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QC 440000

Third edition
2006-04

Thermistors – Directly heated positive temperature coefficient –

Part 1: Generic specification

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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THERMISTORS – DIRECTLY HEATED POSITIVE TEMPERATURE COEFFICIENT –

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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International Standard IEC 60738-1 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 1998 and constitutes a minor revision. The changes with respect to the previous edition refer to the tables, figures and references.

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

FDIS	Report on voting
40/1651/FDIS	40/1730/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 QC number that appears on the front cover of this publication is the specification number in the IEC Quality Assessment System for Electronic Components (IECQ).

IEC 60738 consists of the following parts, under the general title *Thermistors – Directly heated positive step-function coefficient*:

Part 1: Generic specification

Part 1-1: Blank detail specification – Current limiting application – Assessment level EZ

Part 1-2: Blank detail specification – Heating element application – Assessment level EZ

Part 1-3: Blank detail specification – Inrush current application – Assessment level EZ

Part 1-4: Blank detail specification – Sensing application – Assessment level EZ

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.

A bilingual version of this standard may be issued at a later date.

THERMISTORS – DIRECTLY HEATED POSITIVE TEMPERATURE COEFFICIENT –

Part 1: Generic specification

1 Scope

This part of IEC 60738 describes terms and methods of test for positive step-function temperature coefficient thermistors, insulated and non-insulated types typically made from ferro-electric semi-conductor materials.

It establishes standard terms, inspection procedures and methods of test for use in detail specifications for Qualification Approval and for Quality Assessment Systems for electronic components.

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 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050 (all parts), *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 60068-2-1:1990, *Environmental testing – Part 2: Tests – Tests A: Cold*
Amendment 1 (1993)
Amendment 2 (1994)

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests – Tests B: Dry heat*
Amendment 1 (1993)

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

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

IEC 60068-2-13, *Environmental testing – Part 2: Tests – Test M: Low air pressure*

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

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

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: Tests – Test Ea and guidance: Shock*

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

IEC 60068-2-30:2005, *Environmental testing – Part 2: Tests – Test Db: Damp heat, cyclic (12 h + 12-hour cycle)*

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

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 60068-2-78, *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 (all parts) [DB][1]: *Graphical symbols for diagrams*

IEC 60717, *Method for 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*

IEC 61760-1, *Surface mounting technology – Part 1: Standard method for the specification of surface mounting components (SMDs)*

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

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

3 Terms and definitions

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

3.1

type
group of components having similar design features and the similarity of whose manufacturing techniques enables them to be grouped together either for qualification approval or for quality conformance inspection

They are generally covered by a single detail specification

NOTE Components described in several detail specifications, may, in some cases, be considered as belonging to the same type but they are generally covered by a single detail specification.

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[1] "DB" refers to the IEC on-line database.

3.2
style
variation within a type having specific nominal dimensions and characteristics

3.3
thermistor
thermally sensitive semiconducting resistor which exhibits a significant change in electrical resistance with a change in body temperature

3.4
positive temperature coefficient thermistor
thermistor, the resistance of which increases with its increasing temperature throughout the useful part of its characteristic

3.5
positive step-function temperature coefficient thermistor
PTC
thermistor which shows a step-like increase in its resistance when the increasing temperature reaches a specific value

A PTC thermistor will show secondary effects which are to be taken into account

3.6
zero-power resistance
R_T
value of the resistance of a PTC thermistor, at a given temperature, under conditions such that the change in resistance due to the internal generation of heat is negligible with respect to the total error of measurement

NOTE Any resistance value of a PTC thermistor is dependent on the value and the mode of the applied voltage (a.c. or d.c.) and, when an a.c. source is used, on the frequency (see 3.8 and 3.9).

3.7
nominal zero-power resistance
R_n
d.c. resistance value of a thermistor measured at a specified temperature, preferably at 25 °C, with a power dissipation low enough that any further decrease in power will result only in a negligible change in resistance. Zero-power resistance may also be measured using a.c. if required by the detail specification

3.8
voltage dependency
secondary effect, exhibiting a decreasing resistance with increasing voltage across the thermistor when measured at a constant body temperature

3.9
frequency dependency
secondary effect exhibiting a substantial decrease of the positive temperature coefficient of the thermistor with increasing frequency

3.10
resistance/temperature characteristics
relationship between the zero-power resistance of a thermistor and the temperature of the thermo-sensitive element when measured under specified reference conditions (see Figure 1)

NOTE PTC thermistors may have more than one resistance/temperature characteristic specified. The zero-power resistance of the resistance/temperature characteristics can be measured using a pulse voltage (U_{pulse}) higher than 1,5 V, which is specified in the detail specification. The right curve in Figure 1 shows the typical resistance/temperature characteristic when using the pulse voltage (U_{pulse}).

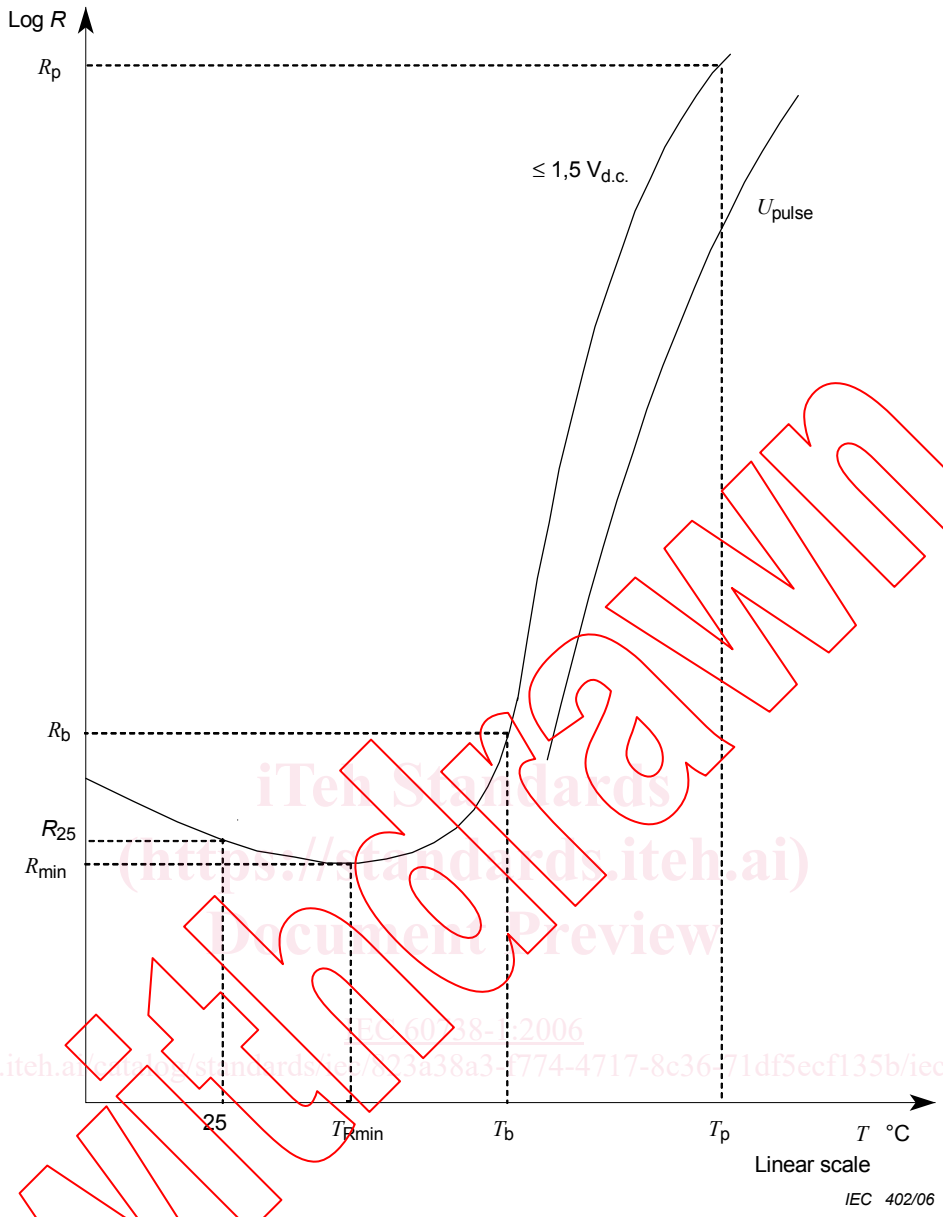


Figure 1 – Typical resistance-temperature characteristic and definitions for PTC thermistors (at zero power)

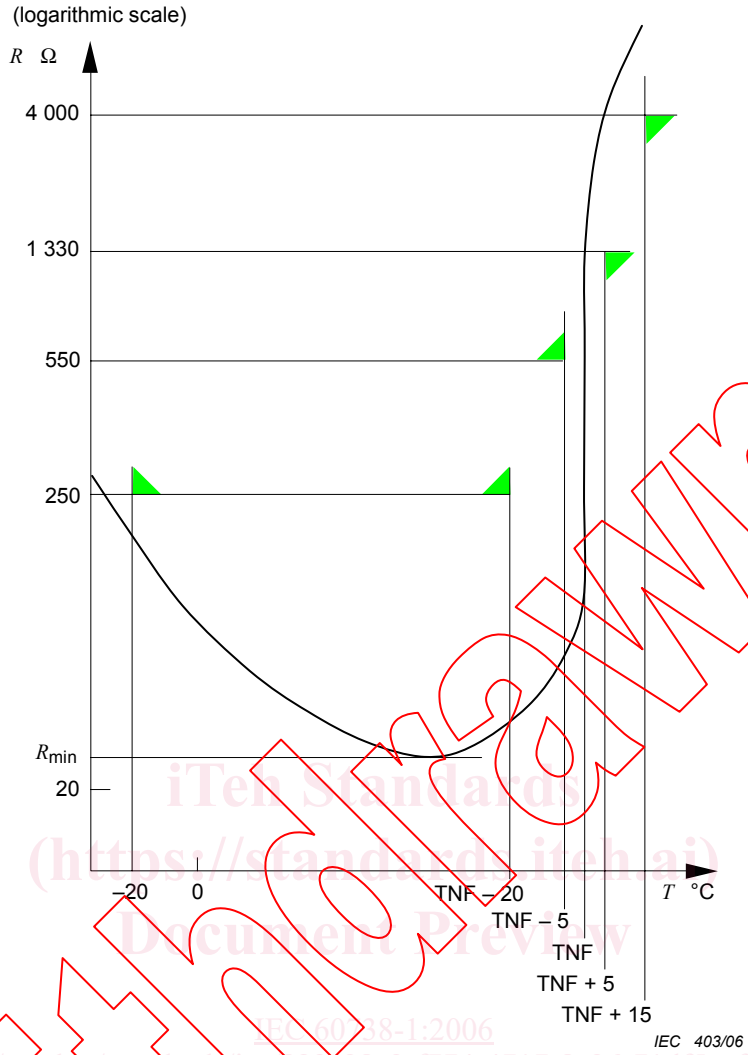
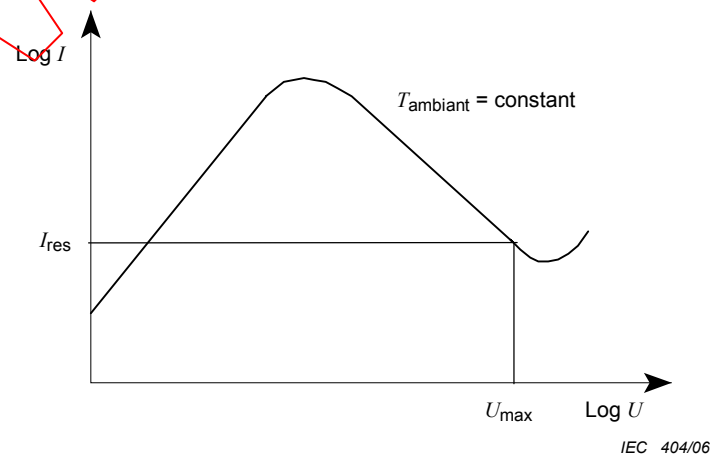


Figure 2 – Typical R-TNF characteristic for PTC thermistors in sensor applications

3.11
current/voltage characteristic
relationship in still air at 25 °C (unless otherwise stated) between the applied voltage (d.c. and/or a.c.) at the thermistor terminations and the current under steady-state conditions (see Figure 3)



NOTE 1 U_{max} will be specified by the manufacturer.

NOTE 2 The breakdown voltage is the value beyond which the voltage-handling capability of the thermistor no longer exhibits its characteristic property

Figure 3 – Typical current/voltage characteristic for PTC thermistors

3.12
nominal functioning temperature
T_{NF}
nominal temperature at the steep part of the resistance temperature characteristic at which the system controlled by the thermistor is designed to operate

NOTE T_{NF} is exclusively defined for PTC resistors in sensor applications.

3.13
switching temperature
T_b
temperature at which the step-like function commences

3.14
minimum resistance
R_{min}
minimum value of the zero-power resistance/temperature characteristic (see Figures 1 and 2)

3.15
resistance at switching temperature
R_b
value of the zero-power resistance corresponding to the switching temperature defined as $R_b = 2 \times R_{min}$. As an alternative definition $R_b = 2 \times R_{25}$ can be used. If this definition is used, this shall be explicitly stated in the detail specification

3.16
temperature for minimum resistance
T_{Rmin}
temperature at which R_{min} occurs

3.17
temperature
T_p
temperature, higher than T_b, in the PTC part of the resistance/temperature characteristic for which a minimum value R_p of the zero-power resistance is specified

3.18
resistance
R_p
zero-power resistance at temperature T_p measured at maximum voltage or a voltage specified in the detail specification and given as a minimum value

NOTE The measurement should be made under such conditions that a change in resistance due to internal generation of heat is negligible with respect to the total error of measurement. The applied voltage and the characteristics of any pulse used should be given in the detail specification; when applying the maximum voltage, the maximum overload current may not be exceeded.

3.19
average temperature coefficient of resistance at a stated voltage
α_R
rate of change of resistance with temperature expressed as %/K

It is calculated from the formula:

$$\alpha_R = \frac{100}{(T_p - T_b)} \times \ln \frac{R_p}{R_b}$$

where T_p exceeds T_b by a minimum of 10 K.