4.4.1: Two-terminal Characteristics

Overview:

In this lab, we will estimate the voltage-current characteristics of a simple circuit containing a power supply from measured data. The voltage-current data estimated from experimental data will be compared to analytical estimates.

Before beginning this lab, you should be able to:

- Calculate voltage-current characteristics for circuits containing sources
- Perform least-squares curve fitting to data (Lab 1.3.2)

After completing this lab, you should be able to:

- Estimate voltage-current characteristics from measured data and compare the result with analytical estimates

This lab exercise requires:

- Analog Discovery module
- Digilent Analog Parts Kit
- Digital multimeter

Symbol Key:

DEMO — Demonstrate circuit operation to teaching assistant; teaching assistant should initial lab notebook and grade sheet, indicating that circuit operation is acceptable.

ANALYSIS — Analysis; include principle results of analysis in laboratory report.

SIM — Numerical simulation (using PSPICE or MATLAB as indicated); include results of MATLAB numerical analysis and/or simulation in laboratory report.

DATA — Record data in your lab notebook.

General Discussion:

This lab assignment concerns the circuit shown in Figure 1 below. (Pay special attention to the polarity of the 3V source relative to the polarity of V_{ab}!)

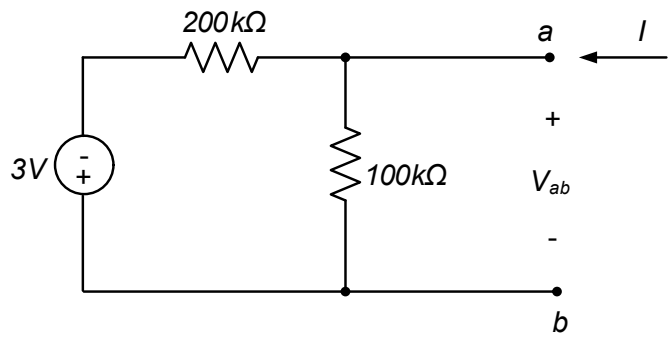

Figure 1. Circuit schematic.

Pre-lab:

ANALYSIS

1. Calculate the functional relationship between the voltage V_{ab} and the current I for the circuit of Figure 1. Plot the voltage V_{ab} as a function of the current, I (the plot should have voltage on the vertical axis and current on the horizontal axis). Calculate the slope of the curve and the y-intercept of the curve.

ANALYSIS

2. Calculate the expected voltage V_{ab} if the terminals a-b are open-circuited. Compare this voltage to the y-intercept of the curve you calculated in part (a) of the pre-lab. Kill the 3V source and determine the equivalent resistance of the circuit seen across the terminals a-b. Compare this value to the slope of the curve you calculated in part (a) of the pre-lab.

Lab Procedures:

DATA

1. Build the circuit of Figure 1. Use W1 to apply the 3V voltage source and W2 to apply the voltage V_{ab}. (Please pay attention to the polarity on the 3V source!) Record the actual resistance values.

DATA

ANALYSIS

2. Record the current, I, resulting from values V_{ab} = 0.2V, 0.5V, 1.0V, 2.0V, 4.0V, and 5.0V. Tabulate the voltage vs. current data. Plot the data, with current on the x-axis and voltage on the y-axis. Perform a least-squares curve fit of a straight line to the data and determine the slope and y-intercept of the line.

DATA

3. Replace the V_{ab} voltage source with an open-circuit and measure the resulting voltage V_{ab}.

DATA

4. With V_{ab} still open-circuited as in step 4, replace the 3V source with a short-circuit and use your DMM to measure the resistance seen across terminals a-b.