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 $V_{ab}$!)

![Circuit Schematic](image)

*Figure 1. Circuit schematic.*

Pre-lab:

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.

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:

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.

2. Record the current, $I$, resulting from values $V_{ab} = 0.2V, 0.5V, 1.0V, 2.0V, 4.0V, \text{ and } 5.0V$. 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.

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

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.