

General Specifications

Resistance Temperature Detectors (RTDs)

RTD Characteristics

Resistance Temperature Detectors (RTDs) are devices that sense temperature by measuring the change in resistance of a material in a known and repeatable manner. An RTD usually contains either a conductive film or a coil of wire. Extension wires allow the electrical resistance to be measured from some distance. RTD elements are packaged in various configurations according to the desired application. RTDs are preferred when accuracy, long-term stability and repeatability are important in an application. Note, these specifications are typical, consult the factory for specific performance based on model number.

Advantages:

- High output signal.
- Used with electronic equipment that is simpler, more accurate and less expensive than a thermocouple requires.
- Greater sensitivity to small temperature changes.
- High accuracy, stability, repeatability and resistance to thermal shock.
- Wide temperature operating range (-200°C to 900°C for platinum)
- Excellent linearity
- 2, 3, 4 wire construction addresses accuracy and leadwire resistance.
- Easily manufactured to different degrees of accuracy.

Disadvantages :

- Higher price.
- Do not perform as well in applications where high vibration and mechanical shock are present (offset by more expensive packaging).

Common Applications :

- HVAC - room, duct and refrigerant equipment
- Textile production
- Plastics processing
- Automotive - air and oil monitoring
- Exhaust gas monitoring
- Air, gas and liquid monitoring
- Petrochemical

Materials and Construction

Platinum is the most widely used material for RTDs. This is due to its stable and predictable nature. It has the highest useful temperature range (up to about 900°C with special construction), is the most repeatable at higher temperature and withstands oxidation / corrosion. Cost considerations may dictate the use of copper and nickel, but these offer a relatively low range of temperature.

Wire Wound:

The typical RTD is constructed by taking a very fine wire and winding it around an inert substrate such as ceramic or glass. These elements are typically encapsulated in glass or ceramic material to protect them from vibration, moisture, dust, and other foreign substances. Extending lead wires is accomplished by soldering, brazing or welding. The element is then ready to be packaged to meet the necessary application.

Thin Film:

The process of creating a thin film element was developed using technologies from the semiconductor industry. In this process a thin film of platinum is deposited onto a substrate usually made of ceramic materials. Through thin film technology, RTDs can be produced in a greater variety of sizes and shapes. Much smaller elements can be made than with wire wound technology. Smaller elements have the advantage of much faster response or tip sensitivity.

RTD Specifications

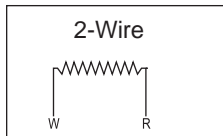
Lead Wire Configuration

RTDs may be purchased with 2, 3, or 4 lead wires extending from the sensor. In determining the number of wires, consideration of the following is important:

- Required accuracy
- Stability
- Receiving device location
- Corrosion potential - environmental conditions
- Nominal sensor range and resistance

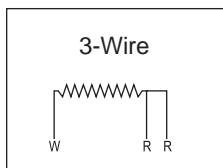
2-Wire:

This is the simplest and least expensive configuration but also the most limiting. Using 2-wire RTDs provides fair temperature measurement when the receiving device is connected directly to the sensor without the use of extension wire. The inherent resistance caused by using extension wires cannot be compensated when using a 2-wire configuration. Extension wires are also subjected to corrosion which may further degrade the reading.



3-Wire:

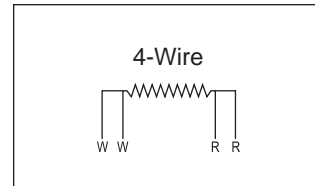
The 3-wire is used for applications that require extension wires between the RTD and the receiving device. Adding a lead and ensuring that the 3 leads have the same resistance values compensates for extension wire length. The 3-wire configuration is still subject to corrosion so proper precautions should be taken.



4-Wire:

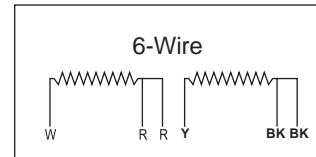
The 4-wire configuration alleviates the problems due to extension wire length and resistance imbalance between the leads. Because of this, corrosion and environmental conditions are less of a concern.

Since there is no issue with lead resistance, 4-wire RTD's can use a smaller gauge wire. For these reasons there are many applications that can benefit from the use of a 4-wire RTD. These are applications that require high accuracy, where the sensor and receiving device are some distance apart, and in corrosive conditions.

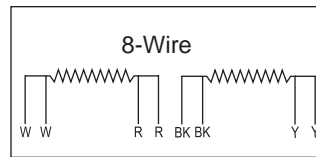


Dual Combinations are also available:

Dual 3-Wire RTDs



Dual 4-Wire RTDs



Standard Lead wire Material

Temp Range Code	Lead wire Material	Maximum Transition Temperature
A	Silver plated Copper/ Teflon Insulation	150°C (300°F)
B	Nickel-Clad Copper/ Fiberglass Insulation	260°C (500°F)
C	Nickel-Clad Copper/ Fiberglass Insulation	260°C (500°F)
D	Nickel-Clad Copper/ Fiberglass Insulation	260°C (500°F)

RTD Specifications

Temperature Coefficient of Resistance (TCR)

The temperature coefficient of resistance of an RTD is determined by the purity of the winding wire used in the manufacture of the element. It is defined as the resistance change per ohm/ohm °C. Weed's standard sensors utilize a high purity of winding wire with the following TCR's:

Platinum: Curve A = .003902 ohms/ohm/°C
 Curve B = .00385055 ohms/ohm/°C
 Nickel: .006720 ohms/ohm/°C
 Copper: .004274 ohms/ohm/°C

Sensor Resistance Change per Degree at 0°C (32°F)

Ice Point Resistance	Ohms
100 ohm Platinum	.39 ohms
200 ohm Platinum	.78 ohms
400 ohm Platinum	1.56 ohms
500 ohm Platinum	1.95 ohms
1000 ohm Platinum	3.90 ohms
120 ohm Nickel	.72 ohms
10 ohm Copper	.039 ohms
100 ohm Copper	.39 ohms

Refer to the expanded RTD Temperature vs. Resistance charts in our Reference Section.

Matched Pairs for Differential Temperature

Weed offers a variety of calibration services which can further improve/enhance the accuracy of an RTD. These include providing calibration constants for an RTD, providing matched RTD pairs, or a match calibrated RTD-to-transmitter. Matched elements and sensor accuracy's can be +/- .1°F with respect to their ice-point values. An RTD's output at various temperatures can be determined and a transmitter calibrated to these values, thus eliminating the sensor accuracy (non repeatability) from the system.

- Matched to Transmitter (MT)
- Matched Elements (ME)
- Matched Probes (MP)

Repeatability

The repeatability of a temperature sensor is defined as the ability of the sensor to repeat the same output value at a given temperature point in a spanned temperature range. This specification is normally of greater importance than absolute accuracy. Weed Instrument sensors will repeat any temperature point within their specified temperature range to ±0.14°C (±0.25°F) or .05%, whichever is greater.

Self Heating

Self heating is the rise in the indicated temperature due to power dissipated within the sensor. In 20°C (68°F) water flowing transverse to the sensor sheath at 3 fps (feet per second), the following data will apply:

Sheath Diameter	Self Heating
1/8"	75mw/°C
3/16"	50mw/°C
1/4"	50mw/°C

Standard Time Response

(Nominal Values for single element sensors)
 Time response is defined as the time necessary for a sensor to reach 63.2% step change of temperature in water moving transverse to the sensor sheath at 3 fps. The following values are typical for single element sensors with a maximum temperature range of 500°F:

Sheath Diameter	Time Response
1/8"	1.5 seconds
3/16"	2.5 seconds
1/4"	5.0 seconds

Consult factory for specific applications requiring faster response time.

Insulation Resistance

At 21°C (70°F) with dry external surfaces, the resistance between any lead wire and the sensor sheath is 100 megohms or greater at 100 VDC.

Vibration

The vibration capability of a typical 5-inch-long sensor is 25 G's from 20 to 2000 Hz in any axis for more than 15 minutes.

RTD Specifications

Temperature Range - Element		
Temp. Range Code	Min. Temp.	Max. Temp
A	-50°C (-58°F)	260°C 500°F)
B	-200°C (-328°F)	925°C (1700°F)
C	-100°C (-148°F)	480°C (900°F)
D	-200°C (-328°F)	650°C (1200°F)

Consult factory for temperature ranges that exceed the above limits.

Temperature Range - Sheath		
Temp. Range Code	Temp. Range	Material
A	260°C (500°F)	316 SS
B	925°C (1700°F)	Inconel 600
C	480°C (900°F)	316 SS
D	650°C (1200°F)	Inconel 600

Consult factory for temperature ranges that exceed the above limits.

Maximum Sheath Pressure - Direct Immersion RTD

Sheath Diameter	Sheath Material	25° C (77°F)	260°C (500°F)	480°C (900°F)	650°C (1200°F)	925°C (1700°F)
1/8"	316SS	3500 psi	2800 psi	2100 psi	-	-
	Inconel 600	-	-	-	2800 psi	900 psi
3/16"	316SS	3150 psi	2550 psi	1950 psi	-	-
	Inconel 600	-	-	-	2550 psi	800 psi
1/4" wt/out fittings	316SS	2400 psi	1900 psi	1500 psi	-	-
	Inconel 600	-	-	-	1900 psi	600 psi
1/4" wt welded fittings	316SS	4000 psi	3200 psi	2500 psi	-	-
	Inconel 600	-	-	-	3200 psi	1000 psi

Standard Accuracy Platinum (100 ohm, DIN B)

Temperature		Tolerance		
°C	°F	+/-°C	+/-°F	+/-ohms
-100	-148	.8	1.44	.32
0	32	.3	.54	.12
100	212	.8	1.44	.30
200	392	1.3	2.34	.48
300	572	1.8	3.24	.64

Optional High Accuracy Platinum (100 ohm, DIN A)

Temperature		Tolerance		
°C	°F	+/-°C	+/-°F	+/-ohms
-100	-148	.35	.63	.14
0	32	.15	.27	.06
100	212	.35	.63	.13
200	392	.55	.99	.20
300	572	.75	1.35	.27