Atmega Kitchen Timer (ENCE-4231)
Beta Release (April 4th, 2023)

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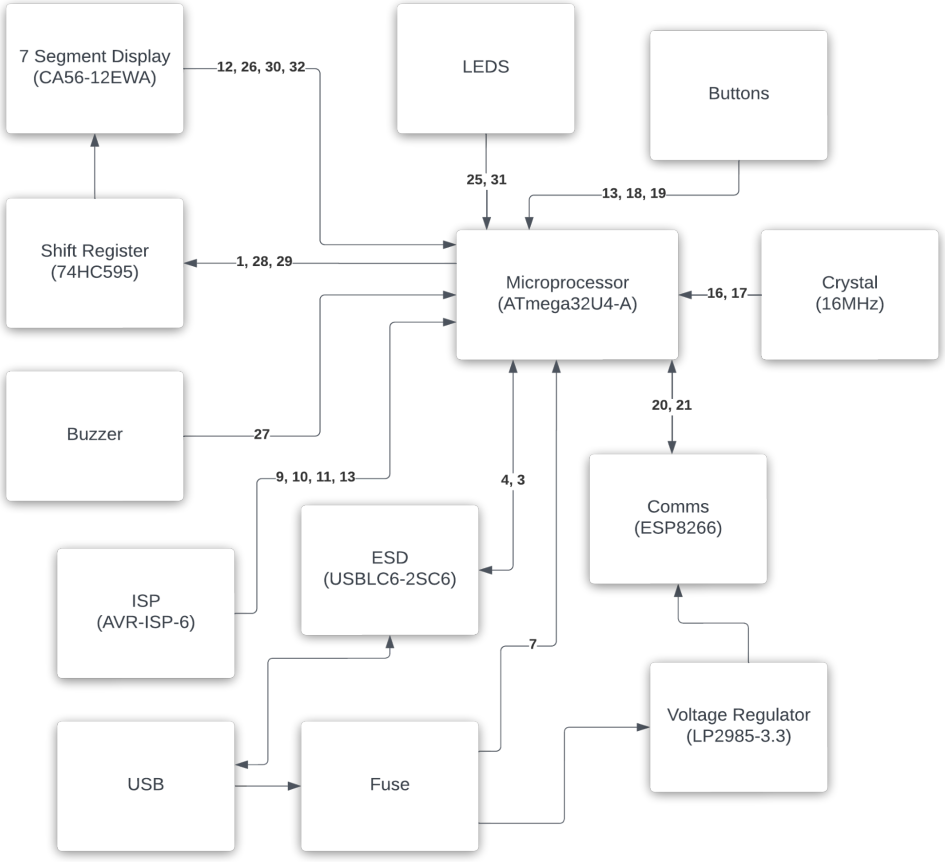
Project Requirements

The requirements for this system include a timer display, the ability to both reset and set the timer, an alarm for when the timer has counted down to zero, a USB power connection, and the ability to receive input remotely.

System Design

The design for this system included the ATmega32U4-A microprocessor and the ESP8266 wifi module. The block diagram describes key components and their pin connections to the ATmega32U4-A.

Block Diagram



Components Selection

Key components for this system include the ATmega32U4-A microprocessor, the ESP2866 wifi module, a 16MHz crystal, the CA56-12EWA display, the LP2985-3.3 voltage regulator, and the USB_B_Mini port.

Components

References	Value	Footprint	#
C2, C3	22pF	Capacitor_SMD:C_0603_1608Metric	2
C15	10nF	Capacitor_SMD:C_0603_1608Metric	1
C1, C4, C5, C12, C6, C7, C10, C11	0.1µF	Capacitor_SMD:C_0603_1608Metric	8
C9, C13	1µF	Capacitor_SMD:C_0603_1608Metric	2
C14	2.2µF	Capacitor_SMD:C_0603_1608Metric	1
C8	10µF	Capacitor_SMD:C_0805_2012Metric	1
R14, R15	22Ω	Resistor_SMD:R_0603_1608Metric	2
R5, R6, R7, R8, R9, R10, R11, R12	100Ω	Resistor_SMD:R_0805_2012Metric	8
R3, R4	330Ω	Resistor_SMD:R_0805_2012Metric	2
R16	1kΩ	Resistor_SMD:R_0603_1608Metric	1
R1, R2	10kΩ	Resistor_SMD:R_0805_2012Metric	2
R13, R17	10kΩ	Resistor_SMD:R_0603_1608Metric	2
D1, D2, D3	LED	LED_SMD:LED_0805_2012Metric	3
U1	CA56-12EWA	Display_7Segment:CA56-12EWA	1
U2	74HC595	Package_SO:TSSOP-16_4.4x5mm_P0.65 mm	1
U3	ATmega32U4-A	Package_QFP:TQFP-44_10x10mm_P0.8 mm	1
U4	USBLC6-2SC6	Package_TO_SOT_SMD:SOT-23-6	1

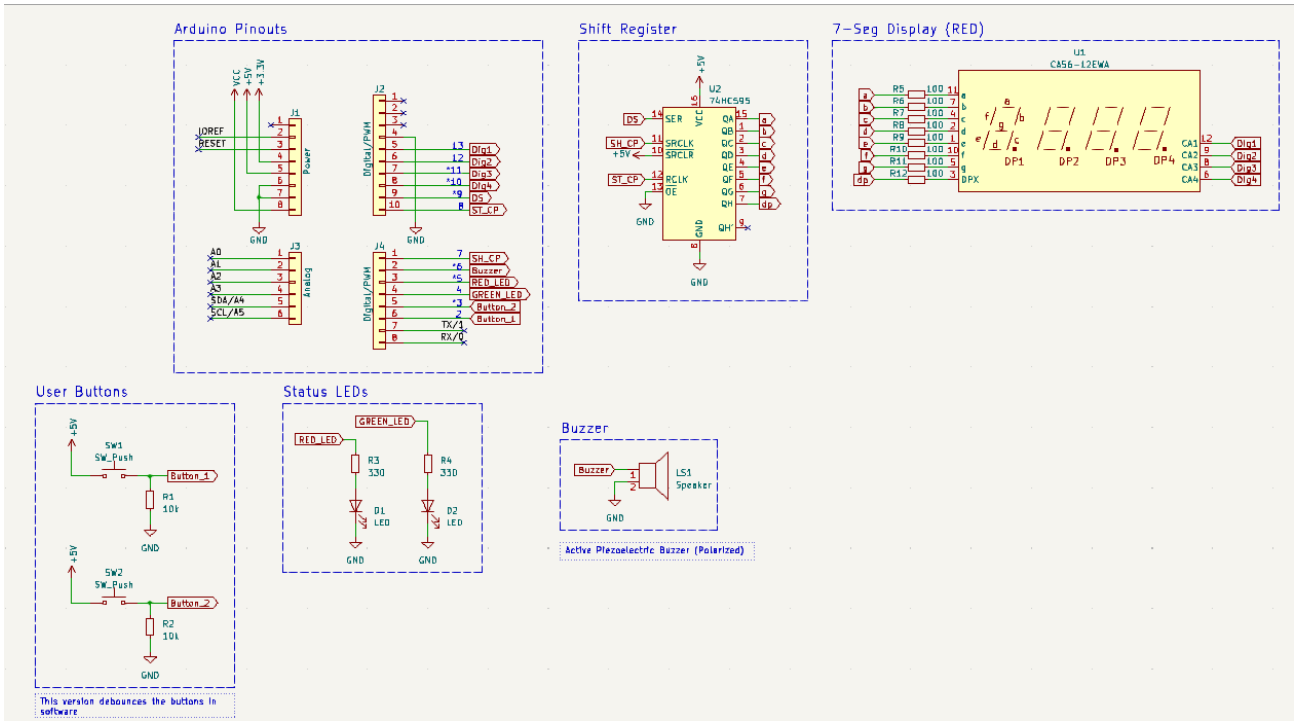
U5	LP2985-3.3	Package_TO_SOT_SMD:SOT-23-5	1
Y1	16MHz	Crystal:Crystal_SMD_Abracon_ABM8G-4Pin_3.2x2.5mm	1
F1	PTCSMD	Fuse:Fuse_1812_4532Metric	1
S1, S2	PTS125SM43SMTR21M_LFS	PTS125_SMD_Button:PTS125_SMD_Button	2
S3	PTS526_SM08_SMTR2_LFS	PTS526_SMD_Button:PTS526_SMD_Button	1
LS1	Speaker	Buzzer_Beeper:Buzzer_12x9.5RM7.6	1
J1	AVR-ISP-6	Connector_PinSocket_2.54mm:PinSocket_2x03_P2.54mm_Vertical	1
J2	USB_B_Mini	Connector_USB:USB_Mini-B_Lumberg_2486_01_Horizontal	1
J3	ESP_Conn	Connector_PinSocket_2.54mm:PinSocket_2x04_P2.54mm_Vertical	1

Build Prototype

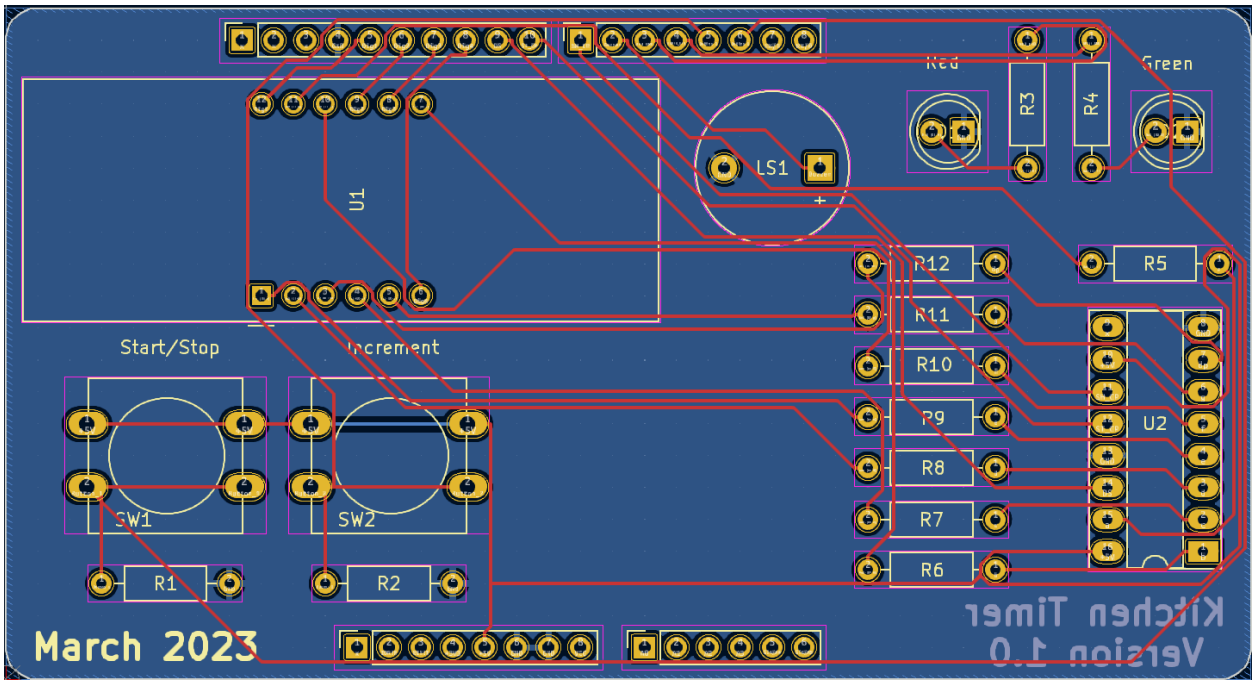
Arduino Shield

The prototype for this design was a PCB that mounted to an Arduino Uno. The Arduino served as the microprocessor and power source for the PCB. Designing the PCB as an Arduino Shield allowed for fast and easy prototyping of the final design. The schematic and PCB can be seen below.

Schematic

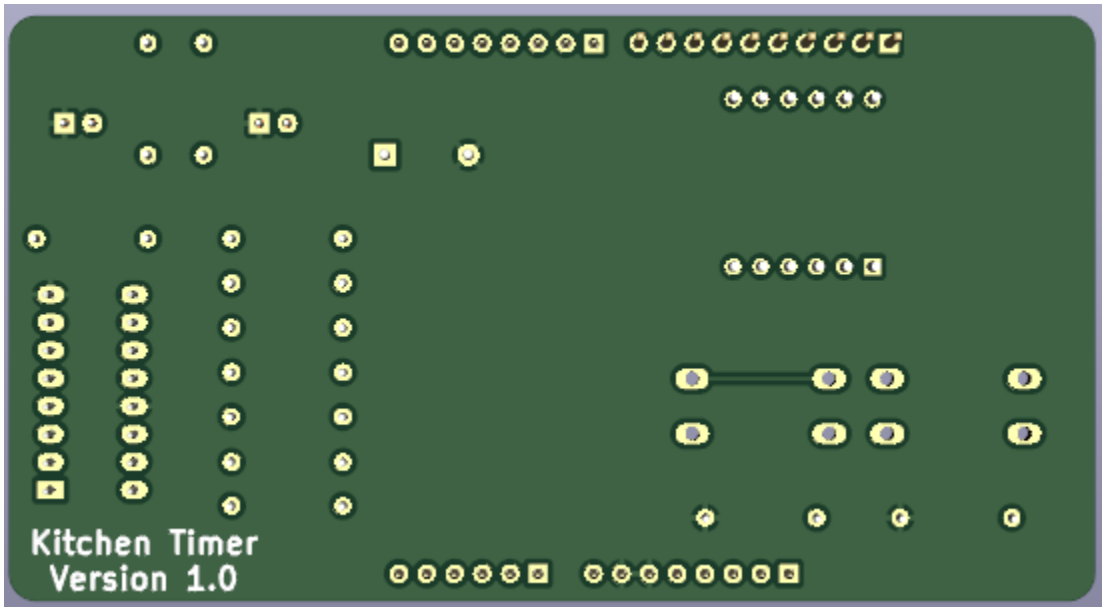


PCB (KiCad)



3D KiCad (Top View)

3D KiCad (Bottom View)



PCB Design

Description

Schematic

The schematic is broken down into separate modules. These modules include the atmega324u, shift register, 7 segment display, ISP programmer, voltage regulator, user buttons, status leds, and the buzzer. The pin connections to the microcontroller are made through labels.

PCB Layout

The PCB layout was designed according to the modules in the schematic. This ensured that connections between components were as short as possible.

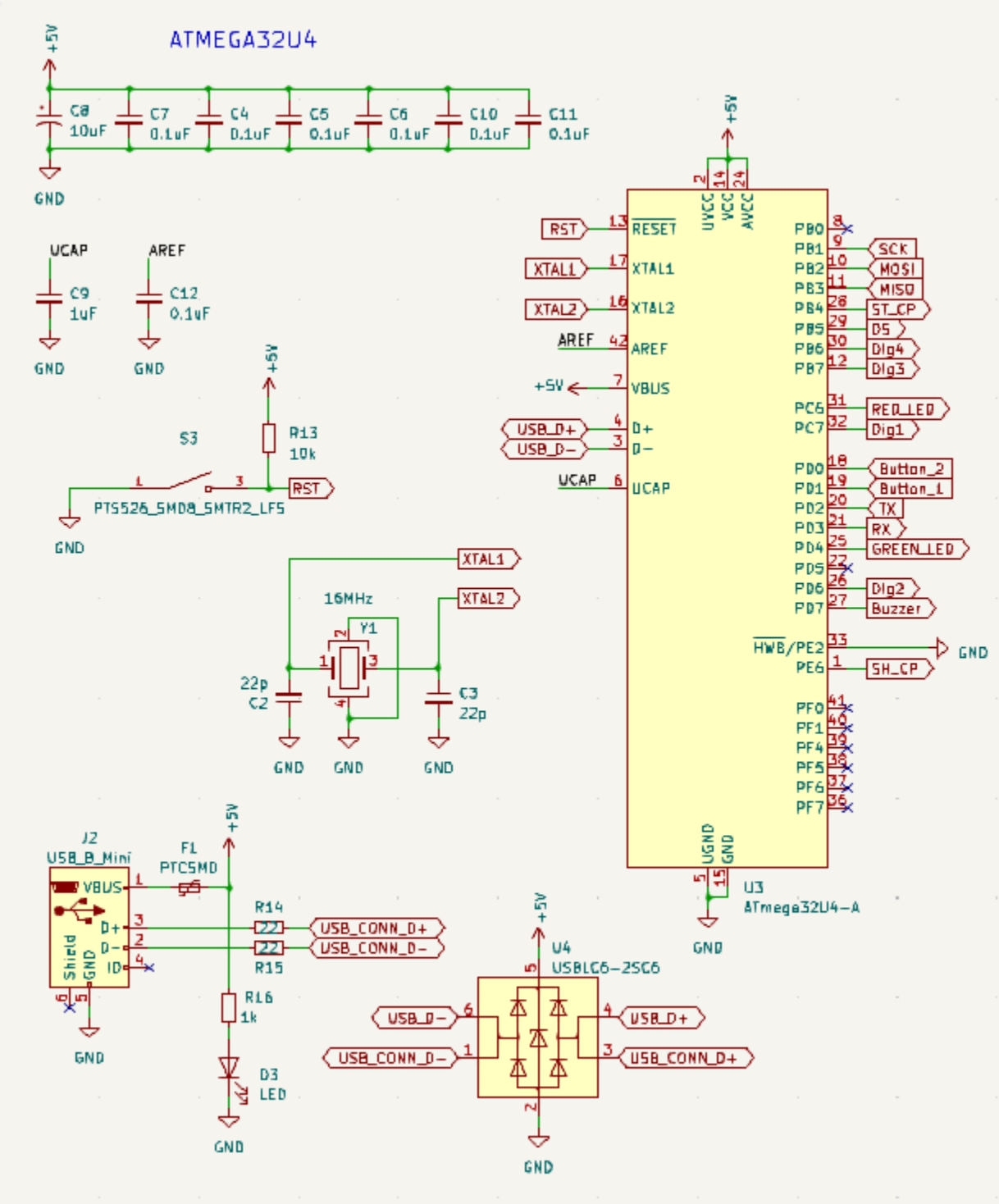
A large concern when designing the board was to align the pins from the usb input and output equidistant to their corresponding pins on the microcontroller.

The skeleton for the layout was created initially. The sketch was then imported into KiCad and the components were placed in their positions. This not only standardized the design process, but it also made the casing design efficient.

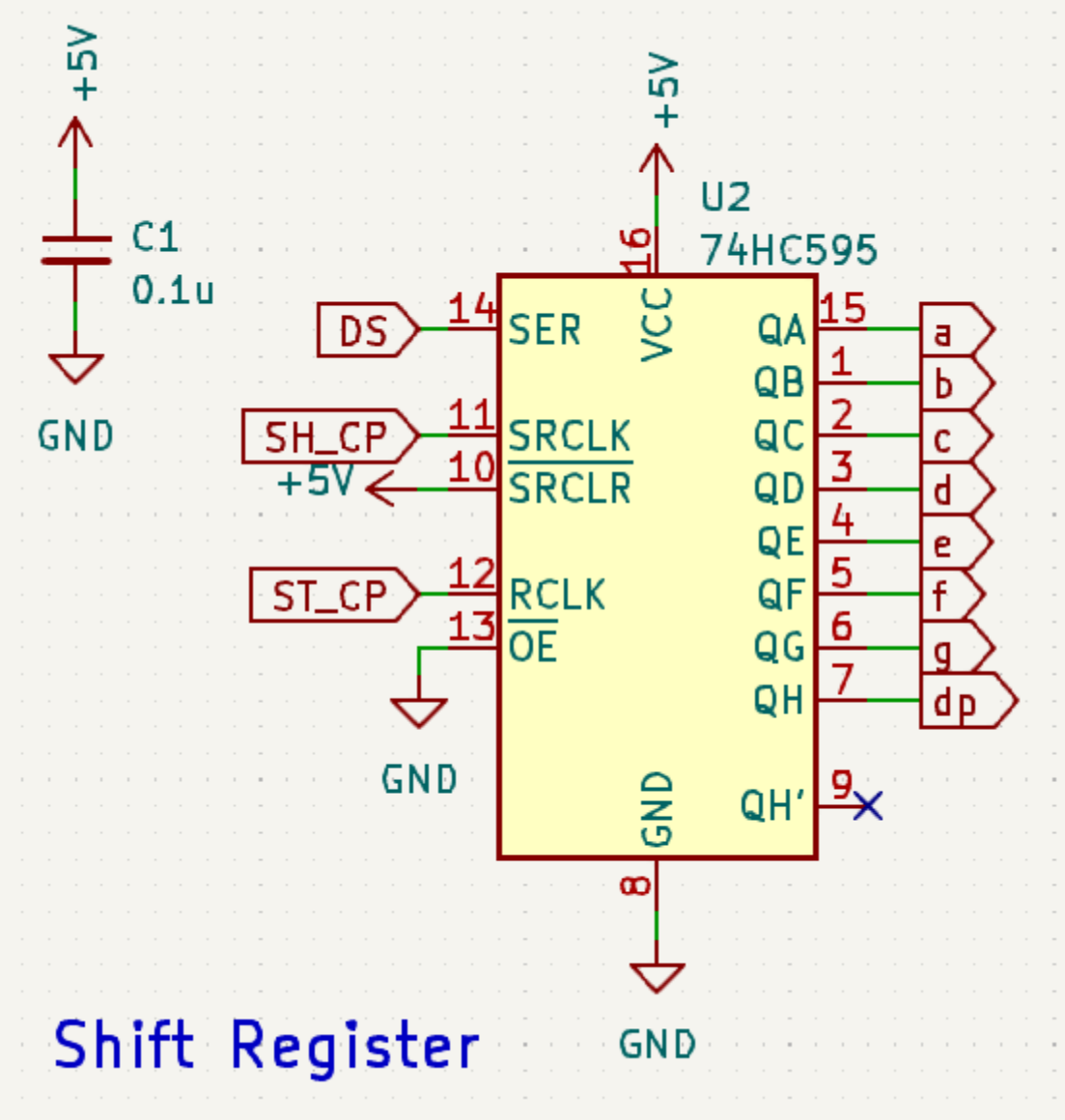
The PCB has arrived and is ready to be soldered. Once the board and all of the components are soldered, the microprocessor will be ready to program.

Schematic

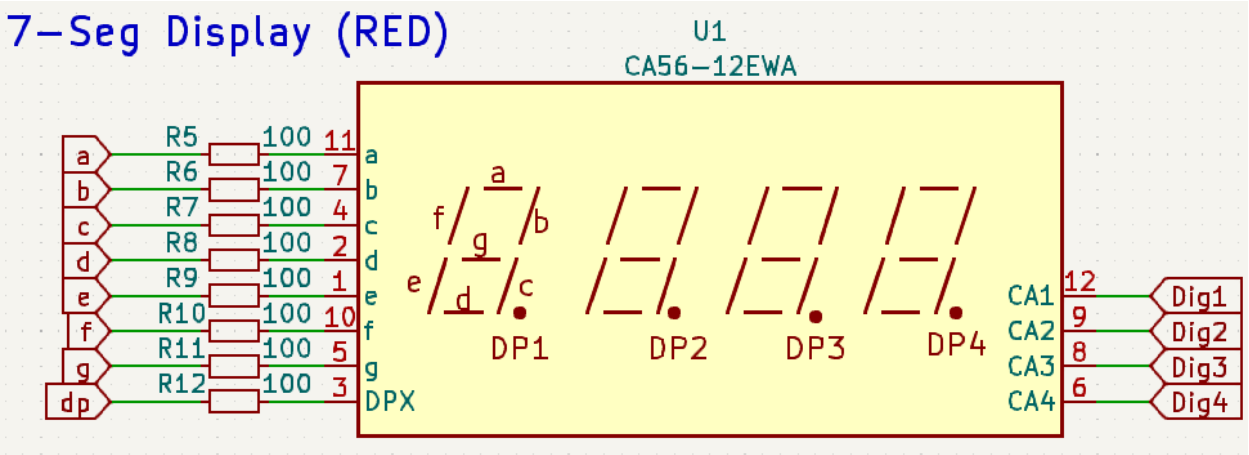
ATMEGA32U4



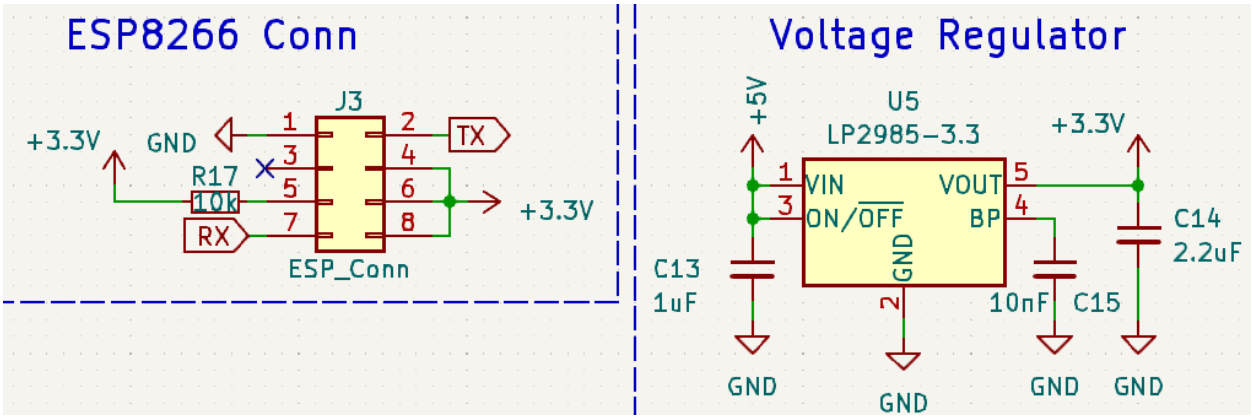
Shift Register



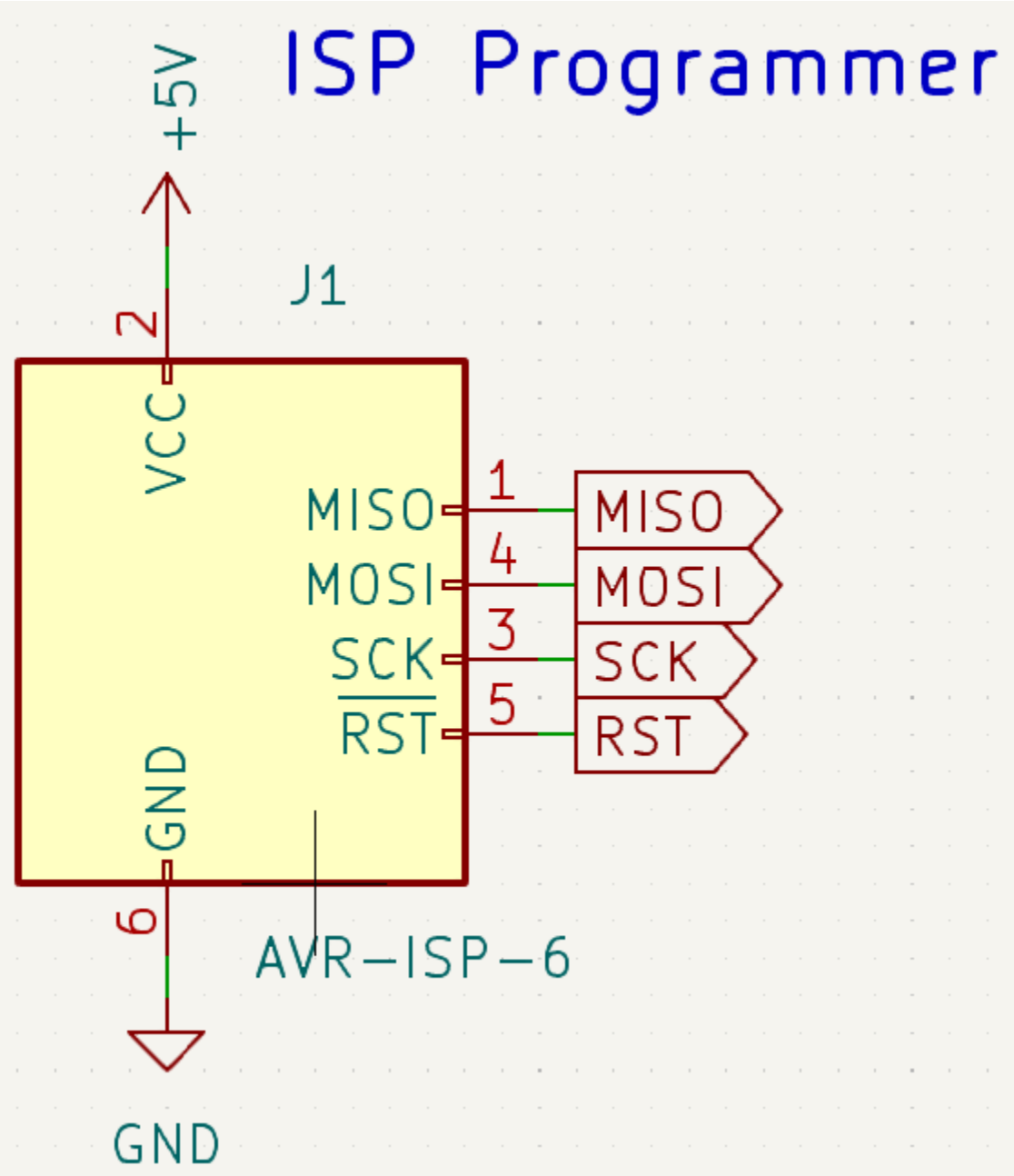
Seven Segment Display



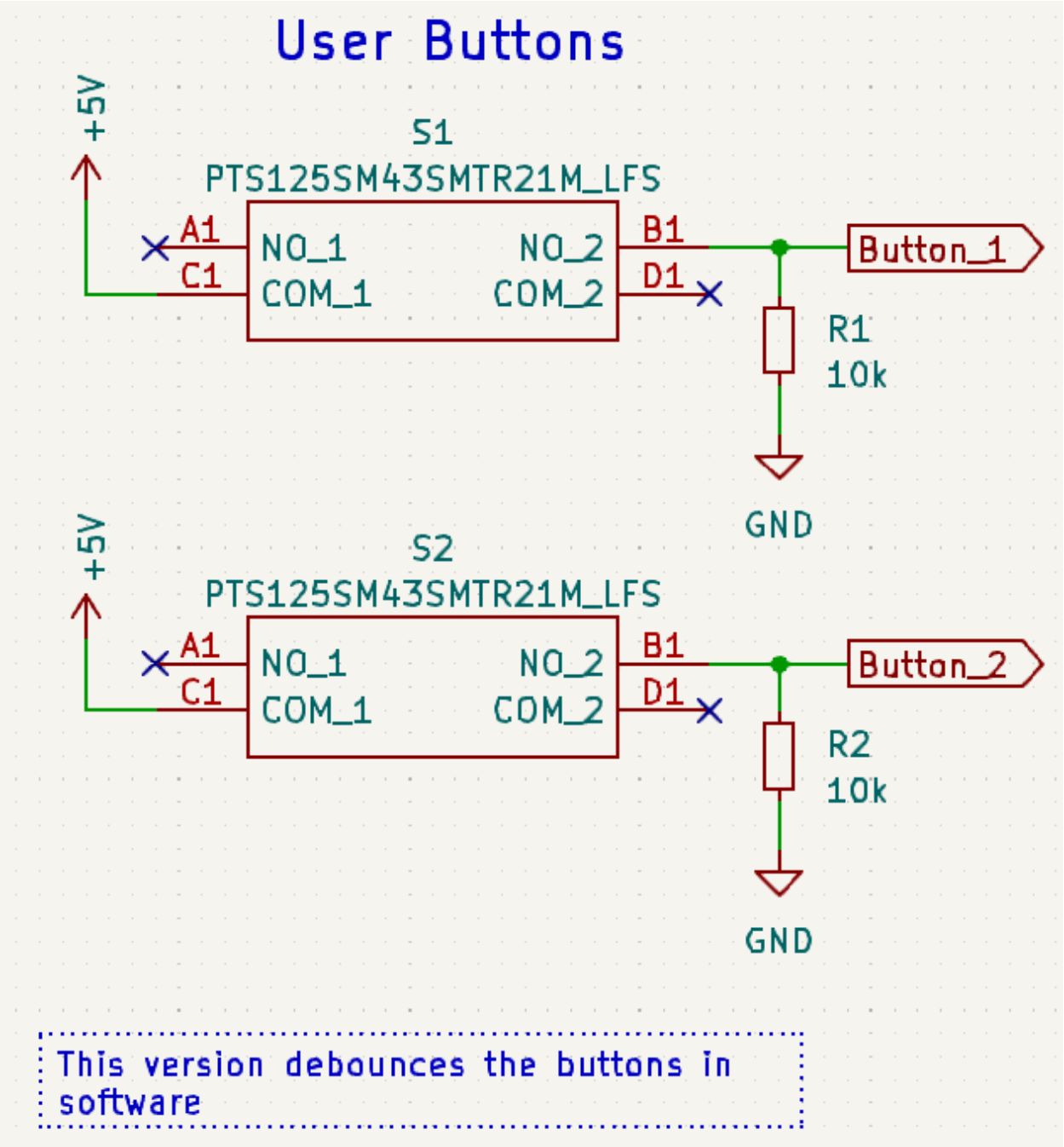
Voltage Regulator & Wifi Module



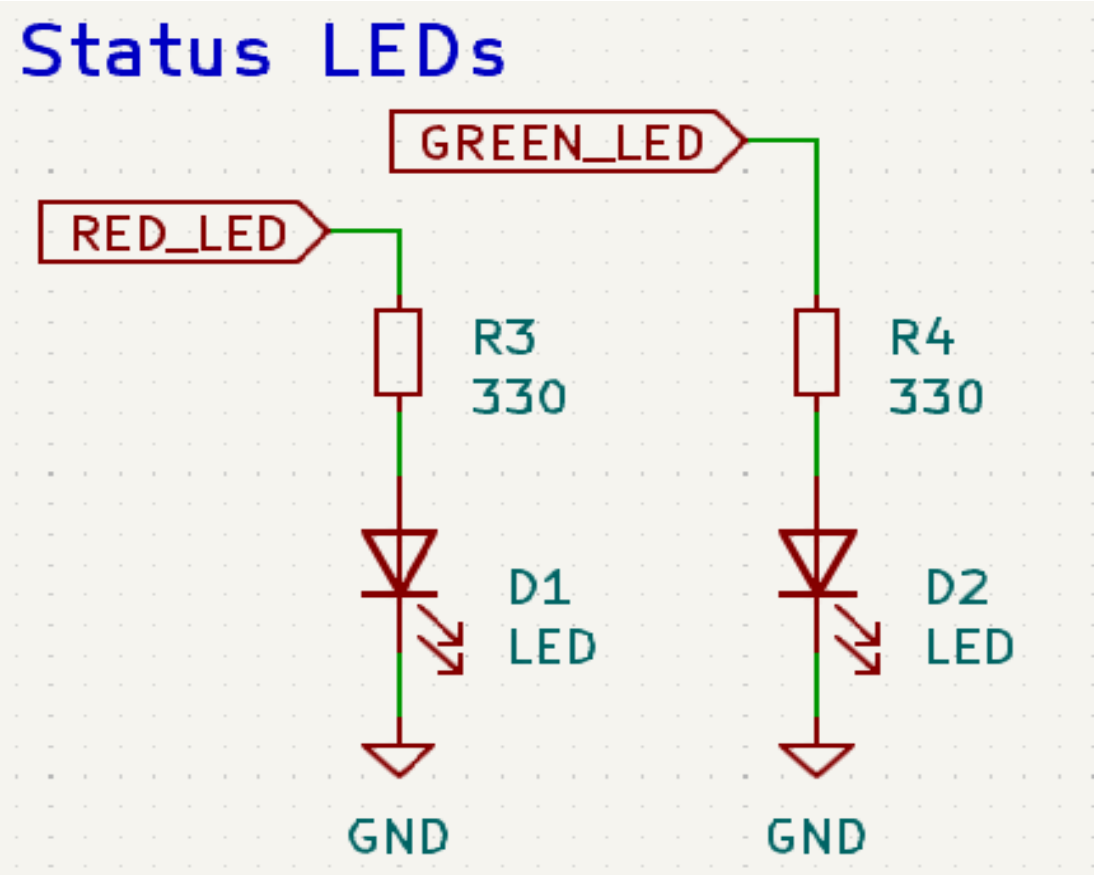
ISP Programmer



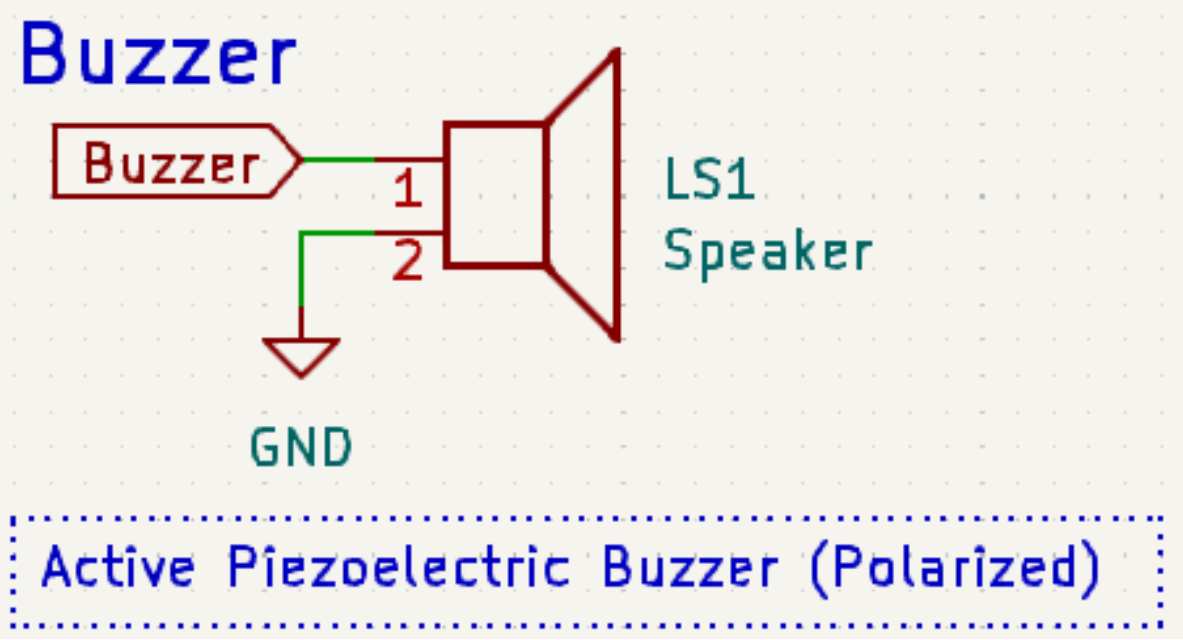
User Buttons



Status LEDs

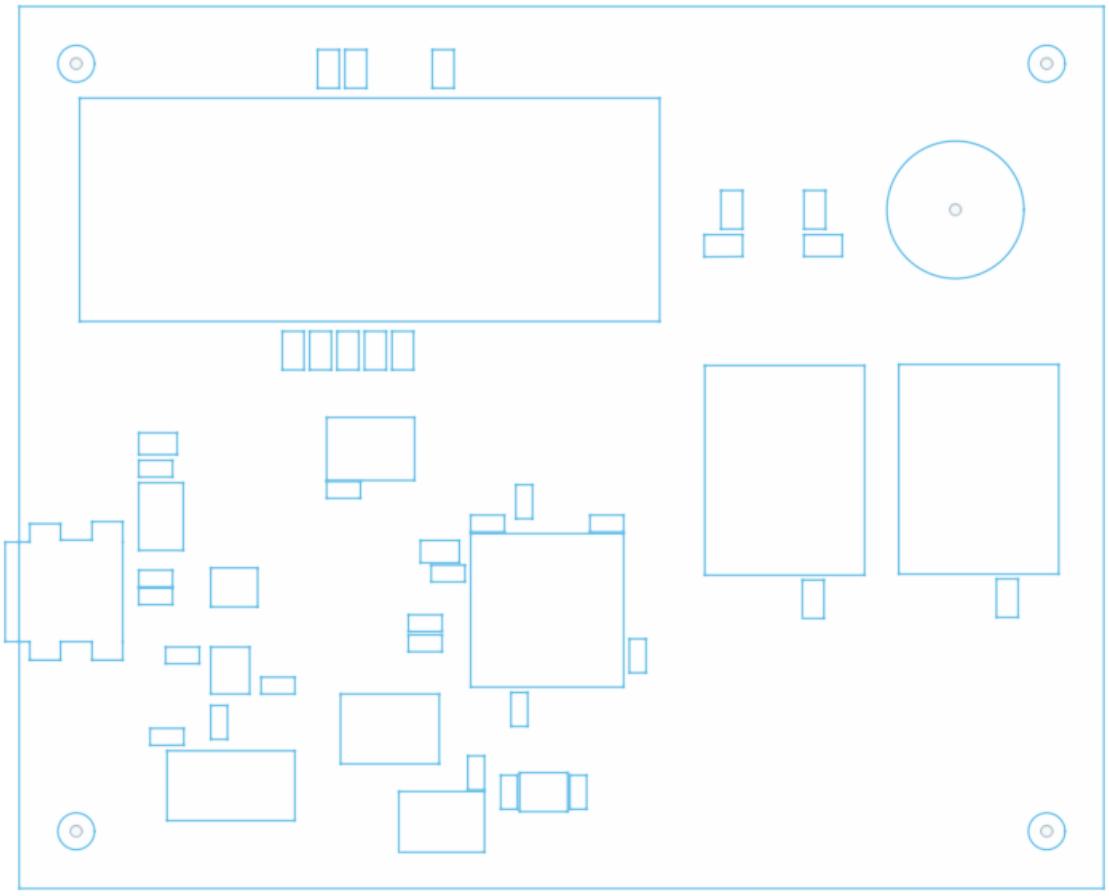


Buzzer

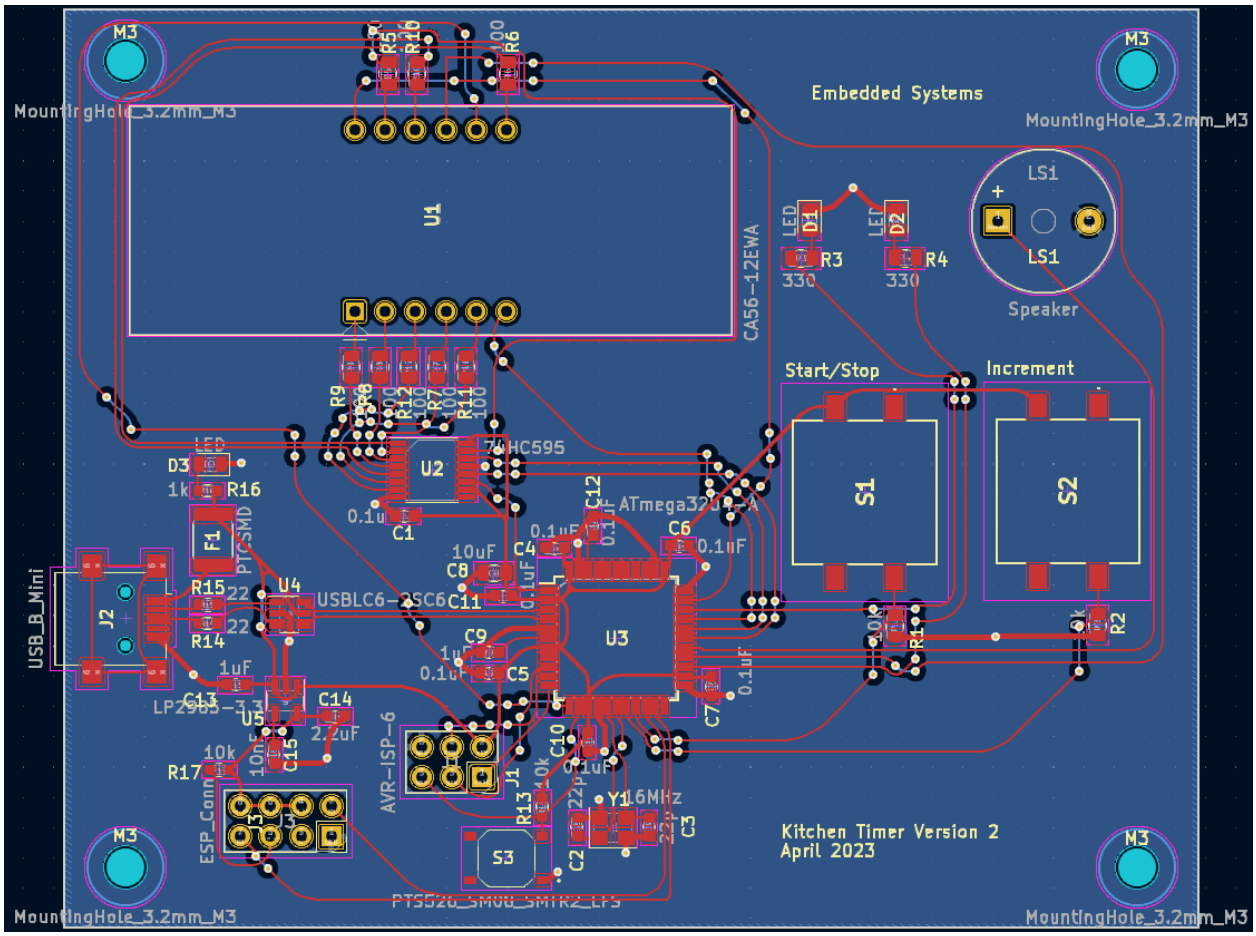


PCB Layout

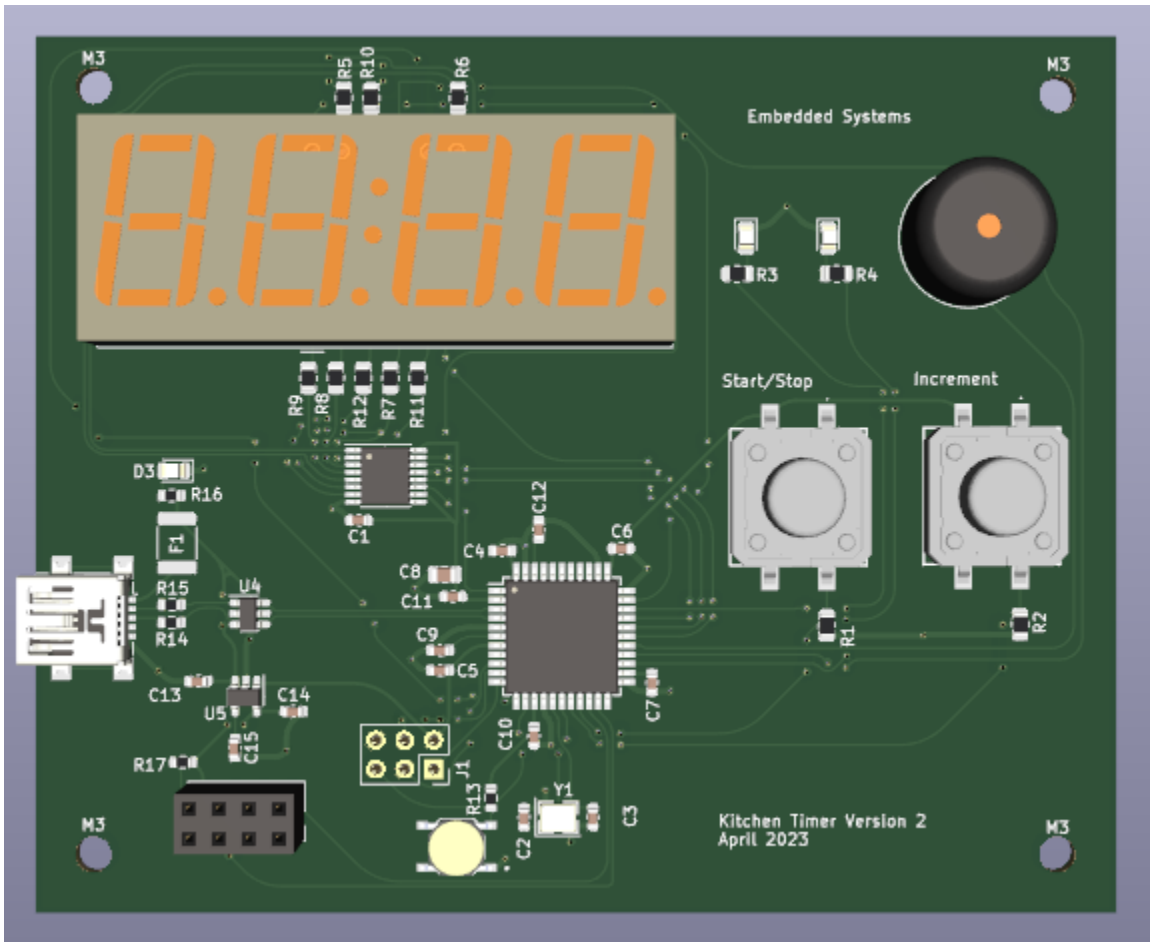
Skeleton



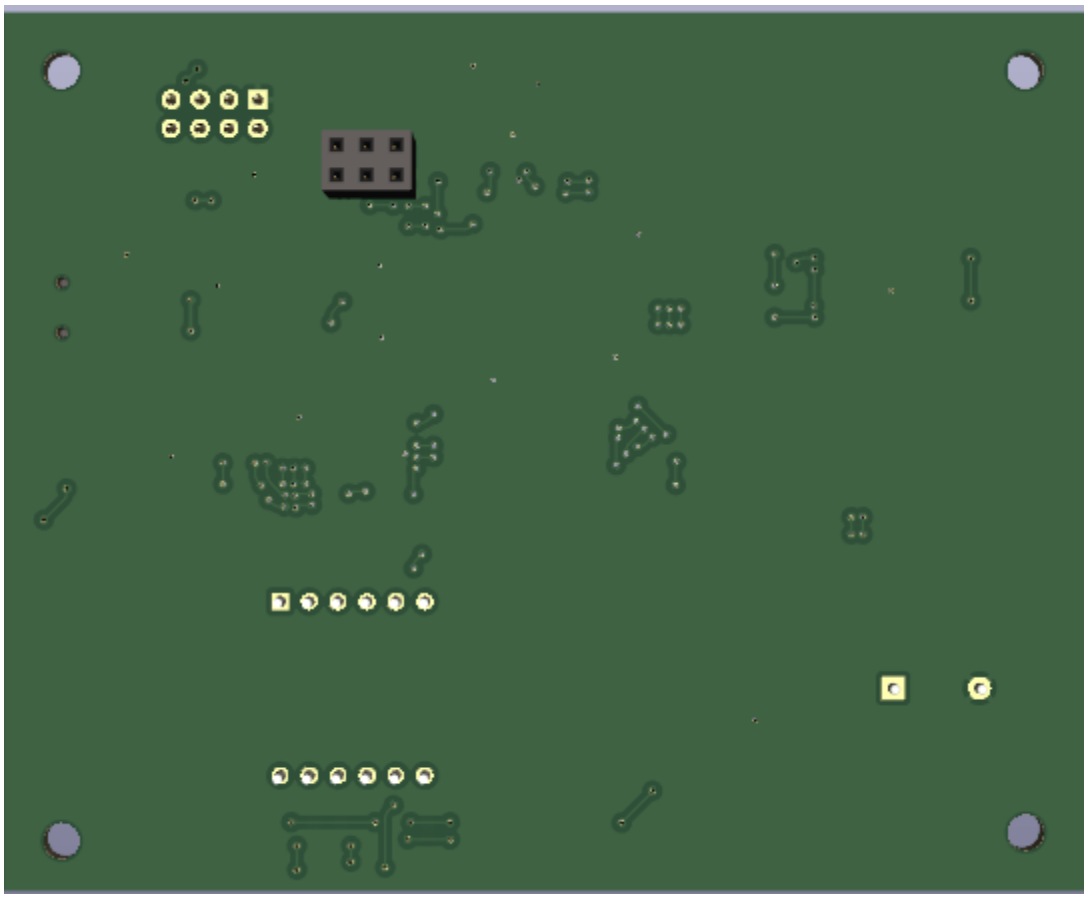
PCB (KiCad)


Embedded Systems
Kitchen Timer Version 2
April 2023
Start/Stop
Increment
Speaker
MountingHole_3.2mm_M3
CA56-12EWA
ATmega328P-PU
74HC595
USBLC6-2SC6
LP2985-3.3
AVR-ISP-6
ESP_Conn
USB_B_Mini
PTS526_SM08_SMTR2_LFS
16MHz

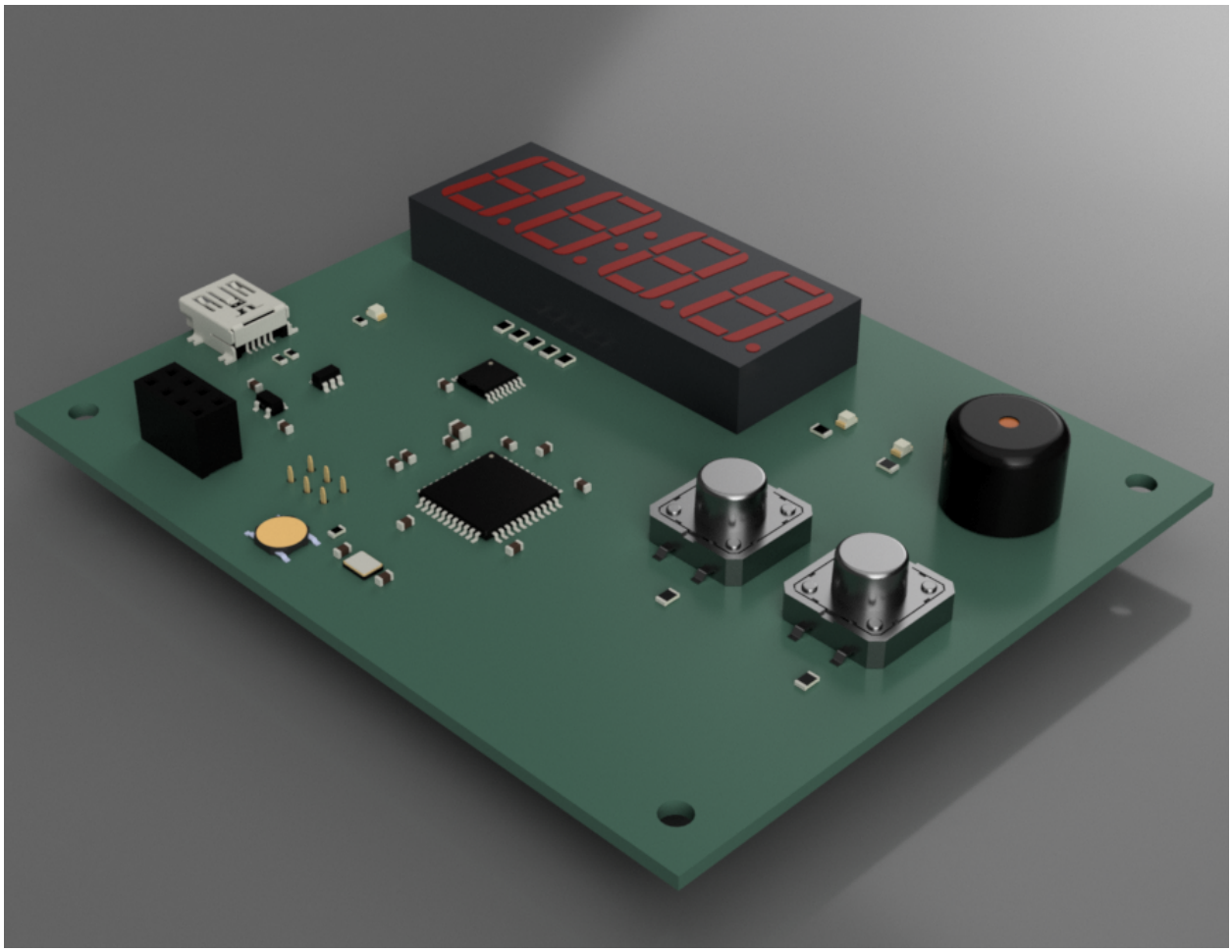
3D KiCad (Top View)



3D KiCad (Bottom View)



3D Render (Isometric View)



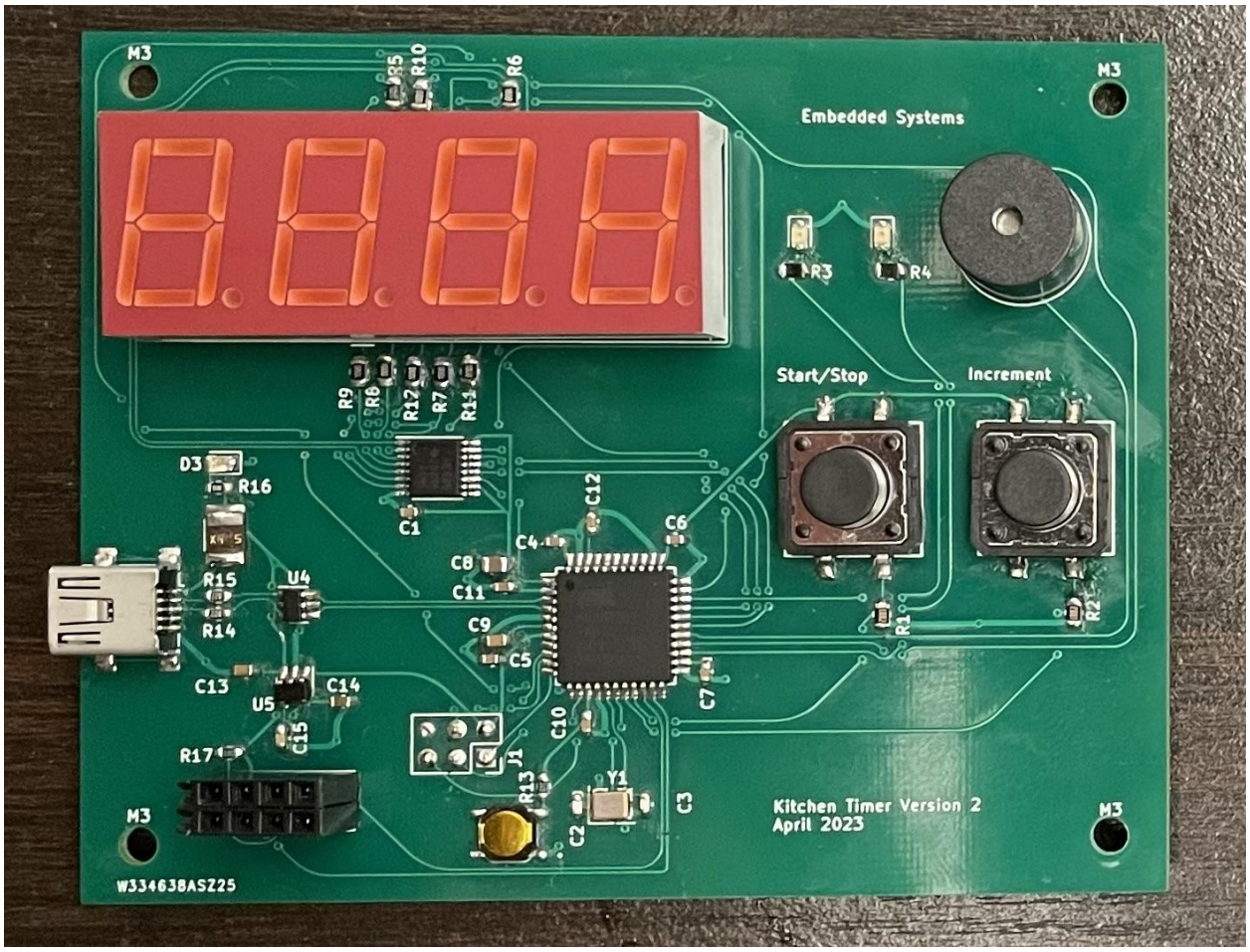
Assembly

The Atmega Kitchen Timer PCB has been soldered. Most components being surface mounted proved difficult when attempting to do solder components for the first time. However, after the first few components were mounted successfully, the process increased in efficiency.

Once the usb connector and fuse were soldered, the diode indicating power was also secured to the board. The power connection was tested by plugging the connector into a laptop. After the power connection was determined successful, the remaining components were soldered.

The boot loader provided by the professor was then connected to the microprocessor, the uploaded data allows the Arduino IDE to recognize the Atmega as a programmable device. The Atmega can then execute Arduino sketches like an Ardiuno device would. The allows for extremely simple portability of existing software to the new device.

PCB with Soldered Components



Software Development

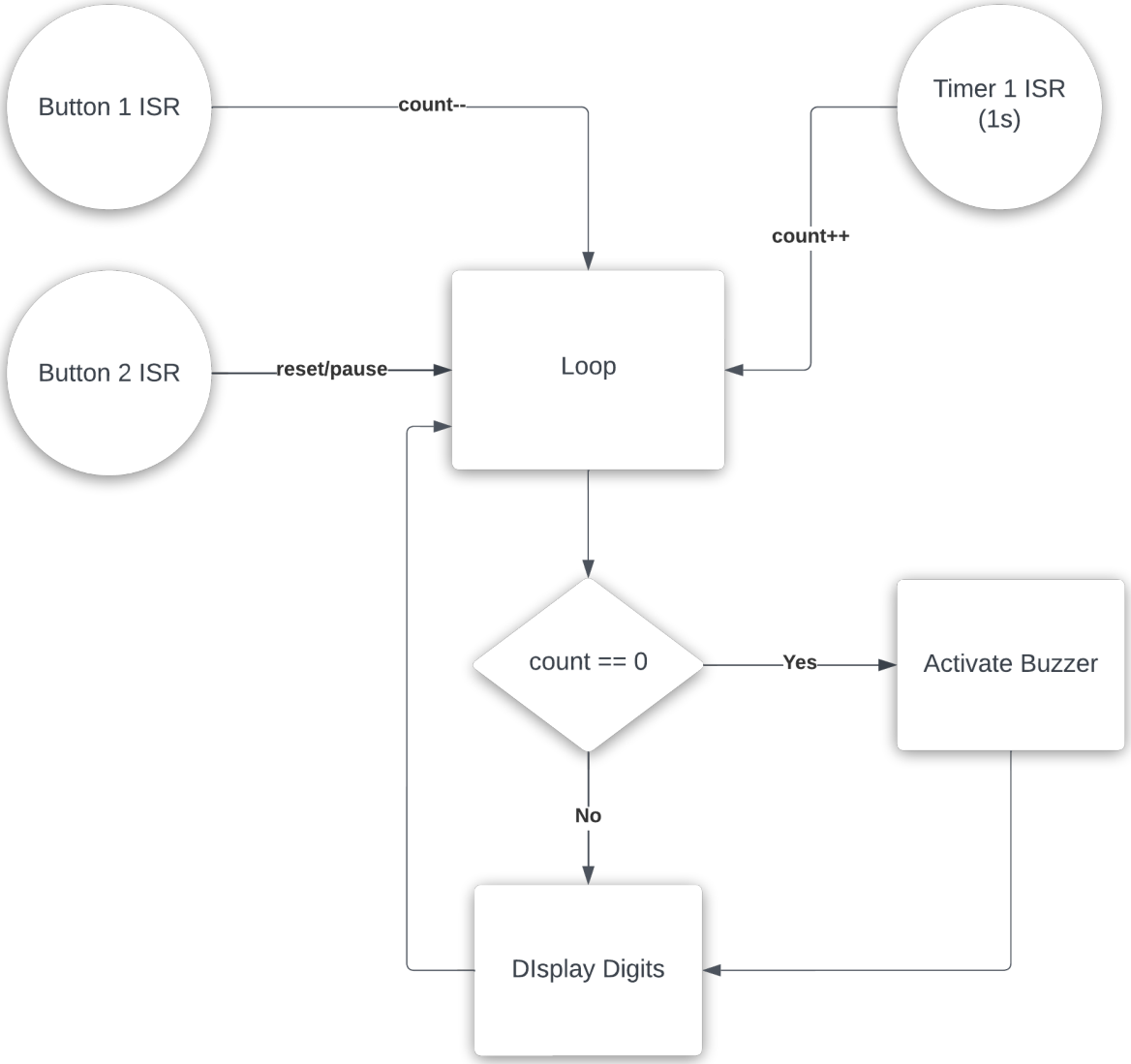
Three interrupts are used in this software implementation of the kitchen timer. These interrupts effect the timer's count which is displayed in a continuous loop. Because both itterrupts and a continuous loop are being used, this program can be considered pooling-driven.

Two interrupts are attached to both user buttons pins. The first user button interrupt (Button 1 ISR), decrements the count. The second button interrupt (Button 2 ISR) both pauses and resets the count depending the timer's state.

The third interrupt is driven by a timer on the Arduino Uno, this is accessed through registers. The interval for the interrupt is set to one second. The service routine now serves as the timing for when to sacrament the count.

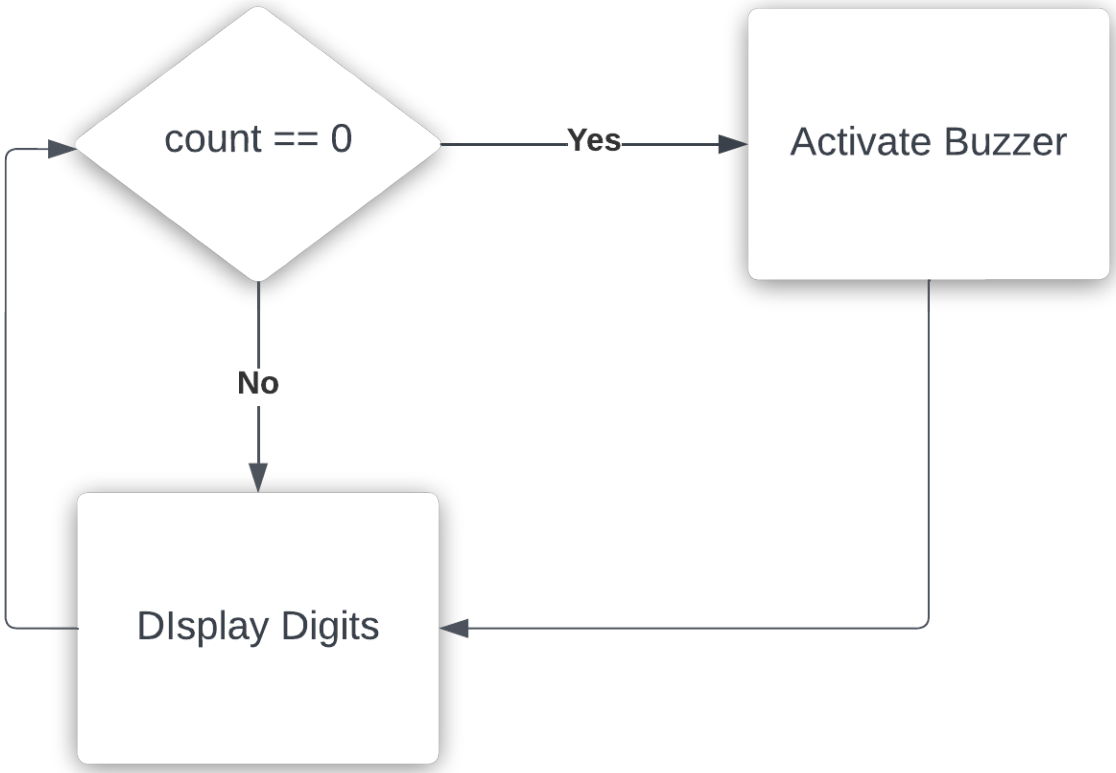
The software for the Arduino Shield can be found at https://github.com/tobywerthan/ENCE_3220_Class2023. The Atmega Kitchen Timer PCB has not been soldered yet. Once all components are successfully placed on the board, the software for this board will be developed.

Block Diagram

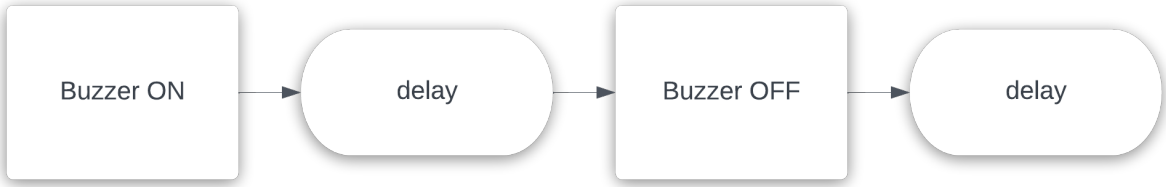


Flow Charts

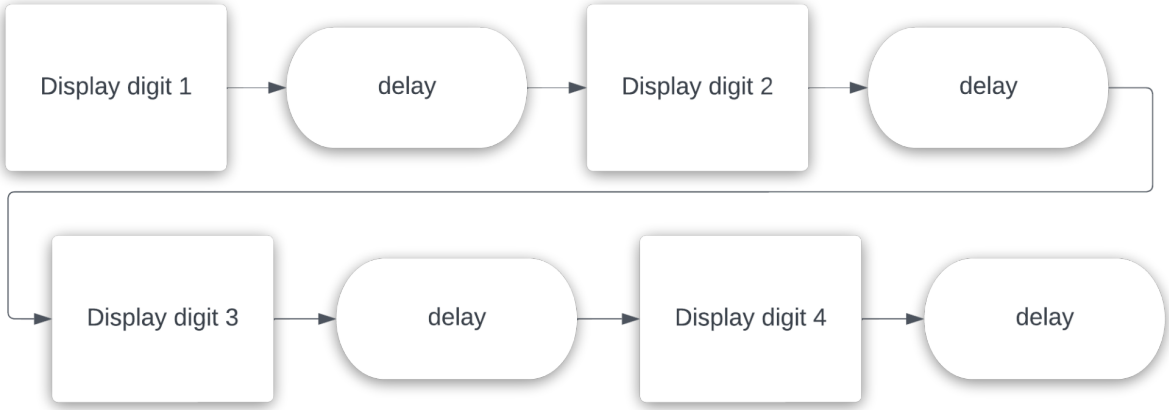
Loop



Activate Buzzer



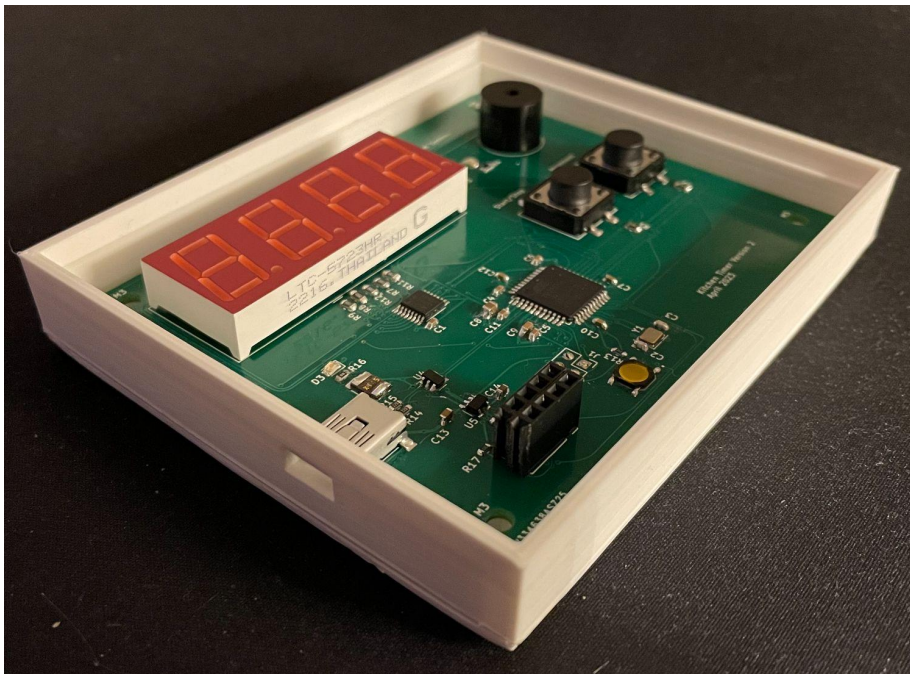
Display Digits



Enclosure Design

The enclosure was designed in Fusion360 and was based on the layout of the PCB. The tolerances in holes for components were too small. This caused the top casing to not fit correctly around the PCB. This loose fit can be seen below.

Bottom Casing



Top Casing

Assembled