Experiment 10 — Superposition

EL 111 - DC Fundamentals

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Objectives:

1. For the student to calculate circuit voltages and currents, when more than one voltage source is present, by the process of superposition and verify calculations by measurements.

Equipment and parts:

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

Power Supply: Agilent E3631A Triple Output DC Power Supply (0-20 V_{DC}, +5V_{DC})

Resistors: 1 - 3 kΩ, 1 - 1.2 kΩ, 1 - 1.6 kΩ

Misc: Component Board

Information:

Superposition is a process for calculating currents and/or voltages for a component in a circuit which has more than one source.

The superposition techniques involve the following steps:

Step 1 Remove all sources except one. You elect which one remains since eventually each existing source will be the stand-alone source before the analysis is complete. Replace the removed sources with their internal resistances. (Note: for this lab you will use voltage sources with a resistance of *zero* and will be instructed to replace the source with a *short*). Calculate the current(s) and/or voltage(s) with the one remaining source in the circuit for the resistor(s) in which you have an interest. Record the amount and direction of current and/or the magnitude and polarity of voltage across each resistor of interest.

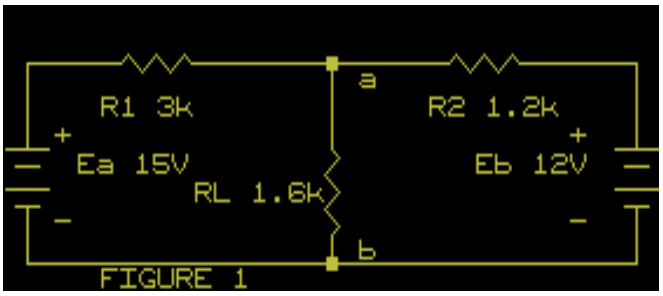
Step 2 Remove the source used in Step 1 and replace another source previously removed. Calculate the current(s) and/or voltage(s) of interest, recording directions, polarities and magnitudes of the current and voltage of interest.

Step 3 Repeat Step 2 until all sources in the original circuit have been used.

Step 4 The actual current and/or voltage for any one resistor will be the algebraic sum of the currents and/or voltages found above for that particular resistor.

Procedure:

1. Refer to Figure 1. **Use the following steps to calculate the current through and the voltage across R_L (the resistor of interest) by superposition techniques.**

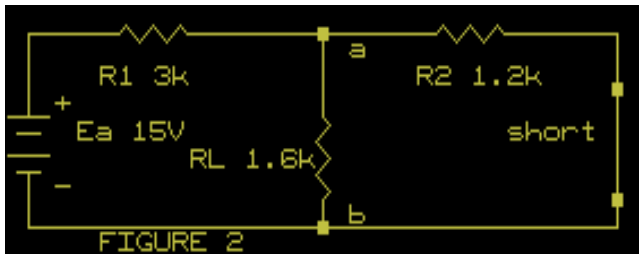


Step 1 **E_a is present, E_b is removed.** Refer to figure 2. Remove E_b, and replace it with a short. (This assume that the voltage source has no internal resistance.) Solve for the magnitude and direction of the current through R_L in figure 2. Calculate the voltage drop across R_L. Determine the polarity of the voltage drop. Record the current, its direction, the voltage drop and the polarity on figure 2. Show your calculations in space provided.

Calculations (E_b removed):

I_{RL} _____

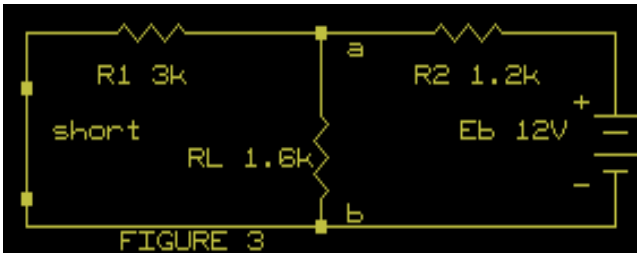
E_{RL} _____



Step 2 Refer to figure 3. Remove the short and replace E_b. Refer to figure 3. Remove E_a and replace it with a short. Solve for the magnitude and direction of the current through R_L in figure 3. Calculate the voltage drop across R_L. Determine the polarity of the voltage drop. Record the current, its direction, the voltage drop and the polarity on figure 3. Show your calculations in space provided.

Calculations (E_a removed):

I_{RL} _____



E_{RL} _____

Step 3 The actual current through and voltage across R_L WILL BE the ALGEBRAIC SUM of the results obtained in steps 1 and 2. Do these summations below and record the resultant current and its direction and the voltage drop and its polarity on Figure 1 on page two.

Algebraic addition: E_{RL} = _____ + _____ = _____

I_{RL} = _____ + _____ = _____

2. Verify the results of the superposition calculations by circuit measurement.

a) Connect the circuit of Figure 1. NOTE: Make sure that the DMM common is at point b.

b) Measure the following:

E_{RL} = _____, and point _____ is positive in respect to point _____.

I_{RL} = _____, current flows from point _____ to point _____.

c) If the calculated results are not reasonable close to the measured results, check your calculations and measurements to find the error.

3. On a separate sheet of paper, repeat Procedures 1 and 2 except **reverse the polarity of E_a**. Show all three circuit diagrams and all calculations as contained in Procedures 1 and 2 of this experiment.