THE DIFFERENCE BETWEEN 2, 3 AND 4 WIRE RTDS

CONTENT

RTDs are a type of temperature sensor; a “Resistance Temperature Detector”. They are available with difference wire configurations; 2 wire, 3 wire and 4 wire.

The correct wire configuration can be determined by the application itself. Different applications will require different levels of accuracy and ease which can help to define which RTD sensor to use.

1. General RTD Information

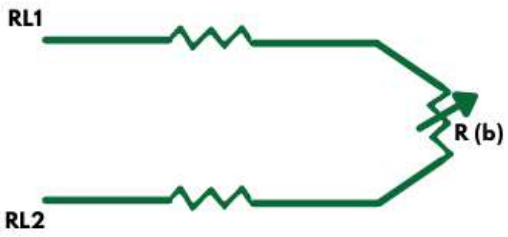
RTDs measure temperatures within an electric circuit, the temperature is determined based on the amount of resistance within the circuit - hence the name Resistance Temperature Detector.
RTDs are passive devices, meaning they don’t produce their own output, an external device is required to measure the resistance of the sensor. This is done by passing a small electrical current through it to generate voltage.
RTDs are manufactured to standardised universal curves and tolerances to describe the resistance vs temperature characteristics. Different materials used for RD wires will alter and change the curves.

2.1 Two Wire RTDs

2 wire RTDs contain a single wire connecting each end of the RTD element. It is the simplest RTD wire configuration. The resistance calculated will include all elements of the circuit which means there is a higher degree for error. As there are only 2 wires, they are unable to compensate for any addition resistance caused by other elements within the circuit.

Systems can be calibrated to eliminate the error; however, this is still not always accurate or the best solution.

Therefore, a 2 wire RTD is often used in applications with short wires, high resistance sensors or where high accuracy is not of the utmost importance.

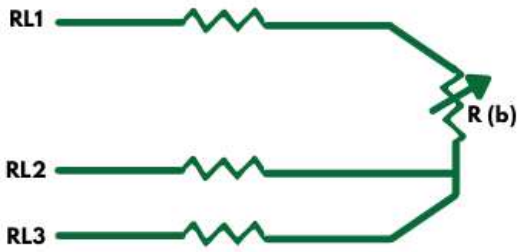


Measured Resistance R_t = $R_1 + R_2 + R_b$

In this instance the measured resistance is Rt=R1+R2+Rb, otherwise known as RTOTAL as it is the total amount of resistance within the circuit. The simplest measurement with a degree of error included.

2.2 Three Wire RTDs

The 3-wire construction of an RTD is the most common type. One side of the element has one wire connected and the other side has two wire connections. This allows for the extra resistance created in the circuit to be compensated for. This gives a more accurate reading.



$$(R_{1+2+Rb}) - (R_{2+3}) = (R_b)$$

The resistance is calculated by first calculating the resistance between wires 1 and 2 and then subtracting the resistance between wires 2 and 3 which results in an accurate measurement for the resistance element (Rb). This method assumes that all wires are measuring the same resistance; they therefore must be identical.

A 3 wire RTD is the most common type as they are accurate for most types of application. However, there are still inaccuracies if the wires have different resistances. Therefore, for a fully accurate solution a 4 wire RTD is recommended.

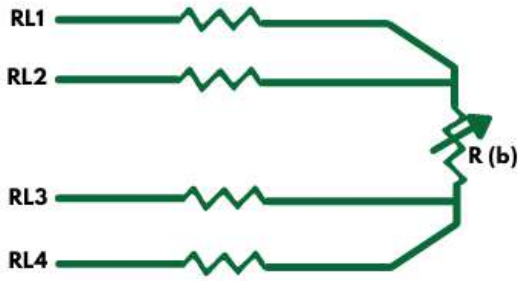
2.3 Four Wire RTDs

It goes without saying that the 4 wire RTD is the most complex solution – this is also reflected in the price of this type of RTD. They are primarily used in laboratory applications where extreme high accuracy is essential.

This circuit is used for longer wire lengths between the measuring element and the measuring electronics as it is able compensate for errors caused by the wire resistance.

In contrast to the 3-wire circuit, where it is assumed that all wires have the same resistance. The 4 wire RTD circuit assumes that each wire has a unique measurement of resistance. This compensates for the entire wire resistance to give the most accurate reading of all RTDs.

When using a 4-wire RTD, two of the wires are connected to each end of the measuring element (usually wires 1 and 4). A distinct small measuring current is constantly applied in the measuring element, so that it can be constantly checked as a comparison variable. The voltage drop that occurs at the measuring resistor can measured on wires 2 and 3. Using the „fault current“ flowing through the very high-resistance input, the voltage drop at the wire resistances can be neglected and the measuring input can then detect the real voltage drop at the measuring resistor almost 1 to 1.



Ohm‘s law can be used to determine the exact measuring resistance by dividing the measuring voltage by the constant current. Umeas / I = Rmeas

4. Conclusion
In conclusion, the main difference between 2,3 and 4 wire RTDs is the level of accuracy. For applications where extreme high accuracy is required, we would recommend the use of a 4 wire RTD.

However, for most applications a 3 RTD is sufficient, this is the most commonly used within most industrial settings.

2 wire RTDs are the least accurate and the lowest cost, for applications where accuracy is not a priority then 2 wire RTDs are a good choice.

5. Further Information
We have a wide range of RTDs available to view on our website. Take a look at our RTD page here.

In addition to our range from our trusted suppliers we also off our very own RTD sensor – the ERTD2. The datasheet can be found here.

Our range of RTD sensors are suitable for use in automotive applications, white goods, energy management, HVAC as well as medical or industrial applications.
If you require further technical information on RTD sensors, please contact us.

Want more information?
Contact us today!

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