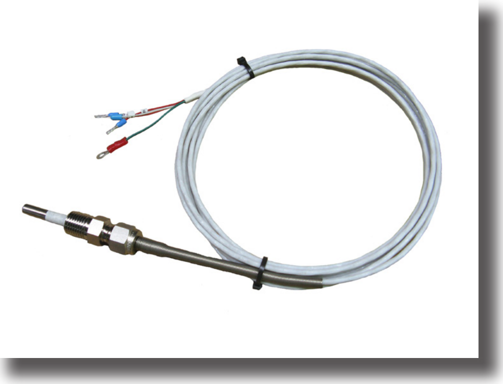
ResistanceTemperature Detector - 4155

The Liquip 4155 Resistance temperature detector (RTD) consists of a wire coil or deposited film of pure metal. The element's resistance increases with temperature in a known and repeatable manner. The RTDs exhibit excellent accuracy over a wide temperature range.



Temperature range	-200 to 600°C
Sensitivity	The voltage drop across an RTD provides a much larger output than a thermocouple.
Linearity	Platinum and copper RTDs produce a more linear response than thermocouples or thermistors. RTD non-linearities can be corrected through proper design of resistive bridge networks.

The most commonly used element material is platinum with a resistance of 100 ohms at 0°C and a temperature coefficient (Alpha) of 0.00385 ohms/ohm/°C.

Other probe materials also used are copper, nickel and nickel-iron. Platinum probes predominate because of their wider range, and because platinum is the most repeatable and stable of all metals.

Tolerance of PT100 Ω (Alpha = 0.003850 @ 0°C)
CLASS 'B' ± 0.12 Ω OR ± 0.30°C
CLASS 'A' ± 0.06 Ω OR ± 0.15°C
1/3 DIN ± 0.04 Ω OR ± 0.10°C
1/10 DIN ± 0.012 Ω OR ± 0.03°C

Probes should be wired using a screened copper conductor cable to prevent Electromagnetic interference.

Ordering Information

- **4155**: Temperature Probe COMP PT100 CLASS A.

Self Heating

All our platinum resistors have a measuring current on 1mA during measurement.

However they will work with a 2mA current but you must be aware that the increase in mA will cause self heating and the greater the mA the more self heating will occur.

Since an RTD measures temperature by passing a current through a resistor (the RTD), the error known as self-heating occurs.

Primarily the sensor's mass, its internal construction, the measurement current and to a large degree environmental conditions determine the magnitude of this error. Normally a very small current, usually 1.5 mA is used in the excitation circuit to minimize this joule heating of the sensor. Thermo Sensors' internal construction technique maximizes heat transfer quality to further reduce the effect.

An installation condition requiring large mass hardware such as thermowells or protective tubes coupled with an environment of still or slow moving air is going to experience a great deal more self-heating than the next example. a small diameter (.250" O.D.) direct immersion probe mounted in an environment of flowing water (min. 3 ft./sec) could totally dissipate the error.

Fortunately if a small measuring current (1-2 ma) is used, self heating errors will be well within acceptable levels for industrial applications.

To approximate the amount of error; consider that normally the dissipation constant will be of the magnitude of 20-100 mw/0°C, and use the formula on the next page.

Self-heating error = $\frac{\text{Power}}{\text{Dissipation constant}}$

Example: Measurement current - 2 ma
Resistance of sensor - 140 ohms
dissipation constant - 50 mw/0°C

Power = 1^2R
= $(.002)^2$ (140) = 0.56 MW

Error = $\frac{.56\ \text{mw}}{50\ \text{mw/0°C}}$ .011°C

TEMPERATURE OFFSET IN STILL AIR

RTD Current	Ceramic SIP	Encapsulated
0.1 mA	< 0.02ºC	< 0.02ºC
1.0 mA	0.83ºC	0.50ºC

Ex ia Circuits

RTD sensor are considered to be a simple apparatus (Ex ia) and with appropriate barriers can be freely installed in IS circuits, (Ex ia) no further certification is required.

Operation values maximum at terminals

Voltage 10V DC
Current 10mA (working current <2mA)
Power 15mW
Capacity 0uF
Inductivity 0mH

*The maximum values must not be exceeded.

Vibration

This is one area where thermocouples have an advantage over RTD sensors. The size of the wires used in a 6.0 mm Dia MIMS Thermocouple are approximately 16 AWG (1.2 mm diameter) and they stand up to vibration much better than the 30 AWG (0.25 mm diameter) wires used for RTD MIMS sensors. The 30 AWG wires are attached to fine Platinum wire (approx. 15 to 30 Microns) used to wind the resistance element and consequently is very fragile if not supported correctly.
Failures maybe in the form of open circuits, noisy circuits or intermittent high readings.
In the manufacture of Ex approved RTD sensors Temperature Controls exclusively use TDI Ltd Ceramic partially supported construction elements.

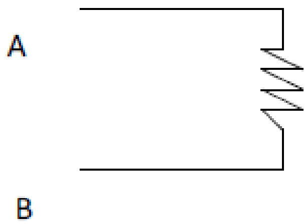
In this construction the wire is wound onto a very small coil and inserted into axial holes in a high purity alumina rod. A small quantity of glass adhesive is introduced into these holes which, after firing, firmly secures part of each turn onto the alumina.

This results in a detector in which the majority of the platinum wire is free to move, giving excellent long term stability, and which will withstand levels of vibration up to 30G without damage.

Connection / Wiring details

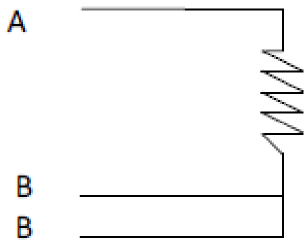
Different connection Types. Standard Colour code; A is white, B is red.

2 wire



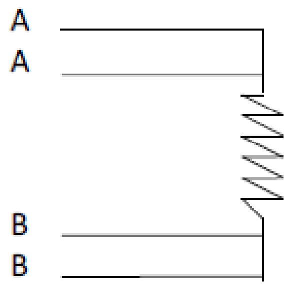
Basic connection where the lead is short. No lead wire compensation, introducing an error into the reading.

3 wire



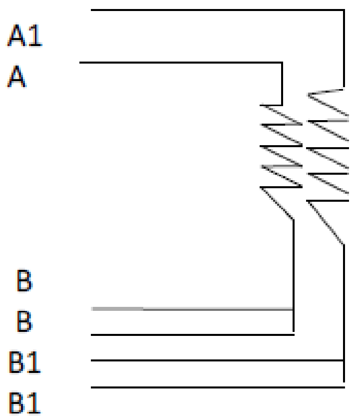
Most common connection 3 wire, the instrument measures the lead wire resistance in the B legs and allows for this in its reading.

4 wire



4 wire connection is the most accurate measurement. The instrument measures the lead resistance of all four lead wires removing these values for its reading

Duplex
RTD



Duplex 3 wire RTD connection as per single RTD but two individual element windings.

Table for Platinum resistance elements.

Resistance values in Ohms from 0°C to + 400°C.

PT100 ohm RTD to DIN 43760 - IEC 751 – EN60 751

R(0) = 100 ohm

°C	0	1	2	3	4	5	6	7	8	9
0	100.00	100.39	100.78	101.17	101.56	101.95	102.34	102.73	103.12	103.51
10	103.90	104.29	104.68	105.07	105.46	105.85	106.24	106.63	107.02	107.40
20	107.79	108.18	108.57	108.96	109.35	109.73	110.12	110.51	110.90	111.28
30	111.67	112.06	112.45	112.83	113.22	113.61	113.99	114.38	114.77	115.15
40	115.54	115.93	116.31	116.70	117.08	117.47	117.85	118.24	118.62	119.01
50	119.40	119.78	120.16	120.55	120.93	121.32	121.70	122.09	122.47	122.86
60	123.24	123.62	124.01	124.39	124.77	125.16	125.54	125.92	126.31	126.69
70	127.07	127.45	127.84	128.22	128.60	128.98	129.37	129.75	130.13	130.51
80	130.89	131.27	131.66	132.04	132.42	132.80	133.18	133.56	133.94	134.32
90	134.70	135.08	135.46	135.84	136.22	136.60	136.98	137.36	137.74	138.12
100	138.50	138.88	139.26	139.64	140.02	140.39	140.77	141.15	141.53	141.91
110	142.29	142.66	143.04	143.42	143.80	144.17	144.55	144.93	145.31	145.68
120	146.06	146.44	146.81	147.19	147.57	147.94	148.32	148.70	149.07	149.45
130	149.82	150.20	150.57	150.95	151.33	151.70	152.08	152.45	152.83	153.20
140	153.58	153.95	154.32	154.70	155.07	155.45	155.82	156.19	156.57	156.94
150	157.31	157.69	158.06	158.43	158.81	159.18	159.55	159.93	160.30	160.67
160	161.04	161.42	161.79	162.16	162.53	162.90	163.27	163.65	164.02	164.39
170	164.76	165.13	165.50	165.87	166.24	166.61	166.98	167.35	167.72	168.09
180	168.46	168.83	169.20	169.57	169.94	170.31	170.68	171.05	171.42	171.19
190	172.16	172.53	172.90	173.26	173.63	174.00	174.37	174.74	175.10	175.47
200	175.84	176.21	176.57	176.94	177.31	177.68	178.04	178.41	178.78	179.14
210	179.51	179.88	180.24	180.61	180.97	181.34	181.71	182.07	182.44	182.80
220	183.17	183.53	183.90	184.26	184.63	184.99	185.36	185.72	186.09	186.45
230	186.82	187.18	187.54	187.91	188.27	188.63	189.00	189.36	189.72	190.09
240	190.45	190.81	191.18	191.54	191.90	192.26	192.63	192.99	193.35	193.71
250	194.07	194.44	194.80	195.16	195.52	195.88	196.24	196.60	196.96	197.33
260	197.69	198.05	198.41	198.77	199.13	199.49	199.85	200.21	200.57	200.93
270	201.29	201.65	202.01	202.36	202.72	203.08	203.44	203.80	204.16	204.52
280	204.88	205.23	205.59	205.95	206.31	206.67	207.02	207.38	207.74	208.10
290	208.45	208.81	209.17	209.52	209.88	210.24	210.59	210.95	211.31	211.66
300	212.02	212.37	212.73	213.09	213.44	213.8	214.15	214.51	214.86	215.22
310	215.57	215.93	216.28	216.64	216.99	217.35	217.70	218.05	218.41	218.76
320	219.12	219.47	219.82	220.18	220.53	220.88	221.24	221.59	221.94	222.29
330	222.65	223.00	223.35	223.70	224.06	224.41	224.76	225.11	225.46	225.81
340	226.17	226.52	226.87	227.22	227.57	227.92	228.27	228.62	228.97	229.32
350	229.67	230.02	230.37	230.72	231.07	231.42	231.77	232.12	232.47	232.82
360	233.17	233.52	233.87	234.22	234.56	234.91	235.26	235.61	235.96	236.31
370	236.65	237.00	237.35	237.70	238.04	238.39	238.74	239.09	239.43	239.78
380	240.13	240.47	240.82	241.17	241.51	241.86	242.20	242.55	242.90	243.24
390	243.59	243.93	244.28	244.62	244.97	245.31	245.66	246.00	246.35	246.69
400	247.04									

There is no maintenance required for RTD sensors however, scheduled calibration checks at ice point (0ºC) are recommended.

RESISTANCE THERMOMETERS AND THEIR ELEMENTS

According to Australian Standard 2091 – 1981 - PT100 Ω DIN 43760 – EN60 751 ALPHA 0.00385.

Method for Determining Ice-Point (°C) Resistance
a. Insulated container. An insulated container at least 300 mm deep and with an internal diameter of 100 mm.

PROCEDURE. The procedure shall be as follows:

(a) Fill the insulated container with finely divided ice made from distilled water.

Note: If ice water from distilled water is not available, the clear part of a block of commercial ice will suffice, provided that all surfaces are first washed with distilled water.

b) Mix the ice with distilled water which has been pre-cooled, using the stirrer, and then drain off the excess water. The ice should be glassy-looking but there should be no free water remaining.

c) Connect the thermometer to an appropriate resistance measuring device and adjust so that the electrical power dissipated in the element does not exceed 1 m W.

d) Immerse the thermometer in the ice so that the element is at a depth of at least 150 mm. Ensure that the lower tip of the thermometer is at least 30 mm clear of the bottom of the container.

Note: Thermometers with stem lengths less than 150 mm should be immersed to their maximum possible depth.

e) When the element reaches equilibrium with the ice, measurements may be taken. Measurements carried out with direct current shall be made with the current in both the forward and reverse directions.

Note: The time taken for the element to reach equilibrium is normally about 3 minutes.

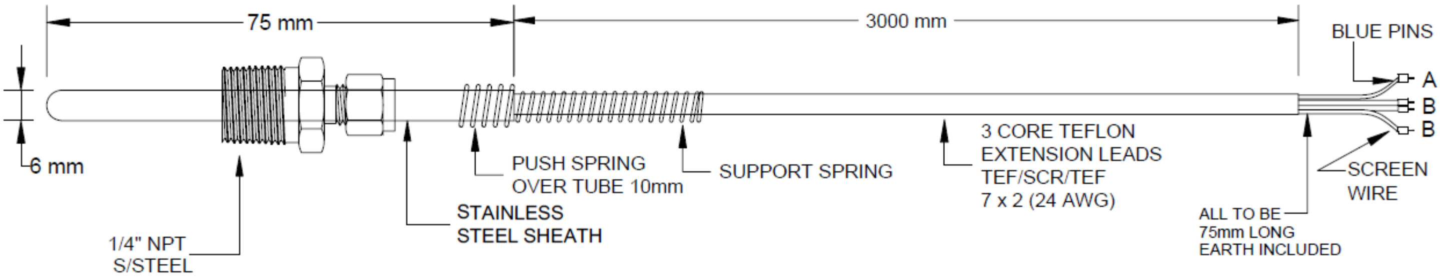
f) Decrease the depth of immersion of the element by 50 mm or 20 percent of the stem length, whichever is the smaller.

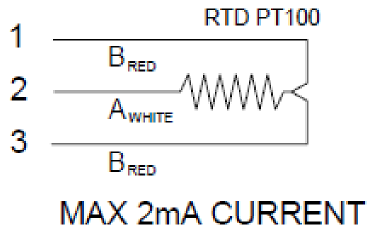
g) Repeat step (e). If the change in reading is more than on-third the appropriate tolerance given in Clause 2.2, the whole procedure shall be repeated with fresh ice.

Workshop certificate. The workshop certificate shall state the following information:

a. Identify instrument ie PT100 Ω DIN 43760 – EN60 751 ALPHA 0.00385
b. The measured resistance at 00C.
c. The difference between the nominal resistance and the measured resistance at 00C.
d. Uncertainty of Bath

Accuracy: RTD Sensors PT100 Ω at 0 °C = Class B +/- 0.3 °C, Class A +/- 0.15 °C, 1/10 DIN = +/- 0.03 °C





RTD PT100 SENSOR
3 CORE TEFLON TAILS
TC02 STYLE
WITH RELIEF SPRING