Introduction

During this exercise you will measure the voltages and currents in a series DC circuit. The results will be used to verify the circuit theory that applies to series DC circuits including Kirchhoff's Voltage Law and the Voltage Divider Equation.

A **Variable Resistance Module** will be used to provide the resistors required for this experiment. The module contains three sets of resistors (red, black, and blue), each consisting of three parallel-connected switched resistors (1200Ω, 600Ω, and 300Ω) as shown in the **Figure 1.1**, one or more of which can be selected by toggling ON or OFF their associated switches:

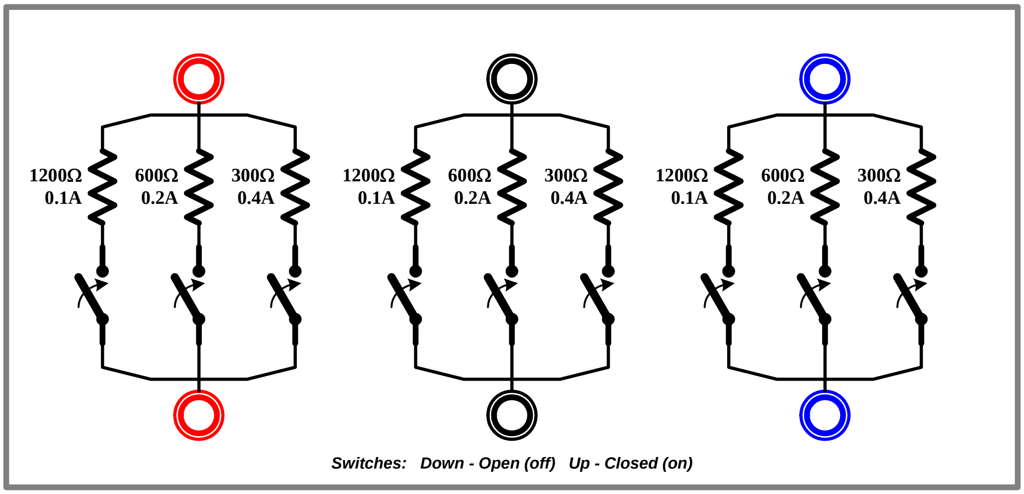

Figure 1.1 – Variable Resistance Module

The **Lab Volt Power Supply**, shown in **Figure 1.2**, will be used to provide the voltage source required for this experiment. This supply contains a variety of different voltage sources, including a constant $208V_{AC}$ three-phase source, a variable 0-$208V_{AC}$ three-phase source, a variable 0-$120V_{DC}$ source, and a constant $120V_{DC}$ source, all of which are (de)energized by the Main Power switch on the panel. Additionally, the supply also contains a constant $24V_{AC}$ source that is provided for use with the Lab Volt Data Acquisition Module. The $24V_{AC}$ source can be energized independently using the red switch located below the Main Power switch.

Specifically, this experiment will require the use of the **variable 0-120V_{DC} source**, the magnitude of which is controlled by the large adjustment knob located in the upper portion of the supply. This knob has a percentage scale ranging from 0 to 100, which indicates the voltage potential that should be present across the supply's terminals (**7-N**) in terms of a percentage of the supply's maximum voltage.

Note that, although the voltage magnitudes stated on the faceplate of the module are nominal voltages, this is not a regulated supply. Therefore, when used for an experiment, the actual voltage present across any of the supply terminals show be checked using external meter.

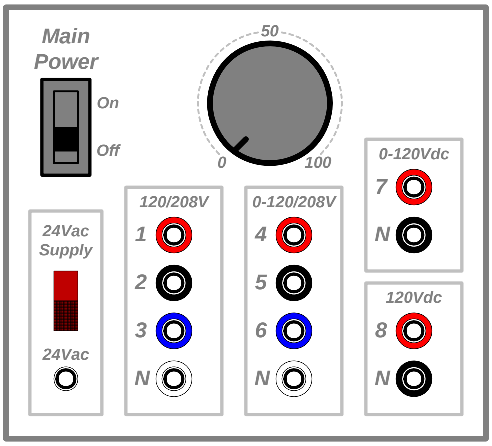

Figure 1.2 – Lab Volt Power Supply

Procedure (Series DC Circuits)

1. Set the switches on the Variable Resistance box to obtain the following three resistance values:

$$\mathbf{R_1 = R_{red} = 300\Omega,\ \ R_2 = R_{black} = 600\Omega,\ \ R_3 = R_{blue} = 300\Omega}.$$

Measure the actual resistance values of the resistors and calculate the relative differences between their measured and nominal values. Maintain at least three significant digits of accuracy during all calculations. Record the results in **Table 1.1**.

$$\text{Relative Difference:} \quad RD\% = \frac{R_{Nominal} - R_{Measured}}{R_{Nominal}} \cdot 100\%$$

Note that relative difference is a signed value. A "positive" relative difference is returned when the measured value is less than the nominal value while a "negative" relative difference is returned when the measured value is greater than the nominal value.

2. Construct the circuit shown in **Figure 1.3** that contains three series-connected resistors:

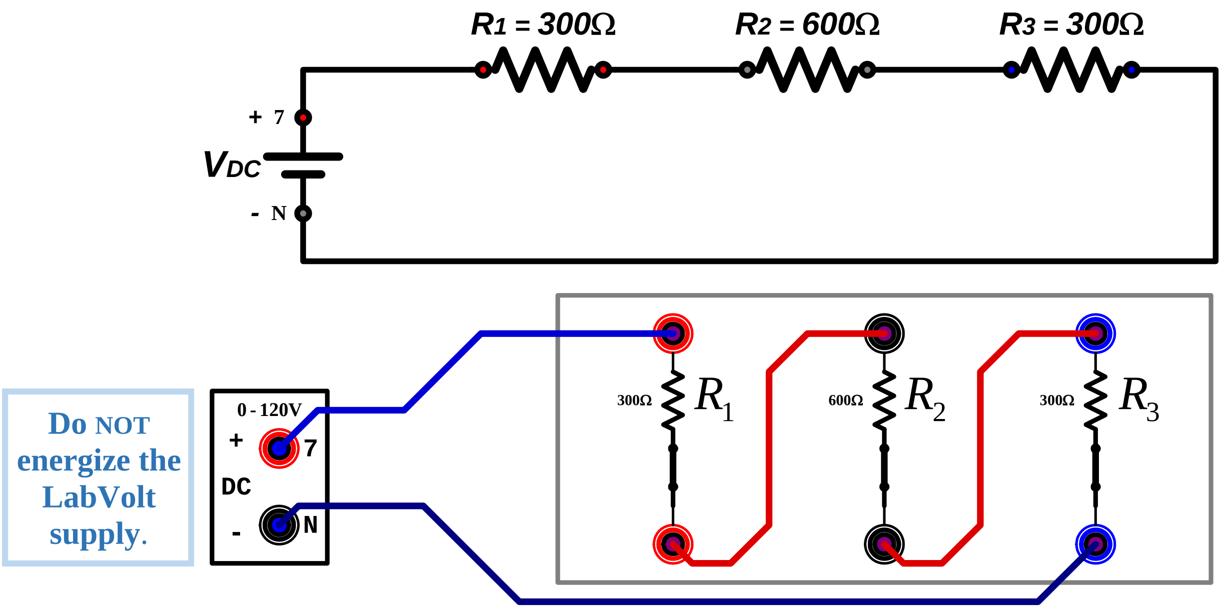

Figure 1.3 - Series DC Circuit and LabVolt Connections

3. Configure the Data Acquisition System to measure the current flowing into each resistor, $\mathbf{I_1}$, $\mathbf{I_2}$, and $\mathbf{I_3}$, and the voltage across each resistor, $\mathbf{V_1}$, $\mathbf{V_2}$, and $\mathbf{V_3}$.

Note – see the figure at the top of the next page for assistance with the wiring of the Data Acquisition System.

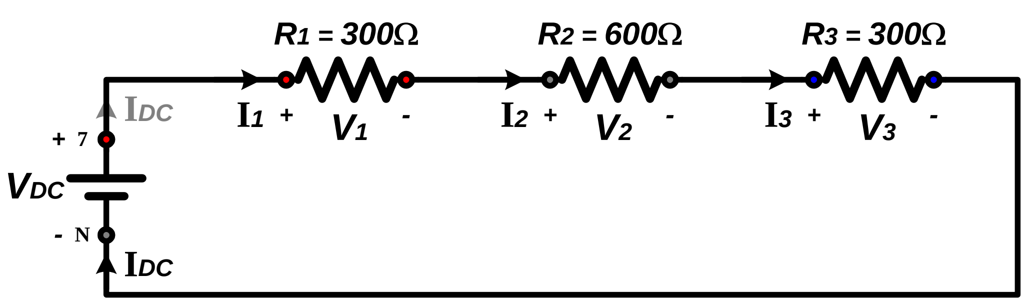

Figure 1.4 - Series DC Voltages and Currents

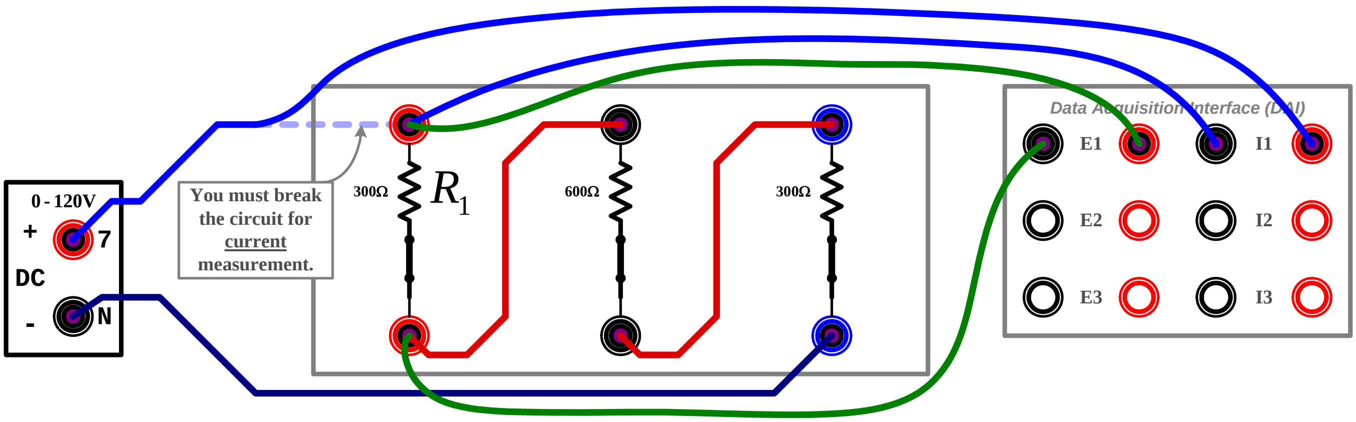

Figure 1.5 – Configuring the Data Acquisition System to Measure I_1 and V_1.

4. Configure a DMM to measure the current flowing into terminal **N** of the DC voltage source, $\mathbf{I_{DC}}$, and a second DMM to measure the DC source voltage, $\mathbf{V_{DC}}$.

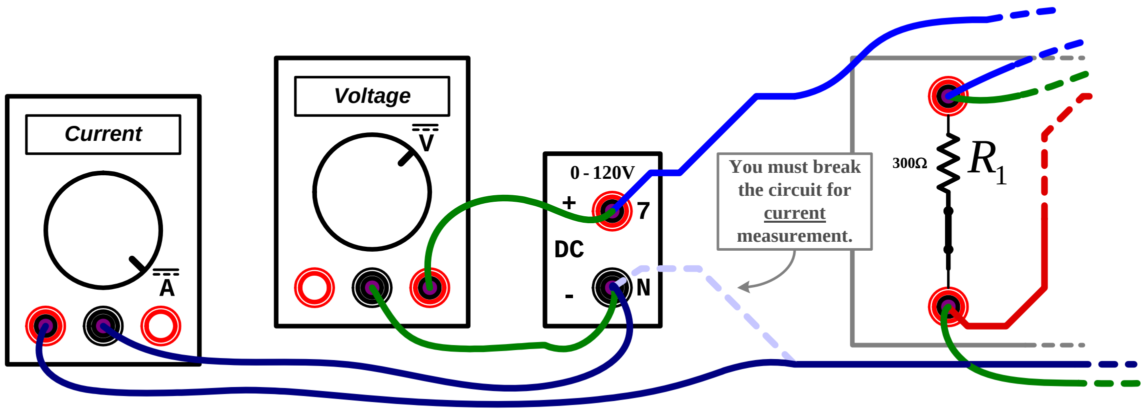

Figure 1.6 – Source Current and Voltage Measurement Using DMMs

Have your instructor check your wiring **before** continuing on to the next step.

5. Be sure to adjust the variable-voltage knob on the LabVolt power supply to its minimum position <u>before</u> energizing the supply.

Using the voltage-configured DMM to verify the voltage magnitude, **switch ON** the LabVolt supply and raise the voltage of variable DC source to **12 volts**.

6. With the source set at $12V_{DC}$, measure the voltages $\mathbf{V_1}$, $\mathbf{V_2}$, and $\mathbf{V_3}$, the currents $\mathbf{I_1}$, $\mathbf{I_2}$, $\mathbf{I_3}$, and the source current $\mathbf{I_{DC}}$. Record all of the measured values in **Table 1.2**.

7. Raise the source voltage from 12 to **24 volts** and repeat the measurements specified in step 6.

8. Raise the source voltage from 24 to **48 volts** and repeat the measurements specified in step 6.

9. Lower the source voltage back down to **0 volts** and **switch OFF** the Lab-Volt supply.

10. Have your instructor **check your results** <u>before disassembling your circuit</u>.

In-Lab Calculations

THE FOLLOWING STEPS ARE TO BE COMPLETED INDIVIDUALLY DURING THE LAB SESSION:

Note – you must show at least one sample calculation for each step that includes the utilized formulas, the numbers entered into the formulas, and the final numerical results.

11. Using your measured resistor values from Table 1.1, **calculate** the **theoretical resistor voltages** $\mathbf{V_{1T}}$, $\mathbf{V_{2T}}$, and $\mathbf{V_{3T}}$, the **theoretical resistor currents** $\mathbf{I_{1T}}$, $\mathbf{I_{2T}}$, $\mathbf{I_{3T}}$, and the **theoretical source current** $\mathbf{I_{DCT}}$, if the source is set to $24V_{DC}$. Record the values in **Table 1.3**.

(Note – you must use the Voltage Divider Equation when calculating the theoretical resistor voltages.)

Determine the **relative difference** between the theoretical values and the measured values.

12. Kirchhoff's Voltage Law provides that, around any closed-loop path in a circuit:

$$\sum V_{rises} - \sum V_{drops} = 0 .$$

Ideally, for the series DC circuit, Kirchhoff's Voltage Law can be expressed as:

$$V_{DC} - V_1 - V_2 - V_3 = 0$$

But, due to measurement and other error sources, the equality may not quite hold-true for the measured values. To check the relationship, let:

$$V_{KVL(error)} = V_{DC} - V_1 - V_2 - V_3 \ .$$

Solve for $V_{KVL(error)}$ using the measured values obtained when the source voltage was set to $\mathbf{24V_{DC}}$ and record the results in **Table 1.4**.

Ideally $V_{KVL(error)} = 0$. **Discuss** whether or not this is the case based on your calculated results.

ECET 3000 – Lab 1 Results **Name: ______________________________**

(Print Name – LAST NAME FIRST)

Experimental Procedure

	$R_{measured}$	$R_{nominal}$	RD (%)
R_1		300 Ω	
R_2		600 Ω	
R_3		300 Ω	

Table 1.1 – Comparison of Measured and Nominal Resistor Values

V_{DC} (V)	V_1 (V)	V_2 (V)	V_3 (V)	I_1 (mA)	I_2 (mA)	I_3 (mA)	I_{DC} (mA)
12 V							
24 V							
48 V							

Table 1.2 – Measured Series Voltages and Currents

In-Lab Calculations

V_{DC} = 24V	V_{1T} (V)	V_{2T} (V)	V_{3T} (V)	I_{1T} (mA)	I_{2T} (mA)	I_{3T} (mA)	I_{DCT} (mA)
measured (From Table 1.2)							
theoretical							
RD%							

Table 1.3 – Measured/Theoretical Comparison for Series DC Circuit

(show your work in the space below)

V_{DC} (V)	$V_{KVL(error)}$ (V)
24 V	

Table 1.4 – Kirchhoff's Voltage Law Calculations

(show your work in the space below)