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INTERNATIONAL STANDARD

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Directly heated negative temperature coefficient thermistors – Part 2: Sectional specification – Surface mount negative temperature coefficient thermistors

IEC 60539-2:2019-07 RLV(en)

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DIRECTLY HEATED NEGATIVE TEMPERATURE COEFFICIENT THERMISTORS –

Part 2: Sectional specification – Surface mount negative temperature coefficient thermistors

FOREWORD

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International Standard IEC 60539-2 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This second edition cancels and replaces the first edition published in 2003 and Amendment 1:2010. This edition constitutes a technical revision.

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

a) revision for the structure in accordance with ISO/IEC Directives, Part 2:2016 (seventh edition) to the extent practicable, and for harmonizing with IEC 60539-1:2016;
b) the upper category temperatures of 175 °C, 200 °C, 250 °C, 315 °C, 400 °C in Table 1 have been added;
c) the dimensions of 0402M in Annex A have been added.

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

FDIS	Report on voting
40/2672/FDIS	40/2680/RVD

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

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

A list of all parts in the IEC 60539 series, published under the general title *Directly heated negative temperature coefficient thermistors*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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DIRECTLY HEATED NEGATIVE TEMPERATURE COEFFICIENT THERMISTORS –

Part 2: Sectional specification – Surface mount negative temperature coefficient thermistors

~~1 General~~

1 Scope

This part of IEC 60539 is applicable to surface mount directly heated negative temperature coefficient thermistors, typically made from transition metal oxide materials with semiconducting properties. These thermistors have metallized connecting pads or soldering strips and are intended to be mounted directly on to substrates for hybrid circuits or on to printed boards.

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 60068-2-2:~~1974~~2007, *Environmental testing – Part 2-2: Tests – Tests B: Dry heat*
~~Amendment 1 (1993)~~
~~Amendment 2 (1994)~~

IEC 60068-2-14:~~1984~~2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature* ~~Amendment 1 (1986)~~

~~IEC 60068-2-30:1980, *Environmental testing – Part 2: Tests – Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*~~
~~Amendment 1 (1985)~~

IEC 60068-2-58:~~1999~~2015, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*
IEC 60068-2-58:2015/AMD1:2017

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

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

IEC 60539-1:~~2002~~2016, *Directly heated negative temperature coefficient thermistors – Part 1: Generic specification*

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

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60539-1 apply.

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

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

4 Information to be given in a detail specification

4.1 General

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

Detail specifications shall not specify requirements inferior to those of the generic, sectional or blank detail specification. When more severe requirements are included, they shall be listed in 1.9 of the detail specification and indicated in the test schedules, for example, by an asterisk.

~~NOTE~~ The information given in 4.2 may for convenience, be presented in tabular form.

The information in 4.2 to 4.4 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.

4.2 Outline drawing and dimensions

There shall be an illustration of the thermistor as an aid to easy recognition and for comparison with others. Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall preferably be stated in millimetres; however, when the original dimensions are given in inches, the converted metric dimensions in millimetres shall be added.

Normally, the numerical values shall be given for the length, width and height of the body. When necessary, for example when a number of items are covered by a detail specification, the dimensions and their associated tolerances shall be placed in a table below the drawing.

When the configuration is other than described above, the detail specification shall state such dimensional information as will adequately describe the thermistor.

4.3 Mounting

The detail specification shall give guidance on methods of mounting for normal use. Mounting for test and measurement purposes (when required) shall be in accordance with ~~4.27 of~~ IEC 60539-1:2016, 5.4.

4.4 Ratings and characteristics

4.4.1 Particular characteristics

Additional characteristics may be listed when they are considered necessary to specify the component adequately for design and application purposes.

4.4.2 Marking

See ~~2.4 of~~ IEC 60539-1:2016, 4.3.

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~~1.4 Terminology~~

~~See 2.2 of IEC 60539-1.~~

5 Preferred ratings and characteristics

5.1 Tolerances on rated zero-power resistance

Preferred values of tolerances on zero-power resistance are:

±0,5 %, ±1 %, ±2 %, ±3 %, ±5 %, ±10 %.

5.2 Climatic categories

The upper and lower category temperatures and the duration of the damp-heat steady-state test shall be selected from Table 1.

Table 1 – Upper and lower category temperatures and duration of the damp heat test

Lower category temperature °C	−55, −40, −25, −10, −5, +5
Upper category temperature °C	70, 85, 100, 105, 125, 150, 155, 175, 200, 250, 315, 400
Damp heat, steady state days	21, 42, 56

The detail specification shall prescribe the appropriate category.

6 Quality assessment procedures

~~3.1 Primary stage of manufacture~~

~~The primary stage of manufacture is defined as the initial mixing process of ingredients.~~

~~3.2 Structurally similar components~~

~~Surface mount thermistors may be grouped as structurally similar for the purpose of forming inspection lots provided that the requirements of 3.1 of IEC 60539-1 are met, with the following addition.~~

~~For the shear test and the substrate bending test, devices may be grouped if they have been made on the same production line, have the same dimensions, internal structure and external finish.~~

~~3.3 Qualification approval procedures~~

~~3.3.1 The manufacturer shall comply with 3.4 of IEC 60539-1.~~

~~3.4 Quality conformance inspection~~

~~Blank detail specifications associated with this specification shall prescribe the test schedule for quality conformance inspection.~~

~~This schedule shall also specify the grouping, sampling and periodicity for the lot-by-lot and periodic inspection.~~

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~~Inspection levels and sampling plans shall be selected from those given in IEC 60410.~~

~~If required, more then one test schedule may be specified.~~

~~3.4.1 Qualification approval on the basis of the fixed sample size procedure~~

~~a) Sampling~~

~~The sample shall be representative of the range of thermistors for which approval is sought. This may or may not be the complete range covered by the detail specification.~~

~~The sample shall consist of specimens having the lowest, highest and middle-rated zero-power resistance of each case size.~~

~~Per value, three spare specimens are permitted and may be used as replacements for specimens which are defective because of incidents not attributable to the manufacturer.~~

~~b) Tests~~

~~The complete series of tests specified in Table 2 are required for the approval of thermistors covered by one detail specification. The tests of each group shall be carried out in the order given.~~

~~The whole sample shall be subjected to the tests of Group "0" and then divided for the other groups.~~

~~Specimens found defective during the tests of Group "0" shall not be used for the other groups.~~

~~"One defective" is counted when a thermistor has not satisfied the whole or a part of the tests of a group.~~

~~Approval is granted when the number of non-conformances does not exceed the specified number of permissible defects for each group or subgroup.~~

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

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~~Table 2 – Fixed sample size test schedule for qualification approval of surface mount negative temperature coefficient thermistors~~
~~Assessment level EZ~~

~~Group No.~~	~~Test~~	~~Subclause of this publication~~	~~Conditions of test and requirements~~	~~n [a]~~	~~c [b]~~
~~0~~	~~Visual examination~~ ~~Marking~~ ~~Dimensions (gauging)~~ ~~Zero-power resistance~~	~~4.3.1~~ ~~4.3.3~~ ~~4.3.4~~ ~~4.4.1~~	~~See 4.3.1 to 4.3.2~~ ~~For requirements, see Table A.1~~	~~90~~	~~0~~
~~1~~	~~Dimensions (detail)~~ ~~B-value or resistance ratio~~ ~~Resistance/temperature characteristic~~ ~~Resistance to soldering heat – dissolution of metallization~~	~~4.3.4~~ ~~4.4.2~~ ~~4.4.3~~ ~~4.6~~	~~For requirements, see Table A.1~~ ~~Choice to be made in the detail specification~~ ~~Measuring temperatures to be defined in the detail specification~~ ~~See 4.6~~	~~10~~	~~0~~
~~2~~	~~Solderability~~ ~~Solvent resistance of marking~~	~~4.7~~ ~~4.16~~	~~See 4.7.1 to 4.7.3~~	~~10~~	~~0~~
~~3~~	~~Resistance to soldering heat – dewetting~~	~~4.6~~	~~See 4.6.1 to 4.6.4~~	~~10~~	~~0~~
~~4~~	~~Mounting~~ ~~Visual examination~~ ~~Zero-power resistance~~	~~4.1~~ ~~4.3.1~~ ~~4.4.1~~		~~60~~	~~0~~
~~4.1~~	~~Dissipation factor~~ ~~Thermal time constant by cooling after self-heating (τ_e)~~	~~4.5.1~~ ~~4.5.2~~		~~10~~	~~0~~
~~4.2~~	~~Shear test~~ ~~Rapid change of temperature~~ ~~Climatic sequence~~	~~4.13~~ ~~4.8~~ ~~4.10~~		~~10~~	~~0~~
~~4.3~~	~~Damp heat, steady state~~	~~4.11~~		~~10~~	~~0~~
~~4.4~~	~~Endurance at θ_3 and P_{max}~~	~~4.12.1~~		~~10~~	~~0~~
~~4.5~~	~~Endurance at upper category temperature~~	~~4.12.2~~		~~10~~	~~0~~
~~5~~	~~Substrate bending test~~	~~4.14~~		~~10~~	~~0~~

~~[a] Number of specimens to be tested.~~

~~[b] Permissible numbers of non-conforming items.~~

~~3.5 Quality conformance inspection~~

~~3.5.1 Formation of inspection lots~~

~~a) Groups A and B inspection~~

~~These tests shall be carried out on a lot-by-lot basis.~~

~~A manufacturer may aggregate the current production into inspection lots subject to the following safeguards:~~

~~a) the inspection lot shall consist of structurally similar thermistors (see 3.2);~~

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~~b) for Group A the sample tested shall consist of each of the values and each of the dimensions contained in the inspection lot~~

~~– in relation to their number;~~

~~– with a minimum of five of any one value;~~

~~c) if there are less than five of any one value in the sample, the basis for the drawing of samples shall be agreed upon between the manufacturer and the National Supervising Inspectorate;~~

~~d) Group C inspection.~~

~~These tests shall be carried out on a periodic basis.~~

~~Samples shall be representative of the current production of the specified periods and shall be divided into small, medium and large sizes. In order to cover the range of approvals in any period, one rated zero-power resistance value shall be tested per group of sizes. In subsequent periods, other sizes and rated zero-power values in production shall be tested with the aim of covering the whole range.~~

~~3.5.2 Test schedule~~

~~The schedule for the lot-by-lot and periodic tests for quality conformance inspection is given in Clause 2, Table 4 of the blank detail specification.~~

~~3.5.3 Delayed delivery~~

~~When, according to the procedures of 3.7 of IEC 60539-1, re-inspection has to be made, solderability and zero-power resistance shall be checked as specified in Group A and Group B inspection.~~

~~3.5.4 Assessment level~~

~~The assessment level(s) given in the blank detail specification shall preferably be selected from Tables 3 and 4.~~

~~Table 3 – Lot-by-lot inspection~~

~~Inspection subgroup~~ ~~d)~~	~~EZ~~		
	~~*IL*~~ ~~a)~~	~~*n*~~ ~~a)~~	~~*c*~~ ~~a)~~
~~A0~~	~~100 %~~ ~~b)~~		
~~A1~~	~~S – 4~~	~~c)~~	~~0~~
~~A2~~	~~II~~	~~c)~~	~~0~~
~~B1~~	~~S – 3~~	~~c)~~	~~0~~
~~B2~~	~~S – 2~~	~~c)~~	~~0~~

~~a) *IL* = inspection level;~~
~~*n* = sample size;~~
~~*c* = permissible number of non-conforming items.~~

~~b) 100 % testing shall be followed by re-inspection by sampling in order to monitor outgoing quality level by non-conforming items per million (ppm). The sampling level shall be established by the manufacturer. For the calculation of ppm values, any parametric failure shall be counted as a non-conforming item. In case one or more non-conforming items occur in a sample, this lot shall be rejected.~~

~~c) Number to be tested: sample size as directly allotted to the code letter for *IL* in Table IIA of IEC 60410 (single sampling plan for normal inspection).~~

~~d) The content of the inspection subgroup is described in Clause 2 of the relevant blank detail specification.~~

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~~**Table 4 – Periodic test**~~

~~**Inspection subgroup** [b]~~	~~**EZ**~~		
	~~p [a]~~	~~n [a]~~	~~c [a]~~
~~C1~~	~~3~~	~~12~~	~~0~~
~~C2~~	~~3~~	~~12~~	~~0~~
~~C3.1~~	~~6~~	~~27~~	~~0~~
~~C3.2~~	~~6~~	~~15~~	~~0~~
~~C3.3~~	~~3~~	~~15~~	~~0~~
~~C3.4~~	~~6~~	~~15 [b]~~	~~0~~
~~C4~~	~~6~~	~~9~~	~~0~~

~~[a] p = periodicity in months;~~
~~n = sample size;~~
~~c = permissible number of non-conforming items.~~

~~[b] The content of the inspection subgroup is described in Clause 2 of the relevant blank detail specification.~~

See Annex B.

7 Test and measurement procedures

7.1 Mounting

See ~~4.27 of~~ IEC 60539-1:2016, 5.4.

7.2 Drying and recovery

7.2.1 Drying

Where drying is called for in this specification, the thermistor shall be conditioned as follows.

For 96 h ± 4 h in an oven at a temperature of 100 °C ± 5 °C, the thermistor shall then be allowed to cool in a desiccator using a suitable desiccant, such as activated alumina or silicagel, and shall be kept therein from the time of removal from the oven to the beginning of the specified tests.

7.2.2 Recovery

Unless otherwise specified, recovery shall take place under the standard atmospheric conditions for testing (see ~~4.2 of~~ IEC 60539-1:2016, 5.3.2).

7.3 Visual examination and check of dimensions

7.3.1 Visual examination

Visual examination shall be carried out with suitable equipment with approximately 10× magnification and lighting appropriate to the specimen under test and the quality level required.

~~NOTE~~ The operator should have facilities available for incident or transmitted illumination as well as an appropriate measuring facility.

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7.3.2 Requirements

7.3.2.1 General

Quantitative values for the requirements below may be given in the detail or in the manufacturer's specification.

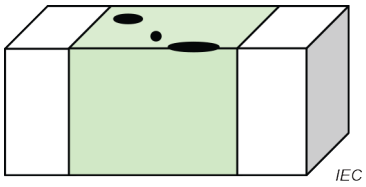
The thermistor shall conform to the following requirements.

7.3.2.2 Requirements for ceramic

Requirements for the ceramic are as follows:

1) Bulk type

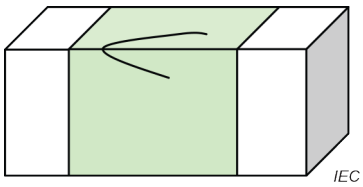
   a) It shall be free of fissures of coating glass longer than 25 % of dimension L_4 (see Annex A, Figure A.1) and defects of glass coating on each face greater than 10 % of the area of that face (see Figure 1).



NOTE Fissure on a corner and defect on one side.

Figure 1 – Fault: fissure or defect

   b) It shall be free of cracks, except for small damage on the surface, which does not impair the performance of the thermistor (see Figure 2).



NOTE Crack on one side or extending from one face to another over a corner.

Figure 2 – Fault: crack

2) Layered type

   a) It shall not exhibit visible separation or delamination between the layers of the thermistor (see Figure 3). Excluding the case when a few things which do not influence a characteristic of the surface implementation form an NTC thermistor, the surface shall not be cracked (see Figure 3).

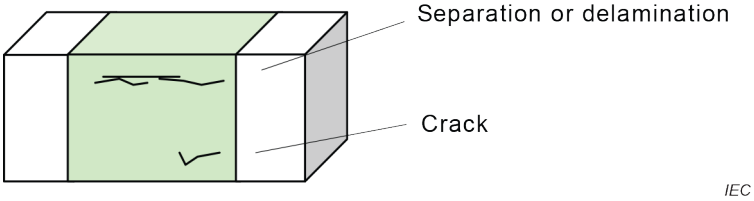


Figure 3 – Separation or delamination

   b) It shall not exhibit exposed electrodes between the two terminations (see Figure 4). It shall not exhibit any visible detachment of the metallized terminations nor any exposed electrodes (see Figure 4).

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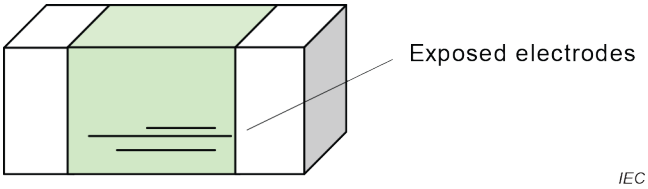

Figure 4 – Exposed electrodes

7.3.2.3 Requirements for the metallization

Requirements for the metallization are as follows:

The principal faces are those noted A, B, C, D and E (see Figure 5).

~~In the case of thermistors of square section, faces D and E are also considered principal.~~

a) Termination on bottom is the principal face noted C.

b) Terminations on 3 sides are the principal faces noted A, B and C.

a) Terminations on 5 sides are the principal faces noted A, B, C, D and E.

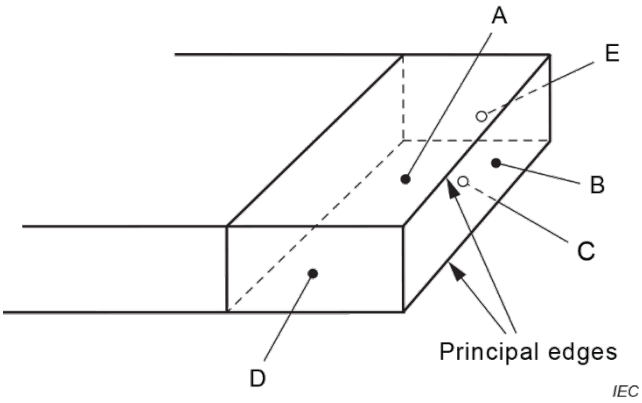

Figure 5 – Principal faces

The maximum area of gaps in metallization on each principal face shall not be greater than 15 % of the area of that face; these gaps shall not be concentrated in the same area. The gaps in metallization shall not affect the two principal edges of each extremity of the block (or four edges for square thermistors). Dissolution of the end-face plating (leaching) shall not exceed 25 % of the length of the edge concerned.

7.3.3 Marking

If there is marking on the body, it shall be legible as determined by visual examination.

a) Gull wing terminations are noted F in Figure 6.

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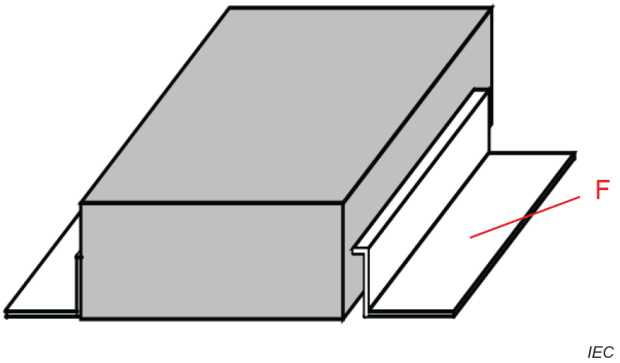

Figure 6 – Principal terminations – Gull wing

b) Round terminations are noted G in Figure 7.

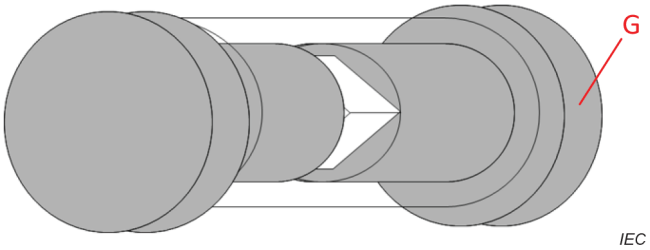

Figure 7 – Principal terminations – Round termination

The names of the structures of termination are in accordance with IEC 62137-3:2011.

7.3.4 Dimensions

The dimensions indicated in the detail specification shall be checked and shall comply with the values prescribed in Annex A.

7.4 Electrical tests

7.4.1 Zero-power resistance

See ~~4.5 of~~ IEC 60539-1:2016, 5.6, with the following details.

The zero-power resistance shall be measured at the temperature given in the detail specification and shall be within the limits specified in the detail specification, taking into account the tolerance.

7.4.2 *B*-value or resistance ratio

See ~~4.6 of~~ IEC 60539-1:2016, 5.7, with the following details:

– calculate the *B*-value or the resistance ratio using zero-power resistance values measured at 25 °C and 85 °C, unless otherwise specified in the detail specification;

– the *B*-value or the resistance ratio shall be within the tolerance specified in the detail specification.

7.4.3 Resistance/temperature characteristic

See ~~4.9 of~~ IEC 60539-1:2016, 5.10, with the following details:

– the measuring temperature shall be selected from those given in IEC 60539-1:2016, Table 1;

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– the resistance/temperature characteristic shall be within the limits specified in the detail specification.

7.5 Thermal tests

7.5.1 Dissipation factor (δ)

See ~~4.10 of~~ IEC 60539-1:2016, 5.11, with the following details:

– thermistors shall be mounted in accordance with 7.1;

– the zero-power resistance shall be measured at the temperature T_b, which is equivalent to 85 °C ± 0,1 °C unless otherwise prescribed in the detail specification;

– the dissipation factor shall be within the limits specified in the detail specification.

7.5.2 Thermal time constant by cooling after self-heating (τ_c)

See ~~4.12 of~~ IEC 60539-1:2016, 5.13, with the following details:

– the thermistors shall be mounted in accordance with 7.1;

– the thermal time constant by cooling after self-heating shall be within the limits prescribed in the detail specification.

7.6 Resistance to soldering heat

7.6.1 General

See IEC 60068-2-58:2015 with the following details.

7.6.2 Initial measurement

The zero-power resistance shall be measured in accordance with 7.4.1.

7.6.3 Test conditions

7.6.3.1 Solder bath method

~~See IEC 60068-2-58, Clauses 5 and 6 with the following details, if not otherwise specified in the detail specification:~~

~~– the specimen shall be preheated to a temperature of 110 °C to 140 °C and maintained for 30 s to 60 s;~~

~~– temperature: 260 °C ± 5 °C;~~

~~– duration of immersion: 10 s ± 1 s;~~

~~– depth of immersion: 10 mm;~~

~~– number of immersion: 1~~

See IEC 60068-2-58:2015, 7.5, unless otherwise specified in the detail specification.

~~**4.6.2.2 Infrared and forced gas convection soldering system**~~

~~See IEC 60068-2-58, Clauses 7 and 8 with the following details:~~

~~a) the solder paste shall be applied to the test substrate;~~

~~b) the thickness of the solder deposit shall be specified in the detail specification;~~

~~c) the terminations of the specimen shall be placed on solder paste;~~

~~d) the specimen and test substrate shall be preheated to a temperature of (150 ± 10) °C and maintained for 60 s to 120 s in an infrared and forced gas convection soldering system;~~

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~~e) the temperature of the reflow system shall be quickly raised until the specimen has reached (235 ± 5) °C and maintained at this temperature for (10 ± 1) s. Number of tests: 2;~~

~~f) the temperature profile shall be specified in the detail specification.~~

7.6.3.2 Reflow method

See IEC 60068-2-58:2015, 7.6, unless otherwise specified in the detail specification.

7.6.4 Recovery

The flux residues shall be removed with a suitable solvent.

7.6.5 Final inspection, measurements and requirements

After recovery, the surface mount thermistors shall be visually examined and measured and shall meet the following requirements.

Visual examination shall be specified in the detail specification with the following details:

– under normal lighting and approximately 10× magnification, there shall be no signs of damage such as cracks;

– dissolution of the end-face plating (leaching) shall not exceed 25 % of the length of the edge concerned.

The zero-power resistance shall be measured in accordance with 7.4.1 and the change shall not exceed ±5 %.

7.7 Solderability

7.7.1 General

See IEC 60068-2-58 with the following details:

7.7.2 Test conditions

7.7.2.1 Solder bath method

~~See IEC 60068-2-58, Clauses 5 and 6 with the following details, if not otherwise specified in the detail specification:~~

~~– the specimen shall be preheated to a temperature of 80 °C to 140 °C and maintained for 30 s to 60 s;~~

~~– temperature: 235 °C ± 5 °C;~~

~~– duration of immersion: 2 s ± 0,2 s;~~

~~– depth of immersion: 10 mm;~~

~~– number of immersion: 1~~

See IEC 60068-2-58:2015 and IEC 60068-2-58:2015/AMD1:2017, 6.5, unless otherwise specified in the detail specification.

~~**4.7.1.2 Infrared and forced gas convection soldering system**~~

~~See IEC 60068-2-58, Clauses 7 and 8 with the following details:~~

~~a) the solder paste shall be applied to the test substrate;~~

~~b) the thickness of the solder deposit shall be specified in the detail specification;~~

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~~c) the terminations of the specimen shall be placed on solder paste;~~

~~d) unless otherwise specified in the detail specification, the specimen and test substrate shall be preheated to a temperature of (150 ± 10) °C and maintained for 60 s to 120 s in infrared and forced gas convection soldering system;~~

~~e) the temperature of reflow system shall be quickly raised until the specimen has reached (215 ± 3) °C and maintained at this temperature for (10 ± 1) s;~~

~~f) the temperature profile shall be specified in the detail specification.~~

7.7.2.2 Reflow method

See IEC 60068-2-58:2015, 6.6, unless otherwise specified in the detail specification.

7.7.3 Recovery

The flux residues shall be removed with a suitable solvent.

7.7.4 Final inspection, measurements and requirements

See the detail specification with the following details:

– the surface mount thermistors shall be visually examined under normal lighting and approximately 10× magnification and there shall be no signs of damage;

– both the end face and the contact areas shall be covered with a smooth and bright solder coating with no more than a small amount of scattered imperfections such as pinholes or un-wetted or de-wetted areas. These imperfections shall not be concentrated in one area.

7.8 Rapid change of temperature

See ~~4.16 of~~ IEC 60539-1:2016, 5.17.

The thermistors shall be mounted in accordance with 7.1.

The zero-power resistance shall be measured in accordance with 7.4.1.

The test shall be carried out in accordance with IEC 60068-2-14, Test Na with the following conditions:

1) the lower temperature T_A shall be the lower category temperature;
2) the higher temperature T_B shall be the upper category temperature;
3) the number of cycles shall be 5;
4) the medium of the test chamber is air.

The thermistors shall be visually examined and the zero-power resistance shall be measured.

Under normal lighting and approximately 10× magnification, there shall be no signs of damage such as cracks.

The zero-power resistance change shall not exceed ±5 %.

7.9 Thermal shock

See ~~4.21 of~~ IEC 60539-1:2016, 5.21, with the following details:

– the thermistors shall be mounted in accordance with 7.1;

– the zero-power resistance shall be measured in accordance with 7.4.1.

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The test shall be carried out according to IEC 60068-2-14, Test Nc with the following details:

1) the lower temperature T_A shall be the lower category temperature;
2) the higher temperature T_B shall be the upper category temperature;
3) the exposure time t1 shall be 30 min;
4) the number of cycles shall be 5;
5) the medium of the test bath shall be oil.

The thermistors shall be visually examined and the zero-power resistance shall be measured.

Under normal lighting and approximately 10× magnification, there shall be no signs of damage such as cracks.

The zero-power resistance change shall not exceed ±5 %.

~~**4.10 Climatic sequence**~~

~~See 4.22 of IEC 60539-1 with the following details:~~

~~– the thermistors shall be mounted according to 4.1;~~

~~– the tests and measurements shall be performed in the following order.~~

~~**4.10.1 Initial measurements**~~

~~The thermistors shall be dried using procedure I of 4.3.1 of IEC 60539-1.~~

~~The zero-power resistance shall be measured according to 4.4.1.~~

~~**4.10.2 Dry heat**~~

~~The thermistors shall be subjected to the test described in 4.24 of IEC 60539-1 for a duration of 16 h.~~

~~**4.10.3 Damp heat (cyclic), first cycle**~~

~~The thermistors of categories –/–/56, –/–/42, –/–/21, –/–/10 and –/–/04 shall be subjected to test Db of IEC 60068-2-30 for one cycle of 24 h.~~

~~After recovery the thermistors shall be subjected immediately to the cold test.~~

~~**4.10.4 Cold**~~

~~The thermistors shall be subjected to the test described in 4.23 of IEC 60539-1 for a duration of 2 h.~~

~~**4.10.5 Damp heat (cyclic), remaining cycles**~~

~~The thermistors shall be subjected to Test Db of IEC 60068-2-30, for the number of cycles of 24 h shown in Table 5.~~

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~~**Table 5 – Number of cycles**~~

~~Categories~~	~~Number of cycles~~
~~–/ –/56~~	~~5~~
~~–/ –/42~~	~~5~~
~~–/ –/21~~	~~1~~
~~–/ –/10~~	~~1~~
~~–/ –/04~~	~~0~~

~~After the test, the thermistors shall be subjected to recovery according to 4.3.2 of IEC 60539-1.~~

~~**4.10.6 Final measurements**~~

~~The thermistors shall be visually examined and the zero-power resistance shall be measured.~~

~~Under normal lighting and approximately 10× magnification, there shall be no signs of damage such as cracks. The zero-power resistance change shall not exceed ±5 %~~

7.10 Damp heat, steady state

See ~~4.25 of~~ IEC 60539-1:2016, 5.24.

The thermistors shall be mounted in accordance with ~~4.1 of IEC 60539-1~~ 7.1.

The zero-power resistance shall be measured in accordance with ~~4.4.1 of IEC 60539-1~~ 7.4.1.

The thermistors shall be subjected to Test Cab of IEC 60068-2-78 using the severity corresponding to the climatic category of the thermistor as given in the detail specification.

At the end of the test, the thermistors shall be removed from the chamber and shall then be subjected to recovery in accordance with ~~4.3.2 of IEC 60539-1~~ 7.3.2.

The thermistors shall be visually examined, and the zero-power resistance shall be measured. Under normal lighting and approximately 10× magnification, there shall be no signs of damage such as cracks. The zero-power resistance change shall not exceed ±5 %.

7.11 Endurance

7.11.1 Endurance at ~~θ_3~~ T_3 and P_{max}

See ~~4.26.3 of~~ IEC 60539-1:2016, 5.25.4, with the following details:

– the thermistors shall be mounted in accordance with 7.1;

– the zero-power resistance shall be measured in accordance with 7.4.1;

– the thermistors shall be placed in a test chamber and subjected to the temperature ~~θ_3~~ T_3 ± 2 °C for 42 days (1 000 h) and at dissipation P_{max};

– after 168 h and 500 h, the thermistors shall be removed from the chamber and allowed to recover under standard atmospheric conditions of testing for not less than 1 h and not more than 2 h;

– the zero-power resistance shall be measured, and its change shall not exceed ±5 %;

– after intermediate measurements, the thermistors shall be returned to the test conditions. The interval between the removal from, and the return to, the test conditions for any thermistor shall not exceed 12 h;

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