ECSE 1010

Class #2: Instruments & Protoboards

Purpose: The objective of this experiment is to explore Ohm's Law using a simple multi-meter and the Analog Discovery Board

Background: Before doing this experiment, students should be able to
- Use Ohm's Law to determine either I, V, or R when given the other two parameters.
- Analyze simple circuits consisting of series and parallel combinations of resistors, especially voltage dividers.

Learning Outcomes: Students will be able to
- Determine the value of a resistor from its color code, measurement with ohmmeter and using a voltage divider
- Plot the current through a resistor as a function of the voltage across the resistor and determine its resistance from the slope of this plot

Resources Required:
- Analog Discovery
- Multi-meter
- Protoboard (aka breadboard) from Parts Kit
- Resistors from Parts Kit

Helpful links for this experiment can be found on the course website under Class #2.

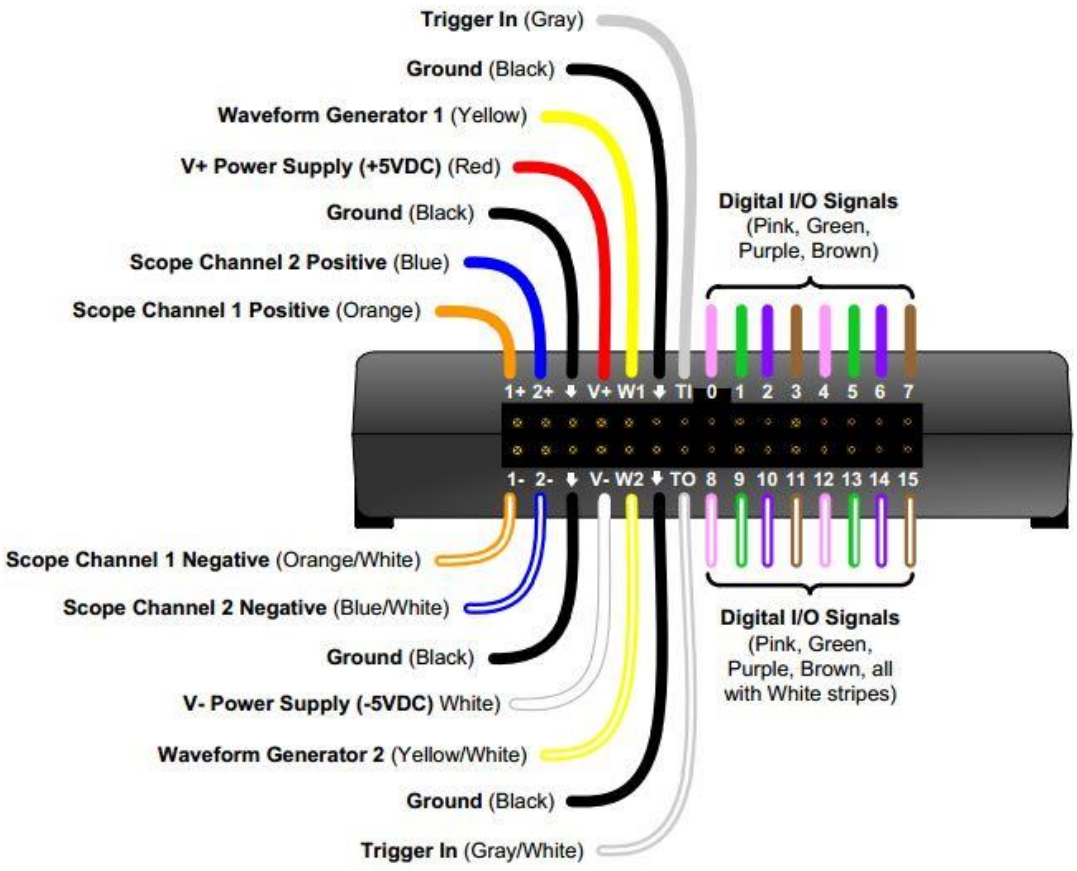
Pre-Lab

Required Reading: Before beginning the lab, at least one team member must read over and be generally acquainted with this document and the other **required reading** materials.
Required Viewing: Before beginning the lab, each team member must view the videos posted for this experiment.
Hand-Drawn Circuit Diagrams: Before beginning the lab, hand-drawn circuit diagrams must be prepared for all circuits either to be physically built and characterized using Analog Discovery.
Due: At the beginning of Class #4

Notes: For this experiment, it will be more convenient if you work together with one or two other students. You will be using a multi-meter and we have only one per table. The two or three groups at each table can take turns using their meter. If you have your own meter, you are encouraged to share to help other groups complete their work in a timely manner.

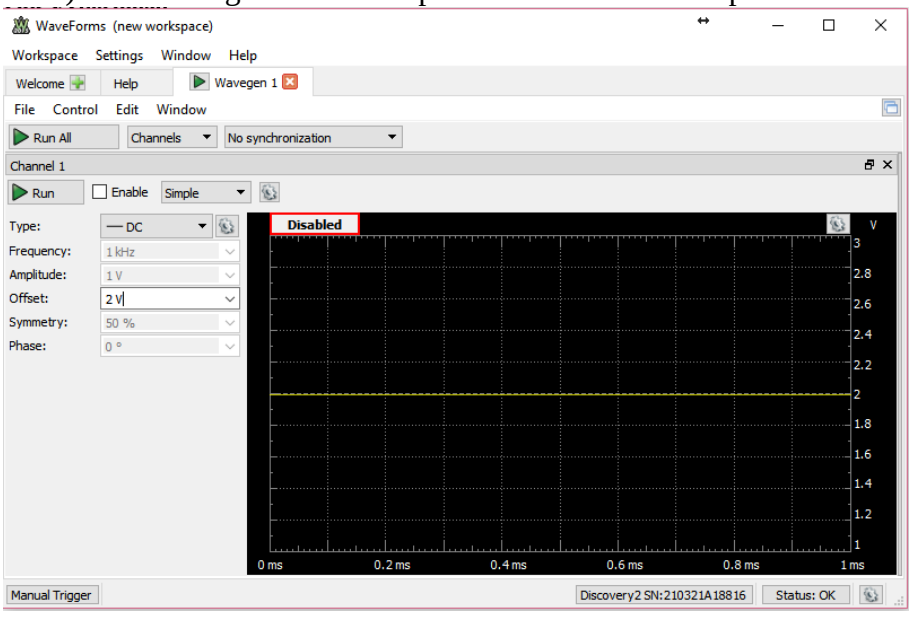
You do not have to do the experiment in the order it is written, especially if you have to wait for a multi-meter.

For future experiments, you will be required to demonstrate some of your measurements to a TA or instructor and have a signature sheet signed. Because this is one of the first two experiments, show a TA or instructor your results from each activity when you have completed it. Your experiment must be running when you do this.

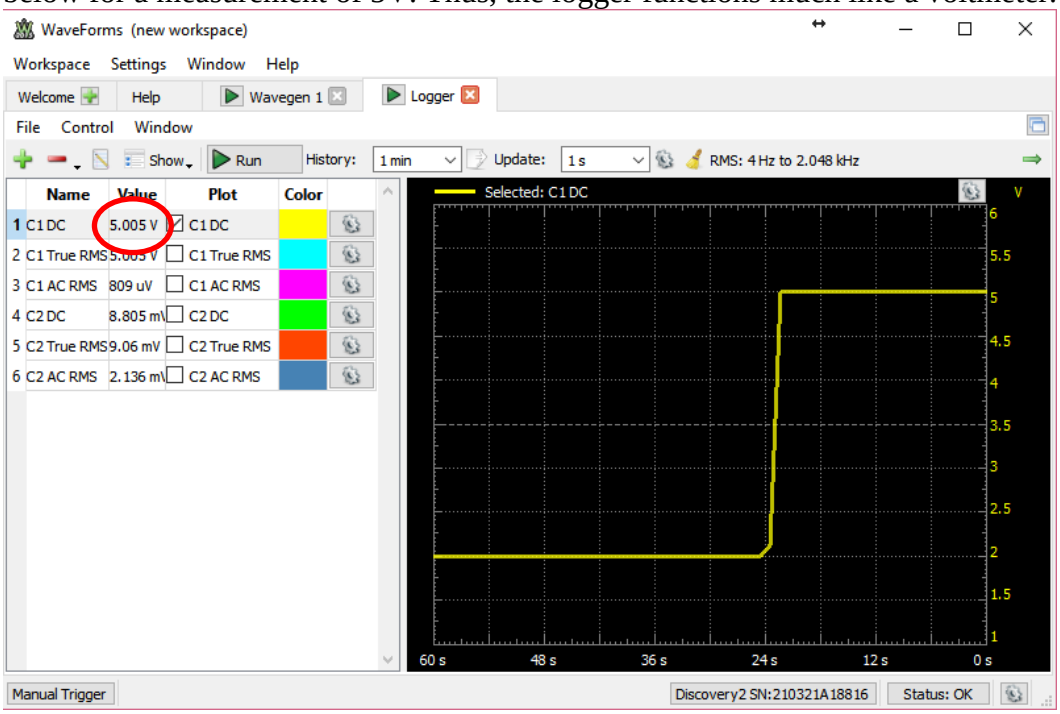


For This Experiment:

1. The wires for the variable DC power supply are yellow (for the voltage) and black (for the ground). Use Wavegen and set it up as shown below to output +2V.



2. The wires for the input to channel 1, to make voltage measurements, are orange (plus) and orange/white (minus). To display the measurement, use either the Scope or the Logger. Shown below is the logger. If you use this option, uncheck everything except channel 1 (C1 DC). The voltage will be displayed on the plot at the right and its value will be displayed as a number just to the left of the check mark. The value is circled below for a measurement of 5V. Thus, the logger functions much like a voltmeter.



3. Multi-Meters can measure voltage, current, & resistance. Shown here is the inexpensive CEN-TECH meter from Harbor Freight. To make a particular measurement, the dial must be set to the desired function and the wires must be plugged into the appropriate location. For what we do in this course, the meter wires are always plugged in as shown. The dial shown here is for resistance measurements up to 2000Ω. In this experiment, you are to measure resistance, current and voltage. For each measurement, choose the function with the dial, selecting the value that is larger than what you expect to measure. If you guess wrong, you can change the range. For resistance, the resistor must be disconnected from the circuit. For voltage measure across the component of interest. For current, the red and black wires must be connected in series with the circuit.

A. Determining Resistor Values

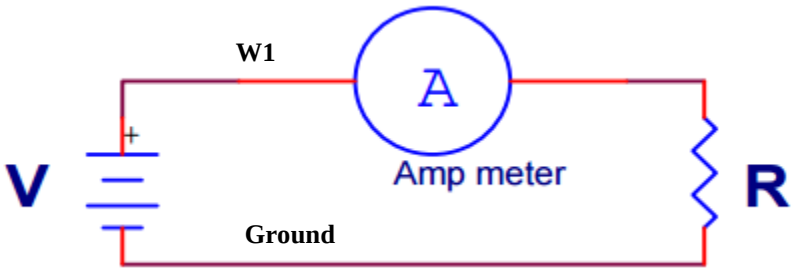
Select any resistor from your parts box. Write down the four color code for this resistor.

Using the information from the Quiz 1 Formula sheet or any other handy reference, identify the value of the resistor from its color code.

Use the ohmmeter function of a multi-meter to measure the resistance.

B. Current Measurements and Resistor I-V Plot

Connect the resistor you measured to a multi-meter used as a current meter and the variable DC source from the Analog Discovery board. Recall that there are two types of DC sources that can be realized using Analog Discovery. The red wire (V+) is a fixed 5V DC supply. The white wire (V-) is a fixed -5V DC supply. The yellow wire (W1) is a variable arbitrary waveform generator so it can be pretty much anything we want it to be. Here we will use it as a variable DC power supply that can produce voltages between -5V and +5V. The yellow wire with the white stripe (W2) can also be anything. We will not be using it in this experiment. The power supply also needs a reference. We will use the black wire because it is a ground (0V). Once you have your circuit built, open Waveforms 2015, but do not turn on the Wave Generator (W1) until you have had your circuit checked by a TA or instructor. Turn the supply off whenever you are making changes to your circuit.



Once your circuit has been approved, turn on the power supply and vary the voltage from 0V to 3V in 0.5V increments. For each voltage, record the current measured by the multi-meter.

Supply Voltage (V)	Current
0	
0.5	
1	
1.5	
2	
2.5	
3	

Plot the current I vs the voltage V. From the slope of your plot, determine the value of the resistor. Compare the value of resistance determined in this manner with the two previous values you obtained from the color code and the ohmmeter measurements.

C. Mystery Resistor

Obtain a mystery resistor from a TA or instructor or have another student select a resistor from their parts kit. Ideally, the color code should be covered so it cannot be read. Use whatever information you are provided to estimate its value. You could, for example, be given the color of the third stripe. If you are given no information, start by assuming the resistor has a value of 1kΩ. Use the procedure described in the ***Voltage Divider Basics*** video to determine the actual value of the resistor. Be sure to show all of your work in your report. Once you have completed the measurement, confirm your answer by measuring the resistance of the mystery resistor using an ohmmeter.

	Voltage Divider Measurement	Ohmmeter Measurement
Mystery Resistor 1		

Have another student in your group select a resistor from their parts kit and the other group member(s) are to repeat the experiment above to determine its value. In this case, do not provide any approximate information on the value of the resistor. The only information will be that it came from a standard kit.

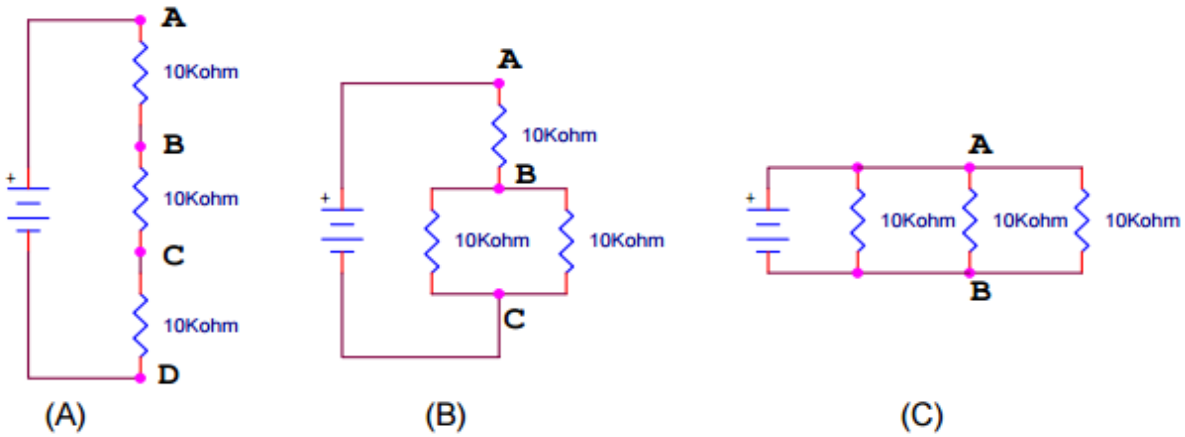
	Voltage Divider Measurement	Ohmmeter Measurement
Mystery Resistor 2		

Note- For the following two activities, the voltage can be measured either with a multi-meter or with analog discovery.

D. Distributing Current and Voltage

For the circuits shown below, calculate the voltage between each pair of adjacent nodes (A-B, B-C, C-D in figure A; A-B & B-C in figure B; A-B in figure C.

Build the three circuits (one at a time) using the fixed 5V supply (red wire) and ground (black wire) on the Analog Discovery board. Then measure the voltages you calculated above and compare your results. That is, connect the red wire to node A and ground to the bottom of the divider (node D in figure (A); node C in figure (B) and node B in figure (C)).



E. Potentiometer (Variable Resistor)

Apply 5V across the potentiometer shown below. Use the same power source as in the previous activity. Rotate the potentiometer clockwise and counter clockwise throughout its entire range. Measure the voltage between one of the end terminals of the potentiometer and the wiper (center terminal). Write down the range of voltages you measure.