SLOVENSKI STANDARD
oSIST prEN IEC 60751:2021

01-marec-2021

Industrijski uporovni termometri in temperaturni senzorji iz platine

Industrial platinum resistance thermometers and platinum temperature sensors

Industrielle Platin-Widerstandsthermometer und Platin-Temperatursensoren

Thermomètres à résistance de platine industriels et capteurs thermométriques en platine

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Ta slovenski standard je istoveten z: prEN IEC 60751:2020

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ICS:

17.200.20	Instrumenti za merjenje temperature	Temperature-measuring instruments

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65B/1187/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC 60751 ED3**	
DATE OF CIRCULATION: **2020-12-25**	CLOSING DATE FOR VOTING: **2021-03-19**
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IEC SC 65B : MEASUREMENT AND CONTROL DEVICES	
SECRETARIAT: United States of America	SECRETARY: Mr Angus Low
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
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TITLE:

Industrial platinum resistance thermometers and platinum temperature sensors

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International Standard IEC 60751 has been prepared by subcommittee 65B: Devices and process analysis, of IEC technical committee 65: Industrial-process measurement, control and automation.

This third edition cancels and replaces the second edition published in 2008, amendment 1 (1986) and amendment 2 (1995). This edition constitutes a technical revision.

The significant technical changes with respect to the previous edition are as follows:

While the temperature versus resistance relationship remains unchanged, there are several changes in the other chapters. Most important are:

– formula of resistance versus temperature relationship become the standard specification and numerical table ceases to be the standard
– tolerance acceptance test is slightly modified;
– several changes in the individual tests;
– numerical table of resistance versus temperature is included in the annex as a reference .

The text of this standard is based on the following documents:

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Enquiry draft Report on voting
65B/XXX/CDV 65B/XXX

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

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This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date1 indicated on the IEC web site 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.

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Industrial platinum resistance thermometers and platinum temperature sensors

1 Scope

This standard specifies the requirements and resistance versus temperature relationship for industrial platinum resistance thermometers later referred to as "thermometers" and industrial platinum resistance temperature sensors later referred to as “platinum resistors” whose electrical resistance is derived by defined function of temperature.
The standard applies to platinum resistors whose temperature coefficient α, defined as

$$\alpha = \frac{R_{100} - R_0}{R_0 \cdot 100°C} ,$$

is conventionally written as α = 3,851·10^{-3} °C^{-1}, where R_{100} is the resistance at t = 100 °C and R_0 is the resistance at t = 0 °C.

Values of temperature in this standard are in terms of the International Temperature Scale of 1990, ITS-90. Temperatures in degrees Celsius are denoted by the symbol t, except in Table A.1 where the full nomenclature t_{90}/°C is used.
The standard covers platinum resistors or thermometers for all or part of the temperature range -200 °C to +850 °C with different tolerance classes, which may cover restricted temperature ranges.

For temperature/resistance relationships with uncertainties less than 0,1 °C, which are possible only for platinum resistors or thermometers with exceptionally high stability and individual calibration, a more complex interpolation equation than is presented in this standard may be necessary. The specification of such equations is outside the scope of this standard.

In order for a thermometer to be compliant with this standard it shall be made from a platinum resistor which is compliant with this standard.

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2 Normative references

The following normative document contains provisions which, through reference to this text, constitute provisions of this International Standard:

IEC 61515 : Process Measurement and Control devices –Mineral insulated metal sheathed thermocouple cables and thermocouples

IEC 61298-1: Process Measurement and Control devices – General Methods and Procedures for Evaluating Performance – Part 1: General considerations

IEC 60068-2-6: Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)

IEC 61152: Dimensions of metal sheathed thermometer elements

JCGM 100:2008 Evaluation of measurement data — Guide to the expression of uncertainty in measurement (GUM).

3 Terms and Definitions

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3.1
platinum resistor
resistor made from a platinum wire or film with defined electrical characteristics, embedded in an insulator (in most cases glass or ceramic), designed to be assembled into a platinum resistance thermometer or into an integrated circuit

3.2
platinum resistance thermometer
PRT
temperature responsive device consisting of one or more sensing platinum resistors within a protective sheath, internal connecting wires and external terminals to permit connection of electrical measurement instruments

Note 1 to entry; Mounting means and connection heads may be included. Not included is any separable protection tube or thermo-well

3.3
nominal resistance
expected resistance R_0 of a platinum resistor or resistance thermometer at 0 °C, declared by the supplier and shown in the thermometer marking, usually rounded to the nearest ohm

Note 1 to entry; platinum resistors are often characterized by their nominal values. For example platinum resistor of Pt-100 is a platinum resistor with R_0 = 100 Ω.

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3.4
terminals
termination of the connections supplied with the platinum resistance thermometer

Note1 to entry: Typical types of terminals are:

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- screws or clamps on the terminal socket
- pins of fixed connectors
- open ends of fixed cables or equivalents.

3.5
temperature sensitive length
length of the thermometer whose temperature directly influences the resistance measured

Note1 to entry; usually the temperature sensitive length is related to the length of the platinum resistor.

3.6
minimum immersion depth
immersion depth at which the change from the calibration at full immersion does not exceed 0,1 °C

3.7
tolerance
maximum allowable deviation of $R(t)$ measured at temperature t from the nominal resistance versus temperature relationship expressed as $\Delta t(t)$ in degrees Celsius

3.8
dielectric strength
maximum voltage between all parts of the electric circuit and the sheath of the thermometer and in the case of a thermometer with two or more sensing circuits, between two individual circuits which the thermometer can withstand without damage

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3.9
insulation resistance
electrical resistance measured between any part of the electric circuit and the sheath at ambient or elevated temperatures and with a specified measuring voltage (AC or DC)

3.10
self-heating
increase of the temperature of the platinum resistor or of the platinum resistor in a thermometer caused by the dissipated energy of the measuring current

3.11
self-heating coefficient
coefficient with the unit °C/mW is a characteristic for a platinum resistor or a thermometer and describes the temperature increase of the platinum resistor per unit power dissipated under specified operating conditions of the platinum resistor or thermometer

3.12
thermal response time
time a thermometer takes to respond at a specified percentage to a step change in temperature

3.13
thermoelectric effect
effect of inducing electro-motive force (abbreviated by emf hereafter) caused by different metals used in the electric circuit of the thermometer and by thermoelectric inhomogeneity of the internal leads at the conditions of temperature gradients along the leads

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3.14
hysteresis
difference between resistance measured in the middle of the temperature range after exposure the thermometer to the lower limit and to the upper limit of the temperature range

3.15
expanded uncertainty
quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand

Note1 to entry: for reference see 3.16.

3.16
coverage factor
numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

Note1 to entry: Coverage factor, k, is typically in the range 2 to 3.

[SOURCE: JCGM 100:2008, GUM 1995 with minor corrections. BIPM (Bureau International des Poids et Mesures), published on-line at www.bipm.org.]

4 Characteristics

4.1 General

The nominal resistance versus temperature relationship for platinum resistors and thermometers and their tolerance class are standardized. This specification is applied to a sensing platinum resistor at its connecting points and to a complete thermometer at its terminals.

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In the case of two-wire connections (see 5.5) the resistance values of the leads between the connecting point of the platinum resistor and the terminals must be considered. They must be subtracted from measured resistances. In some cases it also may be advisable to consider the temperature coefficient of the lead wires, the geometrical characteristics of the wires and the temperature distribution along their length. These information may be supplied to users as additional information (refer to 7).

4.2 Nominal resistance versus temperature relationship

The resistance versus temperature relationships used in this standard are as follows:

For the range -200 °C to 0 °C:

$$R_t = R_0[1 + At + Bt^2 + C(t - 100\ °C)\ t^3]$$

For the range of 0 °C to 850 °C:

$$R_t = R_0\ (1 + At + Bt^2\ )$$

where

R_t is the resistance at the temperature t
R_0 is the resistance at t = 0 °C.

The constants in these equations are

A = 3,9083 x 10^{-3} °C^{-1}
B = -5,775 x 10^{-7} °C^{-2}
C = -4,183 x10^{-12} °C^{-4}.

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4.3 Numerical table of resistance values

Table A.1 is derived by applying the equations and coefficients specified in 4.2 to a thermometer or platinum resistor of nominal resistance R_0 of 100 Ω.
The table is applicable to any thermometer and platinum resistor having any value of R_0 .
In this case resistance values in the Table A.1 shall be multiplied by the factor R_0 /100 Ω.

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Note 1 to entry; in this edition numerical table ceased to be the standard but becomes information. The specification of the standard is the formula described in 4.2 with which user can calculate numerical value of R_t.

Note 2 to the entry; most frequently used device has R_0 of 100 Ω. Devices with R_0 of 10 Ω, 500Ω or 1000 Ω are used frequently as well.

5 Compliance and requirements

5.1 Compliance

Platinum resistors and platinum resistance thermometers shall be tested to prove that the device meets all the applicable requirements specified in this standard. Suppliers shall be responsible to conducting the tests and to proving that the device is compliant with this standard before transferring the device to the user. The test method and evaluation are specified in this standard.

5.2 Tolerance classes

5.2.1 Tolerance class and its temperature range of validity

Tolerance classes for a platinum resistor are given in the Table 1 and for a platinum resistance thermometer in the Table 2 for any value of R_0.
These tolerance classes are closely related to the operable temperature range. Therefore the temperature ranges of validity of a tolerance class are shown in the adjacent column in the table. Temperature ranges of validity are based on the working experience with film and wire platinum resistors.

A thermometer that has wider temperature range of validity than the Table 2 can be compliant with this standard provided that it meets all the applicable specifications and its temperature range is declared.

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Likewise a thermometer or a platinum resistor that has a restricted temperature range of validity compared to the Table 1 or Table 2 can be compliant with this standard provide that it meets all the other applicable specifications and its temperature range is declared.

Thermometers or platinum resistors without a temperature range of validity of tolerance are not permitted in this standard.

5.2.2 Tolerance class of platinum resistors

Table 1 specifies tolerance class of platinum resistors. Tolerances and ranges of validity which differ from values given in Table 1 shall be agreed between supplier and user.

Table 1 – Tolerance class of platinum resistors

Wire wound platinum resistors		Film platinum resistors		Tolerance[1] (°C)
Tolerance class	Temperature range of validity (°C)	Tolerance class	Temperature range of validity (°C)	
W 0,1	-100 to +350	F 0,1	0 to +150	±(0,1 + 0,0017 | *t* |)
W 0,15	-100 to +450	F 0,15	-30 to +300	±(0,15 + 0,002 | *t* |)
W 0,3	-196 to +660	F 0,3	-50 to +500	±(0,3 + 0,005 | *t* |)
W 0,6	-196 to +660	F 0,6	-50 to +600	±(0,6 + 0,01 | *t* |)
Note The symbol | *t* | denotes modulus of temperature in t °C without regard to sign.				

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5.2.3 Tolerance classes and marking of platinum resistance thermometers

5.2.3.1 Tolerance classes of platinum resistance thermometers

Table 2 specifies tolerance class of platinum resistance thermometers.

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Table 2 – Tolerance class of thermometers

Tolerance class	Temperature range of validity (°C) for thermometers made using		Tolerance [1] (°C)
	Wire wound platinum resistors	Film platinum resistors	
AA	-50 to +250	0 to +150	±(0,1 + 0,0017 | *t* |)
A	-100 to +450	-30 to +300	±(0,15 + 0,002 | *t* |)
B	-196 to +600	-50 to +500	±(0,3 + 0,005 | *t* |)
C	-196 to +600	-50 to +600	±(0,6 + 0,01 | *t* |)
Note The symbol | *t* | denotes modulus of temperature in t °C without regard to sign.			

5.2.3.2 Special tolerance classes of platinum resistance thermometers

Tolerances and ranges of validity which differ from the values given in Table 2 shall be agreed between supplier and user. Recommended special tolerance classes may be constructed as multiples or fractions of class B tolerance. The Example 1 shown in 5.2.3.3 demonstrates this case.

It is also left to the suppliers and users to establish tolerance class for their thermometers at temperatures outside the ranges in Table 2. Special tolerance classes may be defined for restricted or extended temperature ranges. The Example 2 shown in 5.2.3.3 demonstrates this case.

Platinum resistance thermometers without specification of the temperature range of validity are not permissible.