ISIM Lab No. 10 Report: Concerning Ultrasonic Range Finding

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December 31, 2019

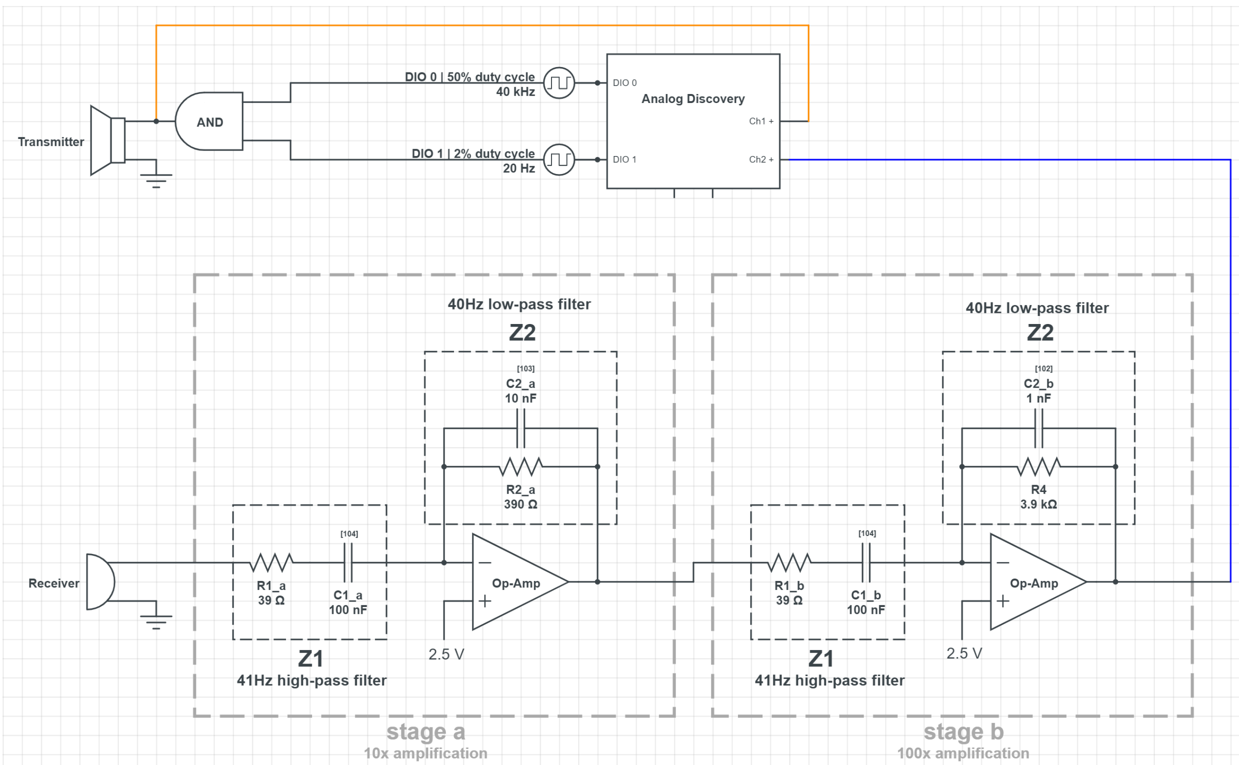

Figure 1: This is the circuit diagram I designed to have a second order band-pass filter for 40kHz with 1000x amplification. the upper portion is the transmitter circuit and the lower portion is the received-signal processing circuit. The orange and blue wires represent the channel 1 and channel 2 voltage monitors respectively.

	stage a	stage b	TOTAL
R1	39.0e+0	39.0e+0	
C1	100.0e-9	100.0e-9	
high-pass filter cutoff frequency (Hz)	40.81e+3	40.81e+3	
R2	390.0e+0	3.90e+3	
C2	10.0e-9	1.0e-9	
low-pass filter cutoff frequency (Hz)	40.81e+3	40.81e+3	
Amplifier gain	10	100	1,000

Figure 2: I calculated the values in blue in the table and the corresponding values in by using the equation saying that the natural frequency in Hz, f, is equal to $\frac{1}{2\pi RC}$. I used 39, 390, and 3.9k resistors respectively any that were exactly 40. This makes my actual natural response frequency 41kHz rather than the assigned 40kHz.

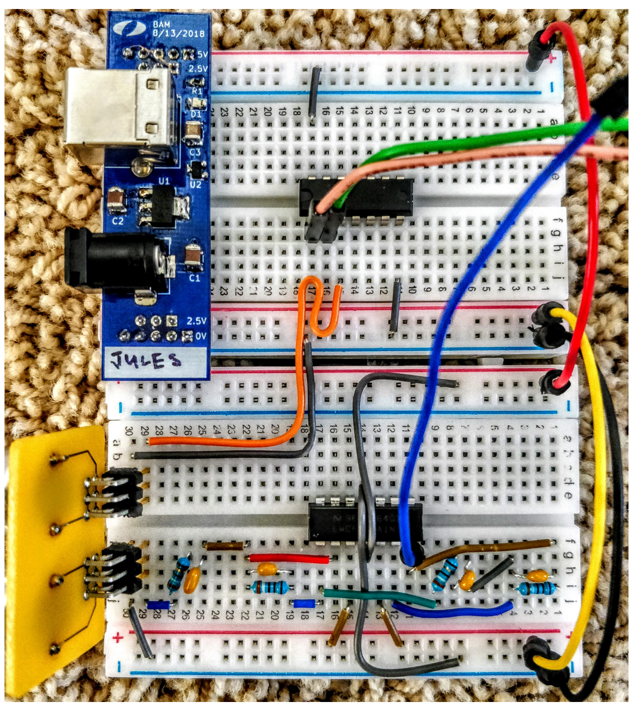

Figure 3: My built circuit, minus the ground wires for the Analog Discovery. The blue wire extending up from the middle for the board is the Ch2+ lead for the final output. The red, yellow, and black wires on the right connect the two smaller breadboards for my convenience.

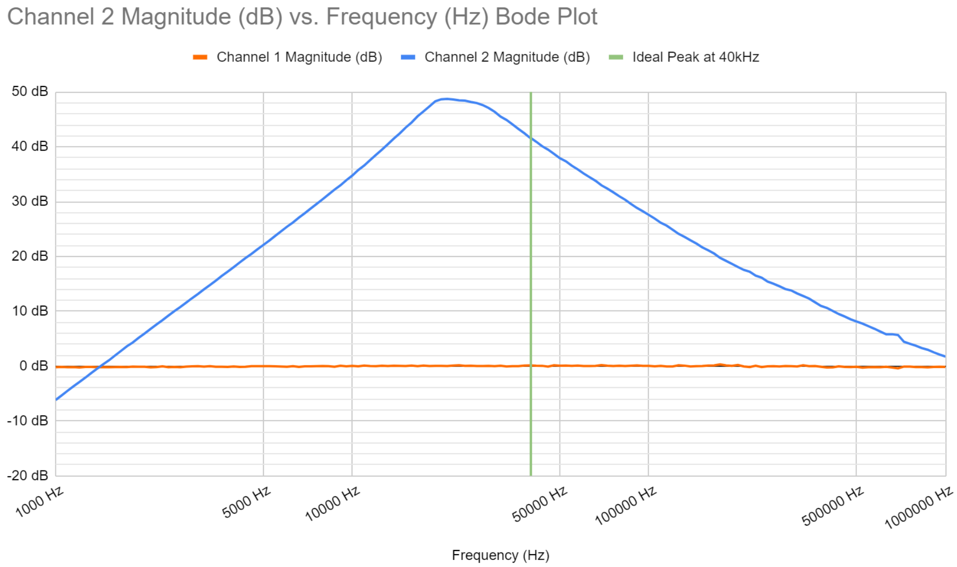

Figure 4: This bode plot shows that the filter is generally working, making the magnitude peak around 40kHz. The green vertical line is where the peak would be in an ideal world. I assume that the variance we see is from the tolerance on the capacitors.

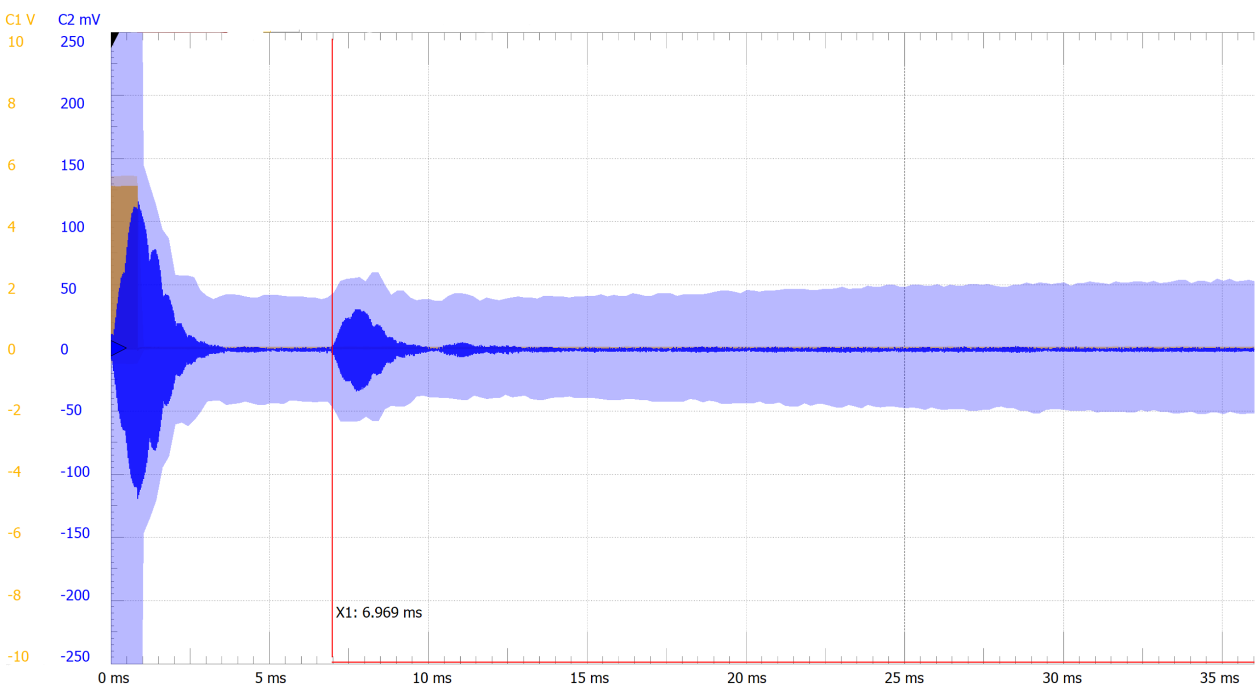

Figure 5: This is what one pulse from the transmitter (orange, with a different scale than blue) looks like when it bounces off a wall four feet away and reaches the receiver circuit. The first, larger blue blip beginning at $x = 0$ms, is the receiver "hearing" the transmitter's pulse in real time. The second blip, starting at around 7 ms is the echo from when the receiver "hears" the pulse return. I used this method to determine the time the pulse was traveling.

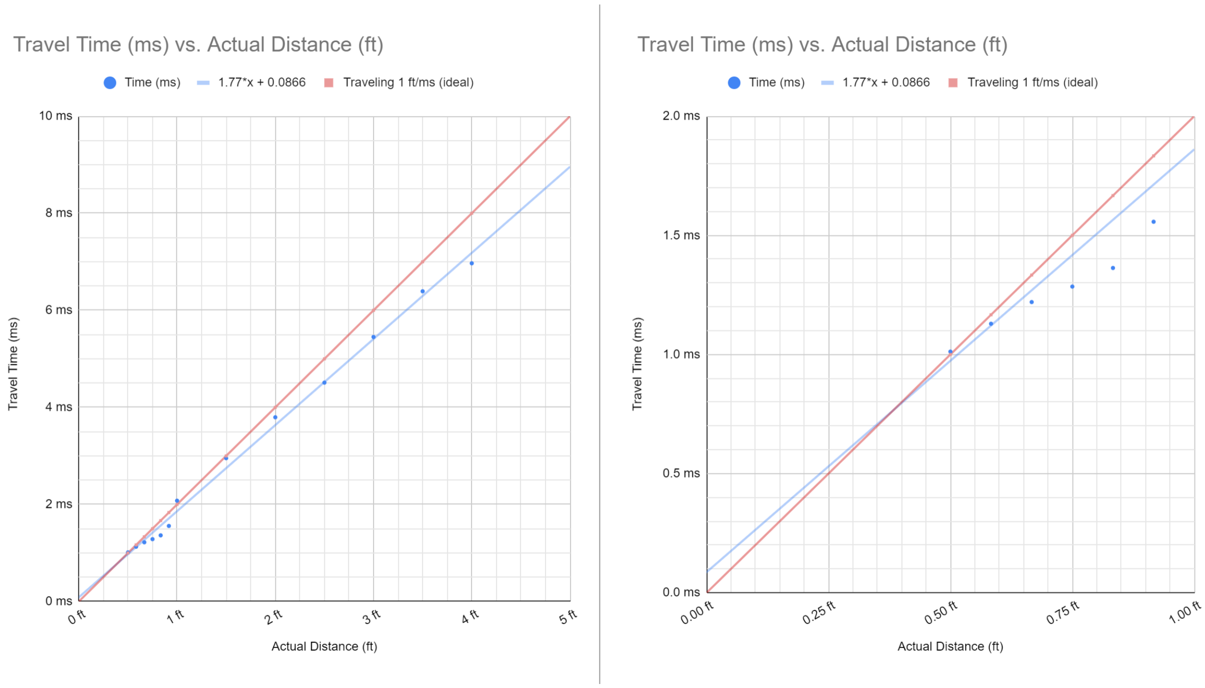

Figure 6: This is my final data plotted. On left is all of the data I recorded, and on the right is just the data from 6-11 inches away from the wall (the lower-left-most marked square). I recorded the 0 to 1 ft data by shortening the pulse emitted, but as you can see, the data gets less reliable. The red line shows the 2ms/ft increased distance number shown by the lab. The blue line is the line of best fit for my actual data. 2ms/ft is a pretty close estimation. Using my fitted line, I would probably trust the results to probably plus or minus 5 inches.