IEC 60584-3

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Thermocouples –
Part 3: Extension and compensating cables – Tolerances and identification system

Couples thermoélectriques –
Partie 3: Câbles d'extension et de compensation – Tolérances et système d'identification

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Part 3: Extension and compensating cables – Tolerances and identification system

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International Standard IEC 60584-3 has been prepared by subcommittee 65B: Measurement and control devices, of IEC Technical Committee 65: Industrial-process measurement, control and automation.

This third edition cancels and replaces the second edition issued in 2007. This edition constitutes a technical revision.

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

a) revision of tolerance values to take recent technological advancement into account,
b) addition of new colour coding for the thermocouple Type C and A in response to the newly revised IEC 60584-1 Edition 3: 2013,
c) creation of an annex to provide examples of sizes for the rod, flat wire and strip of the compensating and extending conductors for thermocouples.

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

FDIS	Report on voting
65B/1189/FDIS	65B/1191/RVD

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

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

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

A list of all parts of the IEC 60584 series, under the general title *Thermocouples*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

THERMOCOUPLES –

Part 3: Extension and compensating cables – Tolerances and identification system

1 Scope

It is necessary for thermocouple temperature measurement that the electro-motive force (abbreviated as e.m.f. hereafter) of the thermocouple circuit is precisely measured by a measuring instrument. A thermocouple is electrically connected to the instrument by a proper pair of electric cables. IEC 60584-3 standardizes these cables. It specifies identification and manufacturing tolerances for extension and compensating cables (mineral insulated extension and compensating cables are not included) provided directly to users of industrial processes. These tolerances are determined with respect to the e.m.f. versus temperature relationship of IEC 60584-1. The requirements for extension and compensating cables for use in industrial process control are specified.

Extension and compensating cables may consist of a single strand (solid) wire or multi-stranded wire for which this document is applied. Specification for extension and compensating conductors of forms of rods, flat wires or strips can be established by agreement between suppliers and users.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60584-1, *Thermocouples – Part 1: EMF specifications and tolerances*

3 Terms and definitions

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

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

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

3.1
extension cables
cables manufactured from conductors having the same nominal composition as those of the corresponding thermocouple

Note 1 to entry: The cables are designated by the letter "X" following the designation of the thermocouple, for example "JX".

3.2
compensating cables
cables manufactured from conductors having a composition different from the corresponding thermocouple

Note 1 to entry: The cables are designated by the letter "C" following the designation of the thermocouple, for example "KC". In some cases, different tolerances apply for the same thermocouple type over different temperature ranges. These are distinguished by additional letters such as, for example, RCA and RCB.

3.3
tolerance
maximum allowable deviation in microvolts caused by the introduction of the extension or compensating cable into the measuring circuit

4 General

Both extension and compensating cables are used for the electrical connection between the open ends of a thermocouple and the reference junction in those installations where the conductors of the thermocouple are not directly connected to the reference junction. A cable always consists of a specific pair (negative and positive conductor), to be connected to the corresponding thermocouple. The thermoelectric properties of extension and compensating cables shall be close to the properties of the corresponding thermocouple. Products are manufactured for each thermocouple type, using various alloy formulations for various purposes. The key characteristic is that the pair of conductors meets the specified e.m.f. tolerance requirements.

5 Tolerance values

Table 1 shows the specified tolerance for extension and compensating cables when used at temperatures within the ranges indicated as "temperature range of validity". Temperature range of validity can be restricted to figures lower than those shown in the table because of temperature limitations imposed by the insulant.

Table 1 – Tolerance classes for extension and compensating cables

Type	Tolerance class				Temperature range of validity	Measuring junction temperature
	1		2			
JX	±85 µV	(±1,5 °C)	±140 µV	(±2,5 °C)	−25 °C to +200 °C	500 °C
TX	±30 µV	(±0,5 °C)	±60 µV	(±1,0 °C)	−25 °C to +100 °C	300 °C
EX	±120 µV	(±1,5 °C)	±200 µV	(±2,5 °C)	−25 °C to +200 °C	500 °C
KX	±60 µV	(±1,5 °C)	±100 µV	(±2,5 °C)	−25 °C to +200 °C	900 °C
NX	±60 µV	(±1,5 °C)	±100 µV	(±2,5 °C)	−25 °C to +200 °C	900 °C
KCA	±60 µV	(±1,5 °C)	±100 µV	(±2,5 °C)	0 °C to +200 °C	900 °C
KCB	±60 µV	(±1,5 °C)	±100 µV	(±2,5 °C)	0 °C to +100 °C	900 °C
NC	±60 µV	(±1,5 °C)	±100 µV	(±2,5 °C)	0 °C to + 200 °C	900 °C
RCA	±20 µV	(±1,5 °C)	±30 µV	(±2,5 °C)	0 °C to +100 °C	1 000 °C
RCB	±30 µV	(±2,5 °C)	±60 µV	(±5,0 °C)	0 °C to +200 °C	1 000 °C
SCA	±20 µV	(±1,5 °C)	±30 µV	(±2,5 °C)	0 °C to +100 °C	1 000 °C
SCB	±30 µV	(±2,5 °C)	±60 µV	(±5,0 °C)	0 °C to +200 °C	1 000 °C
BC			±40 µV	(±3,5 °C)	0 °C to +100 °C	1 400 °C
CC			±110 µV	(±8,0 °C)	0 °C to +200 °C	1 800 °C
ACA	±40 µV	(±3,5 °C)			0 °C to +100 °C	1 800 °C
ACB			±70 µV	(±5,0 °C)	0 °C to +200 °C	1 800 °C

NOTE Tolerances are specified in microvolts. The table also includes, in parentheses, the approximate equivalent tolerances in degrees Celsius. Because thermocouple e.m.f. temperature relationships are non-linear, the tolerance in degrees Celsius depends on the temperature of the measuring junction of the thermocouple where the reference junction is 0 °C. The figures shown in the table are those appropriate to the measuring junction temperatures in the final column. In all cases, the deviations (expressed in degrees Celsius) are different at lower temperatures.

A cable comprising two copper conductors may be used with Type B thermocouples. The expected maximum additional deviation within the cable temperature range 0 °C to +100 °C is 40 µV. The equivalent in temperature is 3,5 °C when the measuring junction of the thermocouple is at 1 400 °C.

6 Colour coding

6.1 Negative conductor

The insulation of the negative conductor shall be coloured in WHITE for all thermocouple types.

6.2 Positive conductor

The insulation of the positive conductor shall be coloured correspondingly to the thermocouple as indicated in Table 2.

6.3 Outer sheath

The outer sheath, if any, shall be coloured as indicated in Table 2. The outer sheath, if any, shall be colored as given in Table 2. In the case of possible confusion with existing IEC color code specification of cables, the color shall be indicated by other means, for instance by putting a label, tag or sticker of the specified color in the Table 2.

Table 2 – Colour code of positive conductor insulation for extension and compensating cables

Thermocouple type	Colour of positive conductor and sheath insulation
T	Brown
E	Purple
J	Black
K	Green
N	Pink
B	Grey
R	Orange
S	Orange
C	Red
A	Dark blue

6.4 Connectors

The connectors, if any, used in conjunction with thermocouples and compensating or extension cables, shall be coloured as indicated in Table 2. The colouring may be a mass colouring or a coloured dot on the connector's surface.

7 Dimensions

The dimensions of conductors of cables should be agreed between supplier and user taking into account, for example, the tensile strength and flexibility of the cable. Table 3 shows typical examples of nominal diameter of single strand (solid) wires. Table 4 shows typical examples of constructions of multi-stranded wires and estimated total cross-sectional areas of the

conductors. The form of the conductors can be rods, flat wires and strips, and examples of their sizes are shown in Annex A.

Table 3 – Nominal diameters of typical single strand (solid) wires

Nominal diameter of single strand (solid) wire mm
0,10
0,12
0,18
0,20
0,30
0,32
0,40
0,45
0,50
0,60
0,63
0,64
0,65
0,80
0,81
1,00
1,25
1,29
1,295
1,38
1,60

Table 4 – Constructions and typical nominal cross-sectional area of multi-stranded wires *(1 of 2)*

Nominal total cross-sectional area mm^2	Construction number of strands × diameter of a strand in mm
0,05	7 × 0,10
0,11	12 × 0,12
0,22	7 × 0,20
	3 × 0,30
0,38	12 × 0,20
0,41	13 × 0,20
0,50	16 × 0,20
	7 × 0,30
0,60	19 × 0,20
0,72	23 × 0,20
0,75	24 × 0,20

Nominal total cross-sectional area mm^2	Construction number of strands × diameter of a strand in mm
	11 × 0,30
1,00	32 × 0,20
	14 × 0,30
	7 × 0,44
	5 × 0,50
	3 × 0,65
1,20	7 × 0,45
	4 × 0,60
1,25	4 × 0,63
1,30	4 × 0,65
1,50	48 × 0,20
	21 × 0,30
	7 × 0,52
	3 × 0,80
2,00	16 × 0,40
	7 × 0,60
2,20	7 × 0,63
2,25	7 × 0,64
2,30	7 × 0,65

8 Requirements

8.1 Materials

8.1.1 Insulating materials

The choice of insulating materials shall be agreed between supplier and user.

8.1.2 Conductor materials

For the cable temperature range, the thermal e.m.f. of conductor materials of a cable shall comply both with IEC 60584-1 and with the tolerances specified in Clause 5 of this document.

8.2 Electromagnetic shielding

To reduce the EMC interference, cables shall be manufactured by using pairs of twisted conductors, and additional shielding can be used for a thermoelectric circuit.

8.3 Capacitance and inductance

The capacitance and inductance – both per metre – (conductors against conductors and conductors against shield – if present) shall be made available.

8.4 Resistance of positive or negative conductor and loop resistance of a cable

The nominal value of the resistance of positive or negative conductors in Ω/m at (20 ± 5) °C shall be declared by the manufacturer and the nominal loop resistance in Ω/m at (20 ± 5) °C shall be made available.