

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**



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2016 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
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

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

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

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

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

65 000 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

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

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

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

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

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

65 000 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

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



IEC 60539-1

Edition 3.0 2016-04

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**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.040.30

ISBN 978-2-8322-3307-8

**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.....	7
1 Scope.....	9
2 Normative references.....	9
3 Terms and definitions	10
4 General items	20
4.1 Units and symbols.....	20
4.2 Preferred values and appropriate category.....	20
4.2.1 General	20
4.2.2 Appropriate category.....	20
4.3 Marking.....	20
4.3.1 General	20
4.3.2 Marking for small size types such as surface mount thermistors	21
4.3.3 Coding.....	21
4.4 Quality assessment procedures	21
5 Test and measurement procedures	21
5.1 General.....	21
5.2 Standard atmospheric conditions for testing.....	21
5.3 Drying and recovery	22
5.3.1 Drying.....	22
5.3.2 Recovery	22
5.4 Mounting (for surface mount thermistors only).....	22
5.4.1 General	22
5.4.2 Substrate and pad.....	22
5.4.3 Mounting on board	22
5.5 Visual examination and check of dimensions	23
5.5.1 Visual examination.....	23
5.5.2 Dimensions.....	24
5.6 Zero-power resistance.....	24
5.6.1 General	24
5.6.2 Measurement procedures	24
5.6.3 Requirements	24
5.7 <i>B</i> -value or resistance ratio.....	25
5.7.1 General	25
5.7.2 Requirements	25
5.8 Insulation resistance (for insulated types only).....	25
5.8.1 General	25
5.8.2 Test methods.....	25
5.8.3 Applied voltage	27
5.8.4 Requirements	28
5.9 Voltage proof (for insulated types only).....	28
5.9.1 General	28
5.9.2 Test voltage.....	28
5.9.3 Requirements	28
5.10 Resistance/temperature characteristic	28
5.10.1 General	28
5.10.2 Test methods.....	28
5.10.3 Requirements	28

5.11	Dissipation factor (δ)	28
5.11.1	General	28
5.11.2	Initial measurements	29
5.11.3	Test methods	29
5.11.4	Requirements	30
5.12	Thermal time constant by ambient temperature change (τ_a)	30
5.12.1	General	30
5.12.2	Initial measurements	30
5.12.3	Preconditioning	31
5.12.4	Test methods	31
5.12.5	Final measurements and requirements	31
5.12.6	Requirements	31
5.13	Thermal time constant by cooling after self-heating (τ_c)	31
5.13.1	General	31
5.13.2	Initial measurements	31
5.13.3	Preconditioning	31
5.13.4	Test method	32
5.13.5	Final measurements and requirements	32
5.14	Robustness of terminations (not applicable to surface mount thermistors)	32
5.14.1	General	32
5.14.2	Initial measurements	32
5.14.3	Test methods	33
5.14.4	Test Ua ₁ – Tensile	33
5.14.5	Test Ub – Bending (half the number of terminations)	33
5.14.6	Test Uc – Torsion (remaining terminations)	33
5.14.7	Final measurements and requirements	33
5.15	Resistance to soldering heat	33
5.15.1	General	33
5.15.2	Preconditioning	34
5.15.3	Test procedure	34
5.15.4	Recovery	34
5.15.5	Final inspection, measurement and requirements	34
5.16	Solderability	34
5.16.1	General	34
5.16.2	Test procedure	34
5.16.3	Final inspection, measurements and requirements	35
5.17	Rapid change of temperature	35
5.17.1	General	35
5.17.2	Initial measurements	35
5.17.3	Test procedures	35
5.17.4	Final inspection, measurements and requirements	35
5.18	Vibration	36
5.18.1	General	36
5.18.2	Initial measurements	36
5.18.3	Test procedures	36
5.18.4	Final inspection, measurements and requirements	36
5.19	Shock	36
5.19.1	General	36

5.19.2	Initial measurements	36
5.19.3	Mounting.....	36
5.19.4	Test procedures	36
5.19.5	Final inspection, measurements and requirements	37
5.20	Free fall	37
5.20.1	General	37
5.20.2	Initial measurements	37
5.20.3	Test procedures	37
5.20.4	Final inspection, measurements and requirements	37
5.21	Thermal shock	37
5.21.1	General	37
5.21.2	Initial measurements	37
5.21.3	Test procedures	37
5.21.4	Final inspection, measurements and requirements	37
5.22	Cold.....	38
5.22.1	General	38
5.22.2	Initial measurements	38
5.22.3	Test procedures	38
5.22.4	Final inspection, measurements and requirements	38
5.23	Dry heat.....	38
5.23.1	General	38
5.23.2	Initial measurements	38
5.23.3	Test procedures	39
5.23.4	Final inspection, measurements and requirements	39
5.24	Damp heat, steady state.....	39
5.24.1	General	39
5.24.2	Initial measurements	39
5.24.3	Test procedures	39
5.24.4	Recovery	40
5.24.5	Final inspection, measurements and requirements	40
5.25	Endurance	40
5.25.1	General	40
5.25.2	Endurance at room temperature with applied continuous maximum current ($I_{\max 25}$) (for inrush current-limiting thermistors only).....	40
5.25.3	Endurance at room temperature with applied cyclic maximum current ($I_{\max 25}$) (for inrush current-limiting thermistors only)	41
5.25.4	Endurance at T_3 and P_{\max}	42
5.25.5	Endurance at upper category temperature	43
5.25.6	Maximum permissible capacitance (for inrush current-limiting thermistors only)	43
5.26	Shear (adhesion) test (for surface mount thermistors only).....	45
5.26.1	General	45
5.26.2	Test conditions	45
5.26.3	Requirements	45
5.27	Substrate bending test (for surface mount thermistors only)	46
5.27.1	General	46
5.27.2	Initial measurements	46
5.27.3	Test procedures	46
5.27.4	Final inspection and requirements	46
5.28	Component solvent resistance.....	46

5.28.1	General	46
5.28.2	Initial measurements	46
5.28.3	Test conditions	46
5.28.4	Requirements	47
5.29	Solvent resistance of marking.....	47
5.29.1	General	47
5.29.2	Test conditions	47
5.29.3	Requirements	47
5.30	Salt mist	47
5.30.1	General	47
5.30.2	Test conditions	47
5.31	Sealing	47
5.32	Composite temperature/humidity cycle.....	47
5.32.1	General	47
5.32.2	Initial measurements	47
5.32.3	Test conditions	48
5.32.4	Final inspection, measurements and requirements.....	48
Annex A (normative) Interpretation of sampling plans and procedures as described in IEC 60410:1973 for use within quality assessment systems		49
A.1	Clause and subclause numbers of IEC 60410:1973.....	49
Annex B (normative) Rules for the preparation of detail specifications for directly heated thermistors for electronic equipment for use within quality assessment systems.....		50
B.1	Drafting.....	50
B.2	Reference standard.....	50
B.3	Circulation	50
Annex C (informative) Typical examples of mountings for measurements of directly heated thermistors		51
C.1	Mounting for surface mount thermistors	51
Annex D (informative) Reference to IEC 60539-1:2008		53
Annex Q (normative) Quality assessment procedures		54
Q.1	General.....	54
Q.2	Primary stage of manufacture	54
Q.3	Structurally similar components	54
Q.4	Qualification approval procedures.....	55
Q.4.1	General	55
Q.4.2	Test procedure for qualification approval	55
Q.4.3	Maintenance of qualification approval	55
Q.5	Quality conformance inspection	56
Q.6	Certified test records of released lots	56
Q.7	Delayed delivery	56
Q.8	Release for delivery under qualification approval before the completion of group B tests	56
Q.9	Alternative test methods.....	56
Q.10	Unchecked parameters.....	56
Bibliography		57
Figure 1 – Typical resistance-temperature characteristic for NTC thermistors.....		13
Figure 2 – Decreased power dissipation curve.....		15
Figure 3 – Maximum current derating		17

Figure 4 – Basic circuit for zero-power resistance measurement	24
Figure 5 – Example of Method 1 for testing the insulation resistance.....	25
Figure 6 – Example of Method 2 for testing the insulation resistance (1)	26
Figure 7 – Example of Method 2 for testing the insulation resistance (2)	26
Figure 8 – Example of Method 3 for testing the insulation resistance.....	27
Figure 9 – Example of Method 4 for testing the insulation resistance.....	27
Figure 10 – Example of test chamber	29
Figure 11 – Dissipation factor measuring circuit.....	30
Figure 12 – Thermal time constant measuring circuit	32
Figure 13 – Endurance at room temperature with $I_{\max 25}$ evaluating circuit.....	41
Figure 14 – Maximum permissible capacitance test circuit (Method 1)	44
Figure 15 – Maximum permissible capacitance test circuit (Method 2).....	45
Figure C.1 – Mounting for measurements of surface mount thermistors.....	52
Table 1 – Lower and upper category temperatures and duration of the damp heat, steady state test	20
Table 2 – Tensile force	33

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**DIRECTLY HEATED NEGATIVE TEMPERATURE
COEFFICIENT THERMISTORS –****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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 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 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.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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 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 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*