

GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer
Engineering
ECE 2040
Lab #1: myDAQ and Basic Resistors

GOAL

To gain experience with data acquisition, proto-boards (breadboards), and physical resistors.

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EQUIPMENT NEEDED

- 1k Ω resistor
- 2k Ω resistor
- Breadboard
- Jumper wires
- NI myDAQ
- Red and black myDAQ leads

BACKGROUND

Breadboard: Breadboards (also known as protoboards) make many connections under the board in order to reduce the number of wires that you have to connect. Typically, groups of 5 holes are connected. The side rails are lines of groups of 5 that are all connected. See Figure 1 below.

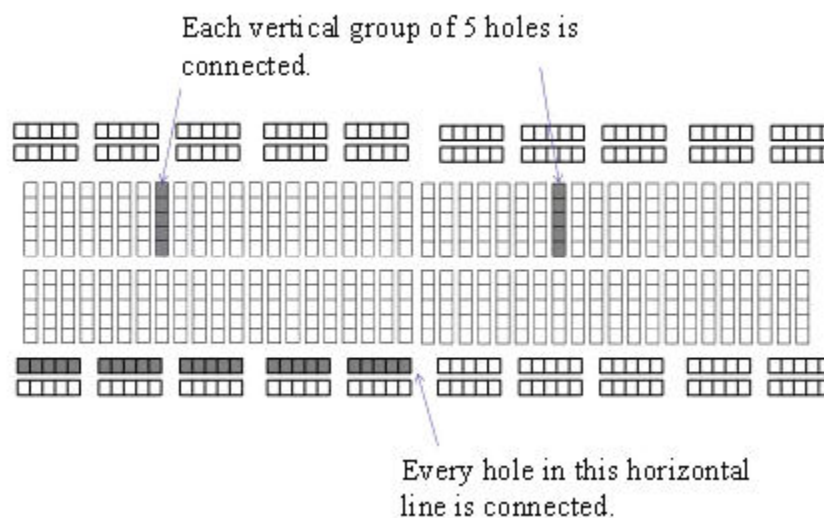


Figure 1. Breadboard Layout

National Instruments MyDAQ: Digital Acquisition Boards (DAQs) are used to measure physical electrical signals and convert them into a form that can be viewed and stored digitally. The National Instruments

MyDAQ also has analog and digital output signals. The MyDAQ comes with several software instrument panels including a digital multimeter (DMM), an oscilloscope (Scope), and a function generator (FGEN).

DMM: Digital multimeters measure voltage, current, and resistance and can be purchased as self-contained units from hardware stores. The symbols typically used on DMMs to represent different signal types are shown in Figure 2 below.

Symbol	Definition
V - -	DC voltage
V~	AC voltage
A- -	DC current
A~	AC current
Ω	Resistance in ohms

Figure 2: Various symbols seen on a DMM and their corresponding definition

Input/Output Interfaces: The DMM interface is on the bottom end of the MyDAQ. The left two connectors are for in conjunction for measuring voltage and resistance. The right two are used in conjunction for measuring current.

The myDAQ has an interface on one side with +15V, -15V, Analog Output (AO), Analog Input (AI), and digital input/outputs. The part of the interface that will be used in this experiment is shown in Figure 3 below.

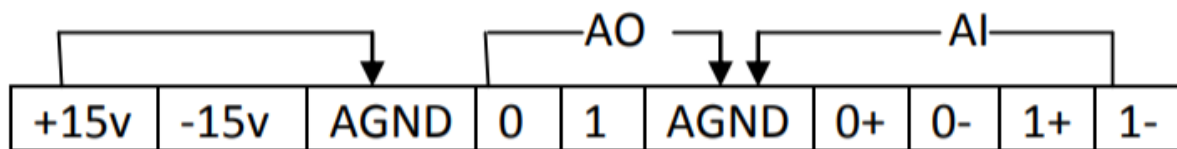


Figure 3. Depiction of analog portion of the myDAQ

Resistors: The resistance of physical resistors is denoted by 4-5 color bands on the resistor. Generally speaking, 4 band resistors are light tan, whereas 5 band resistors are blue. Figure 4 on the next page shows how to read the color code for a 4 band resistor (There is a more in depth color code diagram in Appendix A) as well as an example to get you started.

Color	Value	1 st band and 2 nd band give the first two significant numbers of the resistance 3 rd band gives the base 10 multiplier, $\times 10^n$ 4 th band gives the tolerance (silver is $\pm 10\%$ and gold is $\pm 5\%$)
Black	0	
Brown	1	
Red	2	
Orange	3	
Yellow	4	
Green	5	
Blue	6	
Purple	7	
Grey	8	
White	9	



A resistor with bands (yellow, red, orange, silver) is a 42,000 Ω resistor with a tolerance of $\pm 10\%$.

Figure 4. 4 band resistor color code

PRE-LAB ASSIGNMENT

1. Every Student needs to download the NI ELVISmx software, install it on your laptop, and bring your laptop to class. Make sure that the NI ELVIS Instrument Launcher software runs. *This process takes about an hour to do.* Failure to do this may result in not being able to perform the laboratory exercise. The software can be found on the National Instruments website at: <http://joule.ni.com/nidu/cds/view/p/id/2157/lang/en>.


For students using a MAC, you will need to install the software on a Windows partition and run it from there. The experiment will be done in pairs, so if you cannot get this software to run on your machine, then make sure that you arrange to have a partner who can run it.

2. View the introduction videos at:
<https://www.youtube.com/watch?v=psrfAgDvYfs>
<https://www.youtube.com/watch?v=kdORHmtCoQ>
3. Read the Background section of this laboratory exercise.

LAB PROCEDURES

At certain times during this lab you will be required to record data. Please use the answer sheet at the end of the lab to record your data and be sure to include units. There will be corresponding numbers listed in bold at the beginning of each question so that you may match them with your answer sheet. We will only be grading the answer sheet, so anything you write in the lab will not be counted. Please **PRINT** out your own answer sheet so that we are able to grade it. **Any answers listed on regular scratch paper will result in loss of a letter grade.**

1. Setting up the DMM to measure DC voltage

- a. Plug the myDAQ into a USB port on your computer.
- b. Start the NI ELVISmx Instrument Launcher Software.
- c. Click on the DMM icon to open the DMM screen shown in Figure 5 below.
- d. Set the Mode to Auto and the Acquisition Mode to Run Continuously.
- e. Click on the  symbol. This is used to measure DC voltage.

- f. Plug the black DMM lead into the COM plug on the bottom of the myDAQ. This represents the “common” reference, usually denoted as a negative sign when representing voltage.
- g. Plug the red DMM lead into the red terminal to the left of the COM terminal, marked with a $V\Omega$ label.
- h. Click “Run”.



Figure 5. NI myDAQ DMM Interface

2. **Using the DMM to measure the voltage difference between the +15V terminal and the Analog Ground (AGND)**
 - a. Touch the red DMM lead to the red coated +15v wire and touch the black DMM lead to the analog ground (AGND).
 - b. **[1]** Read and record the voltage.
 - c. Reverse the leads so that the red DMM lead touches the black-coated analog ground wire and the black lead touches the red-coated +15v wire.
 - d. **[2]** Read and record the voltage.

3. Measuring Resistance

- Turn the DMM dial to Ohms (Ω) and touch the leads to both sides of a $1k\Omega$ resistor. It does not matter which color lead goes to which end of the resistor. If the DMM is slow to register, switch the mode to "Specify Range" and select $20k\Omega$.
- [3]** Measure and record the resistance.
- [4]** What tolerance is this resistor supposed to have (from band 4)
- [5]** Is this measured value within tolerance?
- [6]** Measure and record the actual resistance of a $2k\Omega$ resistor.

4. Determining Current by Measuring Voltage Across a Resistor

- Current can be measured directly by placing an ammeter in series in the circuit. Current can also be determined by using Ohm's Law on the voltage measured across a known resistor, as will be done in this part. Build the circuit shown in Figure 6 below. Use a breadboard as well as the resistors used in part 3, where $R_1 = 2k\Omega$ and $R_2 = 1k\Omega$.

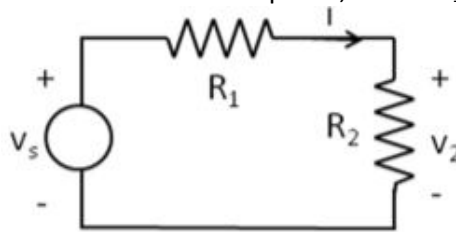


Figure 6. Circuit design

- Use the +15V and AGND wires from the myDAQ for the voltage supply V_s
- [7]** Calculate the voltage across R_2 using the nominal (ideal) resistance and source voltage (this is V_2 from the diagram).
- [8]** Measure the voltage across R_2 using the DMM, using the myDAQ connections as shown in Figure 7 below.

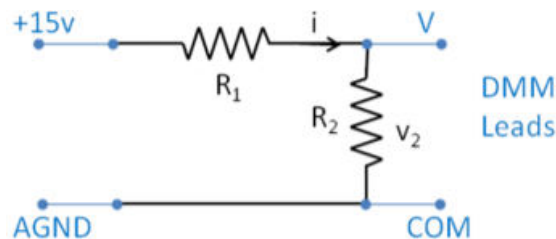


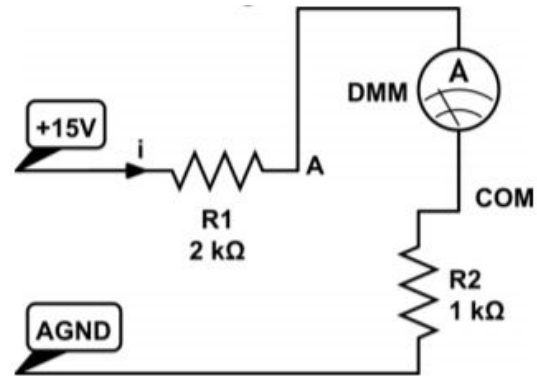
Figure 7. Wiring design to determine voltage of R_2

- [9]** What is the deviation between the nominal (ideal) voltage calculated (Step 4.c.) and the measured voltage (Step 4.d.)?
- [10]** What is the source of the deviation?
- [11]** Derive the current from Ohm's Law: $i = V_2 / R_2$ where R_2 is the measured resistance and V_2 is the voltage measured across R_2 .

5. Determining Current by Measuring Current with an Ammeter

- a. Here, you will measure current by using the DMM in the ammeter configuration, which requires you to put the DMM in series in the branch for which you are measuring current. See Figure 8 below.

Remember to change the red lead from the voltage plug to the ammeter plug on the DMM, and connect the red lead to R_1 and the black lead to R_2 , this gives the same reference direction to current as shown in the figure (from the common black to red)



Measuring current directly by putting the ammeter in series in the circuit

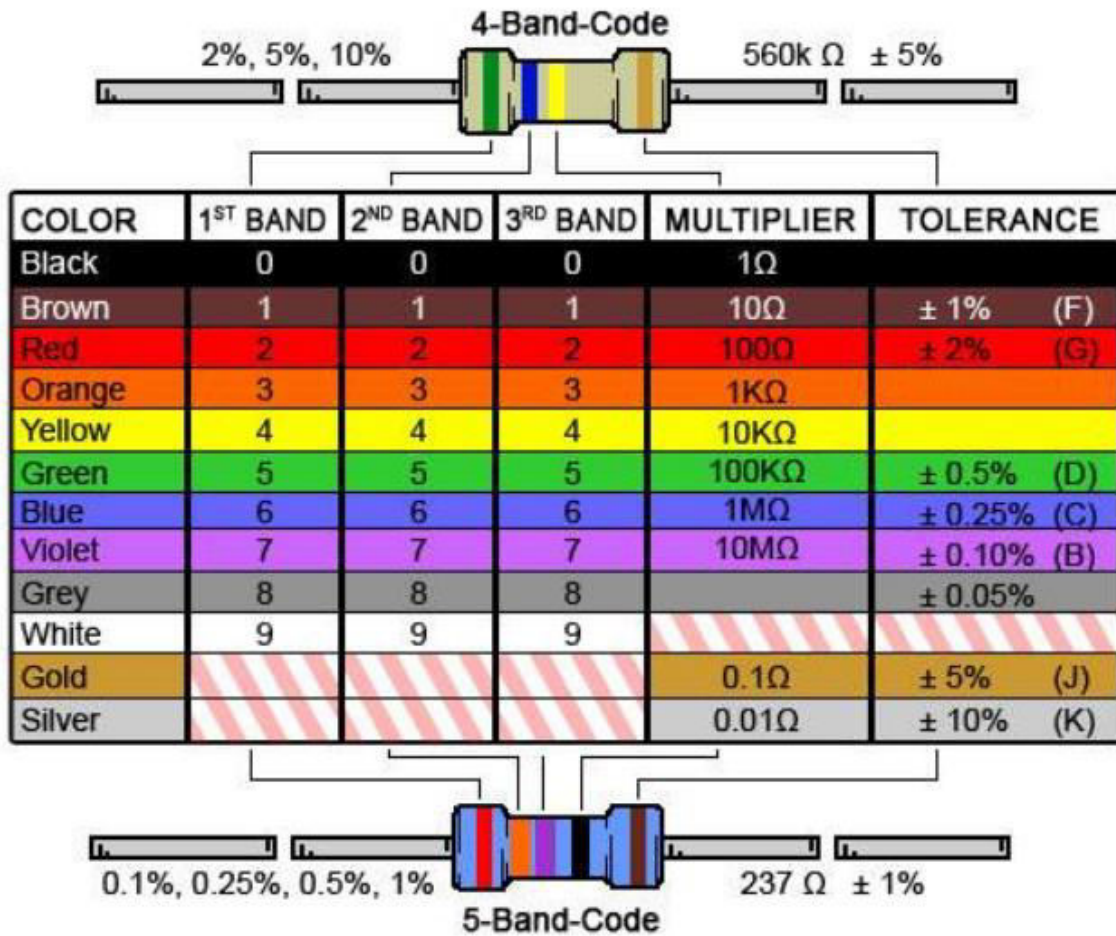
Figure 8. Using an Ammeter

- b. **[12]** Measure and record the current passing through R_2 using the ammeter. Be sure the probes are plugged into the correct ports. Remember, in order to measure current the ammeter must be in series
- c. **[13]** Compare the two methods of measuring current: What is the deviation of the measured current obtained using an ammeter (Step 5.b.) from the derived current obtained by measuring voltage and using Ohm's Law (Step 4.g.).

6. "What if" Questions:

- a. **[14]** If you are going to measure current in a circuit, and that desired current passes through an existing resistor in the circuit, what method would you choose?
- b. **[15]** If you are going to measure current in a circuit, and that desired current does not pass through an existing resistor in the circuit, what method would you choose?

APPENDIX A: Resistor Color Codes



Appendix B: Answer Sheet**1:****2:****3:****4:****5:****6:****7:****8:****9:****10:****11:****12:****13:****14:****15:**