

EE1002 LAB 1: Measurement of Resistance

I. OBJECTIVES

1. To measure a resistance using a voltmeter and an ammeter;
2. To construct a "series ohmmeter" using a single meter only;
3. To study the limitations of the methods in Objectives 1 and 2.

II. EQUIPMENT AND MATERIALS REQUIRED

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

III. PROCEDURE

A. Ammeter/Voltmeter Method

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

$$V = I \cdot R$$

Therefore, measuring the resistance of a resistor needs to measure the voltage and current simultaneously. Two possible circuits for this are shown in Figures 1 and 2.

- (a) Measure the resistance of the provided resistors using a digital multimeter.
- (b) Set up the circuit in Figure 1 with $R = 10 \text{ k}\Omega$. Use an analogue multimeter and a digital multimeter to measure the voltage and current, respectively. Please fill in Table I by changing the source voltage. Plot a graph (y -axis: measured current; x -axis: measured voltage) to find the value of R experimentally.
- (c) Construct the circuit in Figure 2 with $R = 1 \text{ k}\Omega$. Note that the analogue multimeter and digital multimeter are now used to measure the current and voltage, respectively. Please fill in Table II and then plot a graph to find the value of R experimentally.

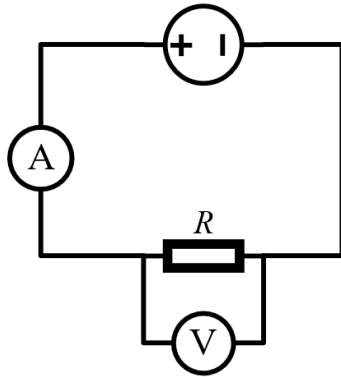


Figure 1

Table I

$R = 10 \text{ k}\Omega$		
Source Voltage / V	Measured Current / mA	Measured Voltage / V
0.0		
2.0		
4.0		
6.0		
8.0		
10.0		

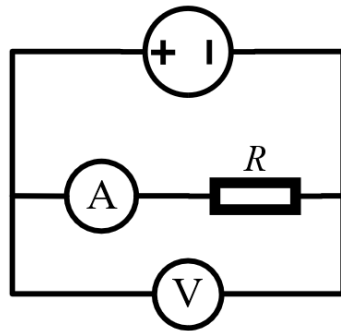


Figure 2

Table II

$R = 1 \text{ k}\Omega$		
Source Voltage / V	Measured Current / mA	Measured Voltage / V
0.0		
2.0		
4.0		
6.0		
8.0		
10.0		

B. Single-Meter Method

The measurement methods as given above require two meters. It is possible to measure the resistance using a single meter only. This method is known as the series ohmmeter method because the resistance to be measured is in series with an ammeter, as shown in Figure 3.

- Connect the circuit in Figure 3 with $R_1 = 150 \text{ k}\Omega$, a trimpot for the potentiometer P , a digital multimeter for the ammeter A , and the resistance R_s to be measured (different values of R_s will be used in the experiment).
- Short-circuit R_s (i.e., replace R_s with a short circuit) and adjust P until the full-scale deflection of the ammeter A is in the range of $50 \mu\text{A}$. This is to set a suitable current range for accurate measurements of unknown resistances ranging from 0 to $\sim 800 \text{ k}\Omega$. Calculate the total resistance R_0 in the circuit, where R_0 is the sum of R_1 , resistance of P , and the internal resistance of A . Write the answer below Table III.

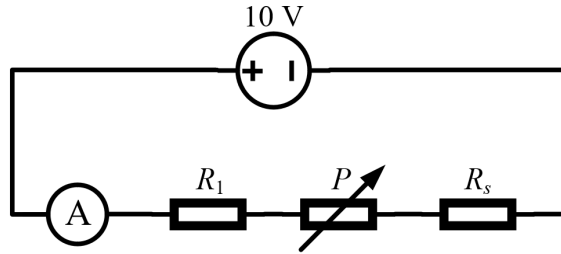


Figure 3

- (c) Restore the circuit in Figure 3 by putting back R_s . Now we are going to obtain a curve for finding the unknown resistance of a resistor ranging from 0 to $\sim 800\text{ k}\Omega$. With reference to the recommended resistances in Table III, use different values of R_s to obtain different currents of about $10\text{ }\mu\text{A}$, $20\text{ }\mu\text{A}$, $30\text{ }\mu\text{A}$, and $40\text{ }\mu\text{A}$. You do not need to have the exact current values, but the current should be reduced uniformly when you increase R_s .
- (d) Calculate R_s for each measured current. Plot the measured current vs calculated R_s in Fig. 4.

Table III

*Recommended $R_s\text{ (}\Omega\text{)}$	Measured Current (μA)	Calculated $R_s\text{ (}\Omega\text{)}$	Actual (used) $R_s\text{ (}\Omega\text{)}$	Error in $R_s\text{ (%)}$
0 (Short circuit)	50	0	0	0
50k				
133k				
300k				
800k				

$R_0 = \underline{\hspace{1cm}} \Omega$

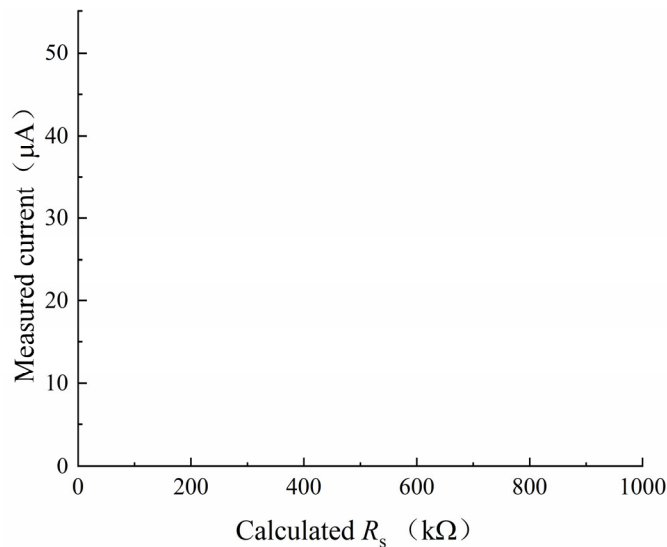


Fig. 4. Measured current vs calculated R_s .

IV. DISCUSSION

1. Explain the discrepancy between the resistances of the actual resistor and the measured resistance using the ammeter/voltmeter methods in Figures 1 and 2.
2. For the single-meter method, how to change the measurement range?
3. By using the curve in Figure 4, find the unknown resistance of a resistor when the measured current using the series ohmmeter is $23\ \mu\text{A}$.
4. Can the curve obtained in Figure 4 be used to determine the unknown resistances if the voltage source in Figure 3 is reduced from 10 V to 1 V (with no changes in R_1 and P)? Explain briefly.

V. 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.