LABFACILITY
TEMPERATURE & PROCESS TECHNOLOGY

Platinum Resistance Thermometer (PRT) Product Guide

Farnell
AN AVNET COMPANY

Newark
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Comparison of Sensor Types

	Platinum Resistance	Thermocouple	Thermistor
Sensor	Platinum-wire wound or flat-film resistor	Thermoelement, two dissimilar metals/alloys	Ceramic (metal oxides)
Accuracy (typical values)	0.1 to 1.0°C	0.5 to 5.0°C	0.1 to 1.5°C
Long term Stability	Excellent	Variable, Prone to ageing	Good
Temperature range	-200 to 650°C	-200 to1750°C	-100 to 300°C
Thermal response	Wirewound – slow Film – faster 1-50 secs typical	Sheathed – slow Exposed tip – fast 0.1 to 10 secs typical	generally fast 0.05 to 2.5 secs typical
Excitation	Constant current required	None	None
Characteristic	PTC resistance	Thermovoltage	NTC resistance (some are PTC)
Linearity	Fairly linear	Most types non-linear	Exponential
Lead resistance effect	3 & 4 wire – low. 2 wire – high	Short cable runs satisfactory	Low
Electrical "pick-up"	Rarely susceptible	susceptible	Not susceptible
Interface	Bridge 2,3 or 4 wire	Potentiometric input. Cold junction compensation required	2 wire resistance
Vibration effects/ shock	wirewound – not suitable. Film – good	Mineral insulated types suitable	Suitable
Output/ characteristic	approx. 0.4 W/°C	From 10µV/°C to to 40µV/°C depending on type	-4% / °C
Extension Leads	Copper	Compensating cable	Copper
Cost	Wirewound – more expensive Film – cheaper	Relatively low cost	Inexpensive to moderate

Comments and values shown in this chart are generalised and nominal. They are not intended to be definitive but are stated for general guidance.

Choosing between a RTD Sensor and a Thermocouple

RTD Sensor

Resistance Thermometers utilise a high precision sensing resistor, usually platinum, the resistance value of which increases with temperature. The dominant standard adopted internationally is the Pt100 which has a resistance value of 100.0 Ohms at 0°C and a change of 38.50 Ohms between 0 and 100°C (the fundamental interval).

The platinum sensing resistor is highly stable and allows high accuracy temperature sensing. Resistance thermometer sensing resistors are 2 wire devices, but the 2 wires will usually be extended in a 3 or 4 wire configuration according to the application, the associated instrumentation and accuracy requirements.

Thermocouples

Thermocouples comprise a thermoelement which is a junction of two specifield, dissimilar alloys and a suitable two wire extension lead. The junction is a short circuit only, the EMF is generated in the temperature gradient between the hot junction and the 'cold' or reference junction. This characteristic is reasonably stable and repeatable and allows for a family of alternative thermocouple types (e.g. J,K,T,N) to be used.

The alternative types are defined by the nature of the alloys used in the thermoelements and each type displays a different thermal EMF characteristic.

RTD's are, generally:

- More expensive
- More accurate
- Highly stable (if used carefully)
- Capable of better resolution
- Restricted in their range of temperature
- Stem, not tip sensitive
- Rarely available in small diameters (below 3mm)

Thermocouples are, generally:

- Relatively inexpensive
- More rugged
- Less accurate
- More prone to drift
- More sensitive
- Tip sensing
- Available in smaller diameters
- Available with a wider temperature range
- More versatile

In both cases, the choice of thermocouple or RTD must be made to match the instrumentation and to suit the application.

Comparison of Sheath Materials

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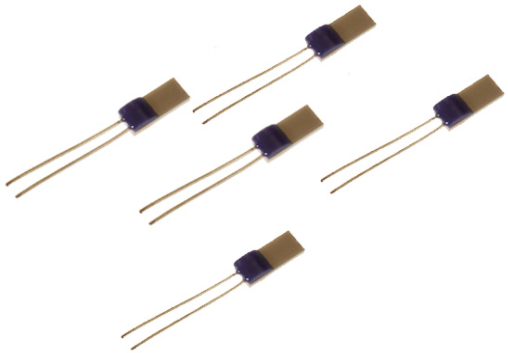
Sheath Material	Max Continuous	Notes	Applications
Refractory Oxide recrystallised, e.g. Alumina Impervious	1750°C	Good choice for rare metal thermocouples. Good resistance to chemical attack. Mechanically strong but severe thermal shock should be avoided.	Forging iron & steel. Incinerators carburizing and hardening in heat treatment. Continuous furnaces. Glass Lehrs.
Silicon Carbide (Porous)	1500°C	Good level of protection even in severe conditions. Good resistance to reasonable levels of thermal shock. Mechanically strong when thick wall is specified but becomes brittle when aged. Unsuitable for oxidising atmospheres but resists fluxes.	Forging iron & steel. Incinerators Billet heating, slab heating, butt welding. Soaking pits ceramic dryers.
Impervious Mullite	1600°C	Good choice for rare metal thermocouples under severe conditions. Resists Sulphurous and carbonaceous atmospheres. Good resistance to thermal shock should be avoided.	Forging iron & steel. Incinerators. Heat treatment. Glass flues. Continuous furnaces.
Mild Steel (cold drawn seamless)	600°C	Good physical protection but prone to rapid corrosion.	Annealing up to 500°C. Hardening pre-heaters. Baking ovens.
Stainless steel 25/20	1150°C	Resists corrosion even at elevated temperature. Can be used in Sulphurous atmospheres.	Heat treatment annealing, flues, many chemical processes. Vitreous enamelling. Corrosion resistant alternative to mild steel.
Inconel 600/800*	1200°C	Nickel-Chromium-Iron alloy which extends the properties of stainless steel 25/20 to higher operating temperatures. Excellent in Sulphur free atmospheres; superior corrosion resistance at higher temperatures. Good mechanical strength.	Annealing, carburizing, hardening. Iron and steel hot blast. Open hearth flue & stack. Waste heat boilers. Billet heating, slab heating. Continuous furnaces. Soaking pits. Cement exit flues & kilns. Vitreous enamelling. Glass flues and checkers. Gas superheaters. Incinerators up to 1000°C. Highly sulphurous atmospheres should be avoided above 800°C.
Chrome Iron	1100°C	Suitable for very adverse environments. Good mechanical strength. Resists severely corrosive and sulphurous atmospheres.	Annealing, carburizing, hardening. Iron & steel hot blast. Open hearth flue and stack. Waste heat boilers. Billet heating, slab heating. Continuous furnaces. Soaking pits. Cement exit flues & kilns. Vitreous enamelling. Glass flues and checkers. Gas superheaters. Incinerators up to 1000°C.
Nicrobell*	1300°C	Highly stable in vacuum and oxidising atmospheres. Corrosion resistance generally superior to stainless steels. Can be used in Sulphurous atmospheres at reduced temperatures. High operating temperature.	As Inconel plus excellent choice for vacuum furnaces and flues.

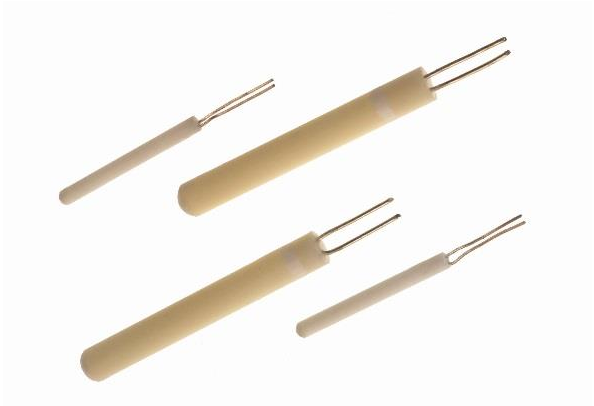
* Tradenames

Sheath materials range from mild and stainless steels to refractory oxides (ceramics, so called) and a variety of exotic materials including rare metals. The choice of sheath must take account of operating temperature, media characteristics, durability and other considerations including the material relationship to the type of sensor.

Thin Film Detectors & Wire-Wound Detector Elements



A **Thin Film Detectors**



B **Wire-Wound Detector Elements**

Image	Resistance	Dimensions (width x length)	Tolerance Class A		Tolerance Class B		Tolerance Class 1/3 Din	
			Farnell order code	Newark Order code	Farnell order code	Newark Order code	Farnell order code	Newark Order code
A	Pt100	2 x 5mm	1289666	24M1444	-	-	-	-
A	Pt100	2 x 10mm	8598525	38K0885	8598533	38K0884	-	-
A	Pt100	2 x 2.3mm	1289667	24M1438	8598541	38K0882	-	-
A	Pt1000	2 x 10mm	8598550	38K0883	7745655	38K0886	2443729	-
A	Pt1000	1.25 x 1.7mm	-	-	2081264	88T3071	-	-

Image	Resistance	Dimensions (Dia x length)	Tolerance Class A		Tolerance Class B		Duel Element (Pt100 x2) Tolerance Class A	
			Farnell order code	Newark Order code	Farnell order code	Newark Order code	Farnell order code	Newark Order code
B	Pt100	1.5 x 8mm	2770780	25AC2612	2770778	25AC2610	-	-
B	Pt100	1.5 x 15mm	2770776	25AC2608	2770779	25AC2611	2770773	-
B	Pt100	2.8 x 15mm	2770777	25AC2609	2770775	25AC2607	-	-
B	Pt100	2.8 x 25mm	2770774	25AC2606	-	-	-	-

Platinum Resistance Pt100 with Terminal Heads

A **Platinum Resistance Pt100 4 wire class B Resistance Thermometer with DIN B Head**

B **Platinum Resistance Pt100 4 wire class B Resistance Thermometer with Compact KNS Head**

C **Platinum Resistance Pt100 3 wire class B Resistance Thermometer with KNE Head and Fitted**

Image	Sensor Type	Probe Diameter	Probe Length	Head Termination	Farnell Order Code	Newark Order Code
A	Pt100	6mm	100	IP67 Din B Head	2749489	15AC8994
A	Pt100	6mm	200	IP67 Din B Head	2749488	15AC8993
A	Pt100	6mm	500	IP67 Din B Head	2816508	44AC8640

Image	Sensor Type	Probe Diameter	Probe Length	Head Termination	Farnell Order Code	Newark Order Code
B	Pt100	6mm	150	IP67 KNS Head	2749482	15AC8987
B	Pt100	6mm	250	IP67 KNS Head	2749485	15AC8990
B	Pt100	6mm	300	IP67 KNS Head	2749487	15AC8992

Image	Sensor Type	Probe Diameter	Probe Length	Head Termination	Transmitter Fitted?	Transmitter Range	Farnell Order Code	Newark Order Code
C	Pt100	6mm	150	IP67 KNE Head	Yes	-50°C to +150°C	2749481	15AC8986
C	Pt100	6mm	150	IP67 KNE Head	Yes	0°C to 100°C	2749479	15AC8984
C	Pt100	6mm	150	IP67 KNE Head	Yes	0°C to 200°C	2749480	15AC8985
C	Pt100	6mm	150	IP67 KNE Head	Yes	0°C to 400°C	2749483	15AC8988

Pt100 Wall-Mounted Air Boxes

A

Platinum Resistance Thermometer Pt100 Outdoor/Cold Store Temperature Sensors

B

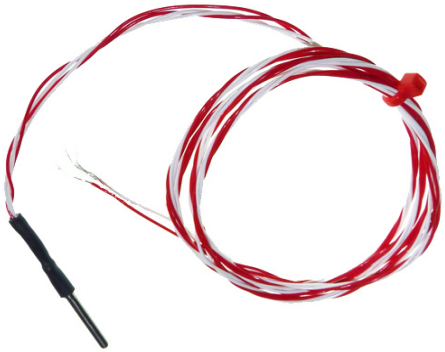
4-20mA remote wall mounted housing, Platinum Resistance Pt100 input with 1 metre lead

Image	Class	Length	Width	Height	Elements Type	Pt100 Connection	4-20Ma Output	Indoor/Outdoor Use?	Farnell Order Code	Newark Order Code
A	B	80mm	74mm	54mm	Single	4 Wire	No	Indoor or Outdoor use	7218760	68C0482
A	B	80mm	74mm	54mm	Duplex	2 x 4 Wire	No	Indoor or Outdoor use	2816461	44AC8647
A	B	80mm	74mm	54mm	Single	3 Wire	Yes (2 Wire)	Indoor or Outdoor use	2816462	44AC8648

Image	Cable Glands	Cable Length	Cable Insulation	Transmitter Fitted?	Transmitter Range	Indoor/Outdoor Use?	Farnell Order Code	Newark Order Code
B	M16	1000mm	PFA Teflon	Yes	-50°C to +150°C	Indoor Only	2749478	15AC8983
B	M16	1000mm	F/G + SSOB	Yes	0°C to + 400°C	Indoor Only	2749477	15AC8982

Platinum Resistance Thermometer Pt100 with Stainless Steel Sheath

A **Platinum Resistance Pt100 Class B Sensors with Teflon Insulated lead in a Stainless-Steel Tube**



B **Platinum Resistance Pt1000 Class B Sensor with Teflon insulated lead in a Stainless-Steel Tube**

C **Platinum Resistance Thermometer Pt100 Industrial Sensor Probe, Class B, in a Stainless-Steel Tube**

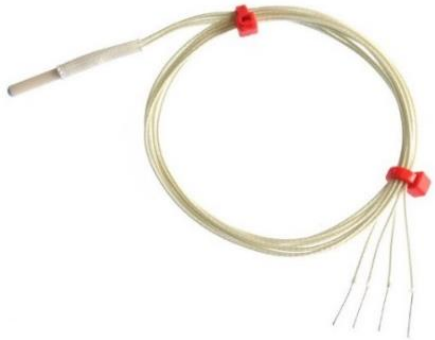
Image	Type	Class	Probe Diameter	Probe Length	Cable Length	Cable Type	Termination	Farnell Order Code	Newark Order Code
A	Pt100	B	3mm	25mm	1m	Teflon® insulated	4 Wire	2420300	-
A	Pt100	B	3mm	100mm	1m	Teflon® insulated	4 Wire	2816454	44AC8646

Image	Type	Class	Probe Diameter	Probe Length	Cable Length	Cable Type	Termination	Farnell Order Code	Newark Order Code
B	Pt1000	B	4mm	40mm	1m	Teflon® insulated	2 Wire	2816526	44AC8675

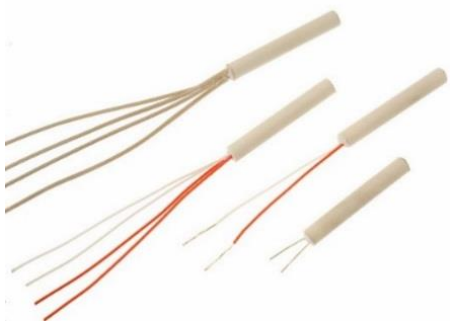
Image	Type	Class	Probe Diameter	Probe Length	Cable Length	Cable Type	Termination	Farnell Order Code	Newark Order Code
C	Pt100	B	3mm	150mm	1m	Teflon® insulated, Screened	4 Wire	4100670	15J1015
C	Pt100	B	4mm	25mm	2m	Teflon® insulated, Screened	4 Wire	2816468	44AC8657
C	Pt100	B	4.5mm	125mm	2m	Teflon® insulated, Screened	4 Wire	2816476	44AC8665
C	Pt100	B	6mm	300mm	2m	Teflon® insulated, Screened	4 Wire	2816483	-

Platinum Resistance Thermometer with Extended Leads

A **Platinum Resistance Pt100 & Pt1000 Detectors with Extended Leads**



B **Pt100 Ceramic Wire-Wound**



C **Pt100 Tubular Ceramic Insert Elements with tail wires**

Image	Type	Class	Detector (WxL)	Cable Length	AWG	Cable Type	Termination	Farnell Order Code	Newark Order Code
A	Pt100	B	2 x 10mm	300mm	24 AWG	Teflon® insulated	2 Wire	2749460	15AC8965
A	Pt100	A	2 x 10mm	1000mm	26 AWG	Teflon® insulated	4 Wire	2749464	15AC8969
A	Pt1000	B	2 x 10mm	500mm	24 AWG	Teflon® insulated	2 Wire	2749468	15AC8973

Image	Type	Class	Detector (WxL)	Cable Length	AWG	Cable Type	Termination	Farnell Order Code	Newark Order Code
B	Pt100	B	2.8 x 15mm	300mm	26 AWG	Teflon® insulated	2 Wire	2749471	15AC8976
B	Pt100	B	2.8 x 15mm	500mm	26 AWG	Teflon® insulated	4 Wire	2749469	15AC8974
B	Pt100	B	2.8 x 15mm	1000mm	26 AWG	Teflon® insulated	4 Wire	2749470	15AC8975

Image	Type	Ceramic Diameter	Ceramic Length	Lead Length	Cable Type	Termination	Farnell Order Code	Newark Order Code
C	Pt100	5mm	35mm	50mm	7/0.2mm SPC Teflon	2 Wire	7255731	68C2775
C	Pt100	5mm	35mm	450mm	7/0.2mm SPC Teflon	4 Wire	7255743	-
C	Pt100	5mm	35mm	10mm	1/0.4mm Nickel	4 Wire	2785075	-

Platinum Resistance Thermometer Pt100 Precision Probes

A **Platinum Resistance Thermometer Pt100 Precision Probe**

B **Platinum Resistance Pt100 Dual Element Mineral Insulated Sensor Probe**

C **Platinum Resistance Pt100 Dual Element Industrial Sensor Probe**

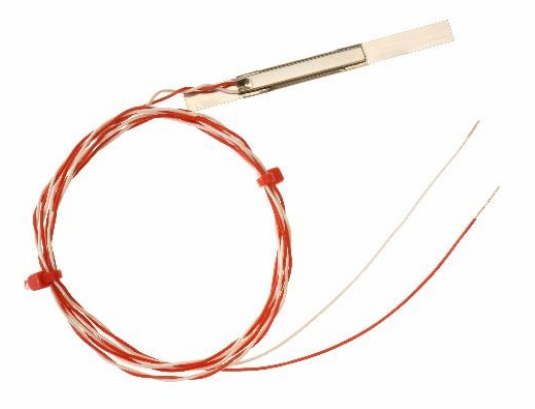
Image	Type	Class	Probe Length	Cable Length	Cable Type	Termination	Probe Temperature Range	Farnell Order Code	Newark Order Code
A	Pt100	1/5th Din	250mm	2m	7/0.2mm PTFE insulated with silver plated copper screen	4 Wire	-50°C to +250°C	7218758	67C7796

Image	Type	Class	Probe Length	Cable Length	Cable Type	Termination	Probe Temperature Range	Farnell Order Code	Newark Order Code
B	Mineral Insulated Duplex PRT	B	150mm	1m	7/0.2mm flexible 6 core Teflon® insulated & screened	2 x 3 wire	-50°C to +500°C	2785116	37AC0967

Image	Type	Class	Probe Length	Cable Length	Cable Type	Termination	Probe Temperature Range	Farnell Order Code	Newark Order Code
C	Pt100	B	150mm	1m	7/0.2mm flexible 6 core Teflon® insulated & screened	2 x 3 wire	-50°C to +250°C	1633503	-

Platinum Resistance Pt100 Sensors

A **Pt100 Heavy Duty Sensor Probe, Class B**



B **Pt100 Sheathed Thin Film Strip Sensor**

C **PT100 'Flat Tip' Probe**

Image	Type	Class	Probe Diameter	Probe Length	Cable Length	Cable Type	Farnell Order Code	Newark Order Code
A	Pt100	B	6mm	50mm	2m	Flexible silicone rubber insulated, 7/0.2mm	8598096	38K0945
A	Pt100	B	6mm	100mm	2m	Flexible silicone rubber insulated, 7/0.2mm	8598100	38K0946

Image	Type	Class	Strip Dimensions (LxWxH)	Cable Length	Cable Type	Farnell Order Code	Newark Order Code
B	Pt100	B	35mm x 6mm x 2mm	1m	7/.02mm Teflon® insulated twin twisted lead	2081307	88T4208

Image	Type	Class	Probe Diameter	Probe Length	Cable Length	Cable Type	Farnell Order Code	Newark Order Code
C	Pt100	B	4mm	150mm	1m	7/0.2mm Teflon® insulated 2 twisted leads	2785055	37AC0964

Information given here is for general guidance only and is not definitive – it is not intended to be the basis for product installation or decision making.

Q. How accurately can I measure temperature using a standard sensor?
A. To published, internationally specified tolerances as standard, typically ± 2.5°C for popular thermocouples, ±0.5°C for PRT. Higher accuracy sensors can be supplied to order, e.g. ±0.5°C for type T thermocouple, ±0.2°C for PRT. All of these values are temperature dependent. A close tolerance, 4-wire PRT will give best absolute accuracy and stability.

Q. How do I choose between a thermocouple and a PRT?
A. Mainly on the basis of required accuracy, probe dimensions, speed of response and the process temperature.

Q. What is the difference between a RTD and PRT sensor?
A. Nothing. RTD means resistance thermometer detector (the sensing element) and PRT means Platinum resistance thermometer (the whole assembly) i.e. a PRT uses a RTD!

Q. What is a Pt100?
A. An industry standard Platinum RTD with a value of 100 Ohms @0°C to IEC751; this is used in the vast majority of PRT assemblies in most countries.

Q. Are there other types of temperature sensor apart from thermocouple and PRT Types?
A. Several, but these two groups are the most common. Alternatives include thermistors, infra-red (non-contact), conventional thermometers (stem & dial types) and many others.

Q. Why offer 2,3 or 4 wire PRT probes?
A. Because all 3 are encountered. Two-wire should be avoided, three-wire is widely used and four-wire gives optimum accuracy. Your instrument will be configured for 2,3 or 4 wire.

Q. What is the minimum immersion depth for a PRT probe?
A. Usually 150mm or more; increase the immersion until the reading is unchanged.

Q. What is the practical difference between wire-wound and film RTDs?
A. Wire-wound type provides greater accuracy and stability but is vulnerable to shock; film type is resistant to shock and has quicker thermal response.

Q. Is a sensor with a calibration certificate more accurate than an uncalibrated one?
A. No. However, the errors and uncertainties compared with a reference sensor are published and corrected values can be used to obtain better measurement accuracy.

Q. How long will my sensor last in the process?
A. Not known but predictable in some cases; this will be a function of sensor type, construction, operating conditions and handling.

Q. What is the longest thermocouple I can have without losing accuracy?
A. Try to ensure a maximum sensor loop resistance of 100 Ohms for thermocouples and 4 wire PRTs. Exceeding 100 Ohms could result in a measurement error. Note By using a 4-20mA transmitter near the sensor, cable runs can be much longer and need only cheaper copper wire. The instrument must be suitable for a 4-20mA input though.

Q. Do I need a power supply when using a transmitter, and what length of extension lead can I run with a transmitter fitted?
A. A 24Vdc, 20mA supply will be needed if this is not incorporated in the measuring instrument. Long runs of copper cable can be used.

Q. What accuracy will I get at a certain temperature using a Pt100 detector; if a better grade detector is used what effect will this have to the accuracy?
A. Refer to this Labfacility Temperature Handbook for Pt100 tolerance information.

Q. What accuracy loss will I get using a transmitter in line?
A. This depends on the accuracy of the specified transmitter; there will always be some degradation.

Q. As most instrumentation only takes 2 or 3 wire Pt100s, if I took the correction made on the 3 wire system and incorporated that on to the single leg could I achieve a 4 wire system?
A. No; cable length and ambient temperature variations come into play.

Q. What is the difference between a flat film and wire wound Pt100 element?
A. Film uses platinum deposition on a substrate; wire wound uses a helically wound Pt wire in ceramic. Wire-wound type provides greater accuracy and stability but is vulnerable to shock; film type is resistant to shock and has quicker thermal response.

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