

INTERNATIONAL STANDARD



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



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IECNORM.COM : Click to view the full text of IEC 60399-2:2019 RVV

INTERNATIONAL STANDARD



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.040.30

ISBN 978-2-8322-7199-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	5
1 General	7
1 Scope	7
2 Normative references	7
3 Terms and definitions	8
4 Information to be given in a detail specification	8
4.1 General	8
4.2 Outline drawing and dimensions	8
4.3 Mounting	8
4.4 Ratings and characteristics	8
4.4.1 Particular characteristics	8
4.4.2 Marking	8
Terminology	9
5 Preferred ratings and characteristics	9
5.1 Tolerances on rated zero-power resistance	9
5.2 Climatic categories	9
6 Quality assessment procedures	9
 Primary stage of manufacture	9
 Structurally similar components	9
 Qualification approval procedures	9
 The manufacturer shall comply with 3.4 of IEC 60539-1	9
 Quality conformance inspection	9
 Qualification approval on the basis of the fixed sample size procedure	9
 Quality conformance inspection	9
 Formation of inspection lots	9
 Test schedule	9
 Delayed delivery	9
 Assessment level	9
7 Test and measurement procedures	13
7.1 Mounting	13
7.2 Drying and recovery	13
7.2.1 Drying	13
7.2.2 Recovery	13
7.3 Visual examination and check of dimensions	13
7.3.1 Visual examination	13
7.3.2 Requirements	14
7.3.3 Marking	15
7.3.4 Dimensions	16
7.4 Electrical tests	16
7.4.1 Zero-power resistance	16
7.4.2 B-value or resistance ratio	16
7.4.3 Resistance/temperature characteristic	16
7.5 Thermal tests	17
7.5.1 Dissipation factor (δ)	17
7.5.2 Thermal time constant by cooling after self-heating (τ_c)	17

7.6	Resistance to soldering heat	17
7.6.1	General	17
7.6.2	Initial measurement	17
7.6.3	Test conditions	17
7.6.4	Recovery	18
7.6.5	Final inspection, measurements and requirements.....	18
7.7	Solderability.....	18
7.7.1	General	18
7.7.2	Test conditions	18
7.7.3	Recovery	19
7.7.4	Final inspection, measurements and requirements.....	19
7.8	Rapid change of temperature	19
7.9	Thermal shock	19
	Climatic sequence.....	
	Initial measurements	
	Dry heat	
	Damp heat (cyclic), first cycle	
	Cold.....	
	Damp heat (cyclic), remaining cycles	
	Final measurements	
7.10	Damp heat, steady state	21
7.11	Endurance	21
7.11.1	Endurance at T_3 and P_{max}	21
7.11.2	Endurance at upper category temperature	22
7.12	Shear (adhesion) test.....	22
7.13	Substrate bending test	22
7.14	Component solvent resistance	22
7.15	Solvent resistance of marking	22
Annex A	(normative) Guide for the specification and coding of dimensions of surface mount negative temperature coefficient thermistors	23
Annex B	(normative) Quality assessment procedure	25
B.1	Primary stage of manufacture	25
B.2	Structurally similar components	25
B.3	Qualification approval procedures	25
B.4	Quality conformance inspection	25
B.4.1	General	25
B.4.2	Qualification approval on the basis of the fixed sample size procedure	25
B.5	Quality conformance inspection	27
B.5.1	Formation of inspection lots	27
B.5.2	Test schedule	28
B.5.3	Delayed delivery	28
B.5.4	Assessment level.....	28
Figure 1	– Fault: fissure or defect	14
Figure 2	– Fault: crack	14
Figure 3	– Separation or delamination	14
Figure 4	– Exposed electrodes.....	15
Figure 5	– Principal faces	15

Figure 6 – Principal terminations – Gull wing	16
Figure 7 – Principal terminations – Round termination	16
Figure A.1 – Dimensioning of surface mount thermistors.....	23
Table 1 – Upper and lower category temperatures and duration of the damp heat test.....	9
Table A.1 – Dimensions	24
Table 2 B.1 – Fixed sample size test schedule for qualification approval of surface mount negative temperature coefficient thermistors Assessment level EZ.....	27
Table 3 B.2 – Lot-by-lot inspection.....	29
Table 4 B.3 – Periodic test.....	29
Table 5 – Number of cycles	

IECNORM.COM : Click to view the full PDF of IEC 60539-2:2019 RLV

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**DIRECTLY HEATED NEGATIVE TEMPERATURE
COEFFICIENT THERMISTORS –****Part 2: Sectional specification –
Surface mount negative temperature coefficient thermistors****FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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*

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.

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:

$\pm 0,5 \%$, $\pm 1 \%$, $\pm 2 \%$, $\pm 3 \%$, $\pm 5 \%$, $\pm 10 \%$.

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.~~

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

~~If required, more than 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.~~

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_0)	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 P_2 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);~~

- 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		
	<i>IL</i> ^{a)}	<i>n</i> ^{a)}	<i>c</i> ^{a)}
A0	100 % ^{b)}		
A1	S—4	e)	0
A2	II	e)	0
B1	S—3	e)	0
B2	S—2	e)	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.~~

^{e)} ~~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.~~

Table 4 — Periodic test

Inspection subgroup ^{b)}	EZ		
	$p^{a)}$	$n^{a)}$	$c^{a)}$
G1	3	12	0
G2	3	12	0
G3.1	6	27	0
G3.2	6	15	0
G3.3	3	15	0
G3.4	6	15 ^{b)}	0
G4	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 $96\text{ h} \pm 4\text{ h}$ in an oven at a temperature of $100\text{ °C} \pm 5\text{ °C}$, 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.

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.

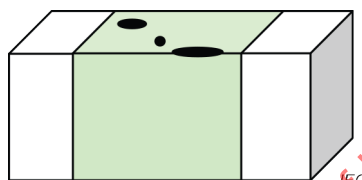
The thermistor shall conform to the following requirements.

7.3.2.2 Requirements for ceramic

Requirements for the ceramic are as follows:

1) Bulk type

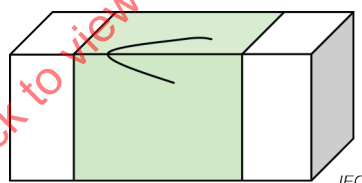
- a) It shall be free of fissures of coating glass longer than 25 % of dimension L_4 (see Annex A, Figure A.1) and defects of glass coating on each face greater than 10 % of the area of that face (see Figure 1).



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).

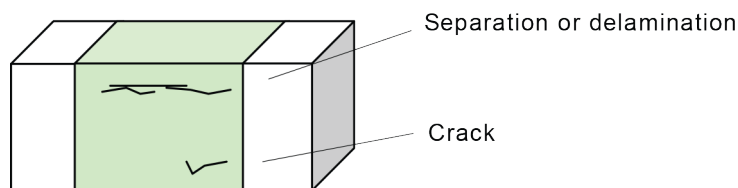
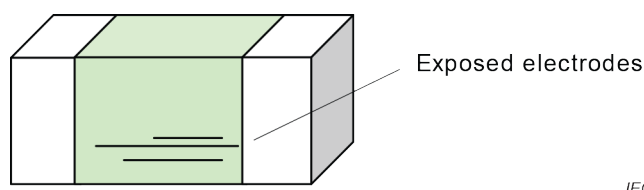


Figure 3 – Separation or delamination

- 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).



IEC

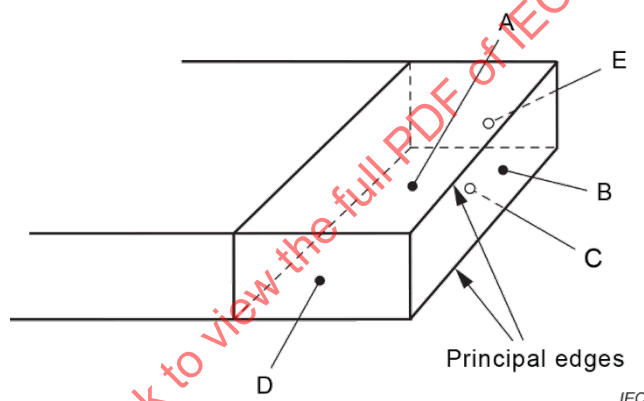
Figure 4 – Exposed electrodes**7.3.2.3 Requirements for the metallization**

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.



IEC

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.

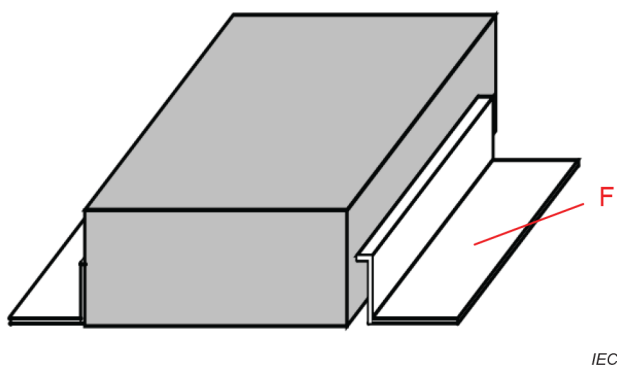


Figure 6 – Principal terminations – Gull wing

b) Round terminations are noted G in Figure 7.

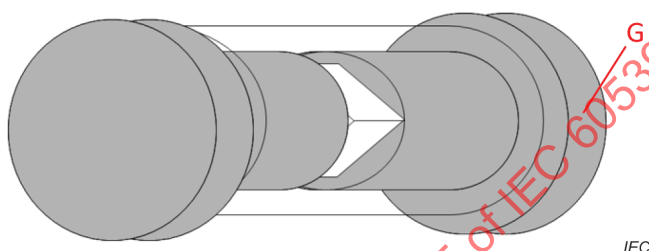


Figure 7 – Principal terminations – Round termination

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;

- 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 $85\text{ °C} \pm 0,1\text{ °C}$ 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: $260\text{ °C} \pm 5\text{ °C}$;~~
- ~~— duration of immersion: $10\text{ s} \pm 1\text{ s}$;~~
- ~~— 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 $(150 \pm 10)\text{ °C}$ and maintained for 60 s to 120 s in an infrared and forced gas convection soldering system;~~

- ~~e) the temperature of the reflow system shall be quickly raised until the specimen has reached $(235 \pm 5)^\circ\text{C}$ 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 $10\times$ 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: $235^\circ\text{C} \pm 5^\circ\text{C}$;~~
- ~~— duration of immersion: $2\text{ s} \pm 0,2\text{ s}$;~~
- ~~— 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;~~

- ~~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 $(150 \pm 10)^\circ\text{C}$ 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 $(215 \pm 3)^\circ\text{C}$ 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 $\pm 5\%$.

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.

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 t_1 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 $\pm 5\%$.

~~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.~~

Table 5 — Number of cycles

Categories	Number of cycles
—/56	5
—/42	5
—/21	4
—/10	4
—/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 $T_3 \pm 2$ °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;

- after 1 000 h $\pm$ 48 h, the thermistors shall be removed and allowed to recover under standard atmospheric conditions for a period of 1 h to 2 h;
- the thermistors shall be visually examined, and the zero-power resistance shall be measured. Under normal lighting and approximately 10 $\times$ magnification, there shall be no signs of damage such as cracks. The zero-power resistance change shall not exceed ± 5 %.

7.11.2 Endurance at upper category temperature

See ~~4.26.4 of~~ IEC 60539-1:2016, 5.25, 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 upper category temperature ± 2 °C and zero dissipation for 1 000 h. The chamber shall meet the requirements of that specified for Test Ba of IEC 60068-2-2;
- 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;
- after 1 000 h $\pm$ 48 h, the thermistors shall be removed and allowed to recover under standard atmospheric conditions for a period of 1 h to 2 h;
- the thermistors shall be visually examined, and the zero-power resistance shall be measured. Under normal lighting and approximately 10 $\times$ magnification, there shall be no signs of damage such as cracks. The zero-power resistance change shall not exceed ± 5 %.

7.12 Shear (adhesion) test

See ~~4.28 of~~ IEC 60539-1:2016, 5.26.

7.13 Substrate bending test

See ~~4.29 of~~ IEC 60539-1:2016, 5.27, with the following details:

- deflection D and the number of bends shall be specified in the detail specification;
- the zero-power resistance change shall not exceed ± 5 %.

7.14 Component solvent resistance

See ~~4.30 of~~ IEC 60539-1:2016, 5.28, with the following details:

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

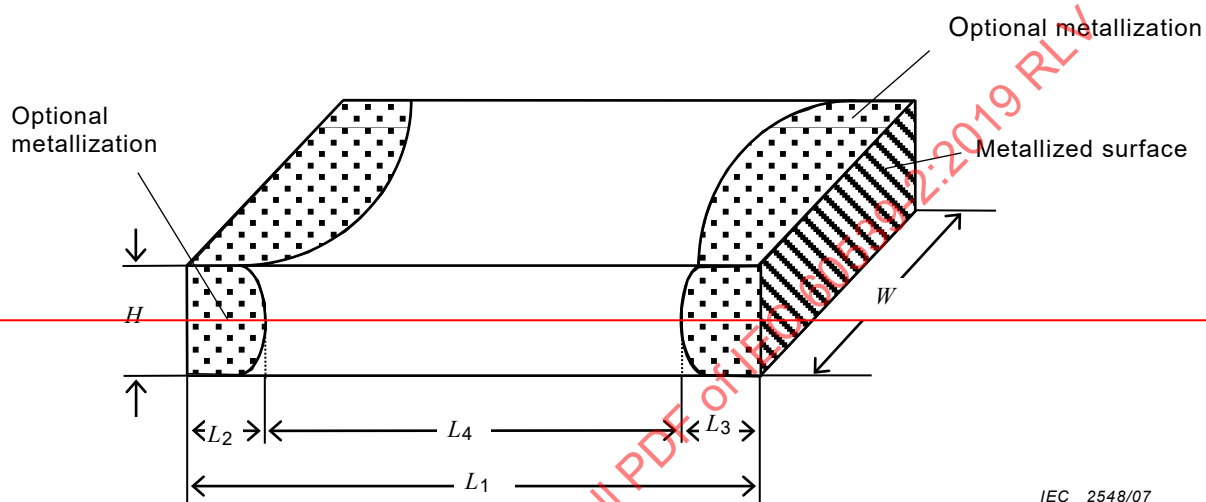
7.15 Solvent resistance of marking

See ~~4.31 of~~ IEC 60539-1:2016, 5.29.

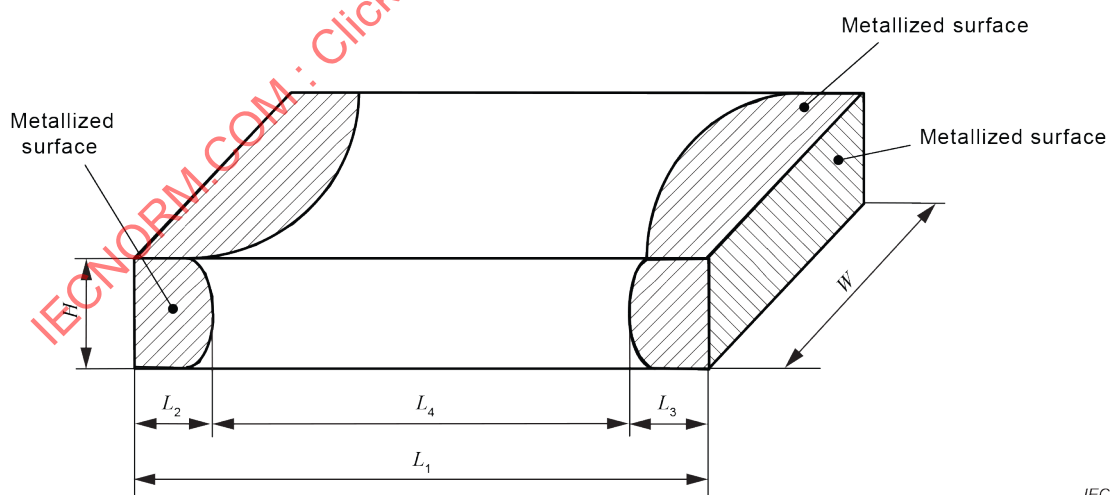
Annex A (normative)

Guide for the specification and coding of dimensions of surface mount negative temperature coefficient thermistors

The following principles should be considered in the dimensioning of surface mount negative temperature coefficient thermistors.



~~The end surfaces (indicated by crosshatch ) shall be metallized; the other surfaces, (indicated by hatch ) , are metallized at the option of the manufacturer.~~



Dimension W should not exceed dimension L_1 .

Dimension H should not exceed dimension W .

If necessary, the thickness of tinning should be specified.

Figure A.1 – Dimensioning of surface mount thermistors

Table A.1 – Dimensions

Dimension in millimetres

Code	Length L_1	Width W	L_2 and L_3 Minimum	L_4 Minimum
0402 M	$0,4 \pm 0,05$	$0,2 \pm 0,05$	0,05	0,10
0603 M	$0,6 \pm 0,05$	$0,3 \pm 0,05$	0,1	0,15
1005 M	$1,0 \pm 0,15$	$0,5 \pm 0,15$	0,1	0,25
1608 M	$1,6 \pm 0,15$	$0,8 \pm 0,15$	0,2	0,35
2012 M	$2,0 \pm 0,2$	$1,25 \pm 0,2$	0,2	0,50
3216 M	$3,2 \pm 0,2$	$1,6 \pm 0,2$	0,3	1,4
3225 M	$3,2 \pm 0,2$	$2,5 \pm 0,3$	0,4	1,4

Other case sizes and dimensions may be specified in the detail specification.

IECNORM.COM : Click to view the full PDF of IEC 60539-2:2019 RLV

Annex B (normative)

Quality assessment procedure

B.1 Primary stage of manufacture

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

B.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 IEC 60539-1:2016, Q.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.

B.3 Qualification approval procedures

The manufacturer shall comply with IEC 60539-1:2016, Q.4.

B.4 Quality conformance inspection

B.4.1 General

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.

Inspection levels and sampling plans shall be selected from those given in IEC 61193-2.

If required, more than one test schedule may be specified.

B.4.2 Qualification approval on the basis of the fixed sample size procedure

B.4.2.1 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 that are defective because of incidents not attributable to the manufacturer.

B.4.2.2 Tests

The complete series of tests specified in Table B.1 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 to be 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.

IECNORM.COM : Click to view the full PDF of IEC 60539-2:2019 RLV

Table B.1 – 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	7.3.1 7.3.3 7.3.4 7.4.1	See 7.3.1 to 7.3.2 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	7.3.4 7.4.2 7.4.3 7.6	For requirements, see Table A.1 Choice to be made in the detail specification Measuring temperatures to be defined in the detail specification See 7.6	10	0
2	Solderability Solvent resistance of marking	7.7 7.15	See 7.7.1 to 7.7.3	10	0
3	Resistance to soldering heat – dewetting	7.6	See 7.6.1 to 7.6.4	10	0
4	Mounting Visual examination Zero-power resistance	7.1 7.3.1 7.4.1		60	0
4.1	Dissipation factor Thermal time constant by cooling after self-heating (τ_c)	7.5.1 7.6.2		10	0
4.2	Shear test Rapid change of temperature	7.12 7.8		10	0
4.3	Damp heat, steady state	7.10		10	0
4.4	Endurance at T_3 and P_{max}	7.11.1		10	0
4.5	Endurance at upper category temperature	7.11.2		10	0
5	Substrate bending test	7.13		10	0

^a Number of specimens to be tested.

^b Permissible numbers of non-conforming items.

B.5 Quality conformance inspection

B.5.1 Formation of inspection lots

B.5.1.1 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:

- the inspection lot shall consist of structurally similar thermistors (see B.2);
- 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 fewer 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 Certification Body (CB).

B.5.1.2 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.

B.5.2 Test schedule

The schedule for the lot-by-lot and periodic tests for quality conformance inspection is given in the blank detail specification.

B.5.3 Delayed delivery

When, according to the procedures of IEC 60539-1:2016, Q.7, re-inspection has to be made, solderability and zero-power resistance shall be checked as specified in the inspection of Group A and Group B.

B.5.4 Assessment level

The assessment level(s) given in the blank detail specification shall preferably be selected from Table B.2 and Table B.3.

IECNORM.COM : Click to view the full PDF of IEC 60539-2:2019 RLV

Table B.2 – 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 The inspection shall be performed after removal of nonconforming items by 100 % testing during the manufacturing process. Whether the lot was accepted or not, all samples for sampling inspection shall be inspected in order to monitor outgoing quality level by nonconforming items per million ($\times 10^{-6}$). The sampling level shall be established by the manufacturer, preferably in accordance with IEC 61193-2:2007, Annex A. In the case that 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. Outgoing quality level by nonconforming items per million ($\times 10^{-6}$) values shall be calculated by accumulating inspection data in accordance with the method given in IEC 61193-2:2007, 6.2. ^c Number to be tested: sample size shall be determined in accordance with IEC 61193-2:2007, 4.3.2. ^d The content of the inspection subgroup is described in the relevant blank detail specification.			

Table B.3 – 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	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 the relevant blank detail specification.			

IECNORM.COM : Click to view the full PDF of IEC 60539-2:2019 RLV

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Thermistances à coefficient de température négatif à chauffage direct –
Partie 2: Spécification intermédiaire – Thermistances à coefficient de
température négatif pour montage en surface**

CONTENTS

FOREWORD	4
1 Scope	6
2 Normative references	6
3 Terms and definitions	6
4 Information to be given in a detail specification	7
4.1 General	7
4.2 Outline drawing and dimensions	7
4.3 Mounting	7
4.4 Ratings and characteristics	7
4.4.1 Particular characteristics	7
4.4.2 Marking	7
5 Preferred ratings and characteristics	7
5.1 Tolerances on rated zero-power resistance	7
5.2 Climatic categories	8
6 Quality assessment procedures	8
7 Test and measurement procedures	8
7.1 Mounting	8
7.2 Drying and recovery	8
7.2.1 Drying	8
7.2.2 Recovery	8
7.3 Visual examination and check of dimensions	8
7.3.1 Visual examination	8
7.3.2 Requirements	9
7.3.3 Marking	10
7.3.4 Dimensions	11
7.4 Electrical tests	11
7.4.1 Zero-power resistance	11
7.4.2 B -value or resistance ratio	11
7.4.3 Resistance/temperature characteristic	11
7.5 Thermal tests	12
7.5.1 Dissipation factor (δ)	12
7.5.2 Thermal time constant by cooling after self-heating (τ_c)	12
7.6 Resistance to soldering heat	12
7.6.1 General	12
7.6.2 Initial measurement	12
7.6.3 Test conditions	12
7.6.4 Recovery	12
7.6.5 Final inspection, measurements and requirements	12
7.7 Solderability	13
7.7.1 General	13
7.7.2 Test conditions	13
7.7.3 Recovery	13
7.7.4 Final inspection, measurements and requirements	13
7.8 Rapid change of temperature	13
7.9 Thermal shock	13

7.10	Damp heat, steady state	14
7.11	Endurance	14
7.11.1	Endurance at T_3 and $P_{\max}$	14
7.11.2	Endurance at upper category temperature	15
7.12	Shear (adhesion) test.....	15
7.13	Substrate bending test	15
7.14	Component solvent resistance	15
7.15	Solvent resistance of marking	15
Annex A (normative) Guide for the specification and coding of dimensions of surface mount negative temperature coefficient thermistors		16
Annex B (normative) Quality assessment procedure		17
B.1	Primary stage of manufacture	17
B.2	Structurally similar components	17
B.3	Qualification approval procedures	17
B.4	Quality conformance inspection	17
B.4.1	General	17
B.4.2	Qualification approval on the basis of the fixed sample size procedure	17
B.5	Quality conformance inspection	19
B.5.1	Formation of inspection lots	19
B.5.2	Test schedule	20
B.5.3	Delayed delivery	20
B.5.4	Assessment level.....	20
Figure 1 – Fault: fissure or defect		9
Figure 2 – Fault: crack		9
Figure 3 – Separation or delamination		9
Figure 4 – Exposed electrodes.....		10
Figure 5 – Principal faces		10
Figure 6 – Principal terminations – Gull wing		11
Figure 7 – Principal terminations – Round termination		11
Figure A.1 – Dimensioning of surface mount thermistors.....		16
Table 1 – Upper and lower category temperatures and duration of the damp heat test.....		8
Table A.1 – Dimensions		16
Table B.1 – Fixed sample size test schedule for qualification approval of surface mount negative temperature coefficient thermistors Assessment level EZ		19
Table B.2 – Lot-by-lot inspection.....		20
Table B.3 – Periodic test.....		21

INTERNATIONAL ELECTROTECHNICAL COMMISSION

DIRECTLY HEATED NEGATIVE TEMPERATURE COEFFICIENT THERMISTORS –

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

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

DIRECTLY HEATED NEGATIVE TEMPERATURE COEFFICIENT THERMISTORS –

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

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 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Tests B: Dry heat*

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

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

IEC 60068-2-58:2015/AMD1:2017

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

IEC 60539-1:2016, *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*

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.

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 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 IEC 60539-1:2016, 4.3.

5 Preferred ratings and characteristics

5.1 Tolerances on rated zero-power resistance

Preferred values of tolerances on zero-power resistance are:

$\pm 0,5 \%$, $\pm 1 \%$, $\pm 2 \%$, $\pm 3 \%$, $\pm 5 \%$, $\pm 10 \%$.

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

See Annex B.

7 Test and measurement procedures

7.1 Mounting

See 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 $96 \text{ h} \pm 4 \text{ h}$ in an oven at a temperature of $100 \text{ °C} \pm 5 \text{ °C}$, 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 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.

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

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.

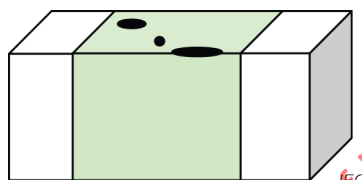
The thermistor shall conform to the following requirements.

7.3.2.2 Requirements for ceramic

Requirements for the ceramic are as follows:

1) Bulk type

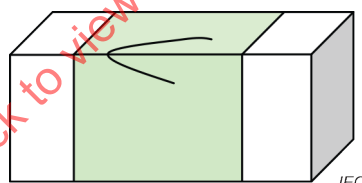
- a) It shall be free of fissures of coating glass longer than 25 % of dimension L_4 (see Annex A, Figure A.1) and defects of glass coating on each face greater than 10 % of the area of that face (see Figure 1).



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).

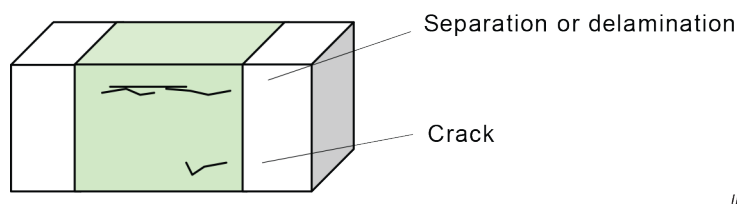


Figure 3 – Separation or delamination

- 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).

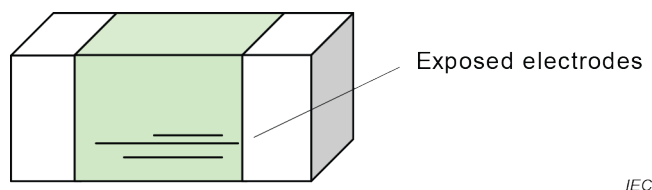


Figure 4 – Exposed electrodes

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).

- a) Termination on bottom is the principal face noted C.
- b) Terminations on 3 sides are the principal faces noted A, B and C.
- c) Terminations on 5 sides are the principal faces noted A, B, C, D and E.

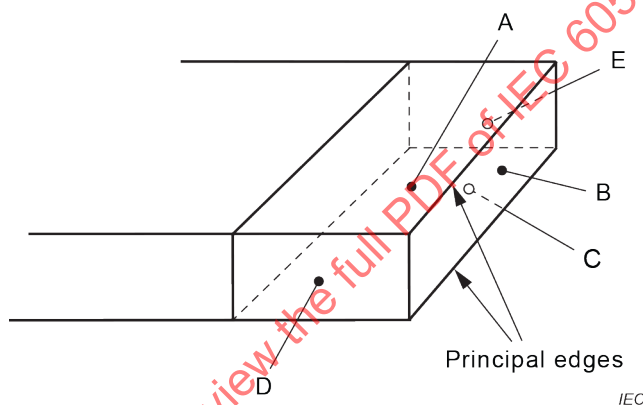


Figure 5 – Principal faces

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.

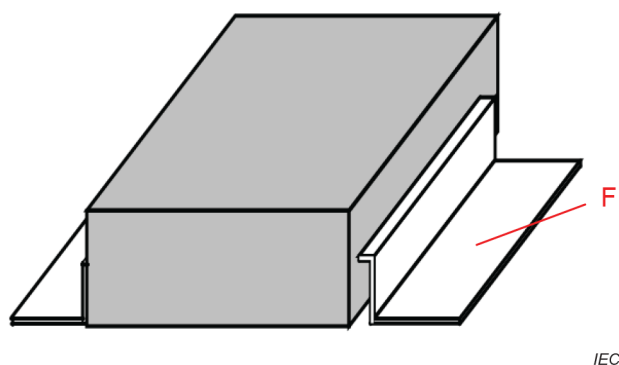


Figure 6 – Principal terminations – Gull wing

b) Round terminations are noted G in Figure 7.

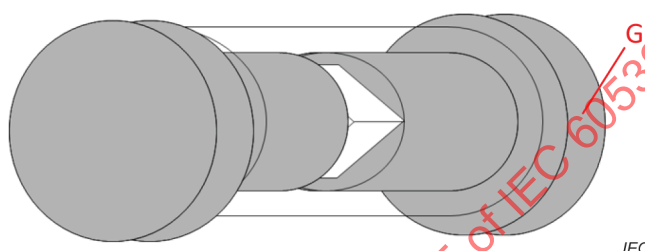


Figure 7 – Principal terminations – Round termination

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 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 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 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;

- 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 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 $85\text{ °C} \pm 0,1\text{ °C}$ 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 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 60068-2-58:2015, 7.5, unless otherwise 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 $\pm 5\%$.

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 60068-2-58:2015 and IEC 60068-2-58:2015/AMD1:2017, 6.5, unless otherwise 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 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 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.

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 t_1 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 $\pm 5\%$.

7.10 Damp heat, steady state

See IEC 60539-1:2016, 5.24.

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 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 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 $\pm 5\%$.

7.11 Endurance

7.11.1 Endurance at T_3 and $P_{\max}$

See 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 $T_3 \pm 2^\circ\text{C}$ 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 $\pm 5\%$;
- 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;
- after 1 000 h $\pm$ 48 h, the thermistors shall be removed and allowed to recover under standard atmospheric conditions for a period of 1 h to 2 h;

- 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 %.

7.11.2 Endurance at upper category temperature

See IEC 60539-1:2016, 5.25, 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 upper category temperature ± 2 °C and zero dissipation for 1 000 h. The chamber shall meet the requirements of that specified for Test Ba of IEC 60068-2-2;
- 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;
- after 1 000 h $\pm$ 48 h, the thermistors shall be removed and allowed to recover under standard atmospheric conditions for a period of 1 h to 2 h;
- 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 %.

7.12 Shear (adhesion) test

See IEC 60539-1:2016, 5.26.

7.13 Substrate bending test

See IEC 60539-1:2016, 5.27, with the following details:

- deflection D and the number of bends shall be specified in the detail specification;
- the zero-power resistance change shall not exceed ± 5 %.

7.14 Component solvent resistance

See IEC 60539-1:2016, 5.28, with the following details:

- before and after the test, the zero-power resistance shall be measured.
- 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 %.

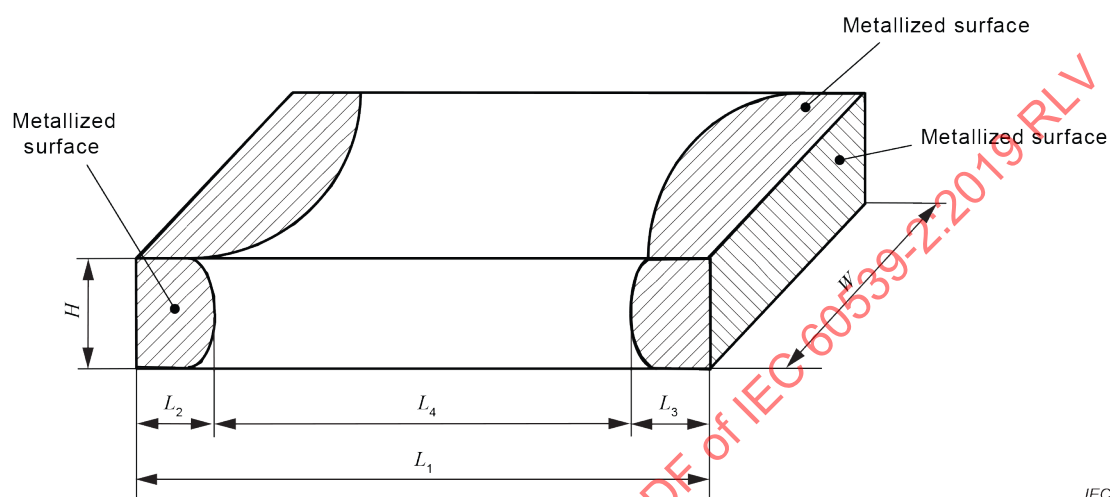
7.15 Solvent resistance of marking

See IEC 60539-1:2016, 5.29.

Annex A (normative)

Guide for the specification and coding of dimensions of surface mount negative temperature coefficient thermistors

The following principles should be considered in the dimensioning of surface mount negative temperature coefficient thermistors.



IEC

Dimension W should not exceed dimension L_1 .

Dimension H should not exceed dimension W .

If necessary, the thickness of tinning should be specified.

Figure A.1 – Dimensioning of surface mount thermistors

Table A.1 – Dimensions

Code	Dimension in millimetres			
	Length L_1	Width W	L_2 and L_3 Minimum	L_4 Minimum
0402 M	$0,4 \pm 0,05$	$0,2 \pm 0,05$	0,05	0,10
0603 M	$0,6 \pm 0,05$	$0,3 \pm 0,05$	0,1	0,15
1005 M	$1,0 \pm 0,15$	$0,5 \pm 0,15$	0,1	0,25
1608 M	$1,6 \pm 0,15$	$0,8 \pm 0,15$	0,2	0,35
2012 M	$2,0 \pm 0,2$	$1,25 \pm 0,2$	0,2	0,50
3216 M	$3,2 \pm 0,2$	$1,6 \pm 0,2$	0,3	1,4
3225 M	$3,2 \pm 0,2$	$2,5 \pm 0,3$	0,4	1,4

Other case sizes and dimensions may be specified in the detail specification.

Annex B (normative)

Quality assessment procedure

B.1 Primary stage of manufacture

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

B.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 IEC 60539-1:2016, Q.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.

B.3 Qualification approval procedures

The manufacturer shall comply with IEC 60539-1:2016, Q.4.

B.4 Quality conformance inspection

B.4.1 General

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.

Inspection levels and sampling plans shall be selected from those given in IEC 61193-2.

If required, more than one test schedule may be specified.

B.4.2 Qualification approval on the basis of the fixed sample size procedure

B.4.2.1 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 that are defective because of incidents not attributable to the manufacturer.

B.4.2.2 Tests

The complete series of tests specified in Table B.1 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 to be 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.

IECNORM.COM : Click to view the full PDF of IEC 60539-2:2019 REV

Table B.1 – 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	7.3.1 7.3.3 7.3.4 7.4.1	See 7.3.1 to 7.3.2 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	7.3.4 7.4.2 7.4.3 7.6	For requirements, see Table A.1 Choice to be made in the detail specification Measuring temperatures to be defined in the detail specification See 7.6	10	0
2	Solderability Solvent resistance of marking	7.7 7.15	See 7.7.1 to 7.7.3	10	0
3	Resistance to soldering heat – dewetting	7.6	See 7.6.1 to 7.6.4	10	0
4	Mounting Visual examination Zero-power resistance	7.1 7.3.1 7.4.1		60	0
4.1	Dissipation factor Thermal time constant by cooling after self-heating (τ_c)	7.5.1 7.5.2		10	0
4.2	Shear test Rapid change of temperature	7.12 7.8		10	0
4.3	Damp heat, steady state	7.10		10	0
4.4	Endurance at T_3 and P_{max}	7.11.1		10	0
4.5	Endurance at upper category temperature	7.11.2		10	0
5	Substrate bending test	7.13		10	0
^a Number of specimens to be tested.					
^b Permissible numbers of non-conforming items.					

B.5 Quality conformance inspection

B.5.1 Formation of inspection lots

B.5.1.1 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:

- the inspection lot shall consist of structurally similar thermistors (see B.2);
- 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 fewer 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 Certification Body (CB).

B.5.1.2 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.

B.5.2 Test schedule

The schedule for the lot-by-lot and periodic tests for quality conformance inspection is given in the blank detail specification.

B.5.3 Delayed delivery

When, according to the procedures of IEC 60539-1:2016, Q.7, re-inspection has to be made, solderability and zero-power resistance shall be checked as specified in the inspection of Group A and Group B.

B.5.4 Assessment level

The assessment level(s) given in the blank detail specification shall preferably be selected from Table B.2 and Table B.3.

Table B.2 – 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 The inspection shall be performed after removal of nonconforming items by 100 % testing during the manufacturing process. Whether the lot was accepted or not, all samples for sampling inspection shall be inspected in order to monitor outgoing quality level by nonconforming items per million ($\times 10^{-6}$). The sampling level shall be established by the manufacturer, preferably in accordance with IEC 61193-2:2007, Annex A. In the case that 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. Outgoing quality level by nonconforming items per million ($\times 10^{-6}$) values shall be calculated by accumulating inspection data in accordance with the method given in IEC 61193-2:2007, 6.2.			
^c Number to be tested: sample size shall be determined in accordance with IEC 61193-2:2007, 4.3.2.			
^d The content of the inspection subgroup is described in the relevant blank detail specification.			

Table B.3 – 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	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 the relevant blank detail specification.			

IECNORM.COM : Click to view the full PDF of IEC 60539-2:2019 RLV

SOMMAIRE

AVANT-PROPOS	24
1 Domaine d'application	26
2 Références normatives	26
3 Termes et définitions	26
4 Informations devant figurer dans une spécification particulière	27
4.1 Généralités	27
4.2 Dessin d'encombrement et dimensions	27
4.3 Montage.....	27
4.4 Valeurs assignées et caractéristiques	27
4.4.1 Caractéristiques particulières	27
4.4.2 Marquage	27
5 Valeurs assignées et caractéristiques préférentielles.....	27
5.1 Tolérances sur la résistance de puissance nulle assignée	27
5.2 Catégories climatiques.....	28
6 Procédures d'assurance de la qualité	28
7 Procédures d'essais et de mesures	28
7.1 Montage.....	28
7.2 Séchage et rétablissement.....	28
7.2.1 Séchage	28
7.2.2 Rétablissement.....	28
7.3 Examen visuel et contrôle des dimensions	28
7.3.1 Examen visuel	28
7.3.2 Exigences.....	29
7.3.3 Marquage	30
7.3.4 Dimensions.....	31
7.4 Essais électriques.....	31
7.4.1 Résistance de puissance nulle.....	31
7.4.2 Valeur B ou rapport de résistance	31
7.4.3 Caractéristique résistance/température.....	31
7.5 Essais thermiques.....	32
7.5.1 Facteur de dissipation (δ)	32
7.5.2 Constante de temps thermique par refroidissement après auto- échauffement (τ_c)	32
7.6 Résistance à la chaleur de brasage	32
7.6.1 Généralités	32
7.6.2 Mesure initiale	32
7.6.3 Conditions d'essai	32
7.6.4 Rétablissement.....	32
7.6.5 Exigences, mesures et contrôle final.....	32
7.7 Brasabilité.....	33
7.7.1 Généralités	33
7.7.2 Conditions d'essai	33
7.7.3 Rétablissement.....	33
7.7.4 Exigences, mesures et contrôle final.....	33
7.8 Variations rapides de température	33

7.9	Choc thermique	34
7.10	Essai continu de chaleur humide.....	34
7.11	Endurance	34
7.11.1	Endurance à T_3 et $P_{\max}$	34
7.11.2	Endurance à la température maximale de catégorie.....	35
7.12	Essai de cisaillement (adhérence).....	35
7.13	Essai de courbure du substrat.....	35
7.14	Résistance au solvant des composants.....	35
7.15	Résistance au solvant du marquage.....	36
Annexe A (normative) Guide pour la spécification et le codage des dimensions des thermistances à coefficient de température négatif pour montage en surface.....		37
Annexe B (normative) Procédure d'assurance qualité		38
B.1	Étape initiale de fabrication.....	38
B.2	Modèles associables.....	38
B.3	Procédures d'homologation.....	38
B.4	Contrôle de conformité de la qualité.....	38
B.4.1	Généralités	38
B.4.2	Homologation s'appuyant sur la procédure utilisant un nombre d'échantillons fixe	38
B.5	Contrôle de conformité de la qualité.....	40
B.5.1	Formation des lots de contrôle.....	40
B.5.2	Programme d'essais	41
B.5.3	Livraison différée	41
B.5.4	Niveau d'assurance de la qualité	41
Figure 1 – Anomalie: fente ou défaut		29
Figure 2 – Anomalie: fissure		29
Figure 3 – Séparation ou décollement interlaminaire.....		29
Figure 4 – Electrodes exposées.....		30
Figure 5 – Faces principales.....		30
Figure 6 – Bornes principales – Aile de mouette		31
Figure 7 – Bornes principales – Bornes circulaires.....		31
Figure A.1 – Dimensionnement des thermistances pour montage en surface		37
Tableau 1 – Températures minimale et maximale de catégorie et durée de l'essai de chaleur humide		28
Tableau A.1 – Dimensions		37
Tableau B.1 – Programme d'essais avec un nombre d'échantillons fixe pour l'homologation de thermistances à coefficient de température négatif pour montage en surface Niveau d'assurance EZ.....		40
Tableau B.2 – Contrôle lot par lot		42
Tableau B.3 – Essai périodique		42

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

THERMISTANCES À COEFFICIENT DE TEMPÉRATURE NÉGATIF À CHAUFFAGE DIRECT –

Partie 2: Spécification intermédiaire – Thermistances à coefficient de température négatif pour montage en surface

AVANT-PROPOS

- 1) La Commission Electrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. A cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
- 2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
- 3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
- 4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
- 5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
- 6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
- 7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
- 8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
- 9) L'attention est attirée sur le fait que certains des éléments de la présente publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de propriété et averti de leur existence.

La Norme internationale IEC 60539-2 a été établie par le comité d'études 40 de l'IEC: Condensateurs et résistances pour équipements électroniques.

Cette deuxième édition annule et remplace la première édition publiée en 2003, ainsi que son amendement 1:2010, dont elle constitue une révision technique.

La présente édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) révision de la structure conformément aux directives ISO/IEC, Partie 2:2016 (septième édition), dans la mesure du possible, et pour l'harmonisation avec l'IEC 60539-1:2016;

- b) les températures maximales de catégorie 175 °C, 200 °C, 250 °C, 315 °C, 400 °C ont été ajoutées dans le Tableau 1;
- c) les dimensions de 0402M à l'Annexe A ont été ajoutées.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
40/2672/FDIS	40/2680/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 60539, publiées sous le titre général *Thermistances à coefficient de température négatif à chauffage direct*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "<http://webstore.iec.ch>" dans les données relatives au document recherché. A cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

IMPORTANT – Le logo "colour inside" qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer cette publication en utilisant une imprimante couleur.

THERMISTANCES À COEFFICIENT DE TEMPÉRATURE NÉGATIF À CHAUFFAGE DIRECT –

Partie 2: Spécification intermédiaire – Thermistances à coefficient de température négatif pour montage en surface

1 Domaine d'application

La présente partie de l'IEC 60539 s'applique aux thermistances à coefficient de température négatif à chauffage direct pour montage en surface, typiquement constituées de matériaux faits d'oxyde de métal de transition dotés de propriétés semi-conductrices. Ces thermistances sont équipées de contacts de connexion métallisés ou de bandes de brasure et sont destinées à être montées directement sur des substrats pour circuits hybrides ou sur des cartes imprimées.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60068-2-2:2007, *Essais d'environnement – Partie 2-2: Essais – Essais B: Chaleur sèche*

IEC 60068-2-14:2009, *Essais d'environnement – Partie 2-14: Essais – Essai N: Variations de température*

IEC 60068-2-58:2015, *Essais d'environnement – Partie 2-58: Essais – Essai Td: Méthodes d'essai de la soudabilité, résistance de la métallisation à la dissolution et résistance à la chaleur de brasage des composants pour montage en surface (CMS)*
IEC 60068-2-58:2015/AMD1:2017

IEC 60068-2-78, *Essais d'environnement – Partie 2-78: Essais – Essai Cab: Essai continu de chaleur humide*

IEC 60539-1:2016, *Thermistances à coefficient de température négatif à chauffage direct – Partie 1: Spécification générique*

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

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'IEC 60539-1 s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse <http://www.electropedia.org/>
- ISO Online browsing platform: disponible à l'adresse <http://www.iso.org/obp>

4 Informations devant figurer dans une spécification particulière

4.1 Généralités

Les spécifications particulières doivent provenir de la spécification particulière-cadre applicable.

Les spécifications particulières ne doivent pas indiquer d'exigences inférieures à celles de la spécification générique, intermédiaire ou particulière-cadre. Si des exigences plus strictes sont incluses, elles doivent être indiquées en 1.9 de la spécification particulière et indiquées dans les programmes d'essais, par exemple, par un astérisque.

Par commodité, les informations de 4.2 peuvent être présentées sous forme de tableau.

Les informations présentées de 4.2 à 4.4 doivent être données dans chaque spécification particulière et les valeurs citées doivent être choisies parmi celles données dans l'article approprié de la présente spécification intermédiaire.

4.2 Dessin d'encombrement et dimensions

Une illustration de la thermistance doit être incluse pour l'identifier facilement et la comparer à d'autres. Les dimensions et les tolérances associées, qui affectent l'interchangeabilité et le montage, doivent être données dans la spécification particulière. Toutes les dimensions doivent de préférence être indiquées en millimètres. Toutefois, quand les dimensions originales sont indiquées en pouces, les dimensions converties en millimètres doivent être ajoutées.

Normalement, les valeurs numériques de la longueur, de la largeur et de la hauteur du corps doivent être indiquées. Si nécessaire, lorsqu'un certain nombre d'éléments sont couverts par une spécification particulière, les dimensions et les tolérances associées doivent être placées dans un tableau sous le dessin.

Lorsque la configuration est différente de celle décrite ci-dessus, la spécification particulière doit indiquer de telles informations sur les dimensions et décrire la thermistance.

4.3 Montage

La spécification particulière doit donner des recommandations sur les méthodes de montage pour une utilisation normale. Les montages pour les essais et les mesures (lorsqu'ils sont exigés) doivent être conformes à 5.4 de l'IEC 60539-1:2016.

4.4 Valeurs assignées et caractéristiques

4.4.1 Caractéristiques particulières

D'autres caractéristiques peuvent être indiquées, si elles sont considérées comme nécessaires pour spécifier le composant de façon appropriée pour les besoins de la conception et de l'application.

4.4.2 Marquage

Voir 4.3 de l'IEC 60539-1:2016.

5 Valeurs assignées et caractéristiques préférentielles

5.1 Tolérances sur la résistance de puissance nulle assignée

Les valeurs préférentielles de tolérances sur la résistance de puissance nulle assignée sont:

$\pm 0,5 \%$, $\pm 1 \%$, $\pm 2 \%$, $\pm 3 \%$, $\pm 5 \%$, $\pm 10 \%$.

5.2 Catégories climatiques

Les températures maximale et minimale de catégorie et la durée de l'essai continu de chaleur humide, doivent être sélectionnées dans le Tableau 1.

Tableau 1 – Températures minimale et maximale de catégorie et durée de l'essai de chaleur humide

Température minimale de catégorie °C	-55, -40, -25, -10, -5, +5
Température maximale de catégorie °C	70, 85, 100, 105, 125, 150, 155, 175, 200, 250, 315, 400
Essai continu de chaleur humide jours	21, 42, 56

La spécification particulière doit prescrire la catégorie appropriée.

6 Procédures d'assurance de la qualité

Voir Annexe B.

7 Procédures d'essais et de mesures

7.1 Montage

Voir 5.4 de l'IEC 60539-1:2016.

7.2 Séchage et rétablissement

7.2.1 Séchage

Lorsque cette spécification fait appel au séchage, la thermistance doit être conditionnée de la manière suivante.

Pendant $96 \text{ h} \pm 4 \text{ h}$ dans une étuve à une température de $100 \text{ °C} \pm 5 \text{ °C}$, la thermistance doit alors être refroidie dans un dessiccateur en utilisant un déshydratant approprié, par exemple de l'alumine active ou du gel de silice, et elle doit y rester entre le moment où elle est retirée de l'étuve jusqu'au début des essais spécifiés.

7.2.2 Rétablissement

Sauf spécification contraire, le rétablissement doit se faire dans les conditions atmosphériques normalisées des essais (voir 5.3.2 de l'IEC 60539-1:2016).

7.3 Examen visuel et contrôle des dimensions

7.3.1 Examen visuel

L'appareil utilisé pour l'examen visuel doit être approprié avec un grossissement d'environ $10\times$ et un éclairage approprié du spécimen en essai et le niveau de qualité exigé.