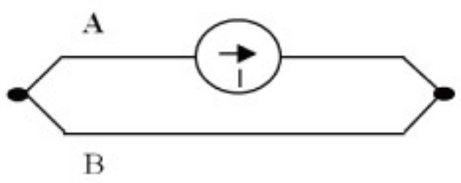
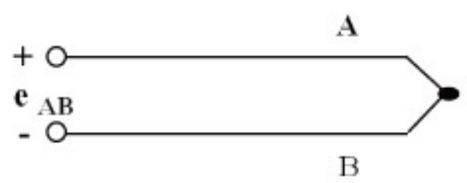
Thermocouple Sensor (TC)

Principals of Thermocouple

Thermocouple is consist of 2 different metal or alloys.
One side is welded together and used as hot junction.
When hot junction receives heat and the other side remains read temperature, preferably at 0 °C thermal electromotive force (EMF / mV) is produced.
Temperature at hot junction is determined by EMF





UNGROUNDED
Due to hot junction insulated from sheath, slower response than that of Grounded type to temp. changes, but useable to wide applications due to it' s shielding effects and durability.

GROUNDED
Faster response to temp. Changes, and suitable for measurements at high pressure/temp., but not suitable in harmful electrical conductivity atmospheres.

EXPOSED
Most fastest response time, and used in high humidity atmospheres of up to 200°C, but not suitable in corrosive atmospheres.

Type of Thermocouple

Type	Alloy Composition of The Conductors	
	Positive (+) Leg	Negative (-) Leg
B	BP(70%Platinum - 30%Rhenium)	BN(94%Platinum - 6%Rhenium)
R	RP(87%Platinum - 13%Rhenium)	RN(100%Platinum)
S	RP(90%Platinum - 10%Rhenium)	RN(100%Platinum)
N	NP(84%Ni - 14.2%Cr - 1.45%Si)	NN(95%Ni - 4.4%Si - 0.15Mg)
K	KP(90%Ni - 10%Cr)	KN(90%Ni - 2%Mn - 2%Al)
E	EP(90%Ni - 10%Cr)	EN Constantan (55%Cu - 45%Nl)
T	TP(99.5%Iron)	TN Constantan (55%Cu - 45%Nl)
J	JP(100%Copper)	JN Constantan (55%Cu - 45%Nl)

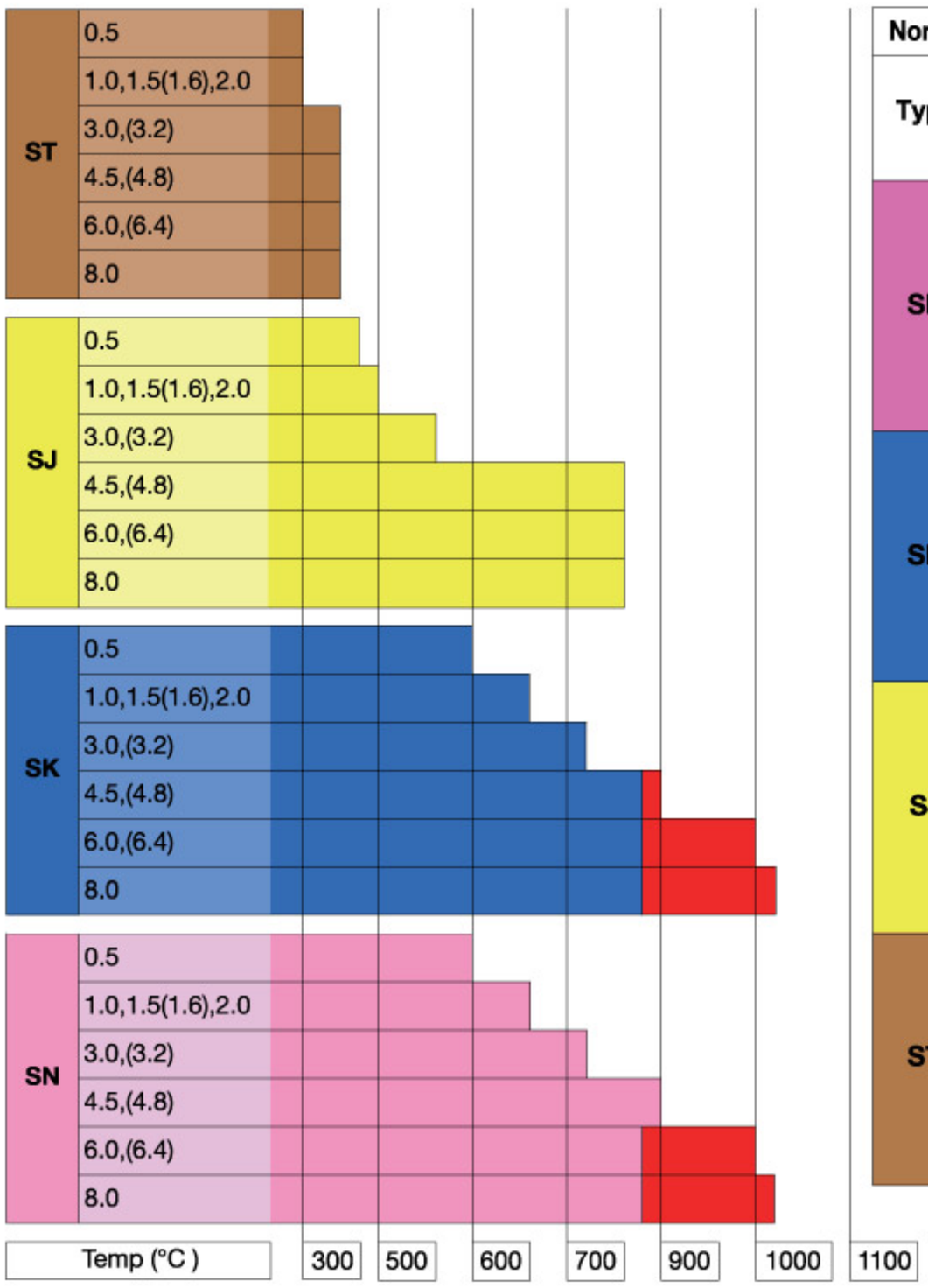
Type B (600 °C ~ 1700 °C.)	Thermocouple can use up to 1700 °C but EMF below 50 °C is very small output so it is not recommended to use below 100 °C. Precious thermocouple is easily contaminated.
Type R (0 °C ~ 1600 °C.)	Is recommended to use in oxidizing atmosphere. As same as type B & type S, it is easily contaminated. Alumina protection tube is necessary.
Type S (0°C ~ 1600 °C.)	Is used similarly as type R but it has less mechanical strength. Type S is used as the standard scale of melting point of gold (1064.43 °C).
Type N (-200 °C ~ 1250 °C.)	This new type of thermocouple is developed to substitute type K for high temperature. Type N has better stability and oxidation resistance than type K from 600 °C ~ 1000 °C.
Type K (-200 °C ~ 1250 °C.)	This is most widely used thermocouple in industries. It is inexpensive and has wide range of probes. This is suitable for oxidizing atmosphere but rong atmosphere should be avoided.
Type T (-200 °C ~ 350 °C.)	This is suited for low temperature. Because of its stability it is widely used in laboratories.
Type J (0 °C ~ 750 °C.)	This has the high EMF and is good for reducing atmosphere

Thermocouple Sensor (TC)

Tolerances on Temperature Reading

Sheath Thermocouple Standard				
Type		Caassification of Tolerances (JIS C 1605-1995)		
		Class 1	Class 2	Class 3
SN	Temp.	-40° C ~ 375° C	-40° C ~ 333° C	-167° C ~ +40° C
	Tolerances	± 1.5° C	± 2.5° C	± 2.5° C
	Temp.	375° C ~ 1000° C	333° C ~ 1200° C	- 200° C ~ -167° C
	Tolerances	± 0.004•(t)	± 0.0075•(t)	± 0.015•(t)
SK	Temp.	-40° C ~ 375° C	-40° C ~ 333° C	-167° C ~ +40° C
	Tolerances	± 1.5° C	± 2.5° C	± 2.5° C
	Temp.	375° C ~ 1000° C	333° C ~ 1200° C	- 200° C ~ -167° C
	Tolerances	± 0.004•(t)	± 0.0075•(t)	0.015•(t)
SJ	Temp.	-40° C ~ 375° C	-40° C ~ 333° C	-
	Tolerances	± 1.5° C	± 2.5° C	
	Temp.	375° C ~ 750° C	333° C ~ 750° C	-
	Tolerances	± 0.004•(t)	± 0.0075•(t)	
ST	Temp.	- 40° C ~ +125° C	- 40° C ~ +133 ° C	- 67° C ~ +40° C
	Tolerances	± 0.5° C	± 1.0° C	± 1.0° C
	Temp.	125° C ~ 350° C	133° C ~ 350° C	- 200° C ~ -67° C
	Tolerances	± 0.004° C	0.0075•(t)	0.015•(t)

Operating and Maximum Temperature Limist



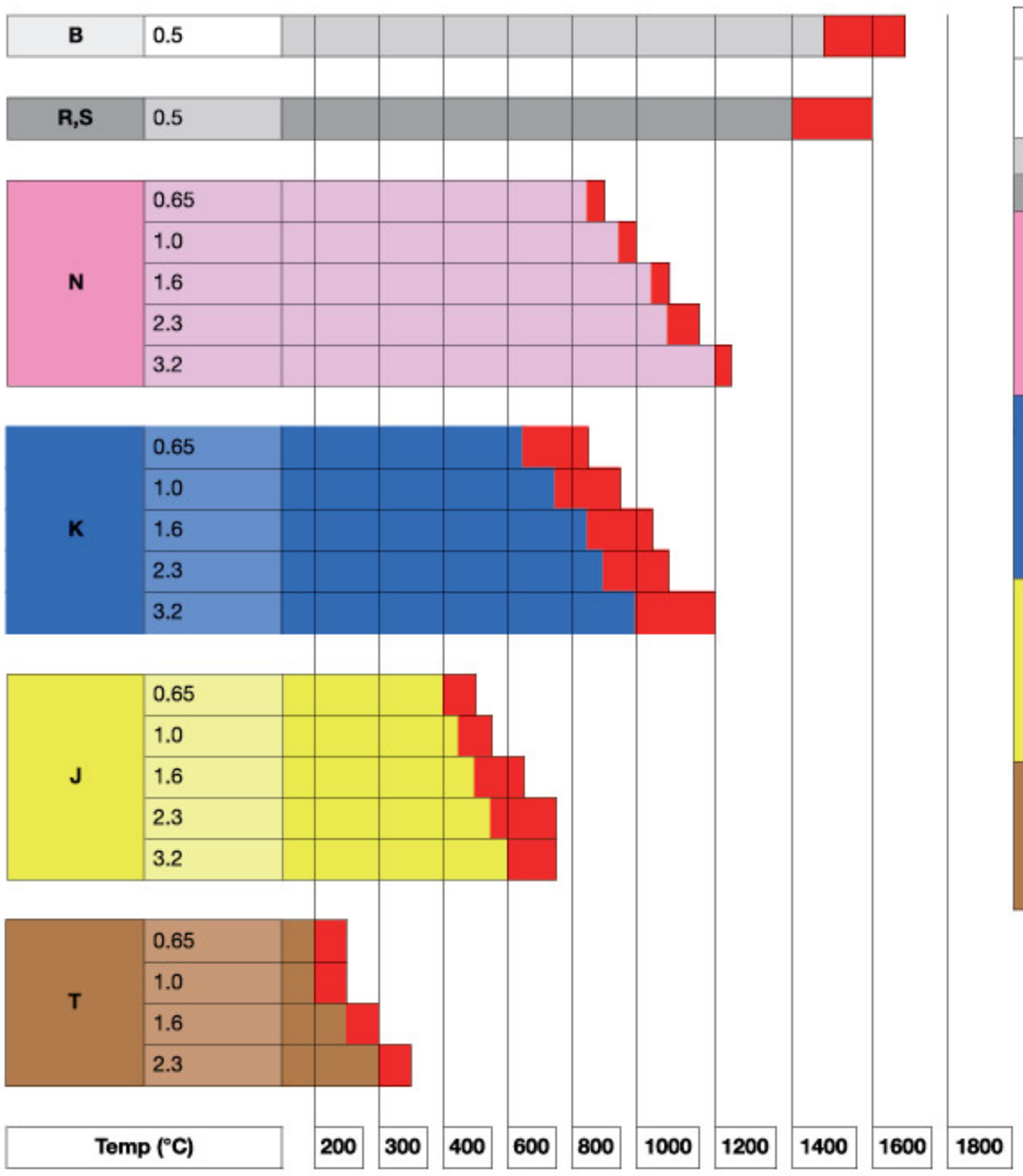
Normal Use Limit of Thermocouple Sheath (JIS C 1605 - 1995)			
Type	Material Sheath	Material Sheath °C	
	Dia. (mm)	Austennite Stainless	Rsistance Super Alloy
SN	0.5	600	
	1.0,1.5(1.6),2.0	650	
	3.0,(3.2)	750	
	4.5,(4.8)	800	900
	6.0,(6.4)	800	1000
	8.0	900	1050
SK	0.5	600	
	1.0,1.5(1.6),2.0	650	
	3.0,(3.2)	750	
	4.5,(4.8)	800	900
	6.0,(6.4)	800	1000
	8.0	900	1050
SJ	0.5	400	
	1.0,1.5(1.6),2.0	450	
	3.0,(3.2)	650	
	4.5,(4.8)	750	
	6.0,(6.4)	750	
	8.0	750	
ST	0.5	300	
	1.0,1.5(1.6),2.0	300	
	3.0,(3.2)	350	
	4.5,(4.8)	350	
	6.0,(6.4)	350	
	8.0	350	

Thermocouple Sensor (TC)

Tolerances on Temperature Reading

Element Thermocouple Standard				
Type		Caassification of Tolerances (JIS C 1602-1995)		
			Class 2	Class 3
B	Temp.	-	-	600° C ~ 800° C
	Tolerances			± 4° C
	Temp.		600° C ~ 1700° C	800° C ~ 1700° C
	Tolerances		± 0.0025•(t)	± 0.005•(t)
R, S	Temp.	1100° C ~ 1600° C	0° C ~ 600° C	-
	Tolerances	± (1+0.003(t-1100)	± 1.5° C	
	Temp.	0° C ~ 1100° C	600° C ~ 1600° C	-
	Tolerances	± 1.0° C	± 0.0025•(t)	
N	Temp.	-40° C ~ 375° C	-40° C ~ 333° C	-160° C ~ 40° C
	Tolerances	± 1.5° C	± 2.5° C	± 2.5° C
	Temp.	375° C ~ 1000° C	333° C ~ 1200° C	-200° C ~ -167° C
	Tolerances	± 0.004•(t)	± 0.0075•(t)	± 0.0015•(t)
K	Temp.	- 40° C ~ +375° C	- 40° C ~ +333 ° C	- 167° C ~ +40° C
	Tolerances	± 1.5° C	± 2.5° C	± 2.5° C
	Temp.	375° C ~ 1000° C	333° C ~ 1200° C	- 200° C ~ -167° C
	Tolerances	± 0.004•(t)	0.0075•(t)	0.015•(t)
J	Temp.	-40° C ~ 375° C	-40° C ~ 333° C	-
	Tolerances	± 1.5° C	± 2.5° C	
	Temp.	375° C ~ 750° C	333° C ~ 750° C	-
	Tolerances	± 0.004•(t)	± 0.0075•(t)	
T	Temp.	-40° C ~ 125° C	-40° C ~ 133° C	-67° C ~ +40° C
	Tolerances	± 0.5° C	± 1.0° C	± 2.5° C
	Temp.	125° C ~ 350° C	133° C ~ 350° C	- 200° C ~ - 67° C
	Tolerances	± 0.004•(t)	± 0.0075•(t)	± 0.015•(t)

Operating and Maximum Temperature Limist



Normal Use Limit of Thermocouple Sheath (JIS C 1605 - 1995)			
Type	Wire Dia. (mm)	Normal Operating Temp, Range (°C)	Max. Temp Limit (°C)
B	0.5	1500	1700
R, S	0.5	1400	1600
N	0.65	850	900
	1.0	950	1000
	1.6	1050	1100
	2.3	1100	1150
	3.2	1200	1250
K	0.65	650	850
	1.0	750	950
	1.6	850	1050
	2.3	900	1100
	3.2	1000	1200
J	0.65	400	500
	1.0	450	550
	1.6	500	650
	2.3	550	750
	3.2	600	750
T	0.32	200	250
	0.65	200	250
	1.0	250	300
	1.6	300	350

Thermocouple Sensor (TC)

Metallic Protection Tubes

Material	Code	Operating Temp °C	Features
SS400	400	Oxi. 600 Red. 800	Good resistance to reducing atmosphere but less resistant to oxidation and acids attack. Thick walled tubes are used in molten aluminium.
304 S.S.	304	980	Widely used as a common protection tube against heat and corrosion but not recommended for use in the presence of sulphur or reducing flame. Subject to stress and "pit" corrosion.
304L S.S.	304L	980	Less carbon content (C=0.3%) than 304 S.S. and better resistance to grain boundary corrosion. Subject to stress and "pit" corrosion.
321 S.S.	321	980	Higher corrosion resistance than 304 S.S. because of its Ti content to prevent carbon preticipation. Excellent resistance to grain boundary corrosion after welding due to less carbon preticipation.
316 S.S.	316	980	Contains Mo and has excellent resistance to corrosives to grain boundary corrosives, heat, acids and alkalis.
316L S.S.	316L	980	Less carbon content than 316 S.S. and has better resistance to grain boundary corrosion. Resistance to "pit" corrosion.
310S S.S.	310S	1000	High Ni-Cr content and good high temperature strength with resistance to oxidation at high temperatures. High mechanical strength.
347 S.S.	347	980	Because of its Nb-Ta content, prevents carbon preticipation. Higher corrosion resistance than 304 S.S. and excellent resistance to grain boundary corrosion.
446 S.S.	446	980	Excellent resistance to oxidizing and reducing flames containing sulphur. Suitable for use in non-ferrous molten metals and other high temperature applications but less mechanical strength.
253 MA	253	1000	Superior oxidation resistance to 310 S.S. at high temperature due to formation of dense and tight oxide layer by silicon and cerium addition.
Inconel 600	600	1050	Excellent resistance to oxidizing and reducing atmospheres at high temperature. But sulphurous atmospheres should. be avoided. Immune to stress and "pit" corrosion
Incoloy 800	800	870	Excellent to high temperature oxidizing atmospheres and thermal shock. About 10 times longer service life than 304 S.S. against high temperature corrosion.
Titanium	TI	Oxi. 250 Red. 1000	Superior corrosion resistance in cryogenic temperatures but at high temperature, easily oxidized and become brittle.

Non-Metallic Protection Tubes

Material	Code	Operating Temp °C	Features
Translucent Quartz Transparent Quartz	QT	1000	99.99% Quartz Excellent to thermal shock but fragile. Poor resistance to alkalis but good to acids. Less gas-tightness in hydrogen and reducing gases. High thermalconductivity.
Recrystallized Aluminam	PT0	1900	99.5%Alumina Superior chemical stability and better than PT1. Recommended for use in molten steel, slag and molten glass, impervious
Mullite	PT1	1600	60%Alumina-40%Silica Sintered alumina. Better than PT2 but slightly less thermal shock resistance. Recommended for use in heating furnace and regenerator, impervious.
Recrystallized Silicon Carbide	SiC	1400	99%SiC Porous but good resistance to acids and alkalis. Recommended for use in air neutral atmospheres up to 1,400°C and also in high temperature stagnant furnace atmosphere as an outer protection tube, etc. Attacked by water vapour.
Silicon Nitride (Si3N4)	Si3N4	1350	Excellent thermal shock resistance. Less corrosion to acids and alkalis. High hardness. Fairly good resistanceagainst most of molten metals.
Zirconia	ZR 1706	1800	MgO Stabillzed ZrO2 Gas-tight and exceptionally good thermal shock resistance. Chemically stable against molten metals other than alkalis. Recommended for use in molten special metals, slag and glass up to 1,800°C. Suitable for use in high temp. protection tube up to 1,900°C where PTO Alumina softens.

PT100 Sensor (RTD)

Thermocouple PT100

Principles of RTD

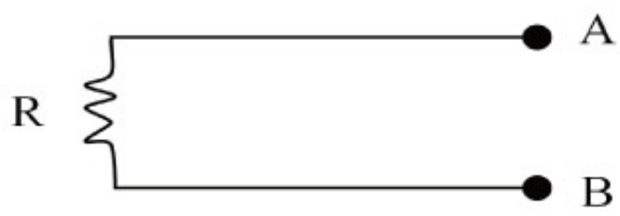
RTD (Resistance temperature detector) is temperature sensor using characteristics of metal which resistance changes acording to temperature.

Platinum (Pt), Copper (Cu) &Nickel (Ni) are used as materials usually. Especially platinum is used widely, because the changing ratio according to temp is big and it is easier to get pure material and it is more stable than others. The current used in RTD are 0.5mA/1mA/2mA. 1mA is used widely. Please choose rated current suitable for your meters.

Wire connection

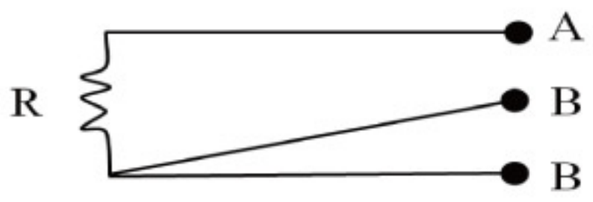
RTD 2 wires

This 2 wires type of RTD is used only where high accuracy is not required. Or Pt1000 which resistance of wiring is too small to effect is suitable for this.



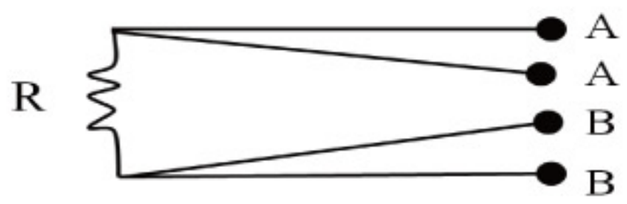
RTD 3 wires

This 3 wires type of RTD is widely used in industrial sections. When resistance of 3 wires are completely same, it can measure temperature without inflvence by surrounding temperature or long wiring



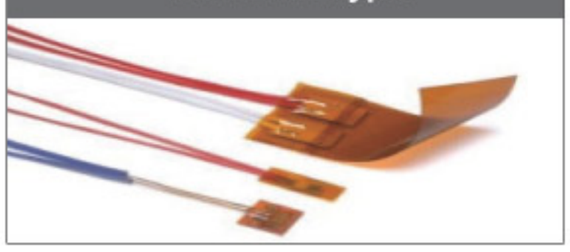
RTD 4 wires

This 4 wires type of RTD is recommendable for high precision measurement or standard RTD for calibration.



RTD PT100 Type

Thin Film Type



Ceramic Type

Mica Type