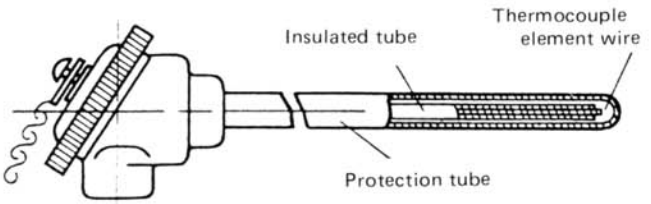
Shinko

TEMPERATURE SENSOR SERIES

THERMOCOUPLE

Thermocouple wire is produced by welding and splicing one end of two kinds of metals which differ from one another. This spliced point is called the measured temperature junction (hot junction), and the other end, reference junction (cold junction). Providing for temperature difference between the two junctions causes the thermal electromotive force (EMF) to have a constant relation with the temperature difference. Therefore, if temperature at the reference junction is kept at a constant value, temperature at the measured temperature junction is known by means of this EMF.

The method of measuring temperature by making the use of this is adopted by a thermoelectric thermometer, and which is adequate to measure a comparative high temperature (600°C to approximately 1400°C or 1112°F to 2552°F).



Construction of thermocouple

CONSTRUCTION

The thermocouple consists of a bare thermocouple, a protection tube, and a terminal box.

Bare Thermocouple

It is necessary to select a type of the bare thermocouple adequate to a temperature to be measured. For temperature measurement, it is vital that the characteristics of the thermal EMF is constant. Therefore, materials of thermocouple wire are carefully selected, and every material in use is of an uniform quality and in conformity to Japan industrial Standards. The wire is insulated with a ceramic insulating tube, fixed to a terminal board, and then inserted into a protection tube.

Protection Tube

This is to physically and chemically protect the bare thermocouple, and the protection tubes are produced with various materials and in various shapes according to the place and purpose for use.

Terminal Box

This is a light alloy-made box comprising the thermocouple wire and the terminal to connect extension wire, preventing the connecting terminals from the effects by external radiant heat, dust, or others, and being so constructed as to be easily maintained with easy replacements of a protection tube or a bare thermocouple.

In case it is necessary to transmit thermal EMF simultaneously to two places, use a twin-core type that is of two bare thermocouples inserted into the same protection tube.

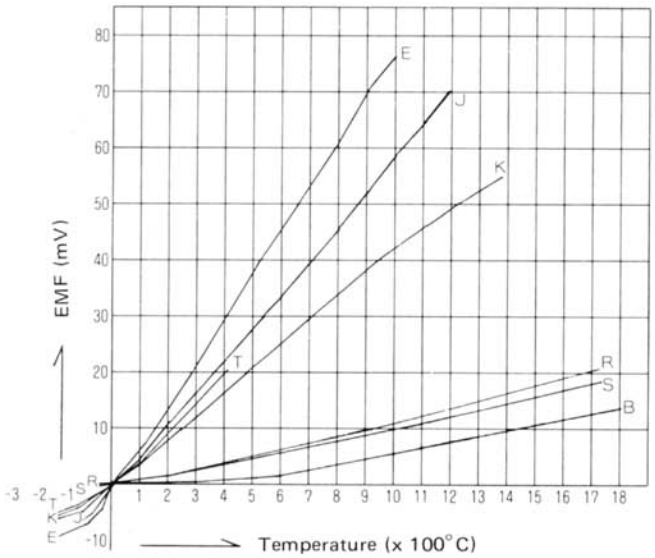
- The following kinds of element wires are available:

B Thermocouple (Platinum · rhodium 30% — Platinum · rhodium 6% thermocouple)
R Thermocouple (Platinum · rhodium 13% — Platinum · thermocouple)
S Thermocouple (Platinum · rhodium 10% — Platinum · thermocouple)
K Thermocouple (Chromel — Alumel thermocouple)
E Thermocouple (Chromel — Constantan thermocouple)
J Thermocouple (Iron — Constantan thermocouple)
T Thermocouple (Copper — Constantan thermocouple)
(All the above-mentioned are in conformity to Japan Industrial Standards)
PR 40/20 thermocouple (Platinum · rhodium 40% — Platinum · rhodium 20% thermocouple)
PR 20/5 thermocouple (Platinum · rhodium 20% — Platinum · rhodium 5% thermocouple)
W/WRe 26 thermocouple (Tungsten — Tungsten · rhenium 26% thermocouple)
WRe 5-26 thermocouple (Tungsten · rhenium 5% — Tungsten · rhenium 26% thermocouple)
Platinel thermocouple

EXTENSION WIRE

The thermocouple EMF occurs due to the temperature difference between the measured temperature junction and the reference junction, and therefore the temperature change at the reference junction becomes the indicated error on the meter.

In order to avoid such error, the reference junction needs to be extended to the position where the temperature will not comparatively change, for which the extension is used. The extension wires differ with kinds of the thermocouple wire, and each wire is made of material having the thermal EMF characteristics approximate to respective thermocouple. And, this is produced in conformity with Japan Industrial Standards.



Thermocouple characteristic curb

SELECTION OF WIRE DIAMETER

Under normal conditions, the life of K(CA) is affected depending upon the ratio of a sectional area to the depth of skin contaminated due to its use. In other words, the skin contamination is all the same irrespective of wire diameter, and therefore the thinner the wire diameter is, the higher the contamination ratio becomes.

The quality degradation of the wire begins at its skin irrspective of whether the degradation is caused by oxidation, corrosion or evaporation, and therefore, thick wires are more resistant to high temperature than thin ones.

PROTECTION OF K THERMOCOUPLE

According to the research report (RP No.1278) by the American Bureau of Standards, an error of approximately 3°F (about 1.7°C) only is recognizable with the K thermocouple wire of 3.2ϕ in the clarified oxide gas even after it has been utilized at 1600°F (about 860°C) for 1000 hours. Moreover, for the K thermocouple wire of 0.65ϕ, an error is approximately 3°F (about 1.7°C) after its use for 100 hours and approximately 7°F after its use at 1600°F for 1000 hours, respectively.

However, any kind of thermocouple wire is indefinitely damaged if it is used in the over-corrosion gas. With the K, it is generally corroded by sulphur, particularly such as that occurrs in the reducing gases like H_2S gas. This will corrode either Cromel and Alumel, particularly crushing the Alumel rapidly by penetrating into its local parts. Additionally, oxidative gas (either oxidises Chrominum or Aluminum, or reduces Nickel) also corrodes the K, and exceptionally the corrosion of Chromel by the gas is extremely noticeable and it enlarges the error (–), lowering its EMF. Almost all the premature trouble of K thermocouple owes to the contamination and corrosion of the K element wires, which are caused by uncontrollable gas within the furnace, breakage of protection tubes, inadequate installation, and other related causes.

- **Corrosion due to Sulfur**

  Sulfur is particularly poisonous to High Nickel alloy like Alumel, and the sulfur can occur in oil, dust, mortar and cement for the furnace, and asbestos while the heat treatment is done.

  Erosion of the K thermocouple by sulfur occurs in a state that Alumel line is destructed; the Alumel line normally having ductility appears to be easily broken, and there is much possibility of the occurrence of erosion by sulfur if cracks occur on the surface of the Alumel line when bended with fingers.

  When a sample of the material is dipped in the rare hydrochloric acid solution containing two or three pieces of metallic zinc, if it emits a peculiar odor of hydrogen sulfide like that emitted by rotten eggs, the material can be determined to include sulfur content. This is a simple method of testing a doubtful material to know whether it contains sulfur or not.

  Another method is holding moist lead sugar paper over the test solution. If the Alumel line contains the sulfur content, the lead sugar paper turns black.

- **Green-Rot Corrosion**

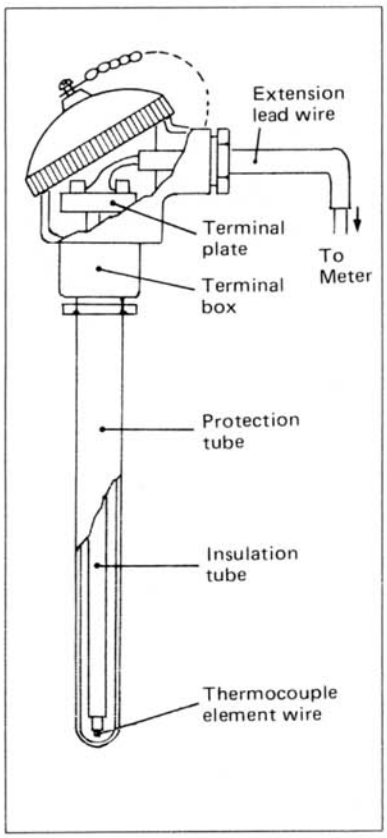
  When the NiCr alloy corrodes, green colored scales are often seen on it. Thus, it is named Green-Rot Corrosion. The appearance of the scales is partly due to reducing gas. The corrosion occurs due to the leakage of such corrosive gas within the furnace into a protection tube wall, or the diffusion of various protecting gas through the protection tube when they are utilized. It is characteristic of such a condition of contamination that affects Chromel far more greatly than Alumel. In case the Green-Rot Corrosion occurs, the Chromel of non-magnetism becomes magnetized, and even there is a case that spotted silver-colored skin is found to appear.

  Such corrosion does not result from the only reducing gas itself but occurs when a little amount of oxygen is obtainable from atmospheric gas or element wire itself. On this occasion, the EMF of Chromel line changes. This is because Chrominum conrtained in the alloy is first oxidized to allow metallic nickel skin to remain. The effect upon the K thermocouple is a decrease in the EMF of Chromel line.

THERMOCOUPLES

MODEL TC-E

TERMINAL BOX TYPE					TERMINAL OPEN TYPE				
	A	B	C	D		A	B	C	D
LARGE	88	83	51	Ps 1/2	LARGE	70	18	50	Ps 1/2
SMALL	65	62	35	Ps 1/4	SMALL	44	10	38	Ps 1/4



KINDS OF THERMOCOUPLE	ELEMENT DIA. mm	OPERATING TEMP. °C	MAX. TEMP. °C
Platinum · Rhodium 30% — Platinum · Rhodium 6% (B)	0.50	1500	1700
Platinum · Rhodium 13% — Platinum (R)	0.50	1400	1600
Platinum · Rhodium 10% — Platinum (S)			
Chromel — Alumel (K)	0.65	650	850
	1.00	750	950
	1.60	850	1050
	2.30	900	1100
	3.20	1000	1200
Chromel — Constantan (E)	0.60	450	500
	1.00	500	550
	1.60	550	650
	2.30	600	750
	3.20	700	800
Iron — Constantan (J)	0.65	400	500
	1.00	450	550
	1.60	500	650
	2.30	550	750
	3.20	600	750
Copper — Constantan (T)	0.32	200	250
	0.65	200	250
	1.00	250	300
	1.60	300	350

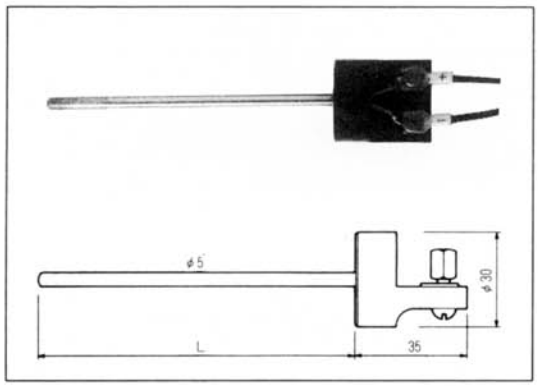
(Materials)	References for Selection of Protection Tubes according to Purposes for Usage (Consider the contents in this colum as reference)
SUS304 (There is a case that SUS316 etc. may be utilized according to a given condition).	Annealing furnace (750 to 950°C), Hardening furnace (approx. 750°C), Steel products heat treatment (900°C or less), Heating furnace waste gas (approx. 600°C), Blast furnace hot blast (approx. 500 to 850°C), Blast furnace to gas (approx. 500°C), Tin plating bath (approx. 300°C), Crude oil heating furnace outlet (400 to 500°C), Volatile oil (80 to 90°C), Acetic acid solvent (Approx. 95°C), Soda Corrosive potash (1000°C or less), Rayon viscose (5 to 35°C), Cement kiln secondary air, Food. Power generation vapor, Steam, Engine exhaust steam, Nitric acid, Fatty acid, Caustic acid, 10% or less (room temperature to boiling point), Gilding liquid (Ca, Ni, Cr, Cd,), Sodium chloride, Sodium sulfide, Sodium nitrate, others.
High chromium steel [NYBY2520(NU5) SANDVIK P4]	Iron foundry hot blast tube air (500 to 850°C), Steel products heat treatment (1100°C or less), Cementation furnace (800 to 950°C), Hardening furnace (75 to 1100°C), Solute bath (1000°C or less), Lead crucible (1000°C or less), Exhaust pipe (850°C), Zinc dissolution (600°C or less), Tin dissolution (250°C or less), Magnesium (700°C or less), Sulphur burner (500 to 700°C), Cement kiln combustion gas (300 to 1100°C), Glass industry checker air (1000°C or less), Zinc refining (350 to 500 °C), Ammonia (1000°C or less), Sulfurized hydrogen (540°C or less), Sulfur dioxide (1000°C or less).
SEH-5 (SUS3105)	Flue gas (750 to 1100°C), Nitric furnace (1150°C or less), Heating furnace combustion gas (1100°C or less), Sulphur burner (500 to 750°C), Cement kiln combustion gas (300 to 1100°C), Roasting furnace (350 to 1000°C).
Recrystallization	Pig iron making furnace regenerator (1000 to 1250°C), Alumina or high alumina open-hearth furnace checker chamber combustion gas (1200°C or less), Heating furnace combustion gas (1100°C or less), Sulphur (approx. 450°C), Continuous heating furnace, Hardening furnace, Annealing furnace.
Others	• SUS304 lead lining for acid cleaning bath • For fused aluminum, there are nitric refractories, cast iron, SS-41, and SUS304 with merits and demerits. • Hot dip temperature measurement by means of immersion thermocouple is most adequate for hot pig iron, molten steel, fused aluminum, fused metal (copper, brass), fused glass, etc.

METALLIC PROTECTION TUBES

Names	Outer dimension mm	Components	Limits for ordinary uses	Characteristics
STP-38	5~22	General steel pipe	600℃	Cheap and high mechanical intensity
SUS-304		18%Cr- 8%Ni	850℃	Acid resistance · excellent heat resistance
SUS-316		17%Cr-13%Ni	850℃	Heat resistance · Acid resistance · Alkali resistance · Corrosion resistance at high temperature
SANDVIK P4	22	27%Cr	1100℃	High chrome steel resistible even to reducing flame containing heat proof sulfur
INCONEL	22	72%Ni 16%Cr	1100℃	Heat resistance · resistible to reducing flame
KANTHAL Al	22	24%Cr 5.5%Al	1100℃	Heat resistance, excellent at corrosion of sulfide
TITANIUM	22	99.7%Ti	480℃	Highly resistible to chlorine, nitric acid, acetic acid hydrochloric acid, salt water, etc.
TEFLON COATING		Teflon-coated STP-38	200℃	High chemical resistance at low temperature
GLASS COATING		Glass-coated SS-41	350℃	High chemical resistance

NON-METALLIC PROTECTION TUBES

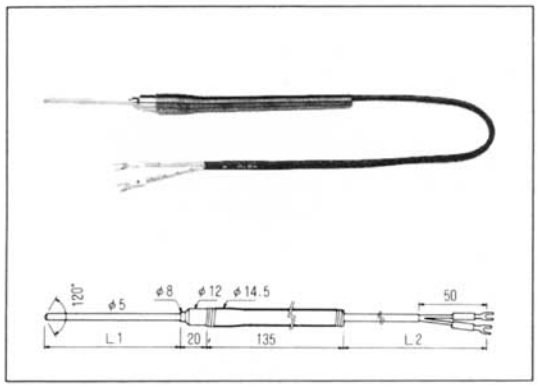
Names	Outer dimension mm	Limit for ordinary uses	Characteristics
High alumina ceramic tube	6~25	1500℃	Al_2O_3 5.8%, rest SIO_2 This consists mostly of mullite and corundum crystal, being airtight, and highly resistive to heat but inferior in quick heating or quenching
Alumina ceramic tube		1400℃	Al_2O_3 51%, rest SIO_2 Mullite airtight, high heat resistance, but inferior in quick heating and quenching
Corrosion resistive ceramic tube CORUNDID C		1400℃	Al_2O_3 Amalgamated body of airtight corundum crystal, particularly highly resistive to slag, and extremely resistive to chemical corrosion
Quartz	7~17	1000℃	Resistible to quick heating, quenching and acid, but not to alkali. Poor airtight to hydrogen reduction air
Silicon carbide NEOFLUX RAREFLUX	40~50	Neo 1450℃ Rare 1600℃	Durable to quick heating or quenching. High durability to oxidation NEOFLUX 86 to 90% SIC RAREFLUX 73.30% SIC RAREFLUX is strong against fused Aluminum.



MODEL PC-A

Standard Spec.

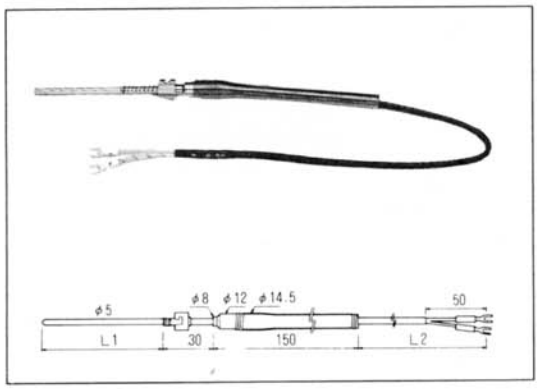
Wire Dia.	φ0.65㎜ K, J
Protection tube materials	Brass · SUS−304
Protection tube Dia.	φ5㎜
Heat sensor part	65㎜, 100㎜ (grounded)
Maximum operating temperature	650℃



MODEL PC-B

Standard Spec.

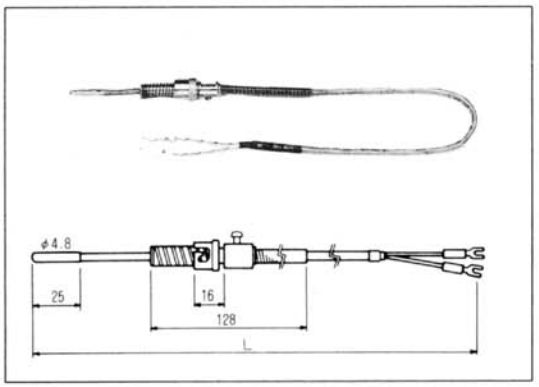
Wire Dia.	φ0.65㎜ K, J
Protection tube materials	Brass · SUS−304
Protection tube Dia.	φ5㎜
Heat sensor part	65㎜, 100㎜
Maximum operating temperature	650℃



MODEL PC-SB (with lock nuts)

Standard Spec.

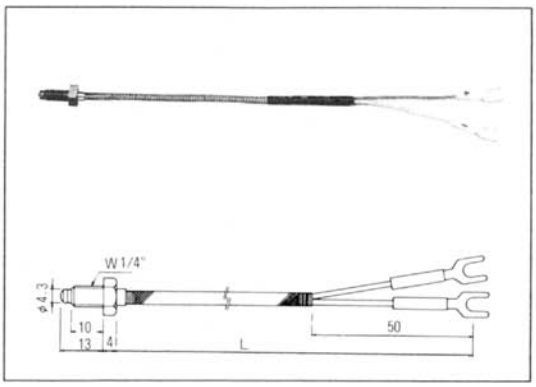
Wire Dia.	φ0.65㎜ K, J
Protection tube materials	Brass · SUS−304
Protection tube Dia.	φ5㎜
Heat sensor part	35㎜, 65㎜, 100㎜
Maximum operating temperature	650℃



MODEL PC-SG

Standard Spec.

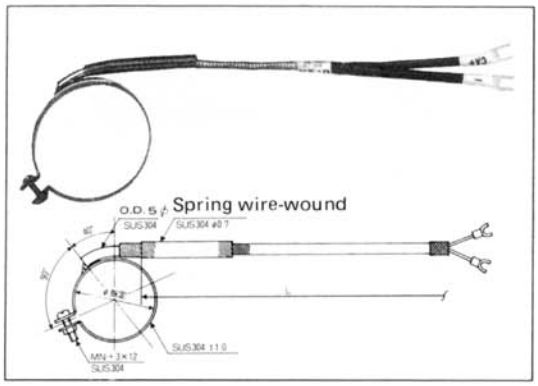
Wire Dia.	φ0.65㎜ K
Protection tube materials	SUS−304
Protection tube Dia.	φ4.8㎜
Heat sensor part	25㎜
Maximum operating temperature	500℃



MODEL PS-C

Standard Spec.

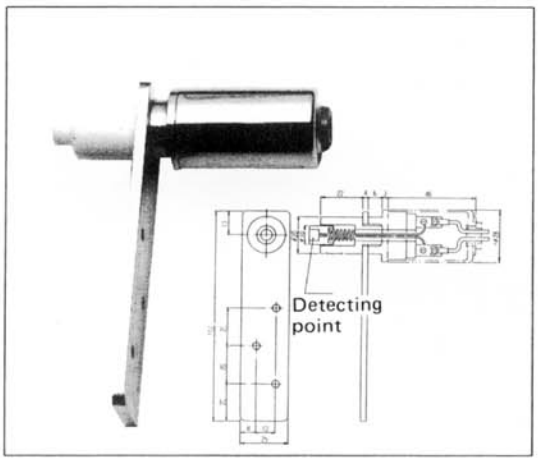
Wire Dia.	φ0.65㎜ K, J
Braided copper	1000㎜
Remarks	with 1/4″ screw (or with M6 screw, SUS−304)
Maximum operating temperature	450℃



MODEL PC-RTN (BAND TYPE)

Standard Spec.

Wire Dia.	φ0.65㎜ K
Band materials	SUS−304
Band Dia.	20～ Various sizes
Maximum operating temperature	300℃

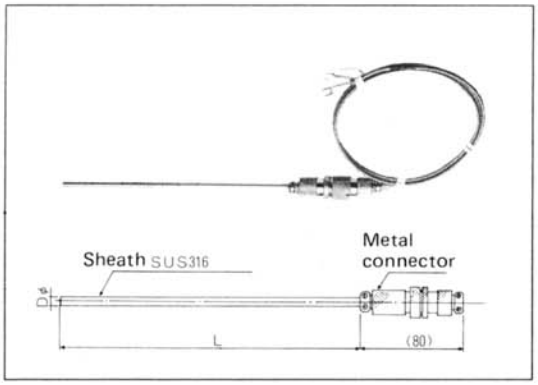


MODEL PC-IR

(FOR MEASUREMENT OF ROLLING SURFACE TEMP.)

Standard Spec.

Wire Dia.	φ0.32㎜ K, J
End tip materials	Brass, teflon (Replaceable)
Maximum operating temperature	250℃

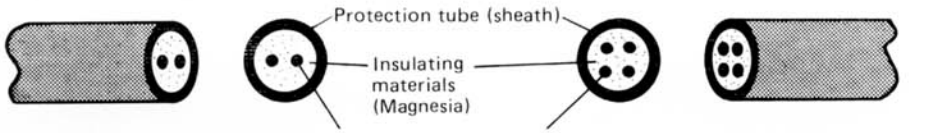


MODEL PC-SK

Standard Spec.

Wire Dia.	φ0.65㎜ K, J
Protection tube Dia.	φ1.0～8.0㎜
Protection tube materials	SUS−316, INCONEL
Heat sensor part	65, 100, 200, 500㎜

SHEATH TYPE THERMOCOUPLES



(Round 2-bore type) (Round 4-bore type)

CHARACTERISTICS OF OUR SHEATH

(1) Although the sheath type thermocouple has a thin outer diameter, its airtightness is high enough to prevent the thermocouple from being corroded by metallic gas or atmospheric gas of the sheath and thus its durability is long.

(2) As it is processed with bright annealing, it is so elastic that it can be manually bended with easiness to the extent of a circle three times as large as its diameter, and yet there is no fear of wire being broken. In addition, it is possible to perform seal welding as it is because of no oxidation coating on the sheath.

(3) It can not only resist either high temperature and high pressure but can very quickly respond to the temperature change.

MAIN APPLICATION OF SHEATH THERMOCOUPLES

The application of the sheath thermocouple is now diversified to a wide variety, and it is possible to replace all of the thermocouple of conventional type with the sheath thermocouples. Some examples of its practical applications making the use of its characteristics are described below:

IRON AND STEEL: Imbedding the sheath thermocouple into the wall and the hearth of making steel furnaces, or heat treatment furnace makes it possible to know its temperature for the maintenance of the furnace in safety, and to measure the temperatures distributed in the furnace. By putting the sheath thermocouple directly to contact with a heated object, the temperature of a heated object can be measured. A variety of the sheath thermocouples in the range of 1.6mmϕ to 6.4mmϕ are used for different temperatures and spaces for installing them, while a size with 3.2mmϕ is mostly used.

CHEMICALS: For the measurement of temperature distributions of gas, liquid and a reaction tower, the sheath thermocouples with 1.0mmϕ, 1.6mmϕ or 3.2mmϕ, which differ to one another in length, are picked up and arranged in several pairs for use.

ELECTRIC POWER: The measurement of a temperature of water, vapor, or of the boiler pipe wall. It can resist even a high pressure of 500kg/cm^2. Available for the measurement of temperatures of a reactor, a misile, a rocket engine, a diesel engine, wind tunnel, kiln, fused glass, salt bath, single crystal refining of semiconductor, synthetic resin forming and a variety in every field.

KINDS OF SHEATH THERMOCOUPLES

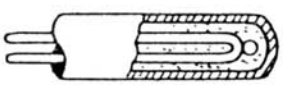
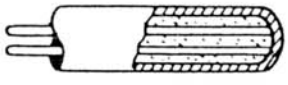
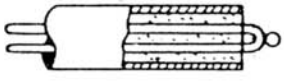
(1) K Thermocouple: (Chromel-Alumel) This is used to the measure temperatures up to 1100°C or thereabout. As compared with the R thermocouple, this is economically priced, has high thermal EMF, and is industrially widely used.

(2) E Thermocouple: (Chromel-Constantan) This has higher thermal EMF than K and J type by approx. 50% and 20% respectively. This is now the most recommendable to measure the temperatures of 300 to 800°C.

(3) J Thermocouple: (Iron-Constantan) This is used to the measure working temperatures of 600°C or less. As this has high sensitivity, this is also well enjoyed following after K type.

(4) T Thermocouple: (Copper-Constantan) Used to measure the temperature of 300°C or less,this has a little higher sensitivity than that of K type, and is a little inferior to J type, and widely used to measure the comparative low temperature because of its high accuracy and low electric resistance.

Ⓥ HOT JUNCTION

Type U (Ungrounded)		This junction is completely welded with inert gas in an insulated substance of high density, has high corrosion resistibility, and can maintain its life for long even if it is used at a place where there is high pressure or a large physical shocks.
Type G (Grounded)		The hot junction is cemented at hot end of the sheath. While this type is used in many fields and particularly in the electrical field, the use in the extreme high temperature or the corrosive air is not recommendable.
Type E (Exposed)		As its hot junction is extruded, it will respond most quickly, but it is not recommended for use under conditions of corrosion.

EXTENSION LEADWIRE FOR SHEATHED

Structure of twisted wires	Insulation and Jacket Materials ,	Application
7/0.3×2 (0.5□)	Glass Yarn Braid, with Stainless wire Outer Shield	For Heat-resistant (150℃)
7/0.3×2 (〃)	Glass Yarn Braid	
7/0.3×2 (〃)	Heat-resistant PVC Copper wire Inner Shield	For general use (90℃)
7/0.3×2 (〃)	Heat-resistant PVC	
20/0.18×2(〃)	Silicone rubber	For Heat & water resistant (150℃)

MAX. AVAILABLE LENGTH FOR HOT JUNCTION ON SHEATHED THERMO-COUPLE

Sheath O.D.		1.0φ	1.6φ	3.2φ	4.8φ	6.4φ	8.0φ
MAX. AVAILABLE LENGTH	TYPE G	50	50	50	50	45	25
	TYPE U	10	20	30	30	30	25

KINDS OF ELEMENT WIRE · SHEATHED MATERIALS · OPERATING TEMP. LIMIT FOR VARIOUS SIZES OF SHEATHED O.D.

Kinds of Element wire	Sheath Material (Name of symbol) \ Sheath O.D.	0.25	0.5	1.0	1.6	3.2	4.8	6.4	8.0
K	SUS316 (C)			500℃	800℃	800℃	800℃	900℃	900℃
	SUS347 (D)			500℃	800℃	800℃	800℃	900℃	900℃
	SUS310S (B)			500℃	800℃	900℃	1000℃	1000℃	1150℃
	INCONEL (F)	500℃	500℃	500℃	800℃	900℃	1000℃	1100℃	1150℃
	HASTELLOY.X (H)					900℃	1000℃	1100℃	1100℃
E	SUS347 (D)			400℃	450℃	500℃	600℃	600℃	650℃
J	SUS316 (C)			400℃	400℃	450℃	500℃	600℃	600℃
	SUS347 (D)			400℃	400℃	450℃	500℃	600℃	600℃
T	SUS316 (C)			200℃	200℃	200℃	200℃	320℃	320℃
R	SUS310S (B)				800℃	900℃	1000℃		
	INCONEL (F)				800℃	900℃	1000℃		
	Platinum.Rhodium10% (P)				1400℃	1400℃	1400℃		

NOTE) Please note that operating temp. limit differs from operating and atmospheric conditions. Using thermocouples around operating temp. limit causes their faster contamination, and so the time of usage should be minimized.

RESISTANCE BULBS

Metallic electrical resistance generally varies with temperature changes, and there is a constant relation between the electrical resistance and the temperature. An instrument to measure the electrical resistance by making the use of this constant relation for the measurement of temperature is a resistant thermometer, of which an instrument using the resistance changes by the temperature of platinum wire is a platinum resistance thermometer, and the heat sensing part is called a Resistance Temperature Detector (RTD) element. We adopt platinum wire of very high purity level as a resistant element for our RTD, and it is used to measure the temperature of approximately −200 to 500°C.

The electrical resistance value of platinum wire changes susceptibly to the temperature changes, and this electrical resistance is in a very accurate relation with the temperature. There are two kinds of the resistance element of values, 100Ω and 50Ω either at 0°C, the specified current values are 2mA and 5mA, and there are 2-wire and 3-wire connection types for measuring methods.

CONSTRUCTION

The RTD consists of a RTD element winding platinum wire around a ceramic or a mica plate, an insulation tube preventing the short circuit of an inner leadwire, a protection tube preventing objects whose temperature to be measured and the internal sections from gas, and a terminal box connecting leadwire extended from an instrument, etc.

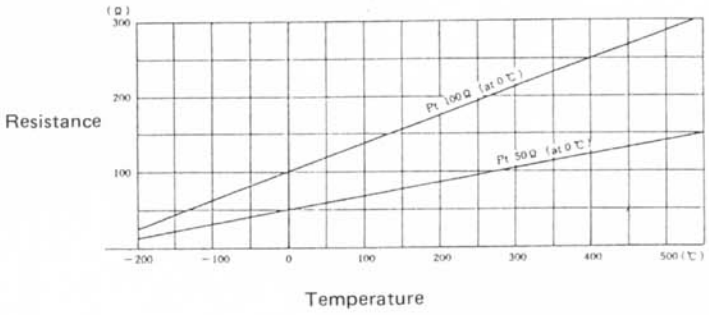
A RTD element consists of a ceramic or mica plate wound with pure platinum wire of 0.03 to 0.05mm, its both ends connected to leadwire via electric welding, and thin and hard glass tube which a resistance value at 0°C adjusted to within the JIS is sealed into. When a protection tube is compared with that for thermocouple, the working temperature for the protection tube is low, therefore corrosion resistance suggests a problem rather than heat resistance, and materials such as stainless, brass tube and hard glass are used for that.

Resistance Tolerance at 0°C

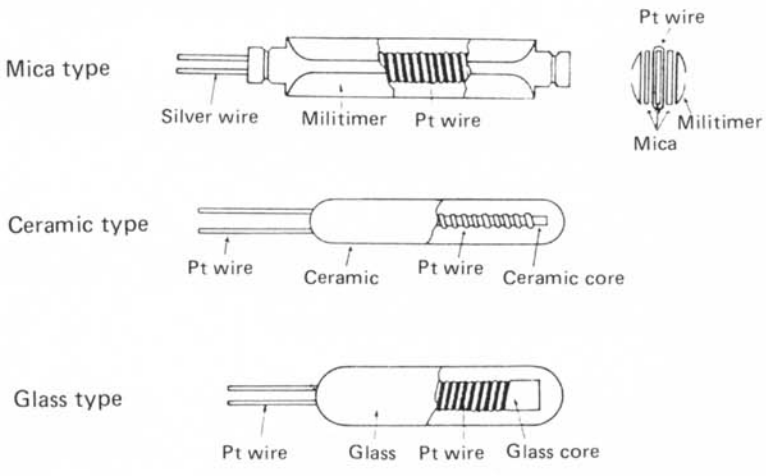
Nominal Resistance	Class	Tolerance Ω
100Ω	0.15	±0.06
	0.2	±0.06
	0.5	±0.12
(50Ω)	0.15	±0.03
	0.2	±0.03
	0.5	±0.06

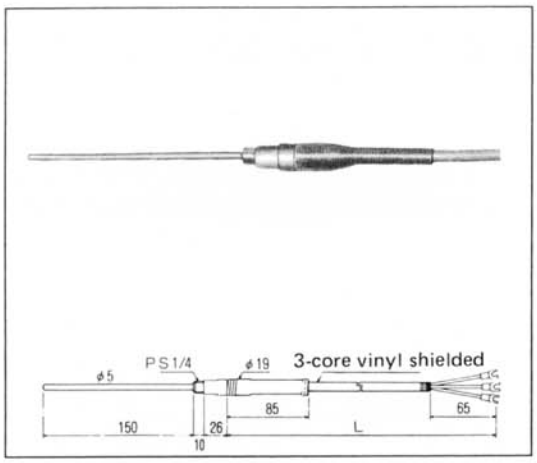
Nominal Resistance	Measuring temperature (°C)	Temperature tolerance (°C)		
		Class 0.15	Class 0.2	Class 0.5
100Ω	−200	±0.45	±0.55	±1.3
	−100	±0.30	±0.35	±0.8
	0	±0.15	±0.15	±0.3
	100	±0.30	±0.35	±0.8
	200	±0.45	±0.55	±1.3
	300	±0.60	±0.75	±1.8
	350	±0.68	±0.85	±2.05
	400		±0.95	±2.3
	500		±1.15	±2.8
(50Ω)	−200	±0.45	±0.55	±1.3
	−100	±0.30	±0.35	±0.8
	0	±0.15	±0.15	±0.3
	100	±0.30	±0.35	±0.8
	200	±0.45	±0.55	±1.3
	300	±0.60	±0.75	±1.8
	350	±0.68	±0.85	±2.05
	400		±0.95	±2.3
	500		±1.15	±2.8

Temperature Characteristics of RTD



Construction of RTD Element

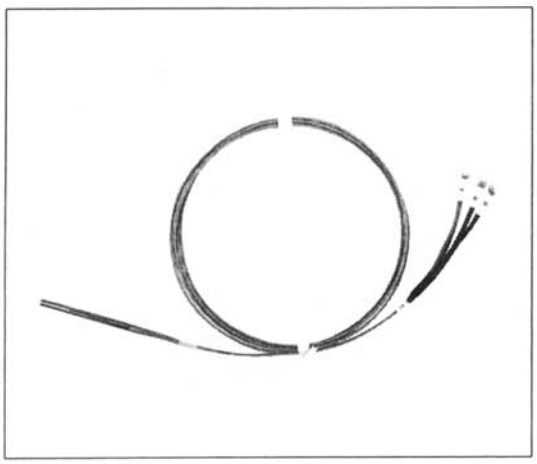




MODEL SP-RB

Standard Spec.

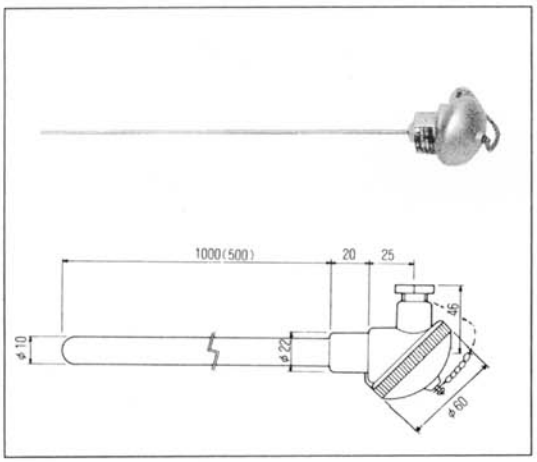
Protection tube materials	Brass
Protection tube diameter	φ5㎜
Heat sensor part	150㎜ Pt 100 (50)
Remarks	3-cores vinyl coating (with PS1/4 screw)
Range	−200～300℃



MODEL NR-100-P

Standard Spec.

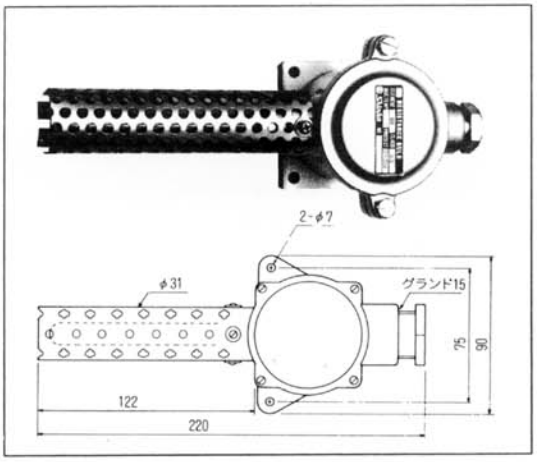
Protection tube materials	Stainless
Protection tube diameter	φ5㎜
Heat sensor part	60㎜ Pt 100
Remarks	3-cores Glass coating
Range	−200～300℃



MODEL TC-R

Standard Spec.

Protection tube materials	Brass		SUS−304		SUS−304
Protection tube diameter	φ10㎜		φ10㎜		φ10㎜
Heat sensor part	Pt 100	Pt 50	Pt 100	Pt 50	Pt 100	Pt 50
	500㎜		500㎜		500㎜	
	1000㎜		1000㎜		1000㎜	
Remarks	Enclosed type for factory				Enclosed type for vessels	
Range	−200～500℃		−200～500℃		−200～500℃	



MODEL TC-RR

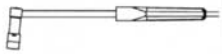
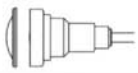
Standard Spec.

Protection tube materials	SUS−304
Protection tube diameter	φ13.2㎜ (cover φ31×120㎜)
Heat sensor part	94㎜ Pt 100 (50)
Remarks	indoor

Miscellaneous Sensors for DFT Series

(Refer to Catalog for DFT Series of Temperature Indicators)

Thermocouple (K)

Model	Drawing	Main objects	Max.
PCE-701		For measuring general surface temperature	400℃
PCE-702		For measuring surface temperature of rolls	400℃
PCE-704		For measuring temperature of liquid and interior	400℃
PCE-706		For measuring temperature of liquid and interior	400℃
PCE-707		For measuring static surface temperature	400℃
PCE-707L		For measuring static surface temperature	400℃
PCE-H7		Designated tip for PCE-707, 707L (for exchange)	400℃
PCE-709		For measuring temperature of liquid and interior (for direct mounting to the DFT-700-M)	400℃
PCE-700-M		For measuring static surface temperature (Magnet type)	300℃

RTD (Pt100)

Model	Drawing	Main objects	Max.
PCR-701		For measuring temperature of liquid and interior	400℃

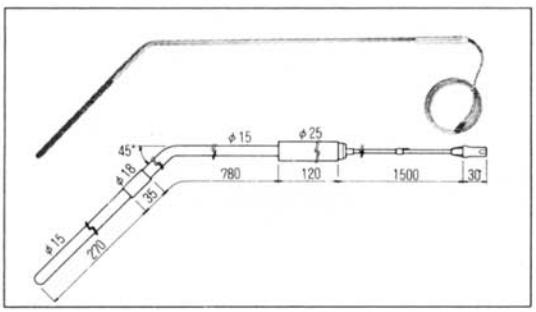
Thermo-hygro sensor

Model	Drawing	Range
THD-700-P		Temperature: 0 to 50℃ Humidity: 20 to 90.0%RH

Conversion plug

Model	Drawing	Note
PCE-CP7		Temperature sensor for DFT-600 (K thermocouple) can be used.

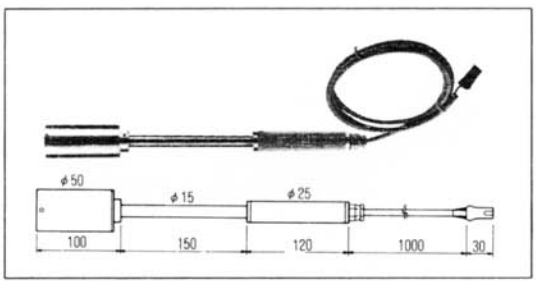
The connector for the sensors above (PCE-701, -702, -704, -706, -707, -707L, -709, -700-M, PCR-701 and THD-700P) is [HR-30-6P-6S] made by Hirose Electric CO., LTD.



MODEL ECD-C

Standard Spec.

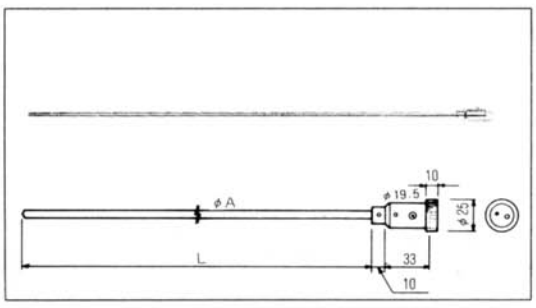
Wire Dia.	φ0.91㎜ K
Protection tube materials	SUS−304
Protection tube dimensions	φ15×815㎜
Heat sensing part	φ4.8㎜(Sheath)×300㎜, φ15×300㎜ Carbon Head
Remarks	For measuring temperature of molten metal
Maximum operating temperature	900℃



MODEL ECH HOLDER

Standard Spec.

Wire Dia.	With extension lead wire φ0.65㎜ K
Protection tube materials	SUS−304
Protection tube dimensions	φ15×370㎜
Heat sensing part	□SK
Remarks	Exclusive use for SK thermocouple



MODEL SK (Exclusive use for ECH holder)

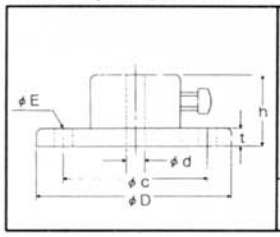
Standard Spec.

SK	Wire Dia.	Protection tube materials	Protection tube dimensions	Remarks	Max.operating temp.
1SK	φ0.20㎜ K	SUS−316	φ1.0×500㎜	For general use and measuring furnace temperature	400℃
2SK	φ0.32㎜ K		φ1.6×500㎜		600℃
3SK	φ0.64㎜ K		φ3.2×500㎜		800℃
4SK	φ0.91㎜ K		φ4.8×750㎜		900℃
6SK	φ1.30㎜ K		φ6.4×1000㎜		1000℃

FITTINGS

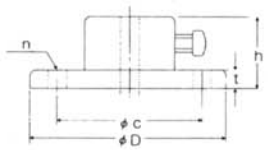
FLANGES

Movable flange (Ordinary steel)



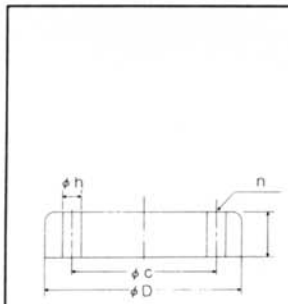
Applicable tube Dia. φd	Flange Dia. φD	Dimensions of each flange part t	Dimensions of each flange part h	Hole for bolt Center circle Dia. φc	Hole for bolt n Number	Hole for bolt φE Dia.
3.2~φ12	50	5	20	38	4	5.4

JIS Standards Movable flange (Ordinary steel)



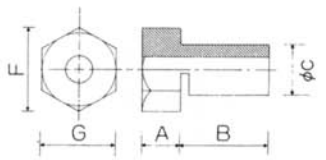
	Nominal Dia. of gas pipe (B)	φD	Dim. of each flange part t	Dim. of each flange part h	Hole for bolt φc	Hole for bolt φh	Hole for bolt n
5kg/cm² Flange	3/8″	75	9	34	55	11	4
	1/2″	80	9	34	60	11	4
	3/4″	85	10	35	65	11	4
	1″	95	10	35	75	11	4
10kg/cm² Flange	3/8″	90	12	33	65	14	4
	1/2″	95	12	33	70	14	4
	3/4″	100	14	31	75	14	4
	1″	125	14	31	90	18	4

JIS Standards Fixed flange



	Nominal Dia. of gas pipe (B)	φD	Thick-ness t	Hole for bolt φc	Hole for bolt φh	Hole for bolt n
5kg/cm² Flange	3/8″	75	9	55	11	4
	1/2″	80	9	60	11	4
	3/4″	85	10	65	11	4
	1″	95	10	75	11	4
10kg/cm² Flange	3/8″	90	12	65	14	4
	1/2″	95	12	70	14	4
	3/4″	100	14	75	14	4
	1″	125	14	90	18	4

Bushing (Movable · Fixed) (SUS-304)

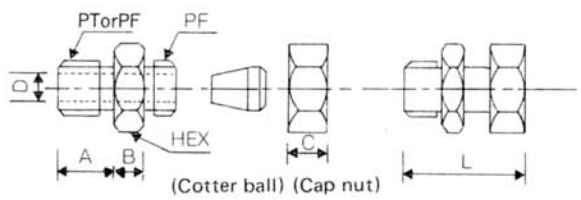


Nominal Dia. (B)	Applicable protection tube Dia. φd	Screw dimensions Outer Dia. C	Screw dimensions Minor Dia.	Number of threads per inch (25.4mm)	Dimensions of heads G	Dimensions of heads F	A	B
PF·PT 1/8″	6 or less	9.7	8.56	28	14	16.2	6	10
PF·PT 1/4″	8 or less	13.1	11.4	19	17	19.6	8	13
PF·PT 3/8″	10or less	16.6	14.9	19	21	24.2	10	15
PF·PT 1/2″	12or less	20.9	18.6	14	26	30	12	20
PF·PT 3/4″	16or less	26.4	24.1	14	32	37	16	20
PF·PT 1″	22or less	33.2	30.2	11	41	47.3	20	30

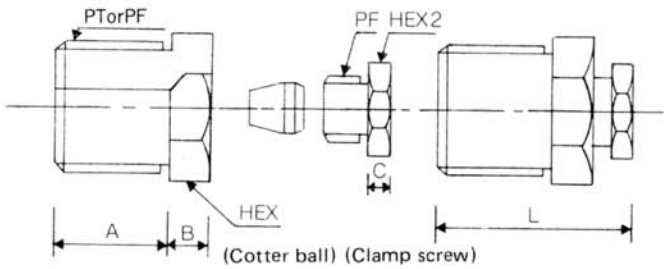
COMPRESSION FITTINGS (CF)

Passing the protection tube through its main body, cotter ball and cap nut (or clamp screw), and tightening the cap nut (or clamp screw) cause the cotter ball to press against the protection tube to fix it and the CF body.

Screw Dia.1/8″, 1/4″, 3/8″



Screw Dia.1/2″, 3/4″



※ Unit: mm except for screw Dia. PF.

Screw Dia.	HEX	A	B	PF	HEX 2	C	L	D (Applicable protection tube Dia.)
1/8″	14	10	6	1/8″	—	12	33	φ1.6, φ2.3, φ3.2
1/4″	17	13	8	1/4″	—	14	41	φ3.2, φ4.8, φ5
3/8″	19	15	8	1/4″	—	14	43	φ6, φ6.4, φ8
1/2″	24	20	10	3/8″	19	8	46	φ8, φ10, φ12
3/4″	29	20	15	1/2″	24	9	54	φ12, φ15, φ16

EXTENSION WIRE

Classifications		New JIS Code	Old JIS Code	Core wire construction (mm)		Core wire coating			Outer packaging		Finished outside shape (mm)	Operating temperature range (°C)	Code No.
				+ side	– side	Materials	Colors		Materials	Colors			
							+	–					
B		BX-G	–	Copper 0.65 x 7	Copper 0.65 x 7	Vinyl	Red	Wht.	Cotton braided	Gry.	–	–	–
R		RX-G	–	Copper 0.65 x 7	Copper alloy 0.65 x 7	Vinyl	Red	Wht.	Vinyl	Blk.	5 x 8	–	SW-9
		RX-H	–			Glass wool braided			Glass wool braided		4 x 6.5	–	SW-4
S		SX-H	–	Copper 0.65 x 7	Copper alloy 0.65 x 7	Glass wool braided	Red	Wht.	Glass wool braided	Blk.	–	–	SW-4
K	Standard	VX-G	WCA-G	Copper 0.65 x 7	Constantan 0.65 x 7	Vinyl	Red	Wht.	Vinyl	Ble.	5 x 8	–	SW-6
		WX-H	WCA-H	Iron 0.65 x 7		Glass wool braided			Glass wool braided		4 x 6.5	–	SW-1
		VX-G	WCA-G	Copper 0.65 x 7	Constantan 0.3 x 7	Vinyl			Vinyl		3 x 4.9	–	SV-6
		WX-H	WCA-H	Iron 0.3 x 7		Glass wool braided			Glass wool braided		2.4 x 4	–20 ~ 150	SV-1
									Stainless braided		2.8 x 4.5		SSO-11
	Special	KX-GS	WCA-GS	Chromel 0.65 x 7	Alumel 0.65 x 7	Vinyl			Vinyl		5 x 8	–20 ~ 90	SSG-06
		KX-HS	WCA-HS			Glass wool braided			Glass wool braided		4 x 6.5	–20 ~ 150	SSC-06
J		JX-G	WIC-G	Iron 0.65 x 7	Constantan 0.65 x 7	Vinyl	Red	Wht.	Vinyl	Ylw.	5 x 8	–20 ~ 90	SW-7
						Glass wool braided			Glass wool braided		4 x 6.5	–20 ~ 150	SW-2
		JX-H	WIC-H	Iron 0.3 x 7	Constantan 0.3 x 7	Vinyl			Vinyl		3 x 4.9	–20 ~ 90	SV-7
						Glass wool braided			Glass wool braided		2.4 x 4	–20 ~ 150	SV-2
									Stainless braided		2.8 x 4.5		SSO-12
E		EX-G	WCRC-G	Chromel 0.65 x 7	Constantan 0.65 x 7	Vinyl	Red	Wht.	Vinyl	Vlt.	5 x 8	–20 ~ 90	SW-10
						Glass wool braided			Glass wool braided		4 x 6.5	–20 ~ 150	SW-5
		EX-H	WCRC-H	Chromel 0.3 x 7	Constantan 0.3 x 7	Vinyl			Vinyl		3 x 4.9	–20 ~ 90	SV-10
						Glass wool braided			Glass wool braided		2.4 x 4	–20 ~ 150	SV-5
									Stainless braided		2.8 x 4.5		SSO-15
T		TX-G	WCC-G	Copper 0.65 x 7	Constantan 0.65 x 7	Vinyl	Red	Wht.	Vinyl	Brn.	5 x 8	–20 ~ 90	SW-8
		TX-H	WCC-H	Copper 0.3 x 7	Constantan 0.3 x 7	Vinyl			Vinyl		3 x 4.9		SV-8
						Glass wool braided			Glass wool braided		2.4 x 4	–20 ~ 150	SV-3
									Stainless braided		2.8 x 4.5		SSO-13

Extraction from JIS

THERMOCOUPLE

1) KINDS, AND MATERIALS FOR CONSTRUCTION

Type	Old Code (for ref.)	Materials for construction	
		+ leg	− leg
B	——	Platinum rhodium alloy including 30% of rhodium	Platinum rhodium alloy including 6 % of rhodium
R		Platinum rhodium alloy including 13% of rhodium	Platinum
S		Platinum rhodium alloy including 10% of rhodium	Platinum
K	CA	Alloy comprising nickel and chrome as main contents	Alloy comprising nickel as main contents
E	CRC	Alloy comprising nickel and chrome as main contents	Alloy comprising copper and nickel as main contents
J	IC	Iron	Alloy comprising copper and nickel as main contents
T	CC	Copper	Alloy comprising copper and nickel as main contents

Note) The + leg denotes the pin to be connected to the plus terminal of an instrument measuring thermal EMF and a leg on the opposite side is called − leg.
PR according to the old JIS, which has a different content of Rhodium that is the constituent parts of the + leg, does not correspond to R.

2) Working Limits of Bare Thermocouple

Types of constituent materials	Old Code (for ref.)	Element wire Dia. mm	Operating temp. limits °C	Max. operating limits °C
B	——	0.50	1500	1700
R	——	0.50	1400	1600
S				
K	CA	0.65	650	850
		1.00	750	950
		1.60	850	1050
		2.30	900	1100
		3.20	1000	1200
E	CRC	0.65	450	500
		1.00	500	550
		1.60	550	650
		2.30	600	750
		3.20	700	800
J	IC	0.65	400	500
		1.00	450	550
		1.60	500	650
		2.30	550	750
		3.20	600	750
T	CC	0.32	200	250
		0.65	200	250
		1.00	250	300
		1.60	300	350

Notes) ① Operating temperature limit means the upper temp. where thermocouple can be used continuously in air.
② Maximum limit means the upper temp. where thermocouple can be used temporarily owing to inevitable circumstances.

RTD

1) R_{100}/R_0 value of Nominal Resistance Element

Code	R_{100}/R_0 value
Pt100	1.385 0
(JPt100)	(1.391 6)

1. R_{100} : Resistance value of resistance element at 100 °C.
2. R_0 : Resistance value of resistance element at 0 °C.
( ) : JIS1604-1989, it will be abolished in the future.

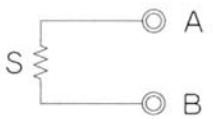
2) Specified Current

The specified current must be one of the following currents. However, 5mA is not applied to class A.

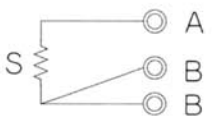
1mA, 2mA or 5mA

3) Connecting method of Internal Lead Wire

1. For a type of 2-wire connection, a piece of wire is connected to either end of the RTD element.
2. For a type of 3-wire connection, two pieces of lead wire and a piece of lead wire are connected to one end of the RTD element and another end of that respectively, thereby, being in a form that will remove the effect by the lead resistance.



[Fig. 1]



[Fig. 2]

◎ shows the terminal, S shows the RTD element and the line to connect between the terminal and RTD shows the internal lead wire.

4) Materials of Internal Lead Wire

The internal lead wire materials should be of good quality that local thermoelectromotive force generation, vapor, oxidation, etc. due to heating will not prevent the temperature measurement.

5) Insulation of Internal Lead Wire

Such an insulating tube, conductor coating materials or insulating materials as to have sufficient heat and cold resistances and insulation property against working temperature as well as not to contaminate internal lead wire need to be utilized for the insulation of the internal lead wire.

6) Resistance of Internal Lead Wire

The internal lead wire resistance must be 0.5 Ω /m or less per wire at room temperature with the exception of a protection tube of 4.5mm or less in outer diameter.

Standard Thermal EMF of K (JISC1602-1995)

Unit:μV

℃	0	−10	−20	−30	−40	−50	−60	−70	−80	−90	−100
−200	−5891	−6035	−6158	−6262	−6344	−6404	−6441	−6458			
−100	−3554	−3852	−4138	−4411	−4669	−4913	−5141	−5354	−5550	−5730	−5891
0	0	−392	−778	−1156	−1527	−1889	−2243	−2587	−2920	−3243	−3554
℃	0	10	20	30	40	50	60	70	80	90	100
0	0	397	798	1203	1612	2023	2436	2851	3267	3682	4096
100	4096	4509	4920	5328	5735	6138	6540	6941	7340	7739	8138
200	8138	8539	8940	9343	9747	10153	10561	10971	11382	11795	12209
300	12209	12624	13040	13457	13874	14293	14713	15133	15554	15975	16397
400	16307	16820	17243	17667	18091	18516	18941	19366	19792	20218	20644
500	20644	21071	21497	21924	22350	22776	23203	23629	24055	24480	24905
600	24905	25330	25755	26179	26602	27025	27447	27869	28289	28710	29129
700	29129	29548	29965	30382	30798	31213	31628	32041	32453	32865	33275
800	33275	33685	34093	34501	34908	35313	35718	36121	36524	36925	37326
900	37326	37725	38124	38522	38918	39314	39708	40101	40494	40885	41276
1000	41276	41665	42053	42440	42826	43211	43595	43978	44359	44740	45119
1100	45119	45497	45873	46249	46623	46995	47367	47737	48105	48473	48838
1200	48838	49202	49565	49926	50286	50644	51000	51355	51708	52060	52410
1300	52410	52759	53106	53451	53795	54138	54479	54819			

Standard Thermal EMF of E (JISC1602-1995)

Unit:μV

℃	0	−10	−20	−30	−40	−50	−60	−70	−80	−90	−100
−200	−8825	−9063	−9274	−9455	−9604	−9718	−9797	−9835			
−100	−5237	−5681	−6107	−6516	−6907	−7279	−7632	−7963	−8273	−8561	−8825
0	0	−582	−1152	−1709	−2255	−2787	−3306	−3811	−4302	−4777	−5237
℃	0	10	20	30	40	50	60	70	80	90	100
0	0	591	1192	1801	2420	3048	3685	4330	4985	5648	6319
100	6319	6998	7685	8379	9081	9789	10503	11224	11951	12684	13421
200	13421	14164	14912	15664	16420	17181	17945	18713	19484	20259	21036
300	21036	21817	22600	23386	24174	24964	25757	26552	27348	28146	28946
400	28946	29747	30550	31354	32159	32965	33772	34579	35387	36196	37005
500	37005	37815	38624	39434	40243	41053	41862	42671	43479	44286	45093
600	45093	45900	46705	47509	48313	49116	49917	50718	51517	52315	53112
700	53112	53908	54703	55497	56289	57080	57870	58659	59446	60232	61017
800	61017	61801	62583	63364	64144	64922	65698	66473	67246	68017	68787
900	68787	69554	70319	71082	71844	72603	73360	74115	74869	75621	76373
1000	76373										

Standard Thermal EMF of J (JISC1602-1995)

Unit:μV

℃	0	−10	−20	−30	−40	−50	−60	−70	−80	−90	−100
−200	−7890	−8095									
−100	−4633	−5037	−5426	−5801	−6159	−6500	−6821	−7123	−7403	−7659	−7890
0	0	−501	−995	−1482	−1961	−2431	−2893	−3344	−3786	−4215	−4633
℃	0	10	20	30	40	50	60	70	80	90	100
0	0	507	1019	1537	2059	2585	3116	3650	4187	4726	5269
100	5269	5814	6360	6909	7459	8010	8562	9115	9669	10224	10779
200	10779	11334	11889	12445	13000	13555	14110	14665	15219	15773	16327
300	16327	16881	17434	17986	18538	19090	19642	20194	20745	21297	21848
400	21848	22400	22952	23504	24057	24610	25164	25720	26276	26834	27393
500	27393	27953	28516	29080	29647	30216	30788	31362	31939	32519	33102
600	33102	33689	34279	34873	35470	36071	36675	37284	37896	38512	39132
700	39132	39755	40382	41012	41645	42281	42919	43559	44203	44848	45494
800	45494	46141	46786	47431	48074	48715	49353	49989	50622	51251	51877
900	51877	52500	53119	53735	54347	54956	55561	56164	56763	57630	57953
1000	57953	58545	59134	59721	60307	60890	61473	62054	62634	63214	63792
1100	63792	64370	64948	65525	66102	66679	67255	67831	68406	68980	69553
1200	69553										

Standard Thermal EMF of T (JISC1602-1995)

Unit:μV

℃	0	−10	−20	−30	−40	−50	−60	−70	−80	−90	−100
−200	−5603	−5753	−5888	−6007	−6105	−6180	−6232	−6258			
−100	−3379	−3657	−3923	−4177	−4419	−4648	−4865	−5070	−5261	−5439	−5603
0	0	−383	−757	−1121	−1475	−1819	−2153	−2476	−2788	−3089	−3379
℃	0	10	20	30	40	50	60	70	80	90	100
0	0	391	790	1196	1612	2036	2468	2909	3358	3814	4279
100	4279	4750	5228	5714	6206	6704	7209	7720	8237	8759	9288
200	9288	9822	10362	10907	11458	12013	12574	13139	13709	14283	14862
300	14862	15445	16032	16624	17219	17819	18422	19030	19641	20255	20872
400	20872										

Standard Thermal EMF of R (JISC1602-1995)

Unit:μV

℃	0	−10	−20	−30	−40	−50	−60	−70	−80	−90	−100
0	0	−51	−100	−145	−188	−226					
℃	0	10	20	30	40	50	60	70	80	90	100
0	0	54	111	171	232	296	363	431	501	573	647
100	647	723	800	879	959	1041	1124	1208	1294	1381	1469
200	1469	1558	1648	1739	1831	1923	2017	2112	2207	2304	2401
300	2401	2498	2597	2696	2796	2896	2997	3099	3201	3304	3408
400	3408	3512	3616	3721	3827	3933	4040	4147	4255	4363	4471
500	4471	4580	4690	4800	4910	5021	5133	5245	5357	5470	5583
600	5583	5697	5812	5926	6041	6157	6273	6390	6507	6625	6743
700	6743	6861	6980	7100	7220	7340	7461	7583	7705	7827	7950
800	7950	8073	8197	8321	8446	8571	8697	8823	8950	9077	9205
900	9205	9333	9461	9590	9720	9850	9980	10111	10242	10374	10506
1000	10506	10638	10771	10905	11039	11173	11307	11442	11578	11714	11850
1100	11850	11986	12123	12260	12397	12535	12673	12812	12950	13089	13228
1200	13228	13367	13507	13646	13786	13926	14066	14207	14347	14488	14629
1300	14629	14770	14911	15052	15193	15334	15475	15616	15758	15899	16040
1400	16040	16181	16323	16464	16605	16746	16887	17028	17169	17310	17451
1500	17451	17591	17732	17872	18012	18152	18292	18431	18571	18710	18849
1600	18849	18988	19126	19264	19402	19540	19677	19814	19951	20087	20222
1700	20222	20356	20488	20620	20749	20877	21003				

Standard Thermal EMF of S (JISC1602-1995)

Unit:μV

℃	0	−10	−20	−30	−40	−50	−60	−70	−80	−90	−100
0	0	−53	−103	−150	−194	−236					
℃	0	10	20	30	40	50	60	70	80	90	100
0	0	55	113	173	235	299	365	433	502	573	646
100	646	720	795	872	950	1029	1110	1191	1273	1357	1441
200	1441	1526	1612	1698	1786	1874	1962	2052	2141	2232	2323
300	2323	2415	2507	2599	2692	2786	2880	2974	3069	3164	3259
400	3259	3355	3451	3548	3645	3742	3840	3938	4036	4134	4233
500	4233	4332	4432	4532	4632	4732	4833	4934	5035	5137	5239
600	5239	5341	5443	5546	5649	5753	5857	5961	6065	6170	6275
700	6275	6381	6486	6593	6699	6806	6913	7020	7128	7236	7345
800	7345	7454	7563	7673	7783	7893	8003	8114	8226	8337	8449
900	8449	8562	8674	8787	8900	9014	9128	9242	9357	9472	9587
1000	9587	9703	9819	9935	10051	10168	10285	10403	10520	10638	10757
1100	10757	10875	10994	11113	11232	11351	11471	11590	11710	11830	11951
1200	11951	12071	12191	12312	12433	12554	12675	12796	12917	13038	13159
1300	13159	13280	13402	13523	13644	13766	13887	14009	14130	14251	14373
1400	14373	14494	14615	14736	14857	14978	15099	15220	15341	15461	15582
1500	15582	15702	15822	15942	16062	16182	16301	16420	16539	16658	16777
1600	16777	16895	17013	17131	17249	17366	17483	17600	17717	17832	17947
1700	17947	18061	18174	18285	18395	18503	18609				

Rtvalue of Nominal RTD Element (Pt100 JIS C 1604-1997 IEC Pub.751-1995)

Unit:Ω

℃	0	−10	−20	−30	−40	−50	−60	−70	−80	−90	−100
−200	18.52										
−100	60.26	64.30	68.33	72.33	76.33	80.31	84.27	88.22	92.16	96.09	100.00
0	100.00	103.90	107.79	111.67	115.54	119.40	123.25	127.08	130.90	134.71	138.51
℃	0	10	20	30	40	50	60	70	80	90	100
0	100.00	103.90	107.79	111.67	115.54	119.40	123.24	127.08	130.90	134.71	138.51
100	138.51	142.29	146.07	149.83	153.58	157.33	161.05	164.77	168.48	172.17	175.86
200	175.86	179.53	183.19	186.84	190.47	194.10	197.71	201.31	204.90	208.48	212.05
300	212.05	215.61	219.15	222.68	226.21	229.72	233.21	236.70	240.18	243.64	247.09
400	247.09	250.53	253.96	257.38	260.78	264.18	267.56	270.93	274.29	277.64	280.98
500	280.98	284.30	287.62	290.92	294.21	297.49	300.75	304.01	307.25	310.49	313.71
600	313.71	316.92	320.12	323.30	326.48	329.64	332.79	335.93	339.06	342.18	345.28
700	345.28	348.38	351.46	354.53	357.59	360.64	363.67	366.70	369.71	372.71	375.70
800	375.70	378.68	381.65	384.60	387.55	390.48					

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- This instrument is intended to be used for industrial machinery, machine tools and measuring equipment. Verify correct usage after consulting purpose of use with our agency or main office.
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SHINKO TECHNOS CO., LTD.
OVERSEAS DIVISION

Reg. Office : 2-5-1, Senbahigashi, Minoo, Osaka, 562-0035, Japan
Tel : 81 - 72 - 727 - 6100
Fax : 81 - 72 - 727 - 7006
URL : http://www. shinko-technos. co. jp
E-mail : overseas @ shinko-technos. co. jp