Embedded Systems

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Project Requirements

A simple kitchen timer shall be implemented with the features below:

- The system shall have 2 user buttons.
- The system shall have 2 status LED's.
- The system shall have a 7-segment display w/ shift register.
- The system shall have a microprocessor for processing.
- The system shall have a Mini-USB for programming.
- The system shall have a crystal for timing processes.
- The system shall also have a voltage regulator.
- The system shall have a buzzer to notify user when done.
- The system shall have a comms module for communication (ESP8266)
- The system should debounce the buttons (done through software).

System Design

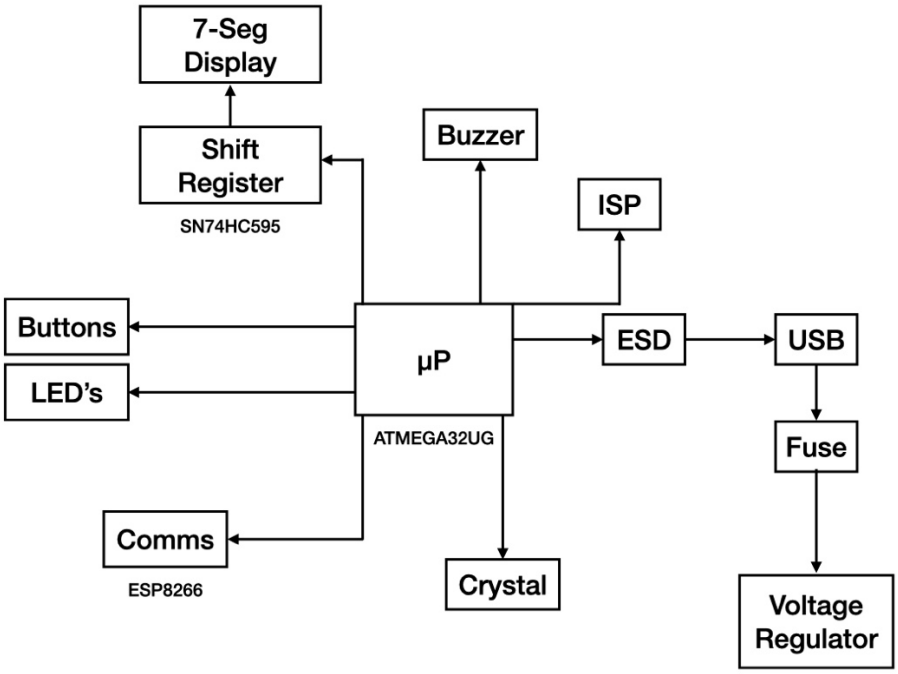

Figure 1: Simple System Design for Phase B

Component Selection

null	Placed	References	Value	Footprint	Quantity
1		C1, C4, C5, C6, C7, C10, C11, C12	0.1uF	C_0603_1608Metric	8
2		C2, C3	22p	C_0603_1608Metric	2
3		C9, C13	1uF	C_0603_1608Metric	2
4		C8	10uF	C_0805_2012Metric	1
5		C14	2.2uF	C_0603_1608Metric	1
6		C15	10nF	C_0603_1608Metric	1
7		R5, R6, R7, R8, R9, R10, R11, R12	100	R_0805_2012Metric	8
8		R1, R2	10k	R_0805_2012Metric	2
9		R3, R4	330	R_0805_2012Metric	2
10		R13, R17	10k	R_0603_1608Metric	2
11		R14, R15	22	R_0603_1608Metric	2
12		R16	1k	R_0603_1608Metric	1
13		D1, D2, D3	LED	LED_0805_2012Metric	3
14		U1	CA56-12EWA	CA56-12EWA	1
15		U2	74HC595	TSSOP-16_4.4x5mm_P0.65mm	1
16		U3	ATmega32U4-A	TQFP-44_10x10mm_P0.8mm	1
17		U4	USBLC6-2SC6	SOT-23-6	1
18		U5	LP2985-3.3	SOT-23-5	1
19		Y1	16MHz	Crystal_SMD_Abracon_ABM8G-4Pin_3.2x2.5mm	1
20		F1	PTCSMD	Fuse_1812_4532Metric	1
21		S1, S2	PTS125SM43SMTR21M_LFS	PTS125_SMD_Button	2
22		LS1	Speaker	Buzzer_12x9.5RM7.6	1
23		S3	PTS526_SM08_SMTR2_LFS	PTS526_SMD_Button	1
24		J1	AVR-ISP-6	PinSocket_2x03_P2.54mm_Vertical	1
25		J2	USB_B_Mini	USB_Mini-B_Lumberg_2486_01_Horizontal	1
26		J3	ESP_Conn	PinSocket_2x04_P2.54mm_Vertical	1

Figure 2: Phase B Component List

Build Prototype

For the prototype we used the Arduino UNO to test some software and get an idea on how the timer will work.

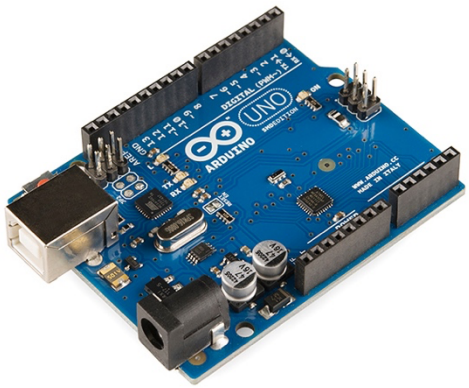

Figure 3: Arduino UNO Board used for prototype.

Figure 4: Final Render of prototype timer

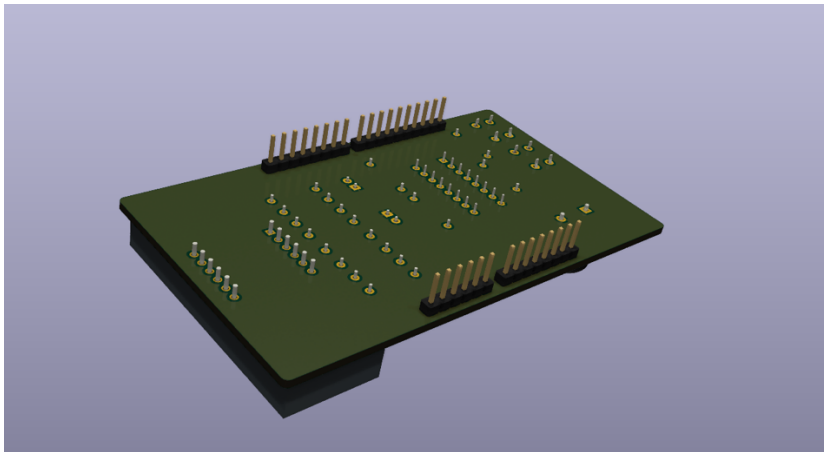
Figure 5: Final Render of prototype timer

As you can see in Figure 4 & 5 an Arduino Shield was used to be able to attach the PCB directly to the Arduino UNO. This is a feature in KiCAD, the software that was used to allow direct connection of PCBs to devices.

PCB Design

After Prototyping we started to design our final design making some slight changes to the prototype.

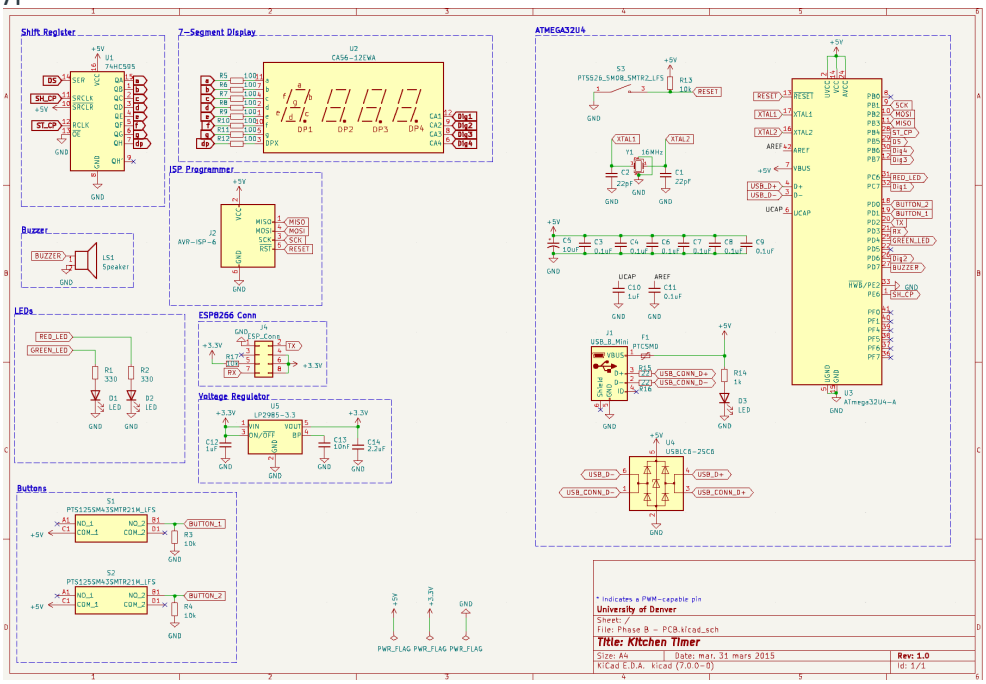

Figure 6: Final Timer Schematic

For the final design many of the things from the prototype was used, just this time a microprocessor is implemented instead of the Arduino UNO.

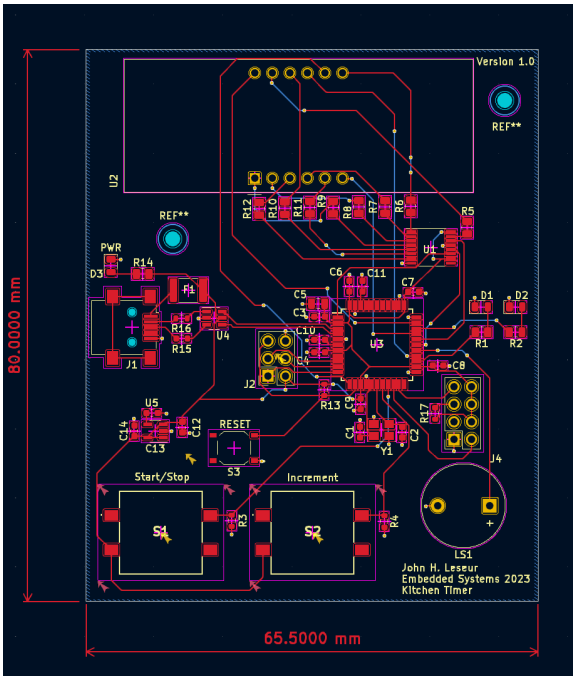

Figure 7: Final PCB in KiCAD

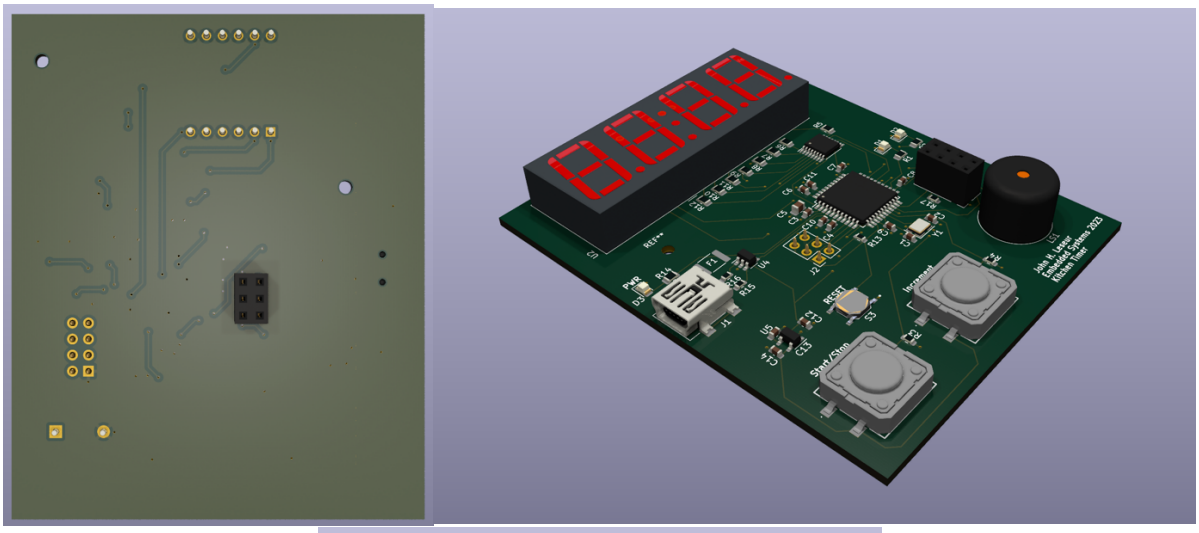

Figure 8, 9, 10: Final Design Render for Kitchen Timer

Assemble Stage

Not Applicable

Enclosure Design

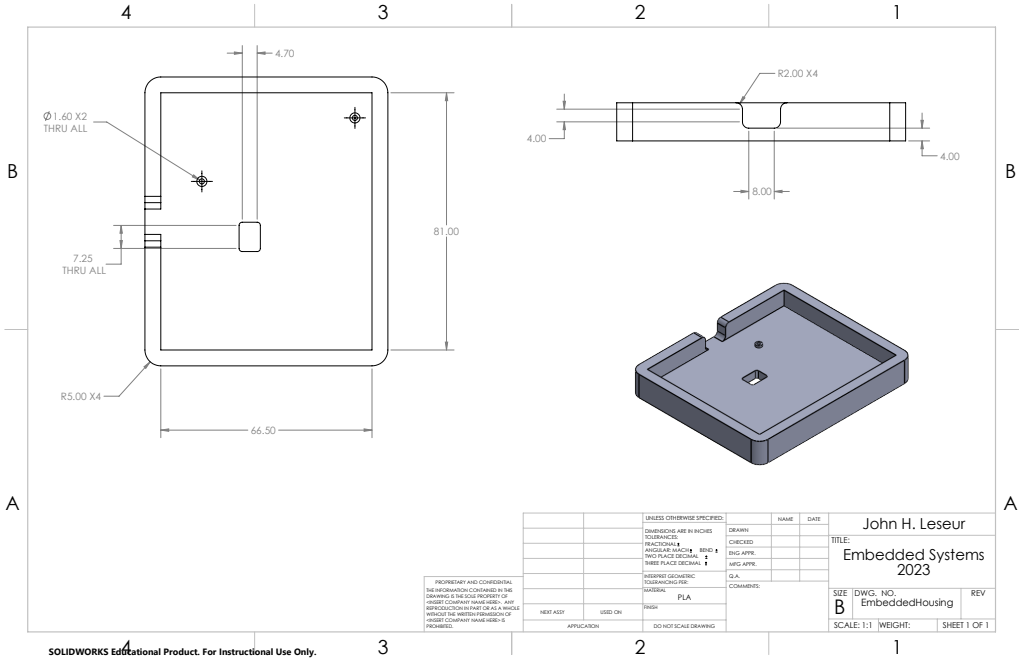

Figure 11: Engineering Drawing of Timer Enclosure

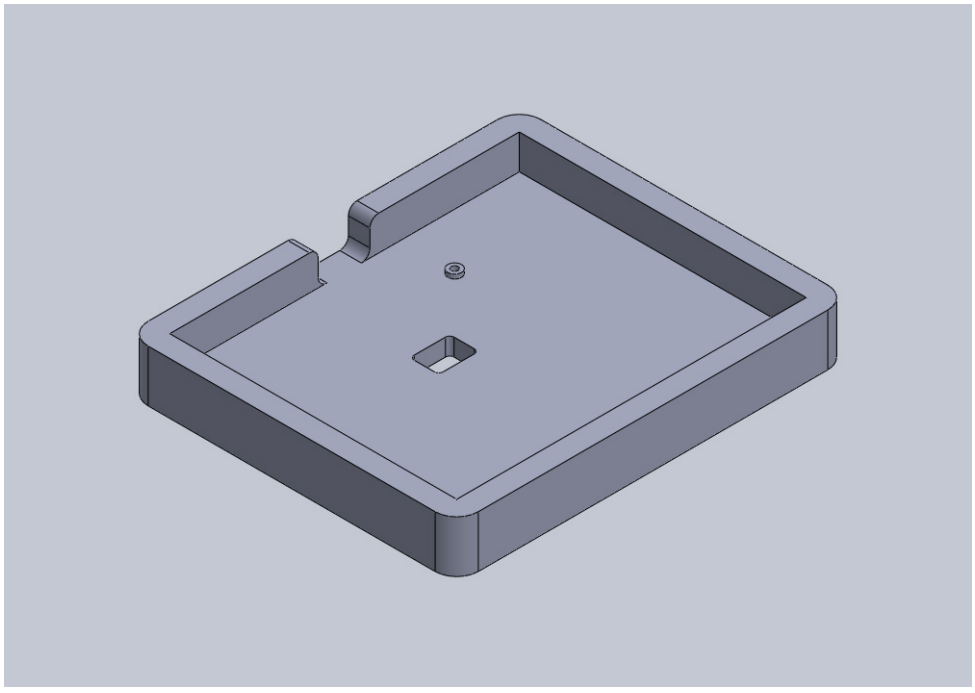

Figure 12: Isometric View of Enclosure

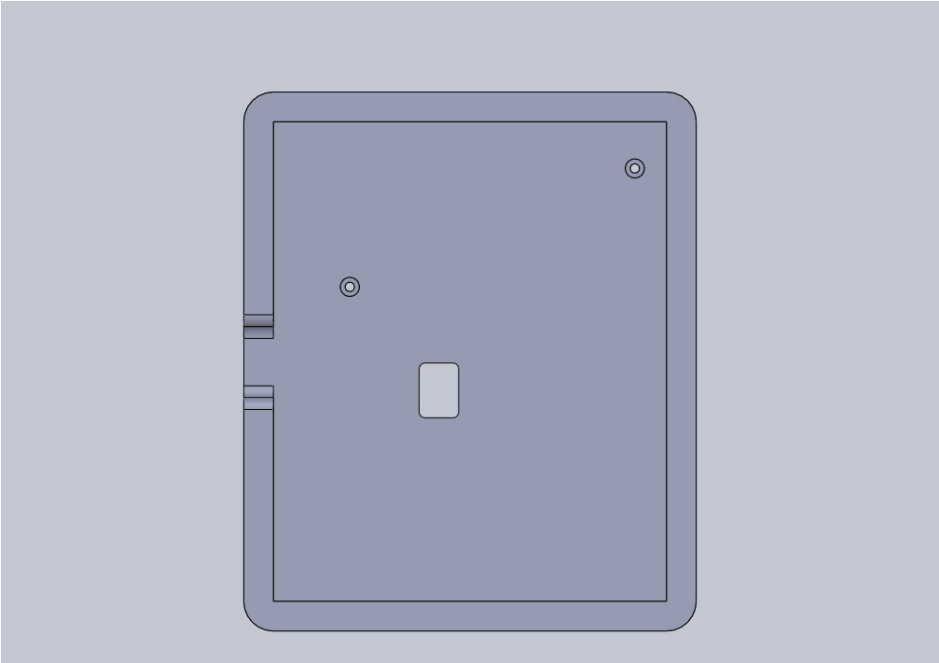

Figure 13: Top View of Enclosure

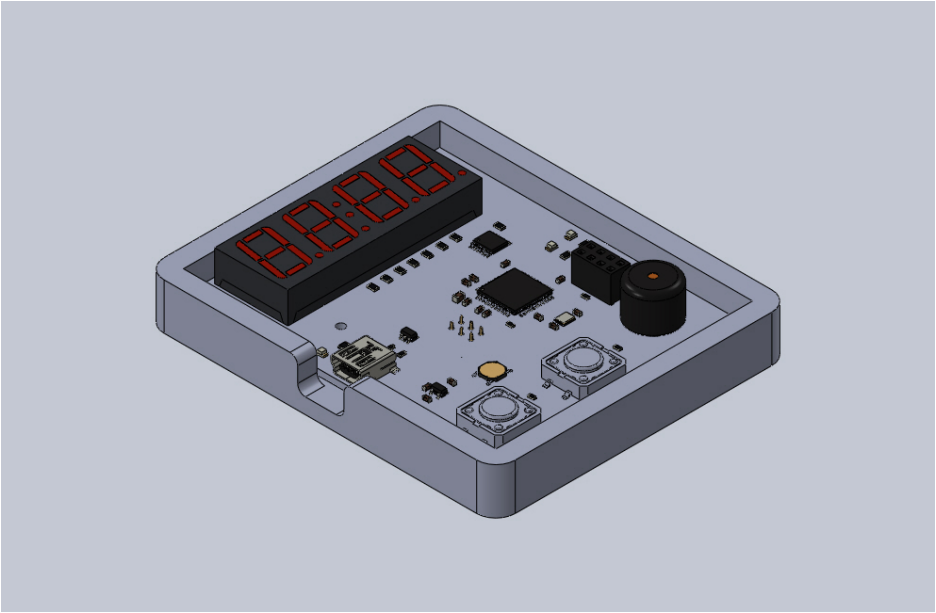

Figure 14: Final PCB inside the Housing

I went with an open face design so that the PCB work can be admired and not covered up. A face plate could be made to cover up the electronics in the future.