University of Moratuwa
Faculty of Engineering
Department of Electronic & Telecommunication Engineering
Semester 4 (Intake 2020)

Development of a Space Management System Incorporating a Bidirectional Visitor Counting Unit

Final Report(Design Documents)

LUCKSHAN G.W.C.M.
INDEX NUMBER : 200358G

This document is submitted as a partial fulfilment of module EN2160 - Electronic Design Realization
July 24, 2023

Contents

Abstract

The product presented in this **design report** accurately tracks and displays two essential metrics: **the total number of visitors who enter a specific location and the current count of visitors present inside that location**. The primary focus is to provide valuable information concerning the number of present visitors within the premises, which is advantageous for managing congestion during high footfall periods, such as festivals and crowded shopping malls.

By offering real-time data on the number of people inside the venue through its integration with the relevant organization's webpage, this product enables visitors to make informed decisions about when to visit. Being aware of the crowd situation, consumers can arrive at a different time, effectively reducing congestion and streamlining their overall experience.

Furthermore, this solution relieves service providers from the burden of managing large crowds, as the continuous updates on visitor count empower them to offer better services without *constant manual intervention.*

The versatility of this product extends beyond shopping malls and festival venues. Locations of natural or historical significance, such as museums and botanical gardens, can also benefit from its usage by maintaining daily records of total visitors and current footfall. As a result, the product becomes a valuable tool for *recording and analyzing visitor data over time*, allowing users to access records through the website, thereby providing insights in the form of graphical representations.

The applications of this product expand to events like exhibitions and film halls, where it can accurately count overall attendees and those present at any given moment. This feature benefits organizers and visitors, offering valuable insights into visitor trends and fluctuations.

In summary, the product's core functionality revolves around efficiently tracking the total and current visitor counts, optimizing congestion control, enhancing service delivery, and facilitating informed decision-making for visitors to various venues and events.

1 Problem Definition

1.1 Introduction to the Problem

Visitor counters are commonly used in locations where tracking the number of people entering is essential. Such counters prove particularly useful when managing queues or when individuals need to know their queue position. Hospitals, for instance, frequently employ these systems to aid patient flow. However, in scenarios where groups need an overall visitor count, a dedicated person must tally the visitors manually. This necessity arises in museums, exhibition areas, and competitions where competitor counts are crucial for equipment preparation. Unfortunately, manual counting can lead to inaccuracies, rendering the obtained data less reliable.
During festival seasons, shopping malls and markets experience increased footfall, resulting in congestion. Shoppers often strive to obtain their desired products quickly, leading to competition and potential discomfort. Nevertheless, visitors must know the congestion level before arriving at a location. Even at the entrance, they must figure out the current situation. If visitors could access information about the number of people already inside the shopping complex beforehand, they could choose more suitable times, mitigating congestion by making informed decisions. However, updating manual counts on a website during the festival season proves impractical due to the rapidly changing visitor numbers.

1.2 Need List for solving the problem

To address the problem effectively, it is crucial to identify the stakeholders interested in our product. Key stakeholders include authoritative figures from shopping complexes, security officers, and the consumers who utilize the services within these establishments. After conducting discussions and interviews with stakeholders, the following need list was compiled:

- **Real-time Visitor Count Display** : Security guards and security personnel can quickly gauge the congestion level and control visitor entry by prominently displaying the number of people inside the establishment near the entrance. When the visitor count decreases (people exit), they can permit additional visitors up to the maximum capacity of the location.
- **Bidirectional Visitor Counter** : The system must function as a bidirectional counter, particularly for places where the entrance and exit doors are the same. This ensures clarity in identifying whether visitors are entering or exiting.
- **Exceeding Maximum Capacity Alert** : Indicating when the visitor count surpasses the maximum capacity of the location allows both watchmen and visitors to understand the situation and take appropriate actions.
- **Visitor Count Accessibility** : Providing the current visitor count to the visitors empowers them to decide on suitable visitation times, optimizing their valuable time.
- **Suggesting Low Congestion Alternatives** : Offering suggestions for nearby places utilizing visitor counters with lower congestion helps users make informed decisions and regulate overall congestion.

1.3 Features of the Existing Products

The current product solely indicates the visitor count inside the location, lacking information on the maximum capacity. As such, it fails to aid congestion control, where knowledge of the maximum capacity is essential for both visitors and authorities.
The product's display-only approach necessitates visitors physically coming to the location to access the current visitor count, leading to time wastage.
The links provided appear to be for existing products in the market. As mentioned above;

However, they lack the capability to remotely access the data and require users to be physically present to observe the count data from the display. Additionally, there is no indication of the maximum capacity of the premises.

Links:

People Visitor Counter with Visitor Chime Function Wireless, Non Directional Footfall Counter - AliExpress

Chinese and English dual system Highlight IR light people counter infrared sensor counter - Alibaba

1.4 Proposed Features to Add

To address the identified needs and improve the product, the following features should be incorporated:

- **Bidirectional Visitor Counter** : Implement a bidirectional visitor counter capable of discerning whether a person is entering or exiting the premises.
- **Webpage with Comprehensive Visitor Data** : Develop a dedicated webpage displaying the total visitor count and the number of current visitors inside the place. Users can search for the business or organization to view visitor data for specific periods, such as the last month, week, or day.
- **Exceeding Capacity Alert** : Integrate a buzzer system to alert relevant parties when the current visitor count exceeds the user-defined maximum capacity, which should be adjustable.
- **Nearby Low Congestion Suggestions** : Provide suggestions for nearby places employing visitor counters with lower congestion levels to aid visitors in making informed decisions.
- **Efficient Power Consumption** : Optimize power consumption by ensuring the product operates only when visitors are present, entering sleep mode when not in use. Manual control (switching on and off) is impractical, as human presence detection is essential to avoid counting irrelevant objects.

By incorporating these proposed features, the product can effectively address the identified needs, enhance user experience, and improve congestion management in various establishments and event locations.

2 Design Process

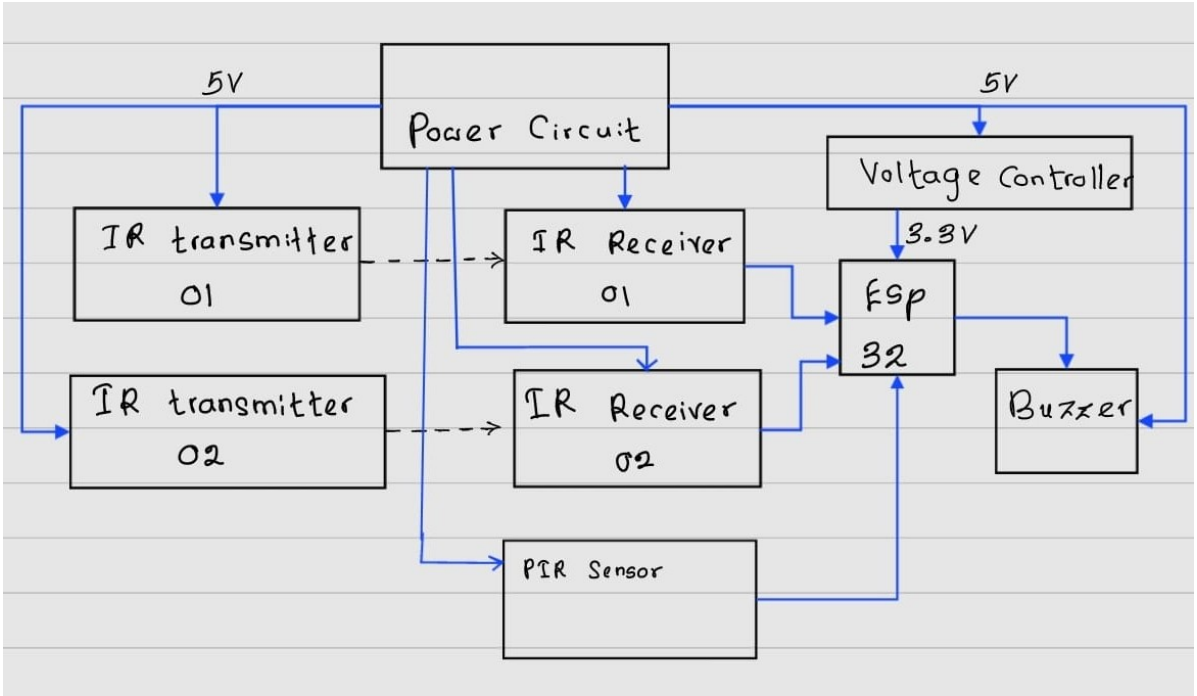
2.1 Stimulating Ideas

To address the requirements outlined in the need list, the following components and design considerations are proposed:

- **IR Sensors for Visitor Counting** : In order to accurately count visitors entering and exiting the premises, infrared (IR) sensors are chosen for their reliability and sensitivity. Two IR sensors are strategically placed at the entrance/exit points to form a bidirectional visitor counter. The system relies on the interruption of IR beams to detect visitors' movement, and by analyzing the sequence of beam breaks, the chip can determine whether it is a "VISITOR IN" or "VISITOR OUT" event. IR break beam sensors are ideal for this application due to their simplicity and ability to provide digital outputs when the IR beams are broken.
- **Webpage Integration with WIFI Module** : For seamless communication between the product and the relevant organization's webpage, a chip equipped with a WIFI module is chosen. The ESP32 chip is a versatile and widely used microcontroller with processing capabilities and built-in WIFI connectivity. This module allows the product to transmit real-time updates of the visitor count to the organization's servers, enabling the display of accurate data on the website for visitors to access conveniently. The chip can be easily programmed to connect with nearby WIFI access points, making it an ideal choice for web-enabled applications.
- **Buzzer for Capacity Exceeding Alert** : A buzzer is incorporated into the system to address the need for capacity control. When the number of visitors inside the place exceeds the maximum capacity set by the user, the buzzer is activated to alert the security guards and visitors. This audio feedback prompts necessary actions to manage the congestion effectively and ensure compliance with safety regulations. The buzzer's activation and deactivation are controlled by the chip based on the real-time visitor count data.

2.2 Block Diagram

The proposed block diagram outlines the system's functionality and critical components:



2.3 Functionality

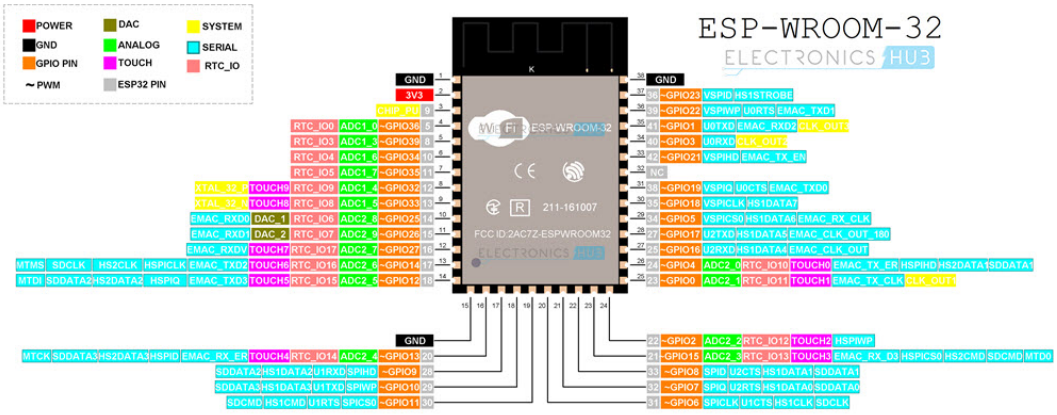
The system operates as follows:

- Two IR transmitters emit continuous IR rays, while two IR receivers continuously detect these rays. The IR beams are strategically positioned to span the entrance/exit points.
- Signals from the IR receivers are fed to the ESP32 chip, which processes the data and determines the direction of visitor movement (in or out) based on the sequence of IR beam interruptions. The chip then stores and updates the counts of total visitors and "VISITOR IN" separately.
- To optimize power consumption, a Passive Infrared (PIR) sensor is used to detect human motion near the entrance. When the PIR sensor detects motion, it triggers the ESP32 chip from deep-sleep mode to active mode. Conversely, when no human motion is detected, the chip remains in deep-sleep mode to conserve power.
- The chip transmits the updated visitor count data to the organization's servers via the WIFI module. This data is then displayed in real-time on the organization's webpage, providing visitors access to the current number of people inside the premises.
- Before deployment, the user inputs the maximum visitor count through the website. If the "VISITOR IN" count exceeds this predetermined limit, the chip activates the buzzer to alert the watchmen and visitors about the potential congestion. The buzzer continues to sound until the "VISITOR IN" count reduces below the maximum capacity.

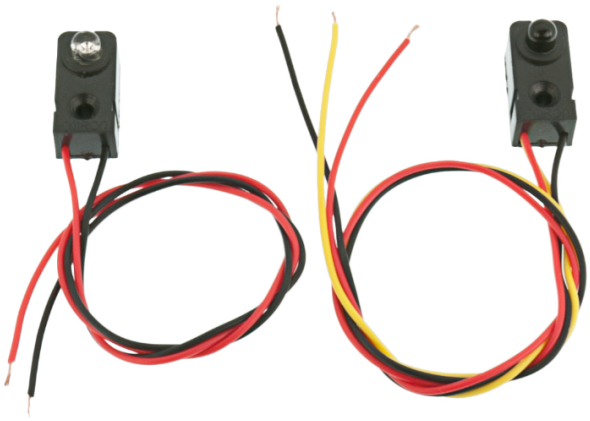
2.4 Component Selection

To fulfill the system's requirements, the following components are selected:

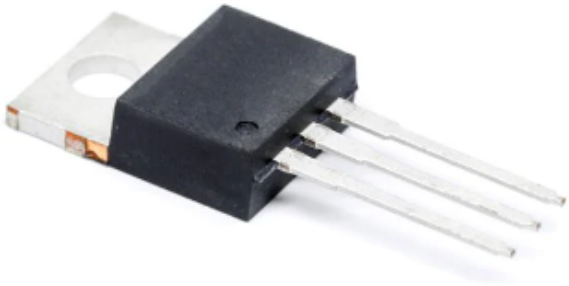
- **ESP32 Chip** : The ESP32 microcontroller is chosen for its processing capabilities and built-in WIFI connectivity. It offers sufficient computing power to manage the visitor counting algorithm and efficiently transmit data to the servers. Moreover, the ESP32's ability to connect with nearby WIFI access points allows for seamless web integration.
  The data sheet of the used processor, ESP WROOM 32 is attached in the Appendix-V



- **IR Break Beam Sensors** : IR break beam sensors are the optimal choice for visitor counting due to their reliability and ease of implementation. These sensors provide digital outputs when the IR beams are interrupted, enabling accurate visitor detection and movement direction identification.
  The data sheet of the used processor, IR Break Beam sensor is attached in the Appendix-V



- **LD1117V33 Fixed Low Drop Positive Voltage Regulator** : The voltage regulator ensures stable and regulated power supply to the ESP32 chip and other components. Its fixed 3.3V output voltage is ideal for the ESP32's power requirements and ensures reliable operation.



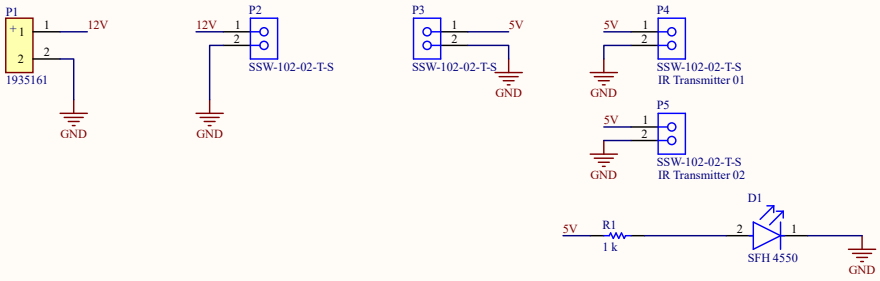
- **DC-to-DC Buck Converter** : A buck converter is employed to reduce the IR transmitters' voltage from 12V to 5V. This ensures efficient power utilization and minimizes heat dissipation.
- **Pull-up Resistors and Capacitors** : The selected pull-up resistors and capacitors are determined based on the ESP32 chip's data sheet to ensure proper communication and programming.

2.5 Schematic

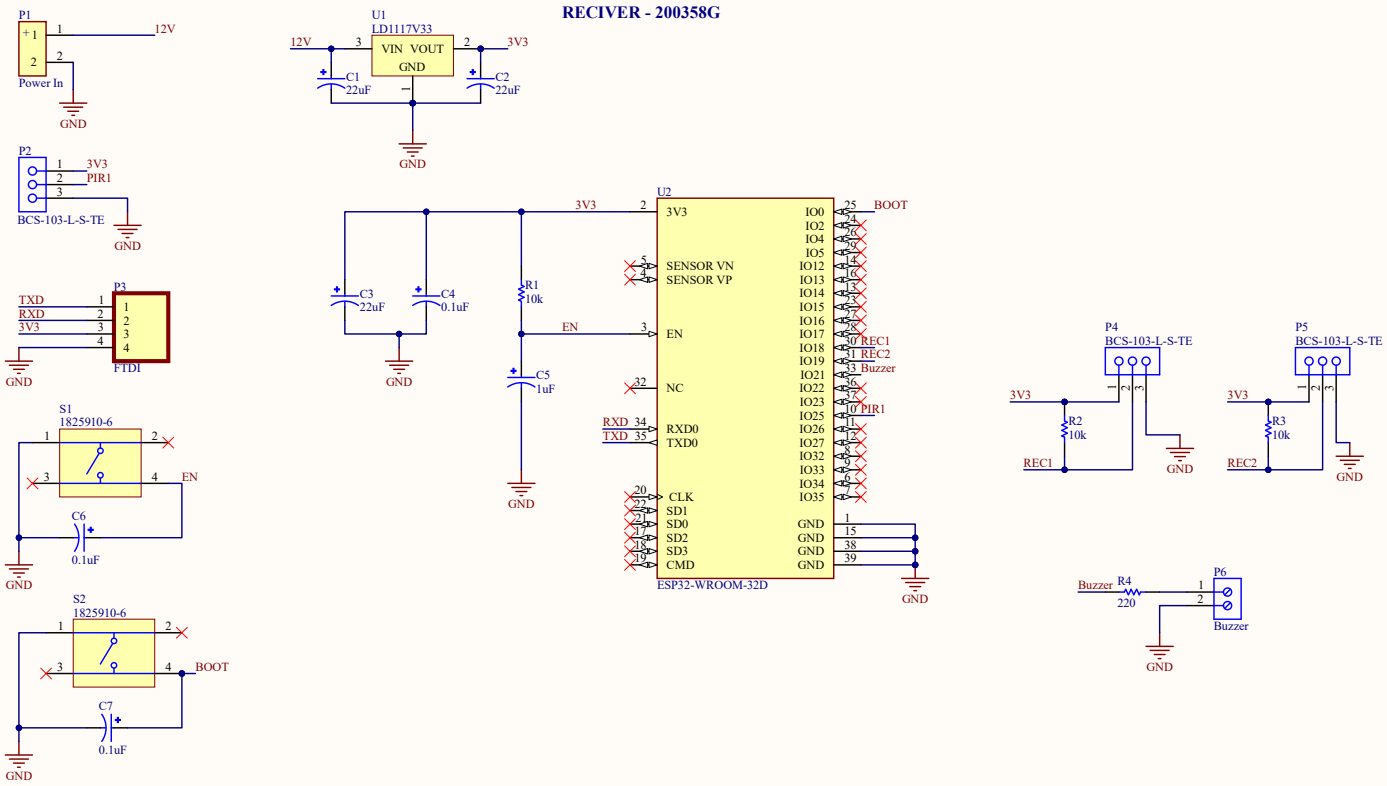
Since the product consists with two parts, there are two schematics for the two separate parts.

- Transmitter Schematic
- Receiver Schematic

TRANSMITTER - 200358G



Title	Transmitter		
Size	Number		Revision
A4	01		01
Date:	7/22/2023	Sheet of	01 of 01
File:	C:\Users\..\IR Transmitter.SchDoc	Drawn By:	G.W.C.M.Luckshan



Title: Reciever		
Size: A4	Number: 1	Revision: 01
Date: 7/22/2023		Sheet of: 01 of 01
File: C:\Users\..\reciever.SchDoc		Drawn By: G.W.C.M.Luckshan

2.6 PCB Design

The PCB design incorporates the above components and adheres to standard trace width calculations based on current requirements. Components are strategically placed to allow easy access and minimize potential signal interference. For example, sensor pins are positioned near the enclosure for straightforward and reliable connections. Pacing pull-up resistors close to the ESP32 chip facilitates efficient RX and TX processes during code uploading. The voltage regulator is positioned near the PCB boundary to dissipate heat effectively and avoid affecting other internal components.
By analysing descriptively,The PCB design ensures an efficient layout, considering trace widths and component placement to optimize signal integrity and minimize interference. Key considerations include:

- **Trace Widths** : Trace widths are calculated based on the current requirements of each circuit path, ensuring proper current flow without generating excessive heat or voltage drops. Adequate trace widths prevent signal degradation and improve the PCB's overall performance.
- **Component Placement:** : Components are arranged to allow easy access for maintenance and connections. Sensor pins are strategically placed near the enclosure, simplifying visitor detection and optimizing accuracy. The WIFI module is positioned to facilitate seamless communication with nearby WIFI access points.
- **Heat Dissipation** : The voltage regulator, which dissipates heat during operation, is placed near the PCB boundary to dissipate heat outside the circuit. This ensures other internal components are not affected by excess heat.
- **Ground Planes** : Proper grounding techniques are employed to minimize noise and ensure signal integrity. Ground planes are used to provide a low-impedance return path for the current flow and reduce the potential for ground loops or interference.

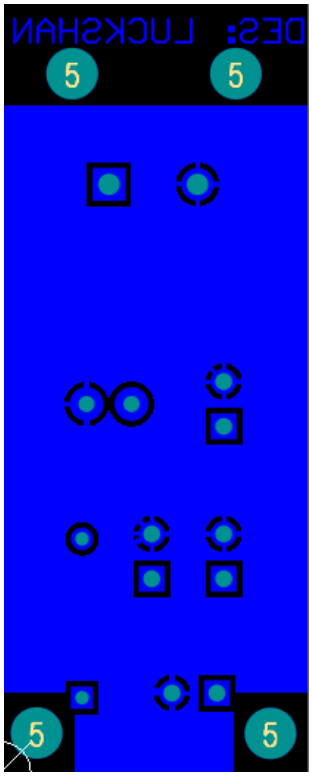
By implementing these design considerations and selecting appropriate components, the proposed system will effectively address the identified needs, providing a reliable and efficient visitor counting solution for various establishments and event locations.

Other Design Rules

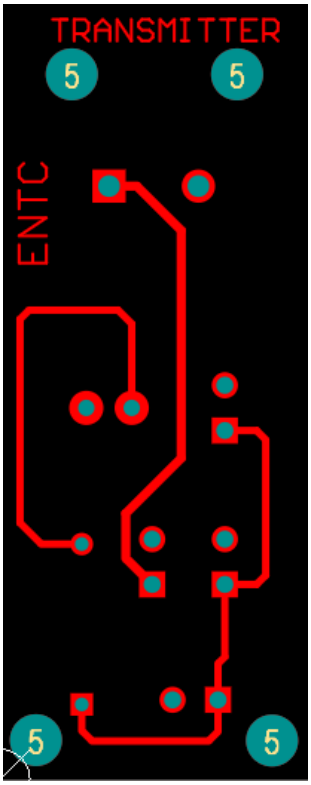
The PCB design specifications entail a 0.5 mm minimum trace width alongside the corresponding clearance. Additionally, the design mandates a minimum hole diameter of 0.3mm and a minimum via diameter of 0.6mm. Furthermore, the specified hole clearance stands at 0.27mm.

Important: When designing the PCB refer to the **13 chapter - Production manual** to identify the design rules.

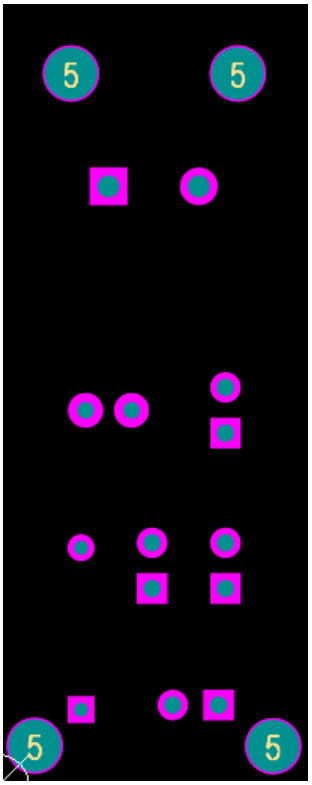
2.7 Transmitter-Layers



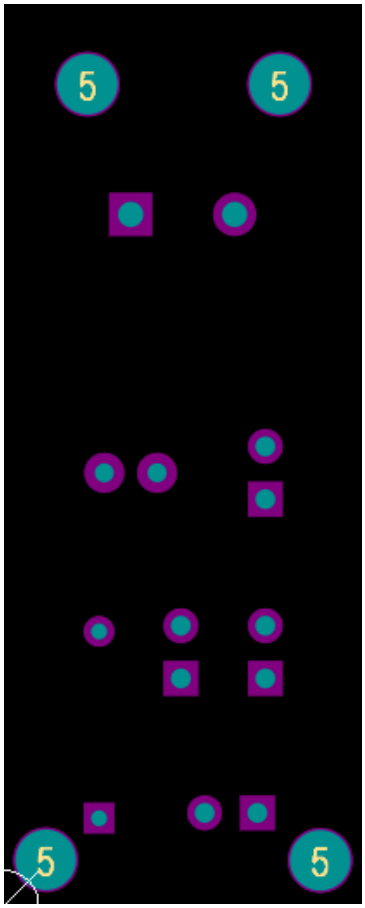
(a) Bottom Layer



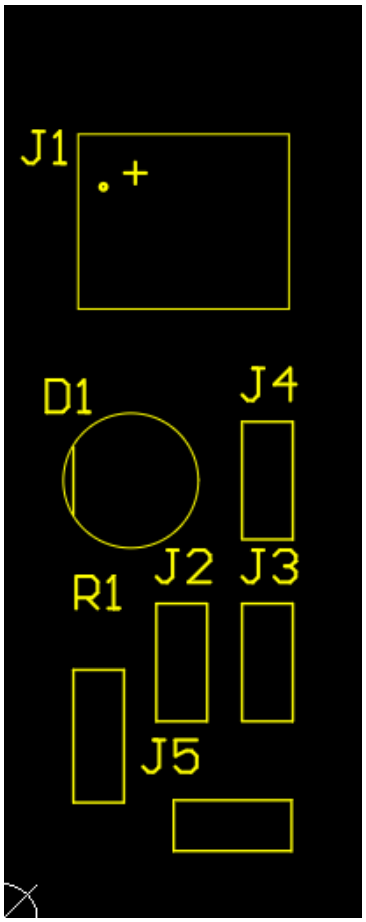
(b) Top Layer



(c) Bottom Solder

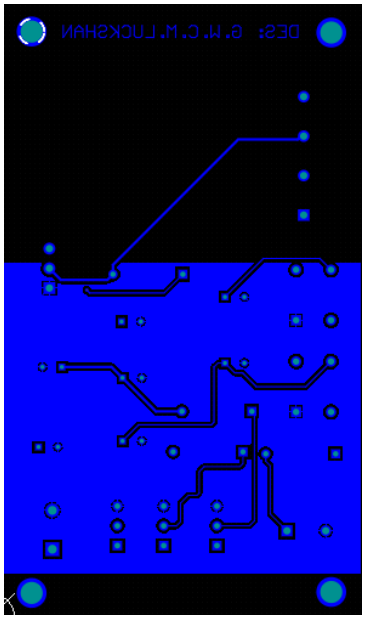


(a) Top Solder Layer

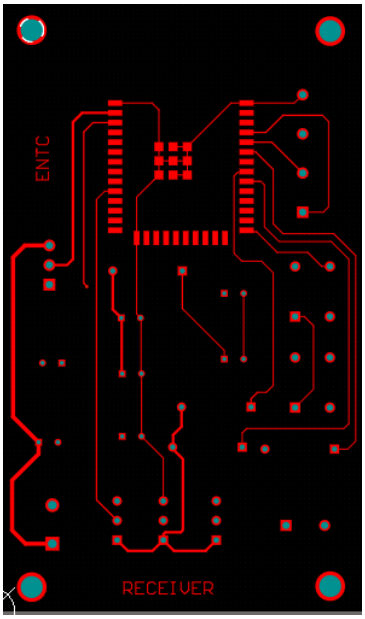


(b) Top Overlay

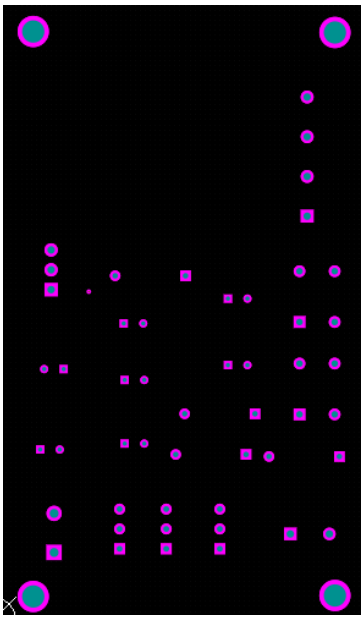
2.8 Receiver-Layers



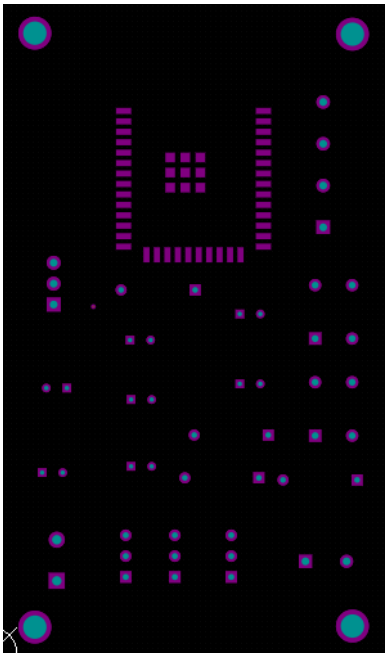
(a) Bottom Layer



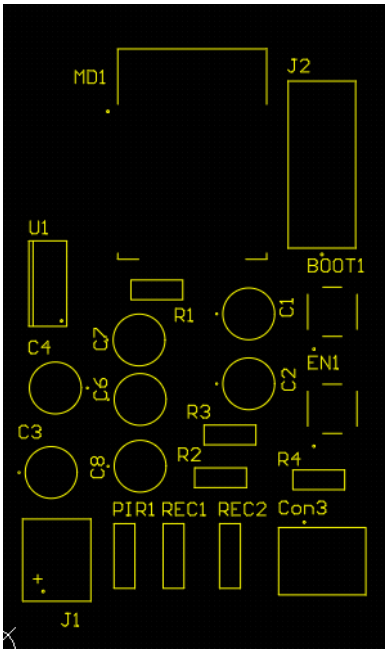
(b) Top Layer



(c) Bottom Solder



(a) Top Solder Layer



(b) Top Overlay

3 Cost of the Product

Cost Analysis Report (in Sri Lankan Rupees - LKR):
Product: Transmitter

- PCB: 1000 LKR
- Components: 1000 LKR
- Sensors: 1800 LKR
- Buck Converter: 1500 LKR
- Connector Wires: 1500 LKR

Product: Receiver

- PCB: 2000 LKR
- Components: 4000 LKR
- Sensors: 1800 LKR
- Buzzer: 300 LKR
- PIR Sensor: 1000 LKR
- Connector Wires: 1500 LKR

Enclosure Design: 4000 LKR
Delivery Costs: 1100 LKR
Total Cost for Receiver: 15800 LKR

Overall Cost:

Total Cost for the Transmitter: 6800 LKR
Total Cost for the Receiver: 15800 LKR

Total Cost for the Product: 22600 LKR

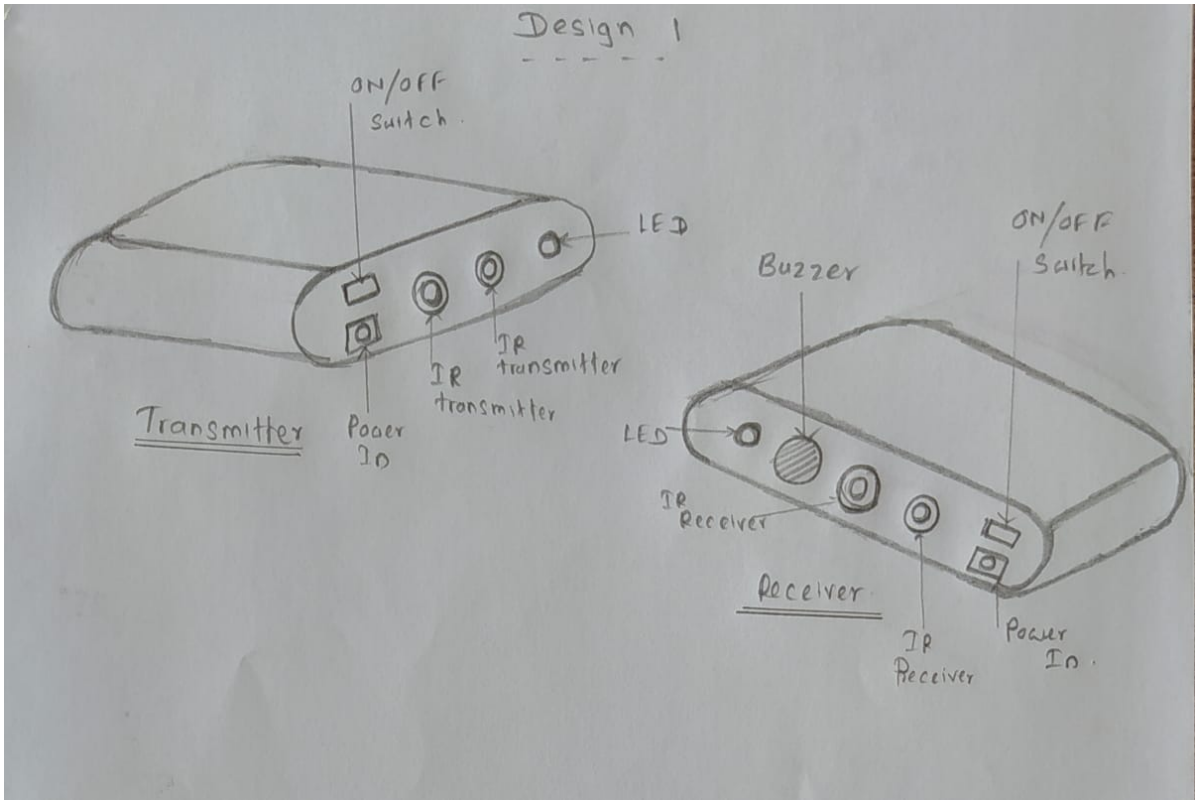
4 BOM

Bill Of Materials - IR Transmitter	
Description	Quantity
EMITTER IR 860NM 100MA RADIAL	1
2 Position Wire to Board Terminal Block Horizontal with Board 0.197 (5.00mm) Through Hole	1
SQ Post Socket, Through-hole, Vertical, -55 to 105 degC, 2.54 mm Pitch, 2-Pin, Female, RoHS	4
Axial Resistor, 1 KOhm, +/- 1%, 250 mW, -55 to 155 degC, 2-Pin THD, RoHS, Bulk	1
IR Break Beam Sensor with Premium Wire Header Ends - 5mm LEDs	2
3-40V to 1.5-35V 4A DC to DC Adjustable Step-Down Buck	1

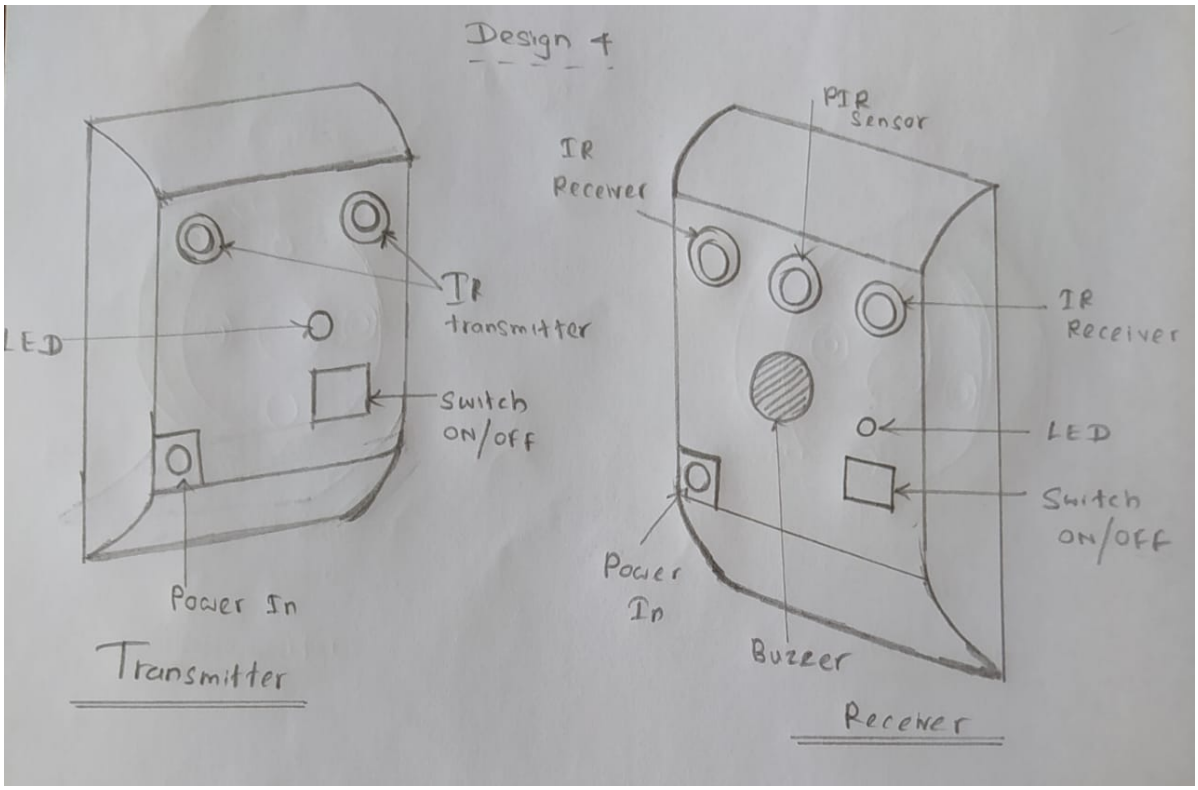
Bill Of Materials - IR Receiver	
Description	Quantity
Cap Aluminum Lytic 22uF 16V 20% (6.3 X 7mm) Radial 2.5mm 39mA 1000h 85C Bulk	3
Cap Aluminum Lytic 22uF 16V 20% (6.3 X 7mm) Radial 2.5mm 39mA 1000h 85C Bulk	3
Cap Aluminum Lytic 22uF 16V 20% (6.3 X 7mm) Radial 2.5mm 39mA 1000h 85C Bulk	1
2 Position Wire to Board Terminal Block Horizontal with Board 0.197 (5.00mm) Through Hole	1
Tiger Claw(TM) Pass-Through Socket, Vertical, -55 to 125 degC, 2.54 mm Pitch, 3-Pin, Female, RoHS	3
4 Position Wire to Board Terminal Block Horizontal with Board 0.200 (5.08mm) Through Hole	1
Female Header, Pitch 5 mm, 1 x 2 Position, Height 10 mm, Tail Length 3.5 mm, Rohs, Bulk	1
Axial Resistor, 1 KOhm, +/- 1%, 250 mW, -55 to 155 degC, 2-Pin THD, RoHS, Bulk	3
Axial Resistor, 1 KOhm, +/- 1%, 250 mW, -55 to 155 degC, 2-Pin THD, RoHS, Bulk	1
Tact Switch, SPST-NO, 0.05 A, -35 to 85 degC, 4-Pin THD, RoHS, Bulk	2
Fixed Low Drop Positive Voltage Regulator, 3.3V, 3-Pin TO-220	1
WIFI MODULE 32MBITS SPI FLASH	1

5 Enclosure Designs

5.1 Initial Hand Sketches

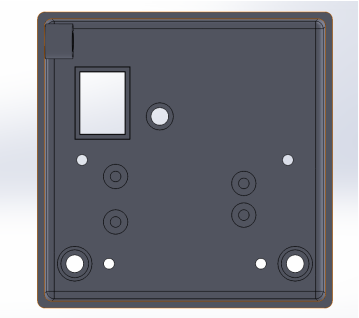
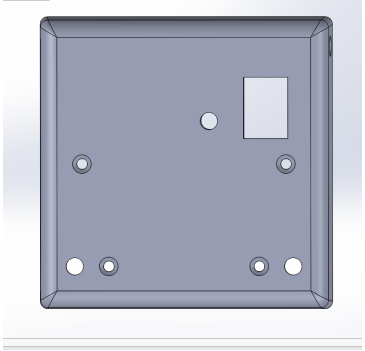
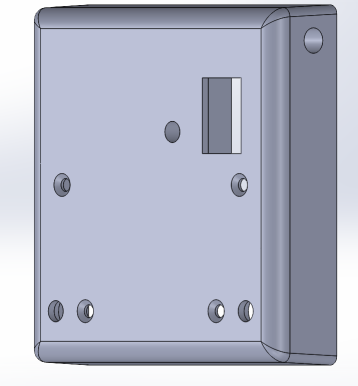


5.2 Final Hand Sketches

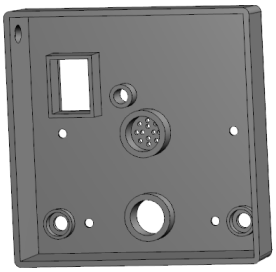
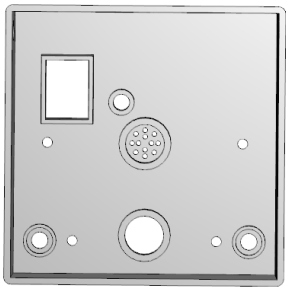


5.3 CAD Designs - Solidworks2021

5.3.1 Transmitter

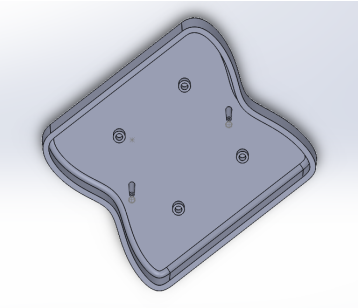
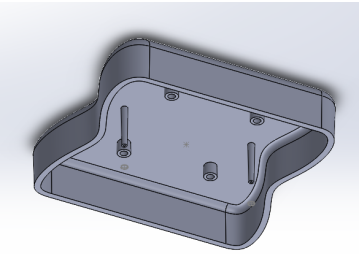
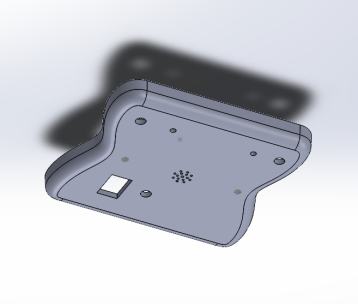




5.3.2 Receiver

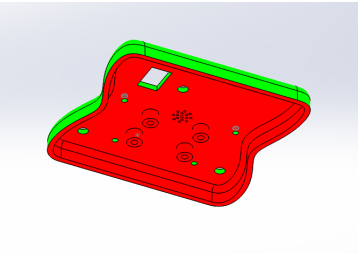
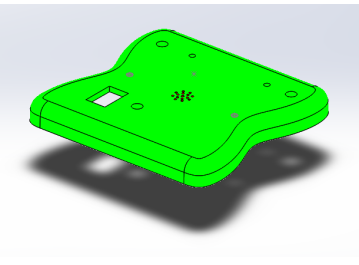
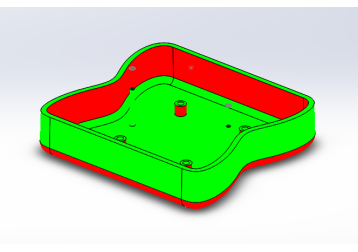




5.4 Aesthetic Designs

5.4.1 Solidworks Design

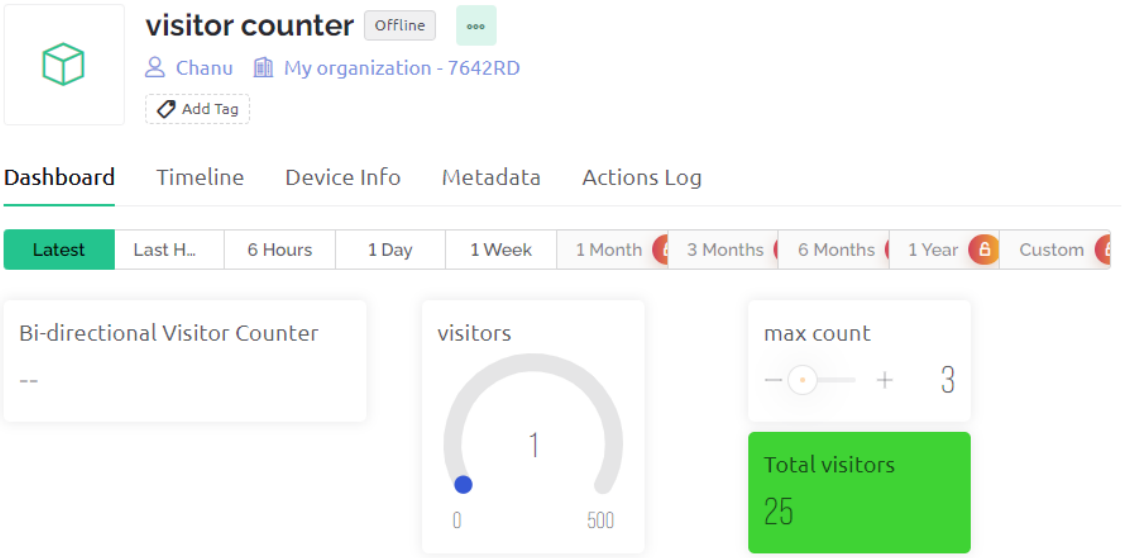
5.4.2 Draft Analysis

6 User Interface

6.1 Web Interface

The system offers a dedicated web interface for each organization utilizing the Visitor Counter product. Through this web interface, organizations can connect to their respective Visitor Counters via WIFI using a unique product key.
To facilitate the web interface and data visualization, the existing Blynk application is leveraged. Organizations can have multiple Visitor Counters, each associated with a specific area or location. Upon accessing the organization's webpage, visitors can view a list of these counters. The webpage redirects to the corresponding counter's information page upon clicking on a specific counter from the list. Here, visitors can access real-time data on TOTAL VISITORS for the current day and historical counts for previous days, weeks, and months. Additionally, the webpage displays the current count of VISITORS IN, providing visitors with valuable insights into the congestion level at that particular location.
For effective congestion management, the authorized personnel from the organization must initially input the maximum visitor count through the web interface. Until this input is provided, the buzzer will sound continuously to alert the need for user input. Visitors who log into the web interface merely to observe the data are restricted from giving user inputs. Their access is limited to viewing the displayed values without any interactive features.



6.2 Smartphone Interface

In addition to the web interface, the system offers a dedicated smartphone application for convenient access to visitor count data on mobile devices. The smartphone application provides real-time information on TOTAL VISITORS and VISITOR IN for each organization's Visitor Counter.
Security officers utilizing the smartphone application can provide user inputs for the maximum visitor count. This capability empowers them to take action when the count approaches the preset limit, ensuring effective congestion control and adherence to safety regulations.
The ability to provide user inputs is restricted for other users accessing the smartphone application solely for observation purposes. These users can only view the displayed visitor count data, gaining valuable insights into the congestion level and making informed decisions about their visit.

6.3 Interface Features Summary

- Web Interface: Each organization has a dedicated webpage linked to their respective Visitor Counter via WIFI and a unique product key. The Blynk application facilitates data visualization and real-time updates.

- Webpage Display: Organizations can list multiple Visitor Counters, categorized by their respective areas or locations. Visitors can select a specific counter to view its real-time and historical counts.
- Real-Time Data: The web interface displays TOTAL VISITORS and VISITOR IN counts, helping visitors understand the current congestion level at the chosen location.
- Historical Counts: Users can access historical data, including previous day, week, and month counts, providing valuable insights into visitor trends.
- User Input for Maximum Count: Authorized personnel from the organization can set the maximum visitor count through the web interface to manage congestion effectively.
- Smartphone Interface: A dedicated smartphone application provides real-time access to visitor count data for enhanced convenience.
- Security Officer Privileges: Security officers utilizing the smartphone application can input the maximum visitor count, taking proactive measures to control congestion.
- Observation-Only Access: Users accessing the web and smartphone interfaces for observation purposes can view the displayed counts without the ability to provide user inputs.

The system provides intuitive and user-friendly interfaces, enabling organizations to make data-driven decisions, optimize congestion control, and enhance overall visitor experiences. The web and smartphone interfaces offer seamless access to real-time and historical visitor count data, empowering organizations to manage visitor flow effectively and ensure a safe and comfortable environment for all patrons.

7 Software Implementation

```
#define BLYNK_TEMPLATE_ID "TMPL6-xo-I4qN"
#define BLYNK_TEMPLATE_NAME "visitor counter"
#define BLYNK_AUTH_TOKEN "fREA_HscEl4OrQpqlHJ9tgU4hlLF0yVX"

#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include <Wire.h>


// You should get Auth Token in the Blynk App.
// Go to the Project Settings (nut icon).
char auth[] = "fREA_HscEl4OrQpqlHJ9tgU4hlLF0yVX";

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "Redmi";
char pass[] = "12345678";


#define sensorPin1 19
#define sensorPin2 18
#define BUZZER_PIN 21 // ESP32 GIOP21 pin connected to Buzzer's pin
```

```
int sensorState1 = 1;
int sensorState2 = 1;
int LED_BUILTIN = 2;
int count=0;
int max_count = 0;
int in_count = 0;


void setup()
{
  Serial.begin(115200);
  Blynk.begin(auth, ssid, pass);
  delay(1000);  // wait a second
  pinMode (sensorPin1, INPUT_PULLUP);
  pinMode (sensorPin2, INPUT_PULLUP);
  pinMode (LED_BUILTIN, OUTPUT);
  pinMode(BUZZER_PIN, OUTPUT);
}

int inputState;
BLYNK_WRITE(V2)
{
  inputState = param.asInt();
}

void loop()
{
  Blynk.run();
  max_count = inputState;
  Serial.println(max_count);
  sensorState1 = digitalRead(sensorPin1);
  sensorState2 = digitalRead(sensorPin2);
  Serial.print(sensorState1);
  Serial.println(sensorState2);

  if(sensorState1 == LOW){
    count++;
    in_count++;
    digitalWrite(LED_BUILTIN, HIGH);
    delay(1000);
    digitalWrite(LED_BUILTIN, LOW);
    delay(500);
  }

  if(sensorState2 == LOW){
    count--;
    digitalWrite(LED_BUILTIN, HIGH);
    delay(1000);
    digitalWrite(LED_BUILTIN, LOW);
    delay(500);
  }

  if (count >= max_count) {
    Serial.println("The button is being pressed");
    digitalWrite(BUZZER_PIN, HIGH); // turn on
  }
  else
  if (count < max_count) {
    Serial.println("The button is unpressed");
    digitalWrite(BUZZER_PIN, LOW);  // turn off
  }

  Blynk.virtualWrite(V1, count); // Visitors In
  Blynk.virtualWrite(V3, in_count); //Total visitor count
  delay(1000);
}
```

8 Proposed System

The proposed product is an integrated crowd management system with counters comprising an Infrared (IR) Transmitter and an IR Receiver. This system aims to address the challenges posed by crowded environments such as busy shopping malls or exhibitions. By employing a reliable and efficient counting mechanism, the product helps in monitoring and regulating the number of individuals entering and leaving specific premises within the monitored areas.
A key component of the system is a user-friendly mobile or web-based application, where real-time data from the counters is wirelessly transmitted and displayed. This application serves as a valuable resource for the regulatory authorities responsible for crowd management. They can utilize the collected data to set and enforce maximum occupancy limits for each area, thereby ensuring safety and optimal utilization of space.
The system operates through strategically placed Counters at the main entrance and sub-counters at various other entry points, such as stalls or other specific zones. This allows for tracking of both the total count of people in the entire mall or exhibition and the number of people present in individual stalls or areas.
To enhance user experience and alleviate congestion, the application provides valuable insights to consumers. It offers real-time information on areas with lower crowd density, enabling users to make decisions and choose less crowded locations. Additionally, the application estimates waiting times for entry, based on the set maximum counts and the allocated time periods for user stay at a stall or area. This feature helps users guess when they can expect to gain access if waiting in a queue.

9 Future Developments

In the pursuit of future developments for this product, several innovative approaches can be explored.
To address the limitation of sequential counting, the product can be included with a count parallel array. This deploys multiple IR transmitters and receivers in a 2D array configuration, positioned to cover different entry points simultaneously. Then data captured from these arrays is being processed through advanced algorithms, allowing the system to count people arriving in parallel and accurately monitor the visitor count from various directions.
In addition to the existing IR-based counting mechanism, the product can be further improved by integrating image processing algorithms. This entails the use of cameras or other visual sensors to capture images or video of the crowd. Advanced computer vision techniques can then be applied to analyze these visuals and extract relevant data, such as the number of people and their movements. By combining image processing with IR counting, the system can be developed to-be much efficient.
Also to create a more extensive and comprehensive crowd management network, the product can be developed to interconnect multiple shopping malls. By linking these through a centralized system, real-time crowd data and insights can be shared among the malls. Users of the mobile or web-based application can then access information not only about the congestion status within a single mall but also about the overall crowd situation across interconnected malls. This feature will allow the users to identify and choose less crowded places to visit, in a larger area with multiple options.

10 Acknowledgment

We extend our heartfelt gratitude and appreciation to all those who have contributed their time, expertise, and dedication to the development of this remarkable marketable product. The successful realization of this design document would not have been possible without the collective efforts of these remarkable individuals and teams.

First and foremost, we express our deepest gratitude to our lecturers, whose unwavering support and encouragement have been the driving force behind this project. Their strategic guidance and commitment to innovation have been instrumental in shaping the concept and guiding us towards excellence.

We also wish to acknowledge the dedication of our friends from the department, whose meticulous testing and attention to detail have ensured that our product adheres to the highest standards of performance and reliability.

We extend our profound gratitude to **Mr. Sameera, our esteemed Analog laboratory technical officer, and Mr. Chanimda, our dedicated Analog laboratory assistant**. Their unwavering collaboration and commitment have played a pivotal role in surmounting various challenges and attaining excellence in product development. Their invaluable support in providing us with the necessary measuring equipment from the laboratory and assisting us in circuit fabrication have been instrumental in our achievements.

Lastly, we extend our warmest appreciation to our customers, whose valuable feedback and unwavering support have been the driving force behind our pursuit of excellence. Their trust in our product motivates us to continually enhance and optimize our offerings.

In conclusion, this marketable product stands as a testament to the power of teamwork, determination, and innovation. Together, we have overcome hurdles, embraced challenges, and produced a product that is poised to revolutionize the market.

11 Appendix - I (User Manual)

User Manual - Bidirectional Visitor Counter

Introduction

Welcome to the Bidirectional Visitor Counter User Manual. This manual provides essential information on efficiently setting up and using the Bidirectional Visitor Counter. Please read this guide carefully before operating the product.

Product Overview

The Bidirectional Visitor Counter accurately tracks the total number of visitors entering a location and displays the real-time count of visitors inside the premises. It helps manage congestion and enhances the visitor experience during peak times.

Key Features

- Accurate Bidirectional Visitor Counting
- Real-time Visitor Count Display
- Historical Data View for Past Counts
- Buzzer Alert for Exceeding Maximum Capacity
- Web Interface for Remote Monitoring
- Smartphone Application for On-the-Go Access

Safety Precautions

- Keep the product away from liquids and moisture.
- Ensure proper power supply to avoid damage.(Use the given adapters only.)
- Do not dismantle or modify the product.
- Only authorized personnel should adjust the maximum visitor count. (Security Guards or the Administrators of the premises.)

Getting Started

Unboxing and Assembly

- Carefully unbox and inspect all components.
- Follow the assembly instructions provided in the package.

Initial Setup

- Connect the Bidirectional Visitor Counter to a stable power source using the provided power adapter.(Only for the 220 V AC power supply)
- Connect the product to the organization's WIFI network for real-time updates.
- **Proceed the alignment process mentioned below**

Accessing the Web Interface

- Use the unique product key to access your organization's webpage..
- View real-time and historical visitor counts.

Installing the Smartphone Application

- Download and install the Bidirectional Visitor Counter app from the app store.
- Access real-time visitor counts and input the maximum (authorized users) visitor count.

Alignment Procedure

Before proceeding with the alignment process, please ensure that the IR Transmitter and Receiver units are securely installed in their designated positions. The transmitter should be appropriately placed, pointing towards the receiver, with no obstacles obstructing the infrared signal's direct path.

- **Step 1: Observe Visitor Count** : Initially, observe the visitor IN count displayed by the system. If you notice a continuous increment in the visitor count without any actual visitors passing through the area, it is an indication that the IR Transmitter and Receiver require alignment.
- **Step 2: Aligning the Transmitter and Receiver** : To align the transmitter and receiver, follow these steps:
  - Carefully adjust the IR transmitter's position to ensure it directly faces the IR receiver unit. Make sure there are no physical obstructions between them, such as walls, furniture, or other objects that could disrupt the infrared signal.
  - Check for any potential sources of interference nearby, such as other electronic devices emitting infrared signals. If any such sources are found, move the transmitter and receiver away from them to minimize interference.
  - To optimize alignment, use a spirit level or alignment tool to ensure the transmitter and receiver are positioned at the same height and angle.
- **Step 3: Resetting the Receiver** : After aligning the IR transmitter and receiver, it is essential to reset the receiver to ensure accurate counting. To reset the receiver, simply power off the unit momentarily and then power it back on. The receiver will initialize and be ready to count visitors accurately.
- **Step 4: Verifying Alignment** : To verify the alignment's success, observe the visitor count displayed by the system once more. If the count remains steady without any false increments, the alignment has been successful.

Using the Web Interface

Accessing Your Organization's Webpage

- Enter the unique product key to access the webpage.
- View a list of visitor counters associated with specific locations.

Real-Time Visitor Count

- Monitor the real-time count of visitors inside the premises.
- Make informed decisions based on current congestion levels.

Historical Data View

- Access historical visitor counts for previous days, weeks, and months.
- Analyze visitor trends and patterns over time.

Inputting Maximum Visitor Count (Authorized Users)

- Authorized personnel can set the maximum visitor count for effective congestion control.
- The buzzer alerts when the count exceeds the set limit.

Smartphone Application Usage

Downloading and Installing the App

- Download the Bidirectional Visitor Counter app from the app store(collaborate with **Blynk IoT**).
- Install the app on your smartphone.

Real-Time Visitor Count

- Monitor the real-time count of visitors inside the premises.
- Make informed decisions based on current congestion levels.

Inputting Maximum Visitor Count (Authorized Users)

- Authorized personnel can set the maximum visitor count for effective congestion control.
- The buzzer alerts when the count exceeds the set limit.

Maintenance and Troubleshooting

Cleaning and Care

Regularly clean the IR sensors and the product enclosure.

Troubleshooting Guide

Contact support if problems persist.

Safety Information and Warnings

- Handle the product and power supply with care.
- Avoid exposing the product to extreme temperatures.
- Keep the product out of reach of children.

Don't hesitate to contact our support team for any questions or assistance.
Thank you for choosing the Bidirectional Visitor Counter. Enjoy a smooth and informed visitor experience!

12 Appendix - II (Maintenance Manual)

Maintenance Manual - Bidirectional Visitor Counter

Introduction

Welcome to the Bidirectional Visitor Counter Maintenance Manual. This manual provides essential instructions for maintaining and caring for the Bidirectional Visitor Counter to ensure optimal performance and longevity. Regular maintenance will ensure accurate visitor counting and reliable congestion control. Please read this guide carefully and follow the maintenance procedures to keep the product in excellent working condition.

Maintenance Schedule

Regular Inspection

: Perform a regular visual inspection of the Bidirectional Visitor Counter to check for any signs of damage or wear. Look for loose connections, frayed cables, or any external factors affecting the product's performance.

Cleaning

: Clean the product and its components regularly to remove dust, dirt, or any other particles that may hinder the proper functioning of the sensors or affect accuracy.

Cleaning Procedures

Product Exterior

- Wipe the product's exterior surface with a soft, dry cloth.
- Avoid using harsh chemicals or abrasive materials that may damage the enclosure.

IR Sensors

- Clean the IR sensors with a soft brush or compressed air to remove dust and debris.
- Ensure that the IR sensors are free from obstructions to maintain accurate visitor counting.

WIFI Module and Chip

- Avoid exposing the WIFI module and chip to moisture or liquids.
- Inspect the connections and ensure they are secure.

Troubleshooting

Common Issues and Solutions

If the Bidirectional Visitor Counter exhibits any issues or malfunctions, refer to the troubleshooting guide provided in the User Manual. Follow the suggested solutions to resolve common problems.

Technical Support

For more complex issues or difficulties not covered in the troubleshooting guide, contact our technical support team for assistance. Provide them with a detailed description of the problem, and they will help diagnose and resolve it.

Firmware Updates

Periodically check for firmware updates for the ESP32 chip to ensure the latest features and enhancements. Follow the instructions provided by the manufacturer to update the firmware safely.

Replacement Parts

If any components of the Bidirectional Visitor Counter require replacement, use only authorized and compatible parts recommended by the manufacturer. Unauthorized factors may lead to product malfunction and void the warranty.

Warranty Information

The Bidirectional Visitor Counter comes with a limited warranty period. Please refer to the warranty information provided with the product for details on coverage and terms.

Safety Precautions

Power Supply

- Disconnect the product from the power supply before conducting any maintenance.
- Handle the power supply with care to avoid electrical hazards.

Component Handling

- Avoid touching sensitive electronic components directly.
- Use an anti-static wrist strap when handling sensitive components to prevent damage from electrostatic discharge.

Storage and Transportation

Storage

- Store the Bidirectional Visitor Counter in a dry, dust-free environment.
- Protect the product from extreme temperatures and direct sunlight.

Transportation

- When transporting the product, ensure it is adequately secured to avoid damage.
- Use appropriate packaging to protect the product during transportation.

Conclusion

Proper maintenance is essential for the reliable and accurate performance of the Bidirectional Visitor Counter. By following the guidelines and procedures in this manual, you can ensure the product's longevity and optimize its functionality. Regular inspection, cleaning, and adherence to safety precautions will contribute to a seamless visitor counting experience.

Don't hesitate to contact our support team for any questions or assistance.

Thank you for choosing the Bidirectional Visitor Counter. Enjoy a smooth and informed visitor experience!

13 Appendix - III (Production Manual)

Production Manual - Bidirectional Visitor Counter

Introduction

Welcome to the Bidirectional Visitor Counter Production Manual. This comprehensive guide outlines the step-by-step procedures and best practices for manufacturing the Bidirectional Visitor Counter. It is essential to follow these instructions carefully to ensure the consistent and efficient production of high-quality products. Please familiarize yourself with the entire production process before initiating any manufacturing activities.

Bill of Materials

Before commencing production, gather all the necessary components and materials for manufacturing the Bidirectional Visitor Counter. Refer to the following Bill of Materials (BOM)

IR Transmitter Production - BOM

Bill Of Materials - IR Transmitter	
Description of the Part	Quantity
EMITTER IR 860NM 100MA RADIAL	1
2 Position Wire to Board Terminal Block Horizontal with Board 0.197 (5.00mm) Through Hole	1
SQ Post Socket, Through-hole, Vertical, -55 to 105 degC, 2.54 mm Pitch, 2-Pin, Female, RoHS	4
Axial Resistor, 1 KOhm, +/- 1%, 250 mW, -55 to 155 degC, 2-Pin THD, RoHS, Bulk	1
IR Break Beam Sensor with Premium Wire Header Ends - 5mm LEDs	2
3-40V to 1.5-35V 4A DC to DC Adjustable Step-Down Buck	1

IR Transmitter Production - BOM

Bill Of Materials - IR Transmitter	
Description of the Part	Quantity
Cap Aluminum Lytic 22uF 16V 20% (6.3 X 7mm) Radial 2.5mm 39mA 1000h 85C Bulk	3
Cap Aluminum Lytic 22uF 16V 20% (6.3 X 7mm) Radial 2.5mm 39mA 1000h 85C Bulk	3
Cap Aluminum Lytic 22uF 16V 20% (6.3 X 7mm) Radial 2.5mm 39mA 1000h 85C Bulk	1
2 Position Wire to Board Terminal Block Horizontal with Board 0.197 (5.00mm) Through Hole	1
Tiger Claw(TM) Pass-Through Socket, Vertical, -55 to 125 degC, 2.54 mm Pitch, 3-Pin, Female, RoHS	3
4 Position Wire to Board Terminal Block Horizontal with Board 0.200 (5.08mm) Through Hole	1
Female Header, Pitch 5 mm, 1 x 2 Position, Height 10 mm, Tail Length 3.5 mm, Rohs, Bulk	1
Axial Resistor, 1 KOhm, +/- 1%, 250 mW, -55 to 155 degC, 2-Pin THD, RoHS, Bulk	3
Axial Resistor, 1 KOhm, +/- 1%, 250 mW, -55 to 155 degC, 2-Pin THD, RoHS, Bulk	1
Tact Switch, SPST-NO, 0.05 A, -35 to 85 degC, 4-Pin THD, RoHS, Bulk	2
Fixed Low Drop Positive Voltage Regulator, 3.3V, 3-Pin TO-220	1
WIFI MODULE 32MBITS SPI FLASH	1

Important : wen selecting the components, Refer the data sheets provided in Appendix-V also.

Production Process

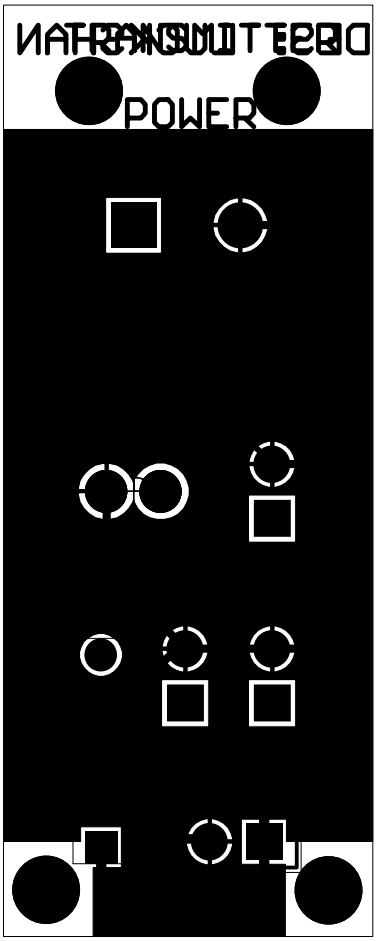
PCB Fabrication

PCB Design and Layout

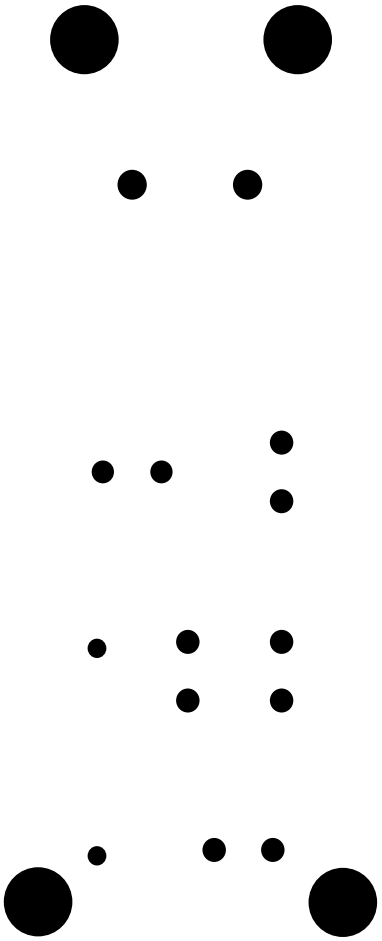
- Create the PCB design using computer-aided design (CAD) software, ensuring the layout accommodates all the components and connections.
- Consider proper grounding and routing to minimize interference and ensure signal integrity.

If you are using **Altium Designer** to design the schematic and the PCB following documents can be used.

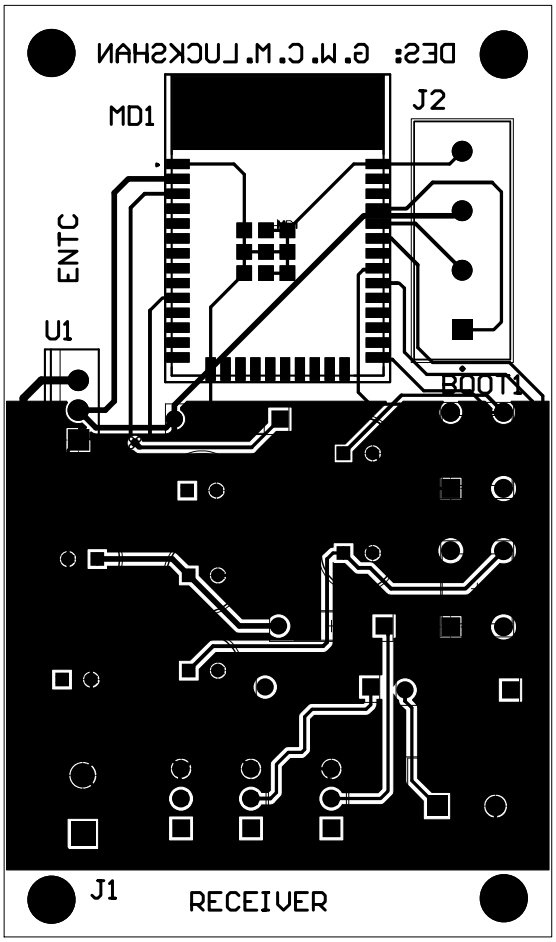
CAMtasticDXP (TM):



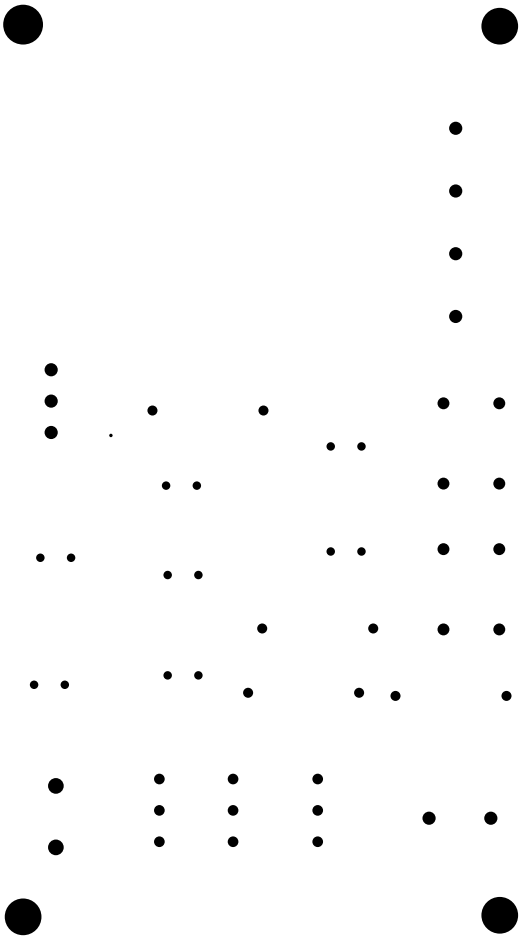
CAMtasticDXP (TM):



CAMtasticDXP (TM):



CAMtasticDXP (TM):



Prototype Testing

- Produce a prototype of the PCB to validate the design and functionality.
- Thoroughly test the prototype for any issues or deficiencies.

Mass Production

- Once the prototype is successfully tested, proceed with mass PCB production.
- Partner with a reliable PCB manufacturing facility to ensure consistent quality.

Component Assembly

Component Procurement

- Source the required electronic components from authorized suppliers, adhering to quality standards and specifications.

Soldering

- Assemble the electronic components on the PCB using automated or manual soldering techniques.
- Ensure precise Soldering to avoid loose connections and faulty joints.

Firmware Integration

ESP32 Programming

- Develop and test the firmware code for the ESP32 chip, incorporating the visitor counting algorithm and WIFI module integration.

Firmware Flashing

- Flash the Firmware onto the ESP32 chips using specialized programming tools.

Enclosure Assembly

Enclosure Selection

- Choose an appropriate enclosure that accommodates all the components and provides adequate protection.(proposed Enclosure designs are in the design files. Refer to the design files.)
- Ensure the enclosure meets necessary safety standards and environmental requirements.

Component Installation

- Carefully install the PCB and all electronic components inside the chosen enclosure.
- Securely fasten all components to prevent damage during use and transportation.

Labeling and Branding

- Affix product labels and branding on the exterior of the enclosure as per the organization's guidelines.

Quality Control

Functional Testing

Conduct functional testing of each assembled Bidirectional Visitor Counter to verify accurate visitor counting and data transmission.

Calibration

Calibrate the visitor counting algorithm to ensure precise counts and bidirectional detection.

Buzzer Functionality

Test the buzzer function to ensure it activates when the visitor count exceeds the preset maximum capacity.

WIFI Connectivity

Verify that each Bidirectional Visitor Counter establishes a stable WIFI connection and transmits data correctly to the organization's webpage.

Packaging and Shipping

Product Packaging

- Package each Bidirectional Visitor Counter securely to prevent damage during transportation and storage.
- Include each unit's user manuals, maintenance manuals, and relevant documentation.

Shipping and Logistics

Partner with reputable shipping and logistics companies to ensure timely and safe delivery of the products to customers.

Conclusion

The production of the Bidirectional Visitor Counter requires meticulous attention to detail and adherence to the outlined procedures. By following this Production Manual, you can ensure the product's consistent quality, functionality, and reliability. Proper quality control measures will lead to high customer satisfaction and a successful market launch.

14 Appendix - IV (Quality Control Document)

Quality Control Document - Bidirectional Visitor Counter

Introduction

The Bidirectional Visitor Counter represents a cutting-edge product designed to provide accurate and reliable visitor counting for various establishments and event locations. To maintain the highest quality and performance standards, this Quality Control Document outlines comprehensive quality control measures to be implemented during the production process. These measures aim to identify deviations, defects, or non-conformities and ensure that only products meeting the strictest quality criteria are delivered to the market.

Quality Control Measures

Incoming Inspection

- Conduct meticulous inspections of all incoming electronic components and materials to verify their quality, authenticity, and compliance with specifications.
- Perform visual checks to identify any physical damage, improper labeling, or inadequate packaging that may affect the final product's performance.
- Cross-reference component data with authorized suppliers and manufacturers to ensure authenticity and traceability.

PCB Assembly Inspection

- Employ skilled technicians to conduct detailed visual inspections during the PCB assembly process to verify proper soldering, component placement, and the absence of shorts or open circuits.
- Utilize advanced automated inspection tools, such as Automated Optical Inspection (AOI), to detect even minute defects that may be challenging to identify through manual inspection alone.

Functional Testing

- Implement rigorous functional testing procedures on each assembled Bidirectional Visitor Counter to verify core functionalities, including accurate visitor counting, bidirectional movement detection, and seamless data transmission.
- Evaluate the interaction between critical components, such as the ESP32 chip, IR sensors, and WIFI module, to ensure cohesive and synchronized operation.

Calibration

- Conduct precise calibration of the visitor counting algorithm to ensure accuracy and consistency in counting and detecting visitor movements.
- Thoroughly assess the system's ability to correctly identify "VISITOR IN" and "VISITOR OUT" events to eliminate any margin of error.

Buzzer Functionality

- Rigorously test the buzzer system to guarantee it reliably activates when the number of visitors exceeds the user-defined maximum capacity.
- Ensure the buzzer emits a clear and audible sound, effectively alerting security guards and visitors in the event of potential congestion.

WIFI Connectivity

- Employ meticulous testing protocols to validate the stability and efficiency of the WIFI connectivity in each Bidirectional Visitor Counter.
- Verify that the system consistently transmits visitor count data to the organization's webpage in real time without delays or data loss.

Enclosure Inspection

- Conduct thorough inspections of the product enclosure to identify and rectify any physical defects, such as cracks, misalignments, or damages.
- Ensure that all electronic components fit securely within the enclosure without interfering with their functionality.

User Interface Testing

- Implement rigorous testing of the web and smartphone interfaces to guarantee seamless and user-friendly access to real-time and historical visitor count data.
- Verify that the interfaces provide accurate and reliable information to visitors, enabling informed decision-making.

Packaging Inspection

- Ensure that each product packaging provides robust protection during transportation and storage, safeguarding the Bidirectional Visitor Counter from potential damage.
- Ensure that each product packaging provides robust protection during transportation and storage, safeguarding the Bidirectional Visitor Counter from potential damage.

Quality Assurance

- Institute a culture of continuous improvement and commitment to quality, with strict adherence to quality control procedures at every stage of the production process.
- Conduct regular quality audits to ensure compliance with established quality standards and procedures while promoting a proactive approach to quality assurance.

Non-Conformance Management

- Develop a systematic non-conformance management process to swiftly address any deviations or defects discovered during quality control inspections.
- Document and record all instances of non-conformance and their corresponding corrective and preventive actions to prevent recurrence.

Conclusion

The Bidirectional Visitor Counter undergoes stringent quality control measures to ensure that each unit meets and exceeds the highest performance, accuracy, and reliability standards. By strictly adhering to the outlined quality control procedures and fostering a culture of excellence, we can confidently deliver products that provide exceptional visitor counting solutions to our customers. This commitment to quality further strengthens our position as a market leader, ensuring customer satisfaction and long-term success in a competitive marketplace.

Further References(All the Design Documents)

GitHuB Link

Link - https://github.com/Chanula-Maduwantha/EDR-Project.git

15 Appendix-V (Other documents for Product Designing)

Comment	Description	Designator	Footprint	LibRef	Quantity
SFH 4550	EMITTER IR 860NM 100MA RADIAL	D1	FP-SFH_4550-MFG	CMP-62016-000011-1	1
1935161	2 Position Wire to Board Terminal Block Horizontal with Board 0.197 (5.00mm) Through Hole	P1	PHOENIX_1935161	1935161	1
SSW-102-02-T-S	SQ Post Socket, Through-hole, Vertical, -55 to 105 degC, 2.54 mm Pitch, 2-Pin, Female, RoHS	P2, P3, P4, P5	SMTC-SSW-102-02-X-S	CMP-1023-00323-1	4
1 k	Axial Resistor, 1 KOhm, +/- 1%, 250 mW, -55 to 155 degC, 2-Pin THD, RoHS, Bulk	R1	RESA60-630X240	CMP-1659-00075-1	1

Figure 9: BOM-Transmitter

Comment	Description	Designator	Footprint	LibRef	Quantity
1825910-6	Tact Switch, SPST-NO, 0.05 A, -35 to 85 degC, 4-Pin THD, RoHS, Bulk	BOOT1, EN1	TECO-1825910-6_V	CMP-1684-00021-1	2
0.1uF	Cap Aluminum Lytic 22uF 16V 20% (6.3 X 7mm) Radial 2.5mm 39mA 1000h 85C Bulk	C1, C2, C7	CAPPRD250W45D630H700	ECEA1CKN220	3
22uF	Cap Aluminum Lytic 22uF 16V 20% (6.3 X 7mm) Radial 2.5mm 39mA 1000h 85C Bulk	C3, C4, C6	CAPPRD250W45D630H700	ECEA1CKN220	3
1uF	Cap Aluminum Lytic 22uF 16V 20% (6.3 X 7mm) Radial 2.5mm 39mA 1000h 85C Bulk	C8	CAPPRD250W45D630H700	ECEA1CKN220	1
Buzzer	Female Header, Pitch 5 mm, 1 x 2 Position, Height 10 mm, Tail Length 3.5 mm, Rohs, Bulk	Con3	TECO-282836-2_V	CMP-1684-00017-1	1
Power In	2 Position Wire to Board Terminal Block Horizontal with Board 0.197 (5.00mm) Through Hole	J1	PHOENIX_1935161	1935161	1
FTDI	4 Position Wire to Board Terminal Block Horizontal with Board 0.200 (5.08mm) Through Hole	J2	TE_282837-4	282837-4	1
ESP32-WROOM-32D	WIFI MODULE 32MBITS SPI FLASH	MD1	FP-ESP32-WROOM-32D-MFG	CMP-194065-000003-1	1
BCS-103-L-S-TE	Tiger Claw(TM) Pass-Through Socket, Vertical, -55 to 125 degC, 2.54 mm Pitch, 3-Pin, Female, RoHS	PIR1, REC1, REC2	SMTC-BCS-103-X-S-TE	CMP-1023-00005-1	3
10k	Axial Resistor, 1 KOhm, +/- 1%, 250 mW, -55 to 155 degC, 2-Pin THD, RoHS, Bulk	R1, R2, R3	RESA60-630X240	CMP-1659-00075-1	3
220	Axial Resistor, 1 KOhm, +/- 1%, 250 mW, -55 to 155 degC, 2-Pin THD, RoHS, Bulk	R4	RESA60-630X240	CMP-1659-00075-1	1
LD1117V33	Fixed Low Drop Positive Voltage Regulator, 3.3V, 3-Pin TO-220	U1	TO220	CMP-0244-00470-1	1

Figure 10: BOM-Receiver