

INTERNATIONAL STANDARD

IEC
60539-2

First edition
2003-11

Directly heated negative temperature coefficient thermistors –

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



Reference number
IEC 60539-2:2003(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site** (www.iec.ch)

- **Catalogue of IEC publications**

The on-line catalogue on the IEC web site (www.iec.ch/searchpub) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

This summary of recently issued publications (www.iec.ch/online_news/justpub) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

Email: custserv@iec.ch
Tel: +41 22 919 02 11
Fax: +41 22 919 03 00

INTERNATIONAL STANDARD

IEC 60539-2

First edition
2003-11

Directly heated negative temperature coefficient thermistors –

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

© IEC 2003 — Copyright - all rights reserved

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 the publisher.

International Electrotechnical Commission, 3, rue de Varembe, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch



Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE

S

For price, see current catalogue

CONTENTS

FOREWORD	4
1 General	6
1.1 Scope	6
1.2 Normative references	6
1.3 Information to be given in a detail specification	6
1.3.1 Outline drawing and dimensions	7
1.3.2 Mounting	7
1.3.3 Ratings and characteristics	7
1.4 Terminology	7
2 Preferred ratings and characteristics	7
2.1 Tolerances on rated zero-power resistance	7
2.2 Climatic categories	7
3 Quality assessment procedures	8
3.1 Primary stage of manufacture	8
3.2 Structurally similar components	8
3.3 Qualification approval procedures	8
3.3.1 The manufacturer shall comply with 3.4 of IEC 60539-1	8
3.4 Quality conformance inspection	8
3.4.1 Qualification approval on the basis of the fixed sample size procedure	8
3.5 Quality conformance inspection	10
3.5.1 Formation of inspection lots	10
3.5.2 Test schedule	11
3.5.3 Delayed delivery	11
3.5.4 Assessment level	11
4 Test and measurement procedures	12
4.1 Mounting	12
4.2 Drying and recovery	12
4.2.1 Drying	12
4.2.2 Recovery	12
4.3 Visual examination and check of dimensions	12
4.3.1 Visual examination	12
4.3.2 Requirements	12
4.3.3 Marking	14
4.3.4 Dimensions	14
4.4 Electrical tests	14
4.4.1 Zero-power resistance	14
4.4.2 B-value or resistance ratio	14
4.4.3 Resistance/temperature characteristic	15
4.5 Thermal tests	15
4.5.1 Dissipation factor (δ)	15
4.5.2 Thermal time constant by cooling after self-heating (τ_c)	15

4.6	Resistance to soldering heat	15
4.6.1	Initial measurement	15
4.6.2	Test conditions	15
4.6.3	Recovery	16
4.6.4	Final inspection, measurements and requirements	16
4.7	Solderability	16
4.7.1	Test conditions	16
4.7.2	Recovery	17
4.7.3	Final inspection, measurements and requirements	17
4.8	Rapid change of temperature	17
4.9	Thermal shock.....	17
4.10	Climatic sequence	18
4.10.1	Initial measurements	18
4.10.2	Dry heat	18
4.10.3	Damp heat (cyclic), first cycle	18
4.10.4	Cold	18
4.10.5	Damp heat (cyclic), remaining cycles	18
4.10.6	Final measurements	19
4.11	Damp heat, steady state	19
4.12	Endurance	19
4.12.1	Endurance at θ_3 and P_{max}	19
4.12.2	Endurance at upper category temperature	19
4.13	Shear (adhesion) test	20
4.14	Substrate bending test	20
4.15	Component solvent resistance.....	20
4.16	Solvent resistance of marking.....	20
Annex A (normative) Guide for the specification and coding of dimensions of surface mount negative temperature coefficient thermistors		21
Table 1 – Upper and lower category temperatures and duration of the damp heat test.....		8
Table 2 – Fixed sample size test schedule for qualification approval of surface mount negative temperature coefficient thermistors Assessment level EZ		10
Table 3 – Lot-by-lot inspection		11
Table 4 – Periodic test		12
Table 5 – Number of cycles		18
Table A.1 – Dimensions		21
Figure 1 – Fault: fissure or defect		13
Figure 2 – Fault: crack		13
Figure 3 – Separation or delamination		13
Figure 4 – Exposed electrodes.....		13
Figure 5 – Principal faces		14
Figure A.1 – Dimensioning of surface mount thermistors.....		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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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.

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

FDIS	Report on voting
40/1346/FDIS	40/1368/RVD

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

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

The committee has decided that the contents of this publication will remain unchanged until 2008. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual edition of this document may be issued at a later date.

www.iec.ch

DIRECTLY HEATED NEGATIVE TEMPERATURE COEFFICIENT THERMISTORS –

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

1 General

1.1 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.

1.2 Normative references

The following referenced documents are indispensable for the application 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, *Environmental testing – Part 2: Tests – Tests B: Dry heat*
Amendment 1 (1993)
Amendment 2 (1994)

IEC 60068-2-14:1984, *Environmental testing – Part 2: 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, *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 60068-2-78: *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, *Directly heated negative temperature coefficient thermistors – Part 1: Generic specification*

1.3 Information to be given in a detail specification

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

Detail specifications shall not specify requirements inferior to those of the generic, 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 1.3.1 may for convenience, be presented in tabular form.

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

1.3.1 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.

1.3.2 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.

1.3.3 Ratings and characteristics

1.3.3.1 Particular characteristics

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

1.3.3.2 Marking

See 2.4 of IEC 60539-1.

1.4 Terminology

See 2.2 of IEC 60539-1.

2 Preferred ratings and characteristics

2.1 Tolerances on rated zero-power resistance

Preferred values of tolerances on zero-power resistance are:

±1 %, ±2 %, ±3 %, ±5 %, ±10 %.

2.2 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
Damp heat, steady state days	21, 42, 56

The detail specification shall prescribe the appropriate category.

3 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	4.3.1	See 4.3.1 to 4.3.2	90	0	
	Marking	4.3.3				
	Dimensions (gauging)	4.3.4	For requirements, see Table A.1			
	Zero-power resistance	4.4.1				
1	Dimensions (detail)	4.3.4	For requirements, see Table A.1	10	0	
	<i>B</i> -value or resistance ratio	4.4.2	Choice to be made in the detail specification			
	Resistance/temperature characteristic	4.4.3	Measuring temperatures to be defined in the detail specification			
	Resistance to soldering heat – dissolution of metallization	4.6	See 4.6			
2	Solderability	4.7	See 4.7.1 to 4.7.3	10	0	
	Solvent resistance of marking	4.16				
3	Resistance to soldering heat – dewetting	4.6	See 4.6.1 to 4.6.4	10	0	
4	Mounting	4.1		60	0	
	Visual examination	4.3.1				
	Zero-power resistance	4.4.1				
	4.1	Dissipation factor		4.5.1	10	0
		Thermal time constant by cooling after self-heating (τ_c)		4.5.2		
	4.2	Shear test		4.13	10	0
		Rapid change of temperature		4.8		
		Climatic sequence		4.10		
	4.3	Damp heat, steady state		4.11	10	0
	4.4	Endurance at θ_3 and P_{max}		4.12.1	10	0
	4.5	Endurance at upper category temperature		4.12.2	10	0
5	Substrate bending test	4.14		10	0	
^{a)} Number of specimens to be tested.						
^{b)} Permissible numbers of non-conforming items.						

3.5 Quality conformance inspection

3.5.1 Formation of inspection lots

a) Groups A and B inspection

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

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

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

- 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	^{c)}	0
A2	II	^{c)}	0
B1	S – 3	^{c)}	0
B2	S – 2	^{c)}	0

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

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

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

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

Table 4 – Periodic test

Inspection subgroup ^{b)}	EZ		
	<i>p</i> ^{a)}	<i>n</i> ^{a)}	<i>c</i> ^{a)}
C1	3	12	0
C2	3	12	0
C3.1	6	27	0
C3.2	6	15	0
C3.3	3	15	0
C3.4	6	15 ^{b)}	0
C4	6	9	0

^{a)} *p* = periodicity in months;
^{a)} *n* = sample size;
^{a)} *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.

4 Test and measurement procedures

4.1 Mounting

See 4.27 of IEC 60539-1.

4.2 Drying and recovery

4.2.1 Drying

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

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

4.2.2 Recovery

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

4.3 Visual examination and check of dimensions

4.3.1 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.

4.3.2 Requirements

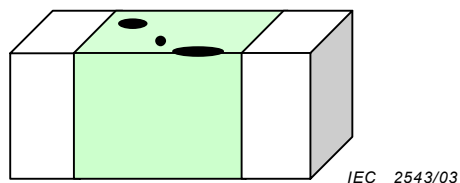
Quantitative values for the requirements below may be given in the detail or in the manufacturer's specification.

The thermistor shall conform to the following requirements.

4.3.2.1 Ceramic

a) Bulk type

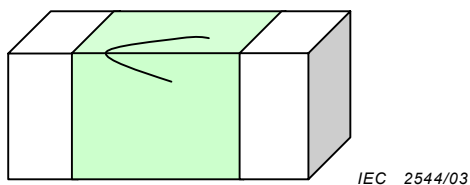
- 1) It shall be free of fissures of coating glass longer than 25 % of dimension L_4 (see Annex A, Figure A.1) and defects of glass coating on each face greater than 10 % of the area of that face (see Figure 1).



NOTE Fissure on a corner and defect on one side.

Figure 1 – Fault: fissure or defect

- 2) 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

b) Layered type

- 1) It shall not exhibit visible separation or delamination between the layers of the thermistor (see Figure 3).

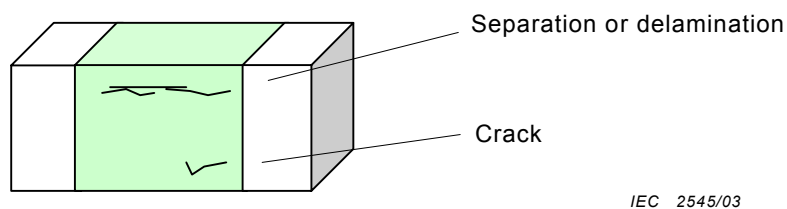


Figure 3 – Separation or delamination

- 2) It shall not exhibit exposed electrodes between the two terminations (see Figure 4).

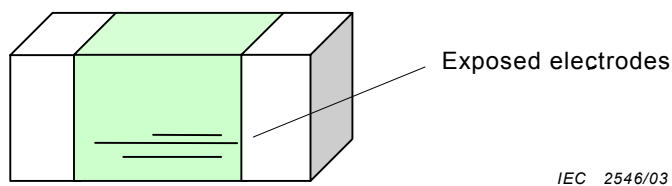


Figure 4 – Exposed electrodes

4.3.2.2 Metallization

- a) It shall not exhibit any visible detachment of the metallized terminations nor any exposed electrodes (see Figure 4).
- b) The principal faces are those noted A, B and C (see Figure 5).

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

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.

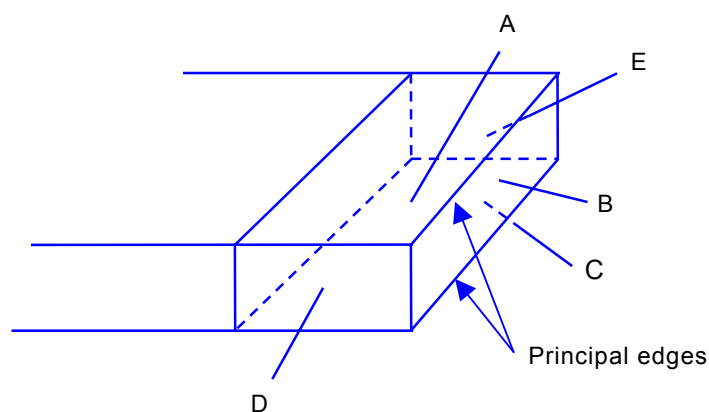


Figure 5 – Principal faces

4.3.3 Marking

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

4.3.4 Dimensions

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

4.4 Electrical tests

4.4.1 Zero-power resistance

See 4.5 of IEC 60539-1 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.

4.4.2 *B*-value or resistance ratio

See 4.6 of IEC 60539-1 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.

4.4.3 Resistance/temperature characteristic

See 4.9 of IEC 60539-1 with the following details:

- the measuring temperature shall be selected from those given in Table 1 of IEC 60539-1;
- the resistance/temperature characteristic shall be within the limits specified in the detail specification.

4.5 Thermal tests

4.5.1 Dissipation factor (δ)

See 4.10 of IEC 60539-1 with the following details:

- thermistors shall be mounted according to 4.1;
- 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.

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

See 4.12 of IEC 60539-1 with the following details:

- the thermistors shall be mounted according to 4.1;
- the thermal time constant by cooling after self-heating shall be within the limits prescribed in the detail specification.

4.6 Resistance to soldering heat

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

4.6.1 Initial measurement

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

4.6.2 Test conditions

4.6.2.1 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 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

4.6.2.2 Infrared and forced gas convection soldering system

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

- a) the solder paste shall be applied to the test substrate;
- b) the thickness of the solder deposit shall be specified in the detail specification;
- c) the terminations of the specimen shall be placed on solder paste;

- d) the specimen and test substrate shall be preheated to a temperature of (150 ± 10) °C and maintained for 60 s to 120 s in an infrared and forced gas convection soldering system;
- e) the temperature of the reflow system shall be quickly raised until the specimen has reached (235 ± 5) °C and maintained at this temperature for (10 ± 1) s. Number of tests: 2;
- f) the temperature profile shall be specified in the detail specification.

4.6.3 Recovery

The flux residues shall be removed with a suitable solvent.

4.6.4 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 according to 4.6.1 and the change shall not exceed ± 5 %.

4.7 Solderability

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

4.7.1 Test conditions

4.7.1.1 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: $235 \text{ °C} \pm 5 \text{ °C}$;
- duration of immersion: $2 \text{ s} \pm 0,2 \text{ s}$;
- depth of immersion: 10 mm;
- number of immersion: 1

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 ± 10) °C and maintained for 60 s to 120 s in infrared and forced gas convection soldering system;

- e) the temperature of reflow system shall be quickly raised until the specimen has reached (215 ± 3) °C and maintained at this temperature for (10 ± 1) s;
- f) the temperature profile shall be specified in the detail specification.

4.7.2 Recovery

The flux residues shall be removed with a suitable solvent.

4.7.3 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.

4.8 Rapid change of temperature

See 4.16 of IEC 60539-1.

The thermistors shall be mounted according to 4.1.

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

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

- a) the lower temperature T_A shall be the lower category temperature;
- b) the higher temperature T_B shall be the upper category temperature;
- c) the number of cycles shall be 5;
- d) 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 %.

4.9 Thermal shock

See 4.21 of IEC 60539-1 with the following details:

- the thermistors shall be mounted according to 4.1;
- the zero-power resistance shall be measured according to 4.4.1.

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

- a) the lower temperature T_A shall be the lower category temperature;
- b) the higher temperature T_B shall be the upper category temperature;
- c) the exposure time t_1 shall be 30 min;
- d) the number of cycles shall be 5;
- e) the medium of the test bath shall be oil.

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

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

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

4.10 Climatic sequence

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

- the thermistors shall be mounted according to 4.1;
- the tests and measurements shall be performed in the following order.

4.10.1 Initial measurements

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

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

4.10.2 Dry heat

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

4.10.3 Damp heat (cyclic), first cycle

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

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

4.10.4 Cold

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

4.10.5 Damp heat (cyclic), remaining cycles

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

Table 5 – Number of cycles

Categories	Number of cycles
<i>-/-/56</i>	5
<i>-/-/42</i>	5
<i>-/-/21</i>	1
<i>-/-/10</i>	1
<i>-/-/04</i>	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 %

4.11 Damp heat, steady state

See 4.25 of IEC 60539-1.

The thermistors shall be mounted according to 4.1 of IEC 60539-1.

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

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 according to 4.3.2 of IEC 60539-1.

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

4.12 Endurance

4.12.1 Endurance at θ_3 and P_{\max} .

See 4.26.3 of IEC 60539-1 with the following details:

- the thermistors shall be mounted according to 4.1;
- the zero-power resistance shall be measured according to 4.4.1;
- the thermistors shall be placed in a test chamber and subjected to the temperature $\theta_3 \pm 2$ °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 conditions of test. The interval between the removal from, and the return to, the conditions of test for any thermistor shall not exceed 12 h;
- after 1 000 h ± 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 %.

4.12.2 Endurance at upper category temperature

See 4.26.4 of IEC 60539-1 with the following details:

- the thermistors shall be mounted according to 4.1;
- the zero-power resistance shall be measured according to 4.4.1;

- 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 conditions of test. The interval between the removal from, and the return to, the conditions of test 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 %.

4.13 Shear (adhesion) test

See 4.28 of IEC 60539-1.

4.14 Substrate bending test

See 4.29 of IEC 60539-1 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 %.

4.15 Component solvent resistance

See 4.30 of IEC 60539-1 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 %.

4.16 Solvent resistance of marking

See 4.31 of IEC 60539-1.

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.

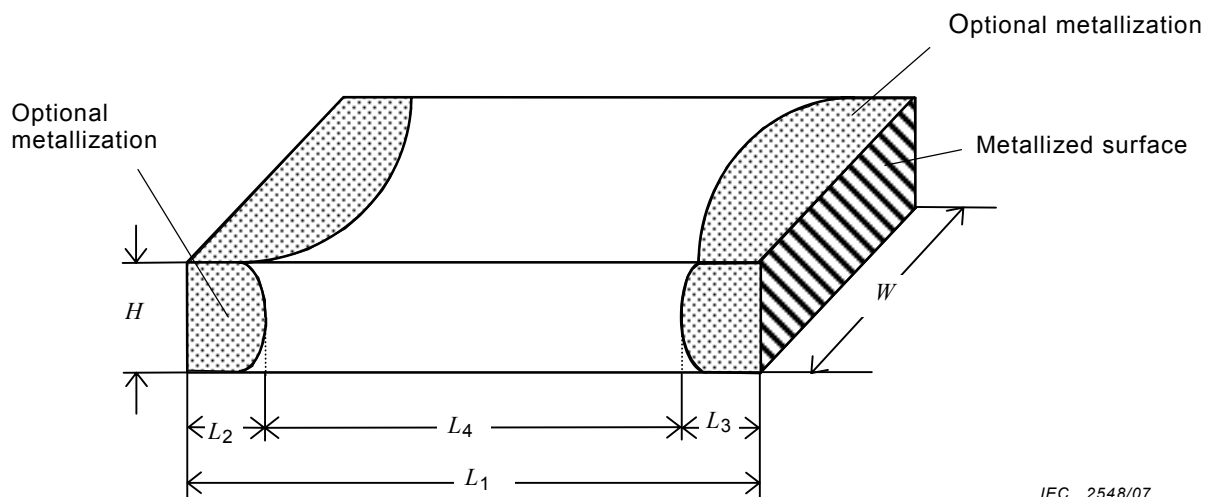



Figure A.1 – Dimensioning of surface mount thermistors

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.

Table A.1 – Dimensions

Code	Length (L_1) mm	Width (W) mm	L_2 and L_3 mm (minimum)	L_4 mm (minimum)
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.



Standards Survey

The IEC would like to offer you the best quality standards possible. To make sure that we continue to meet your needs, your feedback is essential. Would you please take a minute to answer the questions overleaf and fax them to us at +41 22 919 03 00 or mail them to the address below. Thank you!

Customer Service Centre (CSC)

International Electrotechnical Commission

3, rue de Varembé
1211 Genève 20
Switzerland

or

Fax to: **IEC/CSC** at +41 22 919 03 00

Thank you for your contribution to the standards-making process.

A Prioritaire

Nicht frankieren
Ne pas affranchir



Non affrancare
No stamp required

RÉPONSE PAYÉE

SUISSE

Customer Service Centre (CSC)
International Electrotechnical Commission
3, rue de Varembé
1211 GENEVA 20
Switzerland



Q1 Please report on **ONE STANDARD** and **ONE STANDARD ONLY**. Enter the exact number of the standard: (e.g. 60601-1-1)

.....

Q2 Please tell us in what capacity(ies) you bought the standard (tick all that apply). I am the/a:

- purchasing agent
- librarian
- researcher
- design engineer
- safety engineer
- testing engineer
- marketing specialist
- other.....

Q3 I work for/in/as a: (tick all that apply)

- manufacturing
- consultant
- government
- test/certification facility
- public utility
- education
- military
- other.....

Q4 This standard will be used for: (tick all that apply)

- general reference
- product research
- product design/development
- specifications
- tenders
- quality assessment
- certification
- technical documentation
- thesis
- manufacturing
- other.....

Q5 This standard meets my needs: (tick one)

- not at all
- nearly
- fairly well
- exactly

Q6 If you ticked NOT AT ALL in Question 5 the reason is: (tick all that apply)

- standard is out of date
- standard is incomplete
- standard is too academic
- standard is too superficial
- title is misleading
- I made the wrong choice
- other

Q7 Please assess the standard in the following categories, using the numbers:

- (1) unacceptable,
- (2) below average,
- (3) average,
- (4) above average,
- (5) exceptional,
- (6) not applicable

- timeliness.....
- quality of writing.....
- technical contents.....
- logic of arrangement of contents
- tables, charts, graphs, figures.....
- other

Q8 I read/use the: (tick one)

- French text only
- English text only
- both English and French texts

Q9 Please share any comment on any aspect of the IEC that you would like us to know:

.....



.....

ISBN 2-8318-7263-4



9 782831 872636

ICS 31.040.30

Typeset and printed by the IEC Central Office
GENEVA, SWITZERLAND