IEC 60539-1

Edition 4.0 2022-12

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 60539-1:2022-12(en-fr)



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2022 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 Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
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 It also gives information on projects, replaced and withdrawn publications.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 once a month by email.

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: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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.

Recherche de publications IEC - webstore.iec.ch/advsearchform
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 une fois par mois par email.

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

IEC Products & Services Portal - products.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 60539-1

Edition 4.0 2022-12

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 978-2-8322-6192-7

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.

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

CONTENTS

FOREWORD 8
1 Scope 10
2 Normative references 10
3 Terms and definitions 11
4 General items 21
4.1 Units and symbols 21
4.2 Preferred values and appropriate category 21
4.2.1 General 21
4.2.2 Appropriate category 21
4.3 Marking 21
4.3.1 General 21
4.3.2 Marking for small size types such as surface mount NTC thermistors 22
4.3.3 Coding 22
4.4 Quality assessment procedures 22
5 General provisions for measurements and test methods 22
5.1 General 22
5.2 Standard atmospheric conditions for testing 22
5.3 Drying and recovery 23
5.3.1 Drying 23
5.3.2 Recovery 23
5.4 Mounting (for surface mount thermistors only) 23
5.4.1 General 23
5.4.2 Printed wiring board and land pattern 23
5.4.3 Mounting on board 23
6 Electrical tests and measurements 25
6.1 Zero-power resistance 25
6.1.1 General 25
6.1.2 Measurement procedures 25
6.1.3 Requirements 25
6.2 B-value or resistance ratio 25
6.2.1 General 25
6.2.2 Requirements 25
6.3 Insulation resistance (for insulated types only) 26
6.3.1 General 26
6.3.2 Test methods 26
6.3.3 Applied voltage 29
6.3.4 Requirements 29
6.4 Voltage proof (for insulated types only) 29
6.4.1 General 29
6.4.2 Test voltage 29
6.4.3 Requirements 29
6.5 Resistance/temperature characteristic 29
6.5.1 General 29
6.5.2 Test methods 29
6.5.3 Requirements 29
6.6 Dissipation factor (δ) 30

6.6.1 General 30
6.6.2 Initial measurements 30
6.6.3 Test methods 30
6.6.4 Requirements 31
6.7 Thermal time constant by ambient temperature change (τ_a) 31
6.7.1 The hot to cold thermal time constant for ambient temperature change 31
6.7.2 The cold to hot thermal time constant for ambient temperature change 32
6.7.3 Final measurements and requirements 32
6.7.4 Requirements 33
6.8 Thermal time constant by cooling after self-heating (τ_c) 33
6.8.1 General 33
6.8.2 Initial measurements 33
6.8.3 Preconditioning 33
6.8.4 Test method 34
6.8.5 Final measurements and requirements 34
7 Mechanical test and measurements 34
7.1 Visual examination and check of dimensions 34
7.1.1 Visual examination 34
7.1.2 Dimensions 35
7.2 Robustness of terminations (not applicable to surface mount thermistors) 35
7.2.1 General 35
7.2.2 Initial measurements 35
7.2.3 Test methods 35
7.2.4 Test Ua_1 – Tensile 35
7.2.5 Test Ub – Bending (half the number of terminations) 36
7.2.6 Test Uc – Torsion (remaining terminations) 36
7.2.7 Final measurements and requirements 36
7.3 Vibration 36
7.3.1 General 36
7.3.2 Initial measurements 36
7.3.3 Test procedures 36
7.3.4 Final inspection, measurements and requirements 37
7.4 Shock 37
7.4.1 General 37
7.4.2 Initial measurements 37
7.4.3 Mounting 37
7.4.4 Test procedures 37
7.4.5 Final inspection, measurements and requirements 37
7.5 Free fall 37
7.5.1 General 37
7.5.2 Initial measurements 37
7.5.3 Test procedures 38
7.5.4 Final inspection, measurements and requirements 38
7.6 Shear (adhesion) test (for surface mount NTC thermistors only) 38
7.6.1 General 38
7.6.2 Initial measurements 38
7.6.3 Test conditions 38
7.6.4 Final inspection, measurements and requirements 38

7.7 Substrate bending test (for surface mount NTC thermistors only) 38
7.7.1 General 38
7.7.2 Initial measurements 38
7.7.3 Test procedures 38
7.7.4 Final inspection, measurements and requirements 39
8 Environmental and climatic tests 39
8.1 Rapid change of temperature 39
8.1.1 General 39
8.1.2 Initial measurements 39
8.1.3 Test procedures 39
8.1.4 Final inspection, measurements and requirements 39
8.2 Thermal shock 40
8.2.1 General 40
8.2.2 Initial measurements 40
8.2.3 Test procedures 40
8.2.4 Final inspection, measurements and requirements 40
8.3 Cold 40
8.3.1 General 40
8.3.2 Initial measurements 40
8.3.3 Test procedures 40
8.3.4 Final inspection, measurements and requirements 41
8.4 Dry heat 41
8.4.1 General 41
8.4.2 Initial measurements 41
8.4.3 Test procedures 41
8.4.4 Final inspection, measurements and requirements 41
8.5 Damp heat, steady state 42
8.5.1 General 42
8.5.2 Initial measurements 42
8.5.3 Test procedures 42
8.5.4 Recovery 42
8.5.5 Final inspection, measurements and requirements 42
8.6 Endurance 42
8.6.1 General 42
8.6.2 Endurance at room temperature with applied continuous maximum current (I_{max25}) (for inrush current-limiting thermistors only) 43
8.6.3 Endurance at room temperature with applied cyclic maximum current (I_{max25}) (for inrush current-limiting thermistors only) 44
8.6.4 Endurance at T_3 and P_{max} (for other than inrush current-limiting thermistors only) 45
8.6.5 Endurance at upper category temperature 46
8.6.6 Maximum permissible capacitance (for inrush current-limiting thermistors only) 47
8.7 Salt mist 49
8.7.1 General 49
8.7.2 Initial measurements 49
8.7.3 Test conditions 49
8.7.4 Final inspection, measurements and requirements 49
8.8 Sealing 49

8.9 Composite temperature/humidity cycle 49
8.9.1 General 49
8.9.2 Initial measurements 49
8.9.3 Test conditions 50
8.9.4 Final inspection, measurements and requirements 50
9 Tests related to component assembly 50
9.1 Resistance to soldering heat 50
9.1.1 General 50
9.1.2 Preconditioning 50
9.1.3 Initial measurements 50
9.1.4 Test procedure 50
9.1.5 Recovery 50
9.1.6 Final inspection, measurement and requirements 51
9.2 Solderability 51
9.2.1 General 51
9.2.2 Initial measurements 51
9.2.3 Test procedure 51
9.2.4 Final inspection, measurements and requirements 51
9.3 Component solvent resistance 52
9.3.1 General 52
9.3.2 Initial measurements 52
9.3.3 Test conditions 52
9.3.4 Requirements 52
9.4 Solvent resistance of marking 52
9.4.1 General 52
9.4.2 Initial measurements 52
9.4.3 Test conditions 52
9.4.4 Requirements 52
Annex A (normative) Rules for the preparation of detail specifications for directly heated NTC thermistors for electronic equipment for use within quality assessment systems 53
A.1 Drafting 53
A.2 Reference standard 53
A.3 Circulation 53
Annex B (informative) Typical examples of mountings for measurements of directly heated thermistors 54
Annex Q (informative) Quality assessment procedures 56
Q.1 General 56
Q.1.1 Scope of this annex 56
Q.1.2 Quality assessment definitions 57
Q.1.3 Rework 57
Q.1.4 Alternative test methods 57
Q.1.5 Certified test records of released lots 58
Q.1.6 Unchecked parameters 58
Q.1.7 Delayed delivery 58
Q.1.8 Repair 58
Q.1.9 Registration of approvals 58
Q.1.10 Manufacture outside the geographical limits 59
Q.2 Qualification approval (QA) procedures 59

Q.2.1 Eligibility for qualification approval 59
Q.2.2 Application for qualification approval 59
Q.2.3 Subcontracting 59
Q.2.4 Test procedure for the initial product qualification approval 59
Q.2.5 Granting of qualification approval 59
Q.2.6 Maintenance of qualification approval 59
Q.2.7 Quality conformance inspection 60
Q.3 Capability approval (CA) procedures 60
Q.3.1 General 60
Q.3.2 Eligibility for capability approval 60
Q.3.3 Application for capability approval 60
Q.3.4 Subcontracting 61
Q.3.5 Description of the capability 61
Q.3.6 Demonstration and verification of capability 61
Q.3.7 Granting of capability approval 61
Q.3.8 Maintenance of capability approval 61
Q.3.9 Quality conformance inspection 61
Q.4 Technology approval (TA) procedure 62
Q.4.1 General 62
Q.4.2 Eligibility for technology approval 62
Q.4.3 Application of technology approval 62
Q.4.4 Subcontracting 62
Q.4.5 Description of technology 62
Q.4.6 Demonstration and verification of the technology 62
Q.4.7 Granting of technology approval 62
Q.4.8 Maintenance of technology approval 62
Q.4.9 Quality conformance inspection 63
Q.5 Interpretation of sampling plans and procedures as described in IEC 60410 for use within quality assessment systems 63
Q.6 Rules for the preparation of detail specifications for NTC thermistors for electronic equipment for use within quality assessment systems 63
Q.6.1 Drafting 63
Q.6.2 Reference standard 63
Q.7 Layout of the first page of a PCP/CQC specification 64
Q.8 Requirements for capability approval test report 65
Q.8.1 General 65
Q.8.2 Requirements 65
Q.8.3 Summary of test information (for each CQC) 65
Q.8.4 Measurement record 65
Q.9 Guidance for the extension of endurance tests on fixed thermistor 65
Q.9.1 Overview 65
Q.9.2 Guidelines 66
Annex X (informative) Cross-references to IEC 60539-1:2016 67
Bibliography 69

Figure 1 – Typical resistance-temperature characteristic for NTC thermistors 14
Figure 2 – Decreased power dissipation curve 16
Figure 3 – Maximum current derating 18
Figure 4 – Basic circuit for zero-power resistance measurement 25

Figure 5 – Example of Method 1 for testing the insulation resistance 26
Figure 6 – Example of Method 2 for testing the insulation resistance (1) 27
Figure 7 – Example of Method 2 for testing the insulation resistance (2) 27
Figure 8 – Example of Method 3 for testing the insulation resistance 28
Figure 9 – Example of Method 4 for testing the insulation resistance 28
Figure 10 – Example of test chamber 30
Figure 11 – Dissipation factor measuring circuit 31
Figure 12 – Thermal time constant measuring circuit 34
Figure 13 – Endurance at room temperature with I_{max25} evaluating circuit 43
Figure 14 – Endurance at room temperature with I_{max25} evaluating circuit 44
Figure 15 – Maximum permissible capacitance test circuit (Method 1) 48
Figure 16 – Maximum permissible capacitance test circuit (Method 2) 48
Figure B.1 – Mounting for measurements of surface mount thermistors 55

Table 1 – Lower and upper category temperatures and duration of the damp heat, steady state test 21
Table 2 – Tensile force 36
Table B.1 – Recommended land dimensions 54

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.

IEC 60539-1 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Restructured completely to comply to ISO/IEC directives; categorization and reorganization of test methods into these categories;
b) Annex X added for comparison to the previous edition;
c) Some wordings, figures and references have been revised.

The text of this International Standard is based on the following documents:

Draft	Report on voting
40/2975/FDIS	40/3016/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

A list of all parts in the IEC 60539-1 series, published under the general title *Directly heated negative temperature coefficient thermistors*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document 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 are referred to in the text in such a way that some or all of their content constitutes requirements 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 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, *Environmental testing – 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 Ta and Tb: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-21:2021, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-27:2008, *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*

IEC 60068-2-45:1980, *Basis Environmental testing procedures – Part 2-45: Tests – Test XA and guidance: Immersion in cleaning solvents*
IEC 60068-2-45:1980/AMD1:1993

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

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 60068-2-69, *Environmental testing – Part 2-69: Tests – Test Te/Tc: Solderability testing of electronic components and printed boards by the wetting balance (force measurement) method*

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 with axial terminations*

IEC 61193-2, *Quality assessment systems – Part 2: Selection and use of sampling plans for inspection of electronic components and packages*

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*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
type
group of 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 to entry: Mounting accessories are ignored, provided they have no significant effect on the test results.

Note 2 to entry: Ratings cover the combination of

– electrical ratings,

– sizes, and

– climatic category.

Note 3 to entry: The limits of the range of ratings should be given in the detail specification.

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