EE1002 LAB 1: Measurement of Resistance

I. OBJECTIVES

1. To measure resistance using a voltmeter and an ammeter in conjunction;
2. To use a basic meter movement to construct and test a "series ohmmeter";
3. To use a basic meter movement to construct and test a "parallel ohmmeter";
4. To identify the utility and limitations of each method of resistance measurement.

II. EQUIPMENT AND MATERIALS REQUIRED

1. Variable power supply (0 - 10V)
2. Digital multimeter
3. Analogue multimeter
4. Resistors: 100Ω 1k, 10k, 150k, 1M and circuit configuration, and other values for measurement.
5. Trimpot: 100k
6. Solderless breadboard.

III. REFERENCES

1. M. O. Sadiku, S. M. Musa and C. K. Alexander, Applied Circuit Analysis, McGraw Hill, 2012.
2. C. K. Alexander and M.O. Sadiku, Fundamentals of Electric Circuits, 5th Edition, McGraw Hill, 2012.

IV. PROCEDURES

A. Ammeter/Voltmeter Method

Ohm's Law relates the current through a resistor to the voltage across it via the following equation,

$$V = IR$$

Therefore to measure the resistance of a resistor involves the simultaneous measurement of voltage and current. Two possible circuits are shown, respectively in Figure 1 and 2.

(a) Measure the resistance of the resistors provided using a digital multimeter.

(b) Set up the circuit of Figure 1 using the analogue multimeter for the voltage measurement, and the 10kΩ resistor for R. Take five different measurements of voltage versus current in the range of 0 to 10 volts, plot a graph and deduce from it a value for R. Repeat for 1 MΩ resistor.

(c) Set up the circuit of Figure 2 using the analogue multimeter for the current measurement, and the 1k resistor for R. Take five different measurements of voltage versus current in the range of 0 to 10 volts, plot a graph and deduce from it a value for R. Repeat for 100 Ω resistor.
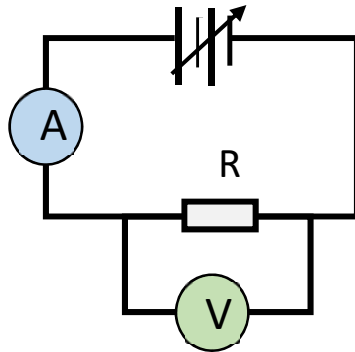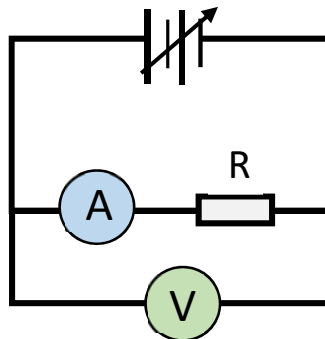

Figure 1

Figure 2

B. "Series" Ohmmeter

Instead of using two meters at the same time to make resistance measurements, it is possible to devise methods which require the use of only a single meter. The configuration for one such method, known as the series ohmmeter (because the resistance to be measured is in series with the meter movement) is shown in Figure 3.

(a) Connect the circuit shown in Figure 3, using 150k for R1 and trimpot for P, a resistor for Rs, (the "resistance to be measured", different values will be used for measurements), and the analogue multimeter for M.

(b) Short circuit the measurement terminals (i.e., replace Rs, with a short circuit) and adjust the potentiometer P for full scale deflection of the meter on the 50 μA range. After this adjustment, remove the short circuit.
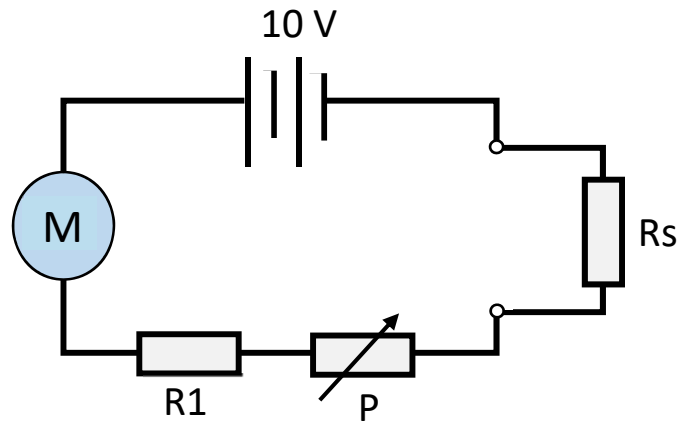

Figure 3

(a) Connect Rs, across the measurement terminals. Choose different values of Rs, so that you can record a reading of about 10 μA, 20 μA, 30 μA, 40 μA and 50 μA in the meter. [You do not need to have the exact values but the readings should be separated evenly.]

(c) Draw a calibration curve, i.e. meter value versus Rs value, for your ohmmeter.

C. "Parallel" Ohmmeter

Single meter resistance measurements can also be done by placing the resistance to be measured in parallel with the meter (see Figure 4).

(b) Connect a circuit as shown in Figure 4.

(c) Leave Rp disconnected. Adjust the potentiometer P to achieve full scale deflection of the meter on its 50 μA range.

(d) Short circuit the measurement terminals and confirm that the current flows through the meter is zero.

(e) Choose different values of Rp, so that you can record a reading of about 10 μA, 20 μA, 30 μA, 40 μA and 50 μA in the meter.

(f) Draw a calibration curve for this ohmmeter.
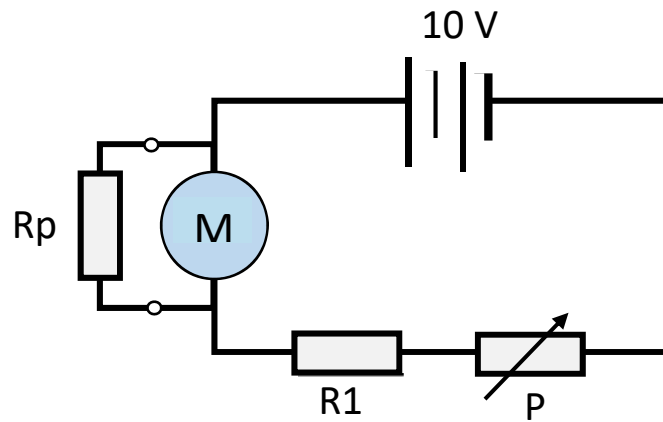
10 V

Rp

M

R1

P

Figure 4

V. DISCUSSION

1. Explain any discrepancy the values obtained for the resistance of the resistors using the ammeter/voltmeter method for resistance measurement.
2. Under what conditions is the series ohmmeter a good instrument for the measurement of resistance?
3. Under what conditions is the parallel ohmmeter a good instrument for the measurement of resistance?
4. How can the range of each ohmmeter be changed?
5. Comment on the accuracy or any other issues may be encountered if the voltage in Figure 3 and 4 are reduced to 1 V with resistance values of R1+P being reduced accordingly to achieve the full scale current of 50 μA.