



## Experiment 2 — Ohm's Law Relationships

EL 111 - DC Fundamentals

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### Objectives:

1. For the student to verify Ohm's Law by calculating, and then by measuring voltage, current and resistance, and then comparing the calculated and measured results.
2. For the student to verify Ohm's Law relationships by increasing one quantity while holding the second quantity constant, then measuring and calculating the effect on the third quantity.

### Equipment and Parts:

- Meters: Agilent 34401A Digital Multimeter (DMM), Milliammeter or Handheld MM such as the Agilent 971A
- Power Supply: Agilent E3631A DC power supply
- Resistors: one of each size - 3.6 kΩ, 6.8 kΩ, 9.1 kΩ

### Information:

The three forms of Ohm's Law are:  $I = \frac{E}{R}$ ,  $E = IR$  and  $R = \frac{E}{I}$

The procedures in this experiment will have the student verify these formulas by comparing measured data with calculated data. Allow for a reasonable tolerance in your data. For example: Measured voltage = 15 V; calculated voltage = 14.8 V. To compare these, we use **[(measured - calculated)/calculated]\*100%:**

$$\text{percent error} = \left[ \frac{15V - 14.8V}{14.8V} \right] 100 \% = +1.4 \%$$

Due to the accuracy of the measurement instruments (digital voltmeter, digital ohmmeter about ±1%; analog ammeter about ±3%), measurements in the DC laboratory that agree within ±5% may be considered equal for most practical purposes.

### Procedures:

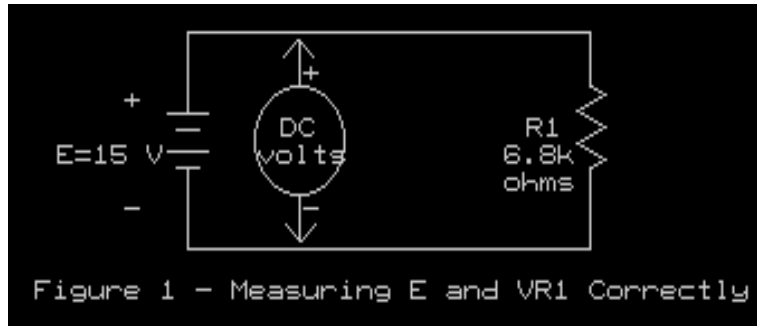
1. Perform the following steps to verify that

CURRENT = VOLTAGE DIVIDED BY RESISTANCE.

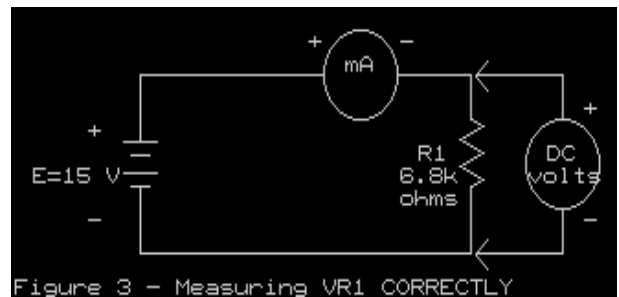
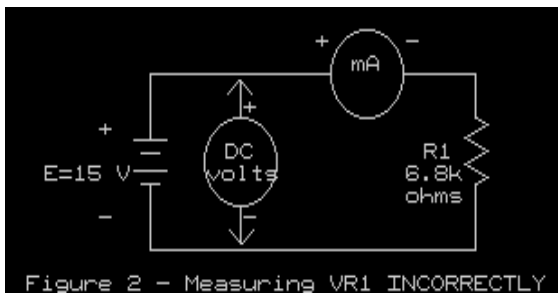
- a. Measure the resistance of the 6.8 kΩ (color-coded value) resistor with the DMM.

R<sub>1 measured</sub>: \_\_\_\_\_

- b. Connect the circuit in Figure 1.



- c. Adjust the power supply voltage to 15.0 V using the DMM set on its DC voltage mode.
- d. Measure and record the voltage across the resistor.  $V_{R1}$ : \_\_\_\_\_



- e. Look carefully at Figure 2: the multimeter is **incorrectly measuring VR1, since it will read both the voltage across R1 AND the voltage across the ammeter.** Figure 3 shows the correct way to measure VR1. Make sure that the voltage across R1 is still 15.0 V (it MAY have dropped slightly due to the milliammeter).
- f. Measure and record the current through R1.  $I_{R1}$  = \_\_\_\_\_
- g. Using the measured values of voltage and resistance, calculate the current through R<sub>1</sub> using Ohm's Law. Show calculations in the space below.

$$I = \frac{E}{R} = \frac{V}{\Omega} = \quad A \qquad I_{R1} = \text{_____}$$

- h. What conclusion can you make from these procedures?

\_\_\_\_\_

\_\_\_\_\_



2. Perform the following steps to verify that

RESISTANCE EQUALS VOLTAGE DIVIDED BY CURRENT:

a. Connect the same circuit as in Figure 3, except change the value of resistance of 3.6 kΩ (color-coded value).

b. Measure and record the voltage **across** R1 and the current flow **through** R1.

$E_{R1} = \underline{\hspace{2cm}}$   $I_{R1} = \underline{\hspace{2cm}}$

c. Calculate the resistance of R1 using the measured values of  $E_{R1}$  and  $I_{R1}$  with Ohm's Law. Show calculation.

$R1 = \underline{\hspace{2cm}}$

d. **Remove R1 from the circuit.** Measure and record the resistance of R1 using the multimeter.

e.

$R1 = \underline{\hspace{2cm}}$

f. What conclusion can you make from these procedures?

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3. Perform the following procedures to verify that

VOLTAGE EQUALS CURRENT TIMES RESISTANCE.

a. Connect the circuit in Figure 3, except change the resistor to 9.1 kΩ. (color-coded value)

b. Measure the resistance of this resistor making sure that the resistor is removed from the circuit.

$R1 = \underline{\hspace{2cm}}$

c. Reinsert the resistor into the circuit and measure the current through the resistor.

$I = \underline{\hspace{2cm}}$

d. Calculate, using Ohm's law, the resistor voltage using the measured values of resistance and current. Show calculation below.

$E = I * R = ( \quad ) A * ( \quad ) \Omega = \quad V$

$E_{R1} = \underline{\hspace{2cm}}$

e. Measure the resistor voltage. Record

$E_{R1} = \underline{\hspace{2cm}}$

f. What conclusion can you make from these procedures?

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4. Perform the following procedures to verify that  
IF THE RESISTANCE IS HELD CONSTANT, INCREASING THE  
VOLTAGE WILL INCREASE THE CURRENT.
- a. Connect the circuit in Figure 3 using a 3.6 k $\Omega$  resistor. Set the voltage source to 10.0 V.
  - b. Measure the current through the resistor. Record.  
 $I = \underline{\hspace{2cm}}$
  - c. Increase the voltage source to 20 volts and again measure the current through the resistor. Record.  
 $I = \underline{\hspace{2cm}}$
  - d. Based on the results of this procedure, what conclusion can be made about the relationship between voltage and current for a fixed value of resistance?
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5. Perform the following procedures to verify that  
IF THE VOLTAGE IS HELD CONSTANT, INCREASING THE  
RESISTANCE WILL DECREASE THE CURRENT.
- a. Connect the circuit in Figure 3, using a 3.6 k $\Omega$  color coded resistor. Set the voltage source to 10.0 volts.
  - b. Measure the current through the resistor. Record.  
 $I = \underline{\hspace{2cm}}$
  - c. Change the resistor value to 6.8 k $\Omega$ , and again measure the current through the resistor. Record.  
 $I = \underline{\hspace{2cm}}$



- d. Based on the results of this procedure, what conclusion can be made about the relationship between resistance and current for a fixed value of voltage?

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6. Perform the following procedures to verify that

IF CURRENT IS HELD CONSTANT, INCREASING THE RESISTANCE WILL INCREASE THE VOLTAGE.

- a. Connect the circuit in Figure 3, using  $R = 6.8 \text{ k}\Omega$ . Adjust the source voltage so that the current through the resistor measures 2.0 mA.
- b. Measure the source voltage. Record.

$$E_{R1} = \underline{\hspace{2cm}}$$

- c. Change the resistor value to  $9.1 \text{ k}\Omega$ . Again adjust the source voltage until the current through the resistor measures 2.0mA.
- d. Measure the source voltage. Record.

$$E_{R1} = \underline{\hspace{2cm}}$$

- e. Based on the results of this procedure, what conclusion can be made about the relationship between resistance and voltage for a fixed value of current?

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