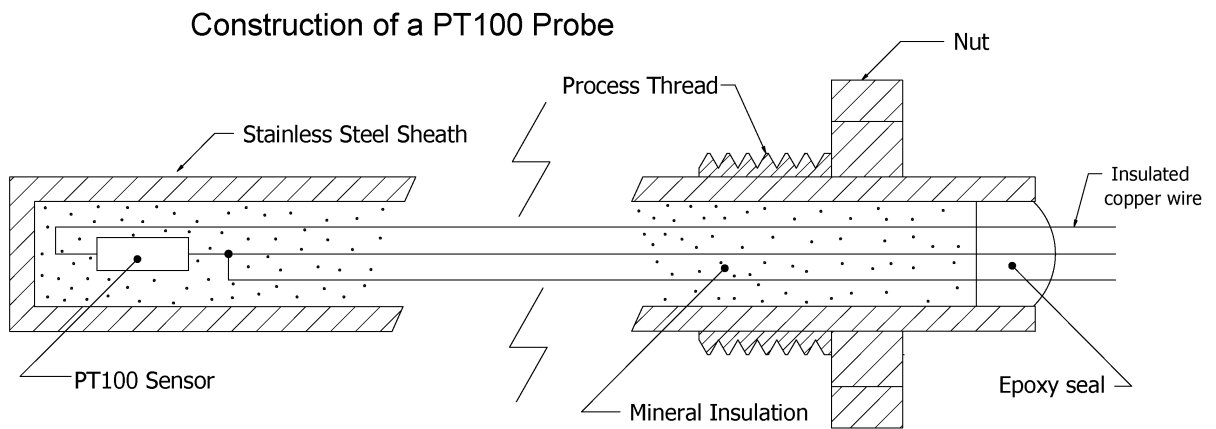


Simple temperature measurement using a PT100 loop powered temperature transmitter.

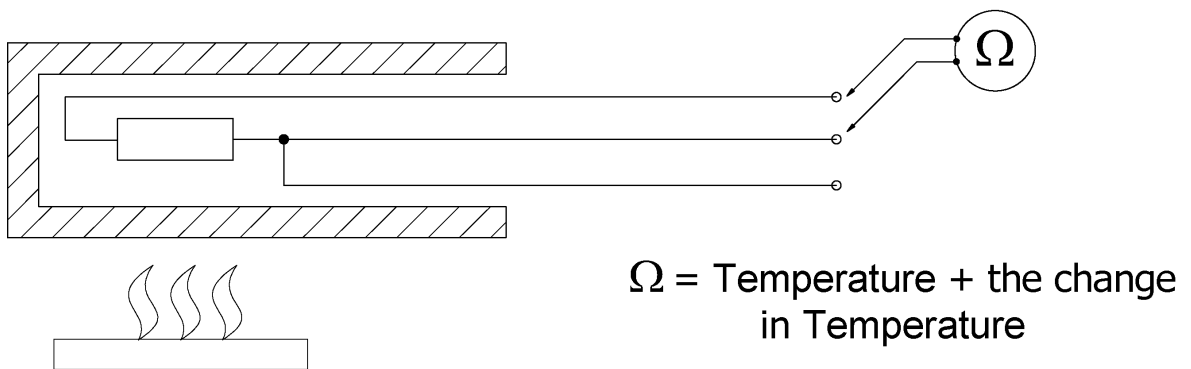
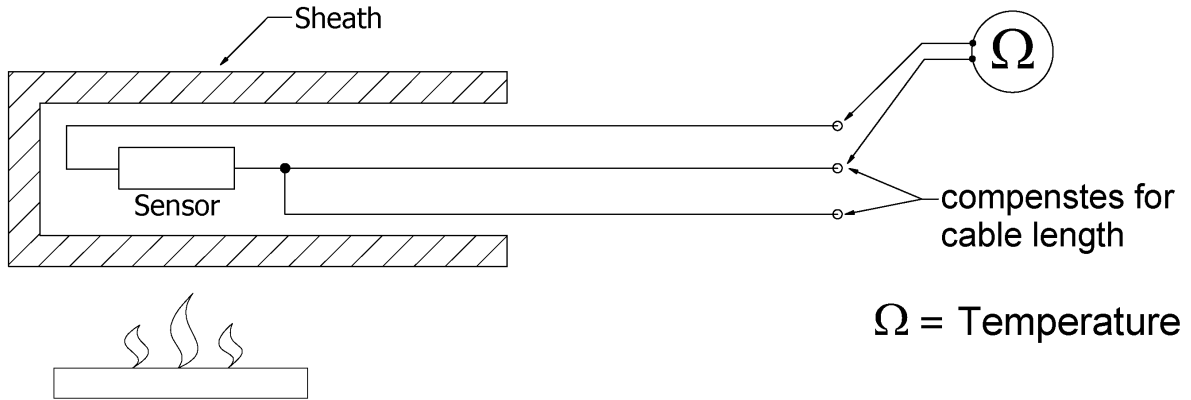
SEM203P	SEM310(X)	SEM1801
SEM206P	SEM315	SEM1802
SEM210(X)	SEM1603P	TTR200(X)
SEM213P	SEM1610	
SEM1802		

### Pt100 Probes



A Pt100 probe or sensor is a type of resistive temperature detector (RTD) that will change its resistance as a function of temperature.

Pt100 probe resistance most commonly measures 100 ohms at 0°C and 138.51 ohms at 100°C, the temperature range for a Pt100 probe is normally within (-200 to 850) °C. However, in practice we tend to switch to thermocouples over 600 Deg C.

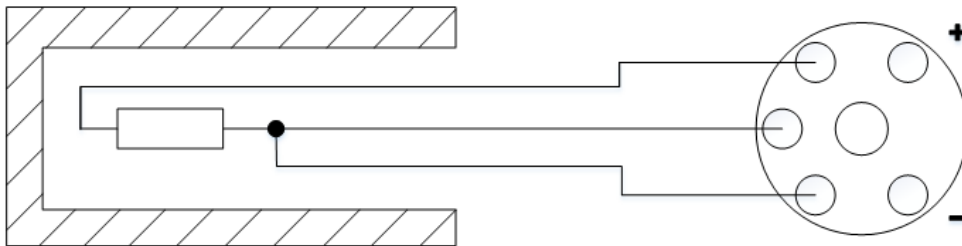


A change in temperature on the Pt100 creates a change in its resistance. The resistance of the probe can be measured and its temperature can be attained.

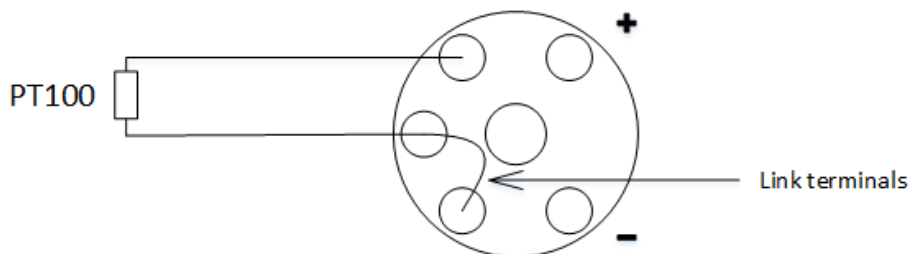
## Pt100 Transmitter Connections

A three wire Pt100 probe normally has two red wires and one white wire. One end of the internal Pt100 sensor is connected to the red wires and the other end of the sensor to the white wire.

The resistance of the sensor is measured across the red wires and the white wire. The two red wires are joined where they connect to the internal Pt100 sensor, this method is used to compensate for the length of the wires so the resistance in the leads will not cause an offset in the temperature reading.

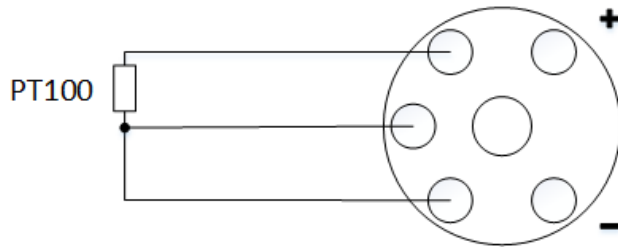


## 2 Wire Connection



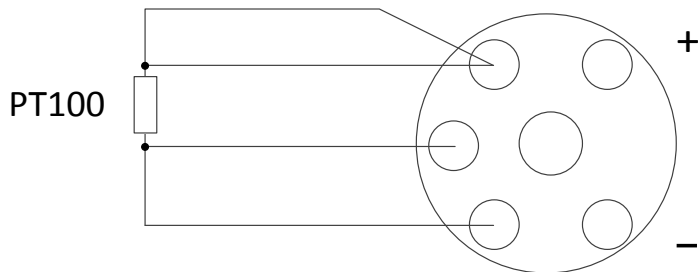
Two wire PT100 probe connected to a loop powered temperature transmitter  
A two wire probe can be connected to a three wire input temperature transmitter by shorting two of the input terminals on the temperature transmitter. However, there will be no lead resistance compensation. In this case lead resistance will be added to sensor resistance. (0.38ohms = 1 DegC)

### 3 Wire Connection

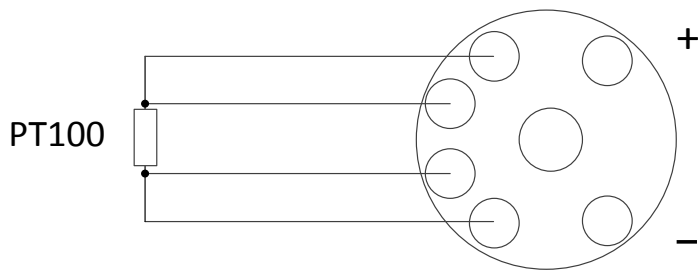


Three wire PT100 probe connected to a loop powered temperature transmitter  
A three wire probe can be connected to a three wire input temperature transmitter as shown above.

### 4 Wire Connections



Four wire PT100 probe connected to a loop powered temperature transmitter



Four wire PT100 probe connected to a four wire temperature transmitter (SEM310)

A four wire probe is typically used for a higher accuracy as it has lead resistance compensation in both sides of the element. This type of probe is used for 2 reasons.

- Long lead length where the resistance of the lead can become an issue and offset the temperature reading.
- Higher accuracy, a higher class of Pt100 element should be used. Class A or 1/10<sup>th</sup> DIN are higher accuracy elements than the standard fit Class B. However, beware it is very difficult to calibrate for complete system accuracies less than 0.5 Deg C.

The Status Instruments SEM310 or SEM315 can be used for 4 wire measurements..

## Loop powered temperature transmitters

A (4 to 20) mA loop can be used for representing a variety of engineering or process values including temperature.

It is a robust signal capable of transmission over 100s of metres and is easily connected to a multitude of control or monitoring equipment.

The temperature transmitter's (4 to 20) mA output current will be configured to represent a range of temperature from the PT100 probe.

For example a temperature range of (0 to 100) °C can be represented by (4 to 20) mA by the output of the temperature transmitter. This relationship between input signal and output range is linear so that:-

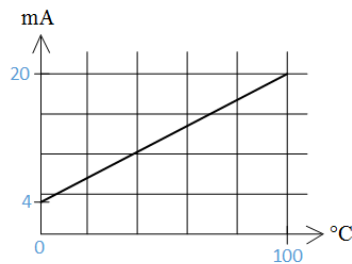
0°C = 4 mA

25°C = 8 mA

50°C = 12 mA

75°C = 16 mA

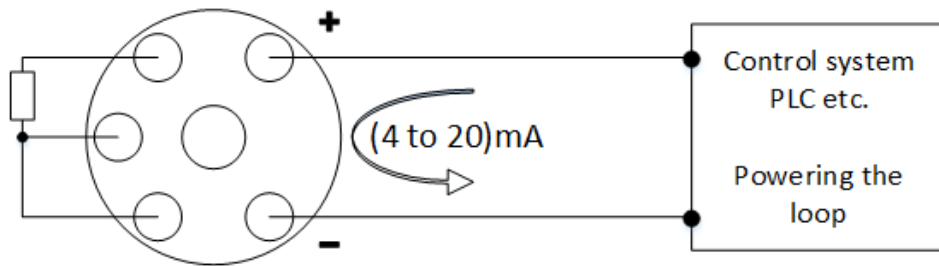
100°C = 20 mA



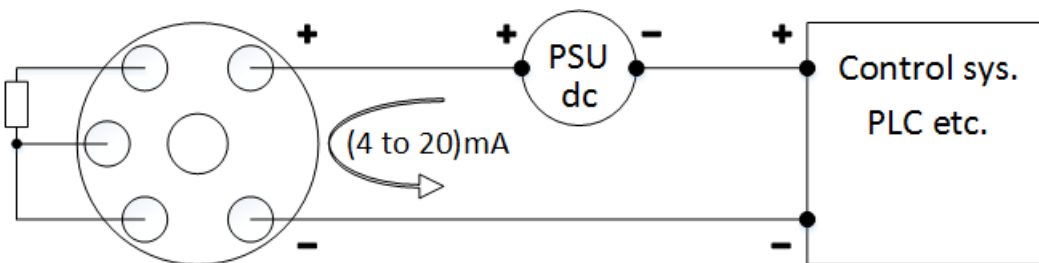
The output temperature range will be chosen to match the application and must also be matched to the control or monitoring system (display, PLC, etc.).

### Loop powered temperature transmitter (4 to 20) mA output connections

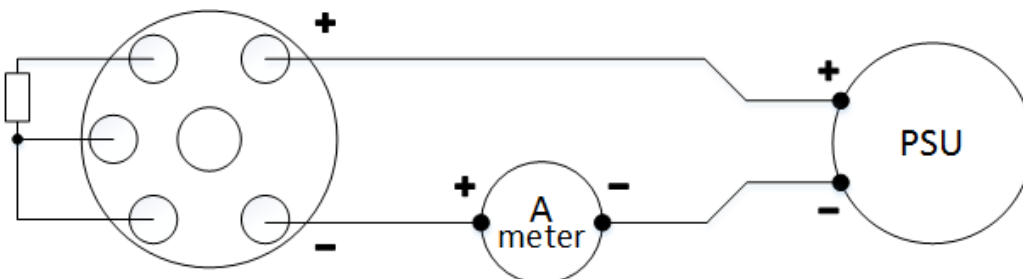
The temperature transmitter's output pins are connected to a supply voltage, this is normally within (10 to 30) VDC, a current of between 4 mA and 20 mA will flow in the circuit. Higher and lower conditions may be possible to indicate fault conditions. (Refer to the product data sheet for information) Known as burnouts .



A temperature transmitter connected to a control system/unit that is powering the (4 to 20) mA loop



A temperature transmitter connected to a control system/unit with an external power supply powering the (4 to 20) mA loop



**Z1485-01-01 Simple temperature measurement using a (PT100) loop powered temperature transmitter**

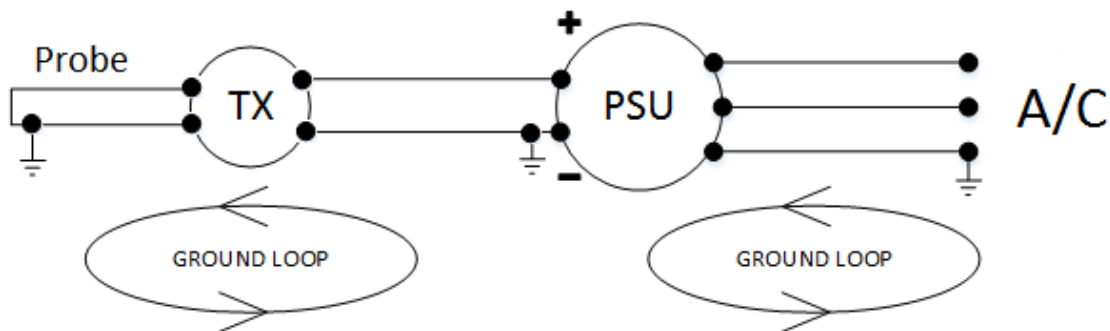
An ammeter can be used to check the current flowing in the loop.

### Ground or Earth Loops

Most analogue (4 to 20) mA loops are grounded at a single point, problems occur when there is more than one grounding point because earth potentials will not be the same, and currents will flow between earth points causing errors or noisy signals.

If the (4 to 20) mA signal is connected to multiple instruments which have non isolated inputs this can cause problems. A simple way to remove ground loops is to use signal isolators

Sometimes leakage through mineral insulated probes can give an undesired path to earth and cause errors, use of a temperature transmitter with an isolated input can help remove this type of problem.

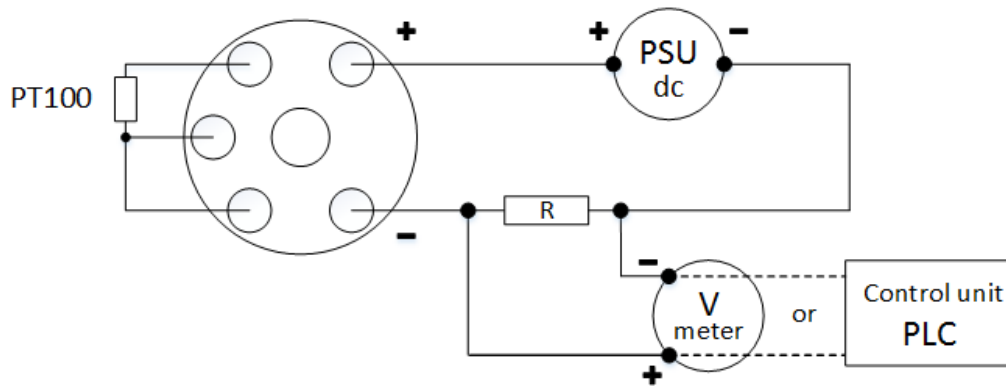


### Voltage output

A voltage output of (1 to 5) V or (2 to 10) V is possible by using an external resistor in series in the loop and detecting the voltage dropped across it.

It is NOT possible to have a (0 to 5) V or (0 to 10) V output.





Resistor Value R

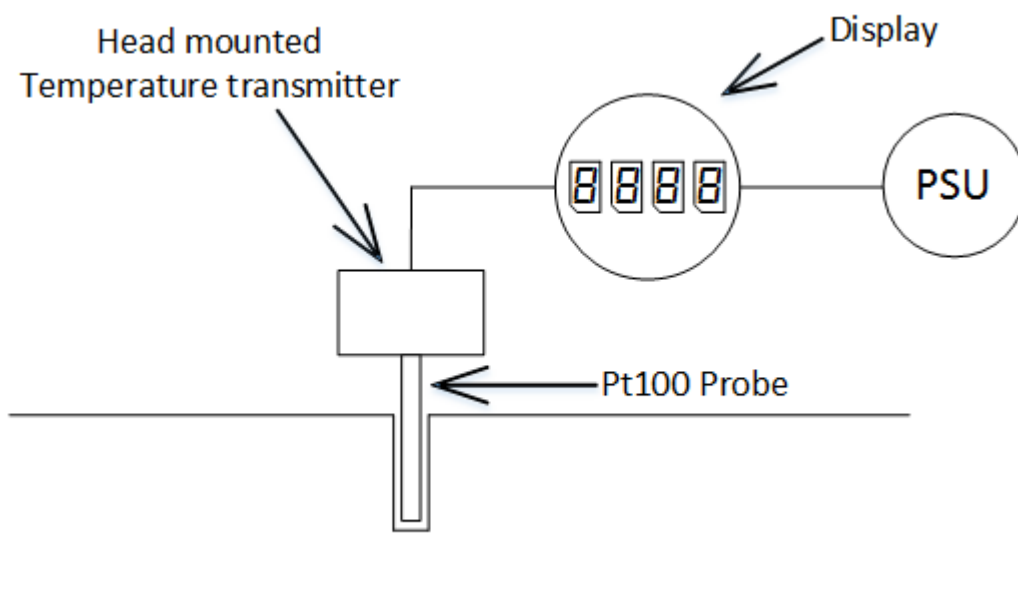
250 Ohm = (1 to 5) V output

500 Ohm = (2 to 10) V output

Temperature measurement using a loop powered temperature transmitter

**Z1485-01-01 Simple temperature measurement using a  
(PT100) loop powered temperature transmitter**

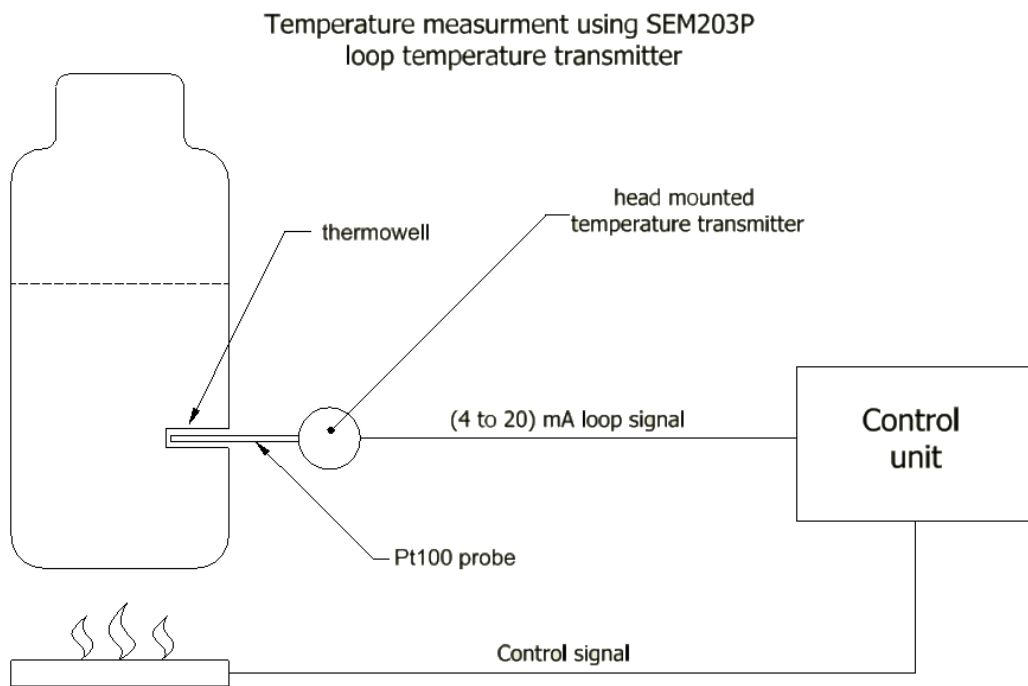
A simple temperature display system is shown below, in this example the probe is fitted to a pipe so the temperature of the liquid flowing in it can be monitored. The probe has a connection head fitted at the non-process end for locating a head mount temperature transmitter



The (4 to 20) mA output loop from the temperature transmitter is being powered by a dc power supply, the signal from the temperature transmitter is also passing through a loop powered display.

The system is displaying the process temperature based on the temperature of the probe.

A simple temperature control system is shown below, in this example a thermo-well or pocket is used to allow a probe to be removed from the tank without the need to drain it first.



A simple temperature control application

The (4 to 20) mA output loop from the temperature transmitter is being powered by the controller which is also sending a signal to a heater, it can also give an alarm if the process goes out of limits.

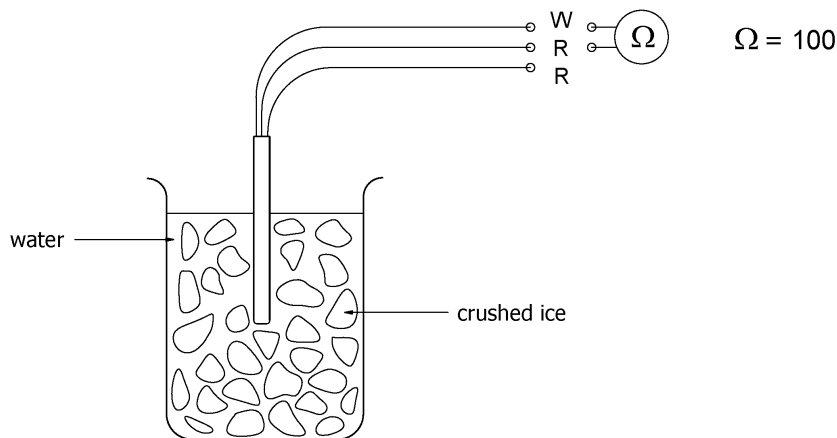
The system is controlling the process temperature based on the temperature of the probe.

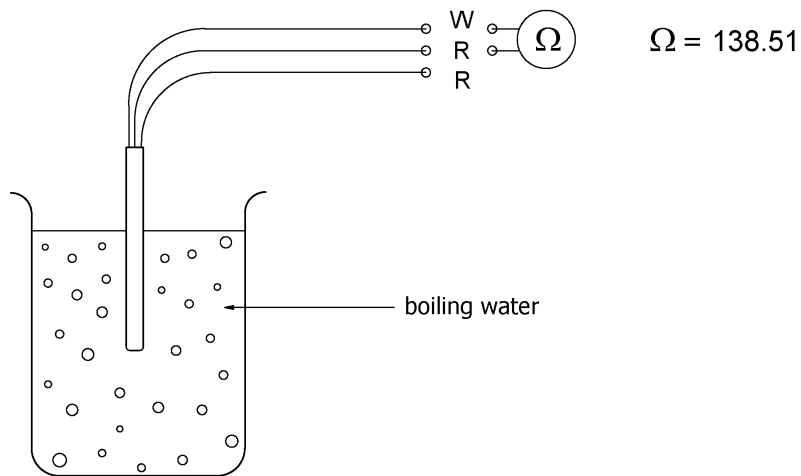
### Simple fault finding

A simple technique for fault finding a PT100 probe is to measure the resistance at known temperatures.

Zero and 100°C test points are easily created.

For 0°C fill a container such as a thermos flask with crushed ice, then top up with water. After the probe has been left to settle in the flask the resistance between the white and red wires should be approximately 100 ohms





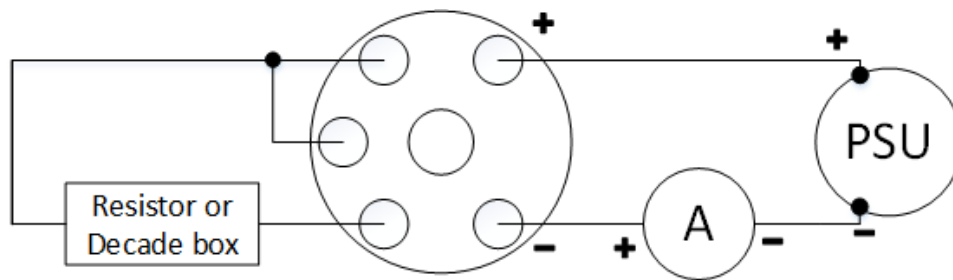
For 100°C fill a container such as a thermos flask with boiling water. After the probe has been left to settle in the flask the resistance between the white and red wires should be approximately 138.51 ohms

A simple technique for fault finding a PT100 temperature transmitter is to simulate the PT100 probe by using resistors or a resistance decade box.

The best values to use are those that correspond to the low, midpoint and high range of the temperature transmitter configuration.

Corresponding resistance to temperature tables for PT100 probes are readily available.

Apply the resistance to the input of the temperature transmitter and look at the current flow through the loop with an ammeter to ensure it is correct for the given value.



Insulation test.

If the insulation in the probe's sheath is breaking down it can cause the probe to give incorrect readings.

Short all the sensor wires together, then with a dedicated insulation tester check between the probe sheath and the shorted wires, look for a value of greater than 20 M ohms.