

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

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

(standards.iteh.ai)

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

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# NORME INTERNATIONALE

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Part 1: Generic specification**

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

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ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
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## DIRECTLY HEATED NEGATIVE TEMPERATURE COEFFICIENT THERMISTORS –

### Part 1: Generic specification

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International Standard IEC 60539-1 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision. Tables, figures and references have been revised.

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

FDIS	Report on voting
40/2430/FDIS	40/2457/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.

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.

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The contents of the corrigendum of September 2017 have been included in this copy.

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

IEC 60062, *Marking codes for resistors and capacitors*

[IEC 60539-1:2016](#)

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, *Basic environmental testing procedures – 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 T: Test methods for solderability and resistance to soldering heat of devices with leads*

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

IEC 60068-2-27, *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 60068-2-54, *Environmental testing – Part 2-54: Tests – Test Ta: Solderability testing of electronic components by the wetting balance method*

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: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance 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 – Epoxy 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.

#### 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 thermistor with wire terminations

thermistor provided with wire terminations

### 3.9 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

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 thermistor

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 thermistor**

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

**3.13****assembled thermistor probe**

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****thermistor for sensing**

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

**3.15****inrush current limiting thermistor**

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 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

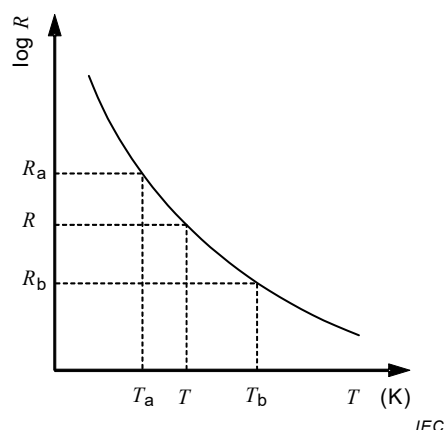
**3.19****nominal zero-power resistance**

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 Slightly downward convexed curve when the temperature range is large.

**Figure 1 – Typical resistance-temperature characteristic for NTC thermistors**

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 ( $\Omega$ ) at absolute temperature  $T$  (K);

$R_a$  is the zero-power resistance ( $\Omega$ ) 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.

### 3.21

#### resistance ratio

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

### 3.22

#### $B$ -value

index of the thermal sensitivity expressed by the formula

$$B = [(T_a \times T_b)/(T_b - T_a)] \times \ln(R_a/R_b)$$

where

$B$  is the  $B$ -value (K);

$R_a$  is the zero-power resistance ( $\Omega$ ) at temperature  $T_a$  (K);

$R_b$  is the zero-power resistance ( $\Omega$ ) at temperature  $T_b$  (K)

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

$$B = 2,303 \times [(T_a \times T_b)/(T_b - T_a)] \times \log(R_a/R_b).$$

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 prescribes 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  $B_{a/b}$ .