

APPLICATION NOTE 106

Battery-Powered Circuit Measures Milli Ohms and Micro Ohms

A simple battery operated adapter and a DVM can be used to make a low-resistance, 4-wire measurement. Circuit shows how to make 2% measurements or improve circuit for more accuracy.

A simple battery-powered adapter (**Figure 1**) converts an ordinary DVM into a 4-wire milliohmmeter that accurately measures the resistance of wiring, motor coils, solenoids, high-current inductors, and meter shunts. It can quickly locate shorts in a power supply or a printed circuit board. The circuit shown is about $\pm 2\%$ accurate. For higher accuracy, you can make component adjustments as described below.

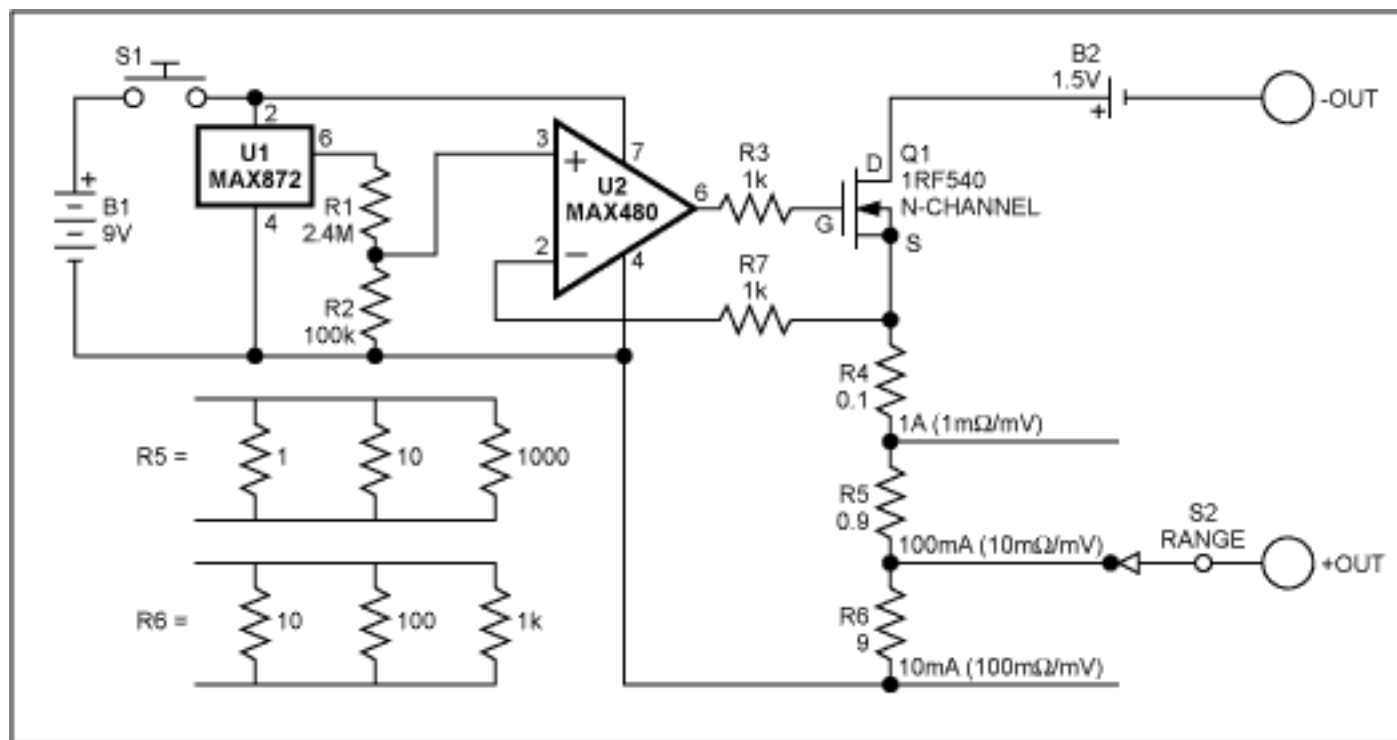


Figure 1. Operating with a DVM, this low-power adapter circuit performs 4-wire, low-resistance measurements.

The circuit applies 1A, 100mA, or 10mA to the unknown resistance via two test leads, according to the range-switch setting. You then set a DVM to the 2V range and connect it with two more test leads, forming a 4-wire connection to the resistance being measured.

The DVM indicates directly in ohms when you depress the momentary-on power switch (S1). A 1.000 Ω resistance, for instance, reads 1.000V on the circuit's 1A range, so one millivolt corresponds to one milliohm. Four-digit and five-digit DVMs frequently have 1 μ V sensitivity, providing resolutions of 1 $\mu\Omega$. Because the output is a current source, the unknown resistance of the connections and test leads is not a source of measurement error.

Accuracy depends on the DVM, the op amp's input offset voltage ($\pm 70\mu$ V maximum), and the tolerance of R1, R2, R4, R5, and R6. First, trim the 1A range by selecting R4 or by adding a trimming potentiometer between R1 and R2. Next, trim the 100mA range and then the 10mA range by adjusting the highest-valued resistors in the

R5 and R6 networks.

Depressing S1 turns on the micropower reference (IC1), which produces 2.500V. R1 and R2 divide that output to 0.1V, and the op amp forces 0.1V at the source of Q1. This action creates a current source that develops 0.1V across R4, R5, and R6. The range switch selects a current of 1A, 100mA, or 10mA in the loop formed by the resistors, the unknown resistance, the 1.5V battery, and Q1.

Note that releasing S1 (or disconnecting the adapter) eliminates all current drain from the 1.5V battery. An alkaline "D" cell therefore produces thousands of measurements, even on the 1A range, if you depress S1 only for brief readings of the DVM. The 9V battery can last for years because its load is less than 30 μ A.

To search for a shorted component or a short between traces on a pc board, first connect the two adapter leads, one to each of the traces in question. Connect a DVM lead to the same point as one adapter lead, and use the other DVM lead to probe along the traces. The highest reading on one trace and the lowest reading on the other trace reveal the location of the short. Constant readings indicate no adapter current flowing in that section of the trace (for a given connection of the adapter leads), so you can eliminate that section from the search.

Application Note 106: <http://www.maxim-ic.com/an106>

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