Phase B Beta Release Report

Embedded Systems
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Project Requirments:

This project aimed to design and develop a kitchen timer that meets specific requirements for use in a school lab setting. The device was required to have two user buttons and two status LEDs for easy user interaction. In addition, the timer needed to be programmable through a micro USB port and have the ability to connect to a computer through WiFi.

System Design:

-Block Diagram:

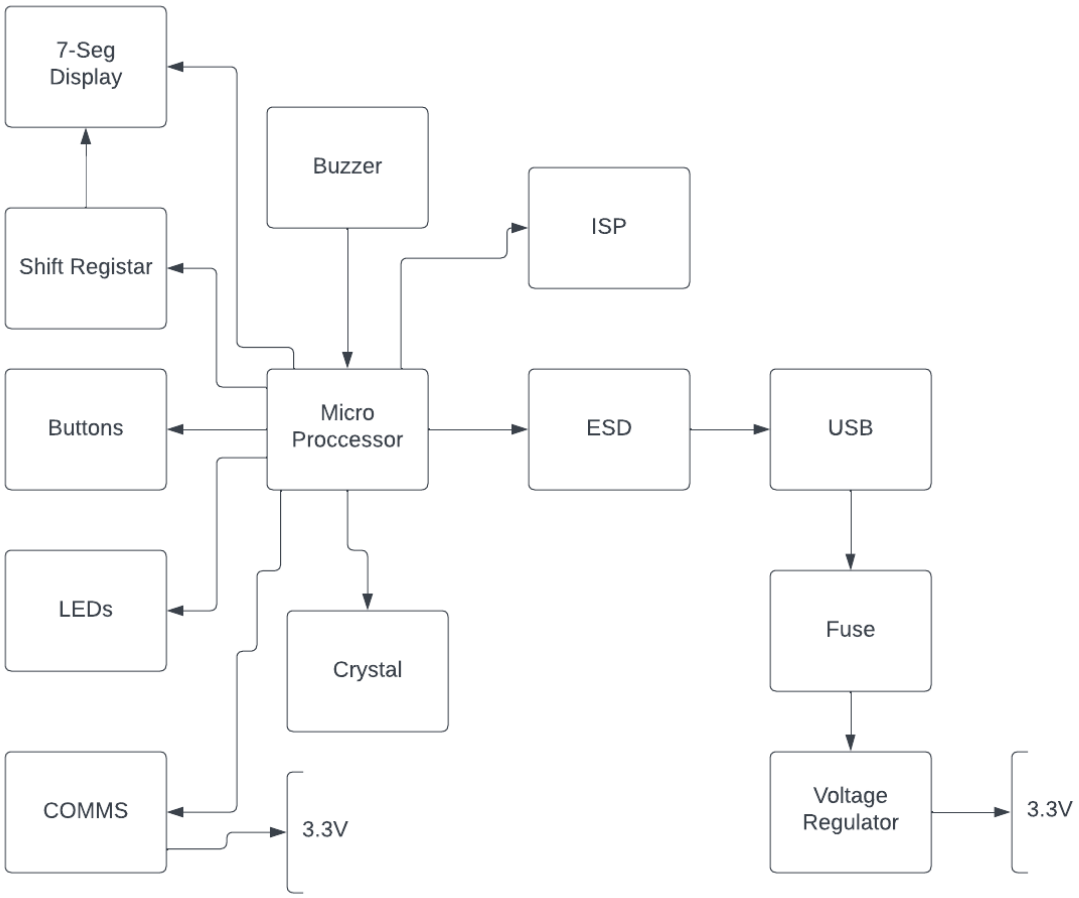


Figure 1: Block Diagram of Kitchen Timer

Components Selection:

For the Kitchen Timer, we chose the following components:

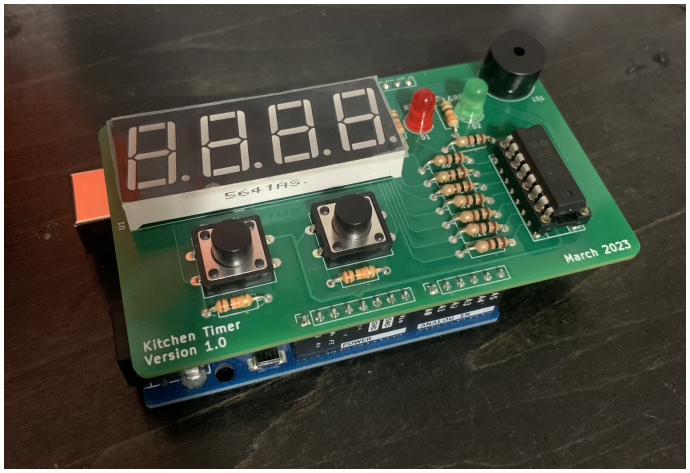
Item	Quantity
Arduino Uno	1
7-Segment Display	1
Shift Register	1
Buttons	2
LEDs	2
Resistors	18
Capacitors	14
Mini Speaker	1
ESP8266	1
Voltage regulator	1

Figure 2: Selected components

The full bill of materials for the kitchen timer can be viewed here: https://github.com/ebur644/PhaseBEmbeddedfinal/tree/main/PCB_Design/BOM

Build Prototype:

For the first prototype, a shield was made for an Arduino Uno. The Arduino shield is an electronic module designed to interface with the output of an Arduino microcontroller, to make it act as a kitchen timer. The Arduino shield incorporates onboard buttons and wifi communication, enabling the user to initiate, pause, resume, and increment timer values from the shield or a device connected to the shield's wifi network. Upon completion of the designated interval, the timer emits an audible signal in the form of a buzzer. The Arduino shield allows us to test the overall features while having an easy-to-use IDE. The final prototype can be seen below.



PCB Design:

Prior to creating the schematic or Printed Circuit Board (PCB), a design template was established to guide the development of the timer. This design features centrally located buttons situated within the bottom section of the device, with the 7-segment display positioned atop the button array. In addition, the USB port is situated on the lower left-hand side of the device.

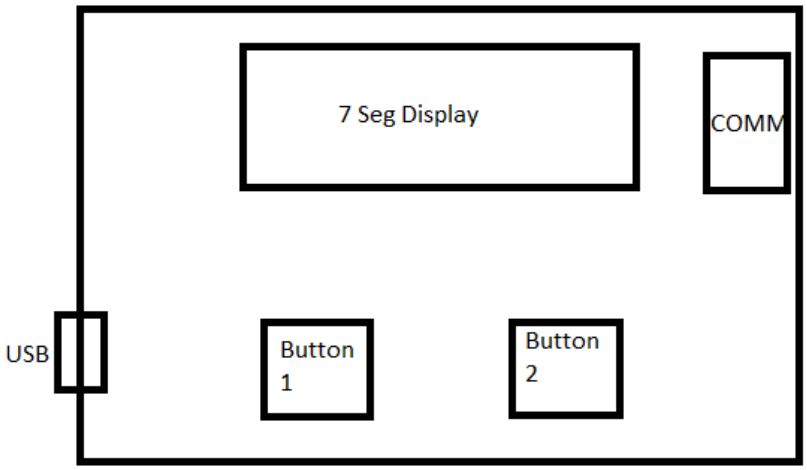


Figure 3: PCB layout prototype

Below is a picture of the schematic with all the components.

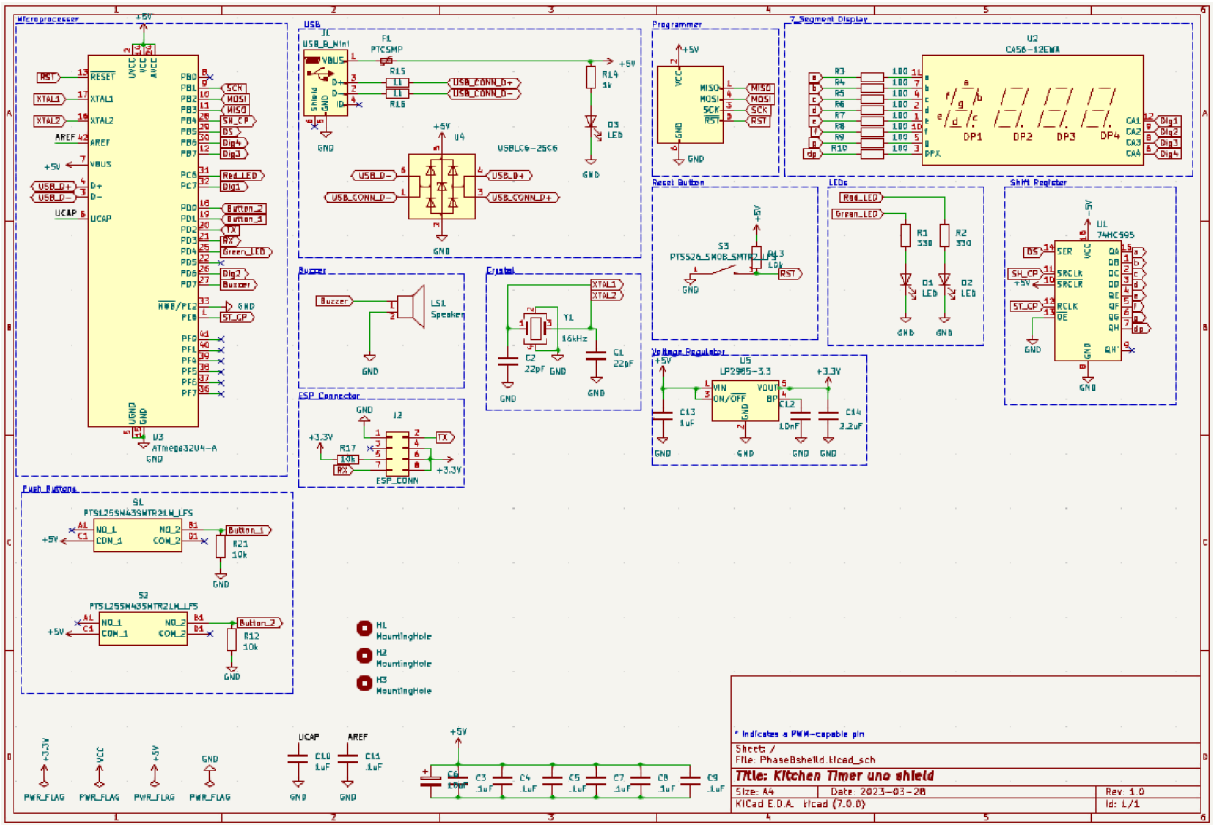


Figure 4: Kitchen timer schematic:

A more detailed image of the schematic can be viewed here: https://github.com/ebur644/PhaseBEmbeddedfinal/tree/main/PCB_Design/Schematics

For the PCB layout and routing, I did the following:

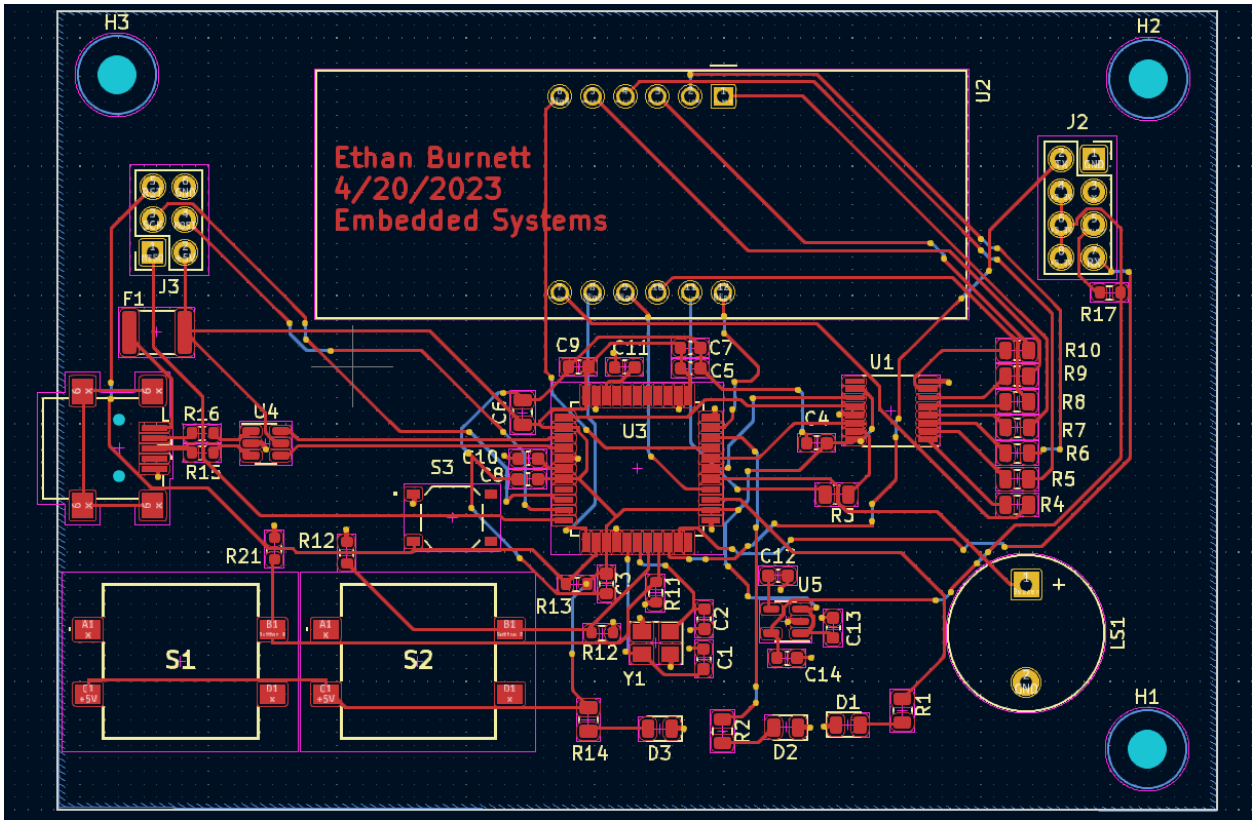


Figure 5: PCB Design and Routing

For the PCB, I tried to keep as many of the traces on the top layer as to not disrupt the ground plane. It was also important to not route underneath the differential pair coming from the USB as that signal integrity is very important. I also chose to move the buttons slightly to the left to make room for other circuit components.

Here is the final PCB 3D model with all the components:

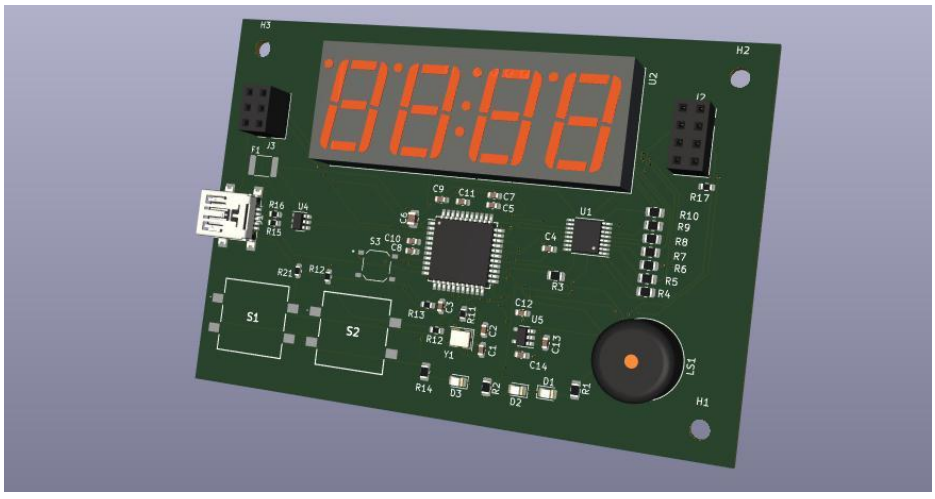


Figure 6: 3D model of kitchen timer pcb

Assemble Stage:
This section will be completed once the PCB board is all soldered. It will include images of the board before and after soldering as well as an explanation of anything that goes wrong.

Software Development:

Before starting on the code a block diagram was made to help lay out the functions that will need to be created.

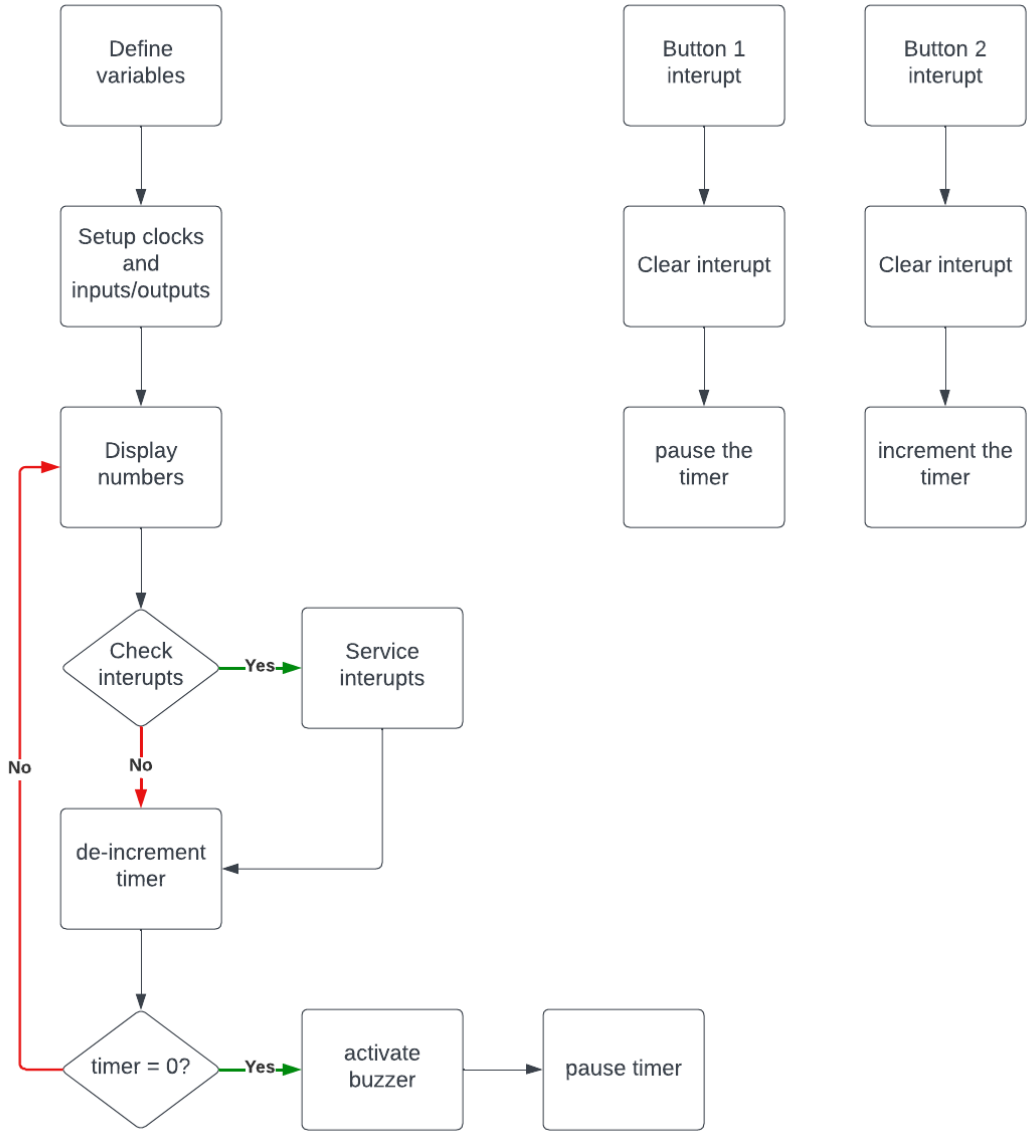


Figure 7: Block Diagram

The final entire final code can be viewed here:

https://github.com/ebur644/PhaseBEmbeddedfinal/tree/main/Arduino_code

In general, the code operates similarly to the examples presented in class. However, a modification was implemented to the code by using the delay function for the display numbers. This alteration was done in order to free up timer 3 for use with the IOT component. The display numbers code can be seen below. Display1-4 correspond to turning on only the first through the fourth digit independently.

```
void Display_Numbers() { //switches between the didgits quickly
  Display1(gcount % 10);
  delay(5);
  Display2(gcount / 10 % 6);
  delay(5);
  Display3(gcount / 60 % 10);
  delay(5);
  Display4(gcount / 600 % 10);
  delay(5);
}
```

Enclosure Design:

The enclosure I designed is relatively simple and doesn't have a top for now since predict there will be slight fitment problems with the design.

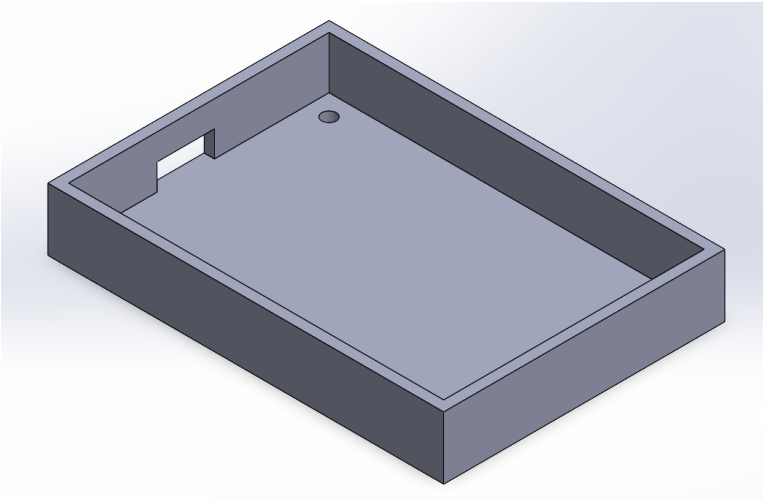


Figure 8:Kitchen timer enclosure

An image of the 3D-printed enclosure will be added once it has been printed.