

Using the DMM Series to make simple and accurate resistance measurements

Application Note

Using two wires to measure resistance is convenient, but causes measurement error. You can virtually eliminate this error by using four leads and a multimeter with separate source and measure terminals. Unfortunately, adding additional leads and connections makes the measurement

more complicated. You have additional leads to connect and you may have to swap clips and probes as you change from voltage to resistance. Now a new concept enables you to take four-wire resistance measurements with just two leads.

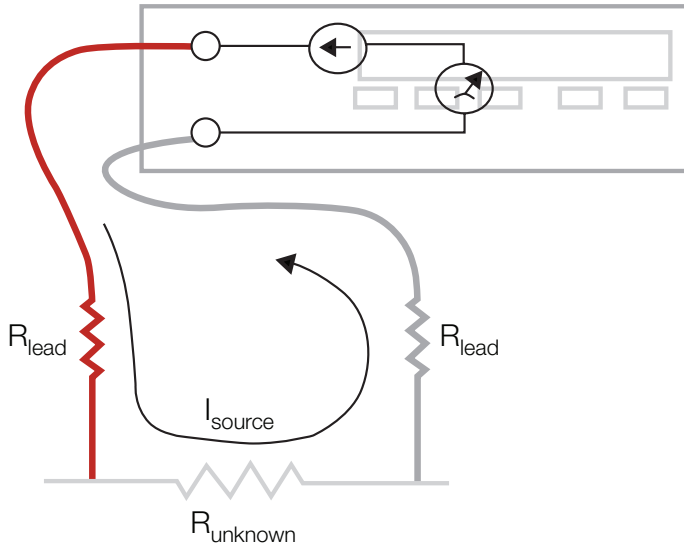


Figure 1. Two-wire resistance measurements introduce error due to voltage drop in the test leads.

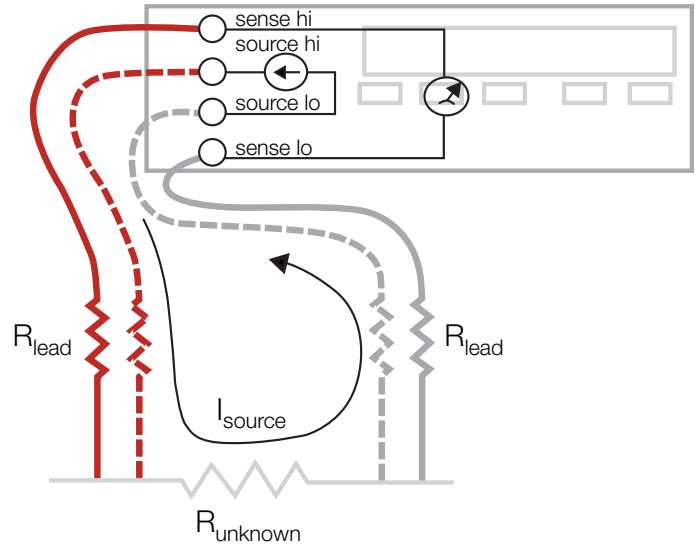


Figure 2. Four-wire resistance measurements eliminate current in the voltage leads and eliminate this source of error.

Why measure resistance with four wires?

Managing two leads can be challenging enough, especially when you are measuring small components in tight spaces. But trying to check a small solder joint, flex connector or chip resistor with four leads can be a real trial.

Switching lead configurations can lead to swapped banana plugs and measurement mistakes. And changing from voltage probes to Kelvin leads and back takes time. So why measure resistance with four wires?

Using two wires to measure voltage does not seriously impact measurement accuracy. The voltage input on a multimeter generally has an input impedance of 10 Megohm, so very little current flows in the leads, and the resulting voltage drop in the leads is negligible. Current measurements are also not significantly affected by series lead resistance. Unfortunately, in the case of resistance measurements, lead resistance can be a source of significant inaccuracies.

When performing a resistance measurement, the multimeter switches a current source into the measurement loop. The current is driven through the unknown resistance and the

multimeter measures the resulting voltage drop. If there are only two leads, as shown in Figure 1, the source current travels on the same path used to measure the voltage drop. The measurement leads are not perfect conductors and have some series resistance of their own. By driving the current through the measurement leads, you see not only the voltage drop across the unknown resistance, but also the voltage drop for each lead. Thus, you end up measuring the combined resistance of the positive lead, the unknown resistance, and the negative lead.

If you use four leads, as shown in Figure 2, the source current and the voltage measurement can be separated. The meter terminals are called “Source” for the current supply and “Sense” for the voltage input.

The series resistance in the Source leads does not affect the current flow. And the measure/sense leads have almost no current flow because of the meter’s high input impedance. This means there is no $I \times R$ voltage drop in the measure leads. So, you measure only the voltage drop across the unknown resistor due to the source current flowing through it.

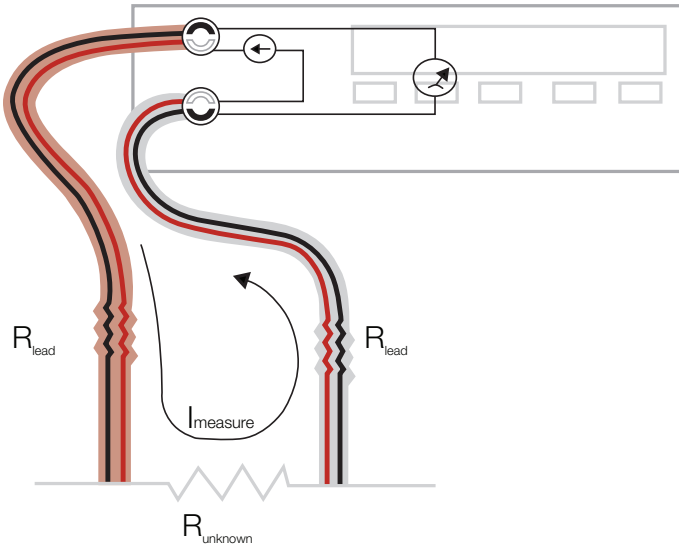


Figure 3. 2x4 wire ohms technology uses special split banana jacks and leads to deliver 4-wire performance with 2 leads.

At the far end of the leads, clips and probes that maintain separation between source and measure signals can deliver 4-wire performance right to the component under test. A line of clips and probes is available which bring four wires right up to the point of connection. They include:

- Test probes
- Alligator (Kelvin) clips
- Tweezers

All of these accessories may be used for measuring 4-wire resistance or voltage.

The 2x4-wire technique available on the DMM Series simplifies making accurate resistance measurements, without having to change cable configurations and without having to work with a tangle of cables.

Introducing 2x4 wire ohms measurements

The patented split terminal jacks on the Tektronix DMM Series maintain the convenience of using two leads for resistance measurements, but deliver the measurement performance of a 4-wire method. The jacks are completely compatible with standard 4 mm banana plugs. But on the inside, each jack is split into two contacts: one source and one measure. Specially-designed test leads have two conductors per lead, again, one source and one measure. The leads align with the contacts inside the jacks and carry the separate source and measure signals over the full length of the leads.

Which multimeter is right for you?

The DMM Series offers a range of models to meet your needs and your budget. The following multimeters offer 2x4 wire ohms measurements.

	DMM4050	DMM4040	DMM4020
Resolution	6.5 digit	6.5 digit	5.5 digit
Basic V dc accuracy	0.0024%	0.0035%	0.015%
Measurements	V ac, V dc, I ac, I dc, Ω , Continuity, Diode, Frequency, Period, Temperature, Capacitance	V ac, V dc, I ac, I dc, Ω , Continuity, Diode, Frequency, Period	V ac, V dc, I ac, I dc, Ω , Continuity, Diode, Frequency
Analysis Modes	TrendPlot™, Statistics, Histogram	TrendPlot™, Statistics, Histogram	Limit Compare
USB Port (Front Panel)	Yes	Yes	No

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