	ECGR 4101/5101 LAB 8 Report	11/21/2023
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Lab Objective:

The objective of this lab was to add to the complexity of the previous labs by incorporating UART for the SparkFun Quad-Digit display along with an Ultra Sonic Sensor and a 3.3V buzzer. The goal was to program an application to measure the distance of an object in the range of 0 to 400 cm using an Ultrasonic Sensor and transmit the value to display it on the Quad-Digit display using UART. In addition, a buzzer was to be used that would alert at varying frequencies using a Pulse Width Modulator based off of the distance measured by the Ultrasonic Sensor. This was expected to be achieved with an efficient and concise code, keeping the number of executable lines under 75, thus ensuring optimized application.

Lab Figures/Tables:

Table 1: Board 1 PIN Mappings

Hardware Peripheral	Purpose
GND	GND (For SparkFun Display)
5.0 V	VCC (For SparkFun Display)
Sparkfun Display Rx	PORT 1.2 (Tx)
PORT 2.4	PWM (For Buzzer)
GND	GND (For Buzzer)
GND	GND (For Ultrasonic Sensor)
3.3 V	VCC (For Ultrasonic Sensor)
PORT 2.0	ECHO (For Ultrasonic Sensor)
PORT 2.1	TRIGGER (For Ultrasonic Sensor)

For the Sparkfun Quad-Digit Display, 3 connections were made to VCC (5V), GND, and between the Receiver (Rx) of the display and the Transmitter (Tx) of the MSP430 board. For the Buzzer, PWM was connected to the board along with a connection to GND. To connect the Ultrasonic Sensor to the board, 4 connections were made including GND and VCC to 3.3 V. PORT 2.0 and PORT 2.1 were connected to the Echo and Trigger to send out a wave and calculate the echo wave's length to further calculate the distance of an object from the sensor. Table 1 shows the connections that were made between MSP430 Board, Ultrasonic sensor, Buzzer, and the SparkFun Quad-Digit display.

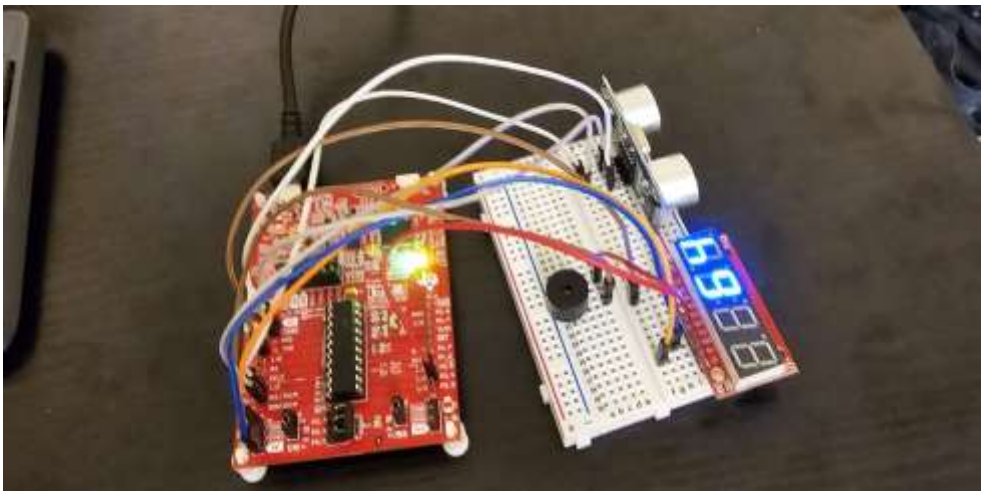

Figure 1: Connections made between the MSP430 Board and the Breadboard with SparkFun Quad-Digit Display, Ultrasonic Sensor, and Buzzer

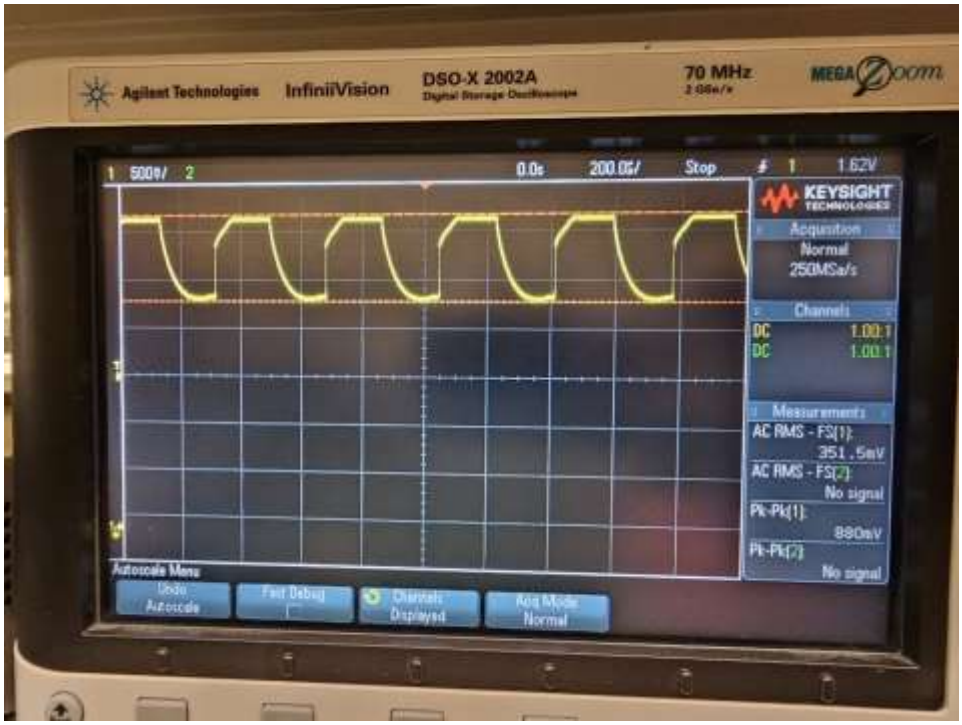

Figure 2: Oscilloscope Display of the Highest Frequency (Loudest)

Figure 2 above shows the oscilloscope display with the highest frequency over a period of 200 us. Multiple pulses around 5 can be seen over this period. It measurement was taken at an Ultrasonic Sensor reading of about 8 cm.

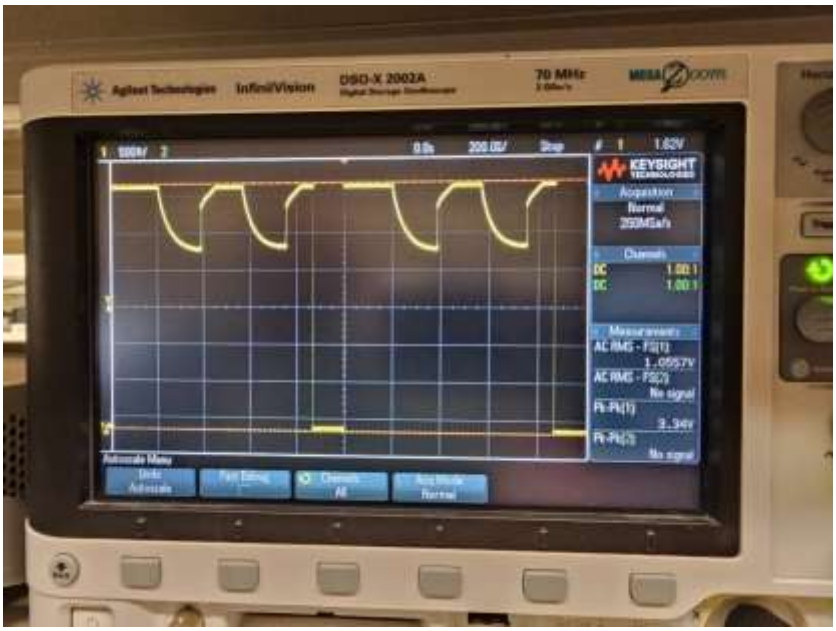

Figure 3: Oscilloscope Display of the Median Frequency

Figure 3 above shows the oscilloscope display with the highest frequency over a period of 200 us. Multiple pulses around only 3 can be seen over this period. It measurement was taken at an Ultrasonic Sensor reading of about 28 cm.

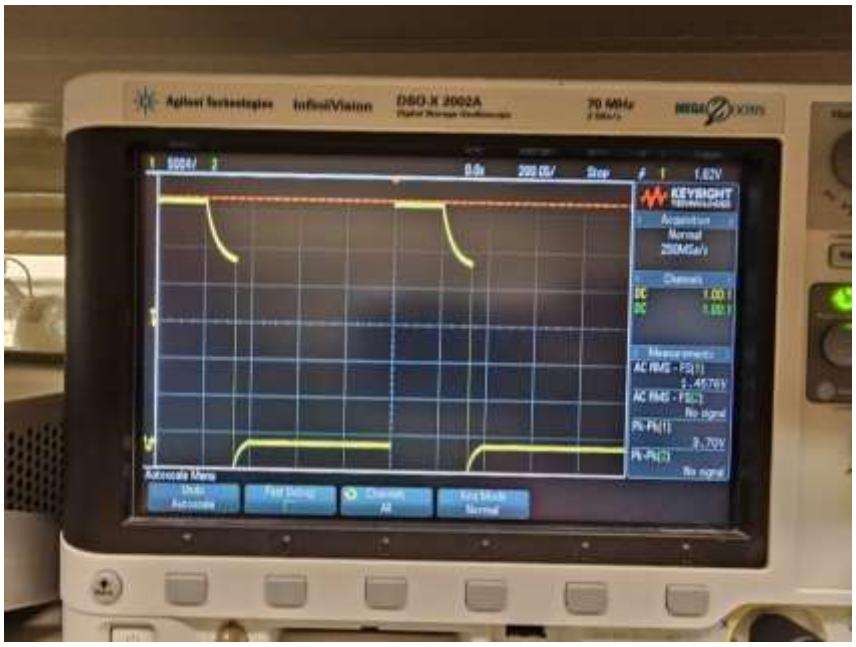

Figure 4: Oscilloscope Display of the Lowest Frequency (Most Quiet)

Figure 4 above shows the oscilloscope display with the highest frequency over a period of 200 us. Multiple pulses around 1 ½ or 2 can be seen over this period. It measurement was taken at an Ultrasonic Sensor reading of about 44 cm.

Thus, as the distance increases, the number of pulses seen over a period of 200 us decreases and this shows that the frequency decreases.

Commentary and Conclusion:

In lab 8, only one MSP430g2553 board was used along with a SparkFun Quad-Digit Display which communicated with the MSP430 via UART. So, this change in the quad-digit display board eliminated the use of a 2nd MSP430 and made it much simpler to physically wire the connections. The only connections needed for this lab were between the TX of the MSP430 and the Rx of the display. The connection for buzzer only included the PWM to the board. Similar to previous labs, requirements for this lab were addressed incrementally. Initially, only the SparkFun Display was tested with a Function that incrementally looped through number from 1 to 100. This made sure that 1 digit, 2 digit, as well as 3 digit numbers were displayed properly. Next, the Ultrasonic sensor code from the previous lab was integrated with the display and it was then tested. Finally, the already tested Buzzer code was added, everything was connected together and then tested for any issues with the hardware as well as the software.

During the lab, a few major challenges were encountered, and with some code changes and physical testing, were resolved. One of the issue from the previous lab was using Timers for the Trigger pulse. For lab 6, a delay_cycle() was used, and thus points were deducted. For this lab, the delay_cycle() was eliminated, and the Ultrasonic Sensor was working nicely. Another minor problem that came up was the application was working correctly when the Buzzer's PWM was connected to PIN 2.2, but not when connected to 2.4. The requirement was that the PWM pin be connected to 2.4. To tackle this, first the pins were tested using an oscilloscope with varying frequencies. One that was working, the software aspect, in this case, the code was tested and adjusted accordingly. It took a while, but the program was running.