

ECEN 240 Lab 1 – Analog vs Digital

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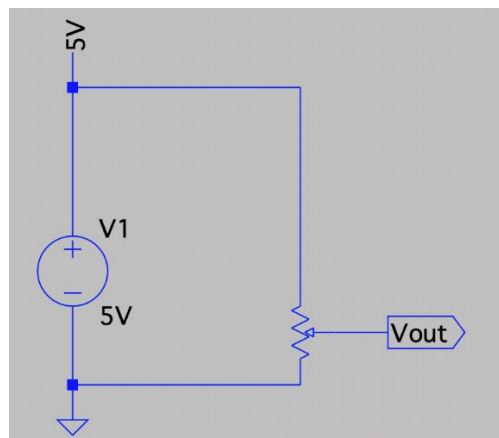
Purposes:

- Become familiar with lab equipment such as digital multimeters and power supplies.
- Learn how to breadboard schematic diagrams.
- Make comparisons between analog and digital circuits.

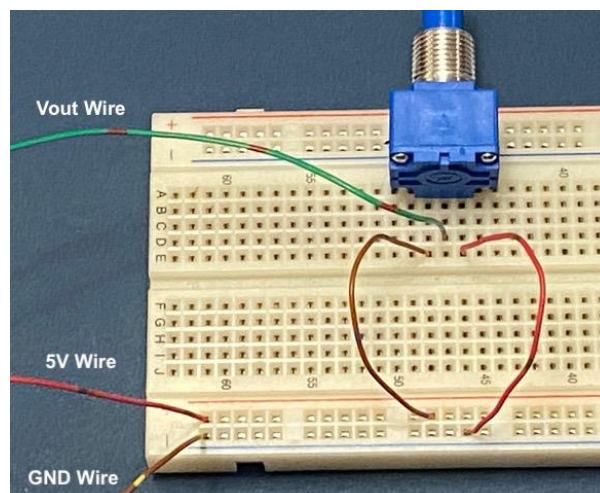
Procedure:

Part 1. Build an analog voltage output generator with a potentiometer and observe the output variation. This circuit will be compared with the circuit of part 2.

- Insert a potentiometer in a breadboard
- Connect the outer pins to 5V and GND
- Connect the middle pin to an output wire
- Connect a 5V power supply to the breadboard (use bottom 2 rows)
- Connect a voltmeter to the output wire and the GND
- Observe the voltage output variation as you turn the knob.



Analog Voltage Generator Schematic

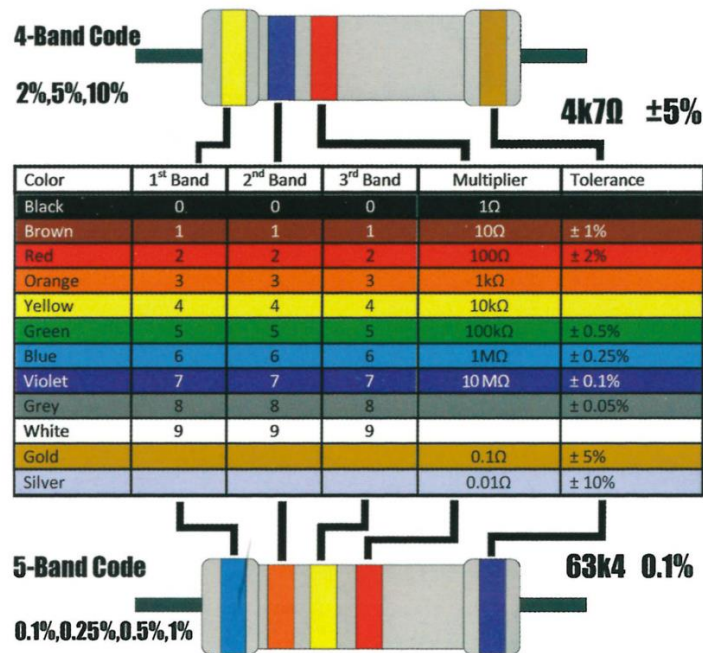


Breadboarding the analog voltage generator

Part 2. Build a simple 4-bit Digital to Analog Converter (DAC) and measure the output voltage

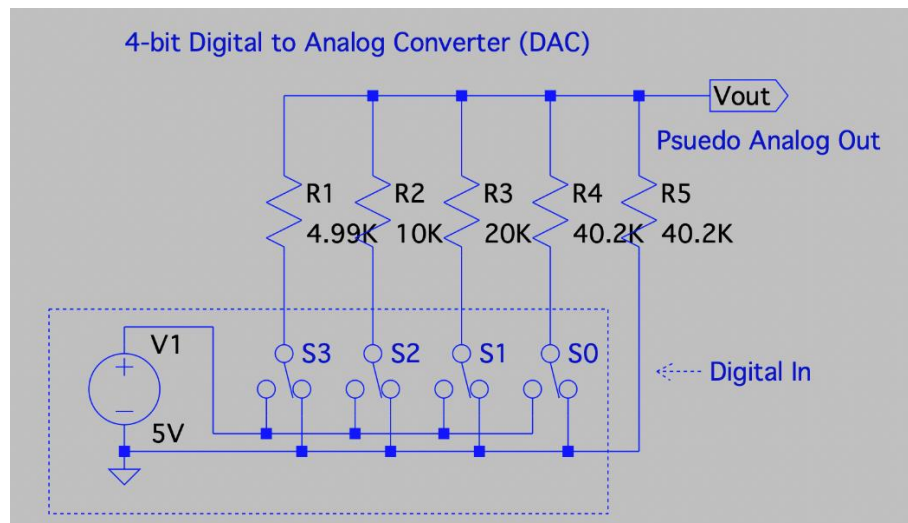
Step 1: Using the resistor color band chart, identify the following resistor color bands:

Resistor	Band1	Band2	Band3	Multiplier	Tolerance
R1 = 4.99K	Yellow	White	White	Brown	Brown
R2 = 10K	Brown	Black	Black	Red	Brown
R3 = 20K	Red	Black	Black	Red	Brown
R4 = 40.2K	Yellow	Black	Red	Red	Brown
R5 = 40.2K	Yellow	Black	Red	Red	Brown

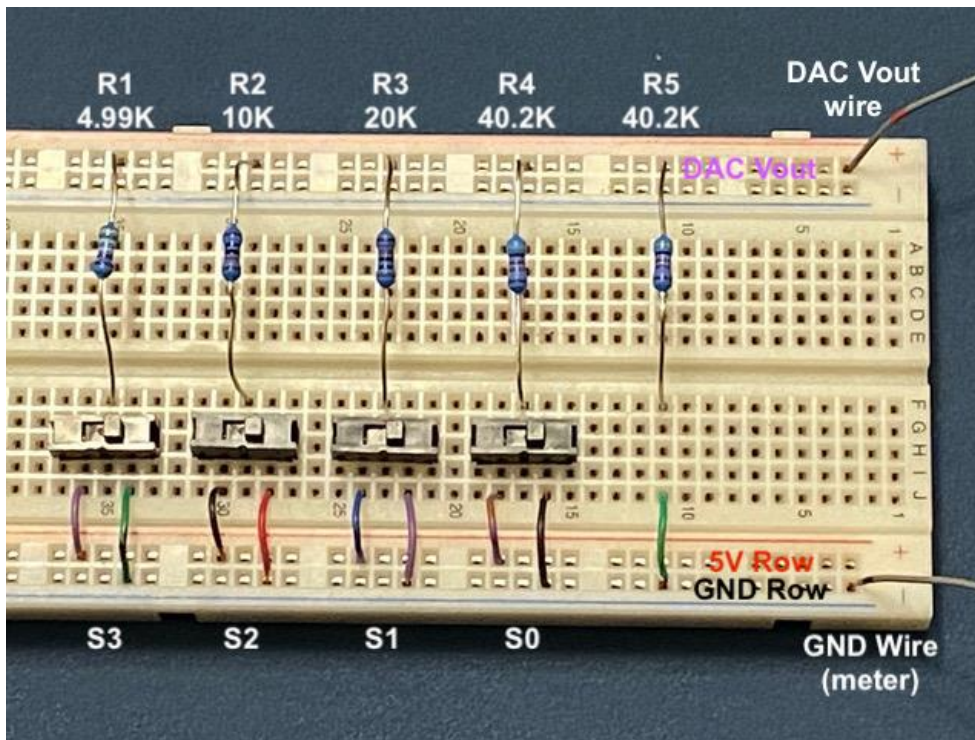


Resistor Color Band Chart

Step 2: Build the simple 4-bit DAC as shown in the schematic diagram. You may need to cut and strip wires in order to complete the project.



Schematic of a simple 4-bit DAC



Step 3: Connect a 5V power supply to the breadboard (use bottom 2 rows)

Step 4: Connect a voltmeter to the DAC out wire with respect to GND.

Step 5: Observe the voltage fluctuations as you flip the switches. Fill out the DAC Vout table for each possible input code.

S3	S2	S1	S0	DAC Vout	Step Size
0	0	0	0	0V	-----
0	0	0	1	0.312V	0.312V
0	0	1	0	0.626V	0.314V
0	0	1	1	0.938V	0.312V
0	1	0	0	1.251V	0.313V
0	1	0	1	1.563V	0.312V
0	1	1	0	1.878V	0.315V
0	1	1	1	2.189V	0.311V
1	0	0	0	2.532V	0.343V
1	0	0	1	2.831V	0.299V
1	0	1	0	3.142V	0.311V
1	0	1	1	3.486V	0.344V
1	1	0	0	3.772V	0.294V
1	1	0	1	4.082V	0.310V
1	1	1	0	4.392V	0.310V
1	1	1	1	4.704V	0.312V

DAC Vout Table (40 Points)

Part 3. Conclusions statement.

Write a brief conclusions statement that discusses all of the original purposes of the lab. Please use complete sentences and correct grammar to express your thoughts on how you fulfilled the purposes of the lab:

Purposes (repeated):

- Become familiar with lab equipment such as digital multimeters and power supplies.
- Learn how to breadboard schematic diagrams.
- Make comparisons between analog and digital circuits.

You might have something to say about the first two bullets, but the 3rd bullet deserves the most attention. Specifically, make sure to address these questions:

1. Is the output of a potentiometer truly an analog output?
2. Is the output of a DAC truly an analog output, or is it more of a pseudo analog output? Why or why not?
3. What is the average voltage step size of the DAC? Can you see how this can be calculated?
4. If you wanted a DAC with a step size 4-times smaller than this DAC, what must you do? To answer this question, you need to understand that the new DAC would need to produce 64 different levels instead of only 16, so how many digital bits would be required?

(The conclusions box will expand as you write)

Conclusions:

I have worked with the lab equipment for this lab before in previous classes, but it was a good reminder to refresh my memory on them. It's becoming easier to decipher a schematic and create it on a breadboard, it was helpful to compare and double check we had things right. This was also a great lab to show the differences between analog and digital circuits. The output of a potentiometer is a truly analog output, because it can hit every value within the range of the voltage source, compared to the output of the DAC which was more of a pseudo analog circuit because it had distinct, consistent steps between recorded values like if an analog output was sampled in consistent steps. The average voltage step for this pseudo analog output was around 0.312 V, and this can be calculated by summing up all the steps and dividing by the amount of steps there were recorded. If you wanted a DAC with a step size 4-times smaller than this one, you'd have to create a larger sample size meaning to create more samples from in the range. This would mean you'd need 2 additional switches, or digital bits. This would add up to 64 different levels instead of just 16 and would result in a step size 4-times smaller because of the greater amount of levels.

Conclusion Statement (40 Points)

Congratulations, you have completed Lab!
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