BS EN 60115-8:2013

BSI Standards Publication

Fixed resistors for use in electronic equipment

Part 8: Sectional specification - Fixed surface mount resistors

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National foreword

This British Standard is the UK implementation of EN 60115-8:2012. It was derived by CENELEC from IEC 60115-8:2009. It supersedes BS EN 140400:2003 and BS QC 400600:1990 (dual numbered as IEC 60115-8:1989), which are withdrawn.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by a vertical line in the left margin of the text.

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

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

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

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

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CENELEC

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CONTENTS

Foreword

This document EN 60115-8:2012 consists of the text of IEC 60115-8:2009, prepared by IEC/TC 40 "Capacitors and resistors for electronic equipment", together with the common modifications prepared by the Technical Committee CLC/TC 40XB "Resistors".

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2013-08-13
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2015-08-13

This document supersedes EN 140400:2003.

Preceding documents on the subject covered by this specification have been:

– EN 140400:1996-11

– CECC 40 400:1989-00,

EN 60115-8:2012 includes the following significant technical changes with respect to EN 140400:2003:

— introduction of a product classification based on application requirements;

— extension of the list of styles and dimensions;

— introduction of the code letters for temperature coefficient as given in EN 60062;

— introduction of description and test methods for lead-free soldering;

— introduction of a new system of test severities for the shear test;

— introduction of new test severities for the single-pulse high-voltage overload test;

— introduction of a test on the resistance to electrostatic discharge;

— amendment of the prescriptions for mounting of components;

— adoption of the IECQ rules of procedure, QC 001002-3:2005;

— separation of the test schedule into separate tables for qualification approval and for quality conformance inspection;

— consolidation of the prescription for 0 Ω resistors in a new annex;

— editorial revision.

In this document, the common modifications to IEC 60115-8:2009 are indicated by a vertical line in the left margin of the text.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

1 General

1.1 Scope

This part of EN 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). They have metallized terminations and are primarily intended to be mounted directly on to a circuit board.

1.2 Object

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

Test severities and requirements prescribed in detail specifications referring to this sectional specification shall be of equal or higher performance level, because lower performance levels are not permitted.

1.3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 60062:2005 + corrigendum 2007, *Marking codes for resistors and capacitors* (IEC 60062:2004)

EN 60068-1:1994, *Environmental testing – Part 1: General and guidance (IEC 60068-1:1988 + A1:1992 + corrigendum Oct. 1988)*

EN 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads* (IEC 60068-2-20:2008)

EN 60068-2-58:2004 + corrigendum 2004, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)* (IEC 60068-2-58:2004)

EN 60115-1:2011, *Fixed resistors for use in electronic equipment – Part 1: Generic specification (IEC 60115-1:2008, modified)*

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

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

EN 61760-1:2006, *Surface mounting technology – Part 1: Standard method for the specification of surface mounting components (SMDs) (IEC 61760-1:2006)*

1.4 Information to be specified in a detail specification

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 subclause of the detail specification and indicated in the test schedules, for example by a note.

The following information shall be given in each detail specification and the values quoted shall preferably be selected from those given in the appropriate clause of this sectional specification.

1.4.1 Outline drawing

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

1.4.2 Style and dimensions

See 2.1.1.

Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification.

1.4.3 Climatic category

See 2.1.2.

1.4.4 Limits of resistance change after testing

See 2.1.4.

1.4.5 Resistance range

See 2.2.1.

NOTE When products approved according 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”.

1.4.6 Tolerance on rated resistance

See 2.2.2.

1.4.7 Temperature coefficient of resistance

See 2.1.3.

1.4.8 Rated dissipation

See 2.2.3.

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, for example the derating, either in a diagram or in the form of a statement. All break points shall be verified by test.

The mounting conditions are as described in 2.4.2.

1.4.9 Limiting element voltage

See 2.2.4.

1.4.10 Insulation voltage

This information is required only for insulated resistors.

See 2.2.6 and the definition for insulation voltage given in EN 60115-1:2011, 2.2.

For small size resistors where the dimensions of the test jig given in EN 60115-1:2011, 4.6 are not adequate, they shall be specified in the detail specification.

1.4.11 Insulation resistance

This information is required only for insulated resistors.

See 2.2.5.

For small size resistors where the dimensions of the test jig given in EN 60115-1:2011, 4.6 are not adequate, they shall be specified in the detail specification.

1.4.12 Marking

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 using one of the coding systems provided by EN 60062:2005, and as many of the remaining items listed in EN 60115-1:2011, 2.4 as possible. All the required information shall be marked on the packaging.

1.4.13 Ordering information

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

The number of the detail specification and style reference.

Resistance, tolerance on resistance and, if required, temperature coefficient of resistance according to EN 60062.

Failure rate level for products classified to Level R, according to EN 60115-1:2011, Annex ZR.

NOTE A nominal failure rate level E0 may be used for products classified to Level P, for which no failure rate level is assessed.

1.4.14 Mounting

The detail specification shall give guidance on methods of mounting for normal use, preferably based on the specification of assembly process conditions of EN 61760-1:2006, Clause 5. Mounting for test and measurement purposes (when required) shall be in accordance with 2.4.2 of this specification and EN 60115-1:2011, 4.31.

1.4.15 Storage

See EN 60115-1:2011, 2.7.

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

1.4.16 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.

1.5 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.

Three general end product levels have been established to reflect characteristic differences in functional, performance and reliability requirements and to permit the use of suitable inspection and test schedules. It should be recognized that there may be overlaps of applications between the levels.

Level G – General electronic equipment, typically operated under benign or moderate environmental conditions, where the major requirement is function. Examples for level G include consumer products and telecommunication user terminals.

Level P – High-performance electronic equipment, where one or more of the following criteria applies:

– uninterrupted performance is desired or mandatory;

– operation in harsh environmental conditions;

– extended lifetime.

Examples for level P include professional equipment, telecommunication transmission systems, industrial control and measurement systems and most automotive applications operated outside the passenger compartment.

NOTE 1 This product classification to Level P adopts the former Version A.

Level R — High-performance and high-reliability electronic equipment, where the requirement for established reliability and for an approved failure rate level applies in addition to the criteria of Level P.

Examples for Level R include military & defence equipment, avionics and aerospace applications.

NOTE 2 This product classification to Level R adopts the former Version E.

Each level shall be used in individual detail specifications, except for Level P and Level R, which may be used in combined detail specifications.

2 Preferred characteristics, ratings and test severities

2.1 Preferred characteristics

The values given in detail specifications shall preferably be selected from the following.

2.1.1 Style and dimensions

The shape and dimensions of rectangular resistors, commonly referred to as chip resistors, is shown in Figure 1, with preferred styles and their respective dimensions given in Table 1a. Style designators of rectangular resistors are prefixed RR.

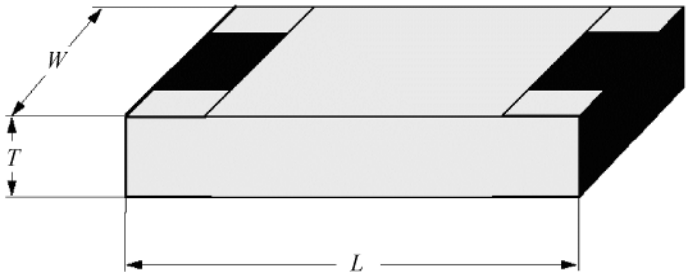


Figure 1 – Shape and dimensions of rectangular (RR) resistors

Table 1a – Preferred styles for rectangular (RR) resistors

Style		Dimensions		
Metric	Imperial [a]	Length L mm	Width W mm	Height T mm
RR0603M	RR0201	0,6 ± 0,05	0,3 ± 0,05	0,23 ± 0,05
RR1005M	RR0402	1,0 ± 0,05	0,5 ± 0,05	0,35 ± 0,05
RR1608M	RR0603	1,6 ± 0,1	0,8 ± 0,1	0,45 ± 0,1
RR2012M	RR0805	2,0 ± 0,1	1,25 ± 0,15	$0{,}5\ ^{+0,15}_{-0,10}$
RR3216M	RR1206	3,2 ± 0,2	1,6 ± 0,15	0,55 ± 0,1
RR3225M	RR1210	3,2 ± 0,2	2,5 ± 0,2	0,55 ± 0,1
RR3245M	RR1218	3,2 ± 0,2	4,6 ± 0,2	0,55 ± 0,1
RR4532M	RR1812	4,6 ± 0,2	3,2 ± 0,2	0,55 ± 0,1
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

[a] Historical style codes, for information only.

The shape and dimensions of cylindrical resistors, commonly referred to as MELF resistors, is shown in Figure 2, with preferred styles and their respective dimensions given in Table 1b. Style designators of cylindrical resistors are prefixed RC.

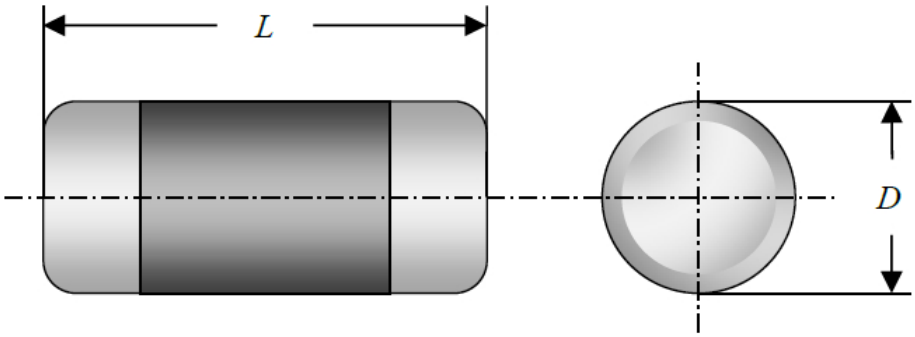


Figure 2 – Shape and dimensions of cylindrical (RC) resistors

Table 1b – Preferred styles for cylindrical (RC) resistors

Style Metric	Dimensions 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	$2,2\ ^{0}_{-0,2}$	$1,1\ ^{0}_{-0,10}$
RC3715M [a]	$3,7\ ^{0}_{-0,3}$	$1,5\ ^{0}_{-0,2}$
RC6123M [b]	$6,1\ ^{0}_{-0,6}$	$2,3\ ^{0}_{-0,3}$

[a] Comparable to the IEC style RC3514M (L = (3,5 ± 0,2) mm; D = (1,4 ± 0,2) mm).

[b] Comparable to the IEC style RC5922M (L = (5,9 ± 0,2) mm; D = (2,2 ± 0,2) mm).

When the component style is other than described above, for example for surface mount wirewound resistors (Style designators are prefixed RW), the detail specification shall state such dimensional information as will adequately describe the resistor.

2.1.2 Preferred climatic categories

The surface mount resistors covered by this specification are classified into climatic categories according to the general rules given in EN 60068-1:1994, 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.

NOTE The climatic performance of assembled resistors is greatly influenced by the circuit board, the assembly method and a final coating.

2.1.3 Variation of resistance with temperature

The preferred limits of change in resistance for the variation of resistance with temperature test are given in Table 2.

Table 2 – Permitted change of resistance

Tempe-rature coefficient [a]		Limit of resistance change, $\Delta R/R$ %								
		Lower category temperature / Reference temperature				Reference temperature / Upper category temperature [a]				
10^{-6}/K	Code [b]	-55 °C / 20 °C	-40 °C / 20 °C	-25 °C / 20 °C	-10 °C / 20 °C	20 °C / 85 °C	20 °C / 125 °C	20 °C / 155 °C	20 °C / 175 °C	20 °C / 200 °C
±1 000	W	±7,50	±6,00	±4,50	±3,00	±6,50	±10,5	±13,5	±15,5	±18,0
±500	V	±3,75	±3,00	±2,25	±1,50	±3,25	±5,25	±6,75	±7,75	±9,00
±250	U	±1,88	±1,50	±1,13	±0,75	±1,63	±2,63	±3,38	±3,88	±4,50
±100	S	±0,75	±0,60	±0,45	±0,30	±0,65	±1,05	±1,35	±1,55	±1,80
±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 or category temperatures are required, these shall be specified in the detail specification.
[b] Code letters according to EN 60062:2005, 5.5.

Each line in the table gives the preferred temperature coefficient and limits of change in resistance for the measurement of the variation of resistance with temperature (see EN 60115-1:2011, 4.8) on the basis of category temperature ranges of 2.1.2 of this specification.

2.1.4 Limits for change in resistance

Tables 3a and 3b list preferred limits for resistance change for all tests listed in the heading. To classify the performance of resistors, they will be assigned to stability classes as listed in Table 3a and Table 3b below.

Table 3a – Limits for change of resistance

Stability class	Limit of resistance change, ΔR Ω			
	Long term tests			Short term tests
	EN 60115-1:2011, 4.23 Climatic sequence 4.24 Damp heat, steady state 4.25.3 Endurance at upper category temperature	EN 60115-1:2011, 4.25.1 Endurance at 70 °C,		EN 60115-1:2011, 4.13 Short time overload 4.18 Resistance to soldering heat 4.19 Rapid change of temperature, 5 cycles 4.21 Shock [b] 4.22 Vibration [c]
		1 000 h	Extended, 8 000 h [a]	4.33 Substrate bending test
5	±(5 % R + 0,1 Ω)	±(5 % R + 0,1 Ω)	±(10 % R + 0,1 Ω)	±(1 % R + 0,05 Ω)
2	±(2 % R + 0,1 Ω)	±(2 % R + 0,1 Ω)	±(5 % R + 0,1 Ω)	±(0,5 % R + 0,05 Ω)
1	±(1 % R + 0,05 Ω)	±(1 % R + 0,05 Ω)	±(2 % R + 0,05 Ω)	±(0,25 % R + 0,05 Ω)
0,5	± (0,5 % R + 0,05 Ω)	±(0,5 % R + 0,05 Ω)	±(1 % R + 0,05 Ω)	±(0,1 % R + 0,01 Ω)
0,25	±(0,25 % R + 0,05 Ω)	±(0,25 % R + 0,05 Ω)	±(0,5 % R + 0,05 Ω)	±(0,05 % R + 0,01 Ω)
0,1	±(0,1 % R + 0,02 Ω)	±(0,1 % R + 0,02 Ω)	±(0,25 % R + 0,02 Ω)	±(0,05 % R + 0,01 Ω)
0,05	±(0,05 % R + 0,01 Ω)	±(0,05 % R + 0,01 Ω)	±(0,1 % R + 0,01 Ω)	±(0,025 % R + 0,01 Ω)
0,025	±(0,025 % R + 0,01 Ω)	±(0,025 % R + 0,01 Ω)	±(0,05 % R + 0,01 Ω)	±(0,01 % R + 0,01 Ω)

[a] This test shall be applied to resistors categorized as level P or level R.
[b] This test shall be applied to resistors of other styles than RR or RC, e.g. of style RW.
[c] This test shall be applied to resistors of styles RR or RC.

Table 3b – Limits for change of resistance

Stability class	Limit of resistance change, ΔR Ω			
	EN 60115-1:2011, 4.19 Rapid change of temperature, ≥ 100 cycles [a]	EN 60115-1:2011, 4.27 Single pulse high-voltage overload test [a]	EN 60115-1:2011, 4.38 Electrostatic discharge [b]	EN 60115-1:2011, 4.39 Periodic electric overload [a]
5	± (1 % R + 0,05 Ω)	±(1 % R + 0,05 Ω)	±(1% R + 0,05 Ω)	±(2 % R + 0,05 Ω)
2				
1	± (0,5 % R + 0,05 Ω)	±(0,5 % R + 0,05 Ω)	±(0,5 % R + 0,05 Ω)	±(1 % R + 0,05 Ω)
0,5				
0,25	±(0,25 % R + 0,05 Ω)			
0,1				
0,05				
0,025				

[a] This test shall be applied to resistors categorized as level P or level R.
[b] Human body model (HBM) according to EN 61340-3-1, using 3 positive and 3 negative discharges for resistors categorized as level P or level R, or 1 positive and 1 negative discharge for resistors categorized as level G.

2.2 Preferred values of ratings

2.2.1 Rated resistance

See EN 60115-1:2011, 2.3.2.

2.2.2 Tolerance on rated resistance

The preferred values of relative tolerance on rated resistance are:

±10 %; ±5 %; ±2 %; ±1 %; ±0,5 %; ±0,25 %; ±0,1 %; ±0,05 %; ±0,02 %; ±0,01 %; 0/-30 %; 0/-20 % and
0/-10 %.

NOTE Asymmetric relative tolerance values (e.g. 0/-20 %) are intended to be used for laser trimmable resistors.

2.2.3 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 3a shows the typical shape of a derating curve that may be used to provide derating information for all cases where the maximum element temperature (MET) is equal to the upper category temperature (UCT).

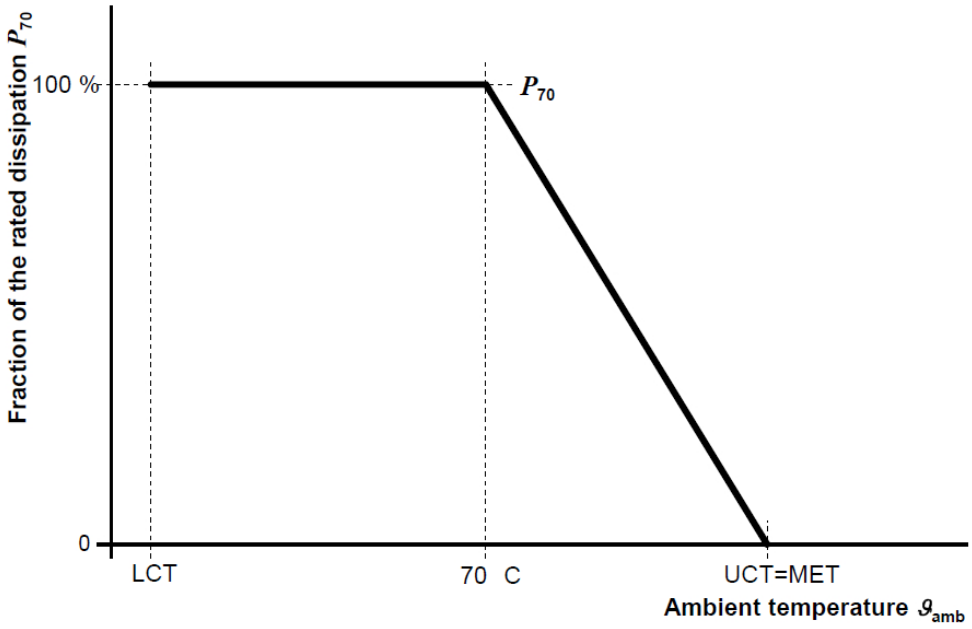


Figure 3a – Derating curve

For cases where the maximum element temperature (MET) exceeds the upper category temperature (UCT), as it is common e.g. for wirewound power resistors, a shape as shown in Figure 3b is better suited to provide the derating information, and also to illustrate the limited temperature range applied for testing.

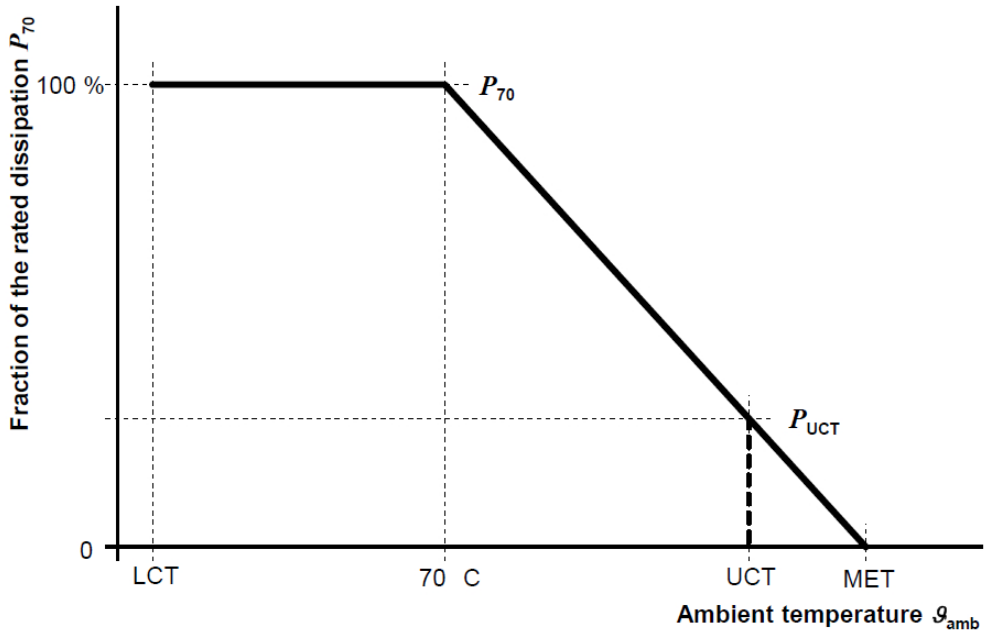


Figure 3b – Derating curve for power resistors

The end points and break points of each curve shall be verified by tests.

2.2.4 Limiting element voltage U_{max}

The preferred values of limiting element voltage U_{max} d.c. or a.c. (r.m.s.) are: 12,5 V; 15 V; 25 V; 50 V; 75 V; 100 V; 150 V; 200 V; 300 V and 500 V.

2.2.5 Insulation resistance

For insulated resistors, the insulation resistance R_{ins} shall be not less than 1 GΩ, when measured according to EN 60115-1:2011, 4.6.

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

- 4.25.1, Endurance at 70 °C
- 4.25.3, Endurance at Upper Category Temperature.

The insulation resistance R_{ins} shall not be less than 100 MΩ after the tests

- 4.23, Climatic sequence
- 4.24, Damp heat, steady state.

2.2.6 Insulation voltage

For insulated resistors, the preferred values of insulation voltage U_{ins} d.c. or a.c. (peak) are: 75 V; 100 V; 200 V; 300 V and 500 V.

2.3 Preferred test severities

2.3.1 Short time overload

See EN 60115-1:2011, 4.13, with the following details:

Applied voltage: The detail specification shall state the applied voltage. Preferred values are

$$U = 2{,}5 \cdot U_r \quad (1)$$

or

$$U = 2 \cdot U_{max} \quad (2)$$

whichever is the less severe,
where

U_r is the rated voltage, $U_r = \sqrt{P_{70} \cdot R}_r$

U_{max} is the limiting element voltage.

Duration: The detail specification shall state the load duration.
Preferred values are 0,5 s; 1 s; 2 s; 5 s and 10 s.
This time shall be fixed in such a way, that the maximum element temperature is at least 30 K above the upper category temperature.

Mounting: See 2.4.2. The distance between individual surface mount resistors shall not be less than the largest surface mount resistor dimension.

The test board shall be mounted horizontally and shall be in free air at the standard atmospheric conditions for testing as given in EN 60115-1:2011, 4.2.1 (e.g. ambient temperature 15 °C to 35 °C).

2.3.2 Solderability

See EN 60115-1:2011, 4.17, with the following details:

The solderability test shall be preceded by accelerated ageing. Unless otherwise specified in the relevant detail specification, Ageing 3a as prescribed in EN 60068-2-20:2008, 4.1.1 (i.e. 4 h at 155 °C dry heat) shall be used. After the accelerated ageing, the specimen shall be subjected to standard atmospheric conditions for testing for not less than 2 h and not more than 24 h.

The solderable termination surface of the resistors shall be compatible with both, traditional SnPb solder and lead-free solder, unless otherwise explicitly stated in the relevant detail specification. Therefore solderability testing is required for both soldering processes.

Solderability with traditional SnPb solder shall be tested according to EN 60068-2-58:2004, 8.2.1 solder bath method with the following severity

Solder alloy: Sn60Pb40 or Sn63Pb37

Bath temperature: (235 ± 5) °C

Immersion time: (2 ± 0,2) s

Lead-free solder alloys are grouped in EN 60068-2-58:2004, Clause 4 according to their typical process temperature. The most popular solder alloys SnAg, SnAgCu and SnAgBi are contained in group 3, medium-high temperature. Solderability with lead-free solder shall be tested according to EN 60068-2-58:2004, 8.1.1, solder bath method with the following representative severity for group 3:

Solder alloy: Sn96,5Ag3,0Cu0,5

Bath temperature: (245 ± 5) °C

Immersion time: (3 ± 0,3) s

2.3.3 Resistance to soldering heat

See EN 60115-1:2011, 4.18, with the following details:

Resistors shall be capable of withstanding the full variety of soldering processes described in EN 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 EN 60068-2-58:2004, 8.2.1 and EN 60068-2-58:2004, 8.1.1 :

Test method: Solder bath method

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

Bath temperature: (260 ± 5) °C

Immersion time: (10 ± 1) s

Test cycles: 1

For resistors, where the relevant detail specification explicitly excludes wave soldering, resistance to soldering heat may be tested with the worst case reflow condition from EN 60068-2-58:2004, 8.2.4 and EN 61760-1:2006, Clause 6.

Test method: Vapour phase soldering

Vapour temperature: (230 ± 5) °C

Immersion time: (40 ± 1) s

Test cycles: 3, the recovery period between two successive cycles shall be at least the time it takes until the specimen drops below 50 °C.

For resistors, where the relevant detail specification explicitly excludes wave soldering and vapour phase reflow soldering, resistance to soldering heat may be tested with the worst case non-vapour phase reflow condition from EN 60068-2-58:2004, 8.2.4 and EN 60068-2-58:2004, 8.1.2.2.

Test method: Infrared and forced gas convection soldering

Preheating: 150 °C to 180 °C
for (120 ± 5) s

Peak temperature: (255 ± 5) °C

Dwell time: (40 ± 1) s above 245 °C
(60 to 90) s above 220 °C

Test cycles: 3, the recovery period between two successive cycles shall be at least the time it takes until the specimen drops below 50 °C.

2.3.4 Shock test

See EN 60115-1:2011, 4.21, with the following details:

Pulse shape: Half sine

Peak acceleration: 500 m/s²

Pulse duration: 11 ms

Number of shocks: 3 successive shocks in each direction of three mutually perpendicular axes of the specimen.

This test shall be applied to specimen of other styles than rectangular resistor (RR) or cylindrical resistors (RC).

2.3.5 Vibration test

See EN 60115-1:2011, 4.22, with the following details:

Procedure: Endurance by sweeping

Frequency range: 10 Hz to 2 000 Hz

Amplitude: 1,5 mm or 200 m/s², whichever is the less severe

Sweep cycles: 10 cycles in each of three mutually perpendicular axes of the specimen

Duration: 2,5 h per axis.

The specimen shall be mounted in such a way that they are not exposed to resonances.

This test shall be applied to all styles of rectangular resistors (RR) and cylindrical resistors (RC).

2.3.6 Single-pulse high-voltage overload test

See EN 60115-1:2011, 4.27, with the following details:

Mounting of specimen: See 2.4.2, or unmounted

Pulse shape: 10 µs/700 µs

Peak voltage: $\hat{U} = 10 \cdot U_r$ or $\hat{U} = 2 \cdot U_{max}$, whichever is the less severe (Severity No. 4), or

$\hat{U} = x \cdot U_r$ or $\hat{U} = y \cdot U_{max}$, whichever is the less severe (Severity No. B), where
x is the multiplier of the rated voltage, $x \geq 10$
y is the multiplier of the limiting element voltage, $y \geq 2$.
The relevant specification shall prescribe the factors x and y.

2.3.7 Component solvent resistance

See EN 60115-1:2011, 4.29, with the following detail:

Solvent temperature: $(50^{\ 0}_{-5})$ °C.

2.3.8 Solvent resistance of marking

See EN 60115-1:2011, 4.30, with the following detail:

Solvent temperature: $(50^{\ 0}_{-5})$ °C.

Rubbing device: Tooth brush.

The toothbrush prescribed as the rubbing device shall be a regular commercial hard grade quality with tightly clustered bristles of consistent length, made of regular synthetic fibres. It shall be used with a single solvent only and applied with normal hand pressure (approx. 0,5 N to 1 N normal to the specimen surface) for the required ten strokes. The toothbrush shall be discarded when there is any evidence of softening, bending, wear, or loss of bristles.

2.3.9 Shear (adhesion) test

See EN 60115-1:2011, 4.32.2 b), with the following details:

Unless otherwise specified in the relevant detail specification, a force as given in Table 4 shall be applied to the surface mount resistor body.

Table 4 – Shear test force

Style		Force N
Rectangular	Cylindrical	
RR0603M	—	$2^{\ +0,2}_{\ 0}$
RR1005M	—	$3^{\ +0,3}_{\ 0}$
RR1608M	RC1610M	$5^{\ +0,5}_{\ 0}$
RR2012M	RC2012M RC2211M	$9^{\ +0,9}_{\ 0}$
RR3216M RR3225M	RC3715M	$25^{\ +2,5}_{\ 0}$
RR3245M RR4532M RR5025M RR6332M	—	$45^{\ +4,5}_{\ 0}$
—	RC6123M	$90^{\ +9,0}_{\ 0}$

NOTE The forces for the shear test given in Table 4 are specified so as to exceed the result of an acceleration of 981 m/s^2 (100 g), for example a shock or a bump, based on the typical mass of resistors of the respective style.

2.3.10 Substrate bending test

See EN 60115-1:2011, 4.33, with the following details:

Substrate thickness (1,6 ± 0,2) mm

Substrate pattern: See 2.4.2

Depth of bend: 2 mm

Number of bends: 3

Electrical continuity shall be monitored; there shall be no open circuit in the bent position of the last bend.

2.3.11 Resistance to electrostatic discharge (ESD)

See EN 60115-1:2011, 4.38 with the following details:

Discharge count: For resistors classified as Level G :
One discharge of positive and one discharge of negative polarity shall be applied.

For resistors classified as Level P or as Level R:
Three discharges of positive and three discharges of negative polarity shall be applied.

Applied voltage: Preferred values are 300 V; 500 V; 800 V; 1 000 V; 1 500 V; 2 000 V; 3 000 V and 4 000 V

Change of polarity may be performed by swapping the terminations of the resistor.

Classification into HBM ESD sensitivity classes shall not be applied.

2.3.12 Periodic pulse overload test

See EN 60115-1:2011, 4.39, with the following details:

Pulse voltage: The preferred pulse voltage is

$$U = \sqrt{15 \cdot P_{70} \cdot R_r} \quad (3)$$

but no more than

$$U = 2 \cdot U_{max} \quad (4)$$

where

P_{70} is the rated dissipation
R_r is the rated resistance
U_{max} is the limiting element voltage.

Pulse duration: 1 000 cycles, 0,1 s on / 2,5 s off.

Mounting: See 2.4.2. The distance between individual surface mount resistors shall not be less than the largest surface mount resistor dimension.

The test board shall be mounted horizontally and shall be in free air at the standard atmospheric conditions for testing as given in EN 60115-1:2011, 4.2.1 (e.g. ambient temperature 15 °C to 35 °C).

2.4 Preparation of specimen

2.4.1 Drying

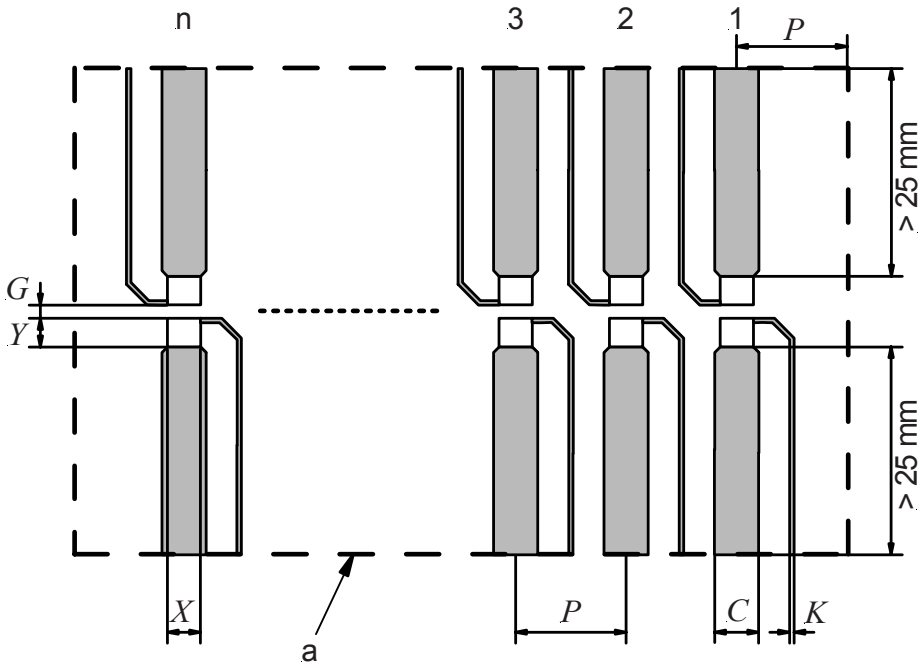
Procedure I of EN 60115-1:2011, 4.3 shall be used.

2.4.2 Mounting of components

Surface mount resistors shall be mounted on a test board with a basic layout as shown in Figure 4 or Figure 6, with the respective dimensions given in Table 5.

The test boards shall be an epoxide woven glass type with a thickness of (1,6 ± 0,1) mm, with conductors made of copper with a nominal thickness of 35 µm. For styles RR1005M and smaller, alternative substrate thickness (0,8 ± 0,1) mm is permissible. If necessary, the detail specification may provide a different material specification and basic layout, including layout dimensions.

No metal area is permitted on the bottom side and on any inner layer under the defined area, except a single straight 0,3 mm conductor for every Kelvin connection.

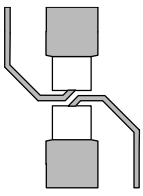


Key

a Limit of the defined area, where dimensions apply as given in Table 5.
Solderable area
Non-solderable area, conductor covered with solder resist

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

As an amendment to the prescribed layout of Figure 4, each pair of sense lines should be attached to the solderable area as shown in Figure 5 for specimen with a rated resistance lower than 100 mΩ.



Key

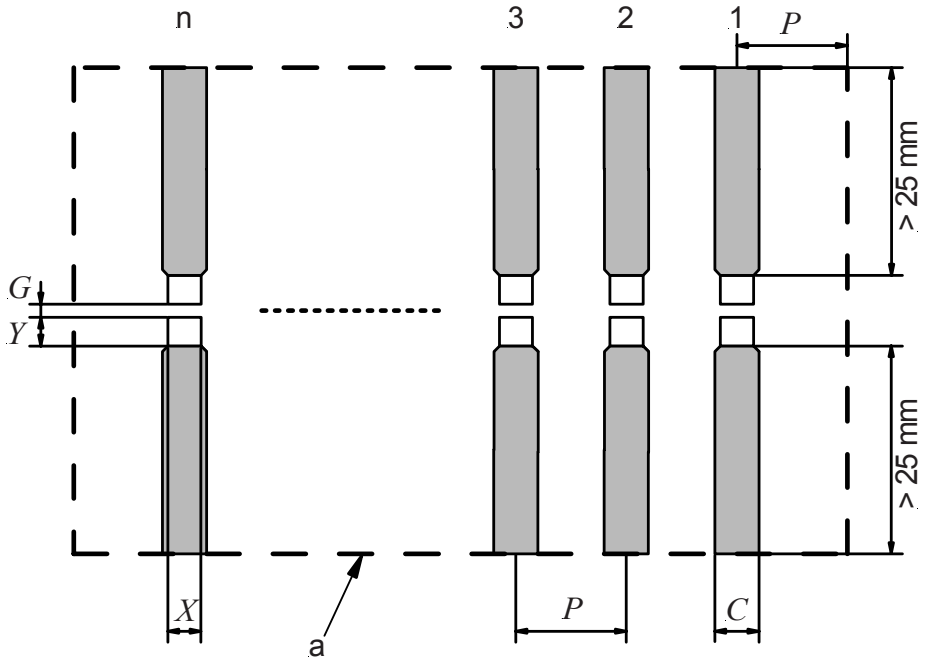
Solderable area
Non-solderable area, conductor covered with solder resist

Figure 5 – Attachment of the sense line for Kelvin (4 point) connections for specimen with rated resistance lower than 100 mΩ

Table 5 – Soldering pad dimensions

Style		*X*	*Y*	*G*	*C*	*K*	*P*
Rectangular	Cyilindrical	mm	mm	mm	mm	mm	mm
RR0603M	—	under preparation					
RR1005M	—	0,7 ± 0,05	0,6 ± 0,05	0,5 ± 0,05	0,3 ± 0,05	0,15 ± 0,05	5,0 ± 0,05
RR1608M	—	1,0 ± 0,05	1,1 ± 0,05	0,6 ± 0,05	0,5 ± 0,05	0,2 ± 0,05	5,0 ± 0,05
RR2012M	RC2211M	1,5 ± 0,1	1,3 ± 0,1	0,6 ± 0,1	2,0 ± 0,1	0,2 ± 0,1	5,0 ± 0,1
RR3216M	RC3715M	2,0 ± 0,1	1,6 ± 0,1	1,5 ± 0,1	2,0 ± 0,1	0,2 ± 0,1	5,0 ± 0,1
RR3225M	—	2,9 ± 0,1	1,6 ± 0,1	1,5 ± 0,1	2,0 ± 0,1	0,2 ± 0,1	10,0 ± 0,1
RR3245M	—	5,0 ± 0,1	1,6 ± 0,1	1,5 ± 0,1	5,0 ± 0,1	0,2 ± 0,1	10,0 ± 0,1
RR4532M	—	3,6 ± 0,1	1,8 ± 0,1	2,3 ± 0,1	5,0 ± 0,1	0,2 ± 0,1	10,0 ± 0,1
RR5025M,	RC6123M	2,9 ± 0,1	1,8 ± 0,1	2,7 ± 0,1	5,0 ± 0,1	0,2 ± 0,1	10,0 ± 0,1
RR6332M	—	3,6 ± 0,1	1,8 ± 0,1	3,8 ± 0,1	5,0 ± 0,1	0,2 ± 0,1	10,0 ± 0,1

Test boards according to Figure 6 may be used for tests for a stability class above 0,1, when the rated resistance is 100 Ω or higher, or for tests not requiring a measurement of the resistance.



Key

a Limit of the defined area, where dimensions apply as given in Table 5.

Solderable area

Non-solderable area, conductor covered with solder resist

Figure 6 – Basic layout for mechanical, environmental and electrical tests

3 Quality assessment procedures

3.1 General

See EN 60115-1:2011, Annex Q.

3.2 Definitions

3.2.1 Primary stage of manufacture

See EN 60115-1:2011, Q.1.2.1.

3.2.2 Structurally similar components

See EN 60115-1:2011, ZR.1.2.

3.2.3 Assessment level EZ

See EN 60115-1:2011, Q.1.2.3.

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

3.3 Formation of inspection lots

An inspection lot shall consist of resistors of the same 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;

– 1/3 with the critical resistance;

– 1/3 with the highest resistance within that range.

The range to be qualified may or may not be the complete range covered by the detail specification. In the case where the critical resistance is outside of the range to be qualified, resistors having a value in the middle of the range (near the geometric mean between lowest and highest resistance, for example 1 kΩ for a range of 1 Ω through 1 MΩ) shall be used for substitution.

When approval is being sought for more than one temperature coefficient of resistance, the sample shall contain a specimen representative of the different temperature coefficients. In general, a lower temperature coefficient is considered representative of any higher temperature coefficient. 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.

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

The low and high extreme values, or any critical values 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.

Low values shall be within 100 % and 200 % of the current lowest approved resistance (or lowest value manufactured within the approval range).

Critical values shall be within 80 % and 100 % of the calculated value.

High values shall be within 70 % and 100 % of the current highest approved resistance (or highest value produced within the approval range).

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

3.4 Qualification approval (QA) procedures

The procedures for qualification approval testing are given in EN 60115-1:2011, Q.2, with the test procedures described in EN 60115-1:2011,Q.2.4.

The sample shall be established according to 3.3. The required total sample size is the sum of all sample sizes in the qualification approval test schedule of Table 6 identified as destructive.

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.

When additional groups with destructive tests are introduced into the qualification approval test schedule, the total sample size shall be increased by the same number as that required for the additional groups.

The test schedule for the qualification approval of resistors categorized as level G, P or R is given in Table 6. The tests of each group shall be carried out in the given order.

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

NOTE In Table 6 the fixed sample size test schedule is given. It includes details of sampling and permissible nonconforming specimen for different tests or groups of tests and gives, together with the details of test contained in EN 60115-1:2011, Clause 4 and Clause 2 of this specification, a complete summary of test conditions and performance requirements.

It is indicated in Table 6 where tests are applicable only to specific styles or to specific product classification levels. The respective detail specifications have to make the appropriate selection.

It is also indicated in Table 6 where, for the test methods, test conditions and/or performance requirements, a choice has to be made in the detail specification.

The conditions of test and the performance requirements for the fixed sample size test schedule have to be identical to those prescribed in the detail specification for quality conformance inspection.

3.4.1 Granting the approval for products classified to level P

The qualification approval for classification level P shall be granted after successful completion of 1 000 h of the test Endurance at 70 °C and all other tests of Table 6.

3.4.2 Granting the approval for products classified to level R

The qualification approval for classification level R, failure rate level E5 shall be granted after successful completion of 1 000 h of the test Endurance at 70 °C and all other tests of Table 6.

Thereafter, the qualification approval for classification level R, failure rate level E6 shall be granted after successful completion of 8 000 h of the test Endurance at 70 °C.

The qualification approval for classification level R shall be withdrawn if the 8 000 h test is not completed successfully.

3.5 Quality conformance inspection

The schedule for the lot-by-lot and periodic tests for quality conformance inspection of resistors categorized as level G, P or R are given in Tables 7a and 7b. The tests of each group shall be carried out in the given order.

For mounted specimen, any specimen found defective after mounting shall not be taken into account as a nonconformance for the succeeding test. They shall be replaced by spare specimen.

3.6 Capability approval (CA) procedures

This sectional specification does not support the capability approval as described in EN 60115-1:2011, Clause Q.3.

3.7 Technology approval (TA) procedures

The procedures for Technology approval are given in EN 60115-1:2011, Clause Q.4.

The requirements for demonstration and verification of a technology are given in EN 60115-1:2011, Q.4.6. The TAS and TADD shall apply the test schedule given in Table 6.

The requirements for maintenance of a TA are given in EN 60115-1:2011, Q.4.8, and for the related quality conformance in sections in EN 60115-1:2011, Q.4.9. The TAS and TADD shall apply the test schedules given in Table 7a and Table 7b.

3.8 Delayed delivery

The provisions of EN 60115-1:2011, Q.1.7 shall apply, except that the inspection level shall be reduced to S-2.

3.9 Certified test records

Certified test records according to EN 60115-1:2011, Q.1.5 can be supplied, if agreed between the manufacturer and the customer.

3.10 Failure rate level

Components qualified according to a detail specification under this sectional specification and classified as level P, shall be delivered without a failure rate level and shall be designated with the nominal failure rate level E0.

NOTE 1 The product classification to Level P adopts and succeeds the Version A as used in prior specifications.

Components qualified according to a detail specification under this sectional specification and classified as level R shall be delivered with a failure rate level E5 or E6 or E7 or E8 and shall be designated accordingly.

NOTE 2 The product classification to Level R adopts and succeeds the Version E as used in prior specifications.

The procedures of EN 60115-1:2011, Annex ZR shall be applied for the determination and qualification of the failure rate level and for the evaluation of the quality factor π_Q.

3.11 Certificate of conformity (CoC)

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

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

Table 6 – Test schedule for qualification approval

Test [a]	Conditions of test	D [b] or ND	n [b]	c [b]	Performance requirements [a]
			Group 1		
4.5 Resistance		ND	… / …[i]	0	As in 4.5.2
			Group 2		
4.4.1 Visual examination	Marking, if applicable	ND	… / …[i]	0	As in 4.4.1
4.4.2 Dimensions (gauging)	An appropriate tool shall be used		(20 of the sample)		As specified in the detail specification
			Group 3		
4.6 Insulation resistance	See EN 60115-1:2011, 4.6.1.4 or 4.6.1.5, as applicable	ND	50	0	R ≥ ... GΩ
4.7 Voltage proof	See EN 60115-1:2011, 4.6.1.4 or 4.6.1.5, as applicable Voltage: $U = 1{,}42 \cdot U_{ins}$ Duration: 1 min				As in 4.7.3
4.13 Short time overload	Mounting: see 2.4.2 or unmounted See 2.3.1 Voltage: ...; Style / Duration … / … … / … Visual examination Resistance	D	(20 of the sample)		As in 4.13.3 As specified in the detail specification
			Group 4		
		D	40	0	
4.17 Solderability [e] with SnPb solder	See 2.3.2 Ageing 4 h at 155 °C dry heat; SnPb solder; Solder bath method; 235 °C; 2 s Visual examination		(half of the sample)		As in 4.17.3, ≥95 % of the surface shall be covered with new solder
4.17 Solderability with lead-free solder [e, f]	See 2.3.2 Ageing 4 h at 155 °C dry heat; SnAgCu solder; Solder bath method; 245 °C; 3 s Visual examination		(the other half of the sample)		As in 4.17.3, ≥95 % of the surface shall be covered with new solder
			Group 5		
4.8 Variation of resistance with temperature	Mounting: see 2.4.2 or unmounted Sequence of measurements: 20 °C / LCT / 20 °C / UCT / 20 °C	D	20	0	As specified in the detail specification

Table 6 *(continued)*

Test [a]	Conditions of test	D [b] or ND	n [b]	c [b]	Performance requirements [a]
			Group 6		
		D	20	0	
4.33 Substrate bending test	Mounting: see 2.4.2 See 2.3.10 Depth of bend … mm; , … successive bends Visual examination Resistance		(half of the sample)		 Electrical continuity, no open circuit when the board is in the bent position of the last bend. As in 4.33.4 As specified in the detail specification
4.19 Rapid change of temperature	Mounting: see 2.4.2 5 cycles; ϑ_A = LCT; ϑ_B = UCT Visual examination Resistance		(the other half of the sample)		 As in 4.19.3 As specified in the detail specification
4.21 Shock (applicable only to other styles than RR or RC, e.g. to style RW)	See 2.3.4 Waveform: Half sine; Acceleration: … ; Pulse duration: … ; … successive shocks in each direction of the three axes Visual examination Resistance				 As in 4.21.5 As specified in the detail specification
4.32 Shear test (applicable only to styles RR and RC)	Mounting: see 2.4.2 See 2.3.9 Style / Force … / … … / … Visual examination				 As in 4.32.3
4.23 Climatic sequence - Dry heat - Damp heat, cyclic first cycle - Cold - Low air pressure - Damp heat, cyclic remaining cycles - d.c. load - Final measurements	Mounting: see 2.4.2 16 h at UCT 1 cycle at 55 °C 2 h at LCT 1 h / … kPa; 15 °C to 35 °C … cycles at 55 °C $U = \sqrt{P_{70} \cdot R_r}$ or $U = U_{max}$, whichever is the less severe; 1 min Visual examination Resistance		(all of the sample)		 As in 4.23.8 As specified in the detail specification

Table 6 *(continued)*

Test [a]	Conditions of test	D [b] or ND	n [b]	c [b]	Performance requirements [a]
			Group 7		
4.25.1 Endurance at 70 °C	Mounting: see 2.4.2 $U = \sqrt{P_{70} \cdot R_r}$ or $U = U_{max}$ whichever is the less severe; 1,5 h on / 0,5 h off; 1 000 h Visual examination Resistance	D	20 / ...[i]	0	 As in 4.25.1.7 As specified in the detail specification
4.25.1.8 Extended endurance at 70 °C (applicable only to resistors categorized as Level P or as Level R)	Duration extended to 8 000 h Examination at 4 000 h (for information only) Resistance				 As specified in the detail specification
			Group 8		
4.24 Damp heat, steady state	Mounting: see 2.4.2 Temperature: (40 ± 2) °C; Rel. humidity: (93 ± 3) %; Duration: … Visual examination Resistance	D	20	0	 As in 4.24.4 As specified in the detail specification
			Group 9		
4.18 Resistance to soldering heat [h]	See 2.3.3 10 s at 260 °C Visual examination Resistance	D	20	0	 As in 4.18.4 As specified in the detail specification
4.35 Flammability	Needle flame test Duration of application t_a = 10 s Duration of burning		(5 of the sample)		 t_b < 30 s
			Group 10		
4.4.3 Dimensions (detail)		D	20	0	As specified in the detail specification
4.25.3 Endurance at upper category temperature	Mounting: see 2.4.2 or unmounted Duration: 1 000 h Visual examination Resistance				 As in 4.25.3.7 As specified in the detail specification
4.14 Temperature rise (applicable only to resistors below the critical resistance)	Mounting: see 2.4.2 Temperature rise		(6 of the sample)		 As specified in the detail specification

Table 6 *(continued)*

Test [a]	Conditions of test	D [b] or ND	n [b]	c [b]	Performance requirements [a]
			Group 11		
4.38 Electrostatic discharge	Mounting: see 2.4.2 or unmounted See 2.3.11 … pos. + … neg. discharge; Style | Voltage … | … … | … Visual examination Resistance	D	20	0	As in 4.38.4 As specified in the detail specification
4.29 Component solvent resistance	See 2.3.7 Solvent: IPA; Temperature: … °C; Immersion for (5 ± 0,5) min Visual examination		(half of the sample)		As in 4.4.1
4.30 Solvent resistance of marking (applicable only to marked resistors)	See 2.3.8 Solvent: IPA; Temperature: … °C; Immersion for (5 ± 0,5) min; Rubbing device:-… Visual examination		(the other half of the sample)		As in 4.4.1
			Group 12		
4.22 Vibration (applicable only to resistors categorized as Level P or as Level R)	Mounting: see 2.4.2 See 2.3.5 Endurance by sweeping Frequency range: ... ; Amplitude: ... ; … sweep cycles in each axis. Visual examination Resistance	D	20	0	As in 4.22.4 As specified in the detail specification
4.39 Periodic pulse overload test (applicable only to resistors categorized as Level P or as Level R)	Mounting: see 2.4.2 See 2.3.12 $U = \sqrt{15 \cdot P_{70} \cdot R_r}$ or $U = 2 \cdot U_{max}$, whichever is the less severe ; 0,1 s on / 2,5 s off; 1 000 cycles Visual examination Resistance				As in 4.4.1 As specified in the detail specification

Table 6 *(continued)*

Test [a]	Conditions of test	D [b] or ND	n [b]	c [b]	Performance requirements [a]
			Group 13		
4.19 Rapid change of temperature ≥100 cycles (applicable only to resistors categorized as Level P or as Level R)	Mounting: see 2.4.2 or unmounted ϑ_A = LCT; ϑ_B = UCT Style / Cycles: … / …; … / … Visual examination Resistance	D	20	0	As in 4.19.3 As specified in the detail specification
			Group 14		
4.27 Single pulse high voltage overload test (applicable only to resistors categorized as Level P or as Level R)	Mounting: see 2.4.2 or unmounted See 2.3.6 Severity No. ... (10/700) Visual examination Resistance	D	20	0	As in 4.27.3.7 As specified in the detail specification

[a] Clause numbers according to EN 60115-1:2011.

[b] Refer to Annex B for lists of letter symbols and abbreviations.

[c] This inspection shall be performed after removal of nonconforming items by 100 % testing during the manufacturing process. Whether the lot was accepted or not, all of the samples for sampling inspection shall be inspected in order to monitor outgoing quality level by nonconforming items per million (ppm). The sampling level shall be established by the manufacturer, preferably according to EN 61193-2, Annex A.

In case one or more nonconforming items occur in a sample, this lot shall be rejected but all nonconforming items shall be counted for the calculation of quality level values. The statistically verified quality limit (SVQL) shall be calculated by accumulating inspection data according to the method given in EN 61193-2, 6.2.

[d] This test may be replaced by in-production testing if the manufacturer installs SPC on dimensional measurements or other mechanisms to avoid parts exceeding the dimensional limits.

[e] Resistors submitted to this test shall not be measured in Group 1, 2, 3, A1, A2 or B1 and are not included in the number of specimen in Group 1 or 2.

[f] Test is not applicable if the relevant detail specification explicitly excludes compatibility with lead-free soldering.

[g] All tests of the sub-group shall be repeated if one or more nonconforming item is obtained. No nonconforming items are permitted in the repeat testing. Release of products may continue during repeat testing.

[h] Conditions of this test may be replaced by a relevant choice from 2.3.3.

[i] The first figure is the sample size for products classified to Level P (former Version A), the second figure is the sample size for products classified to Level R (former Version E).

Table 7a – Test schedule for quality conformance inspection: Lot-by-lot tests

Test [a]	Conditions of test	D [b] or ND	IL [b]	c [b]	Performance requirements [a]
			Group A1		
4.5 Resistance [c]		ND	100 % (As specified in the detail specification)		As in 4.5.2
			Group A2		
4.4.1 Visual examination [d]	Marking, if applicable	ND	S-4 / II [i]	0	As in 4.4.1
4.4.2 Dimensions (gauging) [d]	An appropriate tool shall be used		S-4		As specified in the detail specification
			Group B1		
4.7 Voltage proof	See EN 60115-1:2011, 4.6.1.4 or 4.6.1.5, as applicable U = 1,42 · U_{ins}; Duration: 1 min	ND	S-3	0	As in 4.7.3
4.13 Short term overload	Mounting: see 2.4.2 or unmounted See 2.3.1 Voltage: ... Style / Duration … / … … / … Visual examination Resistance	D			As in 4.13.3 As specified in the detail specification
			Group B2		
		D		0	
4.17 Solderability [e] with SnPb solder	See 2.3.2 Ageing 4 h at 155 °C dry heat SnPb solder; Solder bath method; 235 °C; 2 s Visual examination		S-3		As in 4.17.3, ≥95 % of the surface shall be covered by new solder
4.17 Solderability with lead-free solder [e, f]	See 2.3.2 Ageing 4 h at 155 °C dry heat SnAgCu solder; Solder bath method; 245 °C; 3 s Visual examination		S-3		As in 4.17.3, ≥95 % of the surface shall be covered by new solder
			Group B3		
4.8 Variation of resistance with temperature (applicable only to resistors with a temperature coefficient superior to ± 50 · 10^{-6}/K)	Mounting: see 2.4.2 or unmounted Sequence of measurements: 20 °C / LCT / 20 °C / UCT / 20 °C	D	S-3	0	As specified in the detail specification

NOTE The table footnotes are given at the end of Table 6.

Table 7b – Test schedule for quality conformance inspection: Periodic tests

Test [a]	Conditions of test	D [b] or ND	p [b]	n [b]	c [b]	Performance requirements [a]
			Group C1 [g]			
		D	3	20	0	
4.33 Substrate bending test	Mounting: see 2.4.2 See 2.3.10 Depth of bend ... mm; ... successive bends Visual examination Resistance			(half of the sample)		Electrical continuity, no open circuits when the board is in the bent position of the last bend. As in 4.33.4 As specified in the detail specification
4.19 Rapid change of temperature	Mounting: see 2.4.2 5 cycles; ϑ_A = LCT; ϑ_B = UCT Visual examination Resistance			(the other half of the sample)		As in 4.19.3 As specified in the detail specification
4.21 Shock (applicable only to other styles than RR or RC, e.g. to style RW)	See 2.3.4 Waveform: Half sine Acceleration: ... ; Pulse duration: ... ; ... successive shocks in each direction of the three axes. Visual examination Resistance					As in 4.21.5 As specified in the detail specification
4.22 Vibration (applicable only to other styles than RR or RC, categorized as Level P or as Level R)	Mounting: see 2.4.2 See 2.3.5 Endurance by sweeping Frequency range: ... ; Amplitude: ... ; … sweep cycles in each axis. Visual examination Resistance					As in 4.22.4 As specified in the detail specification
4.32 Shear test (applicable only to styles RR and RC)	Mounting: see 2.4.2 See in 2.3.9 Style / Force … / … … / … Visual examination					As in 4.32.3

Table 7b *(continued)*

Test [a]	Conditions of test	D [b] or ND	p [b]	n [b]	c [b]	Performance requirements [a]
			Group C1 [g] *(continued)*			
4.23 Climatic sequence	Mounting: see 2.4.2			(all of the sample)		
- Dry heat	16 h at UCT					
- Damp heat, cyclic first cycle	1 cycle at 55 °C					
- Cold	2 h at LCT					
- Low air pressure	1 h / ... kPa at 15 °C to 35 °C					
- Damp heat, cyclic remaining cycles	… cycles at 55 °C					
- DC load	$U = \sqrt{P_{70} \cdot R_r}$ or $U = U_{max}$, whichever is the less severe, 1 min					
- Final measurements	Visual examination					As in 4.23.8
	Resistance					As specified in the detail specification
			Group C2 [g]			
4.25.1 Endurance at 70 °C	Mounting: see 2.4.2 $U = \sqrt{P_{70} \cdot R_r}$ or $U = U_{max}$ whichever is the less severe; 1,5 h on / 0,5 h off; Duration: 1 000 h	D	3	20	0	
	Visual examination					As in 4.25.1.7
	Resistance					As specified in the detail specification
4.25.1.8 Extended endurance at 70 °C (applicable only to resistors categorized as Level P or as Level R)	Duration extended to 8 000 h once a year Examination at 4 000 h (for information only)		12			
	Resistance					As specified in the detail specification
			Group C3 [g]			
4.18 Resistance to soldering heat [h]	See 2.3.3 10 s at 260 °C	D	3	20	0	
	Visual examination					As in 4.18.4
	Resistance					As specified in the detail specification
4.35 Flammability	Needle flame test Duration of application t_a = 10 s		36	(5 of the sample)		
	Duration of burning					t_b < 30 s
			Group D1 [g]			
4.8 Variation of resistance with temperature (applicable only to resistors with a temperature coefficient of $\pm 50 \cdot 10^{-6}$/K or inferior)	Mounting: see 2.4.2 or unmounted Sequence of measurements: 20 °C / LCT / 20 °C / UCT / 20 °C	D	12	20	0	
						As specified in the detail specification

Table 7b *(continued)*

Test [a]	Conditions of test	D [b] or ND	p [b]	n [b]	c [b]	Performance requirements [a]
			Group D2 [g]			
4.24 Damp heat, steady state	Mounting: see 2.4.2 Temperature: (40 ± 2) °C; Rel. humidity: (93 ± 3) %; Duration: … Visual examination Resistance	D	12	20	0	 As in 4.24.4 As specified in the detail specification
			Group D3 [g]			
4.4.3 Dimensions (detail)		D	36	20	0	As specified in the detail specification
4.25.3 Endurance at upper category temperature	Mounting: see 2.4.2 or unmounted Duration: 1 000 h Visual examination Resistance					 As in 4.25.3.7 As specified in the detail specification
4.14 Temperature rise (applicable only to resistors below the critical resistance)	Mounting: see 2.4.2 Temperature rise			(6 of the sample)		 As specified in the detail specification
			Group E [g]			
4.38 Electrostatic discharge, Human Body Model	Mounting: see 2.4.2 or unmounted See 2.3.11 … pos. + … neg. discharges Style / Voltage … / … … / … Visual examination Resistance	D	12	20	0	 As in 4.38.4 As specified in the detail specification
4.29 Component solvent resistance	See 2.3.7 Solvent: IPA; Temperature: … °C; Immersion for (5 ± 0,5) min Visual examination			(half of the sample)		 As in 4.4.1
4.30 Solvent resistance of marking (applicable only to marked resistors)	See 2.3.8 Solvent: IPA; Temperature: … °C; Immersion for (5 ± 0,5) min; Rubbing device: … Visual examination			(the other half of the sample)		 As in 4.4.1

Table 7b *(continued)*

Test [a]	Conditions of test	D [b] or ND	p [b]	n [b]	c [b]	Performance requirements [a]
			Group F [g]			
4.19 Rapid change of temperature ≥100 cycles (applicable only to resistors categorized as Level P or as Level R)	Mounting: see 2.4.2 or unmounted ϑ_A = LCT; ϑ_B = UCT; Style … / Cycles … Visual examination Resistance	D	36	20	0	As in 4.19.3 As specified in the detail specification
			Group G [g]			
4.27 Single pulse high voltage overload test (applicable only to resistors categorized as Level P or as Level R)	Mounting: see 2.4.2 or unmounted See 2.3.6 Severity No. ... (10/700) Visual examination Resistance	D	12	20	0	As in 4.27.3.7 As specified in the detail specification

NOTE The table footnotes are given at the end of Table 6.

Annex A
(normative)

0 Ω resistors (Jumper)

A.1 Information to be specified in a detail specification

For 0 Ω resistors, all the subclauses of 1.4 of this sectional specification apply with the following modifications:

– Clause 1.4.7, Temperature coefficient of resistance is not applicable to 0 Ω resistors.

– Clause 1.4.9, Limiting element voltage is replaced by maximum current I_{max}.

A.2 Preferred characteristics

For 0 Ω resistors, all the subclauses of 2.1 of this sectional specification apply with the following modifications:

– Clause 2.1.3, Variation of resistance with temperature is not applicable to 0 Ω resistors.

– Clause 2.1.4, Limits for change of resistance are reduced to compliance with the permitted maximum residual resistance $R_{res\ max}$ for each test.

A.3 Preferred ratings

For 0 Ω resistors, all the subclauses of 2.2 of this sectional specification apply with the following modifications:

– Clause 2.2.1, Rated resistance for 0 Ω resistors is 0 Ω.

– Clause 2.2.2, Tolerance on rated resistance for 0 Ω resistors is reduced to the maximum residual resistance $R_{res\ max}$, to be selected from the preferred values: 10 mΩ; 20 mΩ and 50 mΩ.

– Clause 2.2.4, Limiting element voltage U_{max} is not applicable to 0 Ω resistors, the maximum current I_{max} shall be used instead.

A.4 Preferred severities

For 0 Ω resistors, all the subclauses 2.3 of this sectional specification apply with the following modifications:

– Clause 2.3.1, Short time overload:
The stated applied voltage is not applicable to 0 Ω resistors. Instead the following definition shall be used:

Applied current: The detail specification shall state the applied current. Preferred value is

$$I = 2{,}5 \cdot I_{max} \quad (5)$$

where

I_{max} is the maximum permissible current.

– Clause 2.3.6, Single-pulse high-voltage overload test:
This test is not applicable to 0 Ω resistors.

– Clause 2.3.11, Resistance to electrostatic discharge (ESD):
This test is not applicable to 0 Ω resistors.

A.5 Test schedule for qualification approval

For the qualification approval of 0 Ω resistors, the test schedule of Table 6 applies with the following modifications:

The maximum current I_{max} shall be used where rated voltage U_r or $U = \sqrt{P_{70} \cdot R_r}$ is required in a test condition.

The resistance parameters asked for in the column Performance requirements are reduced to the compliance with the permitted maximum residual resistance $R_{res\ max}$.

Test 4.14, Temperature rise, is applicable to 0 Ω resistors.

The following tests are not applicable to 0 Ω resistors:

– Test 4.8, Variation of resistance with temperature;
– Test 4.27, Single pulse high voltage overload test;
– Test 4.38, Electrostatic discharge, human body model.

A.6 Test schedule for quality conformance inspection

For the quality conformance inspection of 0 Ω resistors, the test schedules for lot-by-lot inspections of Table 7a and for periodical inspections of Table 7b apply with the following modifications:

The maximum current I_{max} shall be used where rated voltage U_r or $U = \sqrt{P_{70} \cdot R_r}$ is required in a test condition.

The resistance parameters asked for in the column performance requirements are reduced to the compliance with the permitted maximum residual resistance value $R_{res\ max}$.

Test 4.14, Temperature rise, is applicable to 0 Ω resistors.

The following tests are not applicable to 0 Ω resistors:

– Test 4.8, Variation of resistance with temperature;
– Test 4.27, Single pulse high voltage overload test;
– Test 4.38, Electrostatic discharge, human body model.

Annex B
(informative)

Letter symbols and abbreviations

B.1 Letter symbols

c	Acceptance number (permissible number of nonconforming items)	1
L	Length, measured along the axis from termination to termination	mm
D	Diameter	mm
I_{max}	Maximum permissible current	A
n	Sample size	1
p	Periodicity	months
P_{70}	Rated dissipation at 70 °C ambient temperature	W
R	Actual resistance value	Ω
R_{crit}	Critical resistance, $R_{crit} = U_{max}^2 / P_{70}$	Ω
R_{ins}	Insulation resistance	Ω
R_r	Rated resistance	Ω
R_{res}	Residual resistance	Ω
$R_{res\ max}$	Maximum permissible residual resistance	Ω
ΔR	Change of resistance	Ω
$\Delta R/R$	Change of resistance related to the prior measurement	%
U	Voltage, for example test voltage	V
U_{ins}	Insulation voltage	V
U_{max}	Limiting element voltage, maximum permissible voltage	V
U_r	Rated voltage, $U_r = \sqrt{P_{70} \cdot R}_r$	V
t_a	Duration of application of a test flame	s
t_b	Duration of burning after removal of the test flame	s
T	Height (thickness)	mm
T_A, ϑ_A	Low temperature of a change of temperature test	°C
T_B, ϑ_B	High temperature of a change of temperature test	°C
W	Width	mm

B.2 Abbreviations

CA	Capability approval
CB	Certification body
CoC	Certificate of conformity
D	Destructive
DMR	Designated management representative (quality system manager)
ESD	Electrostatic discharge
HBM	Human body model, representation of the capacitance and resistance of a human body for ESD testing
IECQ CB	IECQ Certification body
IL	Inspection level
IPA	Isopropyl alcohol, Isopropanol (CAS Registry Number: 67-63-0)
LCT	Lower category temperature
MET	Maximum element temperature
ND	Non destructive
NSI	National supervising inspectorate
	NOTE IECQ 01, IEC Quality Assessment System for Electronic Components (IECQ Scheme) – Basic Rules, has implemented in its 2007-12 revision a change of the term Supervising Inspectorate to IECQ Certification Body (IECQ CB).
ONS	Organisme National de Surveillance (National supervising inspectorate)
	NOTE This term has been used in specifications prior to using the term National Supervising Inspectorate (NSI)
QA	Qualification approval
RC	Style designation for resistor, cylindrical, typically used for film resistors
RR	Style designation for resistor, rectangular, typically used for film resistors
RW	Style designation for resistor, wirewound
SPC	Statistical process control
TA	Technology approval
TADD	Technology approval declaration document
TAS	Technology approval schedule
TC	Temperature coefficient (not specific to resistance)
TCR	Temperature coefficient of resistance
UCT	Upper category temperature

Annex ZX
(informative)

Cross reference to EN 140400

This release of EN 60115-8 is based on IEC 60115-8:2009 together with the common modifications prepared by the Technical Committee CENELEC TC40XB. Table ZX.1 lists the corresponding alphanumeric clause references with respect to the superseded sectional specification EN 140400:2003.

Table ZX.1 – Cross reference to EN 140400

EN 140400:2003	EN 60115-8:2012	Notes
1.1	1.1 1.2	Sectioned into two clauses
1.2	1.4	
—	1.4.1	New clause
1.2 a) to 1.2. l)	1.4.2 to 1.4.13	—
—	1.4.14	New clause
—	1.5	New clause
2.1.x	2.1.x	—
2.2.x	2.2.x	—
2.2.7	—	Omitted
2.3	2.3 2.4	Sectioned into two clauses
2.3.1	2.4.1	—
2.3.2	2.3.1	—
2.3.3	2.4.2	—
—	2.3.2 to 2.3.12	New clauses
3.1	3.1 3.2 3.3	Sectioned into three clauses
—	3.2.1	New clause
3.1.1	3.2.2	—
—	3.2.3	New clause
3.1.2	3.3	—
3.2	3.4	—
—	3.4.1	New clause
—	3.4.2	New clause
3.3	3.5	—
—	3.6	New clause
3.4	3.7	—
3.5	—	Omitted
3.6	3.8	—
—	3.9	New clause

Table ZX.1 *(continued)*

EN 140400:2003	EN 60115-8:2012	Notes
—	3.10	New clause
—	3.11	New clause
Annex A	—	Merged into Clause 3
Table [a]	Table 6 Table 7a Table 7b	Split into three tables
—	Annex A	New annex
Annex B	Annex B	—
Annex C	1.3	—
—	Bibliography	New annex

[a] The sole table in Annex A, titled “Fixed sample size qualification approval and quality conformance inspection test schedule for fixed low power surface mount (SMD) resistors“ is not identified by an alphanumeric table reference.

Bibliography

CECC 240 001:1996, *Technology Approval Schedule: Fixed low power film resistors (leaded / unleaded)*

HD 588.1 S1:1991, *High-voltage test techniques – Part 1: General definitions and test requirements* (IEC 60060-1:1989)

EN 60027-1:2006 + A2:2007, *Letter symbols to be used in electrical technology – Part 1: General* (IEC 60027-1:1995 + A1:1997 + A2:2005)

EN 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold* (IEC 60068-2-1:2007)

EN 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat* (IEC 60068-2-2:2007)

EN 60068-2-6:2008, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)* (IEC 60068-2-6:2007)

EN 60068-2-13:1999, *Environmental testing – Part 2-13: Tests – Test M: Low air pressure* (IEC 60068-2-13:1983)

EN 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature* (IEC 60068-2-14:2009)

EN 60068-2-21:2006, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices* (IEC 60068-2-21:2006)

EN 60068-2-30:2005, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)* (IEC 60068-2-30:2005)

EN 60068-2-45:1992 + A1:1993, *Environmental testing – Part 2-45: Tests – Test XA and guidance: Immersion in cleaning solvents* (IEC 60068-2-45:1980 + A1:1993)

EN 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state* (IEC 60068-2-78:2001)

FprEN 60286-3:201X [1)], *Packaging of components for automatic handling – Part 3: Packaging of surface mount components on continuous tapes* (IEC 60286-3:201X [1)])

EN 60695-11-5:2005, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance* (IEC 60695-11-5:2004)

IEC 60063:1963, *Preferred number series for resistors and capacitors*

Amendment 1 (1967)

Amendment 2 (1977)

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

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

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

IECQ 01, *IEC Quality Assessment System for Electronic Components (IECQ Scheme) – Basic Rules*

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

FprEN ISO 80000-1, *Quantities and units – Part 1: General* (ISO 80000-1)

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