

**Harmonized system of quality assessment
for electronic components**

**Generic specification:
Directly heated positive
temperature coefficient
thermistors typically made
from modified ferro-electric
materials**

The European Standard EN 144000 : 1994 has the status of a
British Standard

Spécification générique:
Thermistances à coefficient de température
positif à chauffage direct habituellement
réalisées dans des matériaux ferro-électriques
modifiés

Fachgrundspezifikation:
Direkt geheizte Kaltleiter, im wesentlichen aus
modifizierten ferroelektrischen Werkstoffen
hergestellt

Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the national committees of the following countries:

Austria	Italy
Belgium	Luxembourg
Denmark	Netherlands
Finland	Norway
France	Portugal
Germany	Spain
Greece	Sweden
Iceland	Switzerland
Ireland	United Kingdom

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National foreword

This British Standard has been prepared under the direction of the Electronic Components Standards Policy Committee and is the English language version of EN 144000 : 1993 *Harmonized system of quality assessment for electronic components. Generic specification: Directly heated positive temperature coefficient thermistors typically made from modified ferro-electric materials*, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with CECC 44000 : 1993 published by the CENELEC Electronic Components Committee (CECC).

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Descriptors: Quality, electronic components, thermistors, directly heated positive coefficient

English version

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This European Standard was approved by CENELEC Electronic Components Committee (CECC) on 20 September 1993. CENELEC members are bound to comply with CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the General Secretariat of the CECC 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 CECC General Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom. The membership of the CECC is identical, with the exception of the national electrotechnical committees of Greece, Iceland and Luxembourg.

CECC

CENELEC Electronic Components Committee
Comité des Composants Electroniques du CENELEC
CENELEC- Komitee für Bauelemente der Elektronik

General Secretariat: Gartenstr. 179, D-60596 Frankfurt am Main

Foreword

The CENELEC Electronic Components Committee (CECC) is composed of those member countries of the European Committee for Electrotechnical Standardization (CENELEC) who wish to take part in a harmonized System for electronic components of assessed quality.

The object of the System is to facilitate international trade by the harmonization of the specifications and quality assessment procedures for electronic components, and by the grant of an internationally recognized Mark, or Certificate, of Conformity. The components produced under the System are thereby acceptable in all member countries without further testing.

This European Standard was prepared by CECC WG 4C, 'Thermistors'.

The text of the draft based on document CECC 44 000 Issue 1 : 1993 was submitted to the formal vote for conversion to a European Standard; together with the voting report, circulated as document CECC(Secretariat)3421 it was approved by CECC as EN 144000 on 20 September 1993.

The following dates were fixed:

- latest date of announcement of the EN at national level (doa) 1994-02-07
- latest date of publication of an identical national standard* (dop) 1994-08-07
- latest date of withdrawal of conflicting national standards* (dow) 1995-08-07

* National Standard (excluding National implementation of IECQ Specifications).

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FOREWORD

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The object of the System is to facilitate international trade by the harmonization of the specifications and quality assessment procedures for electronic components, and by the grant of an internationally recognized Mark, or Certificate, of Conformity. The components produced under the System are thereby acceptable in all member countries without further testing.

This specification has been formally approved by the CECC, and has been prepared for those countries taking part in the System who wish to issue national harmonized specifications for directly heated positive step function temperature coefficient thermistors (PTC-S), insulated and non-insulated types, typically made from ferro-electric semi-conductor materials. It should be read in conjunction with the current regulations for the CECC System.

At the date of printing of this specification, the member countries of the CECC are Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom, and copies of it can be obtained from the addresses shown on the blue fly sheet.

PREFACE

This generic specification was prepared by CECC/WG4C: Thermistors

It is based, wherever possible, on the Publications of the International Electrotechnical Commission.

The text of this specification was circulated to the CECC for voting in the documents listed below and was ratified by the President of the CECC for printing as a CECC Specification.

<u>Document</u>	<u>Date of voting</u>	<u>Report of the Voting</u>
CECC(Secretariat)2371	March 1989	CECC(Secretariat)2436

SECTION ONE. SCOPE

1. Scope

This specification describes terms and methods of test for directly heated positive step function temperature coefficient thermistors (PTC-S), insulated and non-insulated types, typically made from ferro-electric semi-conductor materials.

SECTION TWO. GENERAL

2.1 Related documents

ISO/3	Preferred numbers. Series of preferred numbers.
ISO/R 1000	Rules for the use of units of the International system of units and selection of the decimal multiples and sub-multiples of the SI units.
IEC 27-1 5th Issue (1971)	Letter symbols to be used in electro-technology. Part 1 : General
IEC 50	International electrotechnical vocabulary
IEC 62 2nd Issue (1974)	Marking codes for resistors and capacitors
IEC 63 2nd Issue (1963)	Preferred number series for resistors and capacitors, with Amendments 1 (1967) and 2 (1977)
IEC 68	Basic environmental testing procedures namely :
68-1 (1982)	General and guidance
68-2-1 (1974)	Test A : Cold, and Amd 1 (1983)
68-2-1A (1976)	First supplement
68-2-2 (1974)	Test B : Dry heat and Amd 1 (1983)
68-2-2A (1976)	First supplement
68-2-3 (1969)	Test Ca : Damp heat, steady state and Amd 1 (1984)
68-2-6 (1982)	Test Fc and guidance : Vibration (Sinusoidal) and Amd 1 (1983)
68-2-11 (1981)	Test Ka : Salt mist
68-2-13 (1983)	Test M : Low air pressure

68-2-14 (1984)	Test N : Change of temperature and Amd 1 (1986)
68-2-20 (1979)	Test T : Soldering and Amd 1 (1986)
68-2-21 (1983)	Test U : Robustness of terminations and Amd 1 (1983)
68-2-27 (1987)	Test Ea : Shock
68-2-29 (1987)	Bump
68-2-30 (1980)	Damp heat, cyclic and Amd 1 (1985)
IEC 617	Recommended graphical symbols
IEC 294 (1969)	Measurement of the dimensions of a cylindrical component having two axial terminations
IEC 410 (1973)	Sampling plans and procedures for inspection by attributes (see CECC 00 007)
IEC 539 (1976)	Directly heated negative temperature coefficient thermistors
IEC 738 (1982)	Directly heated positive step function temperature coefficient thermistors. Part 1 : Generic specification
FEN Internal Regulations	2nd Issue (1991)
CECC 00 114 : RP 14	Quality Assessment Procedures
CECC 00 109 1st Edition 1974	Certified Test Records
CECC 00 111 3rd Edition 1980	Specifications and their harmonization
CECC 00 007	Basic specification for IEC 410 : Sampling plans and procedures for inspection by attributes

2.2 Units, symbols and terminology

2.2.1 General

Units, graphical symbols, letter symbols and terminology shall, whenever possible, be taken from the following documents :

ISO/R 1000	Rules for the use of units of the International system of units and selection of the decimal multiples and sub-multiples of the SI units
IEC 27	Letter symbols to be used in electrical technology
IEC 50 IEC 617	International Electrotechnical Vocabulary Recommended graphical symbols

The following clauses contain additional terminology applicable to thermistors.

Where further items are required they shall be derived in accordance with the principles of the documents listed above.

2.2.2 Type

A type comprises products having similar design features manufactured by the same techniques and falling within the manufacturer's usual range of ratings for these products.

NOTES

- 1) Mounting accessories are ignored, provided they have no significant effect on the test results.
- 2) Ratings cover the combination of:

electrical ratings;
sizes;
climatic category.
- 3) The limits of the range of ratings shall be given in the detail specifications.

2.2.3 Style

Variation within a type having specific nominal dimensions and characteristics.

2.2.4 Thermistor

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

2.2.5 Positive temperature coefficient thermistor

A thermistor in which the resistance increases with increasing temperature throughout the useful part of its characteristic.

2.2.6 Directly heated positive temperature coefficient thermistor

A thermistor in which the change in temperature is obtained either by the flow of current through the thermo-sensitive element, or by a change in ambient temperature, or by a combination of both these means.

2.2.7 Positive step-function temperature coefficient thermistor (PTC-S)

A thermistor which shows a step-like increase in its resistance when the increasing temperature reaches a specific value.

A PTC-S thermistor will show secondary effects which have to be taken into account.

2.2.8 Zero-power resistance (R_T)

The value of the resistance of a PTC thermistor, at a given temperature, under conditions such that the change in resistance due to the internal generation of heat is negligible with respect to the total error of measurement.

NOTE - Any resistance value of a PTC thermistor is dependent on the value and the mode of the applied voltage (a.c. or d.c.) and, when an a.c. source is used, on the frequency (see 2.2.9 and 2.2.10).

2.2.9 Nominal zero-power resistance (R_n)

The zero-power resistance used as a reference value for which the following conditions shall be given in the detail specification :

- a) reference temperature, preferably 25 °C
- b) applied voltage (d.c. and/or a.c.)
- c) frequency of the a.c. voltage (if applicable) or the characteristics of any pulse used.

2.2.10 Voltage dependency (of a PTC-S thermistor)

A secondary effect, exhibiting a decreasing resistance with increasing voltage across the PTC-S when measured at a constant body temperature.

2.2.11 Frequency dependency (of a PTC-S thermistor)

A secondary effect exhibiting a substantial decrease of the positive temperature coefficient of the PTC-S with increasing frequency.

2.2.12 Resistance/temperature characteristics

The relationship between the zero-power resistance of a PTC-S thermistor and the temperature of the thermosensitive element when measured under specified reference conditions (see figure 1).

NOTE: PTC-S thermistors may have more than one resistance/temperature characteristic specified.

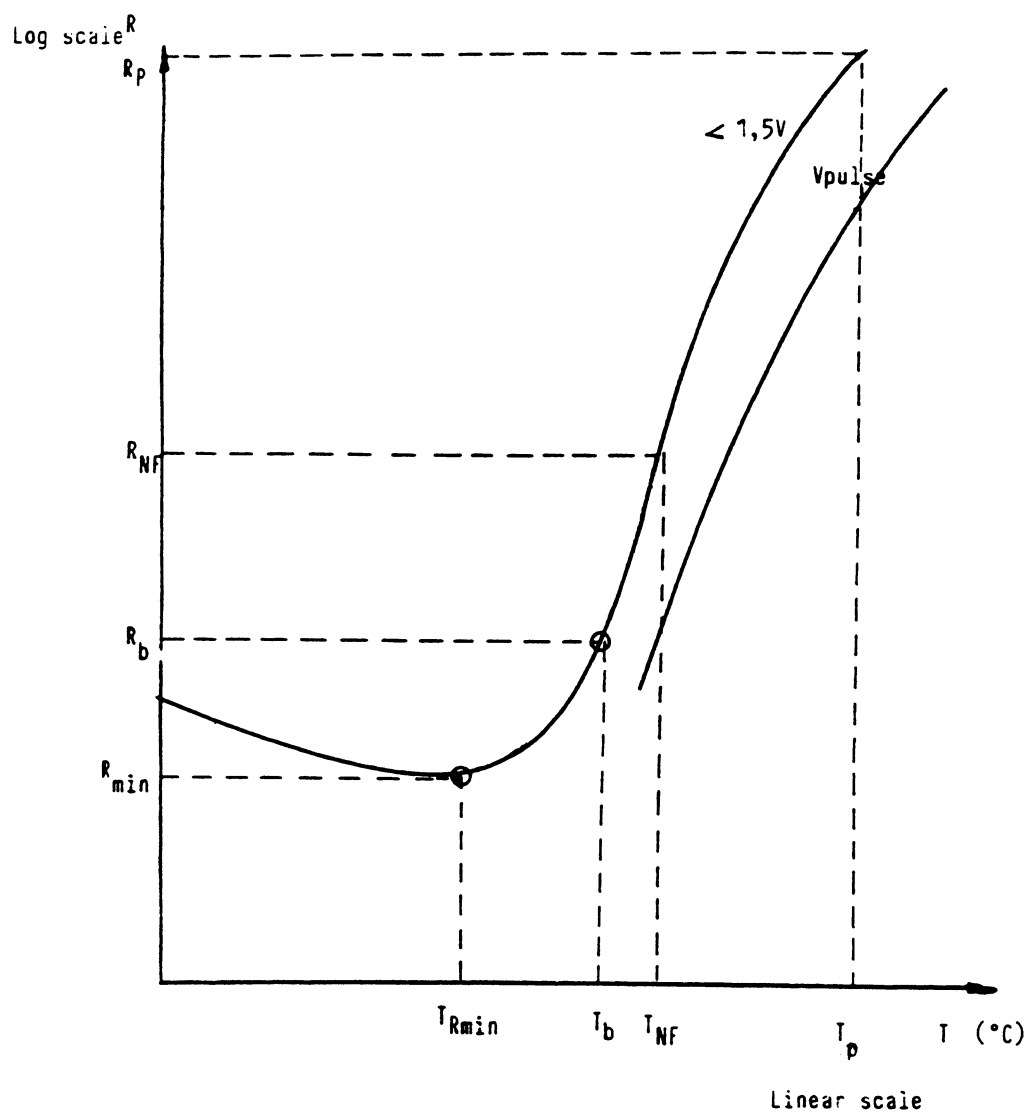
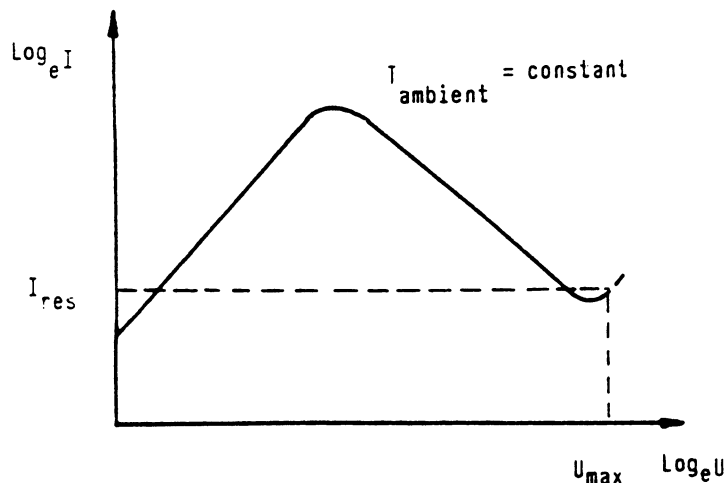


Figure 1 - Typical resistance-temperature characteristic and definitions for PTC thermistors (at zero-power)

2.2.13 Voltage/current characteristic

The relationship in still air at 25 °C (unless otherwise stated) between the applied voltage (d.c. and/or a.c.), at the thermistor terminations and the current under steady state conditions (see figure 2).



NOTE - U_{max} will be specified by the manufacturer and may, for practical reasons, be lower than the point indicated.

Figure 2 - Typical voltage/current characteristic for PTC thermistors

2.2.14 Nominal functioning temperature (T_{NF})

The nominal temperature at the steep part of the resistance/temperature characteristic at which the system controlled by the thermistor, is designed to operate.

2.2.15 Switching temperature (T_b)

The temperature at which the step-like function commences.

2.2.16 Minimum resistance (R_{min})

The minimum value of the zero-power resistance/temperature characteristic (see fig.1).

2.2.17 Resistance at switching temperature (R_b)

The value of the zero-power resistance corresponding to the switching temperature. It is defined as $R_b(T_b) = 2 \times R_{min}$ unless otherwise specified in the detail specification.

2.2.18 Temperature for minimum resistance (T_{Rmin})

That temperature at which R_{min} occurs.

2.2.19 Temperature T_p

That temperature, higher than T_b , in the PTC-S part of the resistance/temperature characteristic for which a minimum value R_p of the zero-power resistance is specified.

2.2.20 Resistance R_p

The zero-power resistance at temperature T_p measured at maximum voltage or a voltage specified in the detail specification and given as a minimum value.

NOTE - When applying the maximum voltage, the maximum overload current shall not be exceeded.

2.2.21 Average temperature coefficient of resistance at a stated voltage (α_R)

The rate of change of resistance with temperature expressed as %/K. It is calculated from the formula:

$$\alpha_R = \frac{100}{T_p - T_b} \log_e \frac{R_p}{R_b}$$

where T_p exceeds T_b by 10 K minimum.

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

NOTE - The detail specification may specify the measurement of the temperature coefficient of resistance in a narrow temperature range where its value is a maximum. The detail specification shall also then provide a method.

2.2.22 Upper category temperature (UCT)

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

2.2.23 Lower category temperature (LCT)

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

2.2.24 Maximum voltage ($U_{\max}$)

The maximum a.c. or d.c. voltage which may be continuously applied to the thermistor. (See 2.2.25.)

NOTE - When applying the maximum voltage, the maximum overload current shall not be exceeded. (See the note in 2.2.27.)

2.2.25 Operating temperature range at maximum voltage

The range of ambient temperatures at which the thermistor can operate continuously at the maximum voltage.

2.2.26 Isolation voltage (Applicable only to insulated thermistors)

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

2.2.27 Maximum overload current (I_{mo})

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

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

2.2.28 Residual current (I_{res})

The value of current in the thermistor at a specified ambient temperature (preferably 25 °C) under steady state conditions. The applied voltage is the maximum voltage unless otherwise specified. (See figure 2.)

2.2.29 Tripping current (I_t)

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

2.2.30 Maximum non-tripping current (I_{∞})

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

2.2.31 Inrush current (I_{in})

The current occurring during the transient period from the moment of switching to the steady state condition measured under specified conditions of ambient temperature, voltage and circuit.

2.2.32 Peak inrush current ($I_{in p}$)

The peak inrush current is the maximum value of current during the transient period (see figure 3).

2.2.33 Minimum peak inrush current ($I_{in p min}$)

The lowest specified value of the peak of the inrush current.

2.2.34 Maximum peak inrush current ($I_{in p max}$)

The maximum specified value of the peak inrush current.

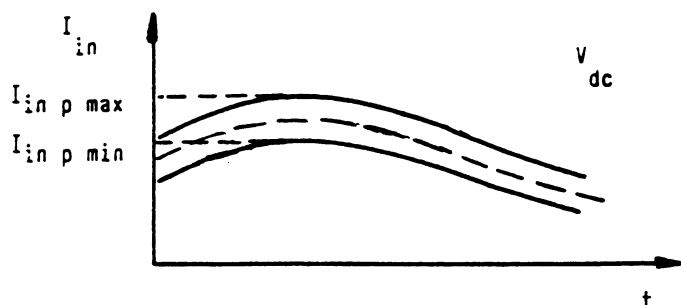


Figure 3

2.2.35 Peak to peak inrush current ($I_{in pp}$) (for a.c. conditions only)

The peak to peak inrush current is the value of the current between the peak inrush current and the peak of following alternance (see figure 4).

2.2.36 Minimum peak to peak inrush current ($I_{in pp min}$)

The lowest specified value of the peak to peak inrush current.

2.2.37 Maximum peak to peak inrush current ($I_{in\ pp\ max}$)

The maximum specified value of the peak to peak inrush current.

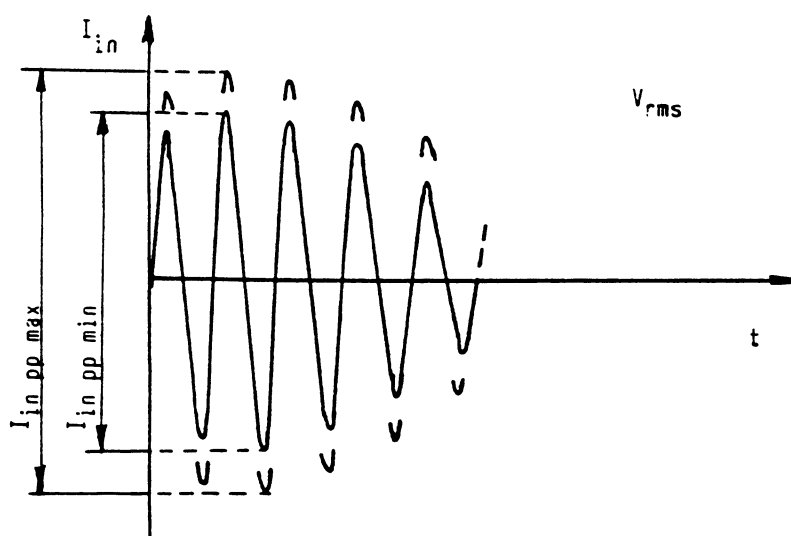


Figure 4

2.2.38 Peak inrush power ($P_{in\ p}$)

The peak inrush power is the peak power ($V \times I_{in\ p}$) measured at the maximum peak value of the current occurring during transient period from the moment of switching to the steady state operating condition measured under specified conditions of ambient temperature, voltage and circuit.

2.2.39 Maximum peak inrush power ($P_{in\ p\ max}$)

The maximum peak power which can occur during the transient period before the thermistor reaches its steady state operating condition.

2.2.40 Maximum power (P_{max})

The maximum power is the power ($V \times I$) which can be dissipated continuously by the thermistor when the maximum voltage is applied under specified conditions of ambient temperature, circuit and thermal dissipation when thermal equilibrium is obtained.

(If the power is supplied by an a.c. source then the voltage and current must be measured with true rms meters).

2.2.41 Dissipation factor (δ)

The quotient (in W/K) of the change in power dissipation in the thermistor and the resultant change of the body temperature under specified ambient conditions (temperature, medium).

2.2.42 Thermal resistance (R_{th})

The quotient (in K/W) of the temperature difference between the thermistor and its ambient and the power dissipated by the thermistor under specified ambient conditions (temperature, medium).

NOTE - "Dissipation factor" and "thermal resistance" are mutually reciprocal.

2.2.43 Heat capacity (C_{th})

The energy (in J) the thermistor needs to raise 1 K in temperature. It is completely determined by the component design.

2.2.44 Response time

a) Response time by ambient temperature change (t_a)

The time (in s) required by a thermistor to change its temperature between two defined conditions when subjected to a change in ambient temperature.

b) Response time by power change (t_p)

The time (in s) required by a thermistor to change its temperature between two defined conditions of power input.

NOTES :
- The initial and final conditions are given in the detail specification.
- Where a special test is included in the inspection requirements of any detail specification, for example where response time is defined under combined temperature and power changes, that specification shall include full details of the method of measurement.

2.2.45 Thermal time constant

The thermal time constant (ideal) for a thermistor is the product of its heat capacity and its thermal resistance.

NOTE : Because of the impracticability of measuring heat capacity and the variation of thermal resistance with temperature, it is usual to specify and measure a practical time constant.