



BSI Standards Publication

Directly heated negative temperature coefficient thermistors

Part 1: Generic specification

National foreword

This British Standard is the UK implementation of EN IEC 60539-1:2023. It is identical to IEC 60539-1:2022. It supersedes BS EN 60539-1:2016, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee W/-, Consumer Products and Services Sector Policy and Strategy Committee.

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

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Date

Text affected

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Part 1: Generic specification
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Thermistances à coefficient de température négatif à
chauffage direct - Partie 1: Spécification générique
(IEC 60539-1:2022)

Direkt geheizte temperaturabhängige Widerstände mit
negativem Temperaturkoeffizienten - Teil 1:
Fachgrundspezifikation
(IEC 60539-1:2022)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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European foreword

The text of document 40/2975/FDIS, future edition 4 of IEC 60539-1, prepared by IEC/TC 40 "Capacitors and resistors for electronic equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60539-1:2023.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2023-10-19
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2026-01-19

This document supersedes EN 60539-1:2016 and all of its amendments and corrigenda (if any).

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The text of the International Standard IEC 60539-1:2022 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60027-1 NOTE Approved as EN 60027-1

ISO 80000-1 NOTE Approved as EN ISO 80000-1

Annex A (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60062	-	Marking codes for resistors and capacitors	EN 60062	-
IEC 60068-1	2013	Environmental testing - Part 1: General and guidance	EN 60068-1	2014
IEC 60068-2-1	-	Environmental testing - Part 2-1: Tests - Test A: Cold	EN 60068-2-1	-
IEC 60068-2-2	-	Environmental testing - Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	-
IEC 60068-2-6	-	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	-
IEC 60068-2-11	-	Environmental testing - Part 2-11: Tests - Test Ka: Salt mist	EN IEC 60068-2-11	-
IEC 60068-2-14	-	Environmental testing - Part 2-14: Tests - Test N: Change of temperature	EN 60068-2-14	-
IEC 60068-2-17	-	Basic environmental testing procedures - Part 2-17: Tests - Test Q: Sealing	EN 60068-2-17	-
IEC 60068-2-20	-	Environmental testing - Part 2-20: Tests - Test Ta and Tb: Test methods for solderability and resistance to soldering heat of devices with leads	EN IEC 60068-2-20	-
IEC 60068-2-21	2021	Environmental testing - Part 2-21: Tests - Test U: Robustness of terminations and integral mounting devices	EN IEC 60068-2-21	2021
IEC 60068-2-27	2008	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	2009
IEC 60068-2-31	-	Environmental testing - Part 2-31: Tests - Test Ec: Rough handling shocks, primarily for equipment-type specimens	EN 60068-2-31	-
IEC 60068-2-38	-	Environmental testing - Part 2-38: Tests - Test Z/AD: Composite temperature/humidity cyclic test	EN IEC 60068-2-38	-

EN IEC 60539-1:2023 (E)

IEC 60068-2-45	1980	Basic environmental testing procedures - Part 2-45: Tests - Test XA and guidance: Immersion in cleaning solvents	EN 60068-2-45	1992
+ A1	1993		+ A1	1993
IEC 60068-2-52	-	Environmental testing - Part 2-52: Tests - Test Kb: Salt mist, cyclic (sodium chloride solution)	EN IEC 60068-2-52	-
IEC 60068-2-58	-	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)	EN 60068-2-58	-
IEC 60068-2-69	-	Environmental testing - Part 2-69: Tests - Test Te/Tc: Solderability testing of electronic components and printed boards by the wetting balance (force measurement) method	EN 60068-2-69	-
IEC 60068-2-78	-	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state	EN 60068-2-78	-
IEC 60294	-	Measurement of the dimensions of a cylindrical component with axial terminations	EN 60294	-
IEC 60717	-	Method for the determination of the space required by capacitors and resistors with unidirectional terminations	EN 60717	-
IEC 61193-2	-	Quality assessment systems - Part 2: Selection and use of sampling plans for inspection of electronic components and packages	EN 61193-2	-
IEC 61249-2-7	-	Materials for printed boards and other interconnecting structures - Part 2-7: Reinforced base materials clad and unclad - Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test), copper-clad	EN 61249-2-7	-

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Directly heated negative temperature coefficient thermistors –
Part 1: Generic specification**

**Thermistances à coefficient de température négatif à chauffage direct –
Partie 1: Spécification générique**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**DIRECTLY HEATED NEGATIVE TEMPERATURE
COEFFICIENT THERMISTORS –****Part 1: Generic specification****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.
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IEC 60539-1 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2016. This edition constitutes a technical revision.

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

- a) Restructured completely to comply to ISO/IEC directives; categorization and reorganization of test methods into these categories;
- b) Annex X added for comparison to the previous edition;
- c) Some wordings, figures and references have been revised.

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

Draft	Report on voting
40/2975/FDIS	40/3016/RVD

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

The language used for the development of this International Standard is English.

A list of all parts in the IEC 60539-1 series, published under the general title *Directly heated negative temperature coefficient thermistors*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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.

DIRECTLY HEATED NEGATIVE TEMPERATURE COEFFICIENT THERMISTORS –

Part 1: Generic specification

1 Scope

This part of IEC 60539 is applicable to directly heated negative temperature coefficient thermistors, typically made from transition metal oxide materials with semiconducting properties.

It establishes standard terms, inspection procedures and methods of test for use in sectional and detail specifications of electronic components for quality assessment or any other purpose.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60062, *Marking codes for resistors and capacitors*

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Tests A: Cold*

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

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

IEC 60068-2-11, *Environmental testing – Part 2-11: Tests – Test Ka: Salt mist*

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

IEC 60068-2-17, *Basic environmental testing procedures – Part 2-17: Tests – Test Q: Sealing*

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Test Ta and Tb: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-21:2021, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-31, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60068-2-38, *Environmental testing – Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test*

IEC 60068-2-45:1980, *Basis Environmental testing procedures – Part 2-45: Tests – Test XA and guidance: Immersion in cleaning solvents*
IEC 60068-2-45:1980/AMD1:1993

IEC 60068-2-52, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 60068-2-58, *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 60068-2-69, *Environmental testing – Part 2-69: Tests – Test Te/Tc: Solderability testing of electronic components and printed boards by the wetting balance (force measurement) method*

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

IEC 60294, *Measurement of the dimensions of a cylindrical component with axial terminations*

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

IEC 60717, *Method for the determination of the space required by capacitors and resistors with unidirectional terminations*

IEC 61249-2-7, *Materials for printed boards and other interconnecting structures – Part 2-7: Reinforced base materials clad and unclad – Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test), copper-clad*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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>

3.1

type

group of products having similar design features manufactured by the same techniques and falling within the manufacturer's usual range of ratings for these products

Note 1 to entry: Mounting accessories are ignored, provided they have no significant effect on the test results.

Note 2 to entry: Ratings cover the combination of

- electrical ratings,
- sizes, and
- climatic category.

Note 3 to entry: The limits of the range of ratings should be given in the detail specification.

3.2

style

variation within a type having specific nominal dimensions and characteristics

3.3 thermistor

thermally sensitive semiconducting resistor whose primary function is to exhibit an important change in electrical resistance with a change in body temperature

3.4 negative temperature coefficient thermistor NTC thermistor

thermistor in which the resistance decreases with increasing temperature

Note 1 to entry: In general, the term 'NTC thermistor' is used.

3.5 directly heated negative temperature coefficient thermistor

thermistor which obtains its resistance variation by the changes of physical conditions.

Note 1 to entry: Physical conditions include the current through the thermistor, ambient temperature, humidity, wind velocity, gas, etc.

3.6 indirectly heated negative temperature coefficient thermistor

thermistor which obtains its resistance variation primarily by the change of temperature of the thermistor, due to the change of a current through a separate heater which is in close contact with, but electrically insulated from, the thermistor element

Note 1 to entry: The temperature of the thermistor can also be changed by the changes of physical conditions such as current through the thermistor element itself, ambient temperature, humidity, wind velocity, gas, etc.

Note 2 to entry: This term is for information only.

3.7 positive temperature coefficient thermistor PTC thermistor

thermistor in which the resistance increases with increasing temperature

Note 1 to entry: In general, the term 'PTC thermistor' is used.

Note 2 to entry: This term is for information only.

3.8 NTC thermistor with wire terminations

NTC thermistor provided with wire terminations

3.9 NTC thermistor without wire terminations

thermistor provided only with two metallized faces, to be used as electrical contacts

Note 1 to entry: This term is for information only.

3.10 insulated thermistor

NTC thermistor coated with materials such as resin, glass or ceramic, capable of meeting the requirements of the insulation resistance and voltage proof tests when specified in the test schedule

3.11 non-insulated NTC thermistor

NTC thermistor with or without coating materials for surfacing of elements but not intended to meet the requirements of the insulation resistance and voltage proof tests when specified in the test schedule

3.12**surface mount NTC thermistor**

NTC thermistor whose small dimensions and nature or shape of terminations make it suitable for use in hybrid circuits and on printed boards

3.13**assembled NTC thermistor probe**

NTC thermistor encapsulated in different materials such as tubes, plastic and metal housing and/or assembled with cables and/or connectors

Note 1 to entry: This term is for information only.

3.14**NTC thermistor for sensing**

thermistor which responds to temperature changes and therefore is used for temperature sensing and control

3.15**inrush current limiting NTC thermistor**

NTC thermistor which limits the inrush current just after switching on the power

3.16**residual resistance**

<inrush current-limiting thermistors> value of the d.c. resistance of a thermistor when its thermal stability is reached with the maximum current passing

Note 1 to entry: This term is for information only.

3.17**maximum permissible capacitance**

<inrush current-limiting NTC thermistors> maximum permissible capacitance value of a capacitor which can be connected to a thermistor under loading

3.18**zero-power resistance**

R_T

value of the d.c. resistance of a thermistor, when measured at a specified temperature, under such conditions that the change in resistance due to the internal generation of heat is negligible with respect to the total error of measurement

3.19**nominal zero-power resistance**

nominal value of zero-power resistance at the standard reference temperature of 25 °C, unless otherwise specified

3.20**resistance-temperature characteristic**

relationship between the zero-power resistance and the body temperature of a thermistor

Note 1 to entry: Typical resistance-temperature characteristic for NTC thermistors is shown in Figure 1.

Note 2 to entry: The resistance law follows approximately the formula:

$$R = R_a \times e^{B \left(\frac{1}{T} - \frac{1}{T_a} \right)}$$

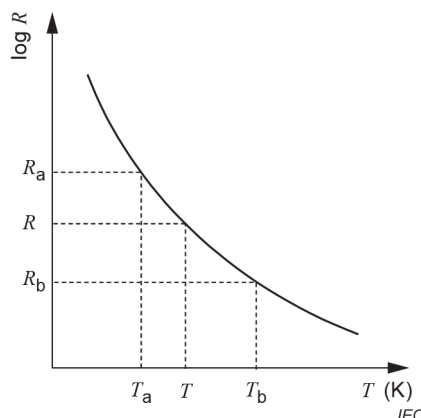
where

R is the zero-power resistance (Ω) at absolute temperature T (K);

R_a is the zero-power resistance (Ω) at absolute temperature T_a (K);

B is the thermal sensitivity index (see 3.22).

This formula is only applicable for representing the resistance variation over a restricted temperature range. For more precise representation of the R/T -curve, a resistance/temperature relation should be specified in tabulated form in the detail specification.



NOTE Slightly downward convexed curve when the temperature range is large.

Figure 1 – Typical resistance-temperature characteristic for NTC thermistors

3.21

resistance ratio

ratio of the zero-power resistance of a NTC thermistor measured at the reference temperature of 25 °C to that measured at 85 °C, or at such other pairs of temperatures that can be stated in the detail specification

3.22

B -value

index of the thermal sensitivity expressed by the formula

$$B = \frac{(T_a \times T_b)}{(T_b - T_a)} \times \ln \frac{R_a}{R_b}$$

where

B is the B -value (K);

R_a is the zero-power resistance (Ω) at temperature T_a (K);

R_b is the zero-power resistance (Ω) at temperature T_b (K)

Note 1 to entry: The B -value can also be expressed by the following formula (common logarithm):

$$B = 2,303 \times \frac{(T_a \times T_b)}{(T_b - T_a)} \times \ln \frac{R_a}{R_b}$$

Note 2 to entry: The preferred values for T_a and T_b are 298,15 K and 358,15 K, respectively. These values are equivalent to +25 °C and +85 °C, respectively.

Note 3 to entry: Where the detail specification states that the B -value should be measured at other temperatures, the specified values (in kelvins) shall be used for T_a and T_b in the calculation in place of the preferred values and the B -value may be expressed by $B_{a/b}$.

3.23 zero-power temperature coefficient of resistance

α_T

ratio at a specified temperature (T) of the rate of change of zero-power resistance with temperature to the zero-power resistance of the thermistor, expressed by the formula

$$\alpha_T = \frac{1}{R_T} \times \frac{dR_T}{dT} \times 100$$

Note 1 to entry: The value α_T can be approximately calculated by the formula:

$$\alpha_T = -\frac{B}{T^2} \times 100$$

where

α_T is the zero-power temperature coefficient of resistance in %/K;

R_T is the zero-power resistance in ohms at temperature T in kelvins (K);

B is the B -value (K).

Note 2 to entry: This term is for information only.

3.24 category temperature range

range of ambient temperatures for which the thermistor has been designed to operate continuously at zero-power, defined by the temperature limits of the appropriate category

Note 1 to entry: This term is for information only.

3.25 upper category temperature

$T_{\max}$

maximum ambient temperature for which an NTC thermistor has been designed to operate continuously at zero-power

3.26 lower category temperature

$T_{\min}$

minimum ambient temperature for which an NTC thermistor has been designed to operate continuously at zero-power

3.27 storage temperature range

range of ambient temperatures for which a thermistor can be stored continuously under no-load condition

Note 1 to entry: This term is for information only.

3.28 decreased power dissipation curve

<except inrush current-limiting thermistors> curve that expresses the relation between the ambient temperature and the maximum power dissipation $P_{\max T}$

Note 1 to entry: This relation is usually expressed as in Figure 2 a) or, alternatively, as in Figure 2 b).

T is the ambient temperature (°C);

T_1 is the temperature (°C) specified in the detail specification, which is equal to the lower category temperature $T_{\min}$ (°C) or higher;

T_2 is the ambient temperature at 0 °C, unless otherwise specified in the relevant detail specification;