

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING  
UNIVERSITY OF MORATUWA

## EN2160 - Electronic Design Realization



### Smart Emergency Bulb Project Report

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25<sup>th</sup> July 2023

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# Abstract

The objective of this project was to develop a marketable smart emergency bulb with innovative features that address a unique combination of needs. The bulb is designed to be voice-controlled through Amazon Alexa, allowing users to easily adjust its settings with voice commands. Additionally, it serves as an emergency bulb, providing illumination during power outages, which sets it apart from other products currently available on the market. The project involved rigorous investigation and research to ensure that the bulb is not only technologically advanced but also meets safety and performance standards. With a power rating of 70W, the smart emergency bulb offers bright and efficient lighting for various applications. To make the product appealing to potential customers, a comprehensive marketing plan was devised, considering customer feedback and preferences. Market surveys were conducted to gain insights and incorporate customer-driven improvements. The integration of voice control and emergency lighting features makes this product a highly desirable and unique solution for consumers. Throughout the project, careful attention was given to all aspects of design, production, and manufacturing. The bulb's compatibility with Amazon Alexa and emergency capabilities were meticulously tested to ensure flawless functionality. The product was branded under a new company name, reinforcing its distinct identity in the market. The successful development of the smart emergency bulb represents a significant milestone, offering users a cutting-edge lighting solution that combines convenience, safety, and functionality in a single, innovative package.

# 1.Introduction

## 1.1. Problem Description and Overview

This project addresses the need for a modern and innovative solution in the field of smart home devices. The problem lies in the absence of a product that combines voice-controlled features with emergency lighting capabilities. Currently, there are no available options that offer both functionalities in a single device. To fill this gap, the project aims to develop a "Smart Emergency Bulb" with a power rating of 70W. The bulb will be integrated with Amazon Alexa for voice commands, allowing users to control its functions hands-free. Additionally, the bulb will automatically activate as an emergency light during power outages, providing critical illumination in dark situations. By combining cutting-edge technology with essential safety features, the Smart Emergency Bulb offers a marketable product that enhances convenience, security, and peace of mind for consumers seeking intelligent lighting solutions for their homes.

### Key Features and Functionality:

**Voice Control via Amazon Alexa:** The Smart Emergency Bulb can be controlled using voice commands through Amazon Alexa, providing a convenient and hands-free user experience.

**Emergency Lighting Functionality:** The bulb is equipped with a built-in rechargeable battery, allowing it to function as an emergency light during power outages. When the main power supply is disrupted, the bulb automatically switches to battery mode, providing essential illumination.

**Seamless Transition:** The Smart Emergency Bulb features an automatic power sensing mechanism that detects power cuts and quickly transitions to emergency mode, ensuring a smooth and immediate response to power interruptions.

**Energy Efficiency:** The bulb is designed to be energy-efficient, maximizing battery life during emergency use. It intelligently manages power consumption to extend the battery's runtime and provide longer backup lighting.

**High Power Output:** With a power rating of 70W, the bulb offers sufficient brightness for everyday use, serving as both a regular light source and an emergency light when needed.

**Rechargeable Battery:** The integrated rechargeable battery eliminates the need for external power sources during emergencies, providing a self-sufficient and reliable lighting solution.

**User-Friendly Installation:** The Smart Emergency Bulb can be easily installed in standard light fixtures, requiring no additional wiring or complicated setup procedures.

**Compatibility:** The bulb is compatible with a wide range of fixtures commonly found in households and offices, ensuring versatility and easy integration into existing lighting setups.

**Enhanced Safety and Security:** The emergency lighting feature enhances safety during power outages, allowing users to move around safely and take necessary actions during critical situations.

**Market Uniqueness:** Thorough investigations confirm the uniqueness of this Smart Bulb, as there are currently no products combining voice-controlled features with emergency lighting in a single bulb.

## **1.2. Product Validation**

The Smart Emergency Bulb underwent comprehensive product validation to ensure its functionality, safety, and alignment with user requirements. Extensive market research, comparative analysis, and user surveys were conducted to understand existing products and gather valuable feedback. Additionally, a thorough cost analysis was performed to make the product competitively priced and accessible to a broader consumer base. Safety testing was prioritized to comply with relevant standards and regulations, ensuring a reliable and secure lighting solution. Through this diligent validation process, the Smart Emergency Bulb is poised to offer an innovative and marketable product that addresses the unmet needs of users seeking a voice-controlled smart bulb with emergency lighting capabilities.

## **1.3. Solution**

The solution for the Smart Emergency Bulb involved innovative design to meet market needs. Integrating voice control through Amazon Alexa allows for convenient hands-free operation. The bulb's built-in rechargeable battery provides emergency lighting during power outages, addressing critical situations. A cost-effective approach ensures affordability without compromising quality. Efforts to optimize power consumption extend backup time, offering prolonged emergency lighting. Safety and compliance testing ensure reliability and user security. The result is a unique and marketable Smart Emergency Bulb that satisfies users' demand for voice-controlled, emergency lighting solutions during power disruptions.

# **2. Product Goals**

## **2.1. Functionality**

The Smart Emergency Bulb is a versatile and innovative lighting solution that offers seamless functionality. Once connected to the power supply, the bulb is ready to be controlled through voice commands via Amazon Alexa. Simultaneously, the built-in rechargeable battery automatically charges whenever electricity is available, ensuring a constant power supply. During power outages, the bulb seamlessly transitions to emergency mode, utilizing the charged batteries to provide essential illumination. Users have the option to manually switch the bulb to battery mode if they wish to conserve electricity or charge the batteries separately. However, the Smart Emergency Bulb also features an auto charging system, eliminating the need for manual switching and ensuring a hassle-free experience. This unique combination of voice control and emergency lighting capabilities sets the Smart Emergency Bulb apart, making it a standout product in the market.

## 2.2. Market Goals

The initial market goal for the Smart Emergency Bulb is to conduct a limited production run of 100 units to gauge market demand and gather user feedback. This approach will help us assess the product's reception and make necessary improvements before proceeding with mass manufacturing. The key objective is to maximize profitability while meeting the needs of our target users effectively. By leveraging the design-driven innovation approach, we aim to position the Smart Emergency Bulb as a unique and sought-after product in the market. Cost optimization will be a priority to ensure competitive pricing, striking a balance between affordability and high-quality features. The market price will be set to reflect the value provided by the bulb, allowing us to achieve our revenue goals while catering to the demands of consumers seeking a reliable, voice-controlled smart bulb with emergency lighting capabilities.

Approximate Cost per Unit – Rs. 7161.00

Market Price – Rs. 8199.00

### 3.Features and Specifications:

- A Voice Control: The Smart Emergency Bulb can be controlled using voice commands through Amazon Alexa, offering a hands-free and convenient user experience.
- Emergency Lighting: The bulb functions as an emergency light during power outages, utilizing the built-in rechargeable battery located within the bulb. The automatic power switching mechanism seamlessly transitions the bulb from the main electrical source to the battery backup during power cuts.
- Intelligent Battery Management: The Smart Emergency Bulb intelligently manages battery charging to prevent overcharging and extend the battery's lifespan, ensuring optimal performance and longevity. It also prevents the batteries from draining below a critical level to maintain battery health.
- Safety Features: The bulb incorporates safety measures to prevent overcharging, short circuits, and other potential hazards, utilizing a Battery Management System (BMS) module. This ensures the safety of the bulb and the user.
- Battery Backup: The bulb offers an impressive battery backup time of up to 7 to 7.5 hours, providing extended illumination during power outages.
- Battery Configuration: The bulb has two li-ion batteries (18650 1800mAh) to deliver reliable power during emergencies.
- Input: The bulb operates on a 230V AC input.
- Output: Power rating of the bulb is 70W.

## 4. Implementation

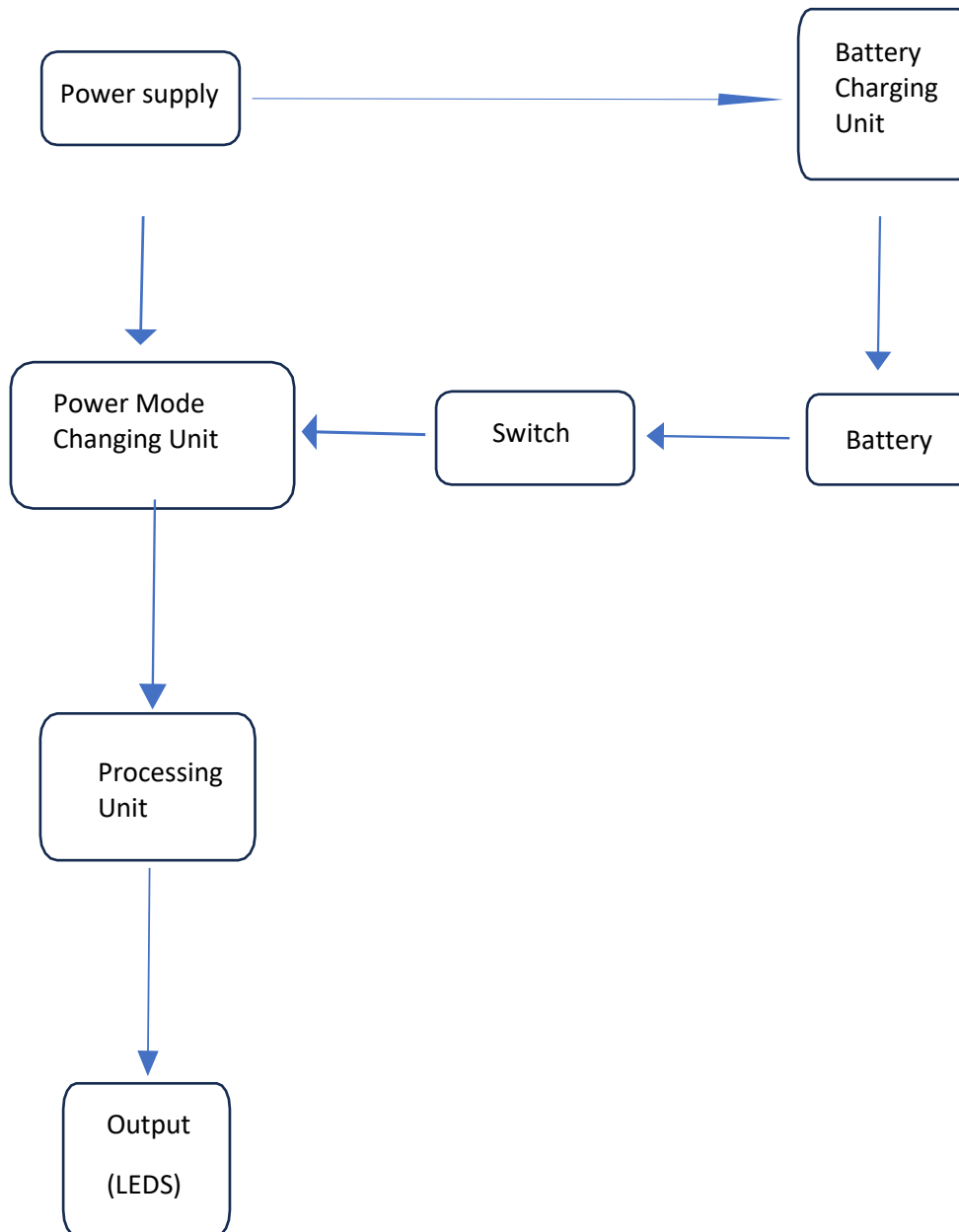
### 4.1. Component Selection

The following are how selected the critical components of our device.

- **WS2812B LED Bulbs:** These LED bulbs provide bright and customizable illumination, allowing users to adjust the brightness and color of the light according to their preferences.
- **ESP8266 D1 Mini Board:** The ESP8266 D1 Mini is a compact and powerful microcontroller board that processes data and establishes a Wi-Fi connection, enabling voice control and seamless integration with Amazon Alexa.
- **5V SPDT Relay:** A Single-Pole Double-Throw relay that switches between AC current and battery power. It enables automatic power switching during power outages, ensuring uninterrupted lighting.
- **Two 18650 Li-ion Rechargeable Batteries:** These high-capacity batteries serve as the backup power source during power outages, ensuring continuous emergency lighting.
- **TP4056 Battery Charging Module:** This module efficiently charges the two 18650 Li-ion rechargeable batteries with built-in protection against overcharging, ensuring safe and optimal battery performance.
- **5V Voltage Regulator:** The 5V voltage regulator converts the standard 230V AC supply to a stable 5V DC output, providing the necessary power for the bulb's components.
- **1N5408 Protection Diodes:** These diodes protect the circuit from voltage spikes and reverse polarity, ensuring the stability and safety of the overall system.
- **XL6009 Boost Converter:** The XL6009 boost converter maintains a constant voltage level for the LED bulbs, ensuring consistent and reliable lighting performance.

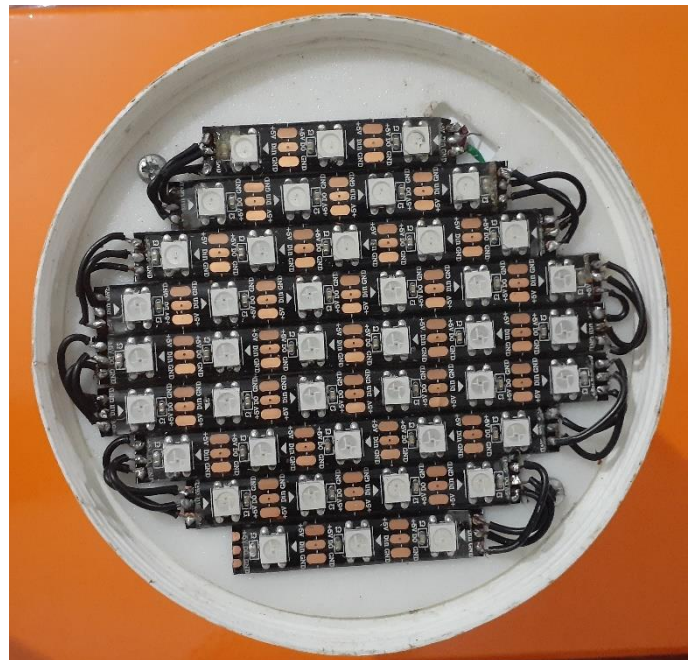


## 4.2. Functional Block Diagram of the Circuit.



In the initial circuit itself worked as expected when it was implemented using wires and then the PCB design was done.





## 5. Instructions for Assembly.

- Gather components and tools.
- Solder components onto the PCB following the circuit diagram.
- Attach 5V voltage regulator for stable power supply.
- Connect TP4056 battery charging module for Li-ion batteries.
- Place and solder WS2812B LED bulbs for illumination.
- Add ESP8266 D1 Mini board for Wi-Fi and voice control.
- Incorporate 5V SPDT relay for automatic power switching.
- Mount XL6009 boost converter for constant voltage.
- Double-check connections and test functionality.
- Enclose PCB in bulb housing and finalize assembly.

Follow the guidelines and safety precautions throughout the assembly process for a successful and safe Smart Emergency Bulb.

## 6.How to test for functionality.

- Connect the Smart Emergency Bulb to the main power supply.
- Test voice control using Amazon Alexa commands to turn the bulb on and off.
- Simulate a power cut by disconnecting the bulb from the main power supply.
- Verify that the bulb switches to emergency mode and continues to illuminate using the charged batteries.
- Reconnect the bulb to the main power supply to check if it switches back and starts charging the batteries automatically.
- Monitor for safety and consistent performance during testing.
- Gather user feedback to improve functionality if needed.

## 7. Bill of Materials

Item	supplier	amount	Priceper unit \$/LKR	Total amount LKR	
HLK-5M05 5V AC to DC Voltage Converter	Tronic.lk	1	1350 LKR	1350.00	<a href="https://tronic.lk/product/hi-link-hlk-5m05-220vac-to-5vdc-5w-step-down-power-supply">https://tronic.lk/product/hi-link-hlk-5m05-220vac-to-5vdc-5w-step-down-power-supply</a>
TP4056 Li-ion Battery charging module	Tronic.lk	1	80 LKR	80.00	<a href="https://tronic.lk/product/tp4056-5v-1a-micro-usb-18650-special-lithium-battery-ch">https://tronic.lk/product/tp4056-5v-1a-micro-usb-18650-special-lithium-battery-ch</a>
1N5408	mouser	2	0.45\$	287.00	<a href="https://mou.sr/3rCK7WU">https://mou.sr/3rCK7WU</a>
18650 Li-ion battery	Tronic.lk	2	600.00 LKR	1200.00	<a href="https://tronic.lk/product/3-7v-1800ma-18650-li-ion-rechargeable-battery-good-qual">https://tronic.lk/product/3-7v-1800ma-18650-li-ion-rechargeable-battery-good-qual</a>
5V SPDT relay	Tronic.lk	1	170.00 LKR	170.00	<a href="https://tronic.lk/product/5vdc-1-way-1-channel-relay-module-transistor-version">https://tronic.lk/product/5vdc-1-way-1-channel-relay-module-transistor-version</a>
ESP 8266 D1 mini board	Tronic.lk	1	900.00 LKR	900.00	<a href="https://tronic.lk/product/nodemcu-d1-mini-lua-wifi-wemos-4m-esp8266-module">https://tronic.lk/product/nodemcu-d1-mini-lua-wifi-wemos-4m-esp8266-module</a>
XL6009 Boost converter	Tronic.lk	1	450.00 LKR	450.00	<a href="https://tronic.lk/product/xl6009-3-32v-to-5-35v-4a-dc-to-dc-adjustable-step-up-bo">https://tronic.lk/product/xl6009-3-32v-to-5-35v-4a-dc-to-dc-adjustable-step-up-bo</a>
WS2812B RGB LED	Tronic.lk	42	22 LKR	924.00	<a href="https://mou.sr/3Y5qfaU">https://mou.sr/3Y5qfaU</a>
Wires and Switch	Tronic.lk		100 LKR	100.00	<a href="https://tronic.lk/">https://tronic.lk/</a>
PCB	JLPCB	1	500 LKR	500.00	<a href="https://jlcpcb.com/">https://jlcpcb.com/</a>
Enclosure	Xydder Labs		1200LK R	1200.00	

**Total cost**

**7161.00 LKR**

## 8. References

<https://www.mouser.com/datasheet/2/849/1n5400-2577224.pdf>

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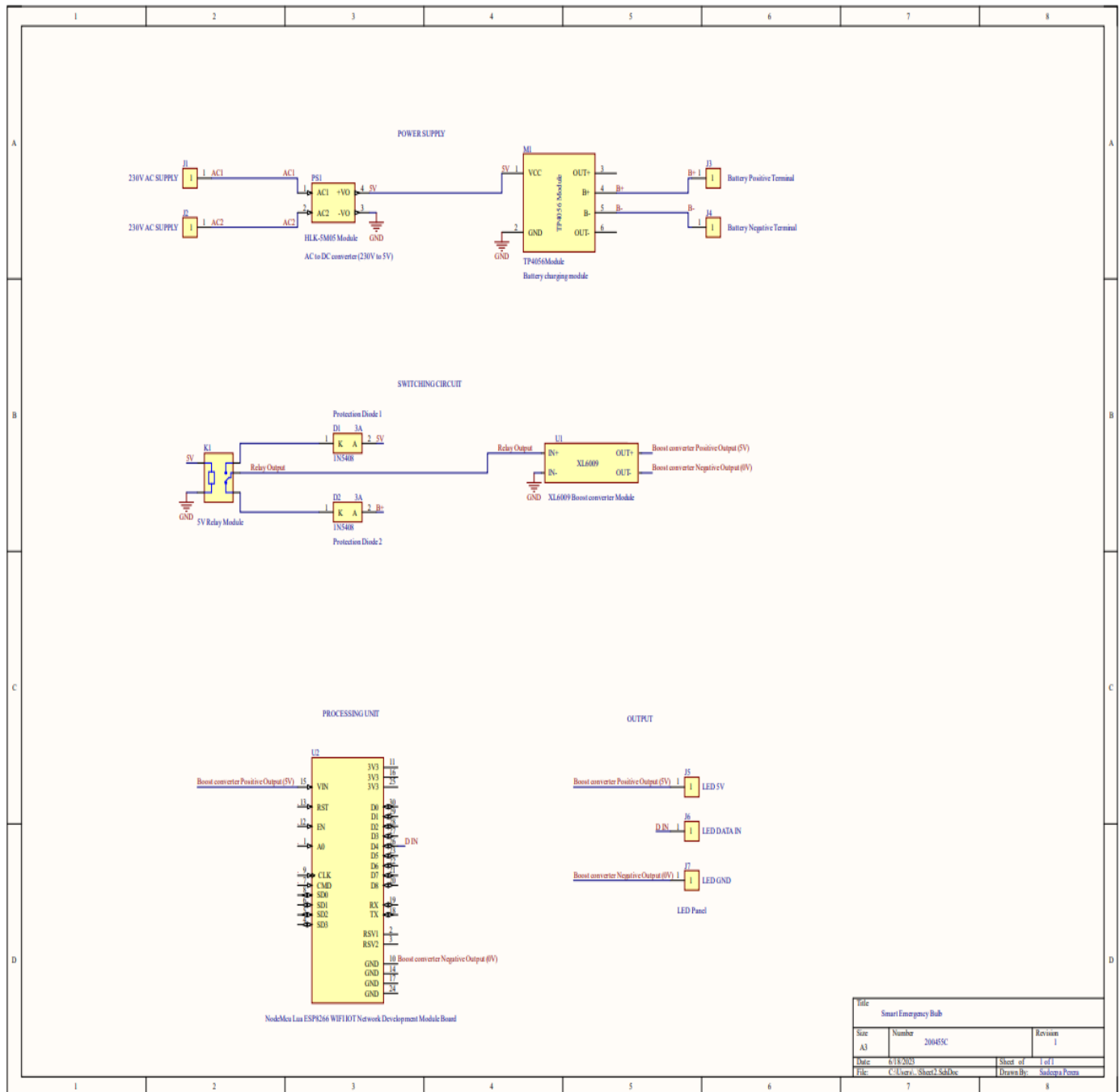
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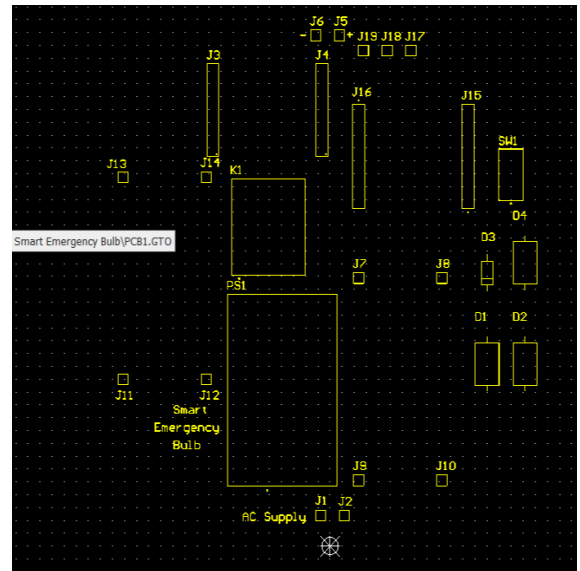
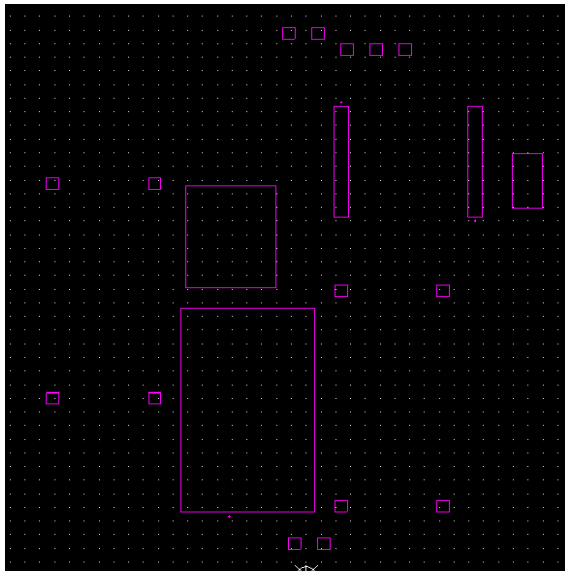
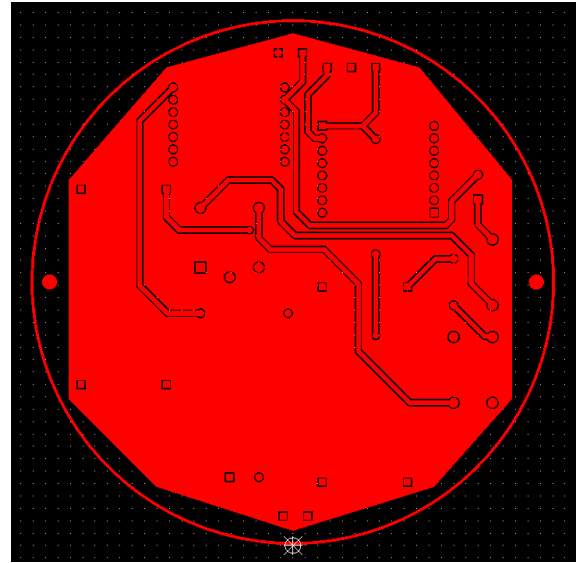
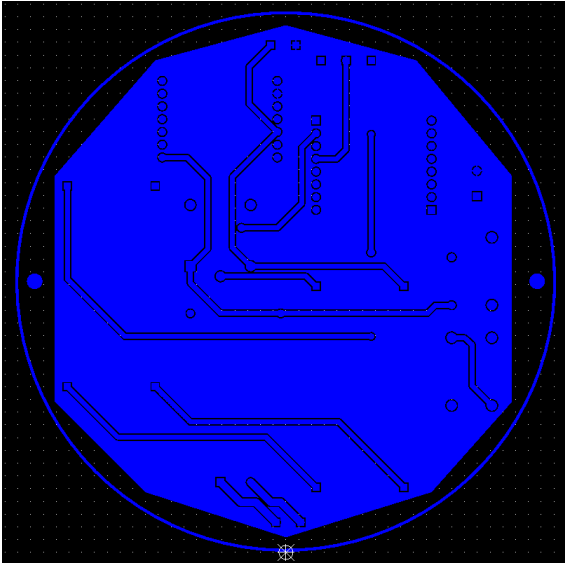
<https://www.openimpulse.com/blog/products-page/product-category/wemos-d1-mini-esp8266-development-board/>

<https://www.sparkfun.com/products/100>

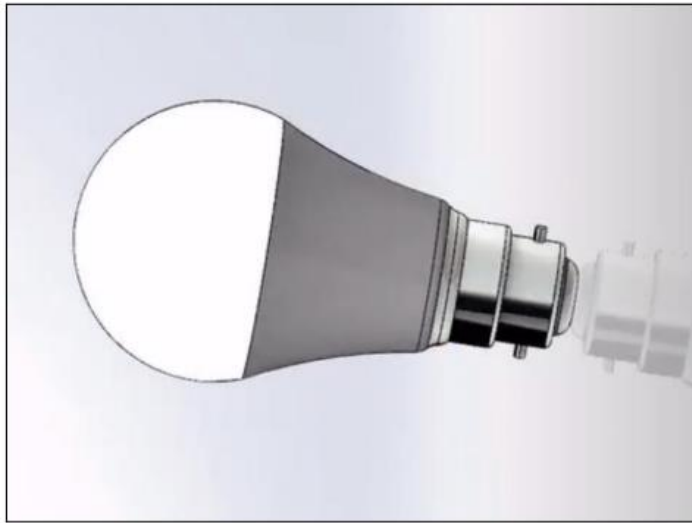
# Appendix A

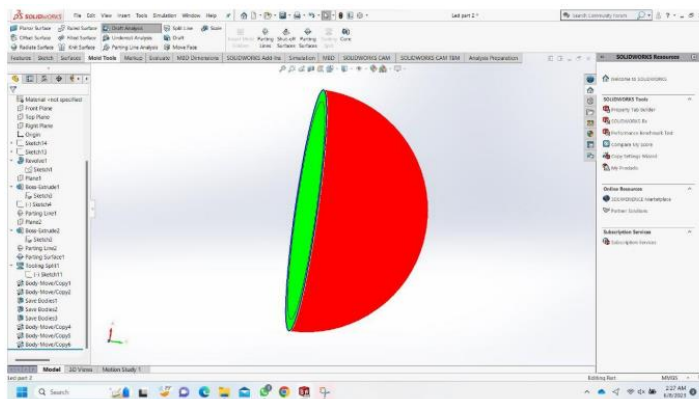
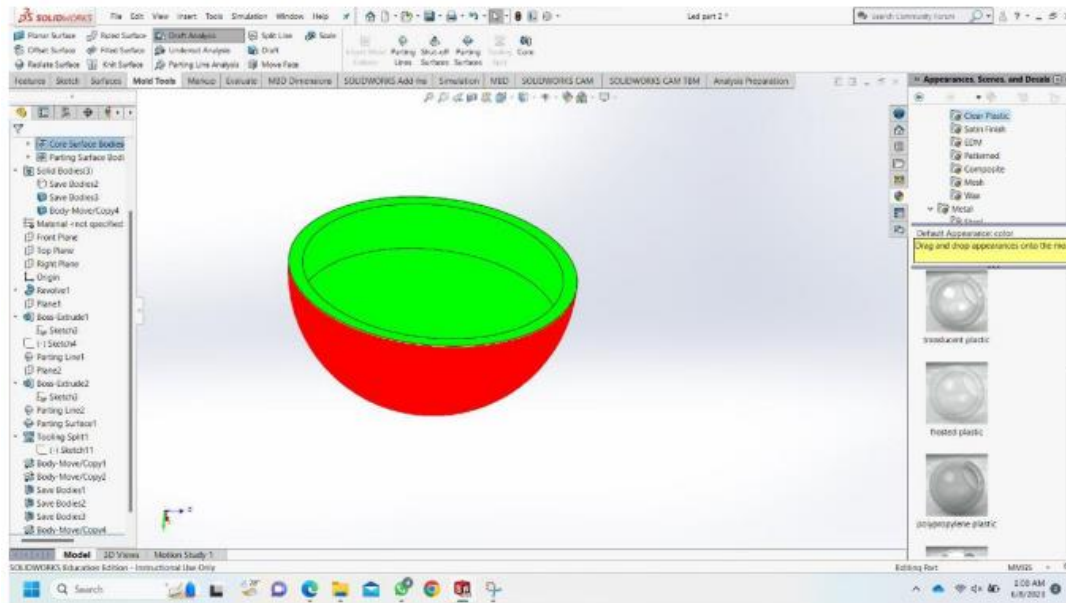






## Appendix B





when It comes to mass manufacturing, It is necessary aspect that the mould design have been done. For that Draft analysis should be done in solid works

## Appendix C

