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**Extension and compensating cables for
thermocouples**

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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 1610** : 1995 is replaced with this Standard.

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Extension and compensating cables for thermocouples

Introduction

This Japanese Industrial Standard has been prepared based on the second edition of **IEC 60584-3** published in 2007 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 JB. Annex JA is the matters not stated in the corresponding International Standard.

1 Scope

This Standard specifies the extension and compensating cables to be used in combination with the thermocouples and the mineral insulated thermocouples (hereafter referred to as “thermocouples”) specified in **JIS C 1602** and **JIS C 1605**.

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

IEC 60584-3 : 2007 *Thermocouples — Part 3 : Extension and compensating cables — Tolerances and identification system* (MOD)

In addition, 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 C 1202 *Circuit testers*

JIS C 1302 *Insulation resistance testers*

JIS C 1602 *Thermocouples*

NOTE : Corresponding International Standard : **IEC 60584-1** : 1995 *Thermocouples — Part 1 : Reference tables* (MOD)

JIS C 1605 *Mineral insulated thermocouples*

JIS C 2525 *Testing method for conductor-resistance and resistivity of metallic resistance materials*

JIS C 3005 *Test methods for rubber or plastic insulated wires and cables*

JIS C 3102 *Annealed copper wires for electrical purposes*

JIS C 3152 Tin coated annealed copper wires

JIS Z 8102 Names of non-luminous object colours

JIS Z 8103 Glossary of terms used in measurement

JIS Z 8703 Standard atmospheric conditions for testing

3 Terms and definitions

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

3.1 extension and compensating cable

a pair of insulated conductors, having nearly the same thermoelectromotive force characteristics to the thermocouple which is to be used in combination with, within appropriate temperature range including ordinary temperature

It is used for the connection between the thermocouple and the reference junction to compensate the temperature difference between the connected part with the thermocouple (compensating junction) and the reference junction.

3.2 conductors

a pair of metal wires (including alloys wires) which constitutes the extension and compensating cable

The conductor to be connected with + leg of thermocouple is called the positive conductor and that with – leg is called the negative conductor.

There are the solid wire and the stranded wire in conductors, and one metal wire that constitutes the solid wire and the stranded wire is called a strand.

According to the constituting materials, there are the extension type conductor composed of the same material as that of the thermocouple and the compensating type conductor composed of different material from that of the thermocouple.

3.3 thermoelectromotive force of extension and compensating cable

the thermoelectromotive force generated corresponding to the temperature change of the measuring junction when a thermocouple is formed with the positive conductor and the negative conductor of the extension and compensating cable

3.4 thermocouple

an element composed of conductors of two types each one end of which is electrically connected to generate thermoelectromotive force (see **JIS C 1602**)

3.5 measuring junction

the junction where conductors are connected, which is placed on the temperature measuring point in the tests

3.6 reference junction

the point of junction of the thermocouple and lead wires, or that of the extension and

compensating cable and lead wires, which is kept at a constant temperature (e.g. ice point) (see **JIS C 1602**)

3.7 compensating junction

the point of junction of the thermocouple and the extension and compensating cable (see **JIS Z 8704**)

3.8 tolerance

the maximum permissible limit caused by the introduction of the extension and compensating cable into the measuring circuit

The reference thermoelectromotive forces of thermocouples used in combination are as given in attached table 1 to attached table 8 of **JIS C 1602**.

4 Classification and symbols

The classification and the symbols shall be as given in table 1 according to the constituting materials of conductors.

NOTE : See Annex JA for the transition of symbols for types and colour coding for outer sheath of the extension and compensating cables.

Table 1 Classification and symbols

Classification			Symbol ^{a)}
Type of thermo-couple combined for service	Constituting materials of conductors		
	Positive conductor	Negative conductor	
B	Copper	Copper	BC
R	Copper	Alloy mainly composed of copper and nickel	RCA
	Copper	Alloy mainly composed of copper and nickel	RCB
S	Copper	Alloy mainly composed of copper and nickel	SCA
	Copper	Alloy mainly composed of copper and nickel	SCB
N	Alloy mainly composed of nickel and chromium	Alloy mainly composed of nickel and silicon	NX
	Alloy mainly composed of copper and nickel	Alloy mainly composed of copper and nickel	NC
K	Alloy mainly composed of nickel and chromium	Alloy mainly composed of nickel	KX
	Iron	Alloy mainly composed of copper and nickel	KCA ^{b)}
	Copper	Alloy mainly composed of copper and nickel	KCB ^{c)}
E	Alloy mainly composed of nickel and chromium	Alloy mainly composed of copper and nickel	EX
J	Iron	Alloy mainly composed of copper and nickel	JX
T	Copper	Alloy mainly composed of copper and nickel	TX

Notes ^{a)} The symbol of classification of the extension and compensating cable is denoted by the type of thermocouple to be used in combination and the material of conductors. The symbol that denotes the extension type conductors composed of the same material as that of thermocouples to be used in combination is taken as X, and the symbol that denotes the compensation type conductors composed of the material different from that of thermocouples to be used in combination is taken as C.

The symbol of the compensation type conductors, when it is classified by the tolerance or the compensating junction temperature, is denoted by attaching A or B.

^{b)} The symbol KCA corresponds to the symbol KCB at the time of revision in 1995 and WX at the time of revision in 1981.

^{c)} The symbol KCB corresponds to the symbol KCC at the time of revision in 1995 and VX at the time of revision in 1981.

5 Tolerance

The tolerance shall be as given in table 2.

Table 2 Tolerance

Symbol	Tolerance ^{a)} μV		Compensating junction temperature ^{b)} $^{\circ}\text{C}$	Measuring junction temperature $^{\circ}\text{C}$
	Class 1	Class 2		
BC	— ^{c)}		0 to 100	—
RCA	—	$\pm 30 (\pm 2.5^{\circ}\text{C})$	0 to 100	1 000
RCB	—	$\pm 60 (\pm 5.0^{\circ}\text{C})$	0 to 200	1 000
SCA	—	$\pm 30 (\pm 2.5^{\circ}\text{C})$	0 to 100	1 000
SCB	—	$\pm 60 (\pm 5.0^{\circ}\text{C})$	0 to 200	1 000
NX	$\pm 60 (\pm 1.5^{\circ}\text{C})$	$\pm 100 (\pm 2.5^{\circ}\text{C})$	−25 to 200	900
NC	—	$\pm 100 (\pm 2.5^{\circ}\text{C})$	0 to 150	900
KX	$\pm 60 (\pm 1.5^{\circ}\text{C})$	$\pm 100 (\pm 2.5^{\circ}\text{C})$	−25 to 200	900
KCA	—	$\pm 100 (\pm 2.5^{\circ}\text{C})$	0 to 150	900
KCB	—	$\pm 100 (\pm 2.5^{\circ}\text{C})$	0 to 100	900
EX	$\pm 120 (\pm 1.5^{\circ}\text{C})$	$\pm 200 (\pm 2.5^{\circ}\text{C})$	−25 to 200	500
JX	$\pm 85 (\pm 1.5^{\circ}\text{C})$	$\pm 140 (\pm 2.5^{\circ}\text{C})$	−25 to 200	500
TX	$\pm 30 (\pm 0.5^{\circ}\text{C})$	$\pm 60 (\pm 1.0^{\circ}\text{C})$	−25 to 100	300

Notes ^{a)} The tolerance is specified in voltage. When the temperature of the measuring junction of the thermocouple to be used in combination is equal to the temperature described in the rightmost column of the table, the corresponding value of temperature (reference value) that becomes almost equivalent to the tolerance specified in voltage is shown in parentheses.

The relation between the temperature of a thermocouple and the thermoelectromotive force is nonlinear, and the corresponding value of temperature of the tolerance of an extension and compensating cable is determined by the temperature of the measuring junction of the thermocouple to be connected. In many cases, the corresponding value of temperature of a tolerance becomes larger as the temperature of the measuring junction of a thermocouple becomes lower.

^{b)} Since the limiting temperature is given according to insulating materials, the range of the compensating junction temperature may become narrower than that in the table.

^{c)} The tolerance is not specified for BC because the same material (copper) is used for the positive conductor and the negative conductor.

Maximum additional deviation to be expected is 40 μV when BC is used within the compensating junction temperature range of 0 $^{\circ}\text{C}$ to 100 $^{\circ}\text{C}$. The equivalent in temperature is 3.5 $^{\circ}\text{C}$ when the temperature of the measuring junction of the thermocouple to be connected is 1 400 $^{\circ}\text{C}$.

6 Service categories and symbols

The service categories and symbols are as given in table 3.

Table 3 Service categories and symbols

Service category	Symbol	Insulating material	Service temperature range	NOTE
General service	G	Vinyl system	−20 °C to 90 °C	Not applicable to RCB and SCB. The service temperature range of BC, RCA, SCA, NC, KCA and KCB shall be 0 °C to 90 °C.
Heat-resistant service	H	Glass system	0 °C to 150 °C	Not applicable to BC, RCA, SCA, KCB and TX.
Super heat-resistant service	S	Fluororesin system	−25 °C to 200 °C	Not applicable to compensation type conductors. The service temperature range of TX shall be −25 °C to 100 °C.

7 Characteristics

7.1 Thermoelectromotive force characteristics

The thermoelectromotive force characteristics shall satisfy values in table 2 when tested as specified in 9.2.2.

7.2 Electrical resistance

The values of electrical resistance shall be those in table 4 or under when tested as specified in 9.2.3. This is the value of the electrical resistance to and from 1 m.

Table 4 Electrical resistanceUnit : Ω

Nominal cross-sectional area of stranded wire mm ²	Symbol									
	BC	RCA RCB SCA SCB	NX	NC	KX	KCA	KCB	EX	JX	TX
0.2	0.18	0.40	6.6	1.3	5.0	3.3	2.8	6.3	3.3	2.8
0.3	0.12	0.28	5.0	0.80	3.6	2.5	2.1	4.5	2.5	2.1
0.5	0.08	0.17	3.0	0.66	2.2	1.4	1.2	2.7	1.4	1.2
0.75	0.05	0.11	2.0	0.44	1.5	0.95	0.75	1.8	0.95	0.75
1.25	0.04	0.080	1.3	0.26	1.0	0.65	0.55	1.3	0.65	0.55
1.3	0.03	0.070	1.1	0.25	0.90	0.55	0.45	1.1	0.55	0.45
1.5	0.03	0.060	1.0	0.22	0.78	0.50	0.42	0.96	0.50	0.42
2.0	0.02	0.045	0.75	0.17	0.55	0.40	0.30	0.70	0.40	0.30
2.3	0.02	0.040	0.65	0.14	0.50	0.30	0.25	0.60	0.30	0.25
NOTE : The nominal cross-sectional area (including that of the strand) not described in this table is upon the agreement between the purchaser and the manufacturer.										

7.3 Insulation resistance

When tested as specified in 9.2.4, the insulation resistance shall be the value in table 5 or more. However, the value of insulation resistance may be determined according to the requirements of the system side into which it is incorporated.