDIS	40/XX/RVD

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

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.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

272 The committee has decided that the contents of this publication will remain unchanged until
273 the stability date indicated on the IEC website under “<http://webstore.iec.ch>” in the data
274 related to the specific publication. At this date, the publication will be

- 275 • reconfirmed;
- 276 • withdrawn;
- 277 • replaced by a revised edition, or
- 278 • amended.

279

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 on to a circuit board.

The object of this standard is to prescribe 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 60068-2-1, *Environmental testing – Part 2-1: Tests - Test A: Cold*

IEC 60068-2-2, *Basic environmental testing procedures – Part 2-2: Tests - Tests B: Dry heat*

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

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

IEC 60286-3:2019, *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)*

3 Terms and definitions

3.1 Terms

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

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 are generally called MELF. However, they 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**

a component designed to use wire wound elements inside the component body which the physical design may 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 purpose of this document, the following product technologies as described in IEC 60115-1:2020, Clause 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 purpose of this document, the following product classification levels as defined in IEC 60115-1:2020, Clause 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 preferably be selected from the following:

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.

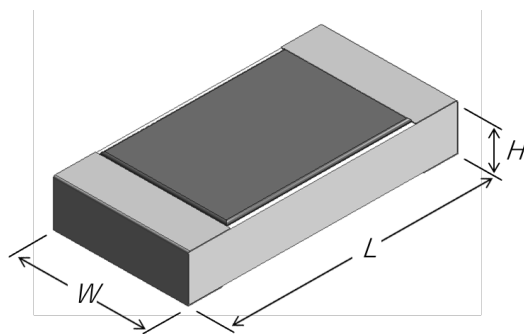


Figure 1 – Shape and dimension of rectangular (RR) resistors

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 RR3245M in the old edition of this document is moved to Table 2 and the new style is RT3245M.				
NOTE 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.

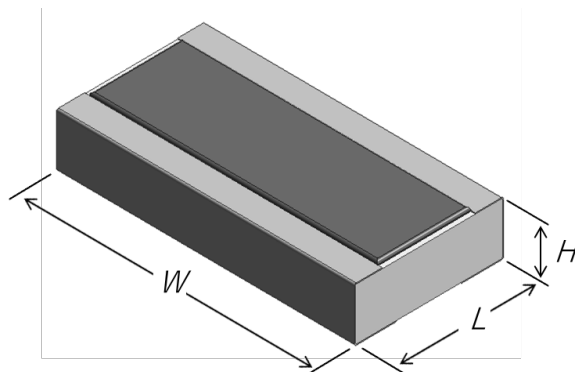


Figure 2 – Shape and dimension of transverse (RT) resistors

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 has been revised to RT3245M and RT1218 since the new name for transverse (RT) resistors are 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.

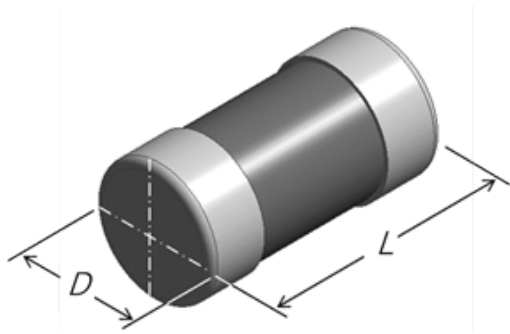


Figure 3 – Shape and dimension of cylindrical (RC) resistors

Table 3 – Preferred styles of cylindrical (RC) resistors

Style	Dimensions	
Metric	Length <i>L</i> mm	Diameter <i>D</i> mm
RC1610M	1,6 ^{+0,10} _{-0,05}	1,0 ^{+0,15} _{-0,05}
RC2012M	2,0 ± 0,1	1,25 ^{+0,2} _{-0,1}
RC2211M	2,2 ⁰ _{-0,3}	1,1 ⁰ _{-0,10}
RC3514M	3,5 ± 0,2	1,4 ± 0,2
RC3715M	3,7 ⁰ _{-0,4}	1,5 ^{+0,1} _{-0,3}
RC5922M	5,9 ± 0,2	2,2 ± 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.

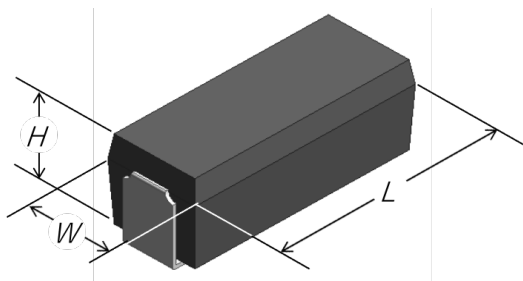


Figure 4 – Shape and dimension of wire wound (RW) resistors

Table 4 – Preferred styles of wire wound (RW) resistors

Style		Dimensions		
Metric	Imperial ^a	Length <i>L</i> mm	Width <i>W</i> mm	Height <i>H</i> mm
RW0503M	RW2012	5,0 +0,6/-0,4	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 specification are classified into climatic categories according to the general rules given in IEC 60068-1:2013, Annex A.

The lower and upper category temperature 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; 21 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 preferably be selected according to the tolerance on resistance as recommended by IEC 60063:2015, Table 3.

4.5 Tolerances on resistance

The preferred tolerances on resistance for fixed resistors are:

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

NOTE 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 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.

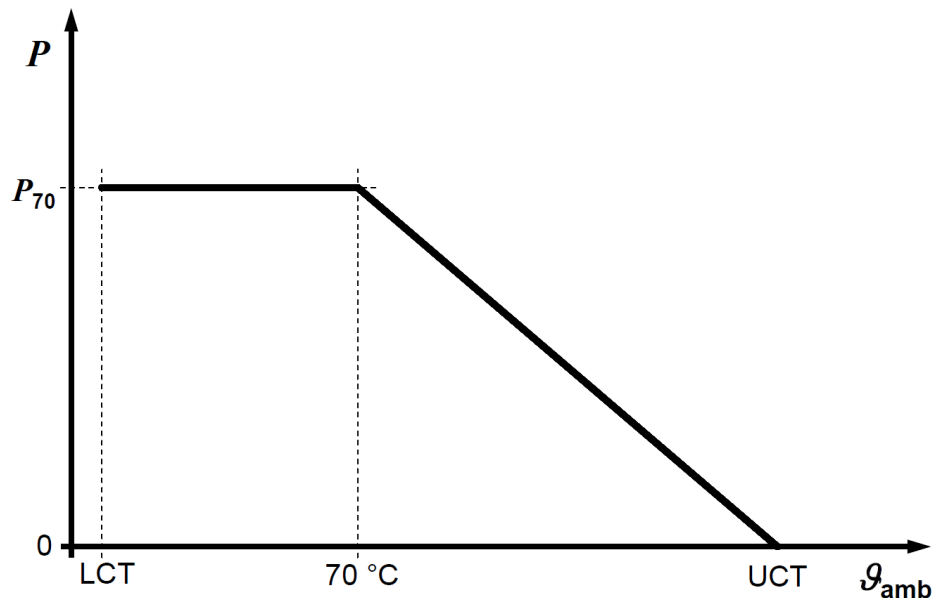


Figure 5 – Derating curve based on ambient temperature

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 preferably be not less than 1 G Ω .

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 specification

Clause 5.2 provides detailed prescriptions related to the preparation of specimens for tests, particularly on a preferred variety of mounting methods. Any deviation from these prescriptions as may be required by the type of resistors covered by a particular detail specification under this sectional specification shall be clearly prescribed by such particular detail specification.

Clause 5.3 provides detailed prescriptions 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 in to the conditions of test column of the respective test schedule and therefore shall take precedence over the overview information.

Clause 5.4 provides detailed prescriptions of additional tests which 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 prescribed number of tests, in the drafting of a detail specification aiming to cover special requirements. Any prescription of such additional test shall be accompanied by the prescription of suitable inspections, e.g. visual inspection 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 as outlined in IEC 60115-1:2020, 5.2.3, unless prescribed otherwise.

Tolerances on specified test parameters shall be applied according to IEC 60115-1:2020, 5.3, unless prescribed 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, with 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

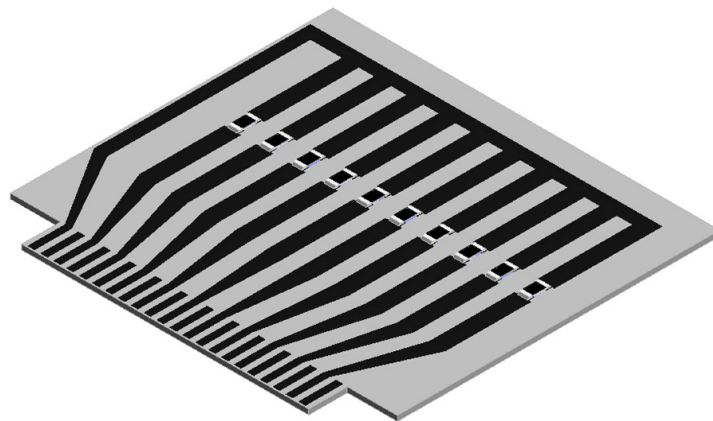
The recommended test boards are basically designed to be around 125 °C at the terminal part when the rated dissipation is applied to the specimen. This is indicated as “Target temperature” in Table 5, Table 6 and Table 7. For reference, an ideal number of specimens are also shown in the tables to consider 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 hot spot 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 prescribed inside. 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 tests, and subject of approval of the responsible certification body. The basic appearance of the test board is shown in Figure 6.



Key

- Conductor tracks (Copper trace)
- Glass epoxy board

Figure 6 – Basic appearance of recommended test board

The detail specification may 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 correspondent test board that forms a uniform baseline for testing.

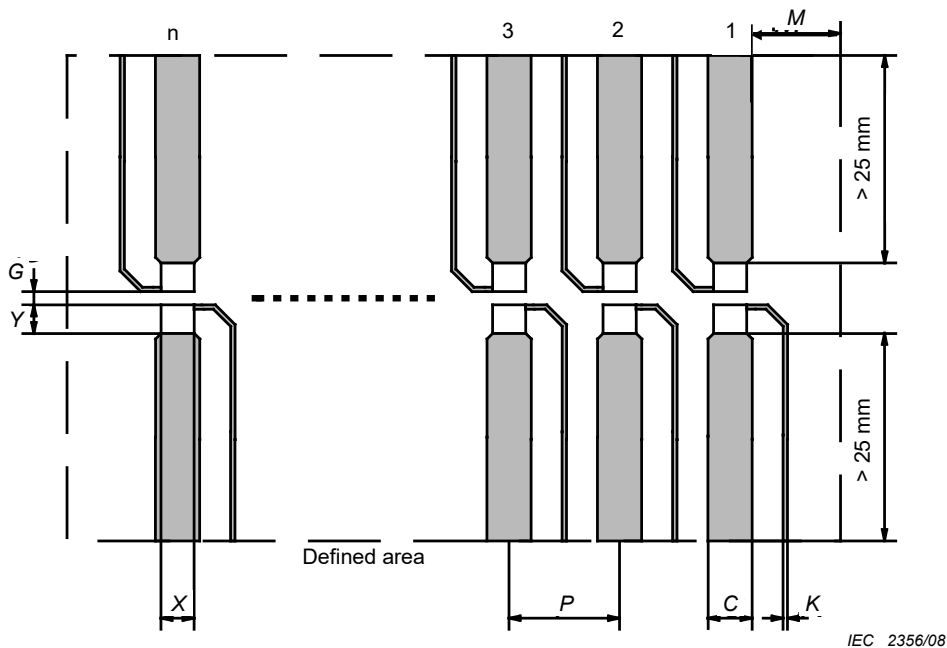
Test boards designed for resistors with higher rated power may have different copper pattern widths compared to traditional test boards. This is because the temperature of the test boards may become extremely high depending on the heat dissipation characteristics of the test boards. See Annex G for reference.

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 according to Figure 7, with the dimensions given in Table 5, Table 6 and Table 7 shall be used for tests for a stability class 0,1 or below and if the resistance of the specimen is below 100 Ω .

Test boards according to Figure 9, with the dimensions given in Table 5, Table 6 and Table 7 may be used for tests for any stability class above 0,1, 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.

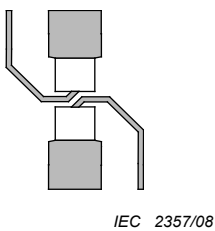


- Key**
- solderable area
 - non solderable area, conductor covered with solder resist

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

NOTE 2 For specimen 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 specimen with nominal resistance lower than 100 mΩ

Pad dimension of X, Y and G shown in Figure 7 and its 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 not limited to the value shown in the tables.

Table 5 – Test board dimensions for RR resistors

Style	X mm	Y mm	G mm	C mm	K mm	P mm	M mm	Board thickness mm	Pattern thickness ^a µm	Rated power 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				1,0	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 run both sense conductors to the same edge of the defined area.												
NOTE Test board dimensions for RC resistors which were in this table in the prior version are moved to Table 7. Test board dimensions for RR3245M was in this table in the prior version 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 ...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 Rated power. Detailed data are shown in Annex F.												
^c ...Lower target temperature for RR0402M and RR0603M are given to fulfil market requests since they do not generate enough heat to reach 125°C with the rated power.												

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Table 6 – Test board dimensions for RT resistors

Style	X mm	Y mm	G mm	C mm	K mm	P mm	M mm	Board thickness mm	Pattern thickness ^a µm	Rated power 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	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			70	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				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 run both sense conductors to the same edge of the defined area.												
NOTE Test board dimensions for RR3245M was in the table for RR resistors in the prior version. The style name is changed to RT3245 and are moved to this table.												
^a ...Pattern thickness is set as design values. Tolerance may be determined by each test board manufacturer.												
^b ...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 Rated power. Detailed data are shown in Annex F.												

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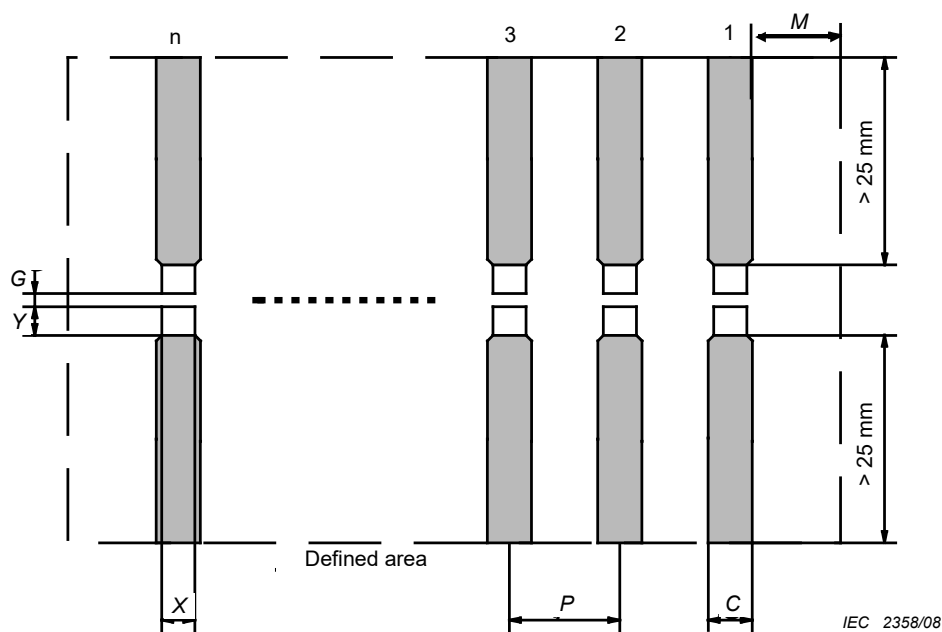
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Table 7 – Test board dimensions for RC resistors

Style	X mm	Y mm	G mm	C mm	K mm	P mm	M mm	Board thickness mm	Pattern thickness ^a µm	Rated power 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	124,5
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				0,3	15	124.5
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				0,4	13	126.3
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				1,0	4	124.9
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 run both sense conductors to the same edge of the defined area.												
NOTE Test board dimensions for RC resistors were in the table for RR resistors in the prior version but are now separated to this table.												
^a ...Pattern thickness is set as design values. Tolerance may be determined by each test board manufacturer. ^b ...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 Rated power. Detailed data are shown in Annex F.												

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Key

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

NOTE For 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 according to 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 according to 5.2.2.

The sequence of temperatures, 20 °C / LCT / 20 ° / 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 according to 5.2.2 or as prescribed by the detail specification. The test board shall 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).

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 according to 5.2.2, or as prescribed 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 shall be tested mounted on a test board according to 5.2.2, or as prescribed 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 according to 5.2.2, or as prescribed by the detail specification. The test board shall 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).

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 prescribe 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 shall be mounted on a test board according to 5.2.2, or as prescribed 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 prescribe 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 according to 5.2.2, or as prescribed by the detail specification. The test board shall 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).

The preferred square pulse overload test voltage is, as prescribed 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: $t_{\text{pulse}} = 100 \mu\text{s}$;

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

The detail specification may prescribe a higher overload factor than the 25 given in severity 3. In such case the test duration of 100 h and the pulse duration of 100 μs shall be maintained and the pulse frequency 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	$1\,000 \times P_r$	$\sqrt{1000 \times P_r \times R_n}$	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 shall be tested mounted on a test board according to 5.2.2, or as prescribed by the detail specification.

The ESD test voltage is a function of the resistor style. The detail specification shall prescribe 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

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

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

5.3.10 Visual inspection

See IEC 60115-1:2020, 9.1

The visual inspection shall be applied to the resistor body and to its terminations.

678 The visual inspection of the marking of marked resistors shall be applied to the required
679 marking items according to 7.1.

680 **5.3.11 Gauging of dimensions**

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

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

684 The length of the resistor body shall be assessed as prescribed in IEC 60294:2012,
685 Clause 3.1.

686 The diameter of the resistor body shall be gauged according to IEC 60294:2012, Clause 5. A
687 similar approach shall be used for a non-cylindrical resistor body.

688 **5.3.12 Detail dimensions**

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

690 All dimensions specified by the detail specification shall be measured.

691 For measurement of the length of the resistor body, a gauge plate according to
692 IEC 60294:2012, 3.1 shall be used.

693 **5.3.13 Shear (adhesion) test**

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

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

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

700

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	25
RR4532M RR5025M RR6332M	—	—	45
—	RT3245M RT1632M RT2550M RT3263M	RC5922M	90

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

701 **5.3.14 Substrate bending test**

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

703 Deflection: $d = (2 \pm 0,2) \text{ mm}$ 704 Deflection holding time: $t_{\text{hold}} = (20 \pm 1) \text{ s}$ 705 Number of deflections: $n = 3$ 706 **5.3.15 Shock**

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

708 Pulse shape: half-sine

709 Peak acceleration, d : $50 g_n (500 \text{ m/s}^2)$ 710 Duration of pulse, t_p : 11 ms711 Number of pulses, n : 3 per axis and direction712 This test is mandatory only for wire wound resistors (Styles RW) unless otherwise requested
713 by the detail specification.714 **5.3.16 Vibration**

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

716 The method to be employed is endurance by sweeping according to IEC 60068-2-6:2007,
717 8.3.1, with the specimen mounted in such a way that they are not exposed to resonances, and
718 with the following details:719 Frequency range: $f_1 = 10 \text{ Hz}$ to720 $f_2 = 2\,000 \text{ Hz}$;721 Amplitude: $\hat{a} = 200 \text{ m/s}^2$, limited by
722 $d = 1,5 \text{ mm}$;

723 Duration: $n = 10$ sweep cycles in each axis (x, y, z),
724 resulting in a test duration $t_{\text{load}} = 2,5$ h per axis.

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

726 **5.3.17 Rapid change of temperature**

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

728 Lower temperature: $\vartheta_{\text{inf}} = \text{LCT}$;
729 Upper temperature: $\vartheta_{\text{sup}} = \text{UCT}$;
730 Number of cycles: $n = 5$.

731 **5.3.18 Rapid change of temperature, ≥ 100 cycles**

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

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

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

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

739 **5.3.19 Climatic sequence**

740 **5.3.19.1 General**

741 See IEC 60115-1:2020, 10.3

742 The specimen shall be mounted on a test board according to 5.2.2, **or** as prescribed by the
743 detail specification.

744 **5.3.19.2 Dry heat**

745 IEC 60115-1:2020, 10.3.4.2

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

750 **5.3.19.3 Damp heat, cyclic, first cycle**

751 See IEC 60115-1:2020, 10.3.4.3

752 **5.3.19.4 Cold**

753 See IEC 60115-1:2020, 10.3.4.4

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