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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently JIS C 1602 : 1995 is replaced with this Standard.

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Thermocouples

Introduction

This Japanese Industrial Standard has been prepared based on the third edition of IEC 60584-1 published in 2013 with some modifications of the technical contents.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JC.

1 Scope

This Standard specifies the thermocouples to be used for the temperature measurement.

NOTE 1 Temperatures in this Standard are based on the International Temperature Scale of 1990 (ITS-90).

NOTE 2 “t” indicates the temperature expressed in degrees Celsius, the unit symbol °C.

NOTE 3 The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows :

IEC 60584-1 : 2013 *Thermocouples — Part 1 : EMF specifications and tolerances* (MOD)

The symbols which denote the degree of correspondence in the contents between the relevant International Standard and JIS are IDT (identical), MOD (modified), and NEQ (not equivalent) according to ISO/IEC Guide 21-1.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7502 *Micrometer callipers*

JIS B 7507 *Vernier, dial and digital callipers*

JIS B 7516 *Metal rules*

JIS C 1302 *Insulation resistance testers*

JIS C 1610 *Extension and compensating cables for thermocouples*

JIS R 1401 *Non-Metallic protection tubes for thermocouples*

JIS R 1402 *Non-metallic insulating tubes for thermocouples*

JIS Z 8103 *Glossary of terms used in measurement*

JIS Z 8703 *Standard atmospheric conditions for testing***3 Terms and definitions**

For the purpose of this Standard, the terms and definitions given in **JIS Z 8103**, and the following apply.

3.1 thermocouple

assembly composed of two types of conductors which are electrically joined at one end each other to generate electromotive force

3.2 thermocouple element wire

metal wire or alloy wire composing a thermocouple

3.3 measuring junction

joint of thermocouple element wires to give thermal contact with an article under temperature measurement

3.4 reference junction

junction between a thermocouple and a lead wire or between a compensating cable and a lead wire for measuring the electromotive force, which is kept at a known constant temperature

In this Standard, the reference junction temperature is 0 °C.

3.5 insulating tube

tube to prevent element wires of thermocouple from short-circuiting each other

3.6 protection tube

tube to be fitted for protection of the temperature measuring junction and the element wires from direct contact with the article under temperature measurement, the atmosphere, etc.

3.7 terminal

metal fitting attached to a thermocouple through which its electromotive force is taken out

3.8 thermocouple with protection tube

thermocouple with insulating tube attached, which is inserted into a protection tube and fitted with terminals

3.9 compensating cable

a couple of conductors covered with insulation having nearly the same electromotive force characteristic as that of the thermocouple to be used in combination at appropriate range of temperatures including the ordinary temperature, which are used for the connection between the connection part of thermocouple and the reference junction to compensate the temperature difference between them

3.10 electromotive force (EMF)

difference in electric power generated in a couple of conductors composing a thermocouple when they are placed in an environment having a temperature gradient

3.11 reference electromotive force

electromotive force imparted to the temperature at measuring junction specified for each type of thermocouple

3.12 reference function

polynomial of temperatures to express the reference electromotive force

3.13 tolerance

allowable maximum limit of the remainder obtained by subtracting the temperature at measuring junction from the temperature obtained by converting the electromotive force using the reference function

3.14 limit of normal service

limit of temperature at which a thermocouple can be used in air continuously

3.15 limit of extended range service

limit of temperature at which a thermocouple can be used in air for a short time

3.16 stability

amount of change in the electromotive force characteristics when a thermocouple is heated in air

3.17 standard thermometer

thermometer used as the standard apparatus in the electromotive force characteristic test which is carried out by the comparison method

4 Classification

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

Table 1 Classification

Symbol of type	Composing materials	
	Positive side conductor	Negative side conductor
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 based on nickel, chromium and silicon	Alloy based on nickel and silicon
K	Alloy based on nickel and chromium	Alloy based on nickel and aluminium
E	Alloy based on nickel and chromium	Alloy based on copper and nickel
J	Iron	Alloy based on copper and nickel
T	Copper	Alloy based on copper and nickel
C	Tungsten — rhenium alloy containing 5 % rhenium	Tungsten — rhenium alloy containing 26 % rhenium

5 Reference electromotive force

The reference electromotive force are defined by the reference function.

The reference function is represented by polynomial (1). However, polynomial (2) is used for Type K thermocouples at temperatures in the range of 0 °C to 1 372 °C. The coefficients of the polynomial for each thermocouple type and the temperature range are as given in Annex JA.

$$E = a_0 + \sum_{i=1}^n a_i t^i \dots\dots\dots(1)$$

$$E = b_0 + \sum_{i=1}^n b_i t^i + c_0 \exp[c_1(t - 126.9686)^2] \dots\dots\dots(2)$$

where, E : reference electromotive force (unit : μV)
 t : arbitrary temperature (unit : °C)
 a_0, b_0, a_i, b_i, c_0 and c_1 : coefficients of polynomial
 n : order of polynomial

The tables of the reference electromotive force obtained by using the reference function are given in Annex A.

6 Tolerances

The tolerances are as given in Table 2.

Table 2 Tolerances

Symbol of type		Classification by tolerance		
		Class 1	Class 2	Class 3 ^{a)}
B	Temperature range	—	—	600 °C or over to and excl. 800 °C
	Tolerance	—	—	±4 °C
	Temperature range	—	600 °C or over to and excl. 1 700 °C	800 °C or over to and excl. 1 700 °C
	Tolerance	—	±0.002 5 · t	±0.005 · t
R, S	Temperature range	0 °C or over to and excl. 1 100 °C	0 °C or over to and excl. 600 °C	—
	Tolerance	±1 °C	±1.5 °C	—
	Temperature range	1 100 °C or over to and excl. 1 600 °C	600 °C or over to and excl. 1 600 °C	—
	Tolerance	±[1 °C + 0.003 · (t – 1 100 °C)]	±0.002 5 · t	—
N	Temperature range	–40 °C or over to and excl. 375 °C	–40 °C or over to and excl. 333 °C	–167 °C or over to and excl. 40 °C
	Tolerance	±1.5 °C	±2.5 °C	±2.5 °C
	Temperature range	375 °C or over to and excl. 1 000 °C	333 °C or over to and excl. 1 200 °C	–200 °C or over to and excl. –167 °C
	Tolerance	±0.004 · t	±0.007 5 · t	±0.015 · t
K	Temperature range	–40 °C or over to and excl. 375 °C	–40 °C or over to and excl. 333 °C	–167 °C or over to and excl. 40 °C
	Tolerance	±1.5 °C	±2.5 °C	±2.5 °C
	Temperature range	375 °C or over to and excl. 1 000 °C	333 °C or over to and excl. 1 200 °C	–200 °C or over to and excl. –167 °C
	Tolerance	±0.004 · t	±0.007 5 · t	±0.015 · t
E	Temperature range	–40 °C or over to and excl. 375 °C	–40 °C or over to and excl. 333 °C	–167 °C or over to and excl. 40 °C
	Tolerance	±1.5 °C	±2.5 °C	±2.5 °C
	Temperature range	375 °C or over to and excl. 800 °C	333 °C or over to and excl. 900 °C	–200 °C or over to and excl. –167 °C
	Tolerance	±0.004 · t	±0.007 5 · t	±0.015 · t
J	Temperature range	–40 °C or over to and excl. 375 °C	–40 °C or over to and excl. 333 °C	—
	Tolerance	±1.5 °C	±2.5 °C	—
	Temperature range	375 °C or over to and excl. 750 °C	333 °C or over to and excl. 750 °C	—
	Tolerance	±0.004 · t	±0.007 5 · t	—
T	Temperature range	–40 °C or over to and excl. 125 °C	–40 °C or over to and excl. 133 °C	–67 °C or over to and excl. 40 °C
	Tolerance	±0.5 °C	±1 °C	±1 °C
	Temperature range	125 °C or over to and excl. 350 °C	133 °C or over to and excl. 350 °C	–200 °C or over to and excl. –67 °C
	Tolerance	±0.004 · t	±0.007 5 · t	±0.015 · t
C	Temperature range	—	426 °C or over to and excl. 2 315 °C	—
	Tolerance	—	±0.01 · t	—

NOTE 1 | t | means the value of measured temperature (°C) regardless of the sign of + or –.

NOTE 2 The tolerances shall apply to new element wires only.

Note ^{a)} Pay attention to Type N, K, E and T thermocouples which satisfy the tolerance Class 1 and Class 2 in the temperature range of –40 °C and above, but do not satisfy the tolerance in the temperature ranges given to Class 3 except special cases.

7 Limit of normal service and limit of extended range service

The limit of normal service and the limit of extended range service are as given in Table 3. The limit of normal service and the limit of extended range service are not specified for Type C thermocouples because they cannot be used in air.

Table 3 Limit of normal service and limit of extended range service

Symbol of type	Diameter of element wire mm	Limit of normal service °C	Limit of extended range service °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

8 Characteristics

8.1 Temperature characteristics

The temperature characteristics are as given in Table 4. The stability of electromotive force for Type C thermocouples are not specified because they cannot be used in air.

Table 4 Temperature characteristics

Items	Characteristics	Applicable clause for test method
Electromotive characteristics	Conform to value in Table 2	12.2.3
Stability of electromotive force	Not more than 1/5 of value in Table 2	12.2.4

8.2 Electrical characteristics

The electrical characteristics are as given in Table 5.

Table 5 Electrical characteristics

Items	Characteristics	Applicable clause for test method
Insulation resistance (only for thermocouple with protection tube, but those of which measuring junction is welded to protection tube are excluded.)	10 M Ω /500 VDC or more for insulation resistance between terminal and protection tube	12.2.5
Dielectric withstand voltage (only for thermocouple with protection tube, but those of which measuring junction is welded to protection tube are excluded.)	Withstand 500 VAC for 1 min.	12.2.6

8.3 Mechanical characteristics

The mechanical characteristics are as given in Table 6.

Table 6 Mechanical characteristics

Items	Characteristics	Applicable clause for test method
Shock-proof characteristics (only for thermocouple with metallic protection tube)	No abnormality in electric connection such as joint of measuring junction and connection point to terminal, and no loosening in connection part.	12.2.7
Vibration-proof characteristics (only for thermocouple with metallic protection tube)		12.2.8

9 Dimensions

9.1 Dimensions of thermocouple element wire

The dimensions of thermocouple element wire are as given in Table 7 and Figure 1. The length shall be upon the agreement between the parties concerned with delivery.

Table 7 Diameter of thermocouple element wire

Symbol of type	Wire diameter of element wire	Unit: mm
B	0.50 ± 0.01	
R		
S		
N	$0.65 \pm 0.03, 1.00 \pm 0.04, 1.60 \pm 0.05, 2.30 \pm 0.05, 3.20 \pm 0.06$	
K		
E		
J		
T	$0.32 \pm 0.01, 0.65 \pm 0.03, 1.00 \pm 0.04, 1.60 \pm 0.05$	
C		
	0.50 ± 0.03	

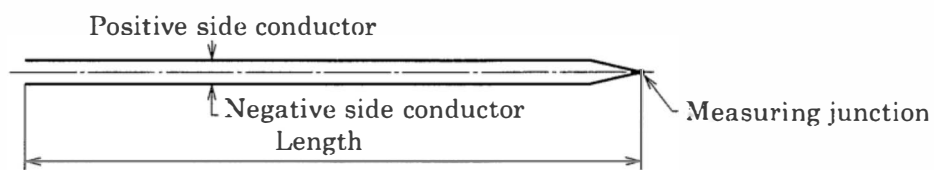


Figure 1 Outline of thermocouple element wire

9.2 Dimensions of thermocouple with protection tube

An example of dimensions of protection tubes for thermocouples with protection tube are as given in Table 8. The expression method of the dimensions is given in Figure 2. An example of dimensions of non-metallic protection tube are as specified in JIS R 1401.

The measuring positions for the dimensions are as given in Figure 2.

Table 8 Example of dimensions of thermocouple with protection tube

Outer diameter of protection tube	Length	Unit: mm
6, 8, 10, 12, 15, 20, 22	500, 750, 1 000	

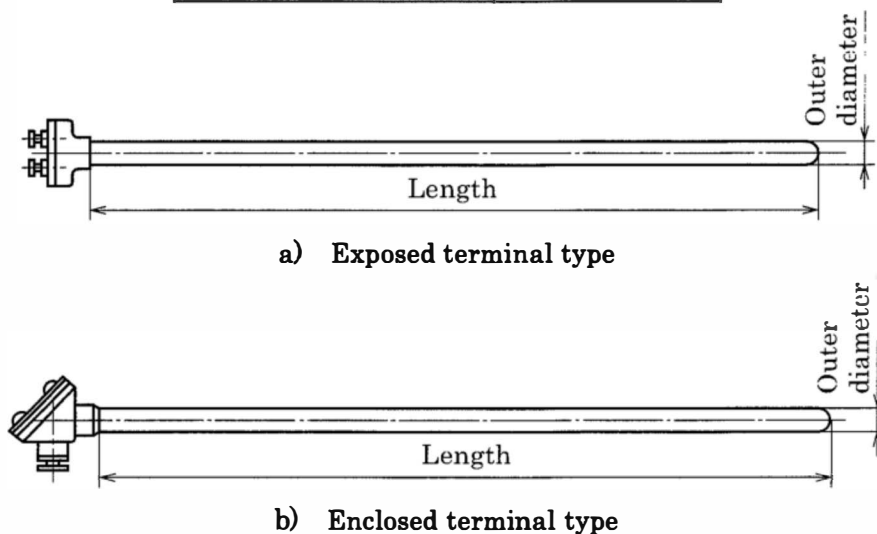


Figure 2 Outline of thermocouple with protection tube

10 Construction

10.1 General

The measuring junction of thermocouple shall be durable, and be jointed surely.

10.2 Thermocouple with protection tube

10.2.1 Terminal

The terminal shall be so constructed that the electromotive force generated at the connection part between the thermocouple and the terminal is as small as possible.

10.2.2 Insulating tube

The insulating tube shall be of materials which will not affect the thermocouple, and also shall have sufficient heat resistance to the service temperature.

It is desirable to use the insulating tubes specified in **JIS R 1402** for non-metallic insulating tubes.

10.2.3 Protection tube

The protection tube shall have sufficient heat resistance and durability under the service conditions so that the measuring junction and the element wires will not be affected by the article under temperature measurement or the atmosphere.

It is desirable to use the protection tubes specified in **JIS R 1401** for non-metallic protection tubes.

10.3 Compensating cable

When the compensating cables are used, they shall be as specified in **JIS C 1610**. The connection between the thermocouple and the compensating cables shall be such that the positive side conductor is connected to the positive side core of compensating cable and the negative side conductor is connected to the negative side core of compensating cable.

11 Appearance

The thermocouple element wires shall be free from defects such as scratch, split, joint and fold. The protection tube of the thermocouple with protection tube shall have no harmful scratch. Also there shall be no abnormality in the joint and shape of the measuring junction as well as in the interrelation between the measuring junction and the protection tube.

12 Tests

12.1 Test conditions

Unless otherwise specified, the test shall be carried out under the ordinary temperature (temperature of $20\text{ }^{\circ}\text{C} \pm 15\text{ }^{\circ}\text{C}$) and the ordinary humidity [humidity of $(65 \pm 20)\%$] specified in **JIS Z 8703**.

12.2 Test methods

12.2.1 Appearance

The appearance shall be examined by the naked eye.

12.2.2 Dimensions

The diameter of element wires shall be measured with the micrometer callipers specified in JIS B 7502, the outer diameter of protection tubes with the vernier calliper specified in JIS B 7507 and the length with the metal rule specified in JIS B 7516 or with a measuring instrument equal or superior to it in accuracy.

12.2.3 Electromotive characteristics

12.2.3.1 General

The electromotive force characteristics shall be obtained, after the completion of the electromotive force stability test specified in 12.2.4 as appropriate, by measuring the electromotive force based on the fixed point method in 12.2.3.2 or the comparison method in 12.2.3.3, then converting to a temperature from the reference function. The traceability of devices used in the test shall be secured. The measuring device accuracies and the effect of the reference junction shall be taken into consideration with respect to the measurement results. When compensating cables are used, their effect shall also be considered. An example of the measurement system is shown in Figure 3.

When a thermocouple with protection tube is used, the test shall be carried out by removing the protection tube.

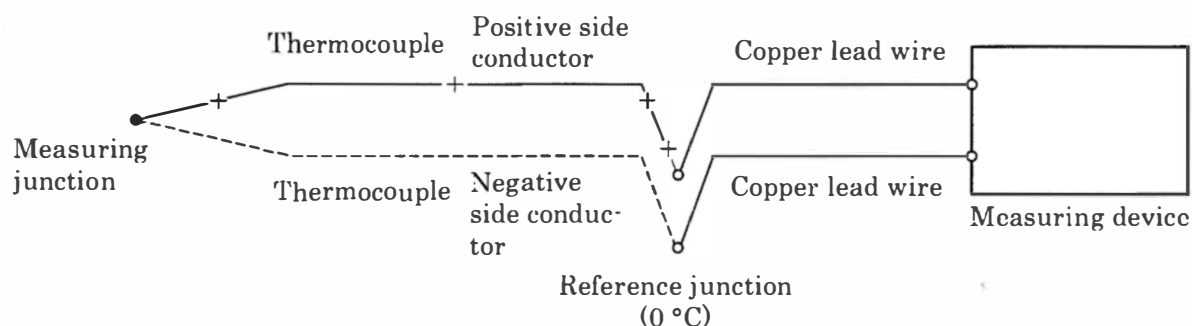


Figure 3 Example of measuring system of electromotive force

12.2.3.2 Fixed point method

In the fixed point method, one of the fixed point temperatures specified in Annex JB shall be attained, and the electromotive force shall be measured at the point by taking the temperature as the reference temperature.

In carrying out the test for measuring the electromotive force based on the fixed point method, the thermocouple under test shall be inserted in the device in which the fixed point temperature has been attained. In this case, the temperature measuring part of the thermocouple under test shall be inserted deep enough so as to be free from any influence of thermal conduction.

12.2.3.3 Comparison method

In the comparison method, the temperature of a comparison apparatus such as a thermostatic oven and an electric furnace which is kept at a constant and even temperature specified in Annex JB shall be determined by means of a standard thermometer such as a standard thermocouple, then the electromotive force shall be measured by taking the temperature thus determined as the reference temperature.

In order to carry out the test based on the comparison method, both the standard thermometer and the thermocouple under test shall be inserted deep enough in the comparison apparatus with their temperature measuring parts being close each other so as to make it possible to compare the both temperatures indicated. In this case, care shall be taken so that the measurements are not affected by radiation and thermal conduction from the heat source.

12.2.4 Stability of electromotive force

The stability of electromotive force shall be obtained in such a manner that the portion of the thermocouple 500 mm or more apart from the measuring junction is heated for 3 h in air so that the temperature of limit of normal service is attained, the electromotive forces are measured before and after the above test by the method according to 12.2.3, and the variation between the two measured values is obtained. The length of insertion of thermocouple when measuring the electromotive force shall not exceed 500 mm.

The test temperature may be arbitrary within the temperature range given in Table 9.

Table 9 Temperature range

Symbol of type	Test temperature
B	600 °C or over to and including limit of normal service
R	
S	
N	400 °C or over to and including limit of normal service
K	
E	
J	200 °C or over to and including limit of normal service
T	

12.2.5 Insulation resistance

For the thermocouple with protection tube, the insulation resistance between the terminal and the protection tube shall be measured with the insulation resistance tester of 500 V in rated measuring voltage specified in JIS C 1302 or that equivalent or superior in performance.

The thermocouples whose measuring junction is welded to the protection tube are excluded from this requirement.

12.2.6 Dielectric withstand voltage

Whether the thermocouple with protection tube withstands the voltage or not shall be tested by applying a nearly sinusoidal voltage of a.c. 500 V at a frequency of 50 Hz or 60 Hz between the terminal and the protection tube for 1 min.

The thermocouples whose measuring junction is welded to the protection tube are excluded from this requirement.

12.2.7 Shock-proof characteristics

For the shock-proof characteristics, the thermocouple with protection tube shall be held horizontally by hands and dropped onto a steel plate of 6 mm thickness placed on a hard floor from a height of 250 mm 10 times. Then, the existence of abnormality in such electric connection as joint of measuring junction, connection to terminal shall be checked.

The thermocouples with non-metallic protection tube are excluded from this requirement.

12.2.8 Vibration-proof characteristics

The resonance test and the constant frequency endurance test shall be carried out on thermocouples with protection tube, and the existence of abnormality in such electric connection as joint of measuring junction, connection to terminal and loosening in connection part shall be checked. The test conditions shall be as given in Table 10.

The thermocouples with non-metallic protection tube are excluded from this requirement.

Table 10 Test conditions

Test items	Frequency Hz	Peak-to-peak am- plitude mm	Test duration min		Direction of vibra- tion
			Sweep	Endur- ance	
Resonance test	30 to 100	0.05	2	—	Biaxial directions including lengthwise direction
Constant frequency endurance test	100	0.02	—	60	
NOTE : In the constant frequency endurance test, if 100 Hz is the resonance point, the test shall be carried out at 70 Hz.					

13 Inspection

13.1 General

The following type inspection or acceptance inspection shall be carried out according to the tests specified in clause 12, and the results shall comply with the provisions in clause 8 to clause 11.

13.2 Type inspection

The type inspection shall be carried out on the following items.

- ### 13.3 Acceptance Inspection

- a) Appearance
- b) Dimensions
- c) Electromotive force characteristics
- d) Insulation resistance

The thermocouple shall be designated by the symbol of type, classification by tolerance, diameter of element wire, outer diameter and length of protection tube (for thermocouple with protection tube), material quality or its symbol of protection tube (for thermocouple with protection tube) and name (thermocouple with protection tube, if concerned).

Example 2	Type R Class 2	0.50 mm	6 mm × 500 mm	Thermocouple with porcelain protection tube
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15.1 Marking on thermocouple

- Symbol of type
- Classification by tolerance
- Diameter of element wire (mm)
- Polarity ¹⁾
- Length (mm) or net mass ²⁾ (g)
- Manufacturer's name or its abbreviation
- Year and month of manufacture or their abbreviation

Notes ¹⁾ Red is for positive side when colours are used for polarity indication.

²⁾ Mass of thermocouple element wire.

15.2 Marking on thermocouple with protection tube

The following items shall be marked on a suitable place of each thermocouple with protection tube.

- a) Symbol of type
- b) Classification by tolerance
- c) Diameter of element wire (mm)
- d) Outer diameter and length of protection tube (mm)
- e) Material quality of protection tube or its symbol
- f) Polarity ³⁾
- g) Service limit ⁴⁾
- h) Manufacturer's name or its abbreviation
- i) Year and month of manufacture or their abbreviation

Notes ³⁾ The polarity shall be marked on the terminal. Red is for positive side when colours are used for polarity indication.

⁴⁾ The "service limit" means such a temperature limit within which the thermocouple with protection tube can be continuously used in addition to the limit of normal service (see Table 3). It is determined according to the type of thermocouple, the element wire diameter, the thermal resistance, and the material quality of insulating tube and protection tube, taking into account totally.

Annex A (informative)

Tables of reference electromotive force

In this Annex, the reference electromotive force values ($E/\mu\text{V}$) for every 1 °C obtained by substituting the reference function coefficients specified in Annex JA in the reference function specified in clause 5 are given in Table A.1 to Table A.9 for the thermocouples of each type.

Table A.1 Reference electromotive force of Type B

Temperature (°C)	Unit: μV										Temperature (°C)
	0	1	2	3	4	5	6	7	8	9	
0	0	0	0	-1	-1	-1	-1	-1	-2	-2	0
10	-2	-2	-2	-2	-2	-2	-2	-2	-3	-3	10
20	-3	-3	-3	-3	-3	-2	-2	-2	-2	-2	20
30	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	30
40	0	0	0	0	0	1	1	1	2	2	40
50	2	3	3	3	4	4	4	5	5	6	50
60	6	7	7	8	8	9	9	10	10	11	60
70	11	12	12	13	14	14	15	15	16	17	70
80	17	18	19	20	20	21	22	22	23	24	80
90	25	26	26	27	28	29	30	31	31	32	90
100	33	34	35	36	37	38	39	40	41	42	100
110	43	44	45	46	47	48	49	50	51	52	110
120	53	55	56	57	58	59	60	62	63	64	120
130	65	66	68	69	70	72	73	74	75	77	130
140	78	79	81	82	84	85	86	88	89	91	140
150	92	94	95	96	98	99	101	102	104	106	150
160	107	109	110	112	113	115	117	118	120	122	160
170	123	125	127	128	130	132	134	135	137	139	170
180	141	142	144	146	148	150	151	153	155	157	180
190	159	161	163	165	166	168	170	172	174	176	190
200	178	180	182	184	186	188	190	192	195	197	200
210	199	201	203	205	207	209	212	214	216	218	210
220	220	222	225	227	229	231	234	236	238	241	220
230	243	245	248	250	252	255	257	259	262	264	230
240	267	269	271	274	276	279	281	284	286	289	240
250	291	294	296	299	301	304	307	309	312	314	250
260	317	320	322	325	328	330	333	336	338	341	260
270	344	347	349	352	355	358	360	363	366	369	270
280	372	375	377	380	383	386	389	392	395	398	280
290	401	404	407	410	413	416	419	422	425	428	290

Table A.1 (continued)

Tem- pera- ture (°C)	Unit: μV										Tem- pera- ture (°C)
	0	1	2	3	4	5	6	7	8	9	
300	431	434	437	440	443	446	449	452	455	458	300
310	462	465	468	471	474	478	481	484	487	490	310
320	494	497	500	503	507	510	513	517	520	523	320
330	527	530	533	537	540	544	547	550	554	557	330
340	561	564	568	571	575	578	582	585	589	592	340
350	596	599	603	607	610	614	617	621	625	628	350
360	632	636	639	643	647	650	654	658	662	665	360
370	669	673	677	680	684	688	692	696	700	703	370
380	707	711	715	719	723	727	731	735	738	742	380
390	746	750	754	758	762	766	770	774	778	782	390
400	787	791	795	799	803	807	811	815	819	824	400
410	828	832	836	840	844	849	853	857	861	866	410
420	870	874	878	883	887	891	896	900	904	909	420
430	913	917	922	926	930	935	939	944	948	953	430
440	957	961	966	970	975	979	984	988	993	997	440
450	1 002	1 007	1 011	1 016	1 020	1 025	1 030	1 034	1 039	1 043	450
460	1 048	1 053	1 057	1 062	1 067	1 071	1 076	1 081	1 086	1 090	460
470	1 095	1 100	1 105	1 109	1 114	1 119	1 124	1 129	1 133	1 138	470
480	1 143	1 148	1 153	1 158	1 163	1 167	1 172	1 177	1 182	1 187	480
490	1 192	1 197	1 202	1 207	1 212	1 217	1 222	1 227	1 232	1 237	490
500	1 242	1 247	1 252	1 257	1 262	1 267	1 272	1 277	1 282	1 288	500
510	1 293	1 298	1 303	1 308	1 313	1 318	1 324	1 329	1 334	1 339	510
520	1 344	1 350	1 355	1 360	1 365	1 371	1 376	1 381	1 387	1 392	520
530	1 397	1 402	1 408	1 413	1 418	1 424	1 429	1 435	1 440	1 445	530
540	1 451	1 456	1 462	1 467	1 472	1 478	1 483	1 489	1 494	1 500	540
550	1 505	1 511	1 516	1 522	1 527	1 533	1 539	1 544	1 550	1 555	550
560	1 561	1 566	1 572	1 578	1 583	1 589	1 595	1 600	1 606	1 612	560
570	1 617	1 623	1 629	1 634	1 640	1 646	1 652	1 657	1 663	1 669	570
580	1 675	1 680	1 686	1 692	1 698	1 704	1 709	1 715	1 721	1 727	580
590	1 733	1 739	1 745	1 750	1 756	1 762	1 768	1 774	1 780	1 786	590
600	1 792	1 798	1 804	1 810	1 816	1 822	1 828	1 834	1 840	1 846	600
610	1 852	1 858	1 864	1 870	1 876	1 882	1 888	1 894	1 901	1 907	610
620	1 913	1 919	1 925	1 931	1 937	1 944	1 950	1 956	1 962	1 968	620
630	1 975	1 981	1 987	1 993	1 999	2 006	2 012	2 018	2 025	2 031	630
640	2 037	2 043	2 050	2 056	2 062	2 069	2 075	2 082	2 088	2 094	640
650	2 101	2 107	2 113	2 120	2 126	2 133	2 139	2 146	2 152	2 158	650
660	2 165	2 171	2 178	2 184	2 191	2 197	2 204	2 210	2 217	2 224	660
670	2 230	2 237	2 243	2 250	2 256	2 263	2 270	2 276	2 283	2 289	670
680	2 296	2 303	2 309	2 316	2 323	2 329	2 336	2 343	2 350	2 356	680
690	2 363	2 370	2 376	2 383	2 390	2 397	2 403	2 410	2 417	2 424	690

Table A.1 (continued)

Unit: μV

Tem- pera- ture (°C)	0	1	2	3	4	5	6	7	8	9	Tem- pera- ture (°C)
700	2 431	2 437	2 444	2 451	2 458	2 465	2 472	2 479	2 485	2 492	700
710	2 499	2 506	2 513	2 520	2 527	2 534	2 541	2 548	2 555	2 562	710
720	2 569	2 576	2 583	2 590	2 597	2 604	2 611	2 618	2 625	2 632	720
730	2 639	2 646	2 653	2 660	2 667	2 674	2 681	2 688	2 696	2 703	730
740	2 710	2 717	2 724	2 731	2 738	2 746	2 753	2 760	2 767	2 775	740
750	2 782	2 789	2 796	2 803	2 811	2 818	2 825	2 833	2 840	2 847	750
760	2 854	2 862	2 869	2 876	2 884	2 891	2 898	2 906	2 913	2 921	760
770	2 928	2 935	2 943	2 950	2 958	2 965	2 973	2 980	2 987	2 995	770
780	3 002	3 010	3 017	3 025	3 032	3 040	3 047	3 055	3 062	3 070	780
790	3 078	3 085	3 093	3 100	3 108	3 116	3 123	3 131	3 138	3 146	790
800	3 154	3 161	3 169	3 177	3 184	3 192	3 200	3 207	3 215	3 223	800
810	3 230	3 238	3 246	3 254	3 261	3 269	3 277	3 285	3 292	3 300	810
820	3 308	3 316	3 324	3 331	3 339	3 347	3 355	3 363	3 371	3 379	820
830	3 386	3 394	3 402	3 410	3 418	3 426	3 434	3 442	3 450	3 458	830
840	3 466	3 474	3 482	3 490	3 498	3 506	3 514	3 522	3 530	3 538	840
850	3 546	3 554	3 562	3 570	3 578	3 586	3 594	3 602	3 610	3 618	850
860	3 626	3 634	3 643	3 651	3 659	3 667	3 675	3 683	3 692	3 700	860
870	3 708	3 716	3 724	3 732	3 741	3 749	3 757	3 765	3 774	3 782	870
880	3 790	3 798	3 807	3 815	3 823	3 832	3 840	3 848	3 857	3 865	880
890	3 873	3 882	3 890	3 898	3 907	3 915	3 923	3 932	3 940	3 949	890
900	3 957	3 965	3 974	3 982	3 991	3 999	4 008	4 016	4 024	4 033	900
910	4 041	4 050	4 058	4 067	4 075	4 084	4 093	4 101	4 110	4 118	910
920	4 127	4 135	4 144	4 152	4 161	4 170	4 178	4 187	4 195	4 204	920
930	4 213	4 221	4 230	4 239	4 247	4 256	4 265	4 273	4 282	4 291	930
940	4 299	4 308	4 317	4 326	4 334	4 343	4 352	4 360	4 369	4 378	940
950	4 387	4 396	4 404	4 413	4 422	4 431	4 440	4 448	4 457	4 466	950
960	4 475	4 484	4 493	4 501	4 510	4 519	4 528	4 537	4 546	4 555	960
970	4 564	4 573	4 582	4 591	4 599	4 608	4 617	4 626	4 635	4 644	970
980	4 653	4 662	4 671	4 680	4 689	4 698	4 707	4 716	4 725	4 734	980
990	4 743	4 753	4 762	4 771	4 780	4 789	4 798	4 807	4 816	4 825	990
1 000	4 834	4 843	4 853	4 862	4 871	4 880	4 889	4 898	4 908	4 917	1 000
1 010	4 926	4 935	4 944	4 954	4 963	4 972	4 981	4 990	5 000	5 009	1 010
1 020	5 018	5 027	5 037	5 046	5 055	5 065	5 074	5 083	5 092	5 102	1 020
1 030	5 111	5 120	5 130	5 139	5 148	5 158	5 167	5 176	5 186	5 195	1 030
1 040	5 205	5 214	5 223	5 233	5 242	5 252	5 261	5 270	5 280	5 289	1 040
1 050	5 299	5 308	5 318	5 327	5 337	5 346	5 356	5 365	5 375	5 384	1 050
1 060	5 394	5 403	5 413	5 422	5 432	5 441	5 451	5 460	5 470	5 480	1 060
1 070	5 489	5 499	5 508	5 518	5 528	5 537	5 547	5 556	5 566	5 576	1 070
1 080	5 585	5 595	5 605	5 614	5 624	5 634	5 643	5 653	5 663	5 672	1 080
1 090	5 682	5 692	5 702	5 711	5 721	5 731	5 740	5 750	5 760	5 770	1 090

Table A.1 (continued)

Unit: μV

Tem- pera- ture (°C)	0	1	2	3	4	5	6	7	8	9	Tem- pera- ture (°C)
1 100	5 780	5 789	5 799	5 809	5 819	5 828	5 838	5 848	5 858	5 868	1 100
1 110	5 878	5 887	5 897	5 907	5 917	5 927	5 937	5 947	5 956	5 966	1 110
1 120	5 976	5 986	5 996	6 006	6 016	6 026	6 036	6 046	6 055	6 065	1 120
1 130	6 075	6 085	6 095	6 105	6 115	6 125	6 135	6 145	6 155	6 165	1 130
1 140	6 175	6 185	6 195	6 205	6 215	6 225	6 235	6 245	6 256	6 266	1 140
1 150	6 276	6 286	6 296	6 306	6 316	6 326	6 336	6 346	6 356	6 367	1 150
1 160	6 377	6 387	6 397	6 407	6 417	6 427	6 438	6 448	6 458	6 468	1 160
1 170	6 478	6 488	6 499	6 509	6 519	6 529	6 539	6 550	6 560	6 570	1 170
1 180	6 580	6 591	6 601	6 611	6 621	6 632	6 642	6 652	6 663	6 673	1 180
1 190	6 683	6 693	6 704	6 714	6 724	6 735	6 745	6 755	6 766	6 776	1 190
1 200	6 786	6 797	6 807	6 818	6 828	6 838	6 849	6 859	6 869	6 880	1 200
1 210	6 890	6 901	6 911	6 922	6 932	6 942	6 953	6 963	6 974	6 984	1 210
1 220	6 995	7 005	7 016	7 026	7 037	7 047	7 058	7 068	7 079	7 089	1 220
1 230	7 100	7 110	7 121	7 131	7 142	7 152	7 163	7 173	7 184	7 194	1 230
1 240	7 205	7 216	7 226	7 237	7 247	7 258	7 269	7 279	7 290	7 300	1 240
1 250	7 311	7 322	7 332	7 343	7 353	7 364	7 375	7 385	7 396	7 407	1 250
1 260	7 417	7 428	7 439	7 449	7 460	7 471	7 482	7 492	7 503	7 514	1 260
1 270	7 524	7 535	7 546	7 557	7 567	7 578	7 589	7 600	7 610	7 621	1 270
1 280	7 632	7 643	7 653	7 664	7 675	7 686	7 697	7 707	7 718	7 729	1 280
1 290	7 740	7 751	7 761	7 772	7 783	7 794	7 805	7 816	7 827	7 837	1 290
1 300	7 848	7 859	7 870	7 881	7 892	7 903	7 914	7 924	7 935	7 946	1 300
1 310	7 957	7 968	7 979	7 990	8 001	8 012	8 023	8 034	8 045	8 058	1 310
1 320	8 066	8 077	8 088	8 099	8 110	8 121	8 132	8 143	8 154	8 165	1 320
1 330	8 176	8 187	8 198	8 209	8 220	8 231	8 242	8 253	8 264	8 275	1 330
1 340	8 286	8 298	8 309	8 320	8 331	8 342	8 353	8 364	8 375	8 386	1 340
1 350	8 397	8 408	8 419	8 430	8 441	8 453	8 464	8 475	8 486	8 497	1 350
1 360	8 508	8 519	8 530	8 542	8 553	8 564	8 575	8 586	8 597	8 608	1 360
1 370	8 620	8 631	8 642	8 653	8 664	8 675	8 687	8 698	8 709	8 720	1 370
1 380	8 731	8 743	8 754	8 765	8 776	8 787	8 799	8 810	8 821	8 832	1 380
1 390	8 844	8 855	8 866	8 877	8 889	8 900	8 911	8 922	8 934	8 945	1 390
1 400	8 956	8 967	8 979	8 990	9 001	9 013	9 024	9 035	9 047	9 058	1 400
1 410	9 069	9 080	9 092	9 103	9 114	9 126	9 137	9 148	9 160	9 171	1 410
1 420	9 182	9 194	9 205	9 216	9 228	9 239	9 251	9 262	9 273	9 285	1 420
1 430	9 296	9 307	9 319	9 330	9 342	9 353	9 364	9 376	9 387	9 398	1 430
1 440	9 410	9 421	9 433	9 444	9 456	9 467	9 478	9 490	9 501	9 513	1 440
1 450	9 524	9 536	9 547	9 558	9 570	9 581	9 593	9 604	9 616	9 627	1 450
1 460	9 639	9 650	9 662	9 673	9 684	9 696	9 707	9 719	9 730	9 742	1 460
1 470	9 753	9 765	9 776	9 788	9 799	9 811	9 822	9 834	9 845	9 857	1 470
1 480	9 868	9 880	9 891	9 903	9 914	9 926	9 937	9 949	9 961	9 972	1 480
1 490	9 984	9 995	10 007	10 018	10 030	10 041	10 053	10 064	10 076	10 088	1 490

Table A.1 (concluded)

Unit: μV

Tem- pera- ture (°C)	0	1	2	3	4	5	6	7	8	9	Tem- pera- ture (°C)
1 500	10 099	10 111	10 122	10 134	10 145	10 157	10 168	10 180	10 192	10 203	1 500
1 510	10 215	10 226	10 238	10 249	10 261	10 273	10 284	10 296	10 307	10 319	1 510
1 520	10 331	10 342	10 354	10 365	10 377	10 389	10 400	10 412	10 423	10 435	1 520
1 530	10 447	10 458	10 470	10 482	10 493	10 505	10 516	10 528	10 540	10 551	1 530
1 540	10 563	10 575	10 586	10 598	10 609	10 621	10 633	10 644	10 656	10 668	1 540
1 550	10 679	10 691	10 703	10 714	10 726	10 738	10 749	10 761	10 773	10 784	1 550
1 560	10 796	10 808	10 819	10 831	10 843	10 854	10 866	10 877	10 889	10 901	1 560
1 570	10 913	10 924	10 936	10 948	10 959	10 971	10 983	10 994	11 006	11 018	1 570
1 580	11 029	11 041	11 053	11 064	11 076	11 088	11 099	11 111	11 123	11 134	1 580
1 590	11 146	11 158	11 169	11 181	11 193	11 205	11 216	11 228	11 240	11 251	1 590
1 600	11 263	11 275	11 286	11 298	11 310	11 321	11 333	11 345	11 357	11 368	1 600
1 610	11 380	11 392	11 403	11 415	11 427	11 438	11 450	11 462	11 474	11 485	1 610
1 620	11 497	11 509	11 520	11 532	11 544	11 555	11 567	11 579	11 591	11 602	1 620
1 630	11 614	11 626	11 637	11 649	11 661	11 673	11 684	11 696	11 708	11 719	1 630
1 640	11 731	11 743	11 754	11 766	11 778	11 790	11 801	11 813	11 825	11 836	1 640
1 650	11 848	11 860	11 871	11 883	11 895	11 907	11 918	11 930	11 942	11 953	1 650
1 660	11 965	11 977	11 988	12 000	12 012	12 024	12 035	12 047	12 059	12 070	1 660
1 670	12 082	12 094	12 105	12 117	12 129	12 141	12 152	12 164	12 176	12 187	1 670
1 680	12 199	12 211	12 222	12 234	12 246	12 257	12 269	12 281	12 292	12 304	1 680
1 690	12 316	12 327	12 339	12 351	12 363	12 374	12 386	12 398	12 409	12 421	1 690
1 700	12 433	12 444	12 456	12 468	12 479	12 491	12 503	12 514	12 526	12 538	1 700
1 710	12 549	12 561	12 572	12 584	12 596	12 607	12 619	12 631	12 642	12 654	1 710
1 720	12 666	12 677	12 689	12 701	12 712	12 724	12 736	12 747	12 759	12 770	1 720
1 730	12 782	12 794	12 805	12 817	12 829	12 840	12 852	12 863	12 875	12 887	1 730
1 740	12 898	12 910	12 921	12 933	12 945	12 956	12 968	12 980	12 991	13 003	1 740
1 750	13 014	13 026	13 037	13 049	13 061	13 072	13 084	13 095	13 107	13 119	1 750
1 760	13 130	13 142	13 153	13 165	13 176	13 188	13 200	13 211	13 223	13 234	1 760
1 770	13 246	13 257	13 269	13 280	13 292	13 304	13 315	13 327	13 338	13 350	1 770
1 780	13 361	13 373	13 384	13 396	13 407	13 419	13 430	13 442	13 453	13 465	1 780
1 790	13 476	13 488	13 499	13 511	13 522	13 534	13 545	13 557	13 568	13 580	1 790
1 800	13 591	13 603	13 614	13 626	13 637	13 649	13 660	13 672	13 683	13 694	1 800
1 810	13 706	13 717	13 729	13 740	13 752	13 763	13 775	13 786	13 797	13 809	1 810
1 820	13 820										1 820

NOTE : The reference junction temperature is 0 °C.