ECSE 1010

Class #5: Current-Voltage Characteristics of a Resistor

Purpose: The objective of this experiment is to explore Ohm's Law using the M1K board and the Alice Source-Meter tool

Background: Before doing this experiment, students should be able to
- Measure the voltage across a component.
- Use Ohm's Law to determine either I, V, or R when given the other two parameters.

Learning Outcomes: Students will be able to
- 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:
- ADALM1000 (M1K) board or Analog Discovery
- Protoboard (aka breadboard) and wires from Parts Kit
- Resistors and LEDs from Parts Kit

Helpful links for this experiment can be found on the course website under Class #5.

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.

Due: February 3rd, 11:59 pm eastern on Gradescope. (one submission per group of 2 students)

Background Theory.

As we saw in Class 2, the relationship between current and voltage in a resistor is defined by Ohm's Law, V = IR (Voltage = Currect*Resistance). This equation is a linear relationship, following the classic expression, $y = mx+b$, where m is the slope of the line and b is the y-intercept. When considering Ohm's Law, we can say the y-variable is the voltage, V, and the x-variable is the current, I. The slope of the line is then the resistance, with the y-intercept being zero.

Important: The description of Alice Meter-Source tool and how to setup the channels to make measurements while sourcing voltages is discussed in this video. Watch and listen carefully before doing this experiment.

https://youtu.be/y-Tl-tksPnk

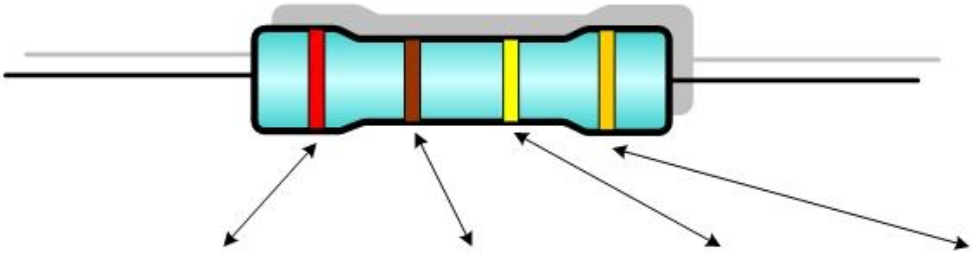
For This Experiment:

A. Determining Resistor Values

Select any resistor from your parts box. (It is a good idea to pick a resistor smaller than 1MΩ, 10^6Ω. The reason for this will be discussed in the next laboratory.)

1) In the template, write down the four color code for this resistor.
2) Using the following table, determine the resistance of the resistor you selected.

4-band Resistor

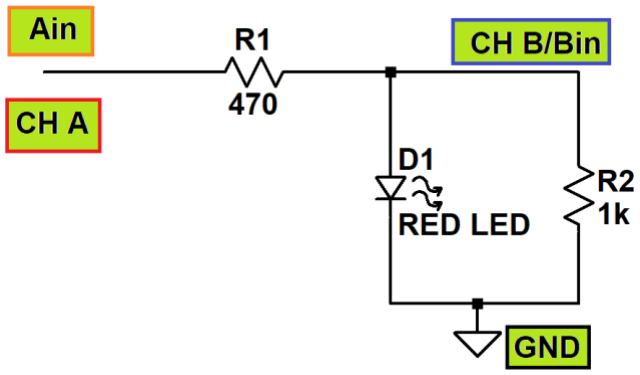


Color	1st band value	2nd band value	Multiplier	Tolerances
Black	0	0	× 1	
Brown	1	1	× 10	± 1%
Red	2	2	× 100	± 2%
Orange	3	3	× 1000	± 3%
Yellow	4	4	× 10,000	± 4%
Green	5	5	× 100,000	± 0.5%
Blue	6	6	× 1,000,000	± 0.25%
Violet	7	7	× 10,000,000	± 0.10%
Grey	8	8	× 100,000,000	± 0.05%
White	9	9	× 1,000,000,000	
Gold			× 0.1	± 5%
Silver			× 0.01	± 10%
No band				± 20%

You can use an online resistor calculator to verify your calculation, a nice reference can be found at All About Circuits using the following link.

https://www.allaboutcircuits.com/tools/resistor-color-code-calculator/

B. Resistor I-V Plot – Part 1



1. Using the process described in the video titled "Source and Measure DC Voltages", configure Channel A (**CH A**) as a variable DC voltage source and the **Ain** pin as the DC voltmeter. The value of the DC voltage source will be adjusted to make multiple measurements. Note, here CH A needs to be in Split I/O mode. Watch video for the details.

2. The source part of the circuit shown above is built using the M1K Board connections. The CH A pin on the M1K board should be connected to resistor R1 using a wire as shown above. You should build your circuit and make connection on the Protoboard.

3. DC voltage source can produce voltages between 0V and +5V. The source also needs a reference. We will use the GND pin on the M1K to provide this reference and connect it to one end of LED and R2 as indicated in the above circuit diagram.

4. To measure the voltage across the resistor R1, connect Ain pin to one side of the resistor and CH B (or Bin) pin to the other side of the resistor using wires. CAV – CBV will give us this value.

5. Once you build your circuit, launch Alice Meter-Source tool, put CH A in Split I/O mode, turn on CH A, and "run" the meter source unit. Vary the DC voltage of CH A from 0V to 3V in 0.5V increments. For each source voltage increment, record the voltage measured across resistor R1. Apply Ohm's Law to determine the current through the resistor

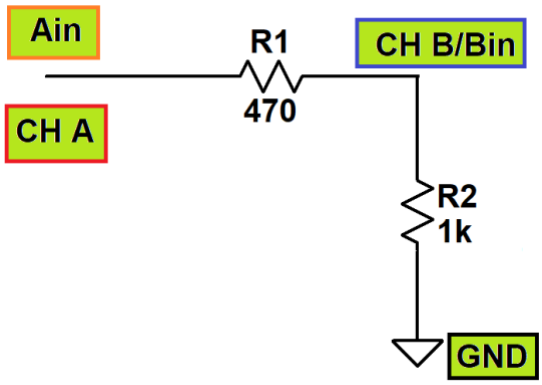
CH A Voltage (V)	Channel A voltage measured on Ain pin, V	Channel B voltage measured on CH B/Bin pin, V	Resistor R1 Voltage, V	Resistor Current, I
0				
0.5				
1				
1.5				
2				
2.5				
3				

(use the table in the template)

6. Plot the resistor current I (x-axis) vs the resistor voltage V (y-axis). From the slope of your plot, verify that Ohm's Law results in a linear relationship with a slope determined by the resistance value.
   Note, the resistor current will have a linear relationship with the resistor voltage. However, the resistor current will not have a linear relationship with the CH A source voltage. You might want to verify that yourself on a separate plot, but it is not required for the laboratory.

Answer on template

C. Resistor I-V Plot – Part 2



1. Remove the LED from the circuit.
2. Now we will also measure voltage across R2, To measure the voltage across the resistor R2, connect CH B (or Bin) pin to one side of the resistor R2 and GND pin to the other side of the resistor using wires. These connections should have already been made for Part 1. CBV – GND (or simply CBV) will give us this value of resistor R2 voltage.
3. As in the previous part, step the CH A source voltage from 0.0 to 3.0V in 0.5V increments.
4. Using voltage measurements CAV and CBV (using Ain and CH B/Bin pins), measure the voltage across R1 and R2. For each voltage, use Ohm's Law to determine the current.

CH A Voltage (V)	R1 Voltage (measured)	R1 Current (calculated)	R2 Voltage (measured)	R2 current (calculated)
0				
0.5				
1				
1.5				
2				
2.5				
3				

(use the table in the template)

For both resistors, plot the V-I curves (voltage vs. current) on the same graph. From the slopes of your plots, verify that Ohm's Law results in a linear relationship with a slope determined by the resistance value. Does the plot of the larger resistor have a steeper slope, as would be expected?

Answer on template