IEC 60539-1

Edition 2.0 2008-02

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

IEC 60539-1:2008

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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DIRECTLY HEATED NEGATIVE TEMPERATURE COEFFICIENT THERMISTORS –

Part 1: Generic specification

FOREWORD

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International Standard IEC 60539-1 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 2002 and constitutes a minor revision related to tables, figures and references.

This bilingual version (2012-01) corresponds to the monolingual English version, published in 2008-02.

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

FDIS	Report on voting
40/1878A/FDIS	40/1895/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.

The French version of this standard has not been voted upon.

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

IEC 60539 consists of the following parts, under the general title *Directly heated negative temperature coefficient thermistors:*

Part 1: Generic specification

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

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

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- withdrawn,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

DIRECTLY HEATED NEGATIVE TEMPERATURE COEFFICIENT THERMISTORS –

Part 1: Generic specification

1 General

1.1 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.

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 60027-1, *Letter symbols to be used in electrical technology – Part 1: General*

IEC 60050, *International Electrotechnical Vocabulary (IEV)*

IEC 60062, *Marking codes for resistors and capacitors*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*
Amendment 1 (1992)

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Tests A: Cold*

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

IEC 60068-2-6:1995, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-11:1981, *Environmental testing – Part 2-11: Tests – Test Ka: Salt mist*

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

IEC 60068-2-17:1994, *Environmental testing – Part 2-17: Tests – Test Q: Sealing*

IEC 60068-2-20:1979, *Environmental testing – Part 2-20: Tests – Test T: Soldering*
Amendment 2 (1987)

IEC 60068-2-21:2006, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-27:1987, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-29:1987, *Environmental testing – Part 2-29: Tests – Test Eb and guidance: Bump*

IEC 60068-2-32:1975, *Environmental testing – Part 2-32: Tests – Test Ed: Free fall*
Amendment 2 (1990)

IEC 60068-2-38:1974, *Environmental testing – Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test*

IEC 60068-2-45:1980, *Environmental testing – Part 2-45: Tests – Test XA and guidance: Immersion in cleaning solvents*
Amendment 1 (1993)

IEC 60068-2-52:1996, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 60068-2-54:2006, *Environmental testing – Part 2-54: Tests – Test Ta: Solderability testing of electronic components by the wetting balance method*

IEC 60068-2-58:2004, *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 60068-2-69:2007, *Environmental testing – Part 2-69: Tests – Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method*

IEC 60068-2-78:2001, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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

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

IEC 60617, *Graphical symbols for diagrams*

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*

IECQ 001002-3, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of procedure – Part 3: Approval procedures*

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units*

2 Technical data

2.1 Units, symbols and terminology

Units, graphical symbols, letter symbols and terminology should, whenever possible, be taken from the following publications:

– IEC 60027-1
– IEC 60050
– IEC 60617
– ISO 1000

When further items are required, they should be derived in accordance with the principles of the publications listed above.

2.2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.2.1
type
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 Mounting accessories are ignored, provided they have no significant effect on the test results.

NOTE 2 Ratings cover the combination of

– electrical ratings;
– sizes;
– climatic category.

NOTE 3 The limits of the range of ratings should be given in the detail specification.

2.2.2
style
variation within a type having specific nominal dimensions and characteristics

2.2.3
thermistor
thermally sensitive semiconducting resistor whose primary function is to exhibit an important change in electrical resistance with a change in body temperature

2.2.4
negative temperature coefficient thermistor (NTC)
thermistor in which the resistance decreases with increasing temperature

2.2.5
directly heated negative temperature coefficient thermistor
thermistor which obtains its resistance variation by the changes of physical conditions such as current through it, ambient temperature, humidity, wind velocity, gas, etc.

2.2.6
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 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.

2.2.7
positive temperature coefficient (PTC) thermistor (for information only)
thermistor in which the resistance increases with increasing temperature

2.2.8
thermistor with wire terminations
thermistor provided with wire terminations

2.2.9
thermistor without wire terminations
thermistor provided only with two metallized faces, to be used as electrical contacts

2.2.10
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

2.2.11
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

2.2.12
surface mount thermistor
thermistor whose small dimensions and nature or shape of terminations make them suitable for use in hybrid circuits and on printed board

2.2.13
assembled thermistor (probe)
thermistor encapsulated in different materials such as tubes, plastic and metal housing and/or assembled with cables and/or connectors

2.2.14
thermistor for sensing
thermistor which responds to temperature changes and therefore is used for temperature sensing and control

2.2.15
inrush current limiting thermistor
thermistor which limits the inrush current just after switching on the power

2.2.16
residual resistance (only for inrush current-limiting thermistors)
value of the d.c. resistance of a thermistor when its thermal stability is reached with the maximum current passing

2.2.17
maximum permissible capacitance (only for inrush current-limiting thermistors)
maximum permissible capacitance value of a capacitor which can be connected to a thermistor under loading

2.2.18
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

2.2.19
rated zero-power resistance
nominal value at the standard reference temperature of 25 °C, unless otherwise specified

2.2.20
resistance-temperature characteristic
relationship between the zero-power resistance and the body temperature of a thermistor

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 in ohms (Ω) at absolute temperature T in kelvins (K);

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

B is the thermal sensitivity index (see 2.2.22).

NOTE 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.

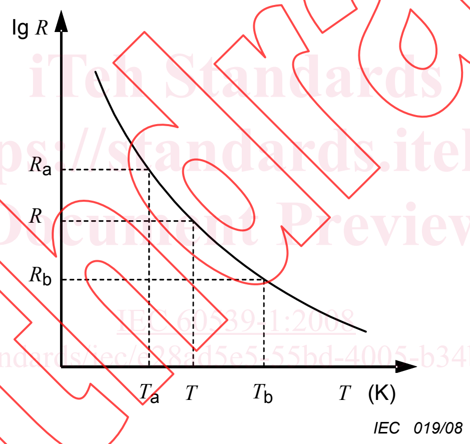

Figure 1 – Typical resistance-temperature characteristic for NTC thermistors

2.2.21
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

2.2.22
***B*-value**
index of the thermal sensitivity expressed by the formula:

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

or

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

where

B is a constant in kelvins (K);

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

R_b is the zero-power resistance in ohms (Ω) at temperature T_b in kelvins (K);

T_a = 298,15 K *;

T_b = 358,15 K *.

* The values given above for T_a and T_b are the preferred values and are equivalent to +25 °C and +85 °C respectively.

NOTE 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 "$B_{a/b}$".

2.2.23
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:

$$\alpha_T = (1/R_T) \times (dR_T/dT) \times 100$$

The value α_T can be approximately calculated by the formula:

$$\alpha_T = (-B/T^2) \times 100$$

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 index of the thermal sensitivity in kelvins (K).

2.2.24
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

2.2.25
upper category temperature, θ_{max}
maximum ambient temperature for which a thermistor has been designed to operate continuously at zero-power

2.2.26
lower category temperature, θ_{min}
minimum ambient temperature for which a thermistor has been designed to operate continuously at zero-power

2.2.27
storage temperature range
range of ambient temperatures for which a thermistor can be stored continuously under no-load condition

2.2.28
decreased power dissipation curve (not for inrush current-limiting thermistors)
relation between the ambient temperature and the maximum power dissipation $P_{max\theta}$, which is usually expressed as curve a or, alternatively, as curve b in Figure 2

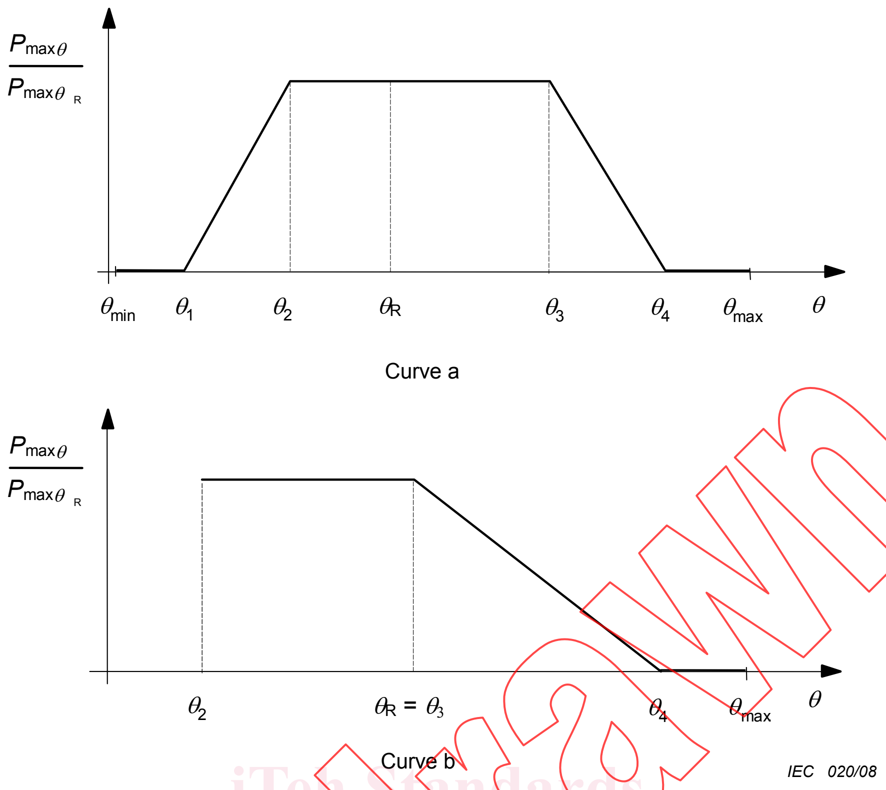

Figure 2 – Decreased power dissipation curve

2.2.29

maximum power dissipation at rated ambient temperature θ_R ($P_{max\theta_R}$)

maximum value of the power dissipation which can be continuously applied to the thermistor at the rated ambient temperature θ_R.

NOTE See curve a, $\theta 2 \le \theta R \le \theta 3$ or curve b, $\theta 2 \le \theta R = \theta 3$ in Figure 2.

The rated ambient temperature θ_R is the ambient temperature specified in the detail specification and is usually 25 °C.

2.2.30

maximum power dissipation at ambient temperature θ ($P_{max\theta}$)

maximum value of the power dissipation which can be continuously applied to the thermistor at an ambient temperature θ

Curve a

The maximum power dissipation rises at a temperature θ_1 linearly to a temperature θ_2. Between temperature θ_2 and θ_3 the power dissipation is constant. When the temperature exceeds θ_3, the power dissipation must be decreased linearly to zero at a temperature θ_4

The maximum power dissipation at ambient temperature θ in general is calculated as follows:

$$P_{max\theta} = I_{max\theta} \times U$$

where U is the voltage across the thermistor (for $I_{max\theta}$, see 2.2.32).

The maximum power dissipation can be expressed by the following formula: