University of Moratuwa
Faculty of Engineering
Department of Electronic & Telecommunication Engineering

EN2160 - Electronic Design Realization

Individual Project

Project Report - Water Overflow And Rain Detector

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Index No: **200164H**

Abstract

This report focuses on developing a micro controller-based system for a water overflow and rain detector. This device detects the presence of water using a water sensor and buzzes to let the user know. This device can be put indoors or outdoors and can be controlled manually or automatically.

Introduction

In this project, we are initially tasked to choose any electronic product that is sold for less than $50 in the market, after which we are instructed to go through all design stages, identify any requirements that already exist, as well as any new features that should be added, in order to create a product that is both more affordable and user-friendly. As my project device, I selected a rain and water overflow detector that I spotted on the market for around $40. I developed the device and added some practical extra features to make it better using an Atmega 328p microcontroller.this report include the full design process of this device.

Contents

1 Problem Statements

The problem at hand is the potential risk of water overflow and the lack of an efficient rain monitoring system. Uncontrolled water overflow can lead to significant property damage, endangering lives and causing financial losses. There may be areas where water leakage is a possibility, but we are not always able to keep an eye on them ourselves. If a water leak occurs abruptly, the furniture will be destroyed, and there is a danger that mold and mildew could form because of the water collection, which poses a health risk.

Another problem that most people experience is a malfunctioning floating valve that is used to detect tank overflow. Water bills will likely go up dramatically as a result of this potential water waste.

The discomfort of having outside clothing and furniture become wet from rain is another frequent issue that many people encounter. Everything that is left outside, including our outdoor furniture and cushions and clothing, might get unexpectedly dampened by rain and can get damaged.

2 Design approach

2.1 Conceptual Design

2.1.1 Enclosure Design

The enclosures which are designed in the conceptual stage

1. Curved sides are used to provide comfort and simplify production stage, while a bump in front face to protects LCD display. Two bulbs and buzzer to power on and alert water detection.

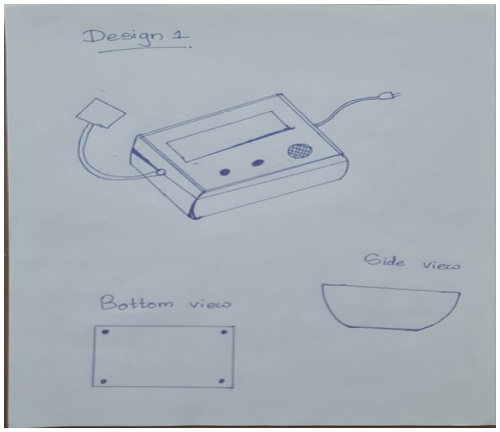


Figure 1: Design 1

2. In this design a box shaped enclosure is used by adding power switch and plug in the side and the display and indicating bulbs in the front and in additionally a holder is designed to place the water sensor such that it can hold to roof.

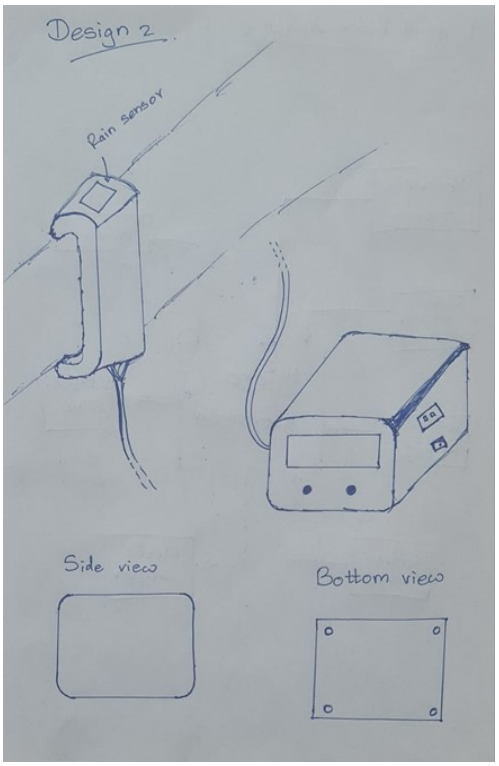


Figure 2: Design 2

3. The enclosure accommodates multiple water sensors, using an OLED display instead of an LCD, maximizing space and forming a box-like design.

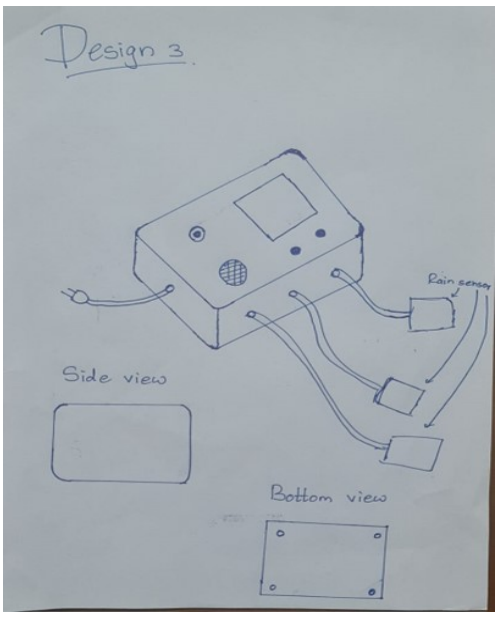


Figure 3: Design 3

4. This design is simplistic and has a user-friendly trapezoidal side perspective. I have utilized a buzzer, a switch to turn off the buzzer, and another light to show the power is on because users preferred a simple, easy-to-use device.

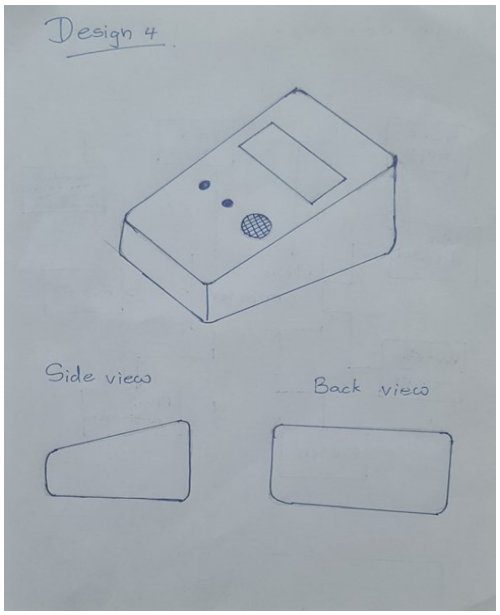


Figure 4: Design 4

2.1.2 Circuit Design

In this stage different types of functional blocks are considered with different functionalities

1. This block's design includes a water sensor and a PH level sensor so that it may also be used as a water purity measuring tool.A web app alerting system is also included.

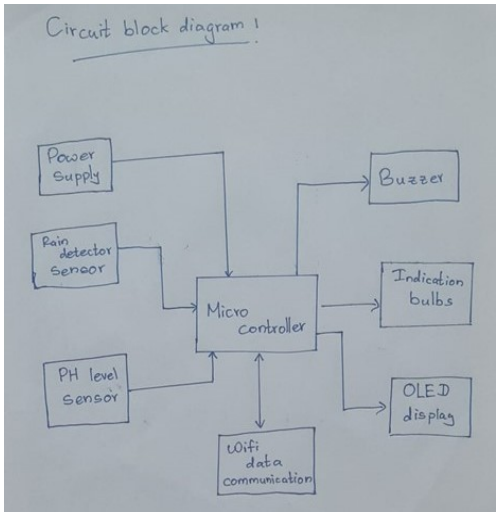


Figure 5: Design 1

2. In this block diagram, Water, temperature, and humidity sensors are included as extra features to forecast rain and warn the user with a buzzer.

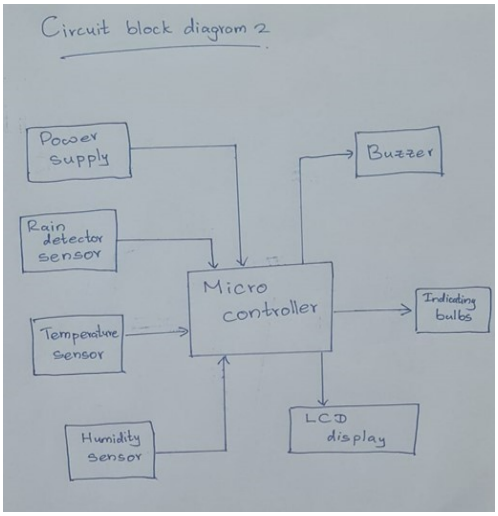


Figure 6: Design 2

3. A rain and humidity sensor are used in this block diagram to maintaining a database to track the rain fall and use that data to compute average rainfall and anticipate rainfall.

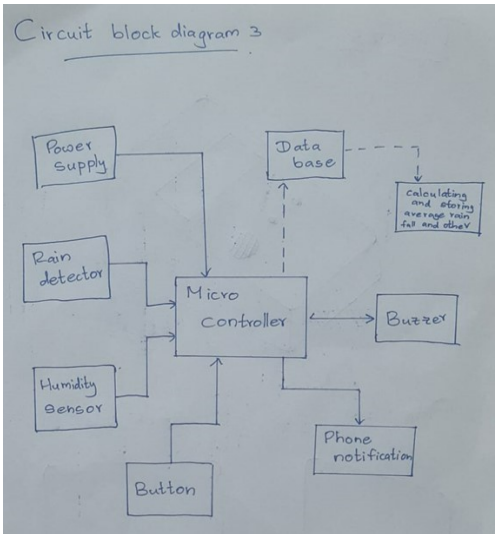


Figure 7: Design 3

4. A web app to update the data and stating that it is preferable to measure the temperature and humidity as well because this device may then be used in an agricultural area to monitor plants. Then a rotating wheel is used to adjust the modes that each sensor measures.

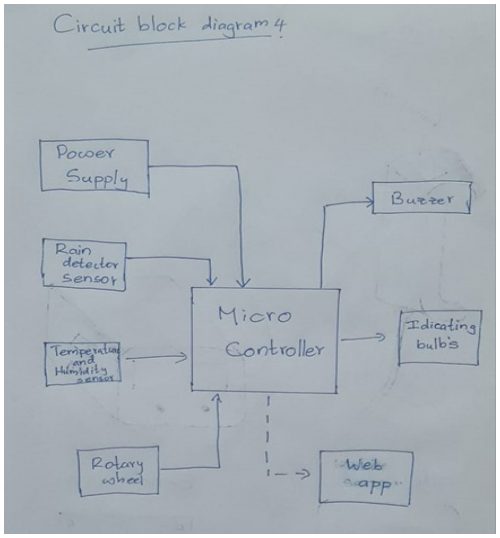


Figure 8: Design 4

2.1.3 Evaluation of the design

The enclosure design and the block diagrams are evaluated under certain criteria

	Design 1	Design 2	Design 3	Design 4
Appearance	4	5	3	5
User interaction	3	4	4	4
Simplicity	4	3	2	5
Size and dimensions	3	3	4	4
Portability	4	3	3	5
Cable management	4	4	3	4
Cost effectiveness	5	3	4	5
Modularity and expandability	3	3	5	3
Compatibility and safety standards	3	3	3	4
Total	**33**	**31**	**31**	**39**

Figure 9: Evaluation enclosure designs.

Circuit	diagram 1	diagram 2	diagram 3	diagram 4
Functionality	2	4	5	4
Power efficient	5	4	3	3
Modularity	3	4	4	4
Scalability	3	5	4	4
Testability and debugging	4	4	3	4
Cost effectiveness	5	4	3	3
Safety consideration	4	4	3	4
Components availability	4	4	3	4
Total	**30**	**33**	**31**	**30**

Figure 10: Evaluation circuit designs

According to the above tables **Enclosure design 4** and **functional block diagram 2** are selected.This pair is practical, affordable, and user-friendly.

2.2 User Centered Design

After talking with the users and asking about there view of the product. I saw that the estimated price was little bit high for the users and they don't need unnecessary additional features which is not frequently used and features which can be done by them self. In order to cut down on manufacturing costs for enclosures, I've decided to use a pre-made box that is already largely affordable and widely available on the market and modify it to meet our needs. After removing the unnecessary features from the block diagram I gave it to a work shop to cut out the spaces in the box for the LCD screen, the LEDs, and the switch.

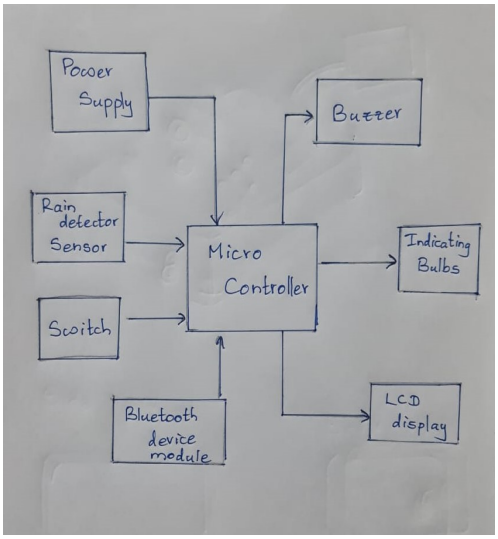


Figure 11: User Centered Design

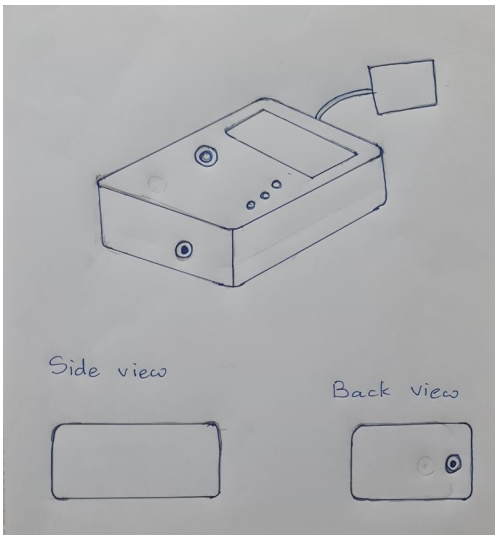


Figure 12: User Centered Design

3 Prototype Design

Making the schematics and choosing the necessary components were the following steps in the design process.

3.1 Main components

- **Microcontroller- ATMega328P**
  A microcontroller is needed to process the input data and to generate required output signals in the product. So I chose ATMega 328P chip which is widely available in the market.This chip has a good selection of libraries and is simple to use. Operating voltage between 1.8-5.5V.

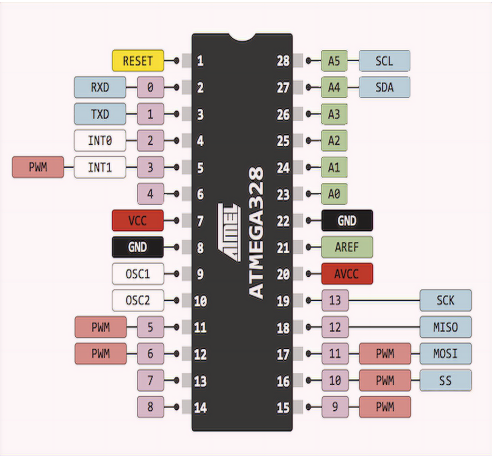


Figure 13: ATMega328P pinout

- **Display- LCD display 16x2**
  The device's LCD display was chosen for its simplicity, affordability, and accessibility, as it displayed only the detected water amount without complex graphics.Operatin voltage is 4.7V-5.3V. It includes two rows where each row can produce 16-characters.

Figure 14: LCD display 16x2

- **Water Sensor YL-83 FC-37**
  To detect the presence of water I used a water sensor.It detects the presence of water by the variation of sensor conductivity when it comes into contact with it.Operating voltage is 3.3V -5 V. Sensitivity can be adjusted by a potentiometer.

Figure 15: Water Sensor

- **Bluetooth Module HC-05**
  To control the device through phone a Bluetooth device is needed. Operating voltage is 5V.It uses Serial communication method.

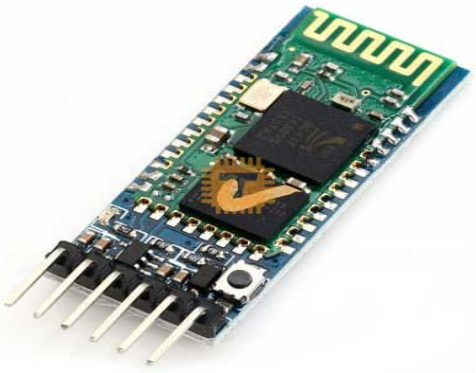


Figure 16: Bluetooth Module HC-05

- **Buzzer**
  To alert the user a buzzer is used.Operating voltage is 5V and at 10cm level sound output is 85dB.

Figure 17: Buzzer

3.2 Power Utilization

First I decided to make it battery powered but find out that the maximum time it can operate is not sufficient for the product.So then decided to make it pluggable.
All the components in the circuit including the micro controller needs 5V to operate correctly.For that I needed an adapter which can convert 230V/50Hz AC voltage to 5V DC voltage.So I chose 5V 2A SMPS Power Adapter which satisfy our given requirements.

Figure 18: 5V 2A SMPS Power Adapter

Adapter Specifications

- Input Voltage rating - 230V/50Hz
- Output Voltage rating - 5V
- Output Current rating - 2A

3.3 Circuit Design

- First the requirements and the components needed for building the basic micro controller were identified from the data sheets and from other documents.

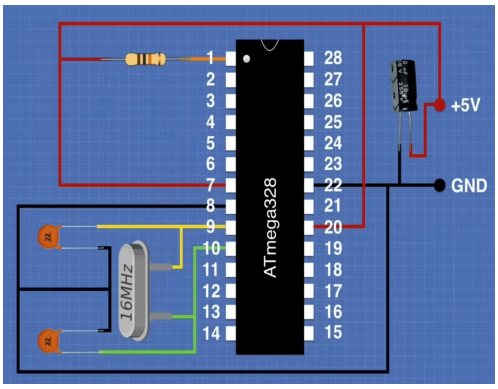


Figure 19: Building the microcontroller

- After identifying the basic functionalities from the block diagram, the code was created in the Arduino IDE by going through the micro controller's data sheets, and it was then uploaded to the micro controller using an Arduino.

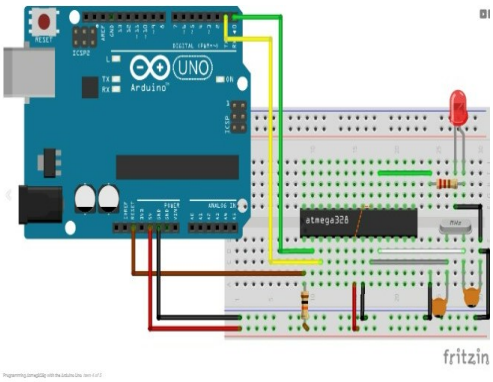


Figure 20: Programming the Micrcontroller

- After examining the code's designated pins, the necessary parts, such as sensors and output devices, were then connected to the microcontroller to complete the schematic of the product.

3.4 Simulations

I used **Proteus Design Suite 8.9** to simulate the circuit before designing the PCB in order to test it. However, the Atmega chip wasn't available in Proteus, so I used an Arduino instead.

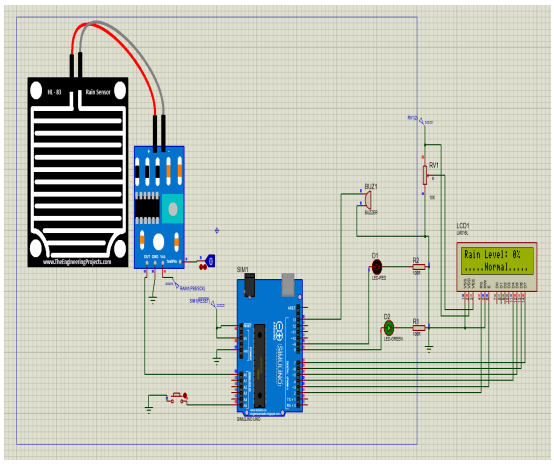


Figure 21: Simulations without water

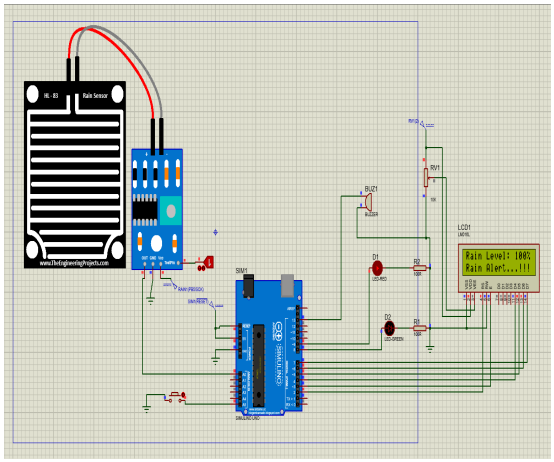


Figure 22: Simulations with water

3.5 Initial Testing

After the circuit simulation, I implemented the circuit on the breadboard and tested it.

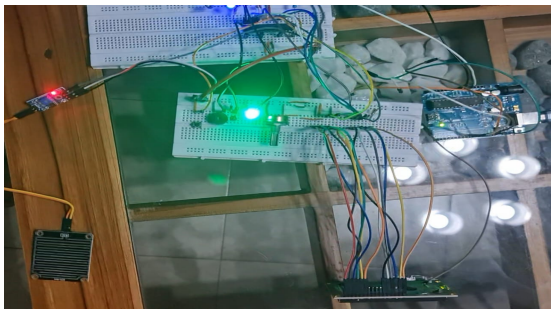


Figure 23: Testing

3.6 Schematic and layout Design

Attached to the appendices.
schematics and layout were drawn using **Altium Designer 23.3.1**
The components which have connection with the outside are placed near the outer edges of the PCB and the trace routes are routed such that to minimise noise.

3.7 PCB Designing and Soldering

- A two layer PCB was designed to make routing easy and to place the components in the required positions.
- A ground polygon pour was applied to the top layer, and a VCC polygon pour was applied to the bottom layer.
- for the signal lines a trace width of 0.3mm and for the power lines a trace width of 0.4mm is used.
- obtuse angles are taken for the vertices to reduce noise.
- JST connectors are used for the connections to minimise the noise.

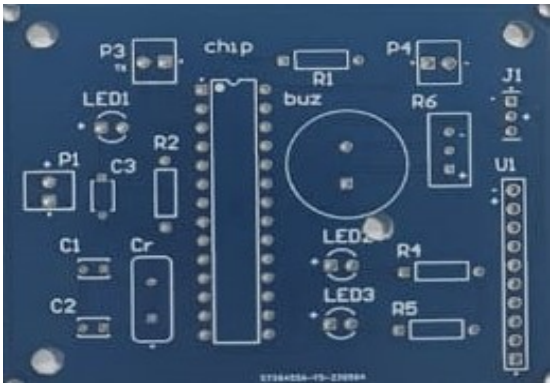


Figure 24: PCB front

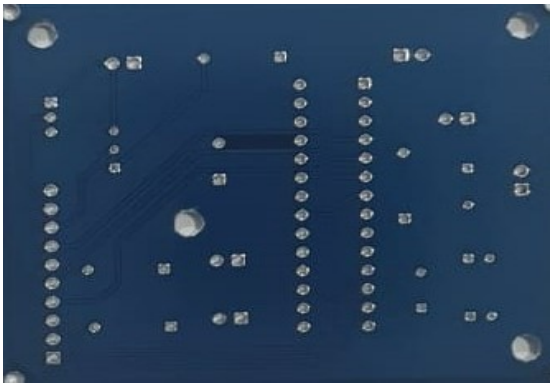


Figure 25: PCB back

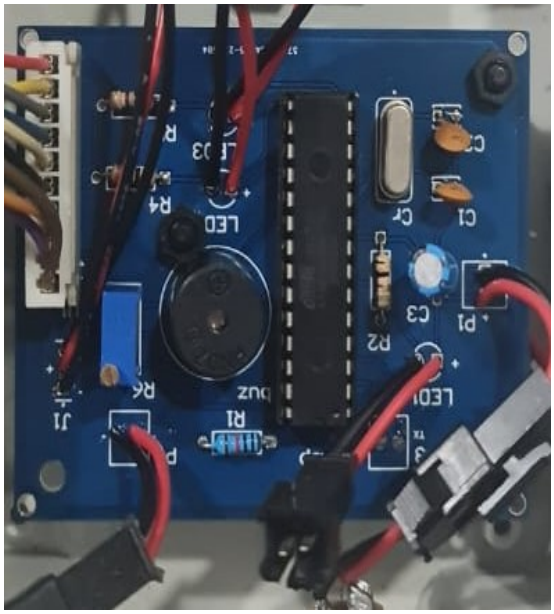


Figure 26: PCB after soldering

Finally, the PCB was tested according to the instructions provided in the PCB testing stage, confirming the proper operation of the features, and then holes were drilled into the PCB for attachment to the enclosure.

3.8 Enclosure Design

Enclosure was designed using **Solidworks 2021**, It was designed to get a better idea about dimensions and the placement of components such as LCD and LEDs.

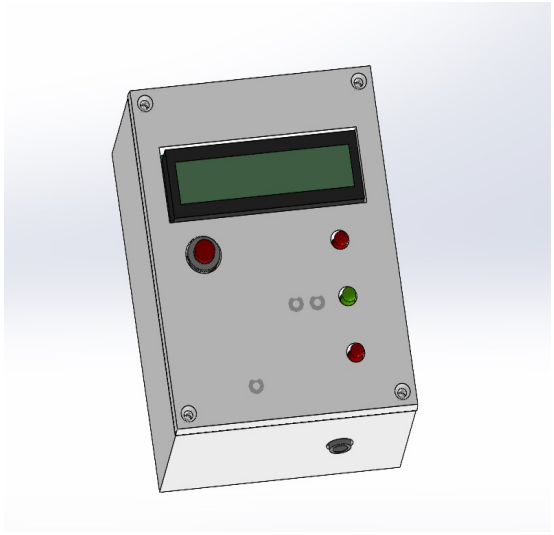


Figure 27: Enclosure Design

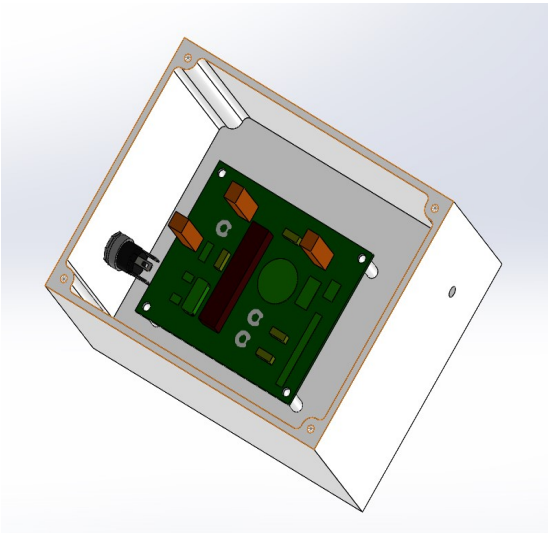


Figure 28: Enclosure inside

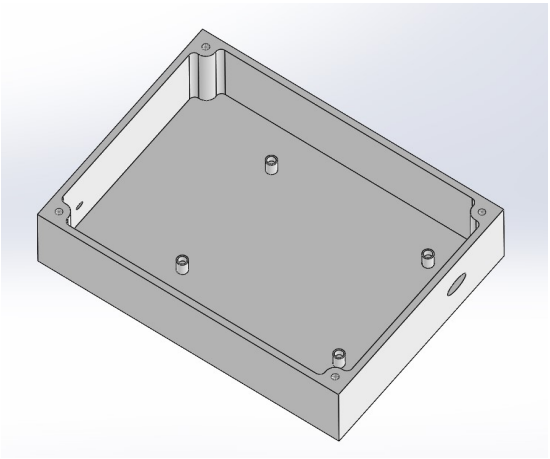


Figure 29: Enclosure bottom part

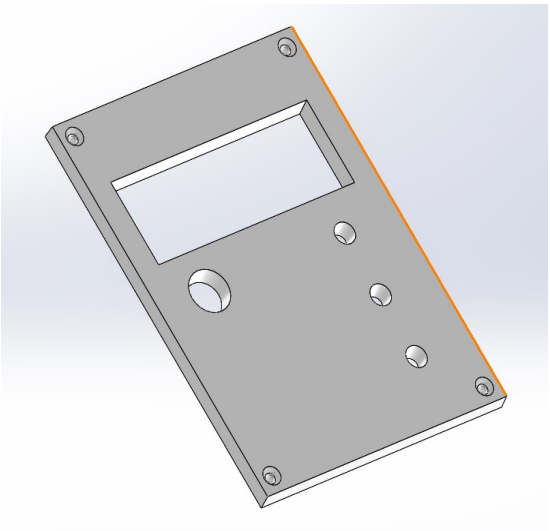


Figure 30: Enclosure top part

4 Product Specification

- **Product :**Water Overflow and Rain Detector
- **Small Description :** This device detects the presence of water using a water sensor and buzzes to let the user know.
- **Size :** 12cm × 9cm × 5cm
- **Weight :** about 150g
- **Power Source :** 230V / 50Hz power supply
- **Sound level of buzzer:** 85dB
- **Material :** Plastic
- **Operating modes :**
  1. Manual control mode
  2. App control mode
- **Additional features :**
  - A display is used to indicate the amount of water detected
  - The device can be controlled manually or using the app.
- **The full product will contain :**
  - A flexible device
  - A user-friendly UI
  - A display to indicate water level details.
  - A mobile app

5 PCB Testing

1. First connect the adapter to the power supply and check whether the light bulb of the adapter is glowing. If so the adapter is working properly.
2. Then connect the adapter to the PCB and check whether the power ON LED is glowing if so the power supply is working properly, if not there is a problem in the power supply.Check the connectivity of the power supply
3. Connect the water sensor to the micro controller using the correct pins. If connected correctly, a red LED should light up. Sprinkle water on sensor and check second red LED for proper functioning; if not, sensor is not working properly.
4. If the sensor is functioning properly but buzzer and LEDs are not reacting, either the buzzer or LEDs are malfunctioning or the microcontroller is not functioning properly.
5. Connect the LCD display to the PCB. If the screen glows, the LCD display is operating properly; otherwise, it is not. When the LCD is connected and flashing, but you still can't see any letters, turn the PCB's potentiometer until you can.

6 Assembly Instructions

1. Disconnect the device from the power source before removing the screws that are fastened to the enclosure's four edges in order to open it.
2. Two screws are used to secure the device's main PCB to the enclosure, and JST connections are employed to join the PCB to other parts. To remove the PCB from the enclosure, unscrew them and disconnect the JST connections.
3. The circuit related to the water sensor is connected to the enclosure using a screw. By unscrewing it the water sensor can be removed from the device.
4. Screws are used to attach the LCD display and switch to the front surface, and JST connectors are employed for connections.To remove them, unscrew and disconnect them. The LEDs can be removed by simply pulling them out from the surface and disconnecting the JST connections since they are directly connected.
5. The power jack can be removed by disconnecting the JST connection and pulling it from the surface of the enclosure

7 Bill of Materials

7.0.1 PCB components

PCB Components					
Component Name	supplier	Quantity	Price per component (Rs)	price (Rs)	link
Atmega328-Pu	LCSC	1	1770.81	1770.81	link
Crystal oscillator	LCSC	1	169.44	169.44	link
10uF capacitor	LCSC	1	126.25	126.25	link
22pF capacitor	LCSC	2	3.16	6.32	link
10k ohm resistor	LCSC	2	2.92	5.84	link
100 ohm resistor	LCSC	2	2.5	5	link
Push button	TRONIC	1	150	150	link
Buzzer	LCSC	1	60	60	link
Variable resistor	LCSC	1	48.81	48.81	link
Water sensor	TRONIC	1	280	280	link

7.0.2 PCB Manufacturing

PCB Manufacturing			
	supplier	link	Price(Rs)
For PCB Manufacturing	JLCPCB	link	300
Shipping cost			2159.52

7.0.3 Enclosure Manufacturing

Enclosure Manufacturing		
	supplier	Price(Rs)
For PCB Manufacturing	Nadee Electronics	700
Modifying costs		500

Total cost for the product : Rs 6,281.99

8 Suppliers

The majority of the components were acquired from JLPCB, a reputable distributor of electronic components, while the enclosure was acquired from an electrical retailer. This enclosure was selected as a result of its widespread availability in numerous stores.

9 Future Improvements

A SMS alert system can be used to alert the user for a potential risk of water overflowing.
A moisture sensor can be included to the device and this device can be used as a plant monitoring system for agricultural purposes.

10 Acknowledgement

I would like to express my sincere gratitude to everyone who contributed to the successful completion of this project. Their unwavering support, guidance, and encouragement were instrumental in making this project a reality.First and foremost, I extend my heartfelt thanks to our dear lecturer, whose invaluable insights and expertise guided us throughout the project journey. Their constructive feedback and continuous encouragement helped us stay on track and deliver our best.In addition, I want to express my gratitude to everyone who helped us reach our goal in whatever way.

11 Bibliography

- Atmega328p Datasheet
- Bluetooth Module HC-05
- Water sensor module
- LCD display 16*2
- LCD display 16*2
- Altium tutorial
- Solidwork tutorial
- Proteus tutorial
- Rain sensor modules
- Similar Water detector
- Similar Water detector product
- water detector implementation

12 Appendices

12.1 User manual

1. First connect the adapter to the main power supply of 230V/50Hz and then connect the other end of the supply to the power jack of the product.
2. If the power is correctly given to the device the power LED should light up.
3. then connect the sensor in the necessary place that you need to detect the water prescense.
4. If there is no water detected by the sensor the Green LED should light up.
5. Whenever the sensor detect the prescense of water it will turn on the buzzer and the RED LED of the device will turn ON.
6. To turn off the buzzer you can simply press the switch or you can use the app to turn off it.
7. To control the device wireless, first you need to download the **Arduino Bluetooth Controller** app to your smart phone or device which has a Bluetooth connectivity.
8. Then select the device in the nearby Bluetooth devices and use the app to control the device wireless.

12.2 Safety measures

- Read the user manual before operating the device
- Always unplug the device when not in use.
- Turn off the power and unplug devices before attempting any electrical repairs.
- Do not place the sensor in a place where it can get scratched.
- Use an adapter with the given power specifications.
- Keep the main device away from water sources to prevent electrical hazards.
- Use insulated tools and avoid touching live electrical components.
- Do not drop the Device

12.3 Schematic Designs

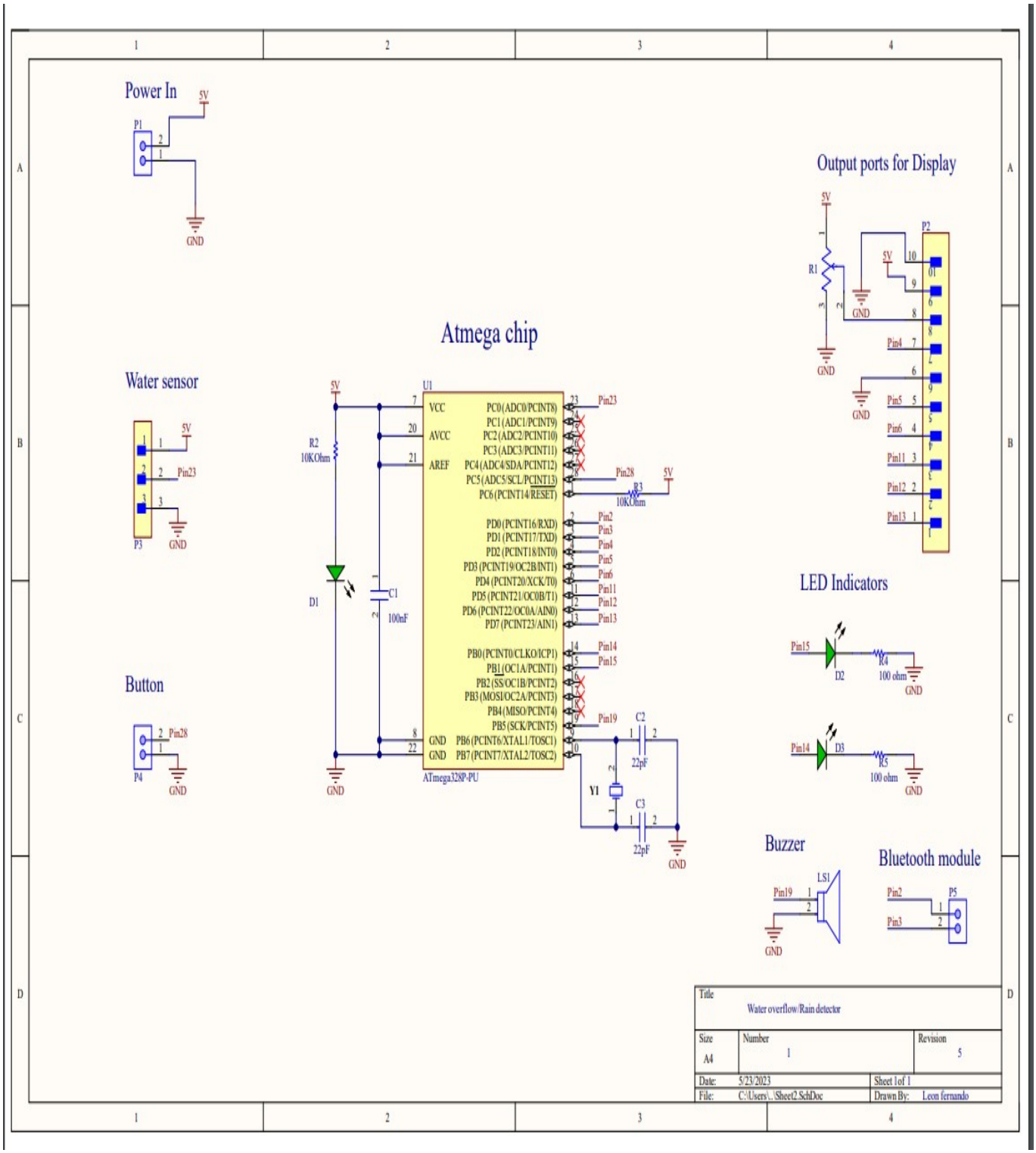


Figure 31: Main schematic

12.4 PCB Layout

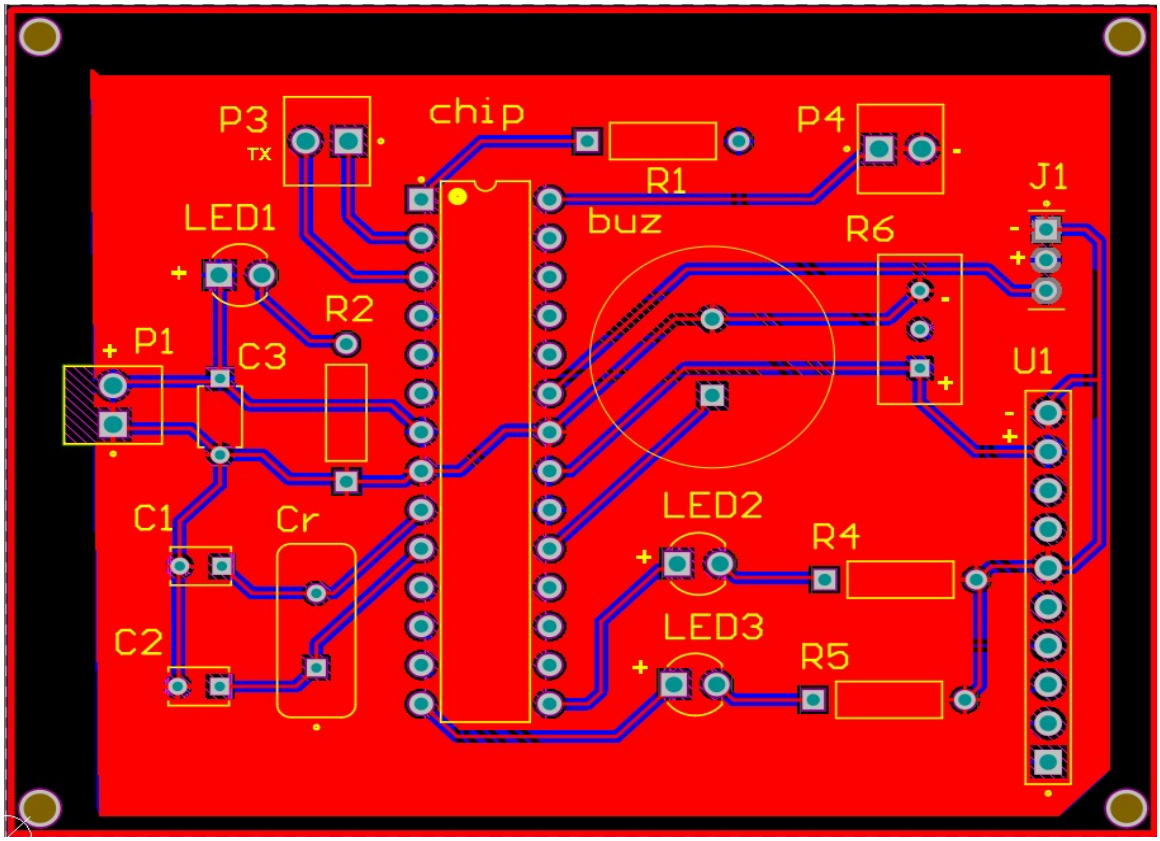


Figure 32: Layout Top layer

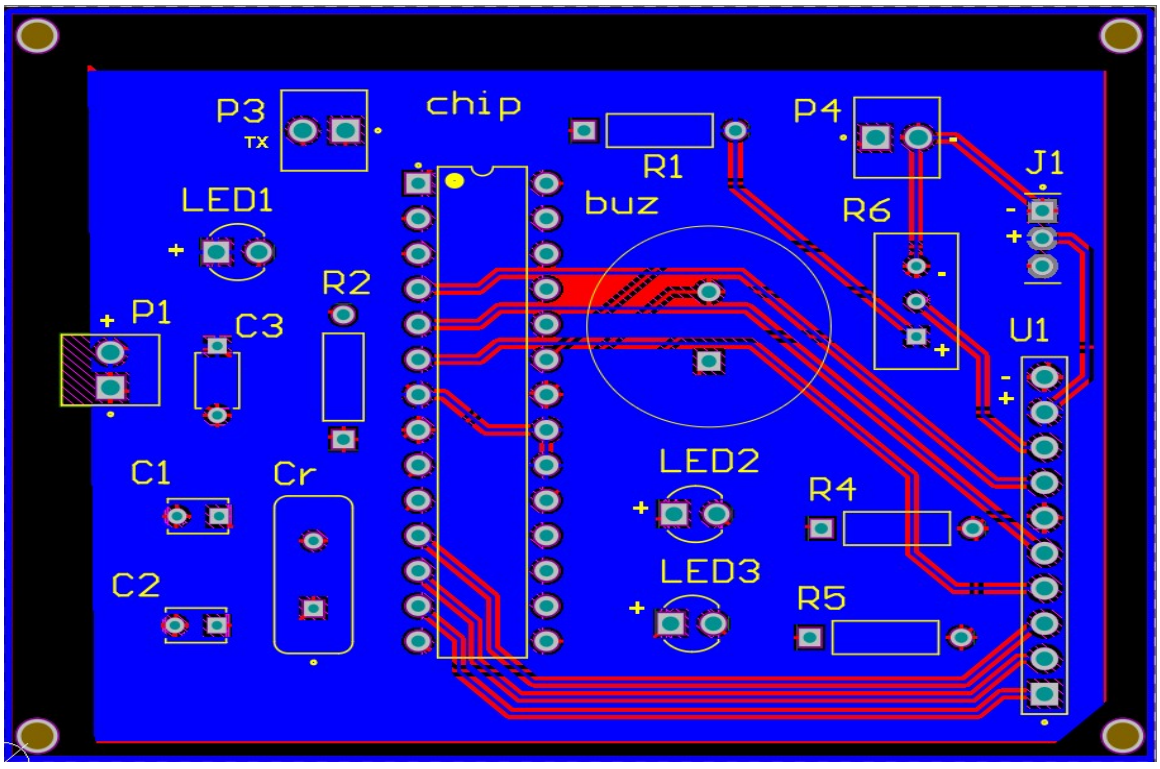


Figure 33: Layout Bottom layer

12.5 3D view of PCB

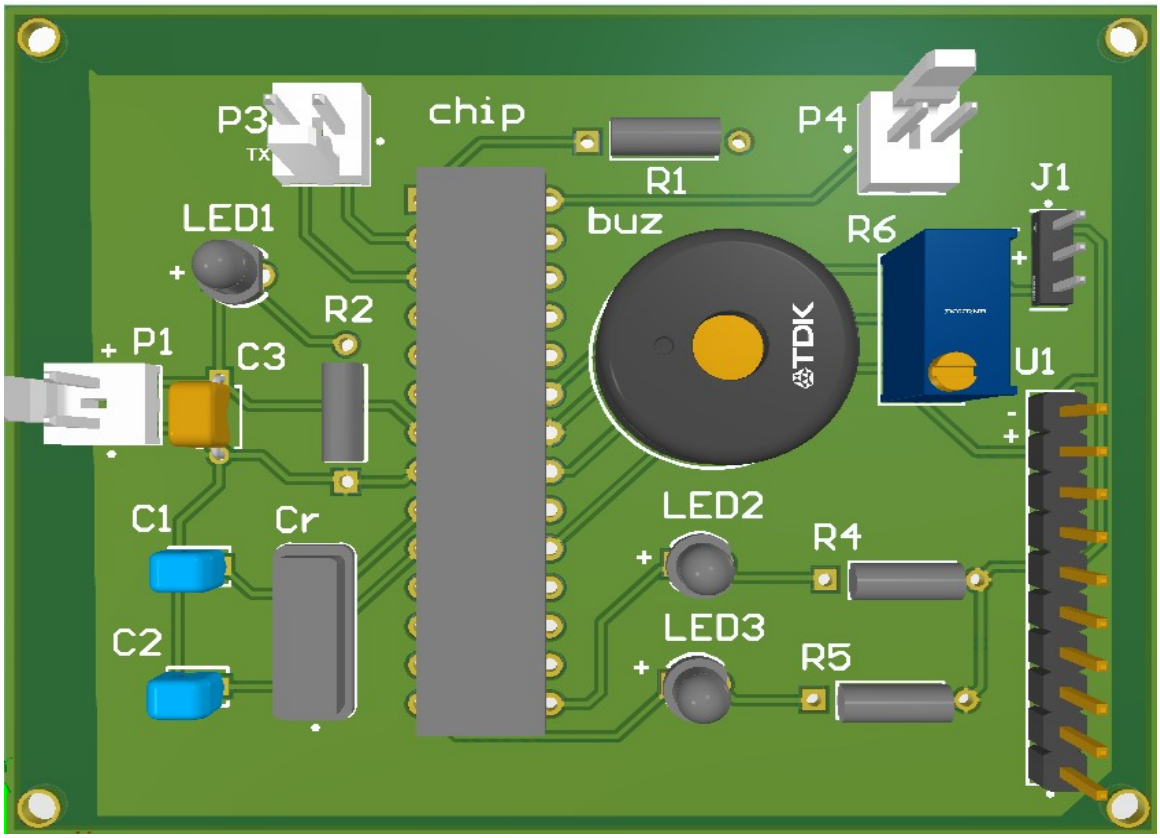


Figure 34: 3D Top layer

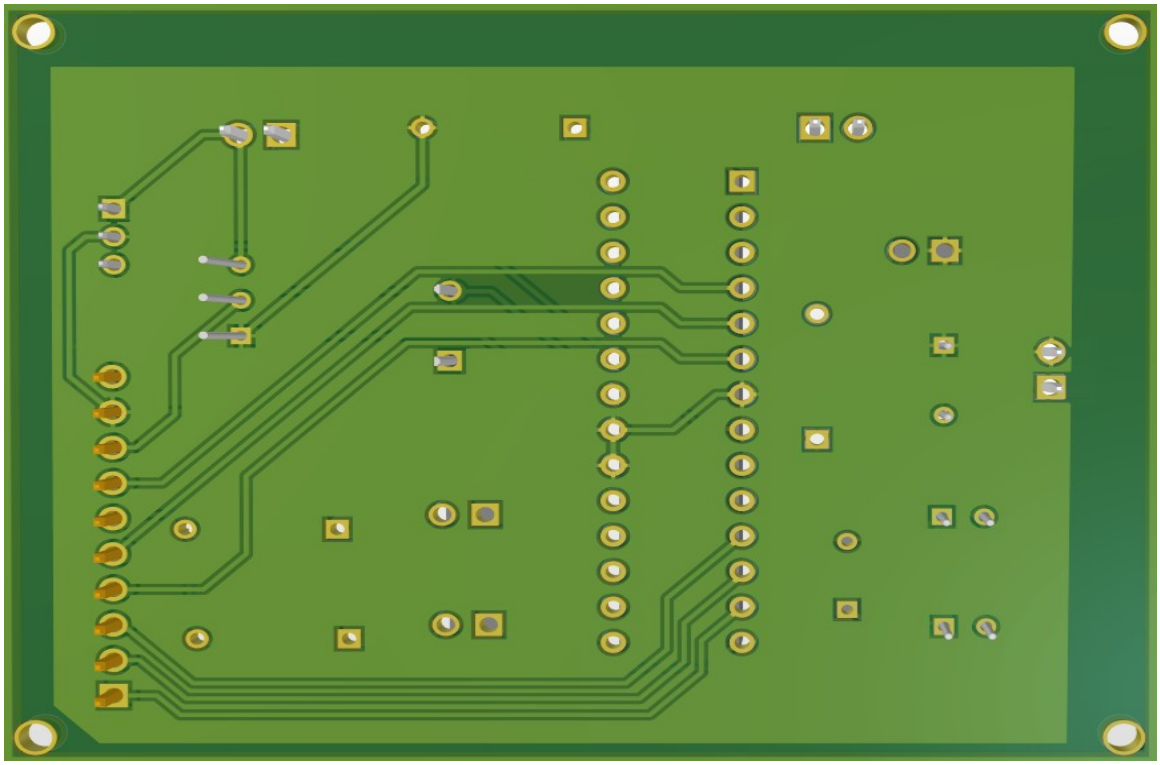


Figure 35: 3D Bottom layer

12.6 Gerber files

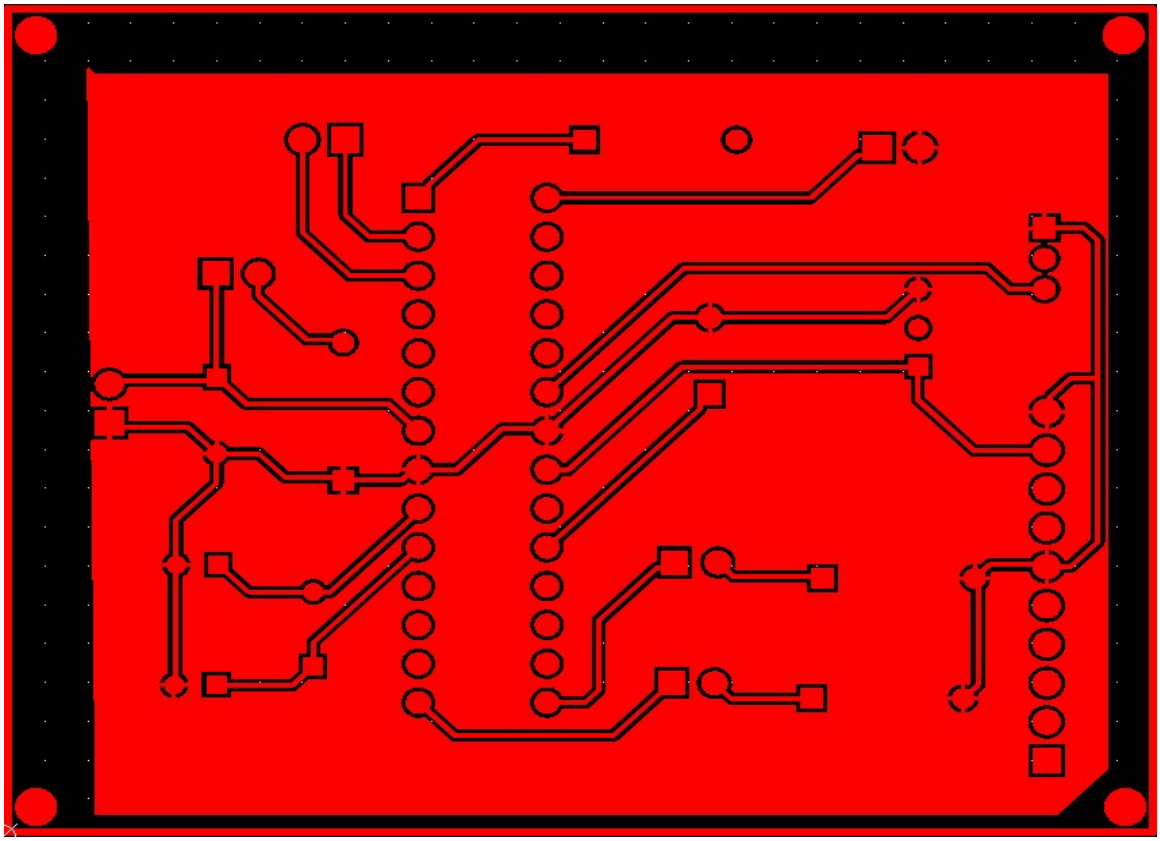


Figure 36: Gerber view Top layer

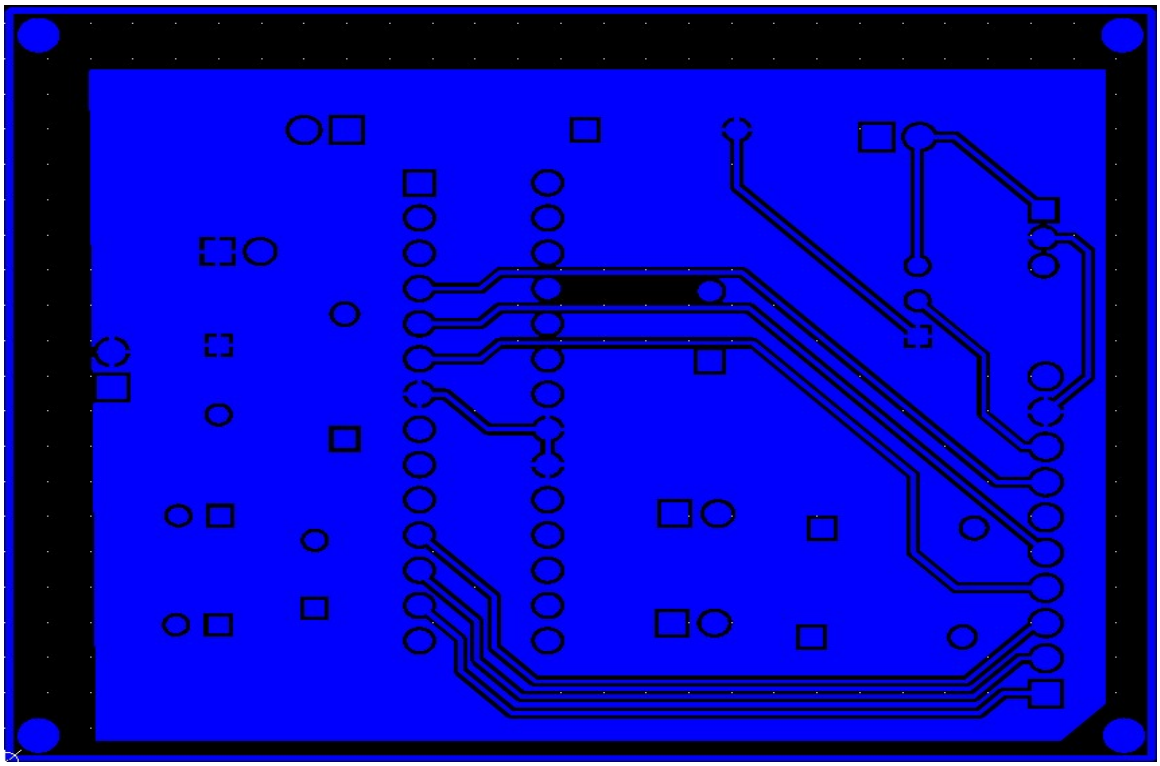


Figure 37: Gerber view Bottom layer

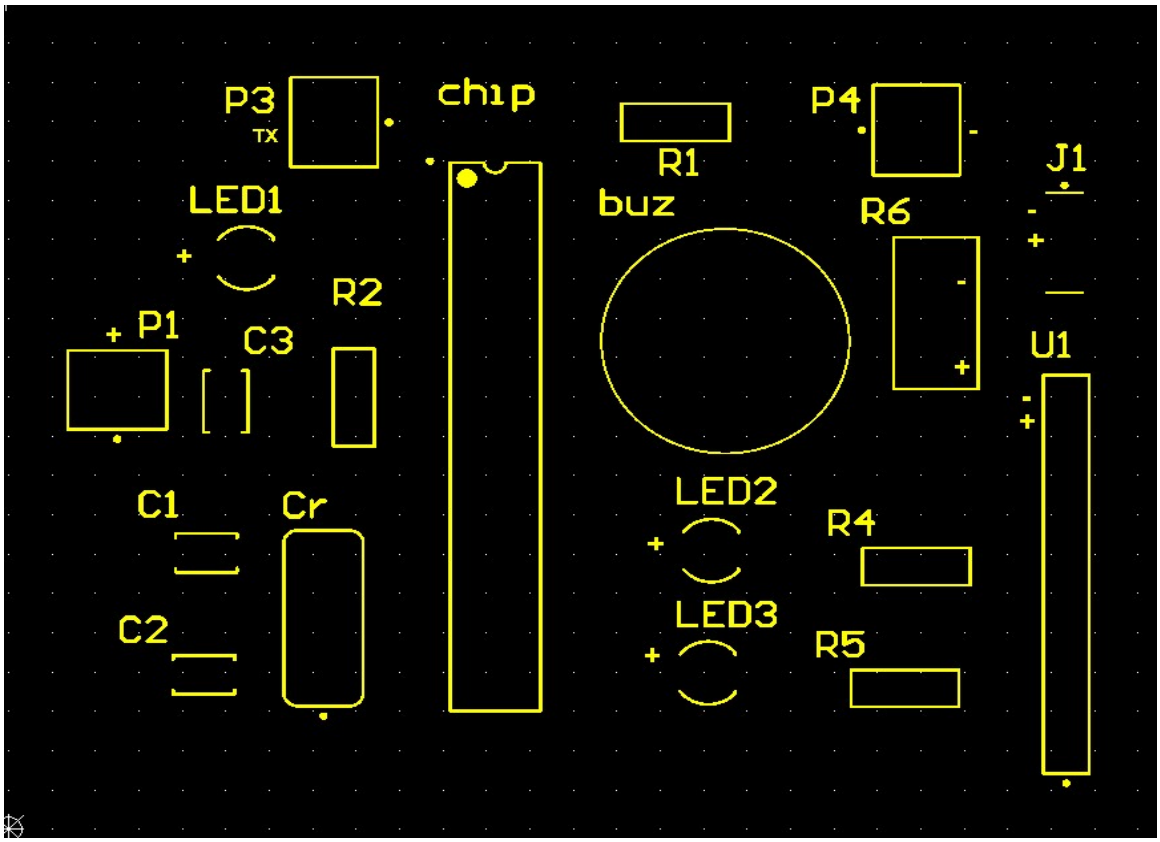


Figure 38: Placement of components

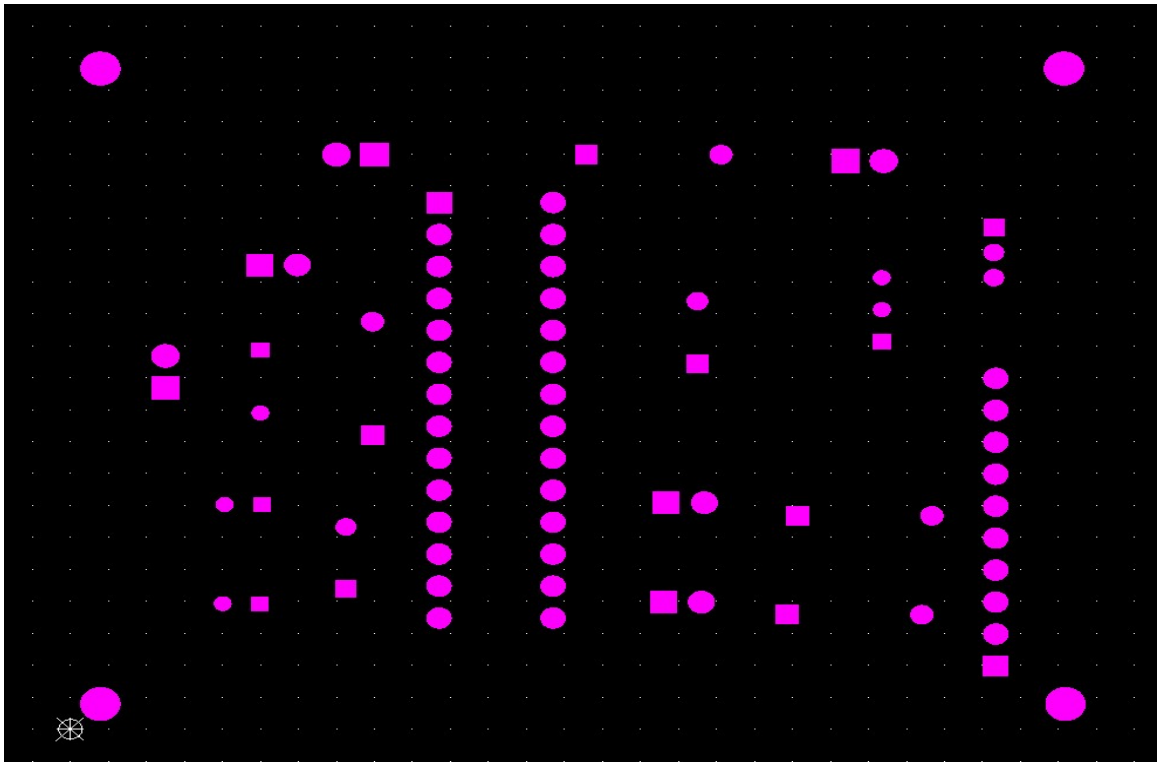


Figure 39: Drill holes

12.7 Enclosure design

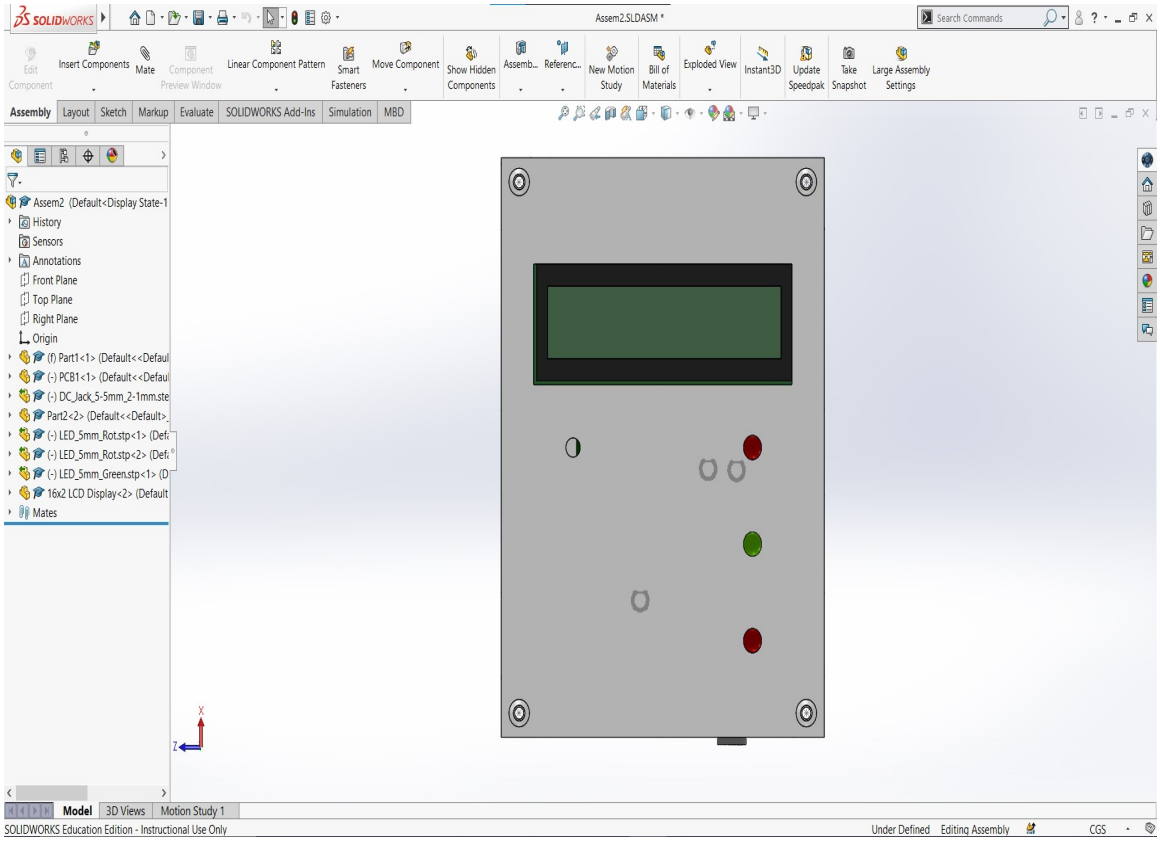


Figure 40: Front view

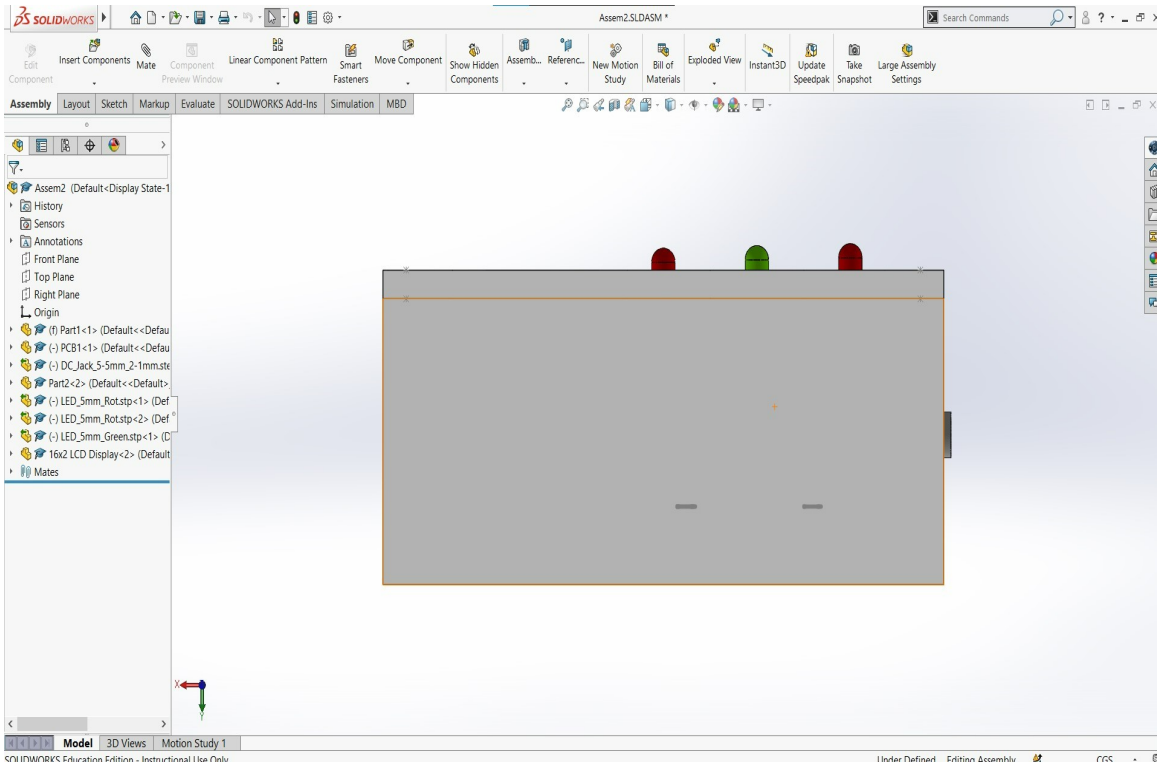


Figure 41: Side view

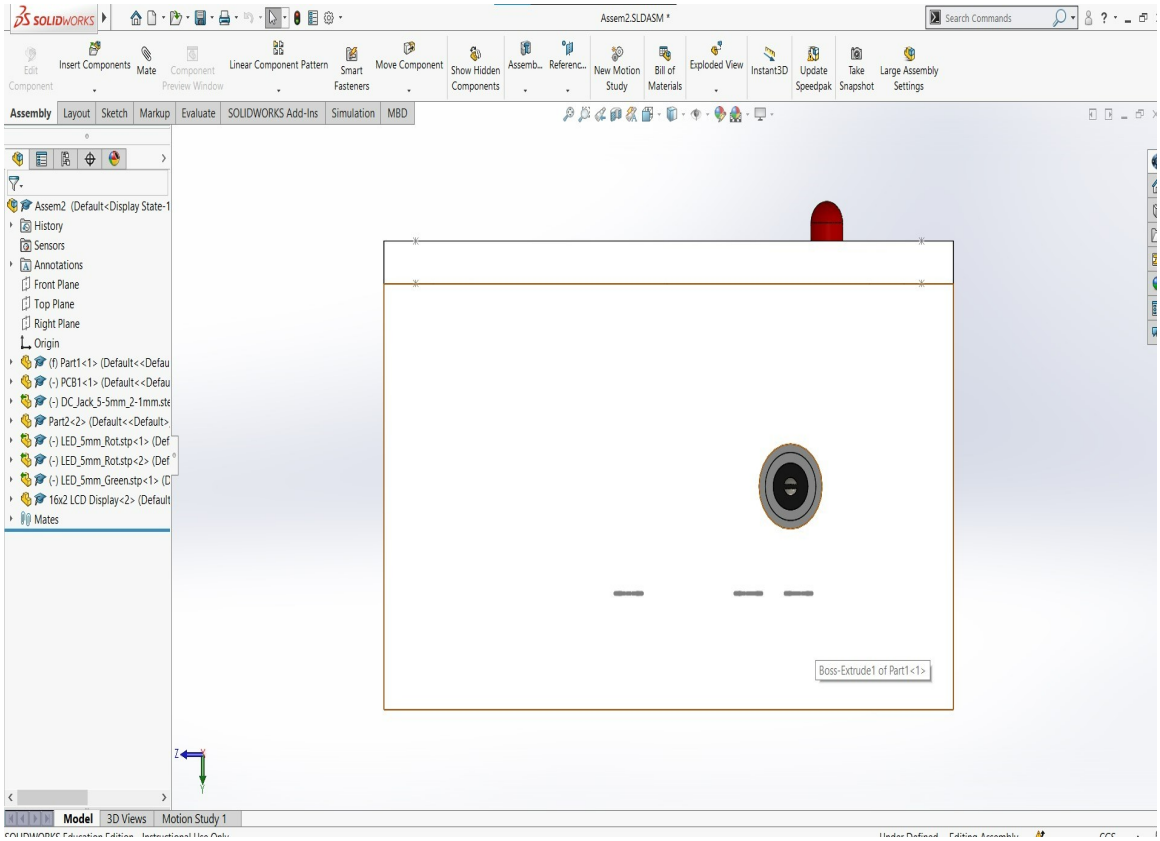


Figure 42: Back view

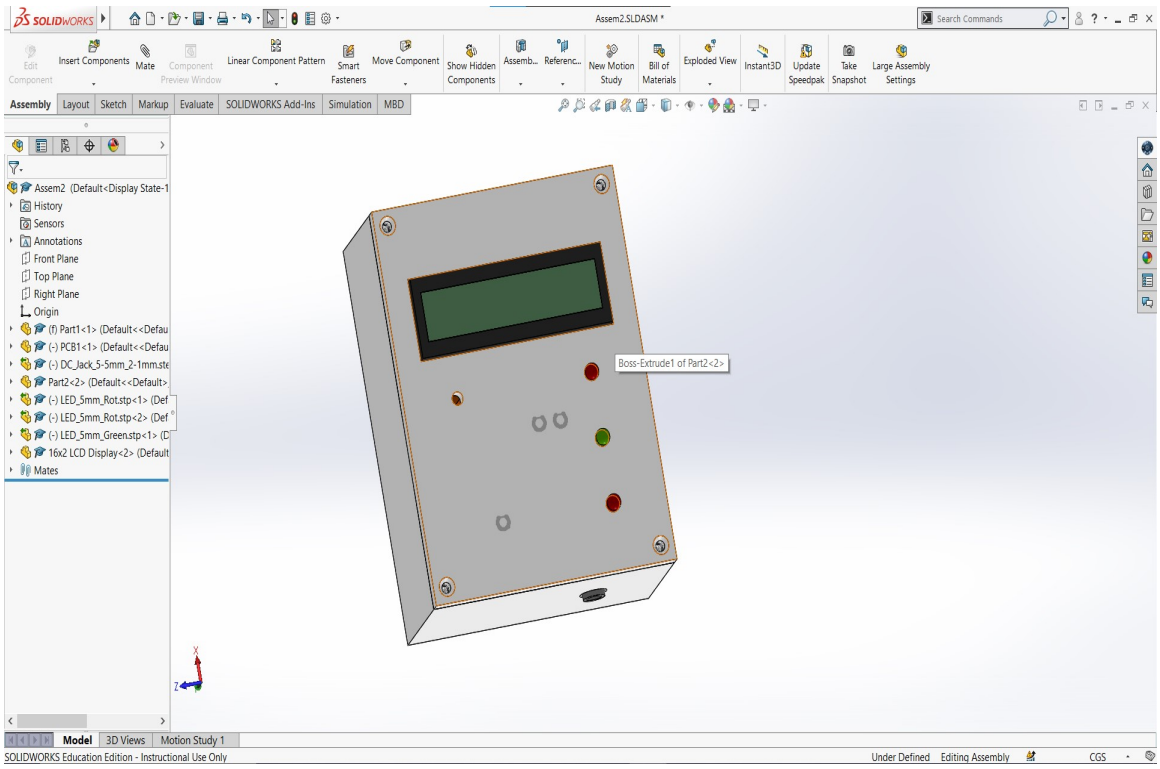
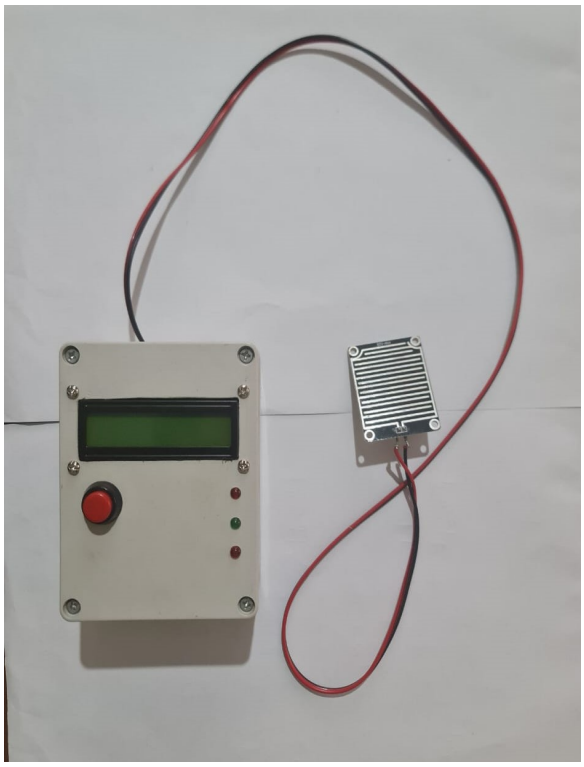


Figure 43: Overall design

12.8 Final product



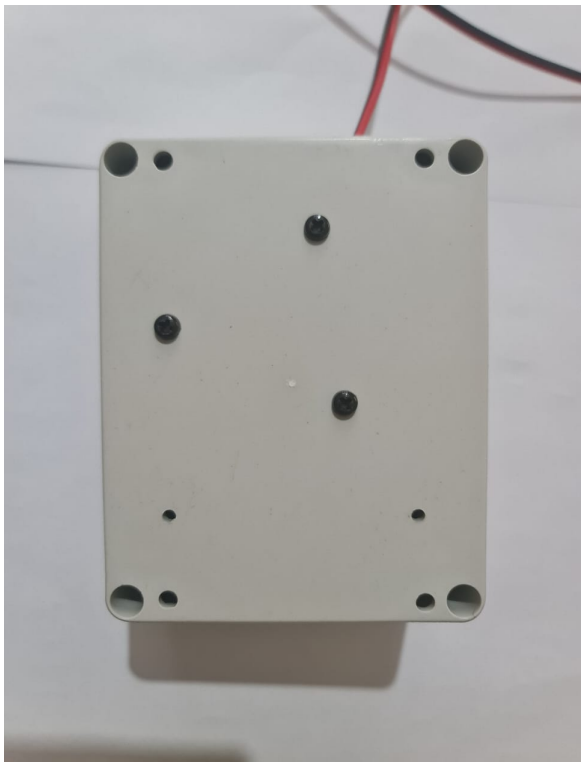


Figure 45: when No water/rain detected

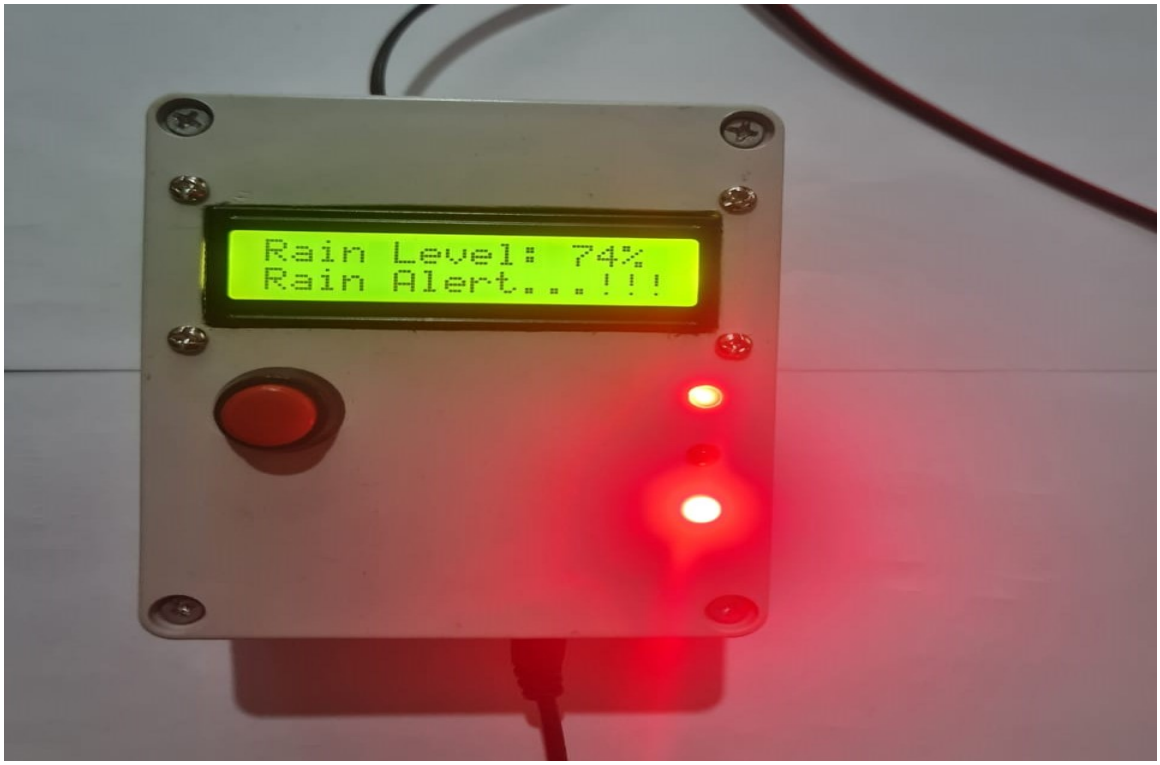
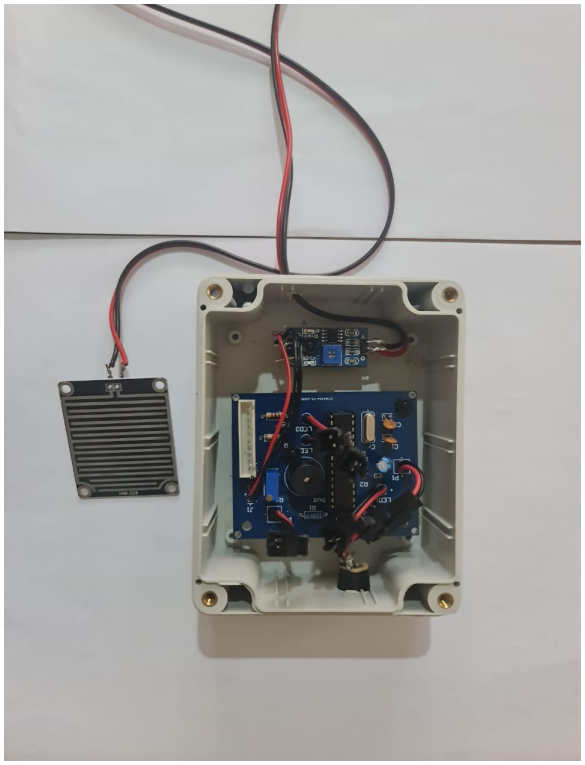


Figure 46: When water/rain detected



12.9 Device's Code

```
#include <LiquidCrystal.h> //Libraries
LiquidCrystal lcd(2, 3, 4, 5, 6, 7); //Arduino pins to lcd

int data;
#define sensor_pin A0
int adc_value;
int percent_value;

#define bt_silent  A5
int silent=0;

#define G_led 8
#define R_led 9

#define buzzer 13

void setup() { // put your setup code here, to run once
pinMode(sensor_pin, INPUT);
Serial.begin(9600);
pinMode(bt_silent, INPUT_PULLUP);

pinMode(R_led,OUTPUT); // declare Red LED as output
pinMode(G_led,OUTPUT); // declare Green LED as output
pinMode(buzzer,OUTPUT); // declare Buzzer as output

lcd.begin(16, 2); // Configura lcd numero columnas y filas
lcd.clear();
lcd.setCursor (0,0);
lcd.print("   Welcome To   ");
lcd.setCursor (0,1);
lcd.print(" Rain  Detector ");
delay(2000);
lcd.clear();
}

void loop() {
if(Serial.available()>0){
  data=Serial.read();
  Serial.println(data);
  }
adc_value= analogRead(sensor_pin);
Serial.print(adc_value);
percent_value = map(adc_value,0,1023,100,0);
Serial.print(" ");
Serial.println(percent_value);
if((digitalRead (bt_silent) == 0)|data==72){
silent = 1;
delay(100);
}

lcd.setCursor(0, 0);
lcd.print("Rain Level: ");
lcd.print(percent_value);
lcd.print("%  ");

lcd.setCursor(0, 1);
if(percent_value>30){
if(silent==0){digitalWrite(buzzer, HIGH);}
lcd.print("Rain Alert...!!!");
digitalWrite(G_led, LOW); // Turn LED off.
digitalWrite(R_led, HIGH);  // Turn LED on.
delay(300);
}else{ silent=0;
lcd.print(".....Normal.....");
digitalWrite(G_led, HIGH); // Turn LED on.
digitalWrite(R_led, LOW);  // Turn LED off.
```

```
}

digitalWrite(buzzer, LOW);
delay(100);
}
```

Listing 1: Device Code