

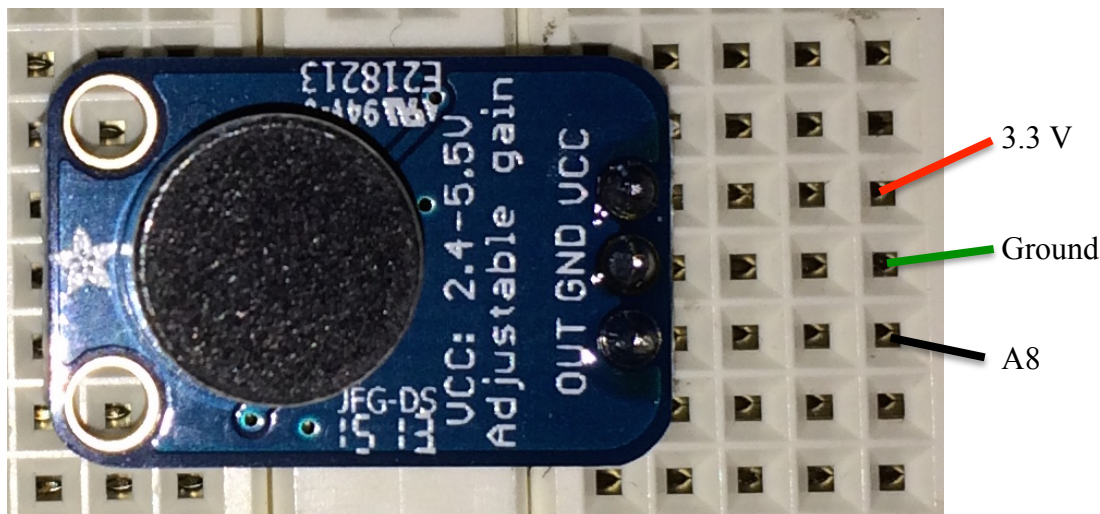
Lab 4 The Sound and the Fourier

Objectives:

- Use the Arduino to collect sound samples with an electret microphone.
- Analyze the data using Fourier transforms.

I. Hook up the microphone circuit to the Arduino.

1. Place the three pins of the electret microphone board (with onboard amplifier) into three adjacent rows on the unpowered breadboard.
2. Using jumper wires, connect the pins on the microphone to the indicated pins on the Arduino.



II. Write the Arduino code. Here are a few things to consider:

1. You want to measure the voltage on pin A8 with as little time delay as possible, so make the code in that part of the loop as short and efficient as possible.
2. To get accurate timing for such short intervals, use `micros()`, which returns the integer number of microseconds elapsed since the program started.
3. The quality of your frequency analysis in part IV will depend on the length of time over which you sample the signal, so you want this to be as long as is practical. But since the Arduino has very limited onboard memory for variables, the code will simply not work if you set aside too much storage for your measurements. Powers of two are often more efficient in the Fourier algorithm, so we'll choose 1024 data points.
4. Since we don't have a "shield" that allows us to store data on a micro SD card, we'll print the data to the serial monitor. That means we have to put in a large delay at the end of the loop to allow us time to copy and paste the data from the serial monitor to a spreadsheet.

III. Take the data

1. Set the frequency on the tone generator app on your phone to a value between 300 Hz and 600 Hz, turn the volume up pretty high, and hold the speaker of your phone about a centimeter away from the microphone.
2. Make sure no other group is about to take data, then start your tone generator, then upload your code (or hit the reset button on your Arduino if the code has already been uploaded).
3. Open the serial monitor window. When the data start to scroll in the window, you can turn your tone generator off. As soon as the data stop scrolling, use your mouse to select all the data and copy it to the clipboard. If 45 seconds isn't enough time, increase the delay at the end of the loop.
4. Paste the data into an Excel spreadsheet file. Make sure the data doesn't get up to 3.3 V (if it does, turn the volume down on your tone generator and try again). Save the data as tab-delimited text.
5. Now use two phones: the first one set as before, and the second one set to a frequency between 1 and 2 kHz. Try not to choose frequencies whose values are small integer multiples of each other. Hold both phones above the microphone and take the data as before.

IV. Analyze the data using Fourier transforms.

1. Using the Mathematica notebook on the website as a guide, analyze and describe the first data file (single frequency) using its Fourier transform.
2. Repeat for the two-frequency file. Remove one frequency at a time and describe how it changes the sound you hear.

V. Write a clear, concise report explaining what you measured, how you analyzed it, and what conclusions and generalizations you can make from your analysis.