

JIS

JAPANESE INDUSTRIAL STANDARD

Thermocouples

JIS C 1602⁻¹⁹⁹⁵

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JAPANESE INDUSTRIAL STANDARD

J I S

Thermocouples

C 1602-1995

1. Scope This Japanese Industrial Standard specifies thermocouples to be used for temperature measurement.

Remarks 1. The standards cited in this Standard are given in Attached Table 9.

2. The International Standards corresponding to this Standard are given below.

IEC 584-1 (1977) Thermocouples Part 1: Reference tables

IEC 584-2 (1982) Thermocouples Part 2: Tolerances

2. Definitions For the purpose of this Standard, the following principal definitions apply:

- (1) thermocouple An element composed of conductors of 2 kinds each one end of which is electrically connected each other to generate thermoelectromotive force.
- (2) thermocouple element wire Metallic wire or alloy wire used for both legs of thermocouple.
- (3) (temperature) measuring junction Junction between the element wires of thermocouple, and it is placed at a point of temperature measurement.
- (4) reference junction The joint of thermocouple and lead wires or that of extension or compensating cable and lead wires which is kept at a constant temperature (for example, ice point).
- (5) insulating tube A tube to prevent element wires of a thermocouple from short-circuiting each other.
- (6) protecting tube A tube to be fitted for protection of the temperature measuring junction and element wires from direct contact with the article under temperature measurement or the atmosphere, etc.
- (7) terminal Metal fittings attached to a thermocouple through which thermoelectromotive force is taken out.
- (8) thermocouple with protecting tube Thermocouple covered with insulating tube, inserted into a protecting tube and fitted with terminals.

- (9) extension or compensating cable A pair of conductors covered with insulation, having nearly the same thermoelectromotive force characteristic as the thermocouple which is to be used in combination with over an appropriate temperature range including ordinary temperature. It is used for connection between the thermocouple and the reference junction to compensate the temperature difference between the junction of thermocouple and the reference junction.
- (10) reference thermoelectromotive force A certain thermoelectromotive force which is generated by an ideal thermocouple (reference thermocouple) corresponding to the temperature of measuring junction when the reference junction is at 0°C.
- (11) standard thermocouple A thermocouple which is used as the standard apparatus in the thermoelectromotive force characteristic test carried out by using comparison method.

3. Classification The thermocouples are classified as given in Table 1 according to composing materials.

Table 1. Classification

Symbol of type	Composing materials	
	+ Leg (¹)	- Leg (¹)
B	Platinum rhodium alloy containing 30 % rhodium	Platinum rhodium alloy containing 6 % rhodium
R	Platinum rhodium alloy containing 13 % rhodium	Platinum
S	Platinum rhodium alloy containing 10 % rhodium	Platinum
N	Alloy main components of which are nickel, chromium and silicon	Alloy main components of which are nickel and silicon
K	Alloy main components of which are nickel and chromium	Alloy main component of which is nickel
E	Alloy main components of which are nickel and chromium	Alloy main components of which are copper and nickel
J	Iron	Alloy main components of which are copper and nickel
T	Copper	Alloy main components of which are copper and nickel

Note (¹) The + leg means a leg to be connected to + terminal of an instrument to measure thermoelectromotive force, and - leg means opposite side one.

4. Tolerances The tolerances are classified in each type of thermocouple as shown in Table 2.

Table 2. Tolerances

Type		Classification by tolerance ⁽²⁾		
		Class 1	Class 2	Class 3
B	Temperature range	-	-	$600^{\circ}\text{C} \leq T < 800^{\circ}\text{C}$
	Tolerance	-	-	$\pm 4^{\circ}\text{C}$
	Temperature range	-	$600^{\circ}\text{C} \leq T < 1700^{\circ}\text{C}$	$800^{\circ}\text{C} \leq T < 1700^{\circ}\text{C}$
	Tolerance	-	$\pm 0.0025 \cdot t $	$\pm 0.005 \cdot t $
	Former grade *	-	-	Grade 0.5
R, S	Temperature range	$0^{\circ}\text{C} \leq T < 1100^{\circ}\text{C}$ ⁽³⁾	$0^{\circ}\text{C} \leq T < +600^{\circ}\text{C}$	-
	Tolerance	$\pm 1^{\circ}\text{C}$	$\pm 1.5^{\circ}\text{C}$	-
	Temperature range	-	$600^{\circ}\text{C} \leq T < 1600^{\circ}\text{C}$	-
	Tolerance	-	$\pm 0.0025 \cdot t $	-
	Former grade *	-	Grade 0.25	-
N	Temperature range	$-40^{\circ}\text{C} \leq T < +375^{\circ}\text{C}$	$-40^{\circ}\text{C} \leq T < +333^{\circ}\text{C}$	$-167^{\circ}\text{C} \leq T < +40^{\circ}\text{C}$
	Tolerance	$\pm 1.5^{\circ}\text{C}$	$\pm 2.5^{\circ}\text{C}$	$\pm 2.5^{\circ}\text{C}$
	Temperature range	$375^{\circ}\text{C} \leq T < 1000^{\circ}\text{C}$	$333^{\circ}\text{C} \leq T < 1200^{\circ}\text{C}$	$-200^{\circ}\text{C} \leq T < -167^{\circ}\text{C}$
	Tolerance	$\pm 0.004 \cdot t $	$0.0075 \cdot t $	$0.015 \cdot t $
	Former grade *	-	-	-
K	Temperature range	$-40^{\circ}\text{C} \leq T < +375^{\circ}\text{C}$	$-40^{\circ}\text{C} \leq T < +333^{\circ}\text{C}$	$-167^{\circ}\text{C} \leq T < +40^{\circ}\text{C}$
	Tolerance	$\pm 1.5^{\circ}\text{C}$	$\pm 2.5^{\circ}\text{C}$	$\pm 2.5^{\circ}\text{C}$
	Temperature range	$375^{\circ}\text{C} \leq T < 1000^{\circ}\text{C}$	$333^{\circ}\text{C} \leq T < 1200^{\circ}\text{C}$	$-200^{\circ}\text{C} \leq T < -167^{\circ}\text{C}$
	Tolerance	$\pm 0.004 \cdot t $	$\pm 0.0075 \cdot t $	$\pm 0.015 \cdot t $
	Former grade *	Grade 0.4	Grade 0.75	Grade 1.5

Table 2. (continued)

Type		Classification by tolerance ⁽²⁾		
		Class 1	Class 2	Class 3
E	Temperature range	$-40^{\circ}\text{C} \leq T < +375^{\circ}\text{C}$	$-40^{\circ}\text{C} \leq T < +333^{\circ}\text{C}$	$-167^{\circ}\text{C} \leq T < +40^{\circ}\text{C}$
	Tolerance	$\pm 1.5^{\circ}\text{C}$	$\pm 2.5^{\circ}\text{C}$	$\pm 2.5^{\circ}\text{C}$
	Former grade *	Grade 0.4	Grade 0.75	Grade 1.5
J	Temperature range	$375^{\circ}\text{C} \leq T < 800^{\circ}\text{C}$	$333^{\circ}\text{C} \leq T < 900^{\circ}\text{C}$	$-200^{\circ}\text{C} \leq T < -167^{\circ}\text{C}$
	Tolerance	$\pm 0.004 \cdot t $	$\pm 0.0075 \cdot t $	$0.015 \cdot t $
	Former grade *	Grade 0.4	Grade 0.75	Grade 1.5
J	Temperature range	$-40^{\circ}\text{C} \leq T < +375^{\circ}\text{C}$	$-40^{\circ}\text{C} \leq T < +333^{\circ}\text{C}$	-
	Tolerance	$\pm 1.5^{\circ}\text{C}$	$\pm 2.5^{\circ}\text{C}$	-
	Former grade *	Grade 0.4	Grade 0.75	-
J	Temperature range	$375^{\circ}\text{C} \leq T < 750^{\circ}\text{C}$	$333^{\circ}\text{C} \leq T < 750^{\circ}\text{C}$	-
	Tolerance	$\pm 0.004 \cdot t $	$\pm 0.0075 \cdot t $	-
	Former grade *	Grade 0.4	Grade 0.75	-
T	Temperature range	$-40^{\circ}\text{C} \leq T < +125^{\circ}\text{C}$	$-40^{\circ}\text{C} \leq T < +133^{\circ}\text{C}$	$-67^{\circ}\text{C} \leq T < +40^{\circ}\text{C}$
	Tolerance	$\pm 0.5^{\circ}\text{C}$	$\pm 1^{\circ}\text{C}$	$\pm 1^{\circ}\text{C}$
	Former grade *	Grade 0.4	Grade 0.75	Grade 1.5
T	Temperature range	$125^{\circ}\text{C} \leq T < 350^{\circ}\text{C}$	$133^{\circ}\text{C} \leq T < 350^{\circ}\text{C}$	$-200^{\circ}\text{C} \leq T < -67^{\circ}\text{C}$
	Tolerance	$\pm 0.004 \cdot t $	$0.0075 \cdot t $	$0.015 \cdot t $
	Former grade *	Grade 0.4	Grade 0.75	Grade 1.5

Notes ⁽²⁾ Tolerance means allowable maximum of the remainder of the temperature converted from thermoelectromotive force using the table of the reference thermoelectromotive force subtracted by the temperature of measuring junction.

⁽³⁾ Tolerance class 1 of type R and type S thermocouples is applicable to standard thermocouples.

Remarks 1. $|t|$ means the value of measured temperature ($^{\circ}\text{C}$) regardless to the sign of + or -.

2. The mark * means informative reference.

5. Reference thermoelectromotive force The reference thermoelectromotive force shall comply with Attached Tables 1 to 8.

6. Limits of normal operating temperature and elevated operating temperature The limits of normal operating temperature⁽⁴⁾ and elevated operating temperature⁽⁵⁾ shall be as given in Table 3.

Notes ⁽⁴⁾ Normal operating temperature limit means the limit of temperature within which thermocouples can be continuously used in the air.

⁽⁵⁾ Elevated operating temperature limit means the limit of temperature at which thermocouples can be used for a short time in the case of unavoidable needs.

Table 3. Limits of normal operating temperature and elevated operating temperature

Symbol of type	Diameter of element wire mm	Normal operating temperature limit °C	Elevated operating temperature limit °C
B	0.50	1 500	1 700
R	0.50	1 400	1 600
S			
N	0.65	850	900
	1.00	950	1 000
	1.60	1 050	1 100
	2.30	1 100	1 150
	3.20	1 200	1 250
K	0.65	650	850
	1.00	750	950
	1.60	850	1 050
	2.30	900	1 100
	3.20	1 000	1 200
E	0.65	450	500
	1.00	500	550
	1.60	550	600
	2.30	600	750
	3.20	700	800
J	0.65	400	500
	1.00	450	550
	1.60	500	650
	2.30	550	750
	3.20	600	750
T	0.32	200	250
	0.65	200	250
	1.00	250	300
	1.60	300	350

7. Characteristics The characteristics of thermocouple shall be as follows when the specimen is tested in accordance with 11.

(1) Temperature characteristics The temperature characteristics shall be as given in Table 4.

Table 4. Temperature characteristics

Item	Characteristics	Applicable sub-clause for test method
Characteristics of thermo-electromotive force	Shall satisfy the value of Table 2.	11.2.3
Characteristics of thermo-electromotive force ⁽⁶⁾	Not more than 1/5 of the value in Table 2.	11.2.4

Note (6) Stability of thermoelectromotive force means the degree of stability in the characteristics of thermoelectromotive force.

- (2) Electrical characteristics The electrical characteristics shall be as given in Table 5.

Table 5. Electrical characteristics

Item	Characteristics	Applicable sub-clause for test method
Insulation resistance (only for thermocouple with protecting tube)	Insulation resistance between terminal and protecting tube shall be 10 MΩ/500 VDC or more.	11.2.5
Dielectric withstand voltage (only for thermocouple with protecting tube)	Shall withstand 500 VAC for 1 min.	11.2.6

- (3) Mechanical characteristics The mechanical characteristics shall be as given in Table 6.

Table 6. Mechanical characteristics

Item	Characteristics	Applicable sub-clause for test method
Shock-proof (only for thermocouple with protecting metal tube)	Shall be no abnormality on electric connection such as joint of temperature measuring junction and connection to terminal and also no loosening in connected parts.	11.2.7
Vibration-proof (only for thermocouple with protecting metal tube)		11.2.8