SmartGlow - Smart Bulb Adapter
Project Report

EN1194 - Engineering Design Project

Department of Electronics and Telecommunication Engineering

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Chapter 1

Problem and Proposed Solution

1.1 Problem Identification

In today's fast-paced world, technology is evolving at a rate faster than we can keep up with it. With recent technological developments, the term *smart home* has come to be more than just a concept, but a realizable solution to our dream of leading a comfortable life. Today, a variety of such solutions are available in the market. Among them are IoT (Internet of Things) devices such as smart alarm systems, smart doorways, and smart home-lighting systems. Our focus in this project was on smart home-lighting systems.

1.2 Problem Validation

Generally, people are hesitant to install existing IoT lighting systems as they require a complete rewiring of the domestic circuit, and/or a complete replacement of the existing bulbs, which also comes with an added cost, as described above.
To validate our hypotheses and obtain feedback/suggestions from actual consumers, we conducted a survey that utilized both online and offline channels, reaching a wide audience. Participants were asked to respond to a set of structured questions designed to gather relevant data for the project. The survey was taken by around 100 individuals.

1.3 Business Potential Analysis

The results of the survey conducted were used to conduct an analysis of the business potential of our product. A summary of our findings is as follows:

- **Smart Bulb Ownership**

  One of the key questions posed in the survey was whether participants already owned smart bulbs. 94.2% of the respondents indicated that they did not currently possess a smart bulb. This indicates the possibility of a product market.

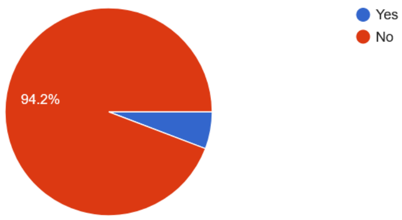


Figure 1.1: Ownership

- **Willingness to Install**

  Participants were asked to rate their willingness to install a smart bulb solution on a scale of 1 to 5, with 1 being "not willing at all" and 5 being "extremely willing". The results revealed a strong inclination towards adoption. Most respondents indicated their willingness at 3 or higher, and the highest number of responses was for 5.

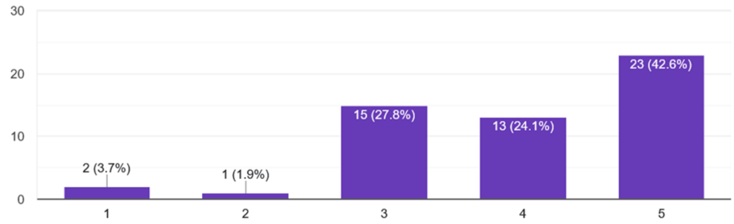


Figure 1.2: Willingness to Install

- **Perceived Usefulness**

  Another crucial aspect explored in the survey was the perceived usefulness of a smart home lighting system. Participants were asked to decide to what extent they believed the system would enhance their daily lives on a scale from 1 to 5, with 1 being "not useful at all" and 5 being "extremely useful". The responses demonstrated a widespread belief on the positive side of the practical benefits of the technology. The majority believed that it would be very useful.

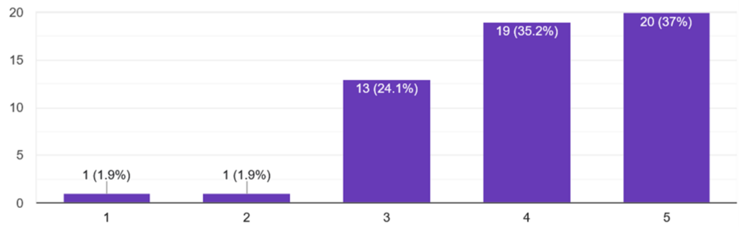


Figure 1.3: Perceived Usefulness

- **Reasons to Install**

  We also asked consumers what their expectations from such a product were. The answers varied, but most were concerned about the power consumption of our device. This showed us that we needed to pay attention to power saving in our production.

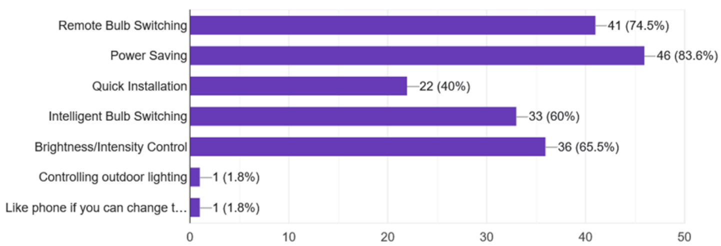


Figure 1.4: Reasons to Install

- **Price Range**

  Finally, participants were given a chance to provide feedback on what their preferred price range was. The majority of participants responded around Rs. 3000, which is an acceptable price for a smart light.

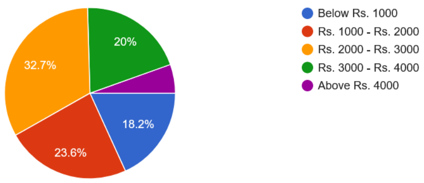


Figure 1.5: Price Range

Further recommendations we obtained through the survey for possible improvements in our methodology are as follows.

- Use detailed explanations for advertising, as the general public might not be aware of smart lighting systems.
- Raise awareness about our product. We found that many view smart home options as "unnecessary luxury items", and might not be willing to take the step forward. Hence, to overcome this belief, we must prove the benefits of our products, and demonstrate its cost-effectiveness and affordability.

The findings from the survey suggest a strong market demand for a smart home lighting system, with participants demonstrating both interest and willingness to invest in such technology. The data also indicates that pricing within the range of Rs. 2000 to Rs. 4000 would be most effective for our design. Additionally, power saving must be considered as a crucial factor in our product.
Further, the market for smart products in Sri Lanka is currently on the rise, in line with the rapid increase in the demand for such products in the global market. In addition, people are presently paying more attention to methods of energy saving, after the recent energy and economic crises. Hence, within the prevailing market environment with a rising popularity in the use of IoT devices in homes, both within Sri Lanka and in the world, we believe that we will be able to secure a favourable market for our product.

1.4 Proposed Solution

Based on the results from the survey and an analysis of the market for a smart lighting solution, the following were identified as areas of concern to be addressed, and objectives to be fulfilled by our solution.

- Control home lighting without requiring to purchase any new bulbs to replace existing ones, thereby reducing electronic waste
- Remote-controlling functionality through a mobile app
- Affordability
- Easy scalability
- Hassle-free installation; a plug-and-play device
- Retain manual control over bulbs through existing switches

Hence, we came up with a design for a bulb adapter that seamlessly integrates into existing bulb holders at home, to which the bulbs already in use can then be connected.
We decided to equip the adapter with WiFi connectivity, and design a mobile app that allows users to communicate with the bulb holder and turn it on or off remotely, over the internet.

Chapter 2

Product Specifications

2.1 Technical Specifications

Rated Voltage	230 V / 50 Hz
Rated Current	75 mA
Wireless Connectivity	WiFi 802.11b/g/n
Dimensions	80 mm (R) 110 mm (H)

Table 2.1: Technical Specifications

2.2 Functional Specifications

Primary Features

- Turn an existing bulb into a WiFi-controlled bulb, without any wiring or complex procedures.
- Turn a bulb on or off, when a stable WiFi connection is available, from anywhere in the world.
- Extend the above capability to any number of bulbs, and operate each one separately with just a single tap.
- Remove and reconfigure existing bulbs.

Secondary Features (to be implemented)

- Change the intensity/brightness of the bulb using the mobile application.
- Group several bulbs together and control each bulb in the group simultaneously (for large scale applications).

Chapter 3

Technical Feasibility

3.1 Hardware Requirements

3.1.1 Printed Circuit Board (PCB) and Modules Used

- The PCB includes surface-mounted devices (SMD), a WiFi enabled micro-controller for remote operating, and a solid state relay for switching.
- A 5 V DC power supply is provided through a 230 V AC - 5 V DC SMPS (Switching Mode Power Supply) unit.

3.1.2 Micro-Controller Unit (MCU)

- The micro-controller should have at least one pin for output.
- Must be WiFi-enabled to be able to connect to a cloud server, and for remote users to send signals to it through a mobile application.

3.1.3 Enclosure

- The enclosure must contain the PCB and the power supply, and connect to the bulb socket at the top, and to a bulb at the bottom.
- Must contain an E27-type/B22-type bulb base to connect to the existing bulb socket, and the same type of bulb holder to connect to the bulb below.
- Material used must withstand the operating temperatures of a typical light bulb.
- Material must be electrically insulating for the protection of the user.
- Must not distract the appearance of a typical light bulb and integrate naturally into the existing environment.

3.2 Software Requirements

3.2.1 Micro-Controller Algorithm

- The micro-controller to be used must be a low-power device, and may not be able to handle heavy algorithms such as asynchronous servers. Hence, the code has to be simple and lightweight.
- The micro-controller may have memory limitations, so the algorithm must consume as little memory as possible.
- Must have permanent memory to store the WiFi credentials of the home network, so that the user does not have to configure it during each boot up.

3.2.2 Cloud Server and Database Architecture

- Since the cloud server can stop at idle processes, we must establish the NodeJS file as a service, to ensure seamless workflow.
- Two tables must be used separately, to ensure that all user data is recorded.
- Delays in synchronization can lead to duplicate entries in databases, and must be handled.

3.2.3 Mobile Application

- Must be user-friendly and self-explanatory as much as possible.
- Must maintain a separate database locally within the device to make the user experience smoother.
- Application size must be small, since a large apps could cause inconvenience, and discourage potential users.

Chapter 4

Product Architecture

Taking all above factors into consideration, we developed the following block diagram model for a product.

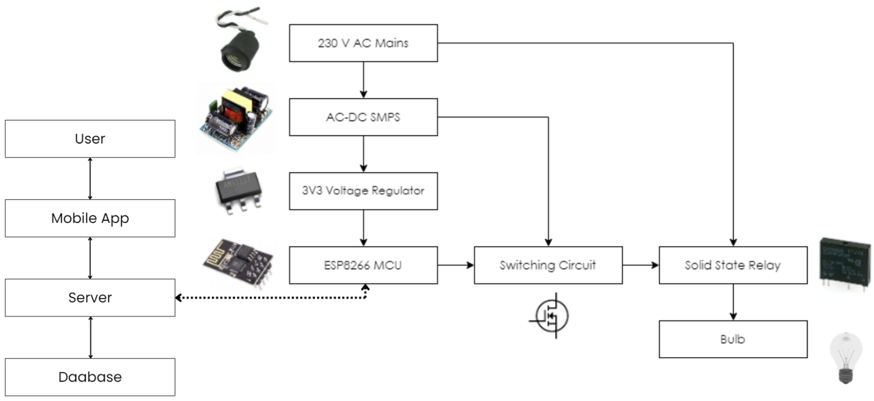


Figure 4.1: Modular Level Architecture of the Product

There are three main sections in the model; a power supply, micro-controller, and a switching circuit.

1. **Power Supply**

   As the product is an adapter for a bulb holder, and is expected to be connected to an existing bulb socket, power can be taken directly through the 230 V AC mains supply. However, the AC voltage must first be converted and stepped down to 5 V DC, and later to levels such as 3.3 V DC through a voltage regulator. 5 V power is needed to run a relay to control the a bulb, and 3.3 V to power the micro-controller unit.

2. **Micro-Controller Unit**

   All functions of the product are to be carried out by a lightweight micro-controller unit, powered with 3.3 V. After powering up the board, it must automatically connect to the home WiFi network (using credentials given to it through a one-time initial setup phase), and to our cloud server through it. Users must be able to connect to the server through our mobile app, and control the bulb as required. Upon receiving the user's signal, it must be delivered to the relay through a switching circuit, that turns the bulb on or off.

3. Switching Circuit

   AC power to turn the bulb on or off must be controlled through a relay. Because the relay operates at 5 V DC and cannot be run directly through the micro-controller, its 3.3 V signal must be used to switch a 5 V signal to the relay through a network of transistors.

Chapter 5

Circuit Design

5.1 Wireless Connection and Micro-Controller

The product uses WiFi for wireless communication with the cloud server and user. Initially, we tried using 433 Hz RF (radio frequency) modules for transmission between the light bulb and a central controller, considering its low power consumption. However, it seemed less reliable without line-of-sight. Hence, it was decided to use WiFi instead. We then considered the possibility of different WiFi-enabled micro-controllers, such as ESP32, ESP12, and ESP01. We selected ESP01 because it meets our pin requirements and storage needs, and has a minimal power consumption over ESP32 and ESP12.

5.2 Power Supply

The micro-controller needs 3.3V, and the SSR needs 5V and the power source can be the AC mains connected to the bulb holder. We observed different power supply options and finalized on 5VDC - 230VAC SMPS-switching mode power supply (buck converter) considering its very high efficiency and moderate cost.

5.3 Switching of 230 V Bulb

For switching the AC line we observed 3 options: electro-mechanical relay, triac-optocoupler, and solid-state relay. Out of these options SSR was identified as the most accurate, reliable and safe option for the circuit and the user.

Since the output of ESP01 is 3.3V but the SSR operates at 5V, a voltage regulator is used to convert the signal to 5V. Also, we used high-side switching with a MOSFET and a BJT, so that the load, in this case the SSR, is always connected to the ground and is isolated from the control circuit.

5.4 PCB Design

Designing the PCB was a challenge due to space constraints imposed by the product enclosure and sizes of the components, and the presence of both AC and DC signals on the same device.
The initial concept was to build a central controller that would connect to the home WiFi network, and to which multiple bulb holders could connect to through RF communication. This required the designing of two PCBs, each one equipped with RF modules. However, due to various issues described throughout the article, and due to issues of signal interference, it was decided instead to equip each bulb holder with a WiFi-enabled chip and allows them to connect directly to a WiFi network, without the need for a central controller.
We attempted initially to construct a stand-alone PCB using the ESP8266-EX chip used in the ESP01-S micro-controller. However, once again due to issues of radio interference and other complications, it was decided to use the ESP01-S micro-controller unit as a whole.
The current PCB design includes two holes on one side to connect wires from the 5 V supply from the SMPS, and the other side to connect wires from the bulb. Further mechanical parameters include two screw holes to mount the PCB in the enclosure.

The PCB consists of three main regions.

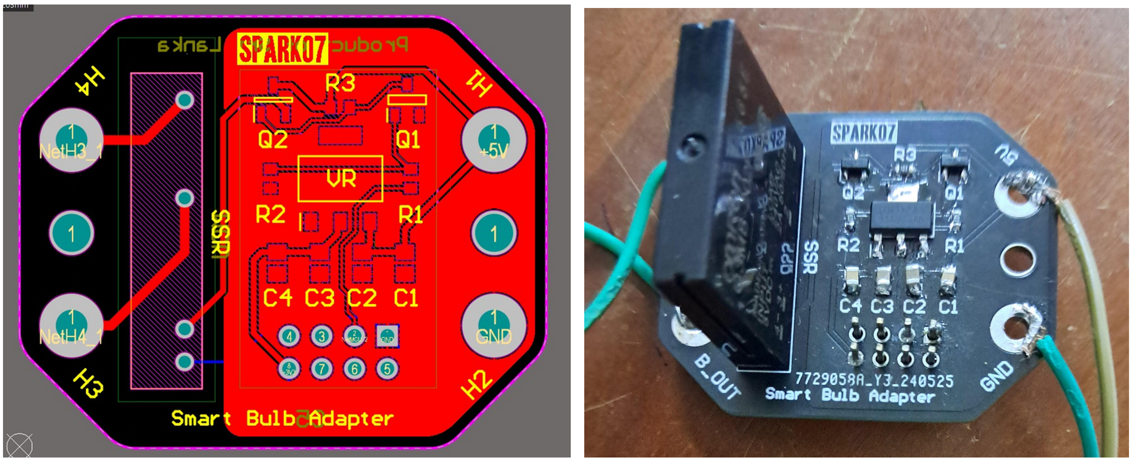


Figure 5.1: (a) PCB Design (b) Assembled PCB

1. **Power Supply Circuit**

   The 5 V power signal is converted to a 3.3 V signal through an AMS1117 regulator circuit.

2. **MCU and Switching Circuit**

   The 3.3 V output from the voltage regulator is routed to the VCC pin of the ESP01-S MCU, through a 22 μF capacitor in parallel, for protection from power surges.

   The GPIO2 pin on the MCU is pulled high through a 2.2 kΩ resistor, to prevent it from being in a floating state during booting. The same pin is used to carry the signal to turn the relay on or off through the switching network described below.

   The switching circuit consists of a BJT (MMBT3904) which is driven to saturation by making the GPIO2 pin high. This in turn, drives the gate of a P-MOSFET (FDN340P) low, turning it on, providing 5 V to the input pin of the SSR.

3. **Relay**

   This section of the PCB is kept separate from the above sections, as it involves AC power lines, to prevent interference and protect the other components from high voltages.

   It mainly contains the footprint of the solid state relay, with its output terminals routed using thick traces, to carry high voltage AC signals, to the two terminals used to connect the bulb.

The schematics of the PCB are attached in Appendix B.

Chapter 6

Enclosure Design

Designing a functional enclosure that is also attractive was an important part of the product development. The enclosure must not alter the appearance of a typical light bulb arrangement and must not appear bulky when attached to the light bulb, as such a design would be distracting, and could discourage users from using one in their well-organized environments such as living rooms, etc.

With regard to functionality, the enclosure must contain the PCB, power supply unit (PSU), and all involved wiring. The minimum area for the PCB and vertical heights were calculated when designing the mid-section where the PCB is to be fixed. The design must allow for the PSU to be placed on a support stand above the PCB, making optimal use of the available space. This would also help to connect the 230 V live and neutral power lines from the bulb holder with minimum wire lengths, and isolate them from the PCB.

The neutral wire to the bulb is wired directly to the neutral line from the holder, and the live wire is switched through the control circuit. The wires are diverted to the bulb holder through the hole at the bottom of the PCB holding section.

The enclosure is followed by a E27 (or B22) bulb holder and a rounded section is added to cover it, and further improve its visual appeal. At the top, an E27/B22 bulb base is attached to connect to any existing bulb holder of thread type (E27) or pin type (B22). Ventilation holes are added at the top to regulate the heat produced by the circuit.

The designed enclosure has two parts, fastened at the top of the PCB holding unit. When the top part is removed, the PCB is installed first, and the PSU is then placed on the support stand.

All involved drawings can be found in Appendix C.

Enclosure drawings and 3D models were generated using the SolidWorks Designer software.

The section of the enclosure except the bulb holder and bulb base was 3D printed using PLA (Polylactic Acid), a biodegradable thermoplastic polyester. PLA was selected due to its strength and heat resistivity, as imposed by the product requirements.

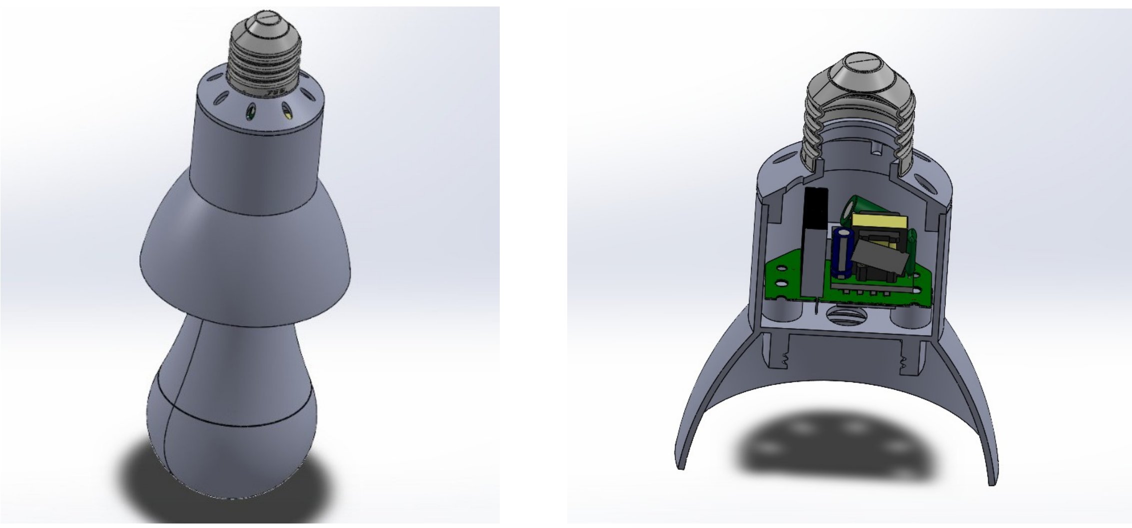


Figure 6.1: (a) External View (b) Section View

Figure 6.2: Appearance of the final product

Chapter 7

Micro-Controller Algorithm

The micro-controller used for the project is the ESP01-S MCU. All code was written using the Arduino IDE.

The basic operation of the algorithm is as follows;

1. As soon as the ESP01 is powered up, it starts act as an access point running a synchronous server, that can be used by our mobile application to send the WiFi credentials of the home network and the MQTT topic of the user to it.

2. The ESP01 stores the received WiFi credentials into its permanent memory (using the `EEPROM` library). This is so that the user can use the device without having to provide WiFi credentials to it each time it is booted up. Once this data is saved to memory, it is recalled at the beginning of each boot-up.

3. Check for unhandled requests at regular intervals.

4. After connecting to a WiFi network with credentials either retrieved from memory or provided through the mobile application, the ESP01 attempts to subscribe to the MQTT topic provided.

5. Repeated the above process at 3-second intervals until a connection is successfully established. Once established, the ESP01 starts listening for the any updates in the MQTT server.

6. When an on or off signal is published from the mobile application to the MQTT server, the listening ESP01 receives it. Such a signal is received in the form of an ASCII tuple

   `(bulb-id , on-off-state)`,

   where `on-off-state` is `1` to denote the on state, and `0` to denote off.

7. The received message is decoded from ASCII to relevant integer values, and the GPIO2 pin of the ESP01 is set to high or low depending on the message.

The following comments are in order.

While running an asynchronous server would be far more efficient, since all callback functions can be executed asynchronously, and all `POST` requests can be handled more efficiently, our implementation uses synchronous server due to power limitations of the ESP01.

Since each ESP01 is programmed specifically to listen to one MQTT topic and one bulb ID, there will not be any confusion,even when multiple users are using the device simultaneously.

Chapter 8

Mobile Application

8.1 Back-End Functionality

An Oracle server with a MYSQL database is used for handling the backend. The implementation is done in NodeJS. The database consists of two main tables, `userMaster` and `bulbinfo`, which are used to store user data, and bulb data respectively.

- userMaster

Field	Type	Null	Key	Default	Extra
id	int	NO	PRI	NULL	auto_increment
username	varchar(100)	YES		NULL	
password	varchar(255)	YES		NULL	
topic	varchar(50)	YES		NULL	
email	varchar(100)	YES		NULL	

Figure 8.1: userMaster table

- bulbinfo

Field	Type	Null	Key	Default	Extra
userid	int	NO	PRI	NULL	
bulbid	int	NO	PRI	NULL	
bulbname	varchar(100)	YES		NULL	
description	varchar(255)	YES		NULL	

Figure 8.2: bulbinfo table

When the backend is initialized, the NodeJS file first sets up a connection to the MySQL database.

When a user tries to login, their credentials are extracted from the data sent received by the server. The received password is then cross-referenced with a hashed password stored in the database. If the values match, a `200 OK` response is sent back to the mobile application, along with the MQTT topic allocated to the user, and all the bulb data relevant to the user, as a single JSON object.

If a new user signs up, data sent from the mobile application is entered into the database. The NodeJS file creates a random 20-character string, which will be used as an MQTT topic for the user. This is sent back to the mobile app, along with a `200 OK` response.

When a user registers a new bulb, the mobile application sends the bulb data along with the user's topic to the server. The the server queries the `userMaster` table using the given topic, and finds the user's ID. Then, the bulb information along with the user's ID is entered into the `bulbinfo` table. If the procedure is successful, a `200 OK` response is sent back to the mobile app along with the bulb index.

Renaming, reconfiguring, and removing bulbs, are handled using separate server endpoints.

8.2 Front-End Functionality

8.2.1 User Interface

The mobile app front-end was developed using the MIT App Inventor software. The interface of the application consists of four main pages as described below.

- **Splash Screen**

  This is the first screen displayed when the app is opened, and used to provide the user a user-friendly environment, and make the application more appealing to the audience.

- **Login/Sign-Up Page**

  The login page, which also doubles as a sign-up page, is used to obtain user information. In the case of a login this user data is then sent to a cloud server where the password is cross referenced with a hashed password stored in a MYSQL database validating the user. In the case of a sign up, the username password and the email is sent to a server where it is saved in our database. Then a unique 20 character long MQTT topic is generated and sent back to the application which is stored in a database created in the mobile phone locally and used to send unique MQTT insructions back to the server in the future.

- **Bulb Setup Page**

  This page is used for setting up/registering new bulbs as well as reconfiguring existing bulbs. To register a new bulbs, the user must first be connected to the access point run within the bulb adapter. The application requires the user to enter the SSID and password of the home WiFi network that the ESP01 is expected to connect to, a name for the new bulb, and an optional description to identify the bulb uniquely, which would be helpful when multiple bulbs are registered.

  The entered data, along with the MQTT topic assigned to the logged-in user are sent to the bulb adapter through a `POST` request. The phone is expected to connect to the internet again, at which point the same data is also sent to the cloud server.

- **Main Screen**

  Registering a new bulb through the above page redirects the user to this screen. This is where the main functionality of the product takes place. It contains a switch to establish an MQTT connection, which is the main protocol used for data transfer between the mobile application and the cloud server.

  A newly registered bulb is displayed on this screen upon receiving a response from the cloud server, following the request sent to it immediately following the registration process as described above.

  The user can now use this page to switch their registered bulbs on and off from anywhere in the world. When either command is selected, the app publishes an MQTT message to the server, on the unique topic assigned to them.

  This screen also provides the user with options for renaming, reconfiguring, and removing existing bulbs.

8.2.2 User Flow and Data Flow

1. First, when the user logs in or signs up, the application receives the existing bulb data and user topic from the server as a JSON object.

2. The application decodes the message and using the bulb data, and creates the existing bulbs dynamically in the main screen. The application maintains a small, separate database locally within the phone to ensure smooth functionality.

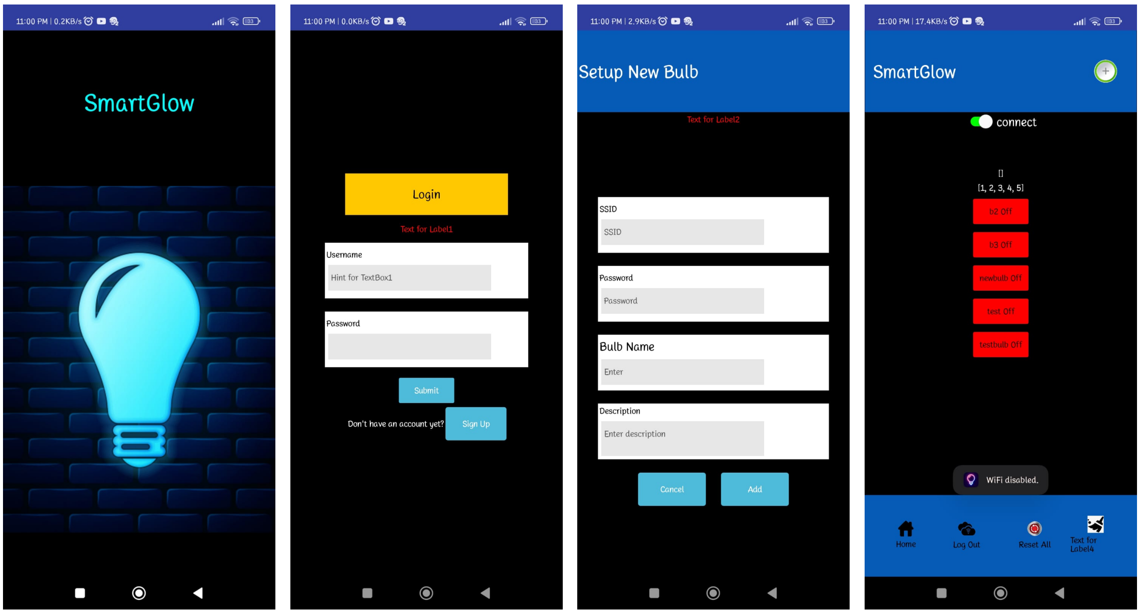


Figure 8.3: (a) External View (b) Section View

3. When registering a bulb, the application opens up a new bulb setup page where the user can enter the data regarding the bulb.

4. During this stage the user needs to be connected to the access point provided by the ESP01. When the data is enterd the data is sent to the ESP01 through a POST request and the user is redirected back to the main screen.

5. Meanwhile a global variable is created to hold on to the new bulbs that are out of sync with the server. When the user connects back to the WiFi network the newly added bulb data is sent to the server and once the 200 OK response is received, the application understands that the bulb has been added successfully and synced with the server and deletes the entry from the global variable.

6. The same procedure is done when renaming and removing bulbs. Finally when the 200 OK response is received, the application creates the bulb in the user interface.

7. By clicking the bulb the user can publish MQTT messages to the server in the format of `(bulbid, on-off state)`. Furthermore the application maintains a global list with the currently added bulbs of the user and a global dictionary consisting of the bulb data of the user in order to provide a smooth experience.

Chapter 9

Marketing and Sales

9.1 Marketing Strategy

9.1.1 Target Audience

The primary market for SmartGlow will be homeowners who show a bit of enthusiasm for tech, young professionals, and other people who are interested in integrating smart home technology into their living spaces. Also we are planning to present this as an energy saving solution too, where users can at any given time check which light bulbs are switched on in your house and switch them off if they are not in use.

Other than that we will be targeting people who are in need of improving the security of their households while they are away from their homes. How it can be done is, as we all know when we leave our house for an extended periods of time, we tend to keep our porch light switched on, at night it isn't a problem, but when the light is still switch on in the morning as there's no one in the house to switch it off, it might signal the outsiders that you are not home, which might lead to huge problems. But when you have a bulb that you can control from anywhere in the world you will not have that problem.

9.1.2 Branding

SmartGlow is positioned as an affordable, easy-to-use entry point into smart home automation. We'll be building our Brand centered around the tagline **"Lights made Smart, and Costs made light"**.The brand SmartGlow will always symbolize ease-of-use, reliability, and modern design.The branding strategy focuses on creating a sense of community around the product, encouraging user-generated content and positive word-of-mouth.

9.1.3 Promotion

To promote the product we'll be leveraging social media. We'll be posting about our product in various social media communities to gain attention.Then we'll be filming simple yet powerful videos showcasing the functions and features of the product and we'll be sharing them on social media, along with that our plan is to carry on a Facebook paid lead campaign to increase consumer engagement and product awareness.

We'll also be maintaining a separate e-commerce website dedicated to our product and also we'll be listing our product on well established e-commerce websites such as Daraz, Etsy, Ebay etc.

9.1.4 Handling Competition

Given below are the lines of products that we see as competition in the market.

IoT Bulbs by Established Companies (e.g., Philips)

- Established brand recognition and consumer trust.
- Higher price points with a focus on premium features.

Figure 9.1: IoT Bulbs by Established Companies

- Extensive product ecosystems that integrate with other smart home devices.

WiFi Switches by Sonoff

Figure 9.2: IoT Bulbs by Established Companies

- Recognizable brand.
- Affordable and can be used in a wide range of devices other than just bulbs.

Sonoff Smart Light Bulb Holder

Figure 9.3: IoT Bulbs by Established Companies

- Recognizable brand.
- Offers the same services as our product, apart for a few more additional services.

How we try to beat the Competiton?

- Even though established IoT bulb brands are well-known, you often have to pay more than twice as much for their bulbs compared to ours. We offer our product at a very competitive price.
- Talking about Sonoff's WiFi bulbs, their product is affordable, but there is some considerable hassle involved in setting it up, including a bit of wiring. In contrast, our product is just plug and play, making it much easier to use.
- Additionally, our product allows you to convert any of your favorite bulbs at home into IoT bulbs, providing even more flexibility and convenience.

9.2 Sales Strategy for SmartGlow

9.2.1 Product Placement

Most of the sales that we are planning to do will be carried out through **e-Commerce platforms and online orders via social media.** Also we are having a plan to partner with **Home Automation Solution providers** as they can reduce their cost by a greater extent by moving to our product.

9.2.2 Retailing

We'll be opening stalls in all kinds of house and office related exhibitions such as **"Kedella"** which in annually held at **BMICH.**.

Also we'll be placing our product in **mid-scale Hardware shops and light bulb shops** so we can bring our product closer to people who are much likely to purchase it.

9.2.3 After Sales Service

We provide reliable after-sales service to ensure customer satisfaction. Our team is available to assist with any technical issues, replacements, or inquiries. We strive to resolve any problems quickly and efficiently, offering support through phone, email, or online chat. Our goal is to ensure that every customer has a positive experience with our product.

We'll consistently create engaging content on our social media platforms about how to set up our bulb and what to do if you encounter any problems. This will help us raise consumer awareness even after the sale and also grow our online audience.**We'll also be offering a warranty period of 1 year.**

9.3 Budget Proposal

The following costs are calculated for the production of 1000 units.

9.3.1 Electronic Component Cost

Name of the component	**Model Number**	**No. of Units per Product**	**Price (LKR)**	**Supplier**
PCB		1	36.45	JLC PCB
ESP-01 Wi-Fi Module	ESP8266 ESP-01	1	320.73	Shenzhen Fly-Fun Technology Co.
OMRON 5V SSR	G3MB-202P	1	301.00	
Buck Converter	Generic	1	127.79	Shenzhen Creatall Electronics Co.
Voltage Regulator	AMS117 3.3V	1	12.50	SKYTRONIC (PVT) LTD
Resistors	SMD	5	11.00	SKYTRONIC (PVT) LTD
Capacitors (10uF 100nF)	SMD	5	15.00	SKYTRONIC (PVT) LTD
NPN-BJT	MMBT3904LT1G	1	12.00	SKYTRONIC (PVT) LTD
P-Channel MOSFET	DMP3099L-7	1	15.00	SKYTRONIC (PVT) LTD

Table 9.1: Electronic Component Costs

9.3.2 Enclosure Cost

Item	Cost Per Unit (LKR)	Supplier
Screw Bulb Threads	20	Locally Sourced
Enclosure (Injection Molding)	300	Locally Sourced

Table 9.2: Enclosure Costs

9.3.3 Marketing Cost

Advertising Per Unit (LKR)	100

Table 9.3: Miscellaneous Costs

9.3.4 Miscellaneous Cost

Server Cost (Added per Unit) (LKR)	15
Service Cost (Per Unit) (LKR)	92
Packaging (Per Unit) (LKR)	40
TOTAL	147

Table 9.4: Miscellaneous Costs

9.3.5 Shipping Costs

Official Logistic Service Provider	Fardar Express Domestic (PVT) LTD
Shipping Coordinator	Deshan Vimukthi
Price Per Kg	8.15 USD
Sri Lanka Customs National Imports Tariff Per Kg (LKR)	1250 LKR

Table 9.5: Shipping Service Provider

Product Name	Country of Shipping	Weight (1000 units)
ESP-01 Wi-Fi Module	CHINA	8 kg
OMRON 5V SSR	CHINA	13 kg
Buck Converter	CHINA	14 kg
PCB	CHINA	8 kg
TOTAL WEIGHT		**43 kg**

Table 9.6: Package Weights

Total Shipping Cost (Including Custom Clearance) 1000 units	**LKR 159,585**
Shipping Cost Per Unit (Including Custom Clearance)	**LKR 159.59**

9.3.6 Final Cost Per Unit

Components (LKR)	851.47
Enclosure (LKR)	320.00
Shipping (LKR)	159.59
Marketing (LKR)	100.00
Other (LKR)	147.00
TOTAL PRODUCTION COST PER UNIT (LKR)	**1578.06**

Table 9.7: Final Production Cost

9.3.7 Selling Price

Profit Margin	28.5%
Profit (LKR)	446.94
Final Selling Price (LKR)	2025

Table 9.8: Selling Price and Profit Margin

Appendix A

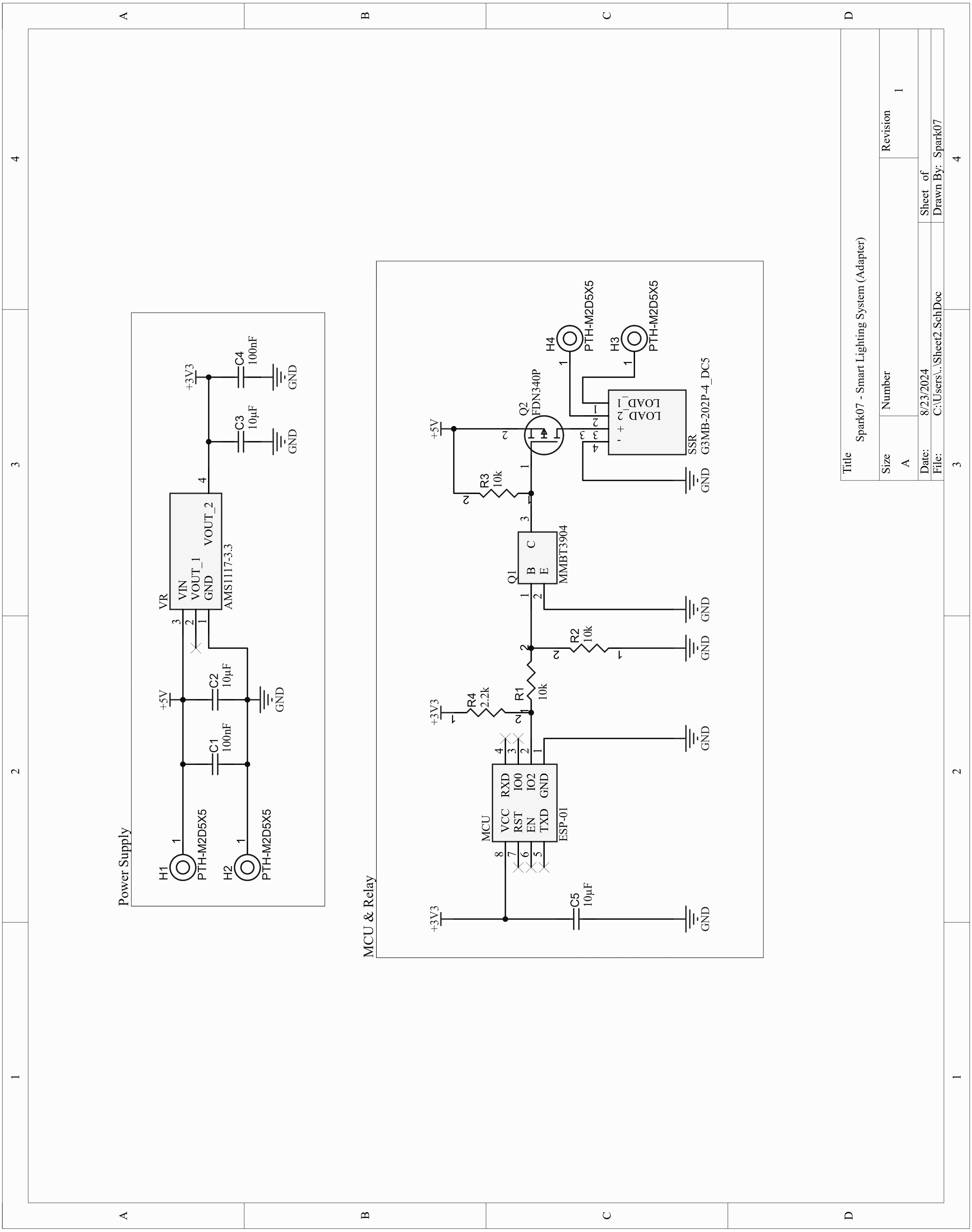
Spark07 Team

Udugamasooriya P.H.J.	Circuit design, PCB design, PCB testing and debugging.
Walgampaya H.K.B.	Microcontroller coding, Mobile application and backend development, IoT testing and debugging.
Warushavithana N.D.	Circuit design, Enclosure design, Enclosure and PCB assembly, PCB testing and debugging.
Weerasinghe K.K.M.	PCB design, Market research and business analysis.

Table A.1: Task Allocation

Appendix B

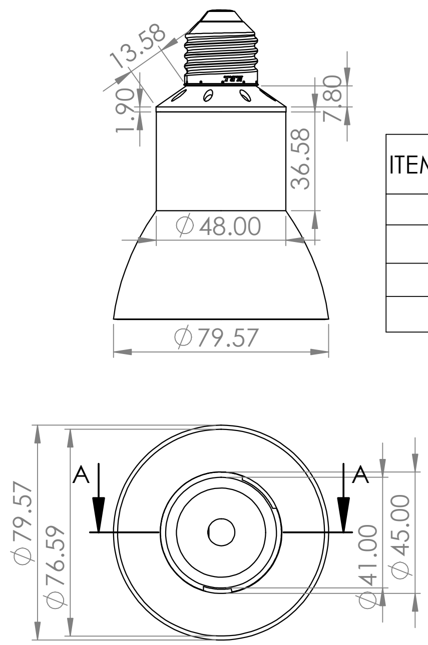
PCB Schematic



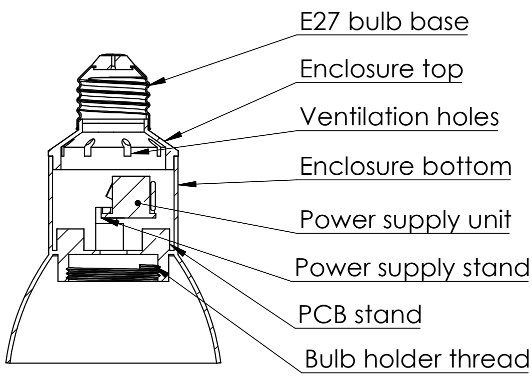
Power Supply
H1
PTH-M2D5X5
H2
PTH-M2D5X5
C1
100nF
C2
10µF
+5V
GND
VR
VIN
VOUT_1
GND
VOUT_2
AMS1117-3.3
+3V3
C3
10µF
C4
100nF
MCU & Relay
MCU
VCC
RST
EN
TXD
RXD
IO0
IO2
GND
ESP-01
C5
10µF
R4
2.2k
R1
10k
R2
10k
Q1
B
C
E
MMBT3904
R3
10k
Q2
FDN340P
SSR
LOAD_1
LOAD_2
G3MB-202P-4_DC5
H3
PTH-M2D5X5
H4
PTH-M2D5X5
Title
Spark07 - Smart Lighting System (Adapter)
Size
A
Number
Revision
1
Date:
8/23/2024
File:
C:\Users\..\Sheet2.SchDoc
Sheet of
Drawn By: Spark07

Appendix C

Enclosure Drawing



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	enclosure-bottom		1
2	enclosure-top		1
7	E27 bulb base		1
9	psu-stand		1



SECTION A-A

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:

FINISH: YES

DEBURR AND BREAK SHARP EDGES

DO NOT SCALE DRAWING

REVISION 2

	NAME	SIGNATURE	DATE
DRAWN	N D Warushavithana		03/05/2024
CHK'D			
APPV'D			
MFG			
Q.A			

TITLE:

Spark07 Smart Bulb Adapter

MATERIAL: PLA

DWG NO. enclosure-assembly

A4

WEIGHT:

SCALE:1:2

SHEET 1 OF 1