BS EN 60539-1:2016

BSI Standards Publication

Directly heated negative temperature coefficient thermistors

Part 1: Generic specification

National foreword

This British Standard is the UK implementation of EN 60539-1:2016. It is identical to IEC 60539-1:2016. It supersedes BS EN 60539-1:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/40X, Capacitors and resistors for electronic equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2016.
Published by BSI Standards Limited 2016

ISBN 978 0 580 83884 2
ICS 31.040.30

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 August 2016.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 60539-1

July 2016

ICS 31.040.30

Supersedes EN 60539-1:2008

English Version

Directly heated negative temperature coefficient thermistors - Part 1: Generic specification (IEC 60539-1:2016)

Thermistances à coefficient de température négatif à chauffage direct - Partie 1: Spécification générique (IEC 60539-1:2016)

Direkt geheizte temperaturabhängige Widerstände mit negativem Temperaturkoeffizienten - Teil 1: Fachgrundspezifikation (IEC 60539-1:2016)

This European Standard was approved by CENELEC on 2016-06-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

© 2016 CENELEC All rights of exploitation in any form and by any means reserved worldwide for CENELEC Members.

European foreword

The text of document 40/2430/FDIS, future edition 3 of IEC 60539-1, prepared by IEC/TC 40 "Capacitors and resistors for electronic equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60539-1:2016.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2017-03-01
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2019-06-01

This document supersedes EN 60539-1:2008.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60539-1:2016 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60027-1	NOTE	Harmonized as EN 60027-1.
ISO 80000-1:2009	NOTE	Harmonized as EN ISO 80000-1:2013 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60062	-	Marking codes for resistors and capacitors	EN 60062	-
IEC 60068-1	2013	Environmental testing - Part 1: General and guidance	EN 60068-1	2014
IEC 60068-2-1	-	Environmental testing - Part 2-1: Tests - Test A: Cold	EN 60068-2-1	-
IEC 60068-2-2	-	Environmental testing - Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	-
IEC 60068-2-6	-	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	-
IEC 60068-2-11	-	Basic environmental testing procedures - Part 2-11: Tests - Test Ka: Salt mist	EN 60068-2-11	-
IEC 60068-2-14	-	Environmental testing - Part 2-14: Tests - Test N: Change of temperature	EN 60068-2-14	-
IEC 60068-2-17	-	Basic environmental testing procedures - Part 2-17: Tests - Test Q: Sealing	EN 60068-2-17	-
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	EN 60068-2-20	-
IEC 60068-2-21	-	Environmental testing - Part 2-21: Tests - Test U: Robustness of terminations and integral mounting devices	EN 60068-2-21	-
IEC 60068-2-27	-	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	EN 60068-2-27	-

Publication	Year	Title	EN/HD	Year
IEC 60068-2-31	-	Environmental testing - Part 2-31: Tests - Test Ec: Rough handling shocks, primarily for equipment-type specimens	EN 60068-2-31	-
IEC 60068-2-38	-	Environmental testing - Part 2-38: Tests - Test Z/AD: Composite temperature/humidity cyclic test	EN 60068-2-38	-
IEC 60068-2-45	1980	Basic environmental testing procedures - Part 2-45: Tests - Test XA and guidance: Immersion in cleaning solvents	EN 60068-2-45	1992
+ A1	1993		+ A1	1993
IEC 60068-2-52	-	Environmental testing - Part 2-52: Tests - Test Kb: Salt mist, cyclic (sodium chloride solution)	EN 60068-2-52	-
IEC 60068-2-54	-	Environmental testing - Part 2-54: Tests - Test Ta: Solderability testing of electronic components by the wetting balance method	EN 60068-2-54	-
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)	EN 60068-2-58	-
IEC 60068-2-69	-	Environmental testing - Part 2: Tests - Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method	EN 60068-2-69	-
IEC 60068-2-78	-	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state	EN 60068-2-78	-
IEC 60294	-	Measurement of the dimensions of a cylindrical component with axial terminations	EN 60294	-
IEC 60717	-	Method for the determination of the space required by capacitors and resistors with unidirectional terminations	EN 60717	-
IEC 61193-2	-	Quality assessment systems - Part 2: Selection and use of sampling plans for inspection of electronic components and packages	EN 61193-2	-
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	EN 61249-2-7	-

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 B-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_{max25}) (for inrush current-limiting thermistors only) 40
5.25.3 Endurance at room temperature with applied cyclic maximum current (I_{max25}) (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_{max25} 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*