

Measuring Small Resistances, version 1.2

By R. G. Sparber

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Freight® Digital Multimeter as shown here.

The modern and low cost Digital Volt Meter² is able to measure down to 0.1 ohm. In most cases, this is plenty good. But there are times when you may need to measure down to 0.005 ohm. Well, it turns out that with two more components and a little bit of math, you can do it.

The key is that these meters can measure down to about 0.001 volt or 1 milli volt.

This procedure assume you own a Harbor

The procedure offered here is based on the Kelvin Connection³.

¹ You are free to copy and distribute this document but not change it.

² Shown here is the bottom of the line model from Harbor Freight® that lists for \$10 but is often on sale for \$7.

³ See http://en.wikipedia.org/wiki/Four-terminal_sensing for the theory.



You will need a fresh 9V battery and a 470 ohm $\frac{1}{2}$ watt resistor.



The battery can be bought at drugstores, supermarkets, and electronics stores like Radio Shack[®]. The resistor can be bought at Radio Shack:

470 ohm 1/2W 5% Carbon Film Resistor Model: 271-1115 | Catalog #: 271-1115.

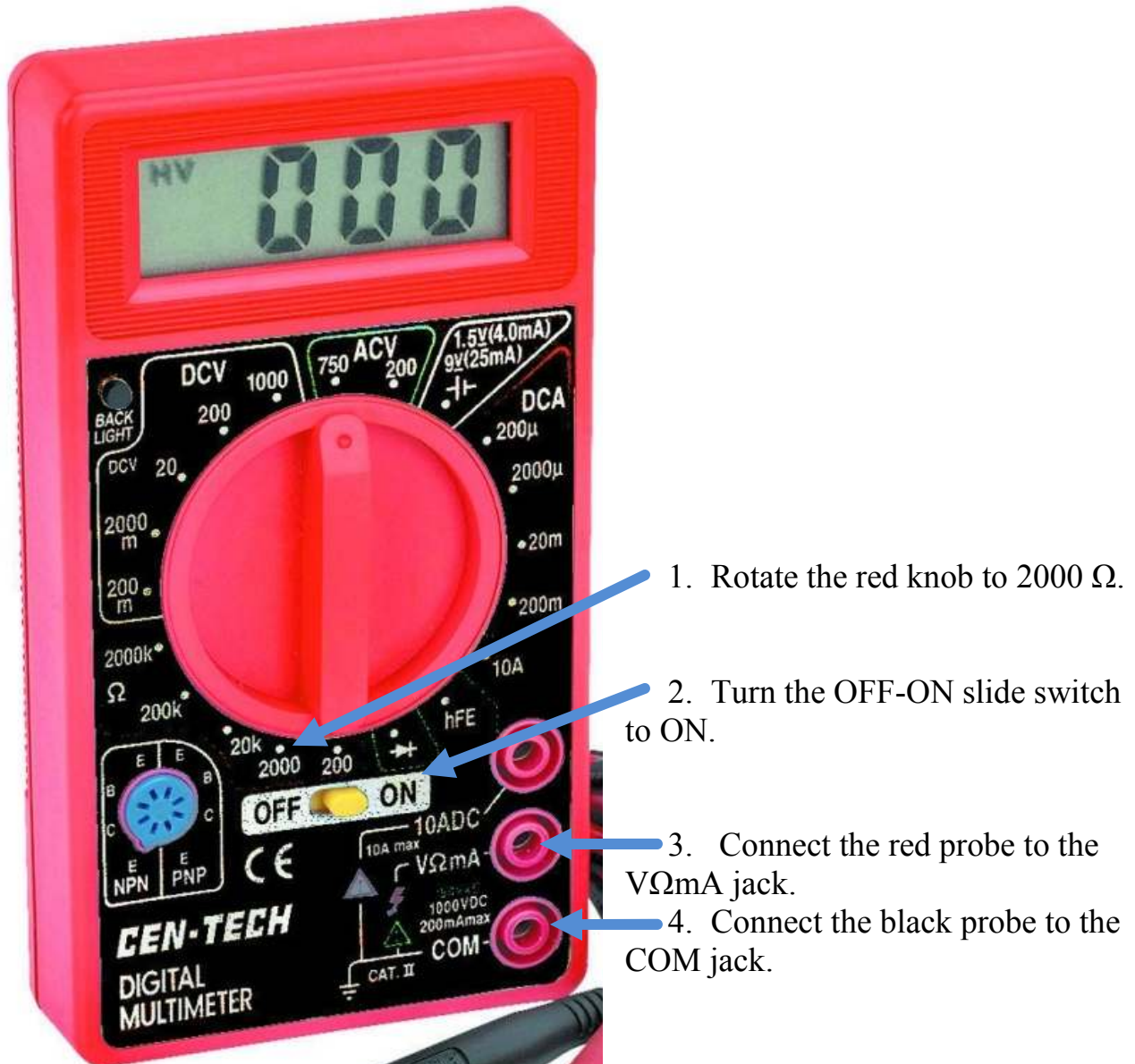
The package of 5 resistors cost about \$1.20. What you buy will have different colors on it than in this picture on the right.



You will also need a way to connect the resistor to the battery and to the resistance you need to measure. One way to do this is with a 9V battery clip which snaps onto the top of the battery. Take care not to touch the two wire ends together as this will quickly kill the battery. At Radio Shack a package of 5 costs less than \$3: Model: 270-324 | Catalog #: 270-324.

Resistor Measurement

We need to measure the resistor using your Digital Multimeter.





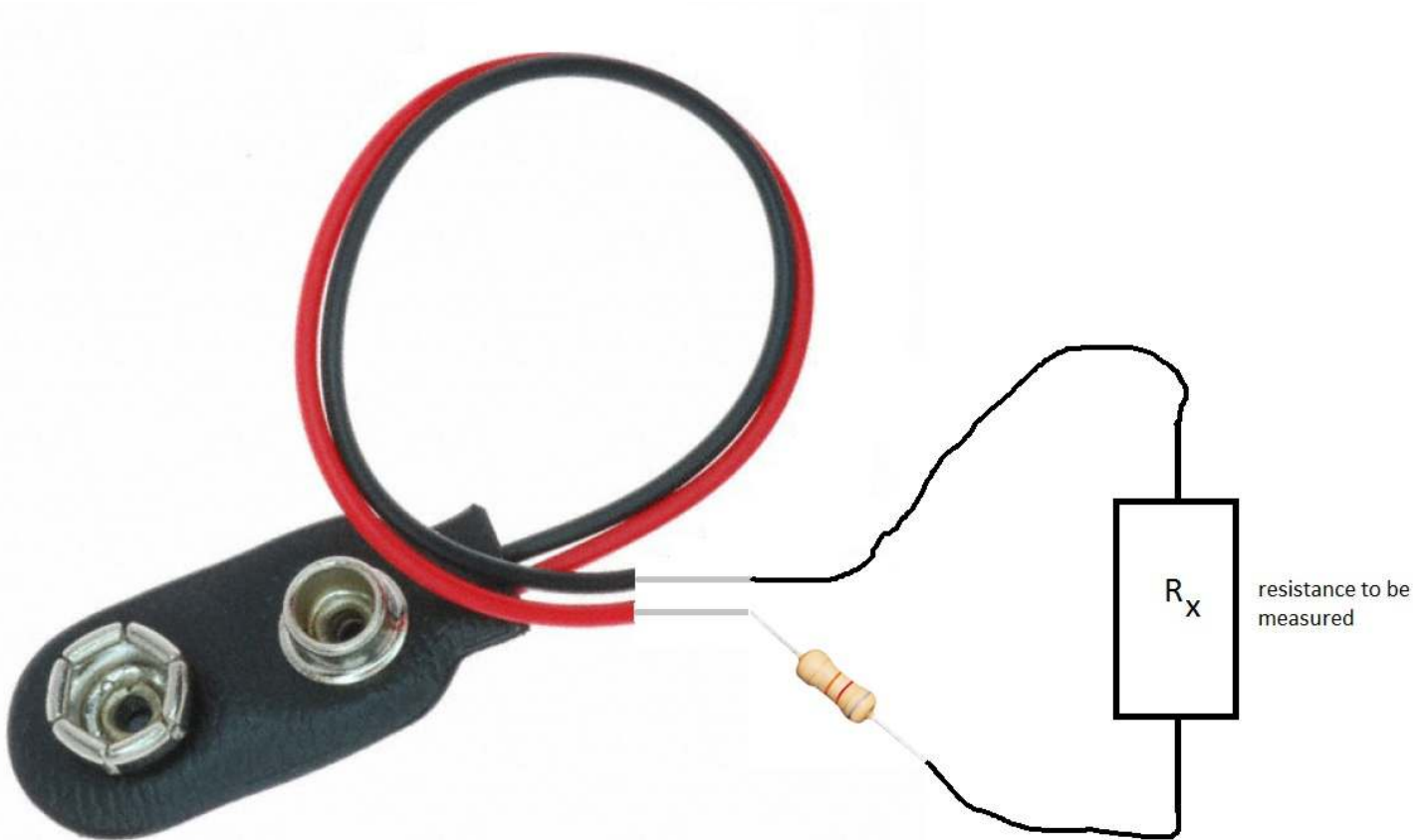
5. Connect the black probe to one side of the 470 ohm resistor.

6. Connect the red probe to the other side of the 470 ohm resistor.

7. Expect to see a number on the display of the meter between 442 and 503.

8. Record the reading and call it "Rs".

Connections



The battery, resistor, and resistance to be measured are all put in series:

1. Connect the red wire from the battery clip to one end of the resistor.
2. Connect the other end of the resistor to one end of the resistance to be measured.
3. Connect the black wire from the battery clip to the other end of the resistance to be measured.

It is best to solder the resistor to the battery clip but you may be able to just twist the wires together if they stay tight. The connection to the resistance to be measured might be accomplished by having someone hold the wires tightly to the two conductive areas. Much better would be to put spring clips on the black battery wire and the end of the resistor.

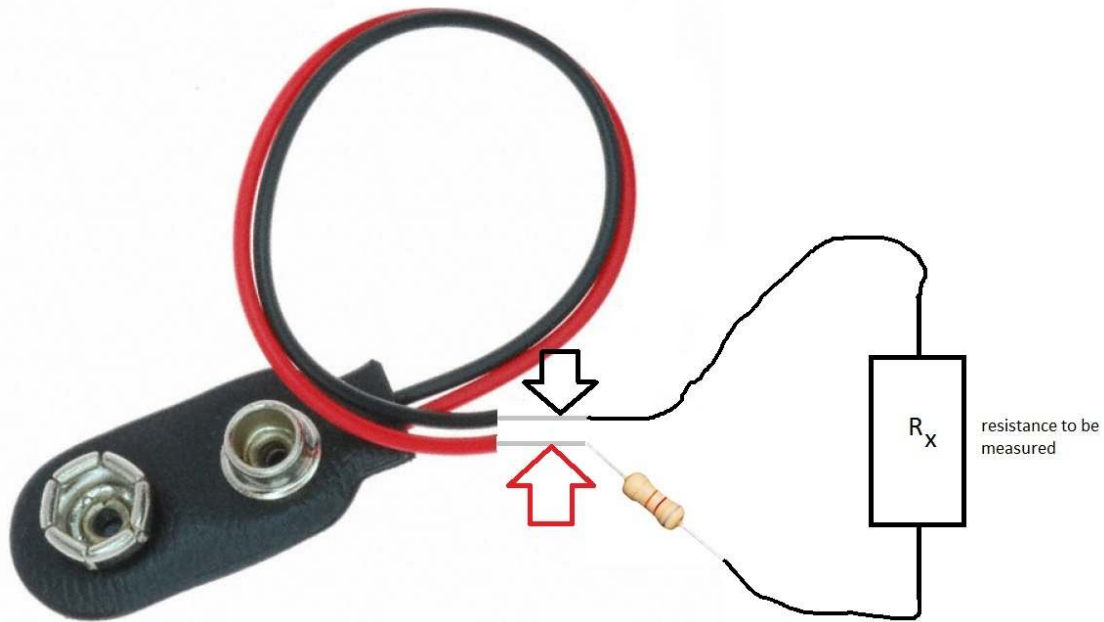
Voltage Measurements



Set up the Digital Multimeter to measure the battery.

1. Rotate the red knob to 20V.
2. Turn the OFF-ON slide switch to ON.
3. Connect the red probe to the "VΩmA" jack.
4. Connect the black probe to the COM jack.
5. The display is indicating "overload" and may be the letters "OL" or flashing. Remember what this looks

like because you may see it later.



Measure the battery voltage while the test set-up is connected to the resistor and resistance to be measured.

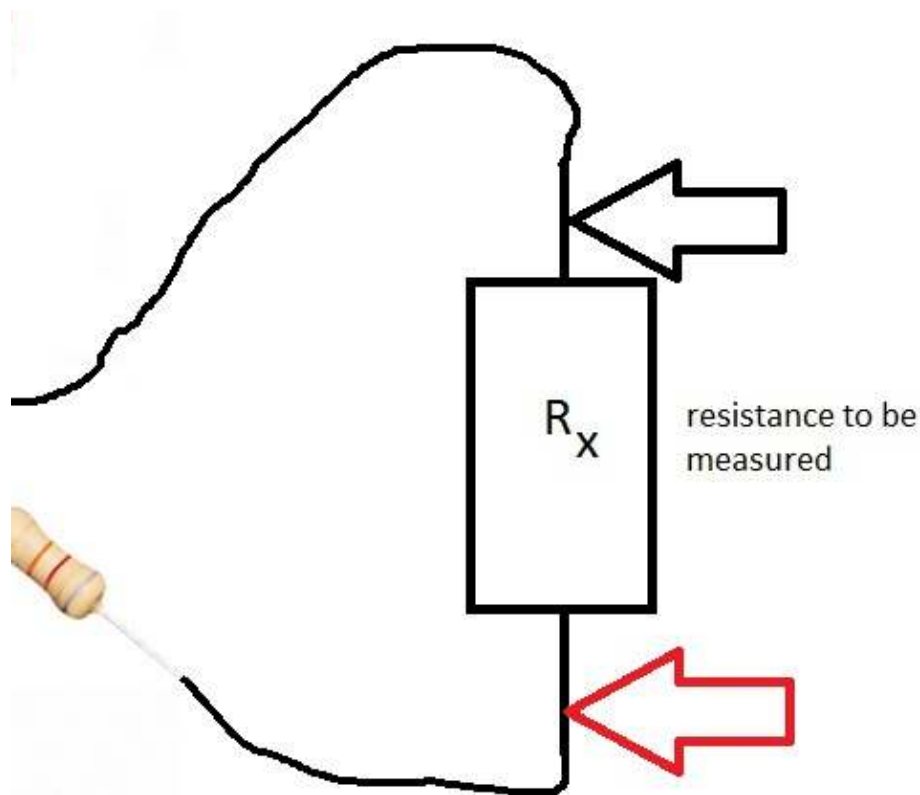
1. Snap the battery into the clip.
2. Touch the black probe connected to the meter to the black wire of the battery clip and keep it there.
3. Touch the red probe connected to the meter to the red wire of the battery clip and keep it there.
4. Read the meter's display and expect to see a number between 7.0 and 10.0.
5. Record this reading and call it V_b .

Note: pay close attention to where the probes are touching the wires. You must be in contact with the wires coming out of the battery clip.



6. rotate the red knob so it reads 200 m.

Note: The battery is still connected to its clip.



7. Connect the black probe to the side of the resistance to be measured as shown above with black probe on the black battery wire side. **Note: Stay away from the place where the battery and resistor wires connect to R_x .**
8. Connect the red probe to the other side of the resistance to be measured as shown above with the red probe on resistor side.



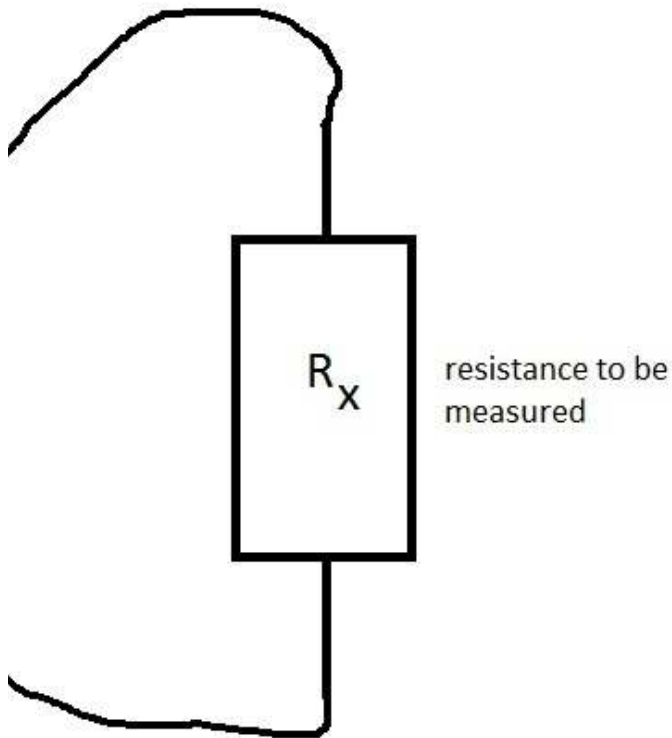
9. The meter should read a number and not show overload (see page 6). If you see overload, rotate the red knob clockwise to 2000 m. If it still reads overload, rotate the red knob clockwise one more time to 20.

10. If you read a voltage on the 20V scale, you do not have a good connection to the resistance to be measured. Try again.

11. Record this reading and call it V_x . Also record the red knob position.

12. Now we need to do a little math in order to calculate the resistance to be measured value:
- Divide V_b from page 7 by R_s from page 4 and call this number I_x
 - Divide V_x from page 9 by I_x
 - If your meter was set to 200m or 2000m, divide your answer by 1000.

The resulting number could be as small as 0.005.



What you have calculated is the resistance, R_x in ohms. So if you calculated 0.01 that means 0.01 ohms.

Note that your meter might be able to measure down to 0.1 ohms but with this technique you are able to measure down to 0.005 ohms.

I welcome your comments and questions.

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