4-Wire Resistance Measurement Basics

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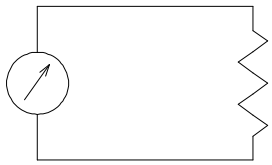
Resistance is the name we give to the ratio of the voltage across a device divided by the electrical current through the device. Resistance is defined by Ohm's law as follows:

Voltage = Current x Resistance

or

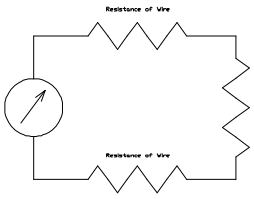
Resistance = Voltage / Current

The circuit to measure resistance using 2 wires is usually drawn like this:



The drawing shows the meter directly connected to the resistance of the device that is being measured. This drawing, although not completely correct, is a close enough approximation when we are measuring the resistance of devices that are MUCH higher than that of the wires connecting the meter to the resistor.

When the resistance of the device being measured is very small, a more accurate circuit diagram is:



The new drawing shows the resistance of the wires that connect the meter to the device. The current through the resistor is identical to the current through the meter and the wire leads – no problem there. Unfortunately, the voltage measured by the meter is the voltage across the resistor *plus* the voltage

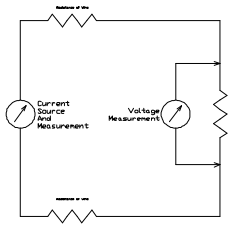
across the two wire leads. If the resistance of these leads is at all significant relative to the device, the voltage developed across them will throw off the measurement.

A 4-wire resistance measurement system contains a ‘high current’ circuit and a ‘low current’ circuit.

In the high-current circuit, current flows through the current source, through the current meter, through the lead wires, and through the device being measured. The leads in the high-current circuit develop a voltage that is significant.

In the low-current circuit the voltage of the device is ‘sensed’ directly at the device and not through the current-carrying leads. Since very little current flows in the voltage-sensing leads, those leads do not develop any significant voltage. The result is an accurate measurement of voltage across the device.

The 4-wire circuit looks like this:



As you can see, the extra two wires allow the voltage across the device to be sensed through separate that carry very low (essentially zero) current. Since there is no current, there is no voltage developed across the leads. The voltage measured by the meter is the actual voltage across the device.

GCA Technology makes custom industrial machinery, automation systems and custom testing electronics.

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