

INTERNATIONAL STANDARD

QC 440000

**Thermistors – Directly heated positive temperature coefficient –
Part 1: Generic specification**

(<https://standards.iteh.ai>)
Document Preview

IEC 60738-1:2006

<https://standards.iteh.ai/en/standards/iec/60738-1-2006>

Withhold



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2009 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, 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 either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

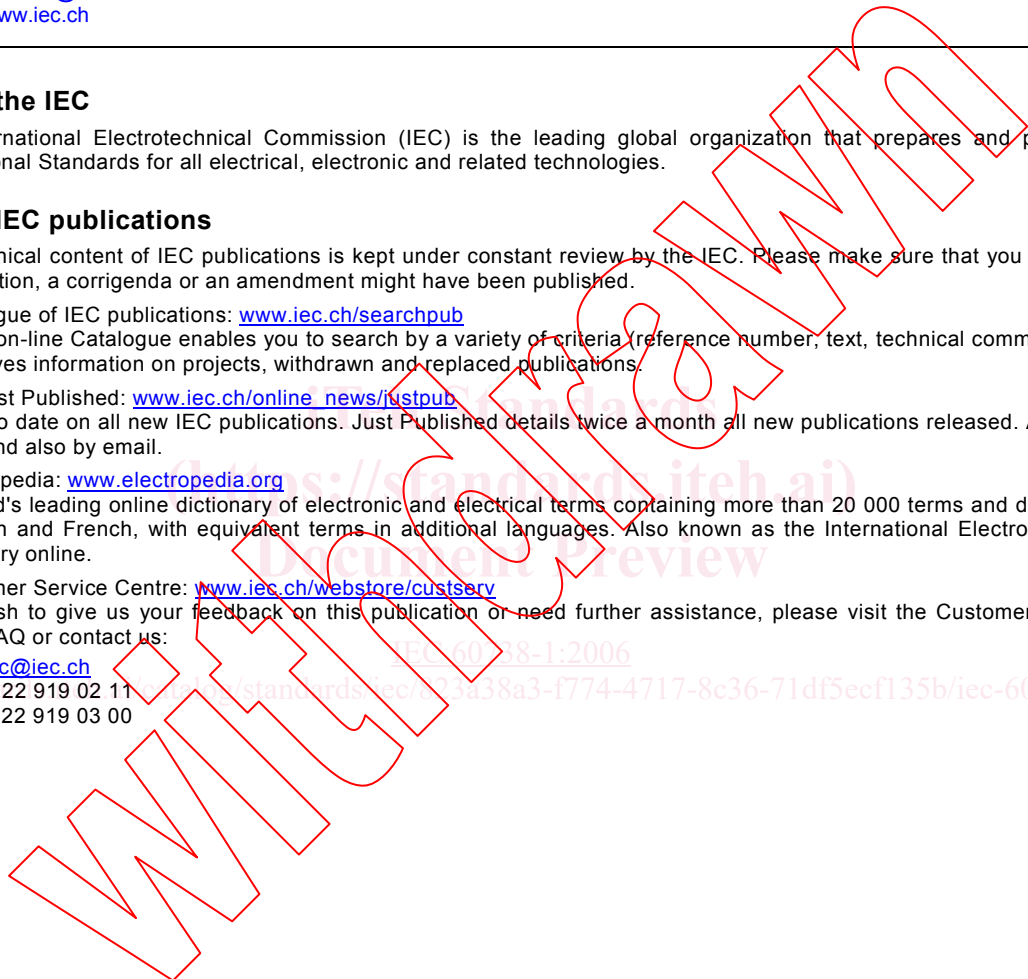
- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00



<https://standards.iteh.ai/>
IEC 60738-1:2006
<https://standards.iec.org/823a38a3-f774-4717-8c36-71df5ecf135b/iec-60738-1-2006>

INTERNATIONAL STANDARD

QC 440000

**Thermistors – Directly heated positive temperature coefficient –
Part 1: Generic specification**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.040.30

ISBN 978-2-88910-269-3

CONTENTS

FOREWORD.....	5
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	8
4 Units and symbols	16
5 Preferred values.....	17
5.1 Climatic categories.....	17
5.2 Marking.....	17
5.3 Spacings.....	18
6 Quality assessment procedures.....	18
6.1 General.....	18
6.2 Primary stage of manufacture.....	19
6.3 Subcontracting.....	19
6.4 Structurally similar components.....	19
6.5 Qualification approval procedures.....	20
6.6 Rework and repair.....	27
6.7 Release for delivery.....	27
6.8 Certified test records of released lots.....	28
6.9 Delayed delivery.....	28
6.10 Alternative test methods.....	28
6.11 Manufacture outside the geographical limits of IECQ NSIs.....	28
6.12 Unchecked parameters.....	28
7 Test and measurement procedures.....	28
7.1 General.....	28
7.2 Standard conditions for testing.....	29
7.3 Drying and recovery.....	29
7.4 Visual examination and check of dimensions.....	30
7.5 Zero-power resistance.....	30
7.6 Temperature coefficient of resistance.....	31
7.7 Insulation resistance (for insulated types only).....	31
7.8 Voltage proof (for insulated types only).....	32
7.9 Resistance/temperature characteristic.....	32
7.10 Dissipation factor at U_{\max} (δ).....	33
7.11 Response time by ambient temperature change (t_a).....	34
7.12 Response time by power change (t_p).....	34
7.13 Thermal time constant by ambient temperature change (τ_a).....	35
7.14 Thermal time constant by cooling (τ_c).....	35
7.15 Robustness of terminations.....	37
7.16 Solderability.....	38
7.17 Resistance to soldering heat.....	39
7.18 Rapid change of temperature.....	40
7.19 Vibration.....	40
7.20 Bump.....	40
7.21 Shock.....	41

7.22 Climatic sequence	41
7.23 Damp heat, steady state	42
7.24 Endurance	43
7.25 Tripping current and tripping time	47
7.26 Non-tripping current	47
7.27 Residual current	47
7.28 Surface temperature	48
7.29 Inrush current	49
7.30 Mounting (for surface mount thermistors only)	49
7.31 Shear (adhesion) test	50
7.32 Substrate bending test	51
Annex A (normative) Interpretation of sampling plans and procedures as described in IEC 60410 for use within the IEC quality assessment system for electronic components (IECQ)	52
Annex B (informative) Mounting for electrical measurements (except surface mount types)	53
Annex C (informative) Mounting for temperature measurements	56
Figure 1 – Typical resistance-temperature characteristic and definitions for PTC thermistors (at zero power)	10
Figure 2 – Typical R-TNF characteristic for PTC thermistors in sensor applications	11
Figure 3 – Typical current/voltage characteristic for PTC thermistors	11
Figure 4 – I_{in} against t at U_{dc}	14
Figure 5 – I_{in} against t at U_{rms}	15
Figure 6 – Dissipation factor test circuit	33
Figure 7 – Temperature gradient	34
Figure 8 – Circuit for measurement of thermal time constant by cooling	36
Figure 9 – Circuit for endurance at maximum operating temperature and maximum voltage	45
Figure 10 – Circuit for surface temperature measurement	48
Figure 11 – Measuring circuit	49
Figure B.1 – Example of a preferred mounting method for thermistors without wire terminations	53
Figure B.2 – Example of a preferred mounting method for thermistors with wire terminations	54
Figure B.3 – Example of a preferred mounting method for surface mount thermistors	55
Figure C.1 – Example of a preferred mounting method for temperature measurement on cylindrical heating elements	56
Table 1 – Creepage distances and clearances	18
Table 2 – Fixed sample size test schedule for qualification approval of thermistors for current limitation – Assessment level EZ	22
Table 3 – Fixed sample size test schedule for qualification approval of thermistors for use as heating elements – Assessment level EZ	23
Table 4 – Fixed sample size test schedule for qualification approval of thermistors for inrush current application – Assessment level EZ	24
Table 5 – Fixed sample size test schedule for qualification approval of thermistors for use as temperature sensing elements, Assessment level EZ	25

Table 6 – Quality conformance inspection for lot-by-lot inspection	26
Table 7 – Quality conformance inspection for periodic testing	27
Table 8 – Tensile force	37
Table 9 – Number of cycles per climatic category	42

Witholdrawn

iTech Standards
(<https://standards.iteh.ai>)
Document Preview

IEC 60738-1:2006

<https://standards.iteh.ai/catalog/standards/iec/623a38a3-f774-4717-8c36-71df5ecf135b/iec-60738-1-2006>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**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.
- 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.

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60738-1 edition 3.1 contains the third edition (2006-04) [documents 40/1651/FDIS and 40/1730/RVD] and its amendment 1 (2009-05) [documents 40/1940/CDV and 40/1999/RVC].

A vertical line in the margin shows where the base publication has been modified by amendment 1.

International Standard IEC 60738-1 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

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 the base publication and its amendments 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.

iTech Standards
(<https://standards.iteh.ai>)
Document Preview

IEC 60738-1:2006

<https://standards.iteh.ai/doc/standards/iec/623a38a3-f774-4717-8c36-71df5ecf135b/iec-60738-1-2006>

WITHDRAWN

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*

<https://www.intel.com/asset/f135b/iec-60738-1-2006>
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.

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}).

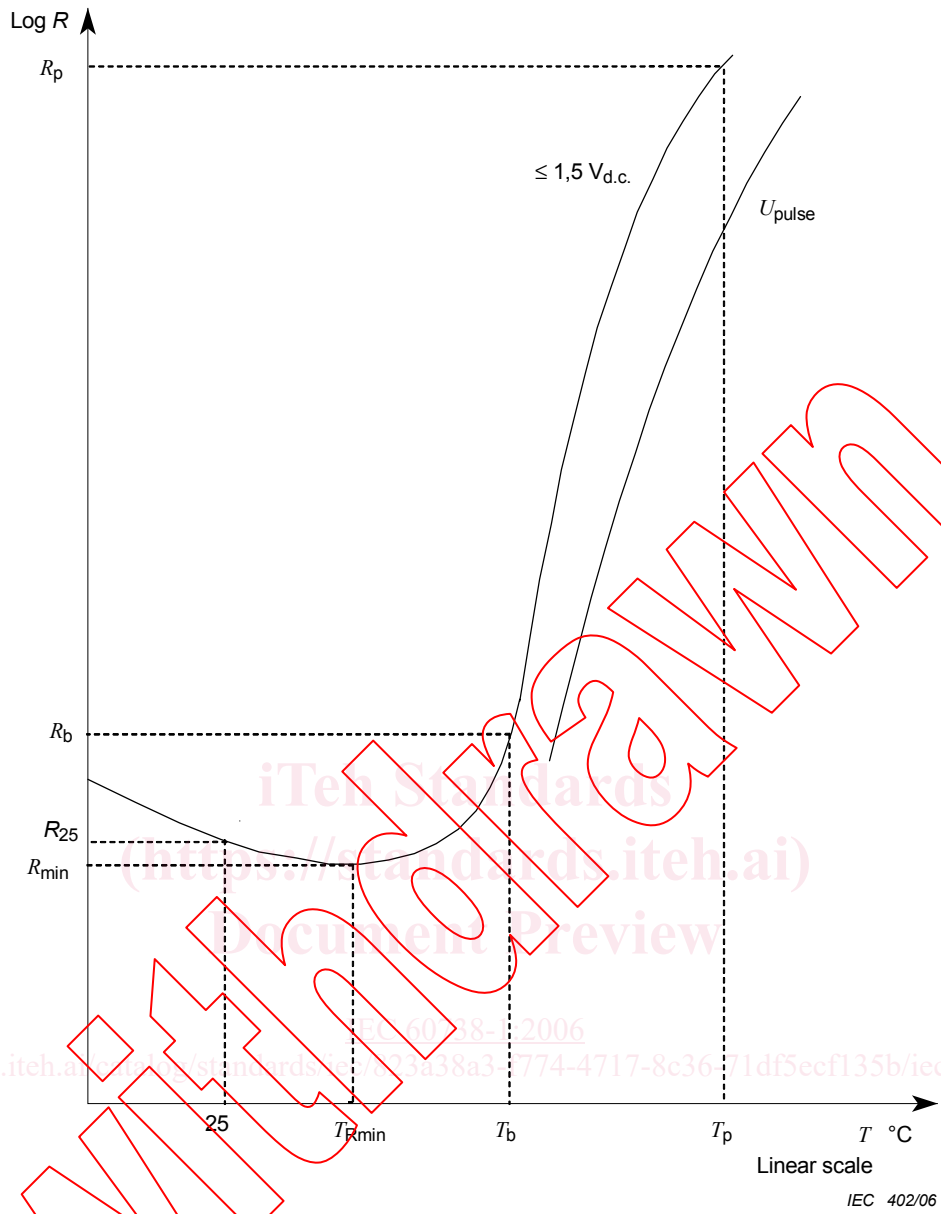


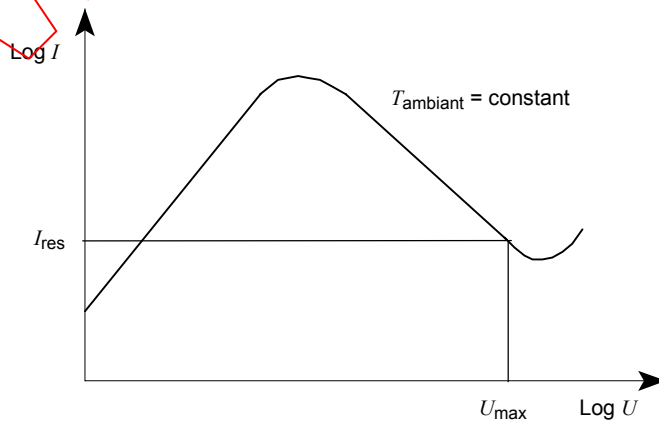
Figure 1 – Typical resistance-temperature characteristic and definitions for PTC thermistors (at zero power)



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.