



## Lab 1: Measuring voltage with a DAQ

### The Project: Circuits and Probes

Company X has expressed an interest in characterizing the behavior of several complex circuits that will be used on a future project. These circuits consist of a number of capacitors, resistors, and inductors to create the desired signal. These circuits will be monitored with a proprietary acquisition software that was developed by Company X employees. In order to understand the behavior of this software, we ask that you characterize the behavior of several simpler circuits. You also will need to verify that the software is providing an accurate measurement.

*You should consult your instructor for additional safety instructions before starting on **ANY** lab. You should cap the current output of your power supply at **.1 A (100 mA)**.*

### Equipment Available to You:

- DC Power Supply
- Pasco CI- 6512 RLC Circuit Board
- Data Acquisition (DAQ) Unit
- BNC to Alligator Cable
- Banana to Alligator Cables
- Alligator to Alligator Cables

### Possible Needed Techniques:

- Measuring Voltage with a DAQ
- Measuring Voltage with a Multimeter
- Basic Python Commands

### Pre-Lab Organizational Questions:

1. You will need to characterize the noise associated with the DAQ. You should not stick the probe directly in the voltage supply. What circuit can you design to test the specifications of the acquisition software?
2. To prove that the custom probe works, you will need to test the measurements of the probe against that of an established voltage probe. What do you plan to use to provide a comparable voltage measurement?
3. Minimizing error is important for sensitive measurements. What procedural steps can you take to reduce the inherent error associated with a measurement? What are the drawbacks to taking these steps?
4. How will you the power supply to achieve the different measurements that you need? You will need to be familiar with the different modes of the power supply (CV vs CC)
5. You will need to find a relationship between voltage and resistance. What will be your independent variable? What will be your dependent variable?
6. Write a preliminary plan for your experimental procedure. Indicate what each person in your group will do to solve the problem, and what data they will record.



## Lab 1: Measuring voltage with a DAQ

### The Requirements:

We ask that you characterize a number of different features of the voltage probe using simple resistors and a DC power supply.

1. Characterize the accuracy of the voltage probe and discuss the noise associated with the custom probe and compare the readings with a commercial device.
2. Understand the difference between a current source and a voltage source.
3. Find a relationship between voltage and resistance.

### Presentation of the solution:

Your team must prepare a presentation that will be given to a member of Company X on the approach that your team is using to complete the project. The presentation may be given by the whole team as a group or by a single member of the team chosen by a member of the Company X team. The presentation must include:

- A description of the basic physics principles used in your project including the equations used to convert the outputted data into current or voltage.
- Plot the relationship between the measured voltage across a resistor and the resistance for different currents from the power supply. Do this for three different resistor values. Discuss any trends and apply the appropriate fits where necessary.
- Provide an equation that directly relates the voltage across a resistor to the current going through the resistor
- Plot the standard deviation of voltage across the resistor as a function of time for different voltage values. You should provide important statistics and information on the measured voltage and any other important parameters in your python script. Be prepared to comment and prove whether any noise associated with the probe is dependent upon the magnitude of the voltage coming from the initial source.
- Discuss the relative error and the absolute error associated with the voltage probe. How does the relative error scale with the magnitude of the output voltage? How does the absolute error scale with the magnitude of the output voltage?
- Discuss techniques that can be implemented to reduce the noise of a voltage measurement. What are the limitations of using these techniques? (Hint: Think about the wall power outlets)