

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



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

[standards.iteh.ai](https://standards.iteh.ai)

**Thermistances – Coefficient de température positif à chauffage direct –  
Partie 1: Spécification générique**

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



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2006 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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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 It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

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

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 14 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

More than 55 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [csc@iec.ch](mailto:csc@iec.ch).

### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Catalogue IEC - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

#### Recherche de publications IEC - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 14 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

#### Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)

Plus de 55 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).



IEC 60738-1

Edition 3.0 2006-04

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



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

**Thermistances – Coefficient de température positif à chauffage direct –  
Partie 1: Spécification générique**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE **XA**  
CODE PRIX

ICS 31.040.30

ISBN 978-2-83221-336-0

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## 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 $U_{\max}$ ( $\delta$ ) .....	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 ( $\tau_a$ ) .....	35
7.14 Thermal time constant by cooling ( $\tau_c$ ).....	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 .....	46
7.26 Non-tripping current .....	47
7.27 Residual current .....	47
7.28 Surface temperature .....	47
7.29 Inrush current .....	48
7.30 Mounting (for surface mount thermistors only) .....	49
7.31 Shear (adhesion) test .....	50
7.32 Substrate bending test .....	50
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) .....	51
Annex B (informative) Mounting for electrical measurements (except surface mount types) .....	52
Annex C (informative) Mounting for temperature measurements .....	55
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 .....	48
Figure B.1 – Example of a preferred mounting method for thermistors without wire terminations .....	52
Figure B.2 – Example of a preferred mounting method for thermistors with wire terminations .....	53
Figure B.3 – Example of a preferred mounting method for surface mount thermistors .....	54
Figure C.1 – Example of a preferred mounting method for temperature measurement on cylindrical heating elements .....	55
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

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[IEC 60738-1:2006](https://standards.iteh.ai/catalog/standards/sist/823a38a3-f774-4717-8c36-71df5ecf135b/iec-60738-1-2006)

<https://standards.iteh.ai/catalog/standards/sist/823a38a3-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.

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.

This bilingual version (2014-01) corresponds to the monolingual English version, published in 2006-04.

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.

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 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.

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[IEC 60738-1:2006](https://standards.iteh.ai/catalog/standards/sist/823a38a3-f774-4717-8c36-1d58c135b/iec-60738-1-2006)

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**



# 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)*  
<https://standards.iteh.ai/catalog/standards/sist/823a38a3-f774-4717-8c36-71d5ecf135b/iec-60738-1-2006>

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]<sup>1</sup>: *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.

---

<sup>1</sup> “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 ( $U_{\text{pulse}}$ ) 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 ( $U_{\text{pulse}}$ ).

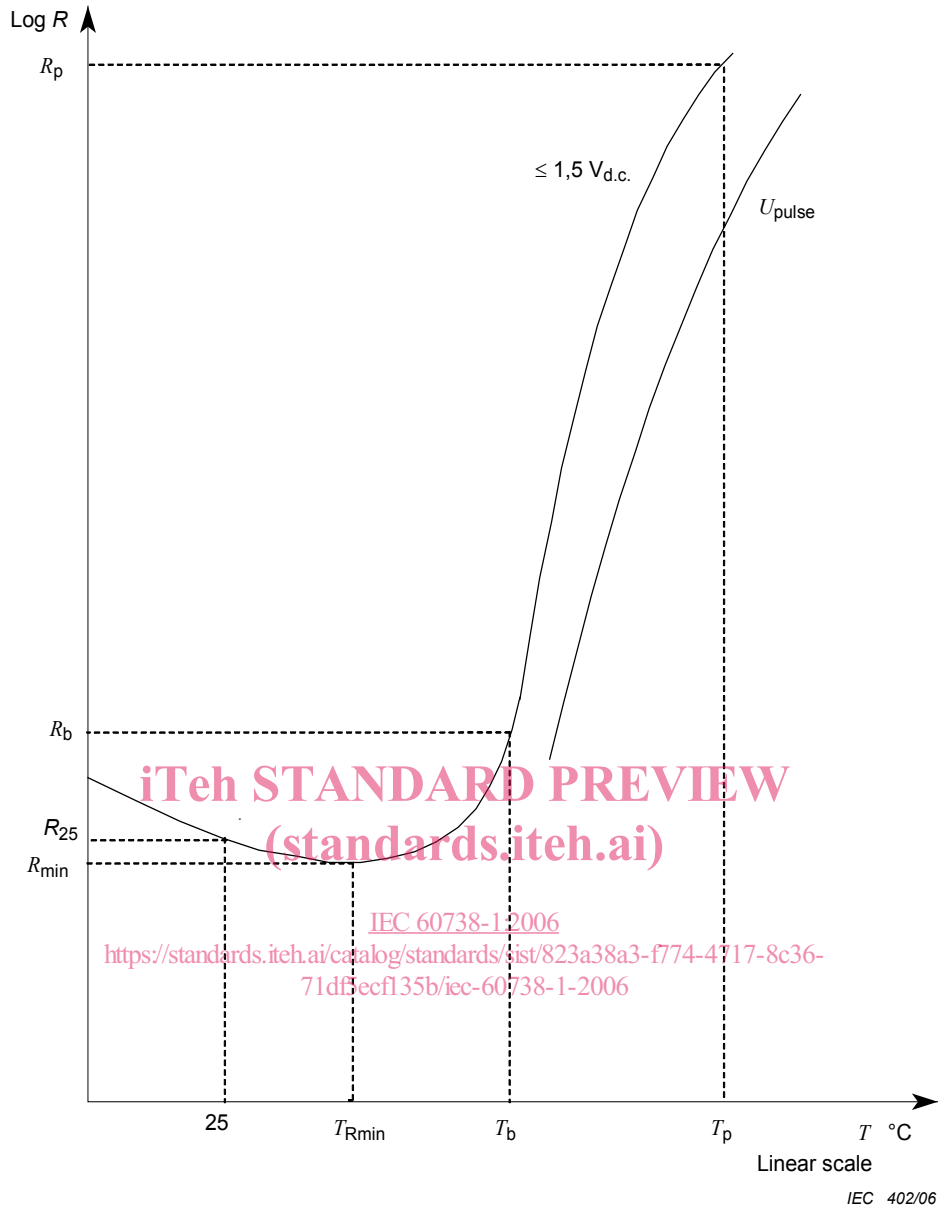
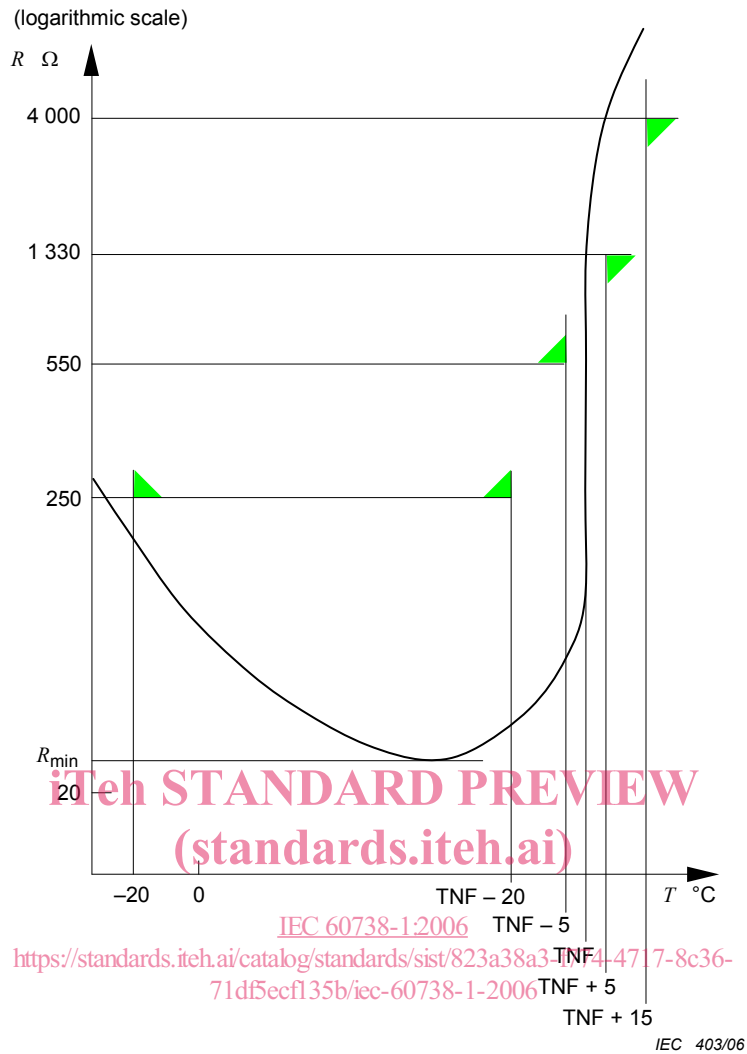


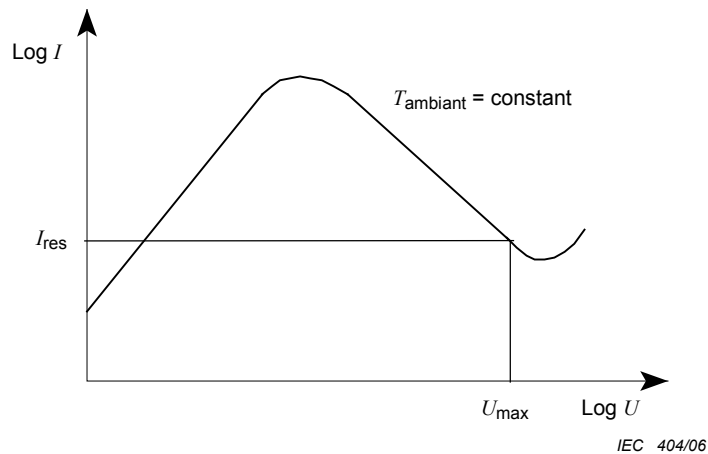
Figure 1 – Typical resistance-temperature characteristic and definitions for PTC thermistors (at zero power)



**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

**iTeh STANDARD PREVIEW**  
(standards.iteh.ai)

[IEC 60738-1:2006](https://standards.iteh.ai/catalog/standards/sist/823a38a3-f774-4717-8c36-71df5ecf135b/iec-60738-1-2006)

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

**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**

$\alpha_R$   
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.

The temperatures  $T_p$  and  $T_b$  are to be given if applicable and the measurement conditions for  $R_b$  and  $R_p$  should be the same, unless otherwise specified in the detail specification

NOTE The detail specification may specify the measurement of the temperature coefficient of resistance in a narrow temperature range where its value is a maximum, together with a suitable test method.

### 3.20

#### upper category temperature

##### UCT

maximum ambient temperature for which a thermistor has been designed to operate continuously at zero power

### 3.21

#### lower category temperature

##### LCT

minimum ambient temperature for which a thermistor has been designed to operate continuously at zero power

### 3.22

#### maximum voltage

##### $U_{\max}$

maximum a.c. or d.c. voltage which may be continuously applied to the thermistor without exceeding the maximum overload current

### 3.23

#### operating temperature range at maximum voltage

range of ambient temperatures at which the thermistor can operate continuously at the maximum voltage without exceeding the maximum overload current

### 3.24

#### isolation voltage (applicable only to insulated thermistors)

maximum peak voltage which may be applied under continuous operating conditions between any of the thermistor terminations and any conducting surface

### 3.25

#### maximum overload current

##### $I_{mo}$

value of current for the operating temperature range, which shall not be exceeded

NOTE It may be necessary to limit the current through the thermistor by the use of a series resistor  $R_s$ .

### 3.26

#### residual current

##### $I_{res}$

value of current in the thermistor at a specified ambient temperature (preferably 25 °C) under steady-state conditions. The applied voltage is the maximum voltage unless otherwise specified (see Figure 3)

### 3.27

#### tripping current

##### $I_t$

lowest current which will cause the thermistor to trip to a high resistance condition at a specified temperature (preferably 25 °C) and within a time to be specified in the detail specification

### 3.28

#### maximum non-tripping current

##### $I_{\max nt}$

maximum current at a specified ambient temperature (preferably 25 °C), which the thermistor will conduct indefinitely in its low-resistance condition