# EXPERIMENT 3
# Electrical Measurements: More Practice with DC Measurements

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## The objectives of this experiment are to:

- Give student further experience with basic DC measurements
- Practice verifying measurements with more advanced circuit solution techniques

## Introduction

This lab will continue to build on the skills developed in Experiment #2. Its lab manual should be reference if students need refreshment on voltage, current, and resistance measurements, breadboard layout, or NI ELVIS board functionality.

In this lab manual, voltages and currents will be defined slightly differently than the two previous lab manuals. Refer to Figure 1 to see three equivalent ways to define a voltage and two equivalent ways to define a current.

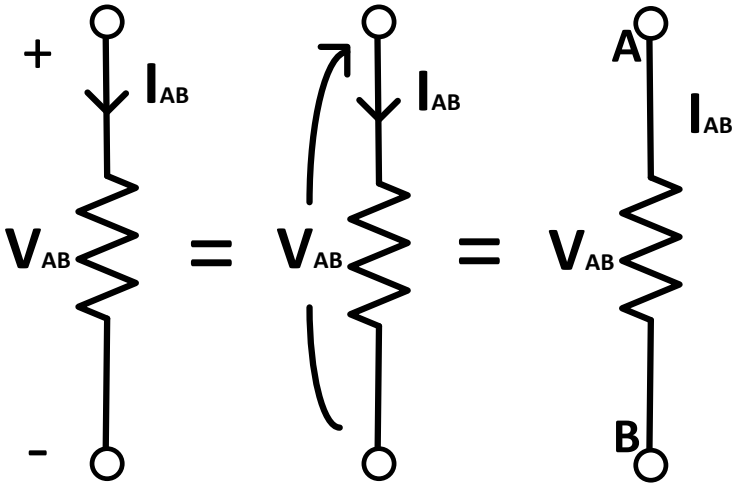


**Figure 1: Voltage & Current Definitions**

Reminder: You will lose points from you lab report for every blown fuse. If you are uncertain whether you have your circuit and DMM wired correctly to make a measurement, check with your T.A. before turning on the power!

## Exercises

In addition to those skills, one needs to use NI ELVIS's variable DC power supply to complete the exercises below. After turning on the main power switch on the back of the NI ELVIS board,

open the Instrument Launcher on your computer. From here, select “Variable Power Suplies” as displayed in Figure 2. This will open the Variable Power Supplies panel shown in Figure 3. One can see the controls for both a “positive source” and a “negative source”. In this lab, we will only be using the positive source, and it will be set at 7 V for all exercises.

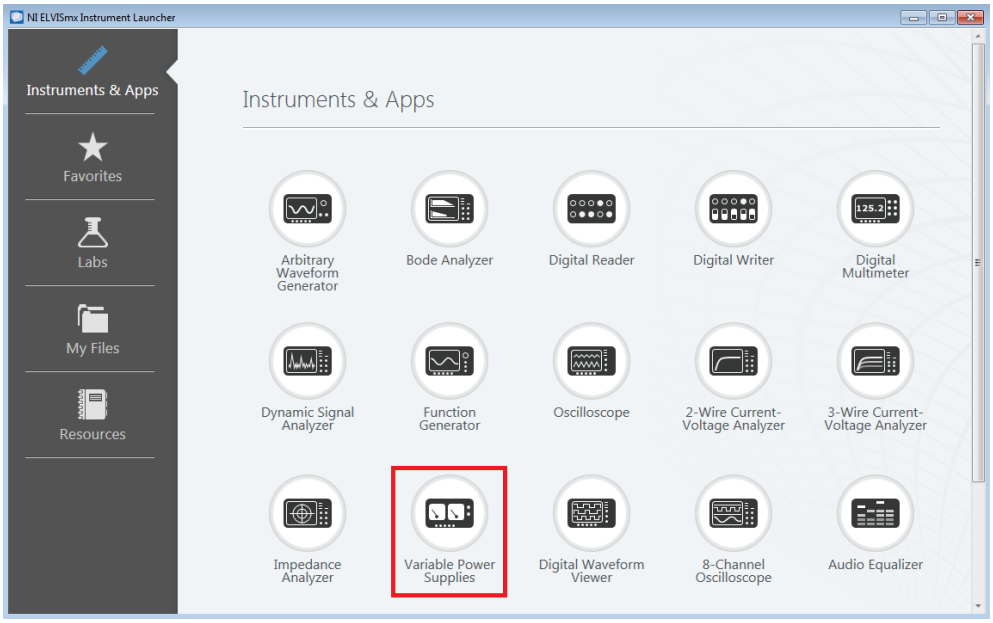


**Figure 2: NI ELVIS Instrument Launcher**

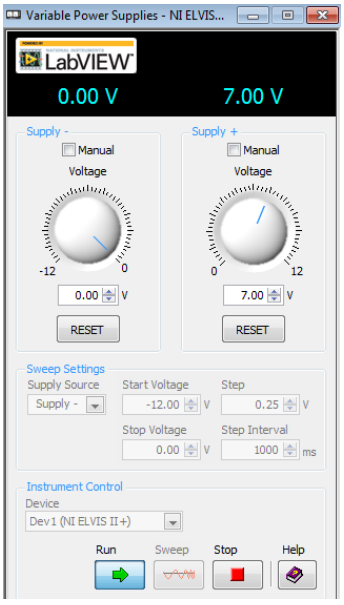


**Figure 3: VPS Panel**

**1)** For all the following exercises, you will be using the NI ELVIS board’s 5 V [fixed] power supply and variable power supply (set at 7 V). Set up your variable power supply as shown in Figure 3 and verify the voltage with a DMM as shown in Figure 4 (either with a handheld DMM or the DMM built into the NI Bench-top Module). Also, verify the voltage of the 5 V supply. Record the measured values of the power supplies in your lab report. In all hand calculations involving the power supplies, use these measured values.

**WARNING:** Never connect the positive terminal of a power supply to the ground (This is called "shorting out the power supply"). Also, for these exercises, the references for both supplies have to be the same node (every circuit is setup this way already).

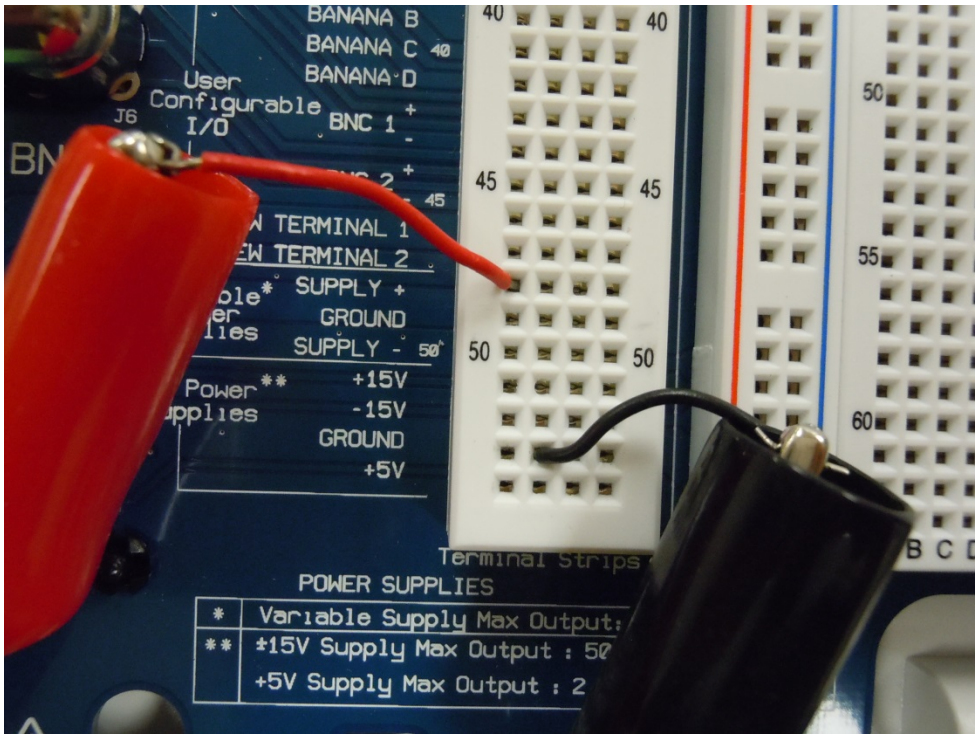


**Figure 4: Measuring the VPS**

**2)** All resistors used in the exercises will be theoretically 330 Ω. You will need seven in total. Create a table of the resistors' measured values (R1 through R7). In all hand calculations involving the resistors, use these measured values. Try to keep up with which resistor is which; this will help you make more exact calculations.

**3)** Breadboard the circuit in Figure 5. Reference Figure 6 if you need assistance. If you do not feel confident in your wiring or measuring, ask for help from your TA before turning on the power.

- Measure $V_A$, $V_B$, $V_C$, $V_D$, $V_{AC}$, and $V_{BD}$.
- Verify Kirchhoff's Voltage Law using $V_A$, $V_C$, and $V_{AC}$.
- Verify Kirchhoff's Voltage law using $V_B$, $V_D$, and $V_{BD}$.
- Measure $I_{DC}$.
- Using your measurement for $I_{DC}$, calculate the value for $I_{AB}$ (do not use your voltage measurements from this exercise in this calculation). You will use a combination of KVL, KCL, and Ohm's Law to solve for $I_{AB}$.

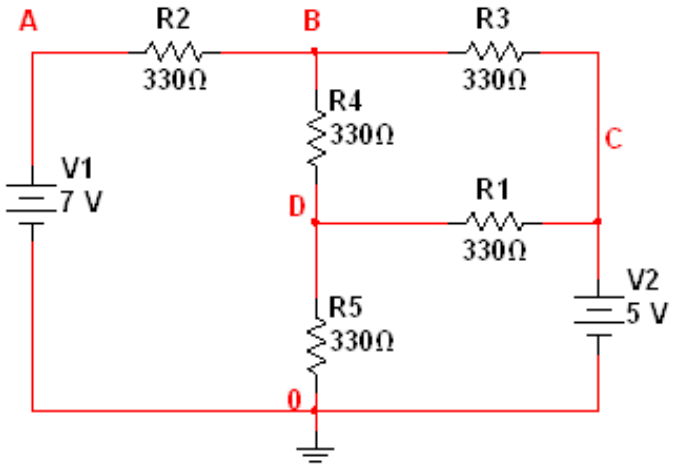


**Figure 5: Circuit for Exaercise 3**

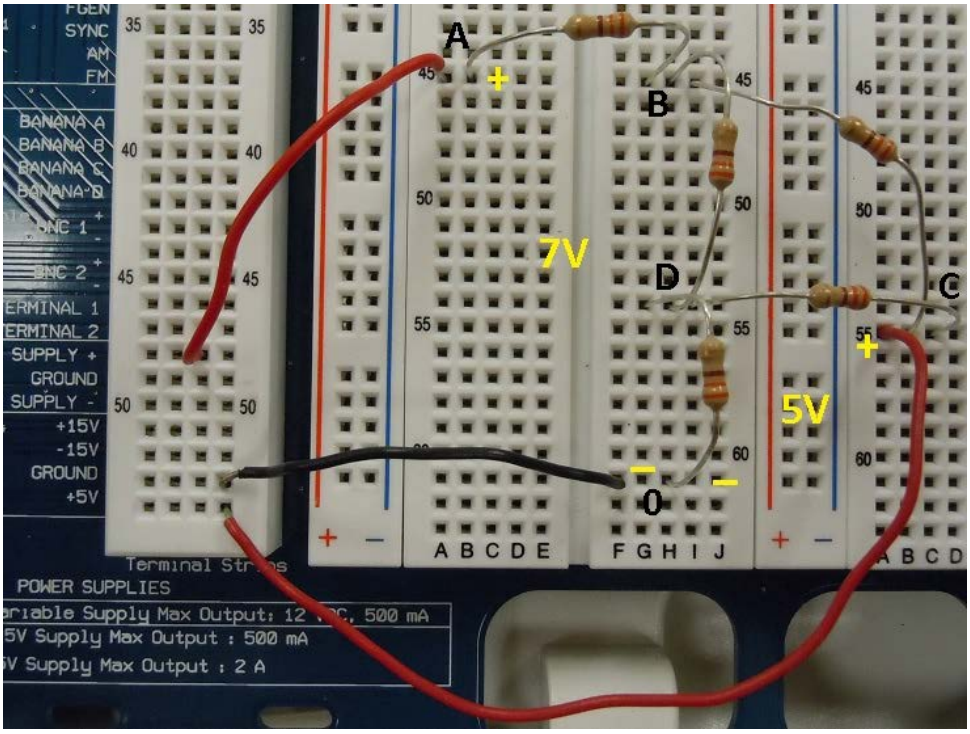


**Figure 6: Exercise 3 Circuit Breadboard**

**4)** Breadboard the circuit in Figure 7. Try to breadboard the circuit in such a way that it resembles the schematic. Keep up with which node is which, particularly which nodes power supplies are connected to.

- Measure $V_A$, $V_B$, and $V_C$. Verify these node voltages using nodal analysis.
- Measure $I_{BA}$, $I_{B0}$, and $I_{BC}$. Verify using Kirchhoff's Current Law at node B.
- Calculate $I_{BA}$, $I_{B0}$, and $I_{BC}$ using your measured node voltages and resistor values (Ohm's Law).

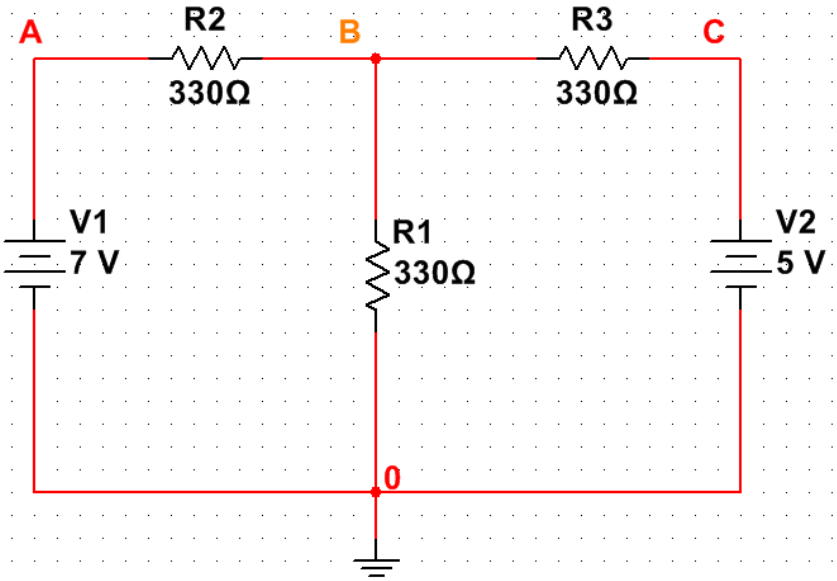


**Figure 7: Circuit for Exercise 4**

**5)** Breadboard the circuit in Figure 8.

- Measure $V_{AC}$, $V_{AB}$, $V_{AD}$, $V_B$, $V_C$, $V_{CE}$, $V_D$, $V_{DE}$, and $V_E$.
- Measure $I_{AC}$, $I_{AB}$, $I_{AD}$, $I_{C0}$, $I_{CE}$, $I_{D0}$, $I_{DE}$, and $I_{E0}$.
- Calculate the power absorbed by every element in the circuit (refer to the elements using the labels given in Figure 8: R1, R2, V1, etc.).
- Verify that the sum of power absorbed by all circuit elements equals 0 W (note that the sum of absorbed power will only be approximately 0 W due to the accumulation of measurement error).

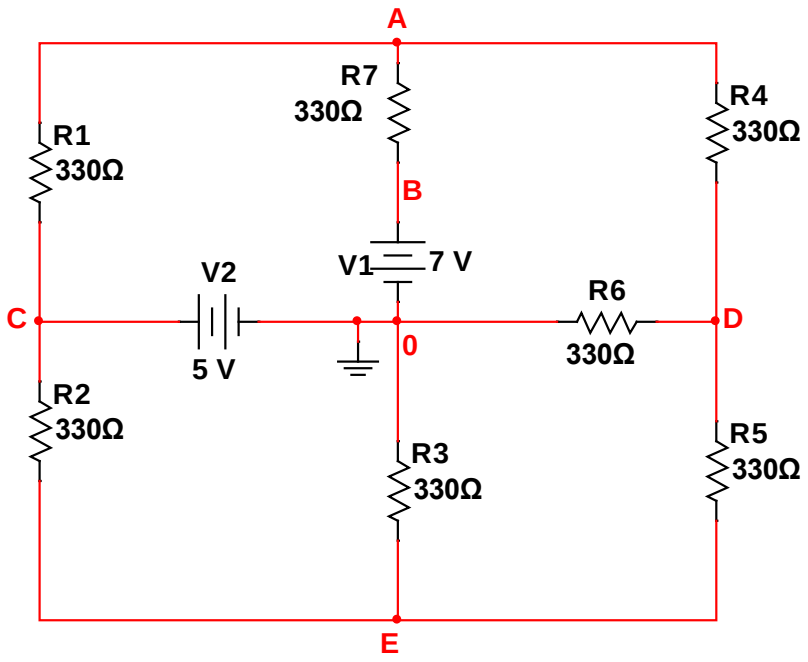


**Figure 8: Circuit for Exercise 5**