Experiment 8 — Series-Parallel Circuits

EL 111 - DC Fundamentals

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Objectives:

1. For the student to measure voltages and currents in a series-parallel circuit and compare with the calculated values.

2. For the student to apply both Kirchhoff's voltage and current laws in series parallel circuits.

Equipment and parts:

- Meters: Digital Multimeter (DMM);
  Milliammeter or Handheld MM such as the Agilent 971A

- Power Supply: Agilent E3631A DC power supply (0 to 20.0V DC)

- Resistors: Seven - 1.2 kΩ, One - other (that value to be determined in step 10)

- Misc: Component Board

Information:

In previous experiments, the student has verified the voltage and current relationships in series circuits and in parallel circuits. In this experiment, the student will exercise these relationships in combination series-parallel circuits.

Procedure:

1. Connect the circuit in Figure 1. When wiring this circuit, allow for convenient means of measuring each individual current and voltage drop.

FIGURE 1
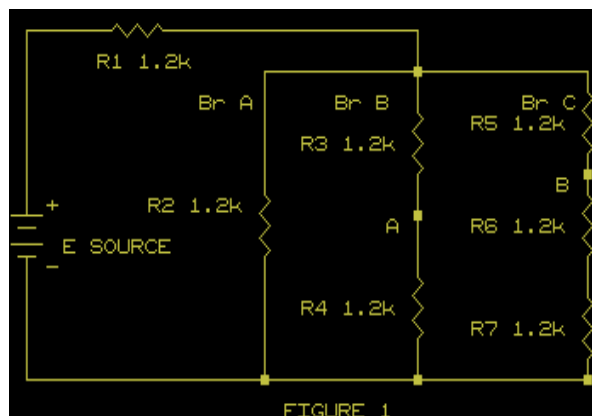
2. With the current meter in series with the entire circuit, set the supply voltage so that the current meter reads exactly <u>6 ma</u>. Measure the source voltage and record.

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

1

3. Using the DMM, measure each resistor's voltage drop. Record in Table 1.

Resistor	R_1	R_2	R_3	R_4	R_5	R_6	R_7
Voltage							
Current							

Table 1

4. Using the milliammeter, measure the current through each resistor. Record in Table 1.

5. Disconnect the circuit from the DC source terminals. Measure with the DMM the total resistance. Record.

$R_T =$ _____(measured)

6. Using the same amount of source voltage measured in Procedure 2, <u>calculate</u> the voltage across and current through each of the seven 1.2 kΩ resistors. Record in Table 2.

Resistor	R_1	R_2	R_3	R_4	R_5	R_6	R_7
Voltage							
Current							

Table 2

7. Compare the measured voltages and currents from Table 1 with the calculated values from Table 2. Are they in reasonably close agreement?   _____

8. Series-parallel circuit analysis: Refer to the circuit in Figure 1.

    a. <u>In branch C</u>, how are R_5, R_6, and R_7 related to each other?

    _____

    How are their currents related?_____

    How are their voltage drops related to the voltage across branch B and branch A?

    _____

    b. <u>In branch B</u>, how are R_3 and R_4 related to each other?

    _____

How are their voltage drops related to the voltage across branch A and

branch C?

_____

c.   What is the relationship between the sum of the currents of branches A, B and C to the current through R_1?

_____

Why?_____

d.   Make a statement that compares the amount of current through each branch A, B, and C with the amount of resistance in branches A, B, and C.

_____

_____

e.   Branch B and branch C are in parallel. Correct?_____

Voltages across parallel branches are the same. Correct?_____

R_3 is in branch B and R_5 is in branch C. Is the voltage across R_3 and R_5 the same?

_____

Why? (or why not?)_____

9.   Reconnect the circuit of Figure 1 to the source voltage. Make sure the voltage source is set to the same value as in Procedure 2.

a.   Write a Kirchhoff's voltage loop equation that will give the voltage at point A in respect to point B. Show this equation below and then calculate this voltage (V_{AB})

    b.   Using the DMM, measure the voltage at point A in respect to point B. Make sure the probe is at A and the common of the meter is at B. Record.

$$V_{AB} = \underline{\hspace{3cm}}$$

    c.   Using the measured current through R_1, branch A, and branch B, write a Kirchhoff's current equation that will yield the current through branch C. Show this equation below and then calculate $I_{branch\ C}$.

    d.   Using the milliammeter, measure the current through branch C.
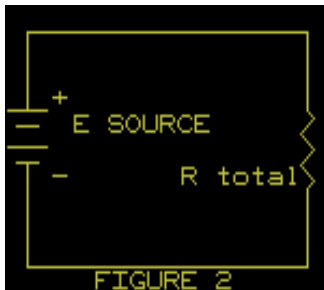
$$I_{branch\ C} = \underline{\hspace{3cm}}$$

10. Obtain a resistor equal to the total resistance measured in Procedure 5. Connect this resistor in the circuit of Figure 2, set the source voltage to that same value measured in Procedure 2. Label these values on the circuit of Figure 2.

    a.   Calculate the current. $I = E/R = \underline{\hspace{2.5cm}}$

    b.   Measure the current. $I = \underline{\hspace{2.5cm}}$

FIGURE 2

    c.   Notice that this single resistor has the same total resistance, same current and same voltage as the original series-parallel circuit in Figure 1. Why, then, could you not use this one resistor to complete all of the procedures in this experiment?
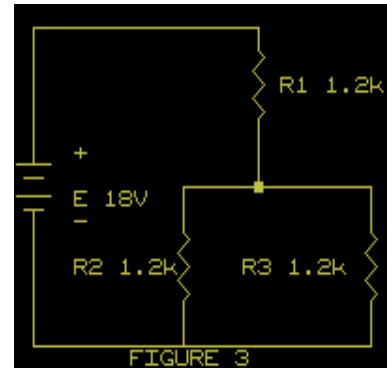
11. Connect the circuit in Figure 3. Note: Adjust the DC supply <u>with</u> the circuit connected.

    a. Repeat procedures 1 through 5. Record in Table 3.

Resistor	R_1	R_2	R_3
Voltage			
Current			

Table 3

FIGURE 3

    b. Change R_2 to a value of 2.2 kΩ. Repeat procedures 1 through 5. Record in Table 4.

Resistor	R_1	R_2	R_3
Voltage			
Current			

Table 4

    c. Compare the results of 11.b) with those of 11.a). Note that R_2 has been <u>increased.</u> Explain why <u>all</u> of the currents and voltages have changed.