

### Two, three and Four Wire Circuits for RTDs

### Case A190409

#### Application

“How far can I run the lead wires from an RTD to a signal conditioner” is a commonly asked question with more than one answer. The two most significant factors to consider are measurement accuracy and the capability of the signal conditioning device. A temperature transmitter for example, typically has a maximum allowable resistance for each lead wire that connects the RTD and that will determine the maximum distance. Measurement accuracy can play into how far you may want to transmit the signal. Two and three wire connections induce a measurement error caused by lead wire resistance being added into the sensor resistance. In a two wire circuit it is a simple addition of the full lead wire resistance and in a three wire circuit the error is due to an imbalance of resistance between each of the three lead wires. A four wire circuit fully compensates for lead wire resistance and causes no lead wire induced measurement error.

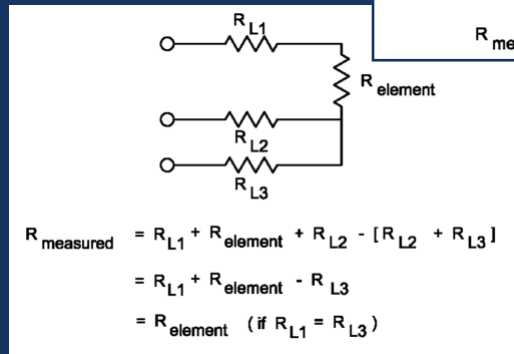
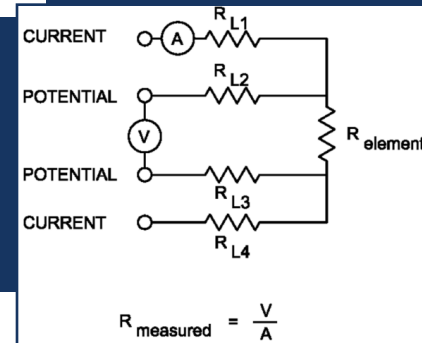
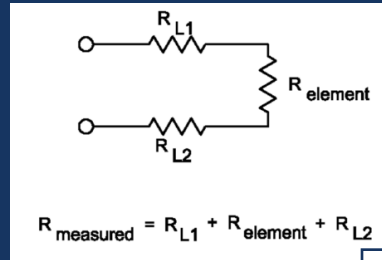
#### Challenge

Some signal conditioning equipment will accept only two or three wire RTD connections and will have a lead wire error associated with them. In those instances where accuracy is critical, steps need to be taken to minimize the error. Fortunately there are methods to do just that.

#### Solution

The best method is to use a 4 wire circuit which fully compensates for lead wire resistance in the circuit. This requires a signal conditioner that has a true 4 wire lead compensation capability. Another solution is to add a transmitter at the measurement point and that will eliminate the lead wire error.

No four wire capability and do not want to add a



#### Schematics

transmitter? A three wire circuit can be trimmed so that each leg has nearly equal resistance. This will minimize the error. Another solution is to use a large gauge wire for the connection. The larger the wire the smaller the error will be. For example an RTD with a 32 AWG lead wire can have a significant error in just a few feet of lead wire. Increasing the size to 22 AWG increases the distance to over 20 feet before significant error is induced.

Two wire circuits are typically used for HVAC applications where simple control equipment is used. RTDs of 1000 ohms are used and the lead resistance becomes a very small percentage of the circuit and has minimal affect on accuracy when used with a 1000 ohm or greater sensor.