BS EN 60539-1:2016

BSI Standards Publication

Directly heated negative temperature coefficient thermistors

Part 1: Generic specification

bsi.

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 It supersedes BS EN 60539-1:2008 which is withdrawn.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.

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)

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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.

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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

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.

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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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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DIRECTLY HEATED NEGATIVE TEMPERATURE COEFFICIENT THERMISTORS –

Part 1: Generic specification

FOREWORD

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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*

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 60068-2-54, *Environmental testing – Part 2-54: Tests – Test Ta: Solderability testing of electronic components by the wetting balance method*

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: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance 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.

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

3.3
thermistor
thermally sensitive semiconducting resistor whose primary function is to exhibit an important change in electrical resistance with a change in body temperature

3.4
negative temperature coefficient thermistor
NTC thermistor
thermistor in which the resistance decreases with increasing temperature

Note 1 to entry: In general, the term 'NTC thermistor' is used.

3.5
directly heated negative temperature coefficient thermistor
thermistor which obtains its resistance variation by the changes of physical conditions.

Note 1 to entry: Physical conditions include the current through the thermistor, ambient temperature, humidity, wind velocity, gas, etc.

3.6
indirectly heated negative temperature coefficient thermistor
thermistor which obtains its resistance variation primarily by the change of temperature of the thermistor, due to the change of a current through a separate heater which is in close contact with, but electrically insulated from, the thermistor element

Note 1 to entry: The temperature of the thermistor can also be changed by the changes of physical conditions such as current through the thermistor element itself, ambient temperature, humidity, wind velocity, gas, etc.

Note 2 to entry: This term is for information only.

3.7
positive temperature coefficient thermistor
PTC thermistor
thermistor in which the resistance increases with increasing temperature

Note 1 to entry: In general, the term 'PTC thermistor' is used.

Note 2 to entry: This term is for information only.

3.8
thermistor with wire terminations
thermistor provided with wire terminations

3.9
thermistor without wire terminations
thermistor provided only with two metallized faces, to be used as electrical contacts

Note 1 to entry: This term is for information only.

3.10
insulated thermistor
thermistor coated with materials such as resin, glass or ceramic, capable of meeting the requirements of the insulation resistance and voltage proof tests when specified in the test schedule

3.11
non-insulated thermistor
thermistor with or without coating materials for surfacing of elements but not intended to meet the requirements of the insulation resistance and voltage proof tests when specified in the test schedule

3.12
surface mount thermistor
thermistor whose small dimensions and nature or shape of terminations make it suitable for use in hybrid circuits and on printed board

3.13
assembled thermistor
probe
thermistor encapsulated in different materials such as tubes, plastic and metal housing and/or assembled with cables and/or connectors

Note 1 to entry: This term is for information only.

3.14
thermistor for sensing
thermistor which responds to temperature changes and therefore is used for temperature sensing and control

3.15
inrush current limiting thermistor
thermistor which limits the inrush current just after switching on the power

3.16
residual resistance
<inrush current-limiting thermistors> value of the d.c. resistance of a thermistor when its thermal stability is reached with the maximum current passing

Note 1 to entry: This term is for information only.

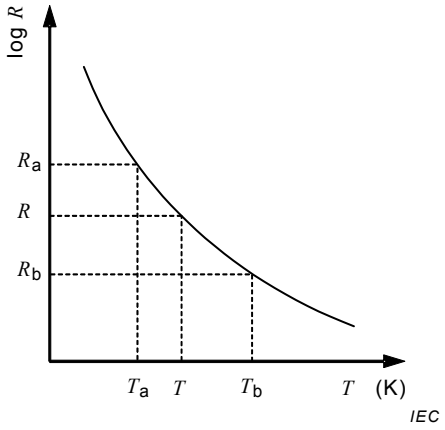
3.17
maximum permissible capacitance
<inrush current-limiting thermistors> maximum permissible capacitance value of a capacitor which can be connected to a thermistor under loading

3.18
zero-power resistance
R_T
value of the d.c. resistance of a thermistor, when measured at a specified temperature, under such conditions that the change in resistance due to the internal generation of heat is negligible with respect to the total error of measurement

3.19
nominal zero-power resistance
nominal value of zero-power resistance at the standard reference temperature of 25 °C, unless otherwise specified

3.20
resistance-temperature characteristic
relationship between the zero-power resistance and the body temperature of a thermistor

Note 1 to entry: Typical resistance-temperature characteristic for NTC thermistors is shown in Figure 1.



NOTE Slightly downward convexed curve when the temperature range is large.

Figure 1 – Typical resistance-temperature characteristic for NTC thermistors

Note 2 to entry: The resistance law follows approximately the formula:

$$R = R_a \times e^{B\left(\frac{1}{T} - \frac{1}{T_a}\right)}$$

where

R is the zero-power resistance (Ω) at absolute temperature T (K);

R_a is the zero-power resistance (Ω) at absolute temperature T_a (K);

B is the thermal sensitivity index (see 3.22).

This formula is only applicable for representing the resistance variation over a restricted temperature range. For more precise representation of the R/T-curve, a resistance/temperature relation should be specified in tabulated form in the detail specification.

3.21
resistance ratio
ratio of the zero-power resistance of a thermistor measured at the reference temperature of 25 °C to that measured at 85 °C, or at such other pairs of temperatures as may be prescribed in the detail specification

3.22
***B*-value**
index of the thermal sensitivity expressed by the formula

$$B = [(T_a \times T_b)/(T_b - T_a)] \times \ln(R_a/R_b)$$

where

B is the B-value (K);

R_a is the zero-power resistance (Ω) at temperature T_a (K);

R_b is the zero-power resistance (Ω) at temperature T_b (K)

Note 1 to entry: The B-value can also be expressed by the following formula (common logarithm):

$$B = 2{,}303 \times [(T_a \times T_b)/(T_b - T_a)] \times \log(R_a/R_b).$$

Note 2 to entry: The preferred values for T_a and T_b are 298,15 K and 358,15 K, respectively. These values are equivalent to +25 °C and +85 °C, respectively.

Note 3 to entry: Where the detail specification prescribes that the B-value should be measured at other temperatures, the specified values (in kelvins) shall be used for T_a and T_b in the calculation in place of the preferred values and the B-value may be expressed by $B_{a/b}$.

3.23
zero-power temperature coefficient of resistance
α_T
ratio at a specified temperature (T) of the rate of change of zero-power resistance with temperature to the zero-power resistance of the thermistor, expressed by the formula

$$\alpha_T = (1/R_T) \times (dR_T/dT) \times 100$$

Note 1 to entry: The value α_T can be approximately calculated by the formula:

$$\alpha_T = (-B/T^2) \times 100$$

where

α_T is the zero-power temperature coefficient of resistance in %/K;

R_T is the zero-power resistance in ohms at temperature T in kelvins (K);

B is the B-value (K).

Note 2 to entry: This term is for information only.

3.24
category temperature range
range of ambient temperatures for which the thermistor has been designed to operate continuously at zero-power, defined by the temperature limits of the appropriate category

Note 1 to entry: This term is for information only.

3.25
upper category temperature,
T_{max}
maximum ambient temperature for which a thermistor has been designed to operate continuously at zero-power

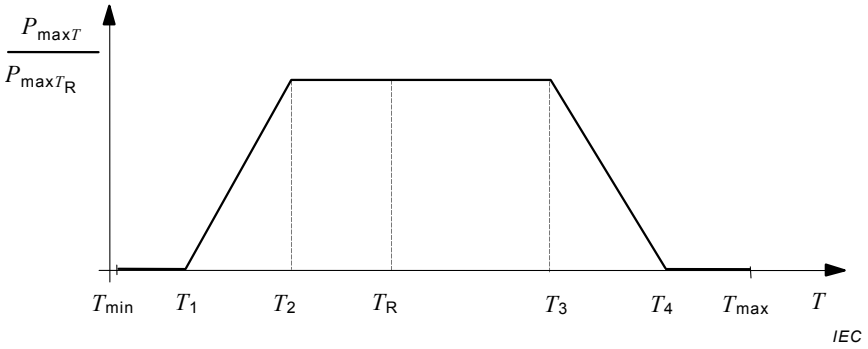
3.26
lower category temperature
T_{min}
minimum ambient temperature for which a thermistor has been designed to operate continuously at zero-power

3.27
storage temperature range
range of ambient temperatures for which a thermistor can be stored continuously under no-load condition

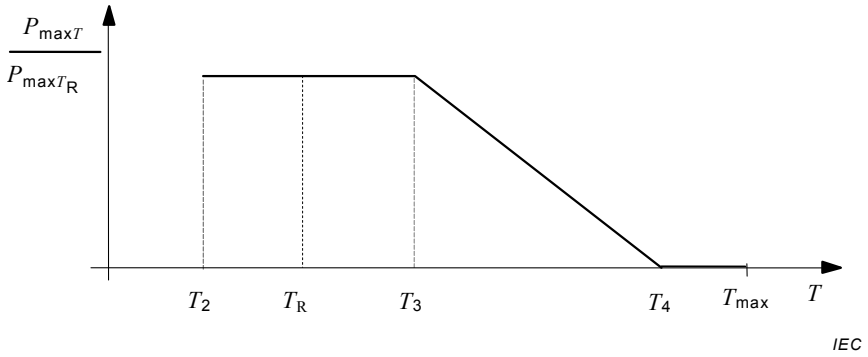
Note 1 to entry: This term is for information only.

3.28
decreased power dissipation curve
<all except inrush current-limiting thermistors> curve that expresses the relation between the ambient temperature and the maximum power dissipation P_{maxT}

Note 1 to entry: This relation is usually expressed as in Figure 2 a) or, alternatively, as in Figure 2 b).



a) Curve a



b) Curve b

Figure 2 – Decreased power dissipation curve

Note 2 to entry: This term is for information only.

3.29
maximum power dissipation at rated ambient temperature
P_{maxTR}
maximum value of the power dissipation which can be continuously applied to the thermistor at the rated ambient temperature T_R.

See Curve a, $T_2 \leq T_R \leq T_3$ or Curve b, $T_2 \leq T_R = T_3$ in Figure 2.

Note 1 to entry: The rated ambient temperature T_R is the ambient temperature specified in the detail specification and is usually 25 °C.

Note 2 to entry: This term is for information only.

3.30
maximum power dissipation at ambient temperature
P_{maxT}
maximum value of the power dissipation which can be continuously applied to the thermistor at an ambient temperature T

Note 1 to entry: **Curve a** (see Figure 2 a) in 3.28)

The maximum power dissipation rises at a temperature T_1 linearly to a temperature T_2. Between temperature T_2 and T_3 the power dissipation is constant. When the temperature exceeds T_3, the power dissipation shall be decreased linearly to zero at a temperature T_4

The maximum power dissipation at ambient temperature T in general is calculated as follows:

$$P_{maxT} = I_{maxT} \times U$$

where U is the voltage across the thermistor (for I_{maxT}, see 3.32).

The maximum power dissipation can be expressed by the following formula:

$T_1 \leq T \leq T_2$: $P_{\max T} = P_{\max T_R} \times \frac{T - T_1}{T_2 - T_1}$

$T_3 \leq T \leq T_4$: $P_{\max T} = P_{\max T_R} \times \frac{T_4 - T}{T_4 - T_3}$

where

T_R is the rated ambient temperature (°C);

T_1 is the temperature (°C) specified in the detail specification below which zero-power shall be applied. T_1 is equal to the lower category temperature T_{min}.(°C) or higher;

T_2 is the lowest temperature at which $P_{\max T}$ can be applied. T_2 = 0 °C, unless otherwise specified in the detail specification;

T_3 is the maximum temperature at which $P_{\max T}$ can be applied. T_3 = 55 °C, unless otherwise specified in the detail specification;

T_4 is the temperature (°C) specified in the detail specification, above which zero-power shall be applied. T_4 is equal to, or lower than, the upper category temperature T_{max} (°C).

Note 2 to entry: **Curve b** (see Figure 2 b) in 3.28)

The maximum power dissipation is constant between temperature T_2 and T_3. T_2 = 0 °C, unless otherwise specified in the detail specification. When the temperature exceeds T_3, the power dissipation must be decreased linearly to zero at a temperature T_4.

The maximum power dissipation at ambient temperature T in general is calculated as follows:

$$P_{\max T} = I_{\max T} \times U$$

where

U is the voltage across the thermistor (for $I_{\max T}$, see 2.2.32).

The maximum power dissipation can be expressed by the following formula:

$T_R \leq T \leq T_4$: $P_{\max T} = P_{\max T_R} \times \frac{T_4 - T}{T_4 - T_R}$

where

T_R is the rated ambient temperature (°C). T_R = 25 °C, unless otherwise specified in the detail specification;

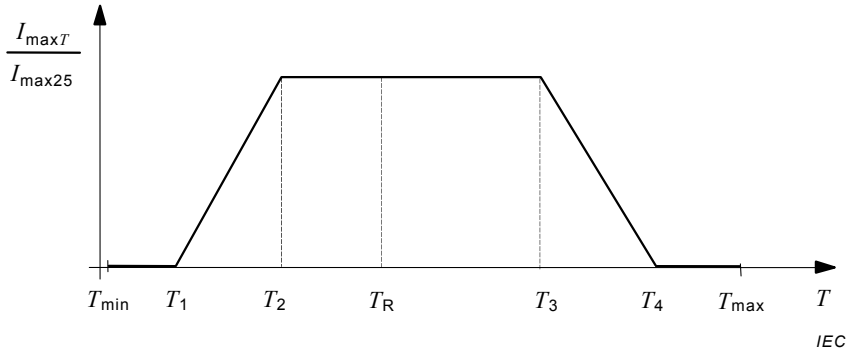
T_4 is the temperature (°C) specified in the detail specification, above which zero-power shall be applied. T_4 is equal to, or lower than the upper category temperature T_{max} (°C).

Note 3 to entry: This term is for information only.

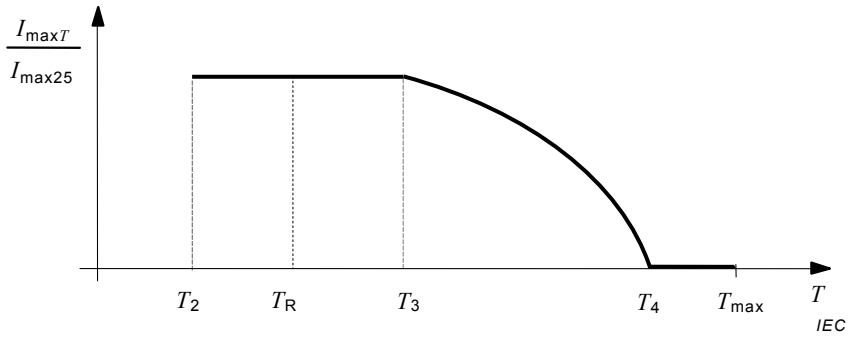
3.31
maximum current at ambient temperature of 25 °C
I_{max25}
<inrush current-limiting thermistors> maximum value of current (d.c. or r.m.s. values for Sine wave shaped a.c.) which can be continuously applied to the thermistor at an ambient temperature of 25 °C

Note 1 to entry: The maximum power dissipation at ambient temperature of 25 °C (P_{max25}) is calculated by $P_{max25} = I_{max25} \times U$, where U is the voltage drop across the thermistor.

Note 2 to entry: See Curve c, $T_2 \leq 25\ °C \leq T_3$ or Curve d, $T_2 \leq T_R = T_3$ in Figure 3.



a) Curve c



b) Curve d

Figure 3 – Maximum current derating

Note 3 to entry: This term is for information only.

3.32
maximum current at ambient temperature T

I_{maxT}

maximum value of the current which can pass continuously through the thermistor at an ambient temperature T

Note 1 to entry: **Curve c** (see Figure 3 a) in 3.31)

The maximum current rises at a temperature T_1 linearly to a temperature T_2. Between temperature T_2 and T_3 the current is constant. When the temperature exceeds T_3, the current must be decreased linearly to zero at a temperature T_4.

The maximum current can be expressed by the following formulae:

$T_1 \leq T \leq T_2$: $\quad I_{maxT} = I_{max25} \times \frac{T - T_1}{T_2 - T_1}$

$T_3 \leq T \leq T_4$: $\quad I_{maxT} = I_{max25} \times \frac{T_4 - T}{T_4 - T_3}$

where

T is the ambient temperature (°C);

T_1 is the temperature (°C) specified in the detail specification, which is equal to the lower category temperature T_{min} (°C) or higher;

T_2 is the ambient temperature at 0 °C, unless otherwise specified in the relevant detail specification;

T_3 is the ambient temperature at 55 °C, unless otherwise specified in the relevant detail specification;

T_4 is the temperature (°C) specified in the detail specification, which is equal to the upper category temperature T_{max} (°C) or lower.

Note 2 to entry: **Curve d** (see Figure 3 b) in 3.31)

The maximum current is constant between temperature T_2 and T_3. T_2 = 0 °C, unless otherwise specified in the detail specification. When the temperature exceeds T_3, the current shall be decreased linearly to zero at a temperature T_4.

The maximum current can be expressed by the following formula:

$$T_R \leq T \leq T_4: \qquad I_{maxT} = I_{max25} \times \frac{T_4 - T}{T_4 - T_R}$$

where

T is the ambient temperature (°C);

T_R is the rated ambient temperature (°C). T_R = 25 °C, unless otherwise specified in the detail specification;

T_4 is the temperature (°C) specified in the detail specification, which is equal to the upper category temperature T_{max} (°C) or lower.

Note 3 to entry: This term is for information only.

3.33
dissipation factor
δ
power dissipation required for a thermistor to raise its temperature by 1 K and which is generally the ratio of the power dissipation change to the resulting thermistor body temperature change at a specified ambient temperature

3.34
response time
time required for a thermistor to change its temperature between two defined conditions when subjected to a change in ambient temperature, power or a combination of temperature and power

Note 1 to entry: Response time measured in seconds.

Note 2 to entry: Because of the impracticability to measure response time direct, two methods are defined to measure the thermal time constant direct.

Note 3 to entry: This term is for information only.

3.35
thermal time constant by ambient temperature change
τ_a
time required for a thermistor to respond to 63,2 % of an external step change in ambient temperature in a defined medium

Note 1 to entry: τ_a is measured in seconds.

Note 2 to entry: Step change and medium are specified in the detail specification.

3.36
thermal time constant by cooling after self-heating
τ_c
time required for a thermistor to cool by 63,2 % of its temperature excess induced by self-heating, in a defined medium

Note 1 to entry: τ_c is measured in seconds.

Note 2 to entry: The medium is specified in the detail specification.

3.37
heat capacity
C_{th}
energy the thermistor needs to raise 1 K in temperature

Note 1 to entry: The heat capacity is measured in joules and is calculated by the following formula:

$$C_{th} = \delta \times \tau_c \text{ or } C_{th} = \delta \times \tau_a$$

Note 2 to entry: Heat capacity is completely determined by the component design.

Note 3 to entry: This term is for information only.

3.38
voltage current characteristic
relationship between the voltage (d.c., a.c. r.m.s.) across the thermistor and the applied steady-state current when the thermistor reaches a thermal equilibrium condition in still air or in the still medium specified in the detail specification, at 25 °C or at the temperature specified in the detail specification

Note 1 to entry: This term is for information only.

3.39
maximum operating power for limited self-heating,
$P_{\Delta T}$
maximum value of the power dissipation ($I_{\Delta T} \times U_{\Delta T}$) based on the consideration of the sensing error due to the internal generation of heat (self-heating) of the thermistor, which can be continuously applied to the thermistor in its practical use

Note 1 to entry: Unless otherwise specified in the detail specification, ΔT is equal to 1 K. The relationship among $P_{\Delta T}$, $I_{\Delta T}$ and $U_{\Delta T}$ is expressed by the following formulae:

$$P_{\Delta T} = \delta \times \Delta T$$

$$I_{\Delta T} = \sqrt{\frac{\delta \times \Delta T}{R_T}}$$

$$U_{\Delta T} = \sqrt{R_T \times (\delta \times \Delta T)}$$

where

$P_{\Delta T}$ is the maximum operating power for limited self-heating;

δ is the dissipation factor;

ΔT is the temperature rise of the thermistor due to its internal generation of heat;

$I_{\Delta T}$ is the permissible operating current;

$U_{\Delta T}$ is the permissible operating voltage;

R_T is the value of resistance at temperature T .

Note 2 to entry: This term is for information only.

4 General items

4.1 Units and symbols

Units, graphical symbols, letter symbols and terminology should, whenever possible, be taken from the following International Standards:

– IEC 60027-1;
– IEC 60050;
– IEC 60617;
– ISO 80000-1:2009.

When further items are required, they should be derived in accordance with the principles of the International Standards listed above.

4.2 Preferred values and appropriate category

4.2.1 General

Preferred climatic categories only shall be given in the preferred values.

4.2.2 Appropriate category

The thermistors covered by this part of IEC 60539 are classified into climatic categories according to the general rules given in IEC 60068-1:2013, Annex A.

The upper and lower category temperatures and the duration of the damp heat, steady state test shall be selected from Table 1.

Table 1 – Lower and upper category temperatures and duration of the damp heat, steady state test

Lower category temperature °C	-90, -80, -65, -55, -40, -25, -10, -5, +5
Upper category temperature °C	30, 40, 55, 70, 85, 100, 105, 125, 150, 155, 175, 200, 250, 315, 400, 500, 630, 800, 1 000
Duration of the damp heat, steady state test d	4, 21, 42, 56

The detail specification shall prescribe the appropriate category.

4.3 Marking

4.3.1 General

The following shall be clearly marked on the thermistor in the following order of precedence as space permits:

a) nominal zero-power resistance;
b) manufacturer's name and/or trade mark;
c) date of manufacture;
d) tolerance on nominal zero-power resistance;
e) the number of the detail specification and style.

The packaging containing the thermistor(s) shall be clearly marked with all the information listed above.

Any additional marking shall be so applied that no confusion can arise.

4.3.2 Marking for small size types such as surface mount thermistors

Small size types such as surface mount thermistors are generally not marked on the body. If some marking can be applied, small size types shall be clearly marked with as many as possible of the above items as is considered useful. Any duplication of information in the marking on the thermistor should be avoided.

4.3.3 Coding

Where coding for resistance value, tolerance or date is used, the method shall be one selected from those given in IEC 60062.

4.4 Quality assessment procedures

See Annex Q.

5 Test and measurement procedures

5.1 General

The sectional and/or blank detail specifications shall contain tables showing the tests to be performed, which measurements are to be made before and after each test or subgroup of tests, and the sequence in which they shall be carried out. The stages of each test shall be carried out in the order written. The measuring conditions shall be the same for initial and final measurements.

If national specifications within any quality assessment system include methods other than those specified in the sectional and/or blank detail specifications, they shall be fully described.

5.2 Standard atmospheric conditions for testing

Unless otherwise specified, all tests and measurements shall be made under standard atmospheric conditions for testing as given in IEC 60068-1:2013, 4.3:

– temperature: 15 °C to 35 °C;
– relative humidity: 25 % to 75 %;
– air pressure: 86 kPa to 106 kPa.

Before the measurements are made, the thermistor shall be stored at the measuring temperature for a time sufficient to allow the entire thermistor to reach this temperature. The same period as is prescribed for recovery at the end of a test is normally sufficient for this purpose.

During measurements, the thermistor shall not be exposed to draughts, direct sun-rays or other influences likely to cause error.

When measurements are made at a temperature other than the specified temperature, the results shall, when necessary, be corrected to the specified temperature. The ambient temperature during the measurements shall be stated in the test report.

When tests are conducted in a sequence, the final measurements of one test may be taken as the initial measurements for the succeeding test.

5.3 Drying and recovery

5.3.1 Drying

Where drying is called for in the specification, the thermistor shall be conditioned before measurement is made, using procedure 1 or procedure 2 as called for in the detail specification.

a) Procedure 1

   For 24 h ± 4 h in an oven at a temperature of 55 °C ± 2 °C and relative humidity not exceeding 20 %.

b) Procedure 2

   For 96 h ± 4 h in an oven at 100 °C ± 5 °C.

   The thermistor shall then be allowed to cool in a desiccator using a suitable desiccant, such as activated alumina or silica gel, and shall be kept therein from the time of removal from the oven to the beginning of the specified tests.

5.3.2 Recovery

Unless otherwise specified, recovery shall take place under the standard atmospheric conditions for testing (5.2). If recovery has to be made under closely controlled conditions, the controlled recovery conditions of IEC 60068-1:2013, 4.4.2, shall be used.

5.4 Mounting (for surface mount thermistors only)

5.4.1 General

Surface mount thermistors shall be fixed on to the printed wiring board with wave soldering or reflow soldering as specified in 5.4.2 and 5.4.3.

5.4.2 Substrate and pad

The printed wiring boards that mount the thermistors shall fulfil the following requirements.

a) The substrate material shall normally be a 1,6 mm thick epoxide woven glass fabric laminated printed board (as defined in IEC 61249-2-7) or a 0,635 mm alumina substrate and shall not affect the result of any test or measurement. The detail specification shall indicate which material is to be used for the electrical measurements.
b) The substrate shall have metallized land areas of proper spacing to permit mounting of surface mount thermistors and shall provide electrical connection to the surface mount thermistor terminals. The details shall be specified in the detail specification.

If another method of mounting applies, the method shall be clearly specified in the detail specification.

5.4.3 Mounting on board

5.4.3.1 General

The thermistors shall be fixed on to the printed wiring board by the method specified 5.4.3.2 or 5.4.3.3.

5.4.3.2 Solder bath method

When the detail specification specifies wave soldering, the following mounting procedure applies.

a) Small dots of the glue shall be applied between the conductors of the substrate by means of a suitable device securing repeatable results.

b) The surface mount thermistors shall be placed on the dots using tweezers. To ensure that no glue is applied to the conductors, the surface mount thermistors shall not be moved about.

c) The substrate with the surface mount thermistors shall be heat-treated in an oven at 100 °C for 15 min.

d) The substrate shall be soldered in a wave-soldering apparatus. The apparatus shall be adjusted to have a pre-heating temperature of 80 °C to 130 °C, a solder bath at 260 °C ± 5 °C and a soldering time of 5 s ± 0,5 s.

The soldering operation shall be repeated once (two cycles in total).

e) The substrate shall be cleaned for 3 min in a suitable solvent (see IEC 60068-2-45:1980/AMD1:1993, 3.1.2).

5.4.3.3 Reflow method

When the detail specification specifies reflow soldering, the following mounting procedure applies.

a) The solder used in preform or paste form shall be silver bearing (2 % minimum) eutectic Sn/Pb solder together with a non-activated flux as stated in IEC 60068-2-20. Alternative solders such as 60/40 or 63/37 may be used on surface mount thermistors the construction of which includes solder leach barriers. The Pb-free solder used in preform or paste form shall be Sn96,5-Ag3,0-Cu0,5 or derivative solder together with a flux as stated in IEC 60068-2-58.

b) The surface mount thermistor shall then be mounted as follows.

1) Mount the preform solder on the land with an appropriate method.

2) Apply the solder paste on the land with an appropriate method. Set the thermistor in between the land part of the printed wiring board. If using the preform solder, apply flux to the soldering part with an appropriate method.

c) The substrate shall then be placed in or on a suitable heating system (molten solder, hot plate, tunnel oven, etc.). The temperature of the unit shall be maintained between 215 °C and 260 °C, until the solder melts and reflows forming a homogeneous solder bond, but for not longer than 10 s.

d) Flux shall be removed by a suitable solvent (see IEC 60068-2-45:1980/AMD1:1993, 3.1.2). All subsequent handling shall be such as to avoid contamination. Care should be taken to maintain cleanliness in test chambers and during post test measurements.

e) In the case of using reflow soldering, the following apply.

1) The detail specification may require a more restricted temperature range.

2) If vapour phase soldering is applied, the same method may be used with the temperatures adapted.

5.5 Visual examination and check of dimensions

5.5.1 Visual examination

5.5.1.1 General

The condition, workmanship and finish shall be satisfactory as determined by visual examination.

5.5.1.2 Marking

Marking shall be legible as determined by visual examination.

5.5.2 Dimensions

5.5.2.1 Gauging

The dimensions indicated in the detail specification as being suitable for gauging shall be checked and shall comply with the values prescribed in the detail specification.

Where applicable, measurements shall be made in accordance with IEC 60294 or IEC 60717.

5.5.2.2 Detail

All dimensions prescribed in the detail specification shall be checked and they shall comply with the values prescribed.

5.6 Zero-power resistance

5.6.1 General

The zero-power resistance shall be measured at the temperature given in the detail specification.

5.6.2 Measurement procedures

The thermistors shall be subjected to the procedures of the zero-power resistance as follows.

a) The thermistors shall be mounted by their normal means in corrosion-resistant clips on a mounting plate made of an appropriate insulating material.
b) The thermistors shall then be deeply inserted into a measurement bath containing a non-corrosive and non-reducing medium, close to the thermometer and for a length of time needed to reach a stable reading of the zero-power resistance.
c) The zero-power resistance shall be measured according to the basic circuit of Figure 4.
d) Implementation all measurements shall be made without self-heating of the devices (zero-power condition).

The total error of measurement of power dissipation, temperature tolerance and the error of the measuring equipment shall not exceed 10 % of the tolerance specified in the detail specification.

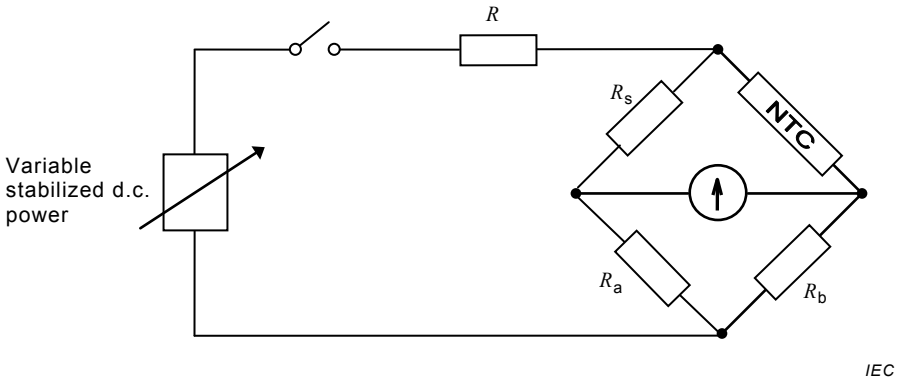


Figure 4 – Basic circuit for zero-power resistance measurement

5.6.3 Requirements

The zero-power resistance shall be within the specified tolerance.

5.7 *B*-value or resistance ratio

5.7.1 General

Calculate the *B*-value (see 3.22) or the resistance ratio (see 3.21) using zero-power resistance values measured at 25 °C and 85 °C (or at such other pairs of temperatures as may be prescribed in the detail specification) using the method specified in 5.6.

5.7.2 Requirements

The *B*-value or the resistance ratio shall be within the specified tolerance.

5.8 Insulation resistance (for insulated types only)

5.8.1 General

The insulation resistance of the protective coating shall be measured as specified in the detail specification. The exposed electrode of the thermistor and the other pole shall be a sufficient distance from each other so as not to be short circuited directly.

5.8.2 Test methods

According to the instructions given in the detail specification, one of the following test methods is used.

a) Method 1

The non-insulated parts of the thermistor shall be wrapped in a good insulating material. The thermistor is placed in a vessel containing metallic balls of 1,6 mm ± 0,2 mm diameter or 1,0 mm ± 0,2 mm diameter, so that only the metallized part is immersed. The metal of the balls shall be such that it does not develop a resistive surface.

An example of Method 1 is shown in Figure 5.

An electrode is placed in the metallic balls.

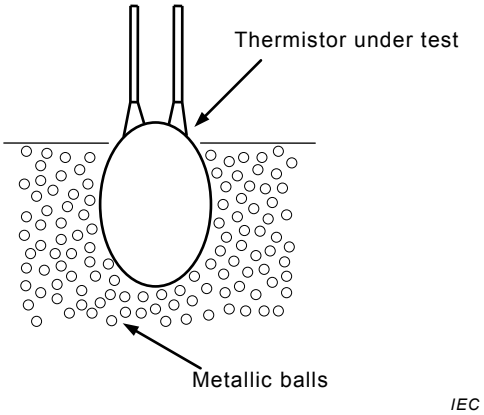


Figure 5 – Example of Method 1 for testing the insulation resistance

b) Method 2

The thermistor shall be placed in water (≤100 Ω·m), so that only the insulated part is immersed.

An example of Method 2 is shown in Figures 6 and 7.

An electrode is immersed in the solution.

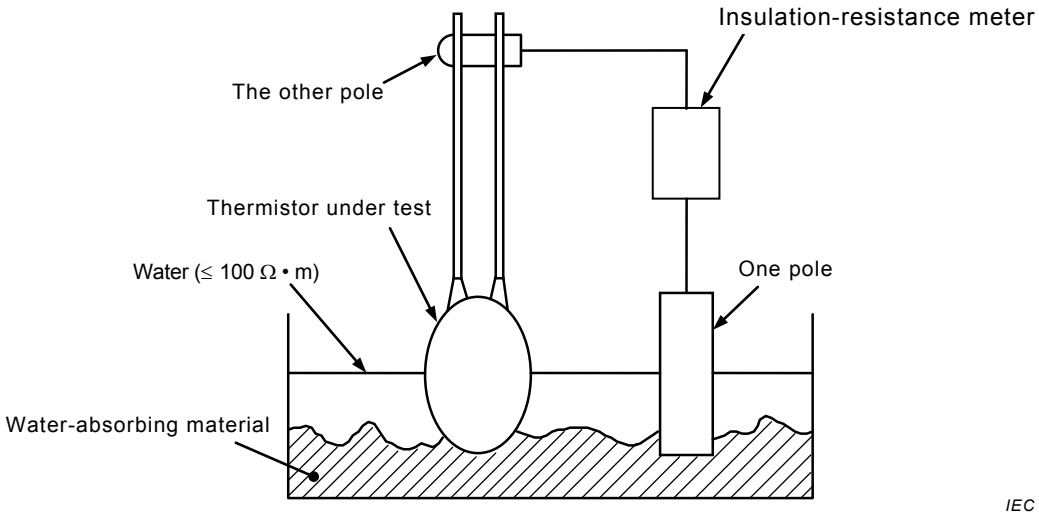


Figure 6 – Example of Method 2 for testing the insulation resistance (1)

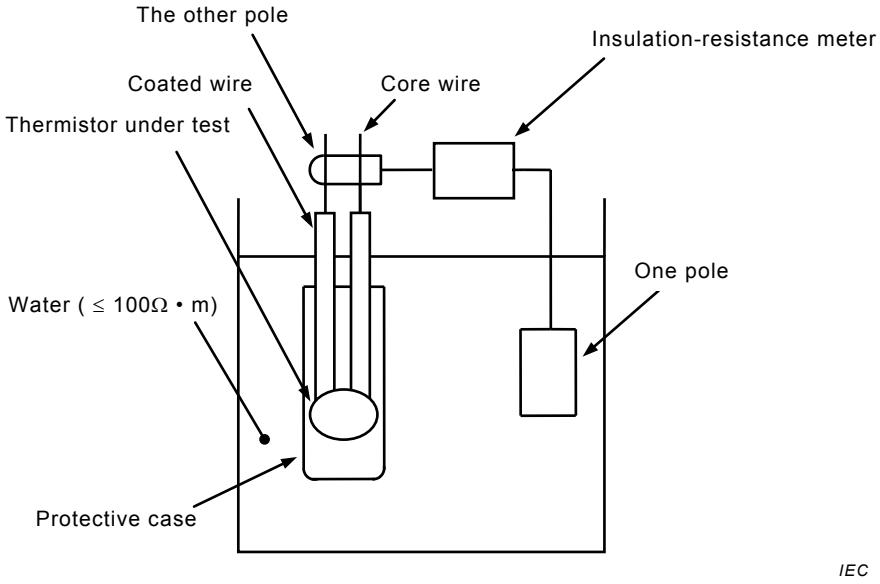


Figure 7 – Example of Method 2 for testing the insulation resistance (2)

c) Method 3

A metal foil shall be wrapped closely around the body of the thermistor.

For those types not having axial terminations, a space of 1 mm to 1,5 mm shall be left between the edge of the foil and each termination. For those types having axial terminations, the foil shall be wrapped round the whole body of the thermistor protruding by at least 5 mm from each end, provided that the minimum space of 1 mm between the foil and the termination can be maintained. The ends of the foil shall not be folded over the ends of the thermistor.

An example of Method 3 is shown in Figure 8.

Dimensions in millimetres

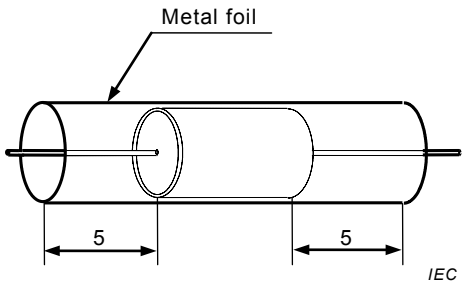


Figure 8 – Example of Method 3 for testing the insulation resistance

d) Method 4

The thermistor shall be clamped in the trough of a 90° metallic V-block of such a size that the thermistor body does not extend beyond the extremities of the block.

The clamping force shall be such as to maintain adequate contact between the thermistor and the block.

The thermistor shall be positioned in the V-block in accordance with the following.

– For cylindrical thermistors: the thermistor shall be positioned in the block so that the termination furthest from the axis of the thermistor is nearest to one of the faces of the block.

– For rectangular thermistors: the thermistor shall be positioned in the block so that the termination nearest to the edge of the thermistor is nearest to one of the faces of the block.

– For cylindrical and rectangular thermistors with axial leads: any out-of-centre positioning of the point of emergence of the terminations from the body shall be ignored.

An example of Method 4 is shown in Figure 9.

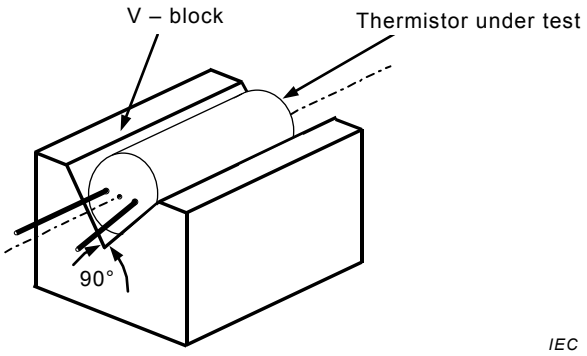


Figure 9 – Example of Method 4 for testing the insulation resistance

e) Method 5

The thermistor shall be clamped between metal plates. The clamping force shall be such as to maintain adequate contact between the thermistor and the plates.

f) Method 6

The thermistor is insulated from the accessory (mounting bracket, flange, and other) which is one pole.

5.8.3 Applied voltage

Unless otherwise specified in the detail specification, the insulation resistance shall be measured with a direct voltage of 500 V ± 15 V between both terminations of the thermistor

connected together as one pole and the metallic balls, the water (≤100 Ω·m), metal foil, V-block, metal plates or accessory as the other pole.

The voltage shall be applied for 1 min, or for such shorter time as is necessary to obtain a stable reading, the insulation resistance being read at the end of that period.

5.8.4 Requirements

When thermistors are measured as specified, the insulation resistance shall be not less than the appropriate figure specified in the detail specification.

5.9 Voltage proof (for insulated types only)

5.9.1 General

The thermistors are tested as specified in 5.9.2. As required by the detail specification. One of the test methods given in 5.8.2 shall be used.

5.9.2 Test voltage

The applied voltage shall be that specified in the applicable safety document.

In the absence of a safety document, an alternating voltage with a frequency of 50 Hz or 60 Hz and with a peak value of 1,4 times the isolation voltage specified in the detail specification shall be applied for 60 s ± 5 s between all terminations of the thermistor connected together as one pole and the metallic balls, the metal foil, the V-block, the metal plates, the accessory or the clean water as the other pole.

The voltage shall be applied gradually at a rate of approximately 100 V/s. The test time may be reduced to 1 s provided the test voltage is increased by 20 %.

5.9.3 Requirements

There shall be no breakdown or flashover.

5.10 Resistance/temperature characteristic

5.10.1 General

The method of test shall be as described in 5.10.2.

5.10.2 Test methods

The measuring temperature shall be selected from those given in Table 1 and the resistance/temperature characteristic shall be measured using the method described in 5.6.2.

5.10.3 Requirements

The resistance/temperature characteristic shall be within the limits specified in the detail specification.

5.11 Dissipation factor (δ)

5.11.1 General

The method of test shall be as described in 5.11.3.

5.11.2 Initial measurements

The zero-power resistance shall be measured at the temperature T_b, which is equivalent to 85 °C ± 0,1 °C, unless otherwise prescribed in the detail specification, and shall be recorded.

5.11.3 Test methods

Unless otherwise prescribed in the detail specification, the thermistors with wire terminations shall be gripped by clips 25 mm ± 1,5 mm from the body of the thermistor.

Thermistors with other than wire terminations shall be supported by clips, if practicable, according to Annex C. Any exceptions to this shall be fully described in the detail specification.

The clips carrying the thermistors shall then be enclosed in a chamber having a volume at least 1 000 times that of the thermistors under test. The wires shall be so positioned that no thermistor is within 75 mm of any other thermistor, or the walls of the chamber (see Figure 10).

Dimensions in millimetres

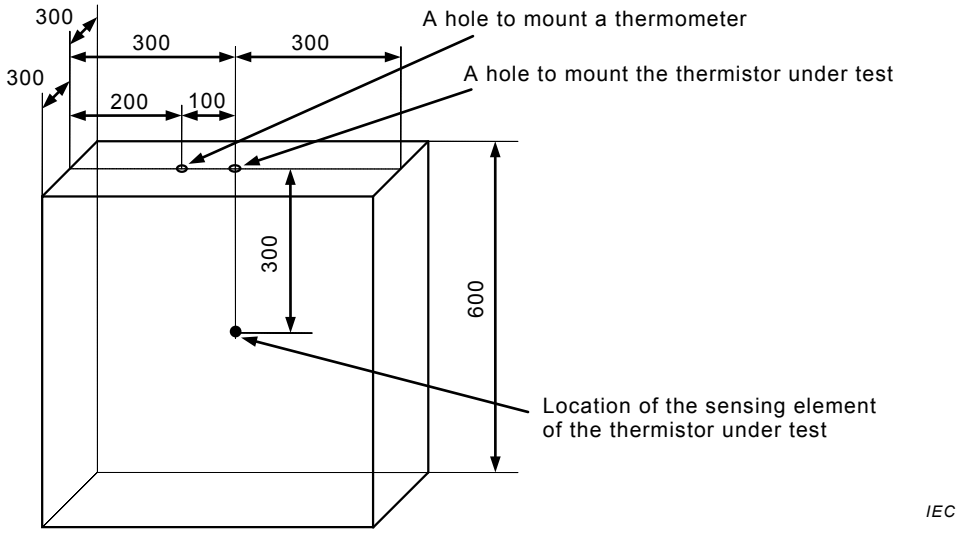
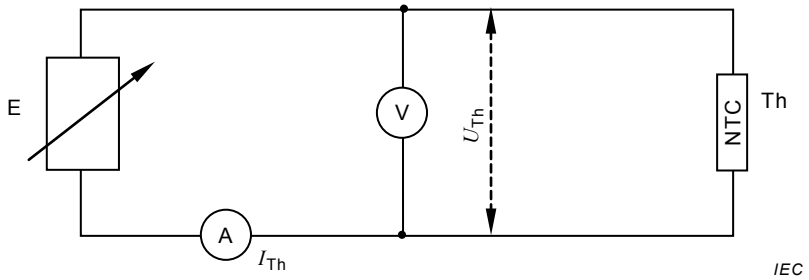


Figure 10 – Example of test chamber

The air in the chamber shall be stationary and shall be at a temperature of 25 °C ± 5 °C. The thermistors shall be connected in the circuit as shown in Figure 11.

The high impedance voltmeter and the ammeter shall have an accuracy better than 1 %.



Key

E variable stabilized d.c. current source

V d.c. voltmeter

A d.c. current meter

Th NTC thermistor under test

U_{Th} voltage applying to NTC thermistor under test

I_{Th} current flowing through NTC thermistor under test

Figure 11 – Dissipation factor measuring circuit

The current I_{Th} shall be adjusted until the ratio U_{Th}/I_{Th} is within 5 % of the zero-power resistance value at T_b. When stable readings have been achieved, the values of U_{Th} and I_{Th} shall be recorded.

The dissipation factor (δ) shall be calculated using the following formula:

$$\delta = (U_{Th} \times I_{Th})/(T_b - 25) \qquad \text{W/°C}$$

where

T_b is 85 °C, unless otherwise specified in the detail specification;

U_{Th} is measured in volts;

I_{Th} is measured in amperes.

5.11.4 Requirements

The dissipation factor shall be within the limits prescribed in the detail specification.

5.12 Thermal time constant by ambient temperature change (τ_a)

5.12.1 General

The method of test shall be as described below.

5.12.2 Initial measurements

The zero-power resistance shall be measured as prescribed in 5.6 at the temperature T_i followed by the same measurement at T_a. The temperature T_i is calculated as follows:

$$T_i = T_b - (T_b - T_a) \times 0{,}632$$

where

T_b is (273,15 + 85) K, unless otherwise specified in the detail specification;

T_a is (273,15 + 25) K, unless otherwise specified in the detail specification.

Measurements shall be recorded.

5.12.3 Preconditioning

The thermistor shall be immersed in a medium with a temperature T_a and allowed to reach the medium temperature.

5.12.4 Test methods

The thermistor shall be transferred rapidly to a medium with a temperature T_b. The time it takes for the thermistor to reach the zero-power resistance at T_i shall be measured.

The resulting time is the thermal time constant by ambient temperature change.

5.12.5 Final measurements and requirements

The thermal time constant by ambient temperature change shall be within the limits specified in the detail specification.

5.12.6 Requirements

The medium used in 5.12.2 and 5.12.3, the temperature tolerance on T_a and T_b, air (flow rate) or liquid (flow rate and viscosity) shall be defined in the detail specification.

NOTE This method is not suitable for miniature thermistors because the change of temperature during transfer from the first to the second medium can lead to a considerable measuring error.

5.13 Thermal time constant by cooling after self-heating (τ_c)

5.13.1 General

The method of test shall be as described below.

5.13.2 Initial measurements

The zero-power resistance shall be measured as prescribed in 5.6 at the temperatures T_b = (358,15 ± 2) K, T_a = (298,15 ± 2) K and T_i which is calculated as follows:

$$T_i = T_b - (T_b - T_a) \times 0{,}632$$

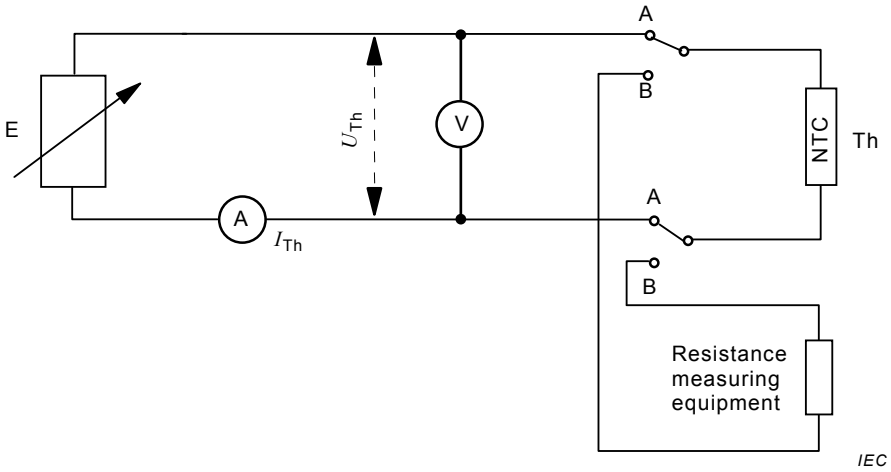
Measurements shall be recorded.

Other values for T_a and T_b may be specified in the detail specification.

5.13.3 Preconditioning

Unless otherwise prescribed in the detail specification, the thermistor shall be mounted and enclosed in a chamber as described in 5.11.2. Before insertion in the chamber, the thermistor shall be connected in the circuit shown in Figure 12.

The high-impedance voltmeter and the ammeter shall have an accuracy better than 1 %. The resistance measuring equipment shall have an accuracy of 0,1 % or better.



Key

E variable stabilized d.c. current source

V d.c. voltmeter

A d.c. current meter

Th NTC thermistor under test

U_{Th} voltage applying to NTC thermistor under test

I_{Th} current flowing through NTC thermistor under test

Figure 12 – Thermal time constant measuring circuit

5.13.4 Test method

The method of measurement shall be as described below.

With contacts AA closed, the current I_{Th} shall be adjusted until the ratio U_{Th}/I_{Th} is within 60 % to 80 % of the zero-power resistance at T_b and stable readings have been achieved.

Throw switch to close contacts BB and start the timing when the zero-power resistance meets the conditions as described above. Stop timing when the zero-power resistance at T_i is reached.

The elapsed time between start and stop is the thermal time constant.

5.13.5 Final measurements and requirements

The thermal time constant shall meet the limits prescribed in the detail specification.

The medium used in 5.13.2 and 5.13.3, the temperature tolerance on T_a and T_b, air (flow rate) or liquid (flow rate and viscosity) shall be defined in the detail specification.

5.14 Robustness of terminations (not applicable to surface mount thermistors)

5.14.1 General

The method of test shall be as described below.

5.14.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured and shall be recorded.

5.14.3 Test methods

The thermistors shall be subjected to the procedure of Tests Ua_1, Ub and Uc of IEC 60068-2-21 as appropriate.

Tests Ub and Uc shall not be applied if the detail specification describes the terminations as rigid.

5.14.4 Test Ua_1 – Tensile

Unless otherwise specified in the detail specification, the force to be applied for 10 s shall be as follows.

– For all types of terminations except wire terminations: 20 N.
– For wire terminations: see Table 2.

Table 2 – Tensile force

Nominal cross-sectional area (S) [a] mm^2	Corresponding diameter (d) for circular-section wires mm	Force with tolerance of ±10 % N
$S \leq 0{,}05$	$d \leq 0{,}25$	1
$0{,}05 < S \leq 0{,}1$	$0{,}25 < d \leq 0{,}35$	2,5
$0{,}1 < S \leq 0{,}2$	$0{,}35 < d \leq 0{,}5$	5
$0{,}2 < S \leq 0{,}5$	$0{,}5 < d \leq 0{,}8$	10
$0{,}5 < S \leq 1{,}2$	$0{,}8 < d \leq 1{,}25$	20
$1{,}2 < S$	$1{,}25 < d$	40

[a] For circular-section wires, strips or pins, the nominal cross-sectional area is equal to the value calculated from the nominal dimension(s) given in the relevant specification. For stranded wires, the nominal cross-sectional area is obtained by taking the sum of the cross-sectional areas of the individual strands of the conductor specified in the relevant specification.

5.14.5 Test Ub – Bending (half the number of terminations)

Two consecutive bends shall be applied (method 1).

5.14.6 Test Uc – Torsion (remaining terminations)

Two rotations of 180° shall be applied (severity 2).

5.14.7 Final measurements and requirements

After each of these tests the thermistors shall be visually examined. There shall be no visible damage.

After the test, the appropriate parameter(s) given in the detail specification shall be measured and shall comply with the requirements prescribed in the detail specification.

5.15 Resistance to soldering heat

5.15.1 General

The method of test shall be as described below.

5.15.2 Preconditioning

When prescribed in the relevant specification the thermistors shall be dried using the method of 5.3.1

The thermistors shall be measured as prescribed in the relevant specification.

5.15.3 Test procedure

Unless otherwise stated in the relevant specification, one of the following tests as set out in the same specification shall be applied.

The test conditions shall be defined in the relevant specification.

a) For all thermistors except those of items b) and c) below:

   IEC 60068-2-20, Test Tb, Method 1 (solder bath).

b) For thermistors not designed for use in printed boards, but with connections intended for soldering as indicated in the detail specification:

   1) IEC 60068-2-20, Test Tb, Method 1 (solder bath);

   2) IEC 60068-2-20, Test Tb, Method 2 (soldering iron).

c) For surface mounting thermistors:

   IEC 60068-2-58, reflow or solder bath method.

5.15.4 Recovery

The period of recovery shall, unless otherwise specified in the detail specification, be not less than 1 h or more than 2 h, except for surface mount thermistors, for which the period of recovery shall be 24 h ± 2 h.

5.15.5 Final inspection, measurement and requirements

For all thermistors, except surface mount thermistors, the following shall apply.

– When the test has been carried out, the thermistors shall be visually examined.

– There shall be no visible damage and the marking shall be legible.

– The thermistors shall then be measured as prescribed in the relevant specification.

Surface mount thermistors shall be visually examined and measured and shall meet the requirements as prescribed in the relevant specification.

5.16 Solderability

5.16.1 General

Not applicable to those terminations which are described as “not designed for soldering” in the detail specification

The relevant specification should prescribe whether ageing is to be applied. If accelerated ageing is required, one of the ageing procedures given in IEC 60068-2-20 should be applied.

Unless otherwise stated in the relevant specification, the test should be carried out with non-activated flux.

5.16.2 Test procedure

Unless otherwise stated in the relevant specification, one of the following tests as set out in the same specification shall be applied.

The test conditions shall be defined in the relevant specification.

a) For all thermistors except those of items b) and c) below:
   1) IEC 60068-2-20, Test Ta, Method 1 (solder bath)

      Depth of immersion (from the seating plane or component body): 2,0 mm, using a thermal insulating screen of 1,5 mm ± 0,5 mm thickness;
   2) IEC 60068-2-20, Test Ta, Method 2 (soldering iron);
   3) IEC 60068-2-54.
b) For thermistors not designed for use in printed boards, but with connections intended for soldering as indicated in the detail specification:
   1) IEC 60068-2-20, Test Ta, Method 1 (solder bath)

      Depth of immersion (from the seating plane or component body): 3,5mm;
   2) IEC 60068-2-20, Test Ta, Method 2 (soldering iron).
c) For surface mounting thermistors:
   1) IEC 60068-2-58, reflow or solder bath method;
   2) IEC 60068-2-69, solder bath or solder globule method.

5.16.3 Final inspection, measurements and requirements

The terminations shall be examined for good tinning as evidenced by free flowing of the solder with wetting of the terminations.

The thermistors shall meet the requirements as prescribed in the relevant specification.

5.17 Rapid change of temperature

5.17.1 General

The method of test shall be as described below.

5.17.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.17.3 Test procedures

The thermistors shall be subjected to the procedure of Test Na of IEC 60068-2-14 as follows.

– The lower temperature T_A shall be the lower category temperature.
– The higher temperature T_B shall be the upper category temperature.
– The number of cycles shall be selected from: 5, 10, 25, 50, 100, 500 and 1 000.
– The medium of the test chamber, if different from air, shall be specified in the detail specification.

5.17.4 Final inspection, measurements and requirements

The thermistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The appropriate parameter(s) given in the detail specification shall be measured using the method specified. The change in value compared with that measured in 5.17.2 shall not exceed the limit specified in the detail specification.

For insulated types, the insulation resistance shall be measured according to 5.8 and shall be not less than that specified in the detail specification.

5.18 Vibration

5.18.1 General

The method of test shall be as described below.

5.18.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.18.3 Test procedures

The thermistors shall be securely mounted by their terminations and/or by their normal mounting means, as defined in the detail specification.

The design of the thermistor may be such that special mounting fixtures are required in its use.

In this case, the detail specification shall describe the mounting fixtures and they shall be used in the performance of the vibration, bump and shock tests.

The thermistors shall be subjected to the procedure of Test Fc of IEC 60068-2-6, using the degree of severity given in the detail specification.

During the last hour of vibration in each direction of movement, an electrical measurement shall be made to determine intermittent contact, open circuit or short-circuit as defined in the detail specification. Detecting equipment shall be sufficiently sensitive to detect an interruption.

5.18.4 Final inspection, measurements and requirements

After the test the thermistors shall be visually examined. There shall be no visible damage.

The appropriate parameters given in the relevant detail specification shall be measured using the method specified. The change in value compared to the initially measured value shall not exceed the limit specified in the detail specification.

5.19 Shock

5.19.1 General

The method of test shall be as described below.

5.19.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.19.3 Mounting

Mounting shall be as specified in 5.18.2.

5.19.4 Test procedures

The thermistors shall be subjected to the procedure of Test Ea of IEC 60068-2-27 using the appropriate degree of severity as specified in the detail specification.

5.19.5 Final inspection, measurements and requirements

After the test the thermistors shall be visually examined. There shall be no visible damage.

The appropriate parameters given in the relevant detail specification shall be measured using the method specified. The change in value compared to the initially measured value shall not exceed the limit specified in the detail specification.

5.20 Free fall

5.20.1 General

The method of test shall be as described below.

5.20.2 Initial measurements

The appropriate parameters given in the relevant detail specification shall be measured using the method specified and recorded.

5.20.3 Test procedures

The thermistors shall be subjected to the Procedure 1 of IEC 60068-2-31.

5.20.4 Final inspection, measurements and requirements

After the test, the thermistors shall be visually examined. There shall be no visible damage.

The appropriate parameters given in the relevant detail specification shall be measured using the method specified. The change in value compared to the initially measured value shall not exceed the limit specified in the detail specification.

5.21 Thermal shock

5.21.1 General

The method of test shall be as described below.

5.21.2 Initial measurements

The appropriate parameters given in the relevant detail specification shall be measured using the method specified and recorded.

5.21.3 Test procedures

The thermistors shall be subjected to the procedure of Test Nc of IEC 60068-2-14 as follows.

– The lower temperature T_A shall be the lower category temperature.
– The higher temperature T_B shall be the upper category temperature.
– The duration of immersion t_1 and transition time t_2 shall be specified in the detail specification.
– The number of cycles shall be selected from: 5, 10, 25, 50 and 100.
– The medium of the test bath, if different from water or oil, shall be specified in the detail specification.

5.21.4 Final inspection, measurements and requirements

After the test the thermistors shall be visually examined. There shall be no visible damage.

The appropriate parameters given in the relevant detail specification shall be measured using the method specified. The change in value compared to the initially measured value shall not exceed the limit specified in the detail specification.

5.22 Cold

5.22.1 General

The method of test shall be as described below.

5.22.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.22.3 Test procedures

The method of test shall be as described below.

a) Method 1

The thermistors for sensing application shall be subjected to the procedure of Test Ab of IEC 60068-2-1 using the degree of severity of the lower category temperature as prescribed in the detail specification. The lower category temperature shall be selected from Table 1 and the duration of the test shall be selected from 2 h, 16 h, 72 h, 96 h, 168 h, 250 h, 500 h and 1 000 h.

The specimen may be loaded in the test chamber under any temperature between the test room temperature and the lower category temperature.

b) Method 2

The thermistors for other applications shall be subjected to the procedure of Test Ad of IEC 60068-2-1 using the degree of severity of the lower category temperature as prescribed in the detail specification. The lower category temperature shall be selected from Table 1 and the duration of the test shall be selected from 2 h, 16 h, 72 h, 96 h, 168 h, 250 h, 500 h and 1 000 h.

5.22.4 Final inspection, measurements and requirements

The thermistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The appropriate parameter(s) given in the detail specification shall be measured using the method specified. The change in value compared with that measured in 5.22.2 shall not exceed the limit specified in the detail specification.

For insulated types, the insulation resistance shall be measured according to 5.8 and shall be not less than that specified in the detail specification.

5.23 Dry heat

5.23.1 General

The method of test shall be as described below.

5.23.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.23.3 Test procedures

The method of test shall be as described below.

a) Method 1

The thermistors for sensing application shall be subjected to the procedure of Test Bb of IEC 60068-2-2 using the degree of severity of the upper category temperature as prescribed in the detail specification. The upper category temperature shall be selected from Table 1 and the duration of the test shall be selected from: 2 h, 16 h, 72 h, 96 h, 168 h, 250 h, 500 h and 1 000 h.

The specimen may be loaded in the test chamber under any temperature between the test room temperature and the lower category temperature.

b) Method 2

The thermistors for other applications shall be subjected to the procedure of Test Bd of IEC 60068-2-2 using the degree of severity of the upper category temperature as prescribed in the detail specification. The upper category temperature shall be selected from Table 1 and the duration of the test shall be selected from: 2 h, 16 h, 72 h, 96 h, 168 h, 250 h, 500 h and 1 000 h.

5.23.4 Final inspection, measurements and requirements

The thermistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The appropriate parameter(s) given in the detail specification shall be measured using the method specified. The change in value compared with that measured in 5.23.2 shall not exceed the limit specified in the detail specification.

For insulated types, the insulation resistance shall be measured according to 5.8 and shall be not less than that specified in the detail specification.

5.24 Damp heat, steady state

5.24.1 General

The method of test shall be as described below.

5.24.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.24.3 Test procedures

The method of test shall be as described below.

a) Method 1

Non-insulated thermistors shall be subjected to the procedure of Test Cab of IEC 60068-2-78 using the severity corresponding to the climatic category of the thermistor as given in the detail specification.

b) Method 2

For insulated types the same procedure shall be applied and the test voltage specified in the detail specification, which is based on the consideration of its practical use situation, should be applied.

5.24.4 Recovery

At the end of this period the thermistors shall be removed from the chamber and shall then be subjected to recovery according to 5.3.2.

5.24.5 Final inspection, measurements and requirements

The thermistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The following characteristics of the NTC thermistors shall be measured and conformed.

a) Non-insulated thermistors

   The appropriate parameter(s) given in the detail specification shall be measured using the method specified.

b) For insulated types

   The change in value compared with that measured initially shall not exceed that prescribed in the detail specification.

For insulated types, the insulation resistance shall be measured according to 5.8 and shall be not less than that specified in the detail specification. The thermistors shall withstand the voltage proof test as defined in 5.9 without breakdown or flashover.

5.25 Endurance

5.25.1 General

The method of test shall be as described below.

5.25.2 Endurance at room temperature with applied continuous maximum current (I_{max25}) (for inrush current-limiting thermistors only)

5.25.2.1 General

The method of test shall be as described below.

5.25.2.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.25.2.3 Test procedures

The following apply.

a) The thermistors shall be connected in the circuit shown in Figure 13.

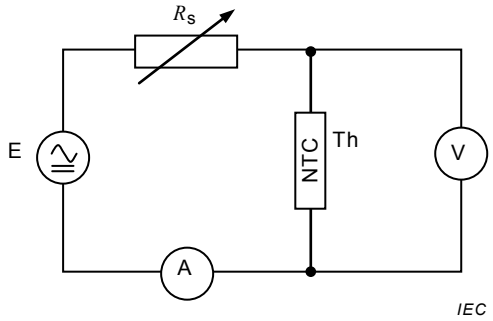
b) The thermistors shall be connected so that their terminations have an effective length of 20 mm to 25 mm, unless otherwise specified in the relevant detail specification.

   The thermistors shall be so placed that the temperature of any one thermistor shall not appreciably influence the temperature of any other thermistor.

c) The thermistors shall be subjected to an endurance test of 42 d (1 000 h) at ambient temperature of between 15 °C and 35 °C. The temperature shall remain within ±5 °C of that at the beginning of the test.

d) The current I_{max25} shall be adjusted.

e) After 168 h, 500 h and 1 000 h, the load shall be removed and the thermistors allowed to recover according to 5.3.2. After intermediate measurements, the thermistors shall be returned to the conditions of test. The interval between the removal from, and the return to, the conditions of test for any thermistor shall not exceed 12 h.



Key

E variable stabilized d.c. current source

R_S load (variable resistor)

V d.c. voltmeter

A d.c. current meter

Th NTC thermistor under test

Figure 13 – Endurance at room temperature with I_{max25} evaluating circuit

5.25.2.4 Final inspection, measurements and requirements

The thermistors shall then be visually examined.

There shall be no visible damage and the marking shall be legible.

The appropriate parameter(s) given in the detail specification shall be measured using the method specified. The change compared with the value(s) measured in 5.25.2.2 shall not exceed the limit specified in the relevant detail specification.

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

5.25.3.1 General

The method of test shall be as described below.

5.25.3.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.25.3.3 Test procedures

The following apply.

a) The thermistors shall be connected in the circuit shown in Figure 13.

b) The thermistors shall be connected so that their terminations have an effective length of 20 mm to 25 mm, unless otherwise specified in the relevant detail specification.

   The thermistors shall be so placed that the temperature of any one thermistor shall not appreciably influence the temperature of any other thermistor. There shall be no undue draught on the thermistors.

c) The thermistors shall be subjected to an endurance test of 1 000 cycles at an ambient temperature of between 15 °C and 35 °C. The temperature shall remain within ±5 °C of that at the beginning of the test.

d) The current I_{max25} shall be adjusted.

e) The power shall be applied intermittently 1 min on and 5 min off, for 1 000 cycles, unless otherwise specified in the relevant detail specification.

The cycles shall start with the thermistors cooled down to room temperature and shall end with the thermistors dissipating electrical power (P_{max25}).

This means that each cycle should cover the portion of the R/T-curve between room temperature and electrical power dissipation (P_{max25}).

f) After approximately 500 cycles and 1 000 cycles, the load shall be removed and the thermistors allowed to recover according to 5.3.2.

After intermediate measurements, the thermistors shall be returned to the conditions of test. The interval between the removal from, and the return to the conditions of test for any thermistor shall not exceed 12 h.

5.25.3.4 Final inspection, measurements and requirements

The thermistors shall then be visually examined. There shall be no visible damage and the marking shall be legible.

The appropriate parameter(s) given in the detail specification shall then be measured using the method specified. The change compared with the value(s) measured in 5.25.3.2 shall not exceed the limit specified in the relevant detail specification.

5.25.4 Endurance at T_3 and P_{max}

5.25.4.1 General

The method of test shall be as described below.

5.25.4.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.25.4.3 Test procedures

The following apply.

a) The thermistors shall be placed in the chamber in such a manner that their temperatures remain within the specified limits. The chamber shall meet the requirements of that specified for Test Bb of IEC 60068-2-2.

b) The thermistors shall be placed in a test chamber and subjected to the temperature $T_3 \pm 2$ °C (see Figure 2) for 42 d (1 000 h) and at dissipation P_{max}.

c) After 168 h and 500 h the thermistors shall be removed from the chamber and allowed to recover under standard atmospheric conditions of testing for not less than 1 h and not more than 2 h.

The appropriate parameter(s) given in the detail specification shall then be measured using the method specified. The change compared with the value(s) measured in 5.25.4.2 shall not exceed the limit specified in the relevant detail specification.

After intermediate measurements, the thermistors shall be returned to the conditions of test. The interval between the removal from, and the return to, the conditions of test for any thermistor shall not exceed 12 h.

d) After 1 000 h $\pm$ 48 h, the thermistors shall be removed and allowed to recover under standard atmospheric conditions for a period of 1 h to 2 h.

5.25.4.4 Final inspection, measurements and requirements

The thermistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The appropriate parameter(s) given in the detail specification shall then be measured using the method specified. The change compared with the value(s) measured in 5.25.4.2 shall not exceed the limit specified in the relevant detail specification.

5.25.5 Endurance at upper category temperature

5.25.5.1 General

The method of test shall be as described below.

5.25.5.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.25.5.3 Test procedures

The following apply.

a) The thermistors shall be placed in the chamber in such a manner that their temperatures remain within the specified limits. The chamber shall meet the requirements of that specified for Test Bb of IEC 60068-2-2.

b) The thermistors shall be placed in a test chamber and subjected to the upper category temperature ± 2 °C for 42 d (1 000 h) and at zero dissipation.

c) After 168 h and 500 h, the thermistors shall be removed from the chamber and allowed to recover under standard atmospheric conditions of testing for not less than 1 h and not more than 2 h.

   The appropriate parameter(s) given in the detail specification shall then be measured using the method specified. The change compared with the value(s) measured in 5.25.5.2 shall not exceed the limit specified in the relevant detail specification.

   After intermediate measurements, the thermistors shall be returned to the conditions of test. The interval between the removal from, and the return to, the conditions of test for any thermistor shall not exceed 12 h.

d) After 1 000 h ± 48 h, the thermistors shall be removed and allowed to recover under standard atmospheric conditions for a period of 1 h to 2 h.

5.25.5.4 Final inspection, measurements and requirements

The thermistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The appropriate parameter(s) given in the detail specification shall then be measured using the method specified. The change compared with the value(s) measured in 5.25.5.2 shall not exceed the limit specified in the relevant detail specification.

5.25.6 Maximum permissible capacitance (for inrush current-limiting thermistors only)

5.25.6.1 General

The method of test shall be as described below.

5.25.6.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.25.6.3 Test procedures

Thermistors shall be connected so that their terminations have an effective length of 20 mm to 25 mm, unless otherwise specified in the relevant detail specification.

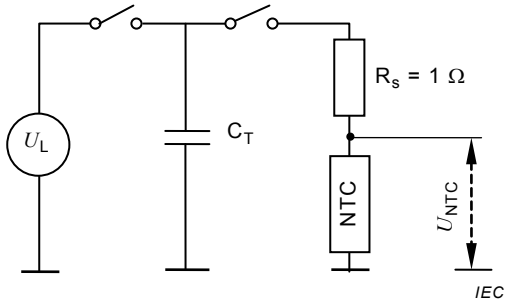
The thermistors shall be so placed that the temperature of any one thermistor shall not appreciably influence the temperature of any other thermistor. There shall be no undue draught on the thermistors.

According to the instructions given in the detail specification, one of the following test methods shall be used.

a) Method 1

The capacitor C_T (see test circuit, Figure 14) specified in the detail specification, shall be discharged across a series fixed resistor and the thermistor. The charge voltage is chosen so that the voltage applied to the thermistor at the beginning of discharge is 180 V/375 V, corresponding to (110 V/230 V + ΔU) × $\sqrt{2}$.

The capacitor shall be discharged 1 000 times at an ambient temperature of between 15 °C and 35 °C. The temperature shall remain within ±2 °C of that at the beginning of the test.



Key

U_L load voltage

C_T capacitor

R_s fixed resistor (R_s = 1 Ω)

U_{NTC} voltage drop across the NTC thermistor

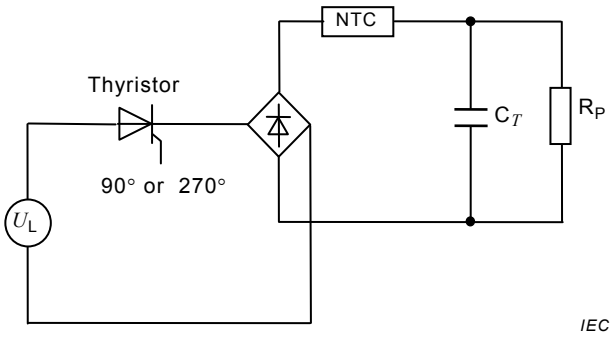
Figure 14 – Maximum permissible capacitance test circuit (Method 1)

b) Method 2

The capacitance of capacitor C_T (see test circuit, Figure 15) shall be adjusted to the maximum permissible capacitance. The value of R_P shall be 10 times greater than the nominal zero-power resistance of the thermistor, unless otherwise specified in the detail specification. The load voltage to the test circuit is 156 V/325 V, corresponding to (110 V/230 V) × $\sqrt{2}$, unless otherwise specified in the detail specification.

The power shall be applied intermittently: One cycle consists of power on for 50 ms, unless otherwise specified, and off for five times the thermal time constant. 1 000 cycles shall be given to the thermistor at an ambient temperature of between 15 °C and 35 °C.

The phase of power shall be adjusted to 90° or 270°, unless otherwise specified in the relevant detail specification. The temperature shall remain within ±2 °C of the temperature at the beginning of the test.



Key

U_L load voltage

C_T capacitor

R_P fixed resistor

Figure 15 – Maximum permissible capacitance test circuit (Method 2)

5.25.6.4 Intermediate measurement

After 500 cycles and 1 000 cycles, the load shall be removed and the thermistors allowed to recover according to 5.3.2.

After intermediate measurements, the thermistors shall be returned to the conditions of test. The interval between the removal from, and the return to, the conditions of test for any thermistor shall not exceed 12 h.

5.25.6.5 Final inspection, measurements and requirements

The thermistor shall then be visually examined. There shall be no visible damage and the marking shall be legible.

The appropriate parameter(s) given in the detail specification shall then be measured using the method specified. The change compared with the value(s) measured in 5.25.6.2 shall not exceed the limit specified in the relevant detail specification.

5.26 Shear (adhesion) test (for surface mount thermistors only)

5.26.1 General

The method of test shall be as described below.

5.26.2 Test conditions

The surface mount thermistors shall be mounted as described in IEC 60068-2-21, Test U.

The thermistors shall be subjected to Test Ue_3 of IEC 60068-2-21 using the following conditions.

– A force of 5 N shall be applied to the surface mount thermistor body progressively, without shock, and shall be maintained for a period of 10 s ± 1 s.

5.26.3 Requirements

The surface mount thermistors shall be visually examined in the mounted state. There shall be no visible damage.

5.27 Substrate bending test (for surface mount thermistors only)

5.27.1 General

The method of test shall be as described below.

5.27.2 Initial measurements

The surface mount thermistor shall be mounted on an epoxide woven glass printed board as described in IEC 60068-2-21.

The zero-power resistance of the surface mount thermistor shall be measured as specified in 5.6 and the relevant sectional specification.

5.27.3 Test procedures

The thermistor shall be subjected to Test Ue of IEC 60068-2-21 using the conditions as prescribed in the detail specification for the deflection *D* and the number of bends.

The zero-power resistance of the surface mount thermistor shall be measured as specified in 5.27.2 with the board in the bent position.

The printed board shall be allowed to recover from the bent position and then removed from the test jig.

5.27.4 Final inspection and requirements

The surface mount thermistor shall be visually examined and there shall be no visible damage.

For reference, another method for the substrate bending test is the following: The zero-power resistance is measured before it is mounted on the test jig.

After the bending test is implemented, it is removed from the test jig and the zero-power resistance is measured again.

The change of resistance, after the test or during bending, shall not exceed the limits prescribed in the detail specification.

5.28 Component solvent resistance

5.28.1 General

The method of test shall be as described below.

5.28.2 Initial measurements

The measurements prescribed in the relevant specification shall be made.

5.28.3 Test conditions

The components shall be subjected to Test XA of IEC 60068-2-45, with the following details:

a) solvent to be used: see IEC 60068-2-45:1980/AMD1:1993, 3.1.2;
b) solvent temperature: 23 °C ± 5 °C, unless otherwise specified in the detail specification;
c) conditioning: Method 2 (without rubbing);
d) recovery time: 48 h, unless otherwise stated in the detail specification.

5.28.4 Requirements

The measurements prescribed in the relevant specification shall then be made and the specified requirements shall be met.

5.29 Solvent resistance of marking

5.29.1 General

The method of test shall be as described below.

5.29.2 Test conditions

The components shall be subjected to Test XA of IEC 60068-2-45, with the following details:

a) solvent to be used: see IEC 60068-2-45:1980/AMD1:1993, 3.1.2;
b) solvent temperature: 23 °C ± 5 °C;
c) conditioning: Method 1 (with rubbing);
d) rubbing material: cotton wool;
e) recovery time: not applicable, unless otherwise stated in the detail specification.

5.29.3 Requirements

After the test the marking shall be legible.

5.30 Salt mist

5.30.1 General

The method of test shall be as described below.

5.30.2 Test conditions

The following apply.

a) Thermistors designed to withstand a salt laden atmosphere shall be subjected to Test Kb of IEC 60068-2-52.
b) To evaluate the quality and the conformity of their protective coatings, the thermistors shall be subjected to Test Ka of IEC 60068-2-11.

5.31 Sealing

The thermistors shall be subjected to the procedure of the appropriate method of Test Q of IEC 60068-2-17.

5.32 Composite temperature/humidity cycle

5.32.1 General

The method of test shall be as described below.

5.32.2 Initial measurements

The appropriate parameter(s) given in the detail specification shall be measured using the method specified and shall be recorded.

5.32.3 Test conditions

The thermistors shall be subjected to the procedure of Test Z/AD of IEC 60068-2-38 using the appropriate degree of severity, as specified in the detail specification.

5.32.4 Final inspection, measurements and requirements

The thermistors shall be visually examined. There shall be no visible damage and the marking shall be legible.

The appropriate parameter(s) given in the detail specification shall be measured using the method specified. The change in value compared with that measured in 5.32.2 shall not exceed the limit specified in detail specification.

For insulated types, the insulation resistance shall be measured according to 5.8 and shall be not less than that specified in the detail specification.

Annex A
(normative)

Interpretation of sampling plans and procedures as described in IEC 60410:1973 for use within quality assessment systems

A.1 Clause and subclause numbers of IEC 60410:1973

When using IEC 60410:1973 for inspection by attributes, the following interpretations of the clauses and subclauses indicated below apply for the purposes of this part of IEC 60539.

1 The responsible authority is the national authorized institution implementing the basic rules and rules of procedure.

1.5 The unit of product is the electronic component defined in a detail specification.

2 Only the following definitions from this clause are required:

– a “defect” is any nonconformance of the unit of product to specified requirements;

– a “defective” is a unit of product which contains one or more nonconformances.

3.1 The extent of nonconformance of a product shall be expressed in terms of per cent defective.

3.3 Not applicable.

4.5 The responsible authority is the IEC technical committee drafting the blank detail specification which forms part of the generic or sectional specification.

5.4 The responsible authority is the designated management representative (DMR), acting in accordance with the procedures prescribed in the document describing the inspection department of the approved manufacturer and approved by the national supervising inspectorate.

6.2 The responsible authority is the DMR.

6.3 Not applicable.

6.4 The responsible authority is the DMR.

8.1 Normal inspection shall always be used at the start of inspection.

8.3.3 d) The responsible authority is the DMR.

8.4 The responsible authority is the national supervising inspectorate.

9.2 The responsible authority is the IEC technical committee drafting the blank detail specification which forms part of the generic or sectional specification.

9.4 (Fourth sentence only) Not applicable.
(Fifth sentence only) The responsible authority is the DMR.

10.2 Not applicable.

Annex B
(normative)

Rules for the preparation of detail specifications for directly heated thermistors for electronic equipment for use within quality assessment systems

B.1 Drafting

The drafting of a complete detail specification by IEC technical committee 40, if required, shall begin only when all the following conditions have been met.

a) The generic specification has been approved.

b) The sectional specification, when appropriate, has been circulated for approval as a Final Draft International Standard (FDIS).

c) The associated blank detail specification has been circulated for approval as an FDIS.

d) There is evidence that at least three national committees have formally approved, as their own national standard, specifications covering a component of closely similar performance.

When a national committee formally asserts that substantial or significant use is made within its country of a part described by some other national standard, this assertion may count towards the foregoing requirement.

B.2 Reference standard

Detail specifications prepared under the responsibility of IEC technical committee 40 shall use the standard of preferred values, ratings and characteristics and severities for environmental tests, etc. which are given in the appropriate generic or sectional specifications.

An exception to this rule may only be granted for a specified detail specification, when agreed by IEC technical committee 40.

B.3 Circulation

The detail specification should not be circulated as an FDIS until the sectional and blank detail specifications have been approved for publication.

Annex C
(informative)

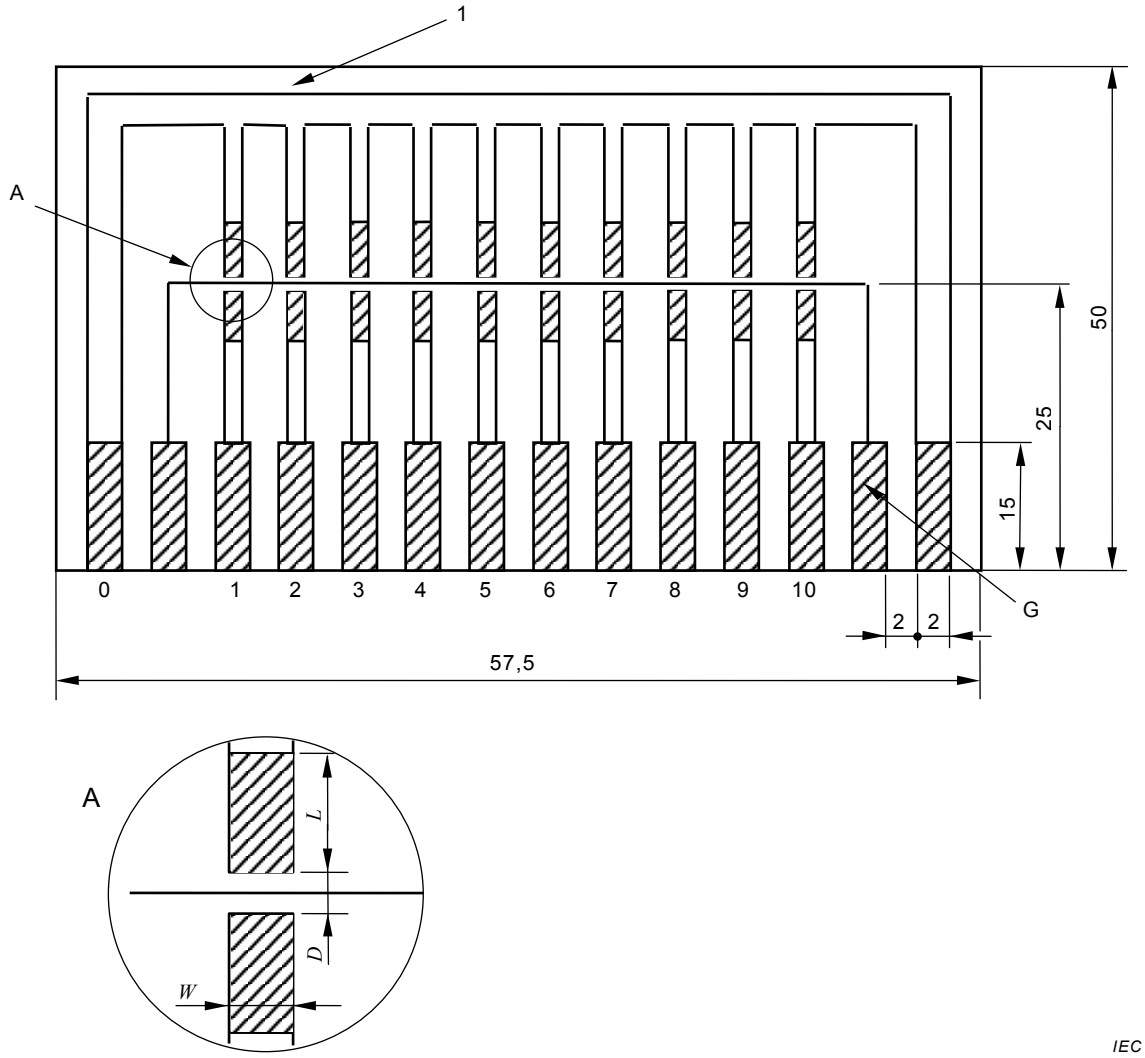
Typical examples of mountings for measurements of directly heated thermistors

C.1 Mounting for surface mount thermistors

Surface mount thermistors shall be mounted on an epoxide woven glass board of 1,6 mm ± 0,19 mm thickness and the board pattern shall be as shown in Figure C.1.

The dimensions D, L and W for the soldering lands on the board shall be specified in the detail specification. The electrode may be on one side or both sides.

Dimensions in millimetres



Key

1	glass-epoxy PWB: 1,6 mm ± 0,19 mm
G	conductor, which may be omitted or used as a guard electrode
L	length of soldering lands
W	width of soldering lands
D	gap of soldering lands

Figure C.1 – Mounting for measurements of surface mount thermistors

Annex D
(informative)

Reference to IEC 60539-1:2008

The drafting of this third edition of IEC 60539-1 has resulted in a new structure. The following table indicates the new clause and subclause numbers with respect to the second edition (IEC 60539-1:2008).

IEC 60539-1:2008 2nd edition Clause/Subclause	**IEC 60539-1:201x** 3rd edition Clause/Subclause	**Notes**
1	1	Gerneral and scope are merged into one
1.1		
1.2	2	In accordance with the ISO/IEC Directives, Part 2
2.1	4.1	
2.2	3	In accordance with the ISO/IEC Directives, Part 2
2.3	4.2	
2.4	4.3	
3	4.4	
4	5	
4.1	5.1	In accordance with the change of clause number
4.2	5.2	
4.3	5.3	
4.4	5.4	
4.5	5.5	
4.6	5.6	
4.7	5.7	
4.8	5.8	
4.9	5.9	
4.10	5.10	
4.11	5.11	
4.12	5.12	
4.13	5.13	
4.14	5.14	
4.15	5.15	
4.16	5.16	
4.17	5.17	
4.18	5.18	
4.19	5.19	
4.20	5.20	
4.21	5.21	
4.22	5.22	
4.23	5.23	
4.24	5.24	
4.25	5.25	
4.26	5.26	In accordance with the change of clause number
4.27	5.27	
4.28	5.28	
4.29	5.29	
4.30	5.30	
4.31	5.31	
4.32	5.32	

Annex Q
(normative)

Quality assessment procedures

Q.1 General

When this part of IEC 60539 and any related standards are used for the purpose of a full quality assessment system, compliance with Q.4 and Q.5 is required.

When such standards are used outside such quality assessment systems for purposes such as design proving or type testing, the procedures and requirements of Q.4.1 and Q.4.2 b) may be used, but the tests and parts of tests shall be applied in the order given in the test schedules.

Q.2 Primary stage of manufacture

The primary stage of manufacture is defined as the initial mixing process of ingredients.

Q.3 Structurally similar components

Q.3.1 Thermistors may be grouped as structurally similar for the purpose of forming inspection lots provided that the following requirements are met.

– They shall be produced by one manufacturer on one site using essentially the same design, materials, processes and methods.
– The sample taken shall be determined from the total lot size of the grouped devices.
– Structurally similar devices should be included in one detail specification but the details of all claims to structural similarity shall be declared in the qualification approval test reports.

Q.3.2 For electrical tests, devices having the same electrical characteristics may be grouped provided that the element determining the characteristics is similar for all the devices concerned.

Q.3.3 For environmental tests, devices having the same encapsulation, basic internal structure and finishing processes, may be grouped.

Q.3.4 For visual inspection (except marking), devices may be grouped if they have been made on the same production line, have the same dimensions, encapsulation and external finish.

This grouping may also be used for robustness of terminations and solderability tests where it is convenient to group devices with different internal structures.

Q.3.5 For endurance tests, thermistors may be grouped if they have been made on the same production line using the same design and differing only in electrical characteristics. If it can be shown that one type from the group is more heavily stressed than the others, then tests on this type may be accepted for the remaining members of the group.

Q.4 Qualification approval procedures

Q.4.1 General

The manufacturer shall comply with

a) the general requirements of the specified quality assessment system governing qualification approval, and

b) the requirements for the primary stage of manufacture (see Q.2).

Q.4.2 Test procedure for qualification approval

In addition to the requirements of Q.4.1, the procedures a) or b) below shall apply.

a) The manufacturer shall produce test evidence of conformance to the specification requirements on three lots taken in as short a time as possible for lot-by-lot inspection and on one lot for periodic inspection.

   Samples shall be taken from the lots in accordance with IEC 61193-2. Normal inspection shall be used, but, where the sample size would give acceptance on zero non-conformances, additional specimens shall be taken to meet the sample size required to give acceptance on one nonconforming item.

b) The manufacturer shall, as an alternative to the procedure specified in Q.4.2 a), produce test evidence to show conformance to the specification requirements on one of the fixed sample size test schedules given in the sectional specification.

   The specimens taken to form the sample shall be selected at random from current production or as agreed with the Certification Body (CB).

For the two procedures the sample sizes and the permissible number of nonconformances shall be of comparative order. The test conditions and requirements shall be the same.

Q.4.3 Maintenance of qualification approval

Qualification approval obtained as part of a quality assessment system, shall be maintained by regular demonstration of compliance with the requirements for quality conformance (see Q.5). Otherwise, this qualification approval shall be verified by the rules for the maintenance of qualification approval given as follows.

a) Maintenance of qualification approval is assured when the conditions detailed in the relevant specification are fulfilled.

b) Otherwise, the qualification approval shall be verified

   1) if the production programme is such that the periodic tests cannot be carried out with their normal frequency, or

   2) if the conformity of the components in production to the qualification approval components is doubtful or potentially so, for example following a technical modification, or

   3) when a change has been made to the specification.

c) The procedure for the verification described in b) above is the same as that followed for the qualification approval itself. The number of tests may be fewer, as described by the Designated Management Representative (DMR) in consultation with the CB, but the sampling requirements for each test are unchanged.

d) Subject to the requirements above, there is no limit to the duration of the validity of the qualification approval.

Q.5 Quality conformance inspection

Blank detail specifications associated with the sectional specifications shall prescribe the test schedule for quality conformance inspection. This schedule shall also specify the grouping, sampling and periodicity for the lot-by-lot and periodic inspection.

Inspection levels and sampling plans shall be selected from those given in IEC 61193-2.

If required, more then one test schedule may be specified.

Q.6 Certified test records of released lots

When certified test records are requested by a purchaser, they shall be specified in the detail specification.

Q.7 Delayed delivery

Thermistors held for a period exceeding two years (unless otherwise specified in the sectional specification) following the release of the lot shall, before delivery, be re-examined as specified in the sectional specification.

The re-examination procedure adopted by the manufacturer's DMR shall be approved by the CB.

Once a lot has been satisfactorily re-inspected, its quality is reassured for the specified period.

Q.8 Release for delivery under qualification approval before the completion of group B tests

When the conditions of IEC 61193-2 for changing to reduced inspection have been satisfied for all group B tests, the manufacturer is permitted to release components before the completion of such tests.

Q.9 Alternative test methods

See the specified quality assessment system, with the following details.

In case of dispute, for referee and reference purposes only the specified methods shall be used.

Q.10 Unchecked parameters

Only those parameters of a component which have been specified in a detail specification and which were subject to testing shall be assumed to be within the specified limits.

It cannot be assumed that any unspecified parameter will remain unchanged from one component to another. If, for any reason, it is necessary for further parameters to be controlled, then a new, more extensive specification shall be used.

The additional test method(s) shall be fully described and appropriate limits, sampling plans and inspection levels specified.

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