Low Pass Filter

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Introduction

The goal of the lab is build a low pass filter and to test whether or not it works. This will be done with a 100 μF and 22 Ω resistor. By using the `tone` function on the arduino, a signal can be sent at a certain frequency from a PWM port, which can then be measured. Then, contrast the filtered and unfiltered signal to show that the low pass filter works.

Data Collection

The arduino is set up as shown in the figure 1. To measure both the filtered and unfiltered signal, connect from the analog side so that the `tone` function can be sent and then can be received at A0 and A2. Set the `tone` to set 60Hz signal to measure. The filtered signal will run through the 22 Ω resistor and will end up at the capacitance, which then will release the signal to be measured. The unfiltered signal needs to run straight to A0, as the tone changes, no filtering is done, so that the comparison can be done. Then with the arduino code linked here, data can be collected.

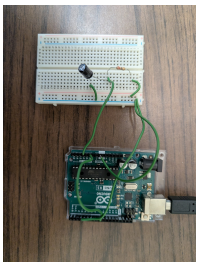

Figure 1: The arduino and thermistor in the measured environment

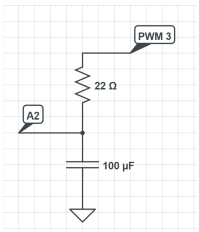

Figure 2: Circuit Diagram

Graphs & Python Code

With the data collection now done, a csv file can be made with the data, which is linked here. Using this csv file, and the python code linked here. The following sets of graph can be made.

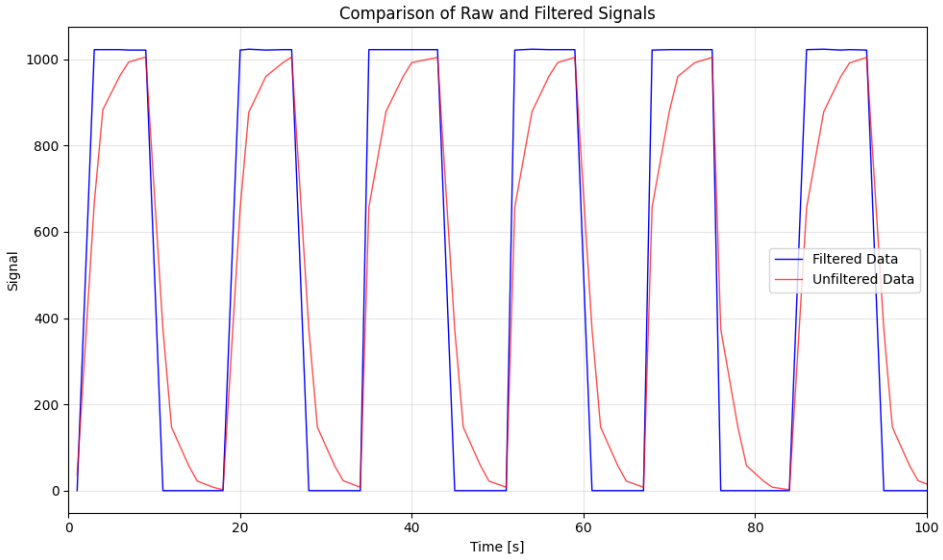

Figure 3: Unfiltered Data (red line) and Filtered Data (blue line) signal across time.

Using the cut off frequency formula f_c, the following calculations can be done

$$f_c = \frac{1}{2\pi RC}$$

which for R = 22 Ω and C = 100 μF then

$$f_c = \frac{1}{(2\pi)(22)(100 \times 10^{-6})} \approx 72.34Hz$$

with the transfer function being

$$|H(f) = \frac{1}{\sqrt{1 + (2\pi f Rc)^2}}$$

This can be graphed with 60Hz to make the following graphs

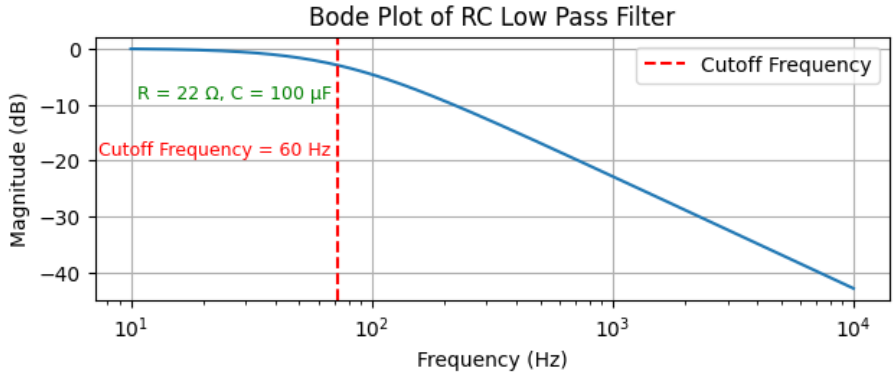

Figure 4: Plot of RC low pass filter at 60Hz

A FFT (Fast Fourier Transform) is performed to show that components are being reduced.

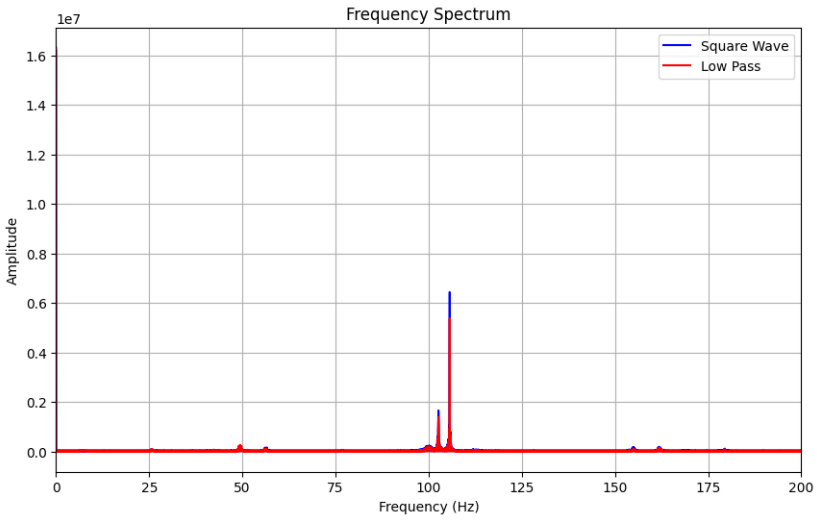

Figure 5: FFT of the data to show signals being reduced.

Conclusion

The goal of the lab was to build and verify the low pass filter works. This was done with the `tone` function built into the arduino to set frequencies to the PWM pin and then measuring them. By doing this, it is shown that the filter works, as shown in the graphs at 5. The signals less than 70 are being dropped out and shows that the filter is working as intended.