



University of Moratuwa
Department of Electronic and Telecommunication
Engineering

EN2160 - Electronic Design Realization

Report

Smart Pill Box

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Introduction

One of the biggest challenges faced by people, especially elderly, who use traditional pill management systems is forgetting to take their medication. Particularly for people with chronic conditions or complex medication schedules, this issue can have serious repercussions. There are many possible causes for forgetting to take the prescribed medicine at the correct time such as busy schedules, memory impairment or just the overwhelming amount of prescriptions to be taken at various times of the day.

Consequences of Forgetting Medicine

- Health Condition worsens
- Reduced treatment efficiency
- Low quality of life
- Hospitalisation

Solution

The “Smart Pill Box” will be a solution to the above mentioned problem. The device comprises 5 compartments to accommodate different types of medicine. When it is time to take the medication, the device rings an alarm, prompting the user. The LCD screen will display which medications should be taken and the corresponding dosage. The time and date will be displayed at other times. In addition, the temperature inside the box will also be indicated which lets the user know if the device overheats.

There will be 3 alarms to be set at different times of the day. The user can change the date, time, alarm times and doses using buttons. Moreover, a Bluetooth option is also available to give the inputs using a mobile phone.

This product will remind people when to take medicine using audio and visual indicators which solves the above problems.

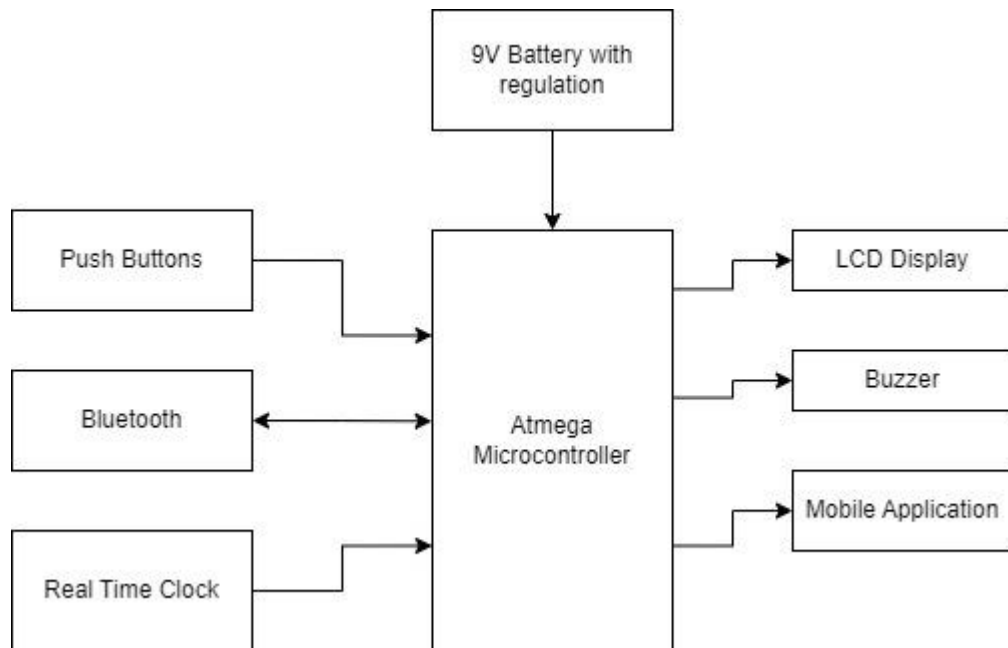
Specifications

- Technical
 - Should track time correctly
 - Should have an alarming system
 - Buttons should have a quick response time
 - Powered using a 9V battery
 - Should have a power saving option

- Operational
 - Should have an intuitive User Interface
 - Battery must last for a significant amount of time

- Mechanical
 - Should be portable
 - Should be sealed shut when closed to prevent moisture
 - Should be lightweight

Functional Block Diagram

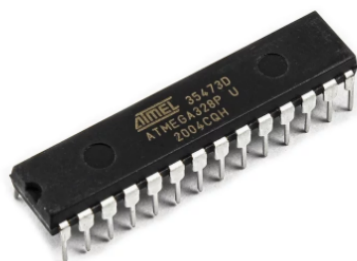


Functionality of the Main Blocks are as follows:

Microcontroller

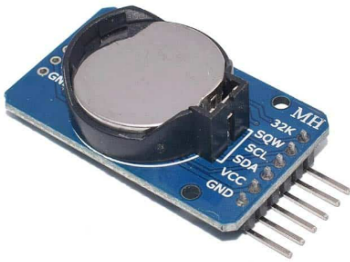
An ATmega328P microcontroller is used which acts as the brain of the system. It performs following tasks

- Take inputs from the user through push button or Bluetooth
- Will ring the buzzer at the correct times
- Will display all the required data on LCD Display
- Goes to sleep mode at regular intervals to save power



Real Time Clock

After initially giving the correct time, the RTC will keep track of the time continuously. It has a separate coin battery which gets charged when the device is on. Therefore, because of this battery, it will keep track of time even when the device is powered off. DS3231 RTC is used. This module also has a built-in temperature sensor.



LCD Display

A 16x2 blue screen LCD is used here to display the necessary information

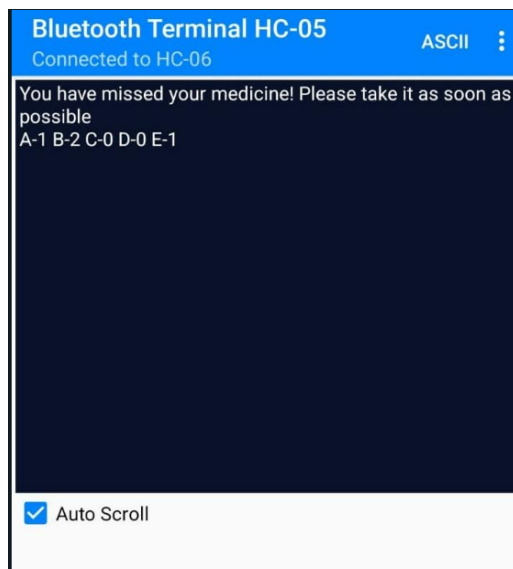


Bluetooth Module

When the phone is connected to Bluetooth, the inputs of changing times and doses will be sent through the Bluetooth module to the microcontroller.

If medication is missed, the microcontroller will send a message to the phone through the Bluetooth module.

Here, a HC-06 Bluetooth Module is used.



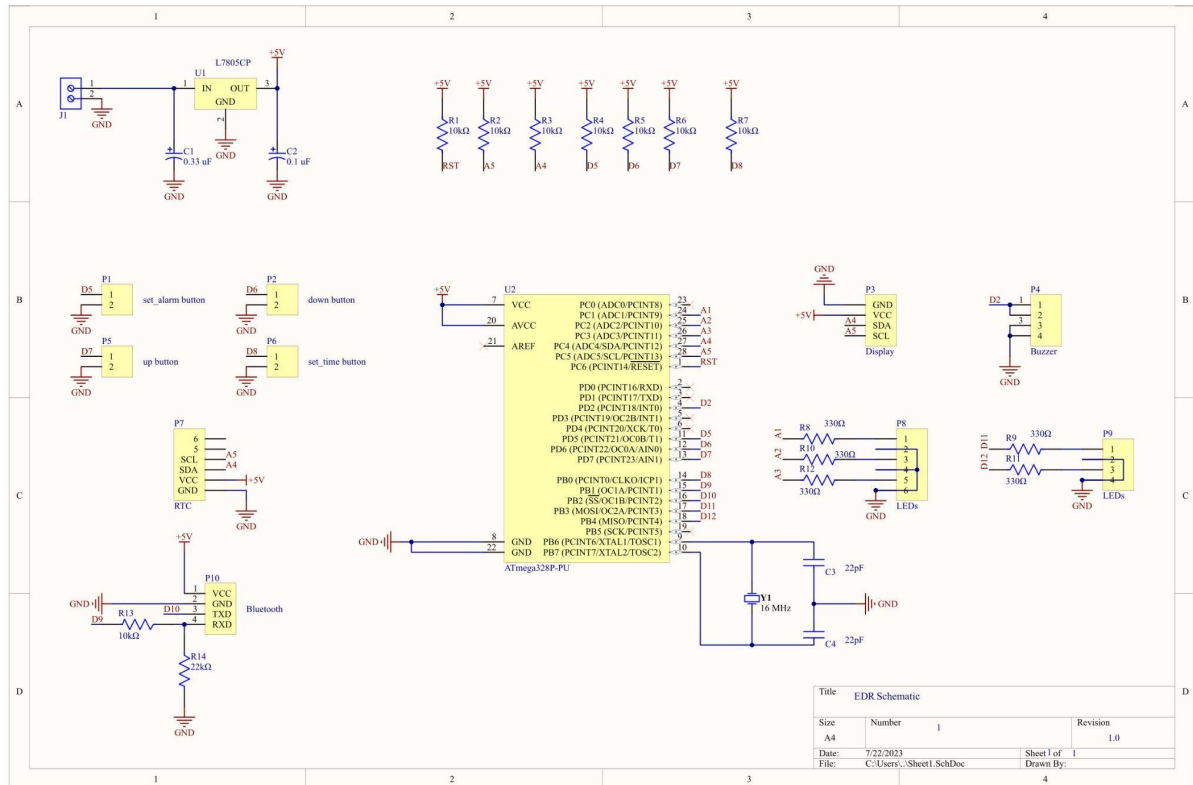
Message to phone

Power Supply

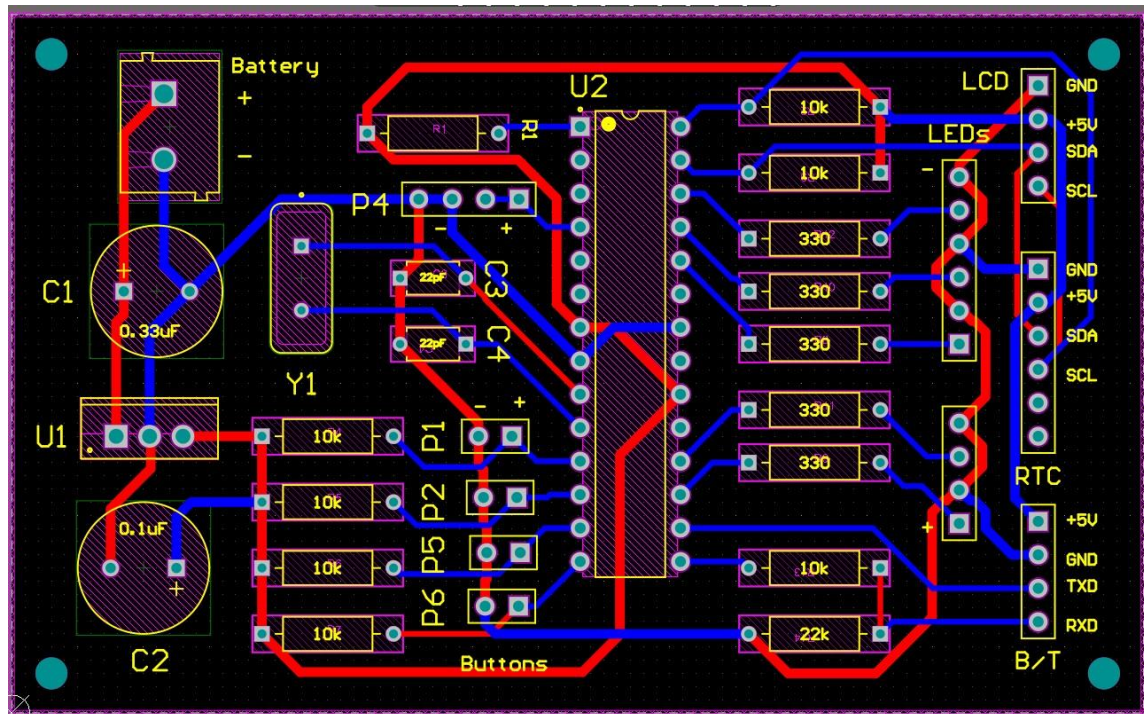
Requires a 9V battery. Power will be supplied to the main circuit through a 5V regulator.

PCB Design

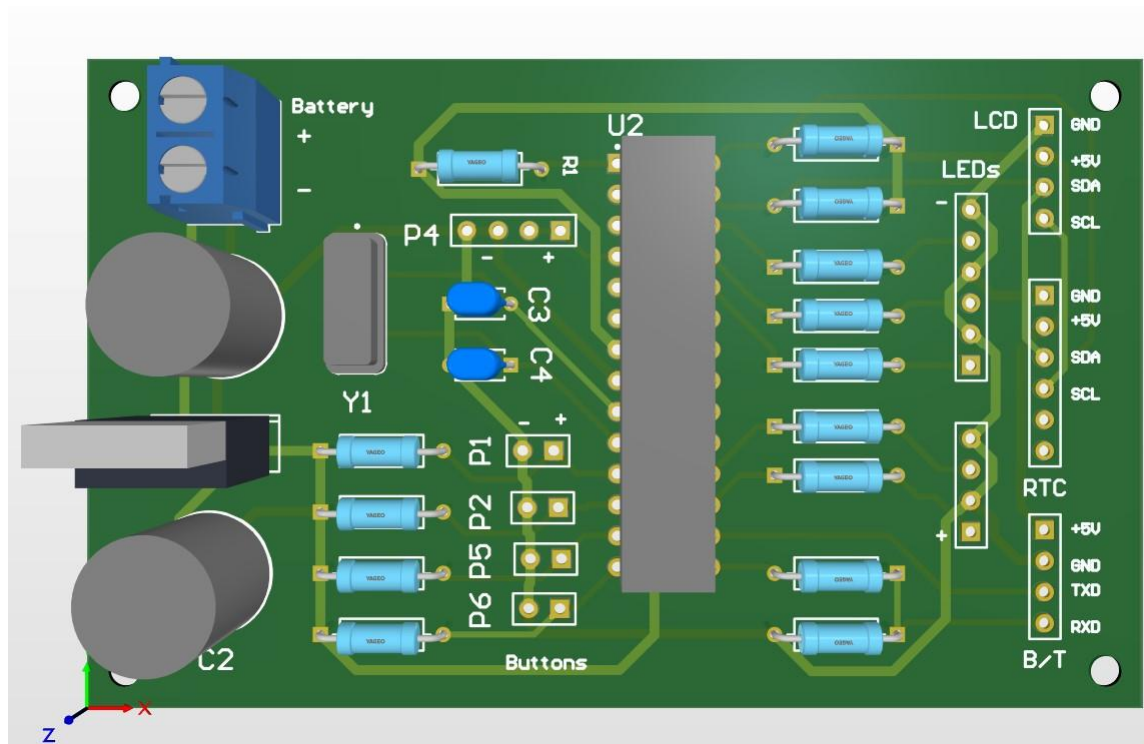
Schematic Diagram



PCB Layout Diagram



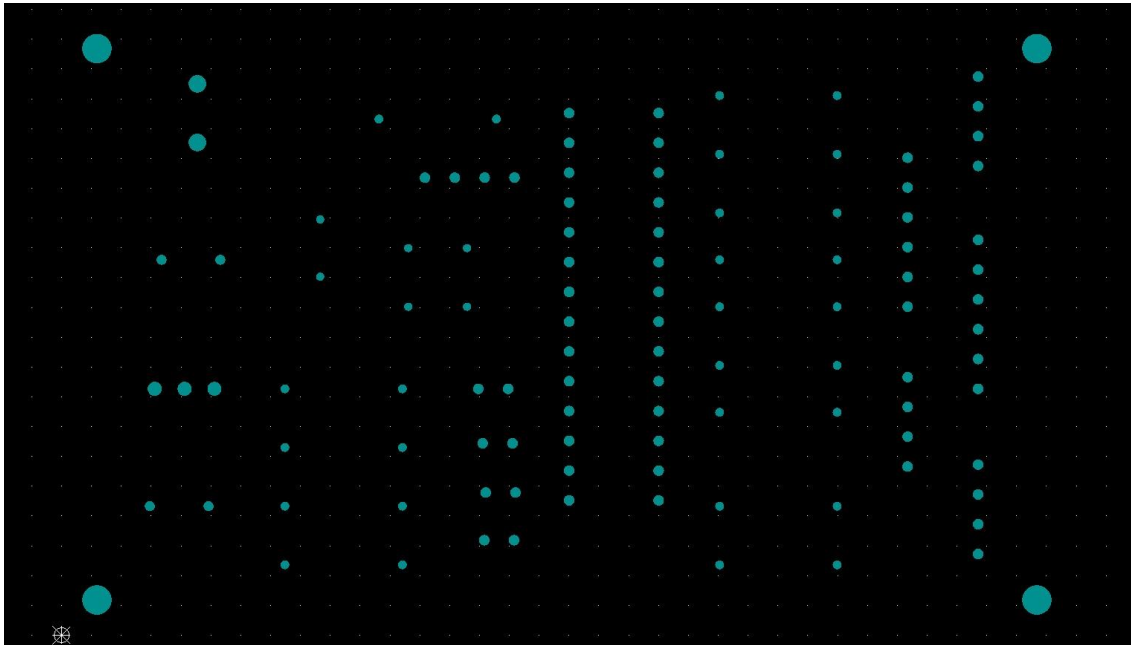
Routing



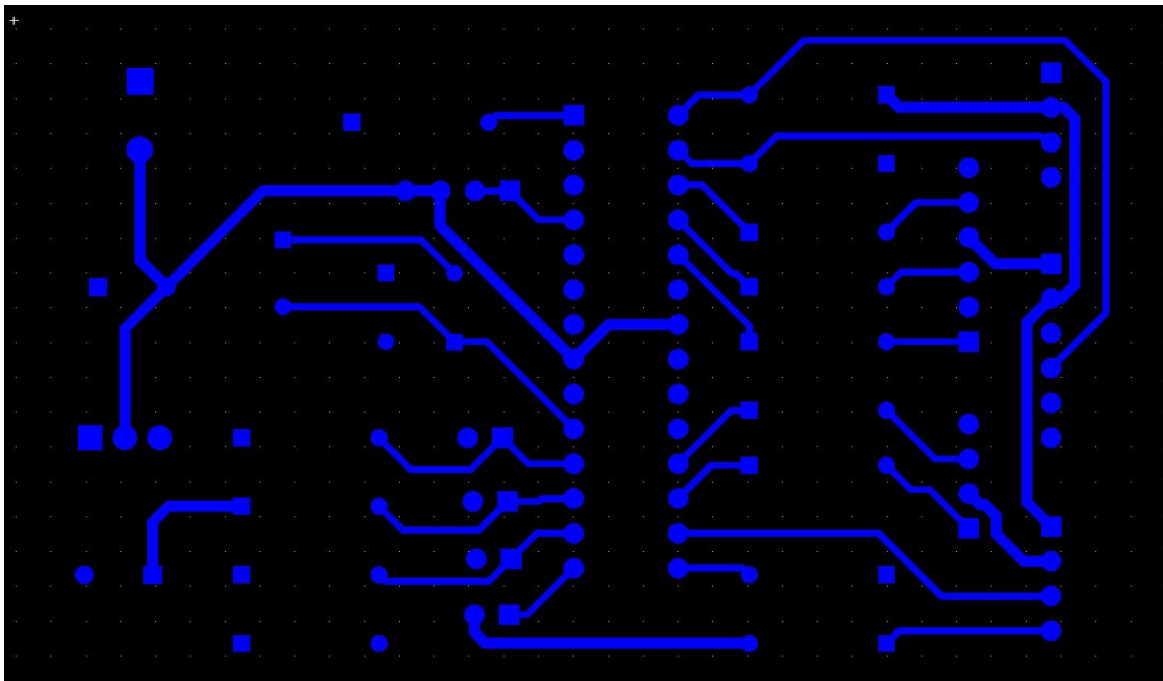
Top 3D View

Dimensions - 86.8mm x 53.3 mm

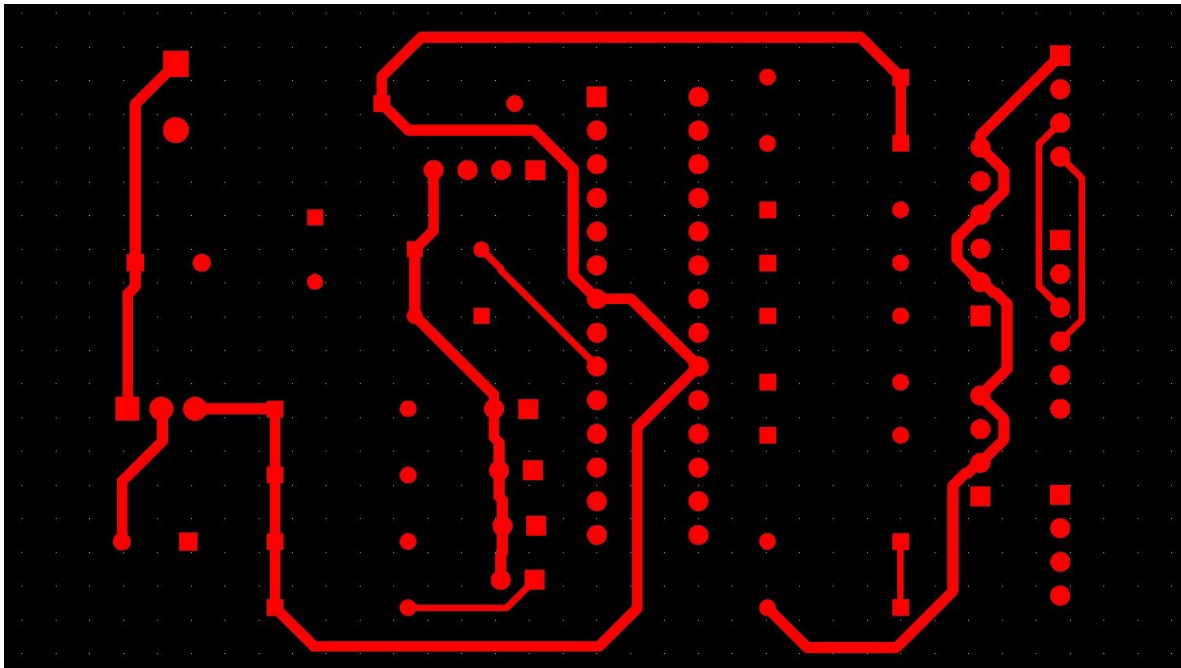
Gerber Files



Drill File



Bottom Layer

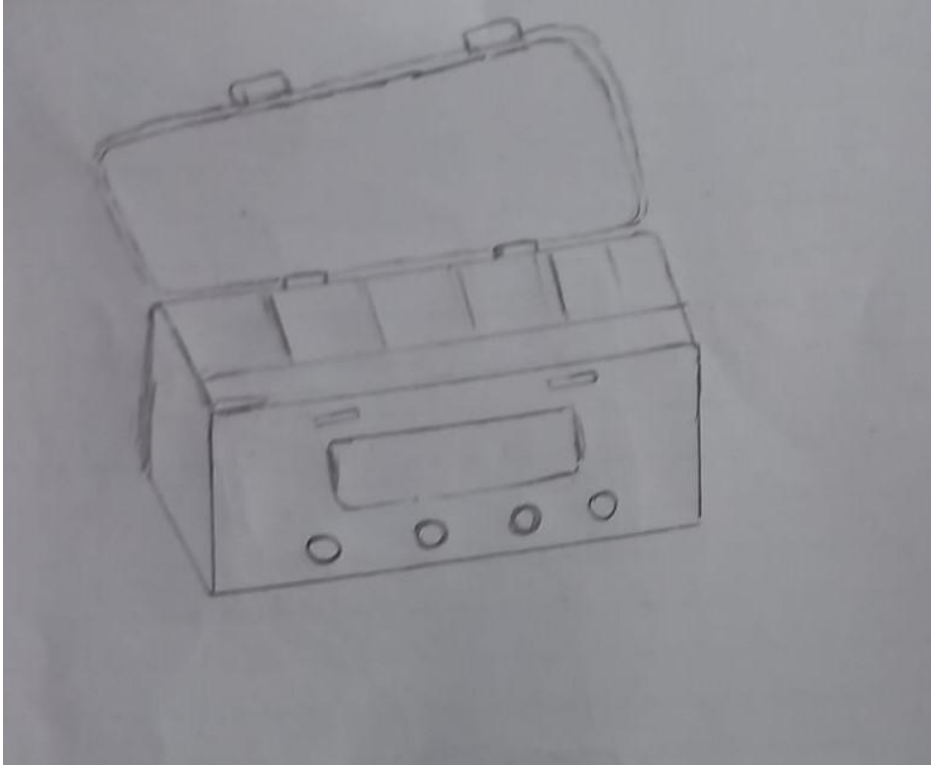


Top Layer

Manufacturer - JLCPCB

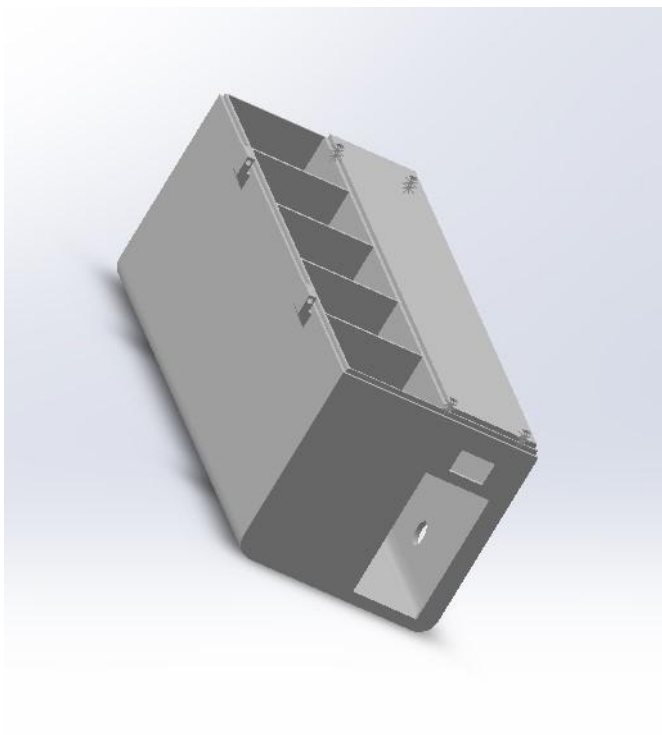
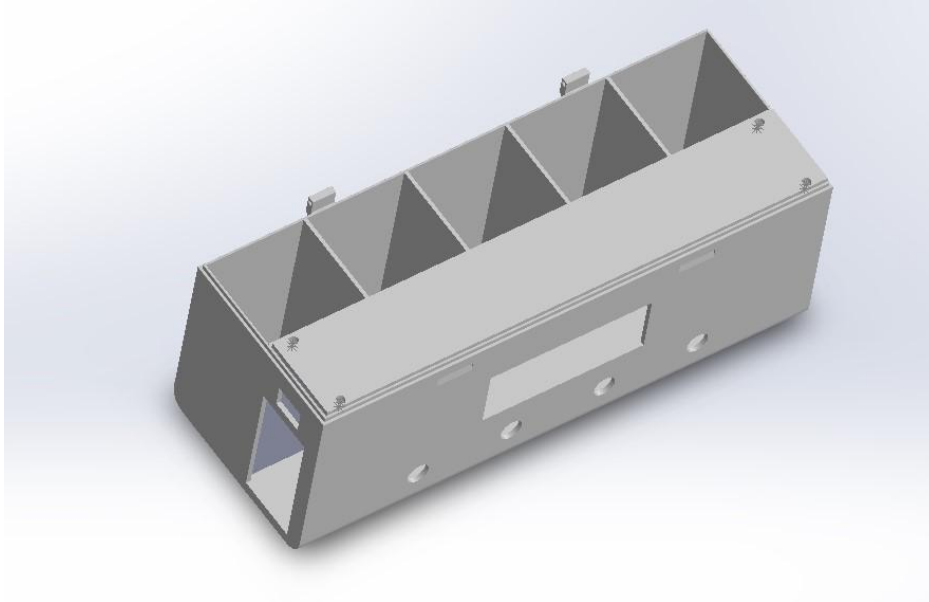
Enclosure Design

Hand Drawn Sketch



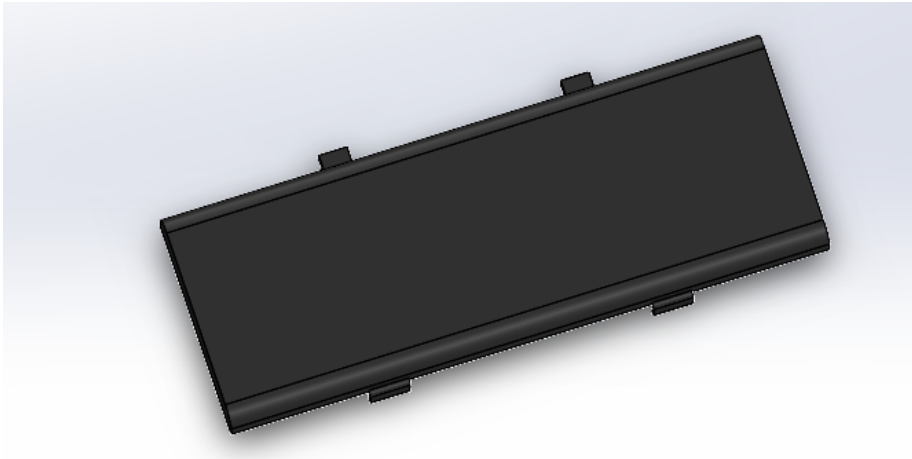
Solidworks Design

Main Part



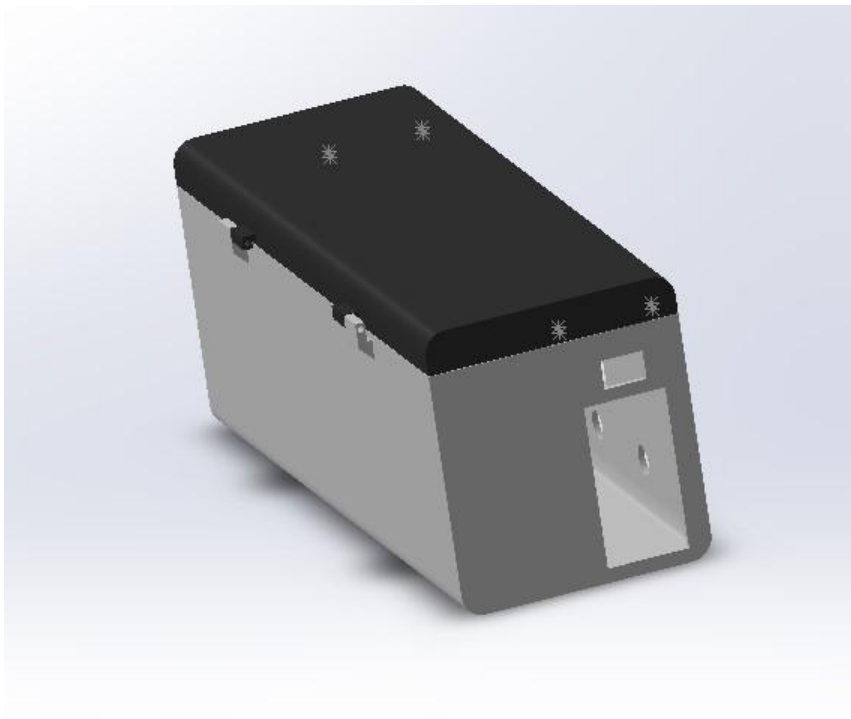
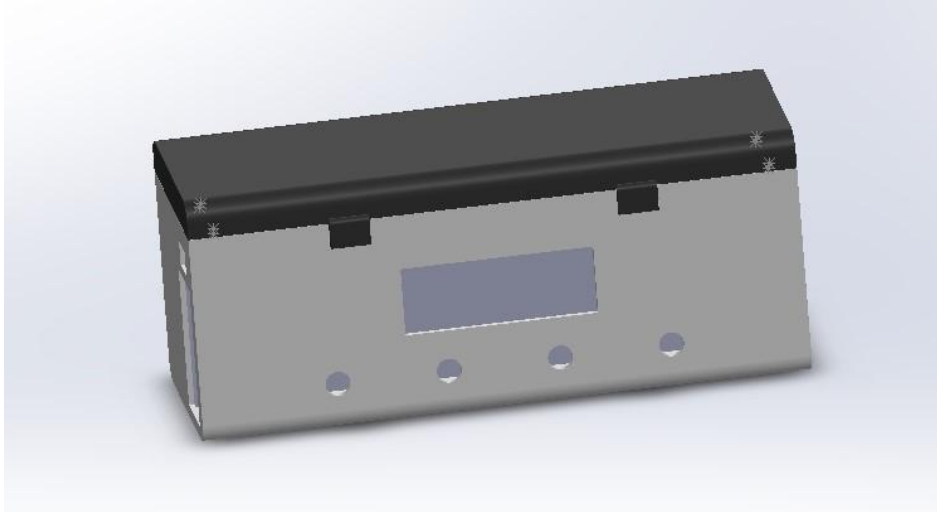
This is the main part of the enclosure

Top Part



This is the lid

Full Assembly



Enclosure



Front View



Top View

Code

The main blocks of the code are as follows:

- **get_Time()**
 - Obtain the time from the RTC module
 - Assign the hour, minute, second, year, month ,day, day of week to separate variable
 - Display the time on the LCD screen
- **set_Alarm()**
 - Get the inputs from push buttons
 - Set the alarms, modes, and dosage number
- **check_Alarm()**
 - Verify whether the current time aligns with one of the set alarm times
 - In the event of a match, ring the buzzer
 - After the alarm stops, the dosage will be shown
 - If intake is not confirmed, send message to phone through Bluetooth
- **ReadEeprom()**
 - Upon powering on the device after being off, the microcontroller will read and access the alarm times stored in its Eeprom, ensuring the preserved variables are retrieved.
- **WriteEeprom()**
 - Write the alarm times to the microcontroller's Eeprom so that the values will be saved in case the device is powered off
- **readBT()**
 - Read the Bluetooth inputs given by the phone
- **set_BT_time**
 - Set the given Bluetooth inputs to variables
 - Set the alarms or time according to the input

Bill of Materials (BOM)

Component	Quantity	Unit Price(Rs.)	Price(Rs.)
ATmega328P-PU Microcontroller	1	1500	1500
16x2 LCD Display	1	1000	1000
DS3231 RTC	1	900	900
HC-06 Bluetooth module	1	2100	2100
LM7805 5V Regulator	1	50	50
16MHz Crystal Oscillator	1	30	30
5V Piezo Buzzer	1	60	60
22pF Capacitor	2	12	24
0.1uF Capacitor	2	5	10
10k ohm Resistor	8	3	24
22k ohm Resistor	1	3	3
Push Button	4	75	300
2 pin JST connectors	4	20	80
4 pin JST connectors	2	40	80
Cost for components without Bluetooth Feature			4061
Cost for components with Bluetooth Feature			6161

There will be 2 types of this product

- With Bluetooth
- Without Bluetooth

Other Costs

- 5 PCB - Rs. 1200
 - 1 PCB - Rs. 240
- Enclosure - Rs. 6000
 - The price of the enclosure was expensive because it was 3D printed. When taking this product to the market, already available enclosures in the market will be bought in bulk. This can reduce the cost per enclosure to Rs. 1000
- Shipping Costs - Rs. 1000

Estimated Cost for Final Product (When buying in bulk)

	Without Bluetooth	With Bluetooth
Components	Rs. 3000	Rs. 5000
PCB	Rs. 200	Rs. 200
Enclosure	Rs. 1000	Rs. 1000
Shipping	Rs. 300	Rs. 300
Total	Rs. 4500	Rs. 6500

- By keeping a 10%-15% profit margin
 - Device without Bluetooth can be sold at Rs. 5000
 - Device with Bluetooth can be sold at Rs. 7500

List of Suppliers

- Microcontroller, Display, Resistors, Capacitors, Buzzer, Buttons, Regulator, Oscillator - LCSC
- Connectors, RTC - Local Suppliers
- Bluetooth module - Mouser Electronics

Further Improvements

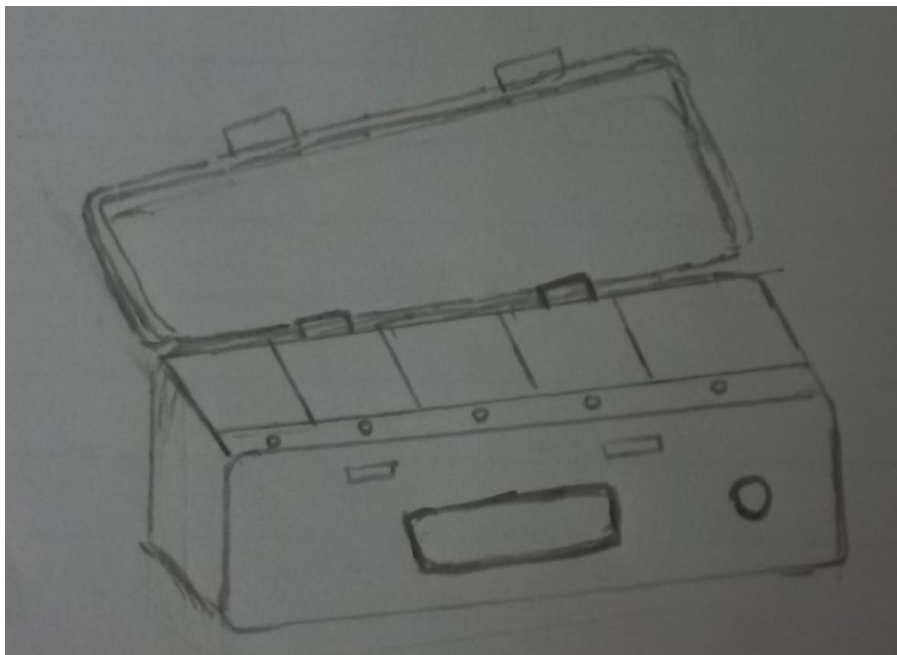
Here are some further improvements that can be made for the product after getting feedback from potential users.

These modifications have not been implemented yet, but they will be addressed in a later stage of development

Problems Identified and Improvements Suggested by Users

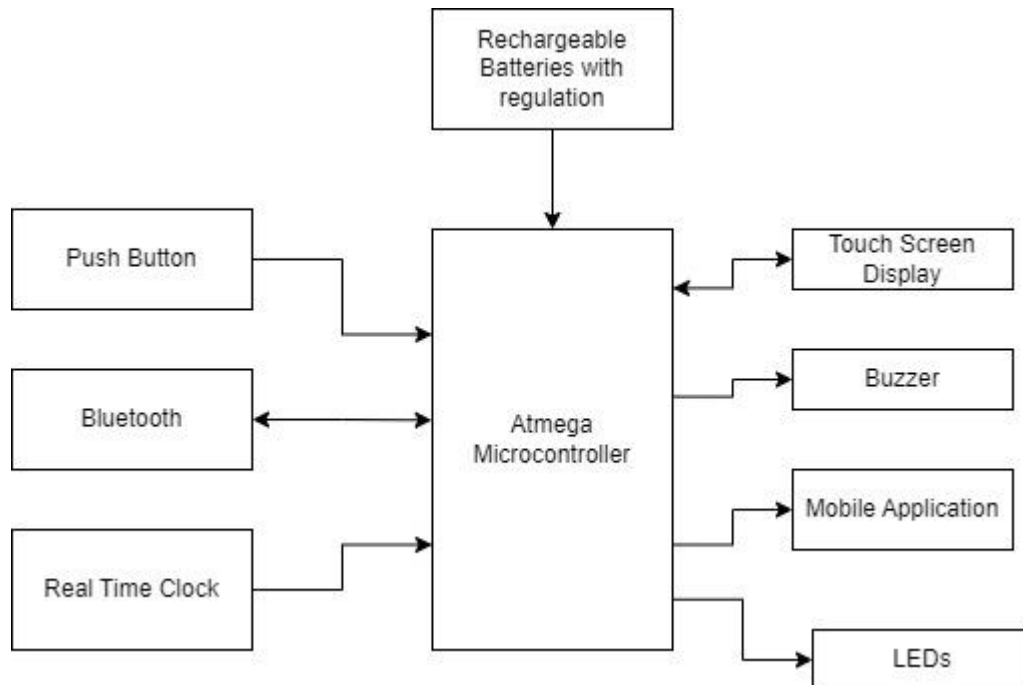
- Reduce the height and length by a little amount
- Use rechargeable batteries
- Use a touch screen display and minimize buttons
- Place LEDs in front of each compartments, which will help as a visual indicator

Here is a sketch drawn after listening to the suggestions

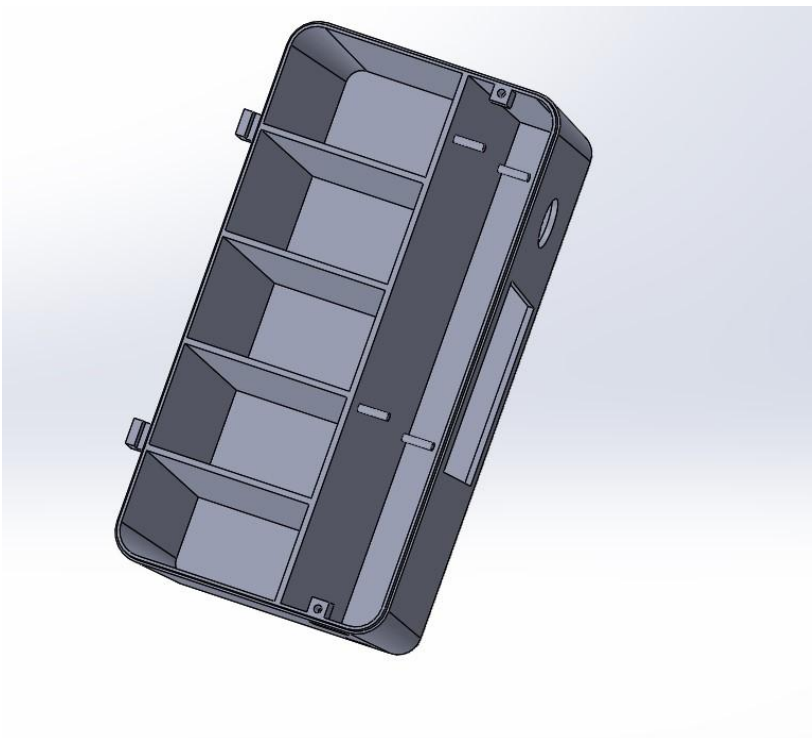
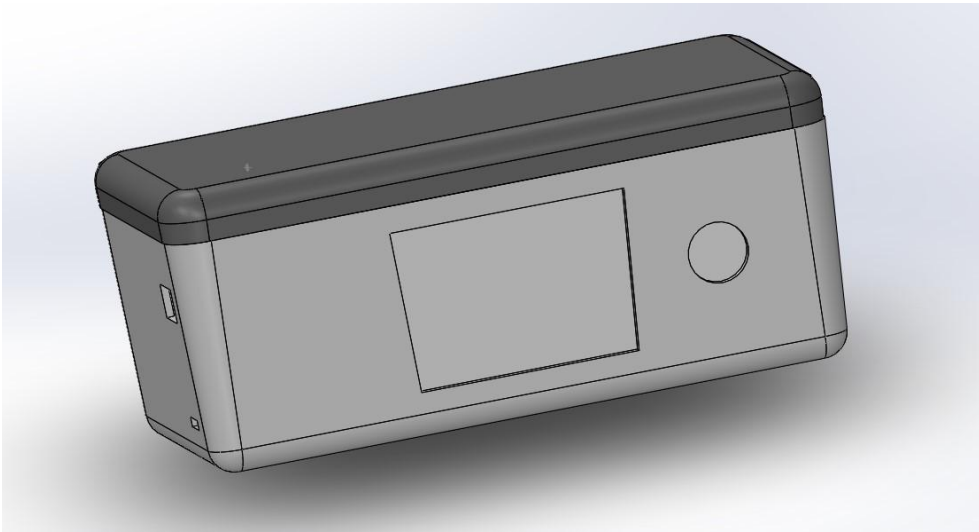


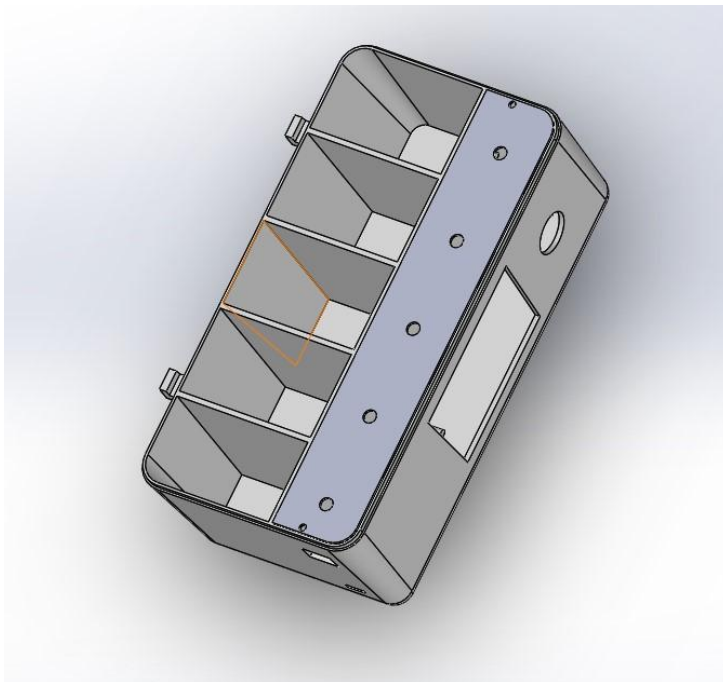
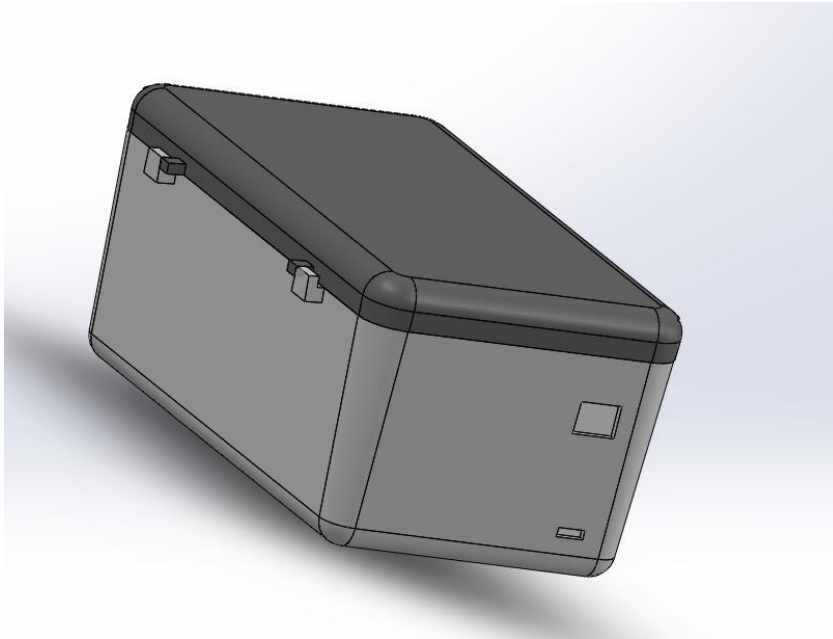
LEDs are placed in front of the compartments. A touch screen is used. Therefore only 1 button is present which is dedicated to stop the alarm while ringing.

Block Diagram of Improved Product



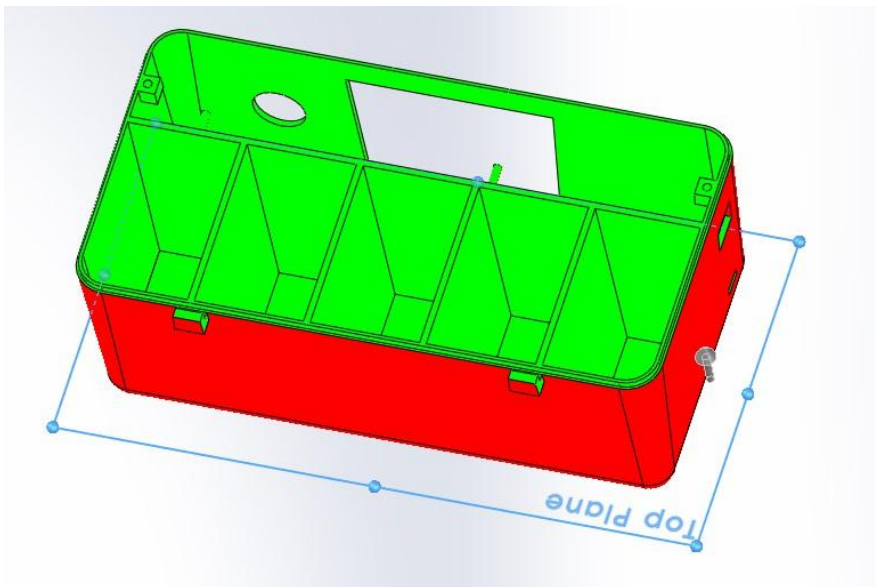
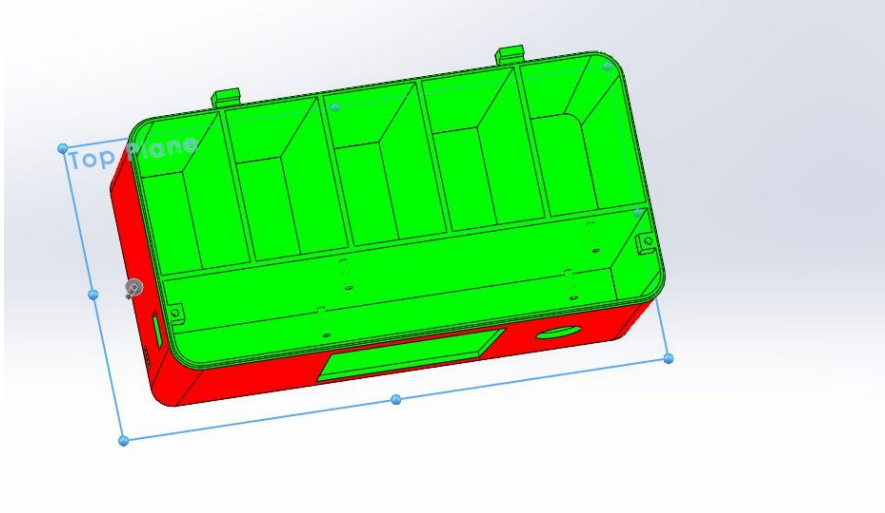
Solidworks Design of Improved Product





Draft Analysis of new Solidworks Design

Draft analysis is done for the new design



User Manual

- This is a “Smart Pill Box” designed to help people keep up with their medication schedules.
- There are 5 compartments named as “A”, “B”, “C”, “D”, “E”.
- Each compartment will hold a different type of medicine.
- Turn on the device by switching on the power button located at the side of the device
- Alarm will ring at the specified inputted times and the LCD will display the specific doses.
- The battery cover is located below the power switch. In case the battery needs to be changed, switch off the device, slide the lid up and replace the battery.
- Users are recommended to disable the LCD backlit when not in use to save power.
- Dimensions - 20cm x 9cm x 8cm

User Interface



The functions of the buttons are as follows:



Used to navigate the menu

- In Main Screen
 - Hour
 - Minute
 - Seconds
 - Day of Week
 - Day
 - Month
 - Year



Main Screen

- In Alarm Screen
 - Go to Alarm features
 - ON/OFF
 - Hour
 - Minute
 - Second
 - Doses
 - A
 - B
 - C
 - D
 - E



Alarm Screen



Alarm Features

+

- Increase the value (When navigating the menus)
- Enable Backlit of the LCD Display (At normal conditions)

=

- Decrease the value (When navigating the menus)
- Disable Backlit of the LCD Display (At normal conditions)

Alarm

- Navigate through Alarm Screen
 - Alarm 1
 - Alarm 2
 - Alarm 3
 - Main Screen
- Press it when alarm is ringing to stop it
- After taking medicine, press it to confirm medication intake

Testing for Functionality

- Power On Test
 - Verify that the display is active and showing relevant information when powered on.
- Alarm Test
 - Set up an alarm time and check if the alarm rings at the correct time.
- Dosage Display Test
 - Confirm that the device displays the correct number of pills to be taken for each type of medication.
- Button Functionality Test
 - Test all the buttons and ensure they are responsive and perform their designated functions properly.
- Confirmation Button Test
 - After taking medicine and pressing the “Alarm” button, check if it acknowledges the intake.
- Bluetooth Connectivity Test (For Bluetooth enabled devices only)
 - Ensure that the mobile phone can pair with the device and give inputs to change the alarms and times.