

## Automated Trip Alert System for Earth Leakage Circuit Breaker (ELCB)

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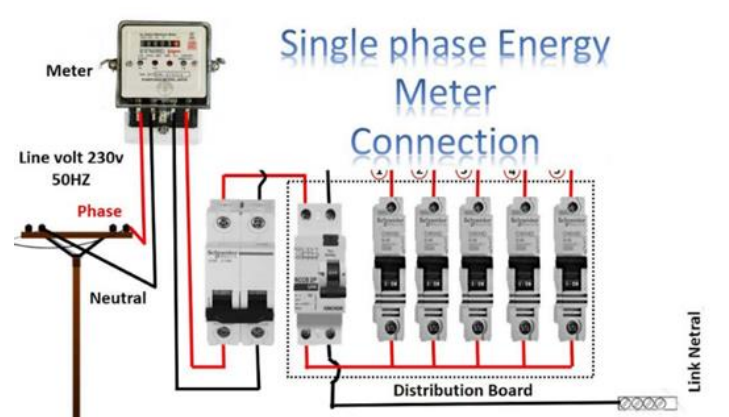
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**Abstract:** The automatic system is the most used method to facilitate tasks that require human effort. This method is typically employed in systems that necessitate immediate action in the event of any issues, ensuring prompt resolution. However, the widespread adoption of this system has been limited due to human resources constraints and high maintenance costs. Based on the Internet of Things (IoT) approach, this project presents a suitable design for an automatic system that can be installed in residential areas. This system assists in maintaining home security during the absence of occupants. The project produces a monitoring system that operates in real-time using an application platform and the Internet of Things (IoT). By utilizing voltage sensors, the voltage readings can be accessed by homeowners even when away from home. Additionally, this project ensures the safety of electrical appliances that require continuous electrical connection. In the event of a circuit malfunction in the house, the time required to detect the fault is significantly reduced, enabling users to be promptly informed. The project's outcome demonstrates the successful detection and reactivation of the Earth Leakage Circuit Breaker (ELCB) in the event of a short circuit. Overall, this project enhances the Distribution Box (DB) system by effectively reactivating the ELCB.

**Keywords:** Automation System, Internet of Things (IoT), Electrical Appliances

### 1. Introduction

The Earth Leakage Circuit Breaker (ELCB) plays a crucial role in ensuring electrical safety by detecting and protecting against electrical leakages. The ELCB is widely employed in residential, commercial, and industrial settings to mitigate the risk of electric shock and fire hazards [1]. However, the manual monitoring of ELCBs can be challenging, especially in large-scale installations or remote locations. To address this limitation, the development of an Automated Trip Alert System for ELCB has emerged as a promising solution. Figure 1.1 shows the single phase of ELCB connection in residential.



**Figure 1.1 Single Phase of ELCB connection.**

The design and implementation of an innovative Automated Trip Alert System for ELCB, leveraging advancements in sensor technology, wireless communication, and intelligent algorithms. The system continuously monitors the electrical parameters and current flow in the circuit, detecting any abnormal leakage and triggering an immediate alert in case of a trip [1]. By automating the monitoring process, this system provides real-time information about electrical faults, allowing for swift response and preventive actions.

The benefits of implementing an Automated Trip Alert System for ELCB are numerous. Firstly, significantly improves the safety of electrical systems by promptly notifying users about ELCB trips, enabling them to take appropriate actions to mitigate the risks. Secondly, automated monitoring reduces the reliance on manual inspections, saving time and resources. Additionally, the system's ability to provide real-time data on electrical faults facilitates better troubleshooting, leading to reduced downtime and improved maintenance practices [1].

### 1.1 Problem Statement

Electrical systems play a crucial role in our daily lives, powering our homes, offices, and industries. However, these systems also pose inherent risks, such as electrical leakages that can lead to electric shock or fire hazards. The Earth Leakage Circuit Breaker (ELCB) is a vital safety device used to detect and protect against such leakages. However, traditional ELCBs often rely on manual inspection, making it challenging to promptly identify and address faults. This delay increases the risk of accidents and can result in significant damage to property and infrastructure. Therefore, there is a pressing need for an automated system that can monitor ELCBs in real-time and alert users about trip events.

Existing solutions for ELCB monitoring and trip alerts often fall short in providing a comprehensive and efficient approach. Some systems rely on manual monitoring, requiring personnel to physically inspect each ELCB periodically. This approach is time-consuming, prone to human error, and does not provide real-time information about trip events. Other solutions use basic monitoring techniques but lack the ability to send instant alerts, leaving users unaware of potential electrical faults until it's too late. Additionally, many available systems are expensive and complex, making them inaccessible to smaller establishments and individuals.

Another challenge in ELCB monitoring is the lack of integration with modern communication technologies. Traditional systems often rely on local alarms or notifications, limiting their effectiveness to on-site personnel. In today's interconnected world, it is crucial to have a system that can send alerts to multiple stakeholders, including facility managers, maintenance personnel, and even homeowners, regardless of their physical location. This requires an automated trip alert system for ELCB that can leverage internet connectivity and mobile communication channels to provide real-time notifications.

Furthermore, the design and implementation of an efficient ELCB monitoring system must consider scalability and adaptability. Different electrical installations may have varying numbers of ELCBs, and the system should be capable of accommodating this diversity. Moreover, as technology continues to evolve, it is essential to create a flexible system that can integrate with emerging advancements, such as machine learning algorithms for predictive maintenance and data analytics for performance optimization. Thus, there is a need to develop an automated trip alert system for ELCB that addresses these challenges, ensuring enhanced electrical safety, timely fault detection, and wider accessibility.

## 2. Materials and Methods

The system consists of the ZMPT101B voltage sensor, connected to the ESP32 module. The system starts by reading sensor data based on the required parameter. Then, the data is sent to the ESP32 and Blynk cloud platform to monitor the data. The data received also be displayed and sent notification of fault to Blynk. All the components and software are listed in Table 2.1 and Table 2.2 respectively.

### 2.1 Component and Software

**Table 2.1: List of Component**

Component	Quantity
ESP32	1
ZMPT101B Voltage Sensor	1
LM2596 Step Down Voltage Regulator	1
MG946R Servo Motor	1
LiPo Battery 7.4V	1
Piezo Buzzer	1

### 2.2 System Flowchart

Flowchart illustrates the Automated Trip Alert system, which operates when the hardware and smartphone are connected via Wi-Fi or the Internet. The Voltage sensor continuously retrieves data from the Earth Leakage Circuit Breaker (ELCB). The Voltage sensor is calibrated to send a signal when detecting a voltage below 240V coming from the ELCB. The generated data is then transmitted to the microcontroller, which in turn signals the servo motor to switch on the ELCB. This process is repeated three times to ensure the absence of faults in the household circuit. If a short circuit occurs between the ground and neutral, the ESP32 sends an alert to the user. Figure 2.1 shows the Flowchart of the system.

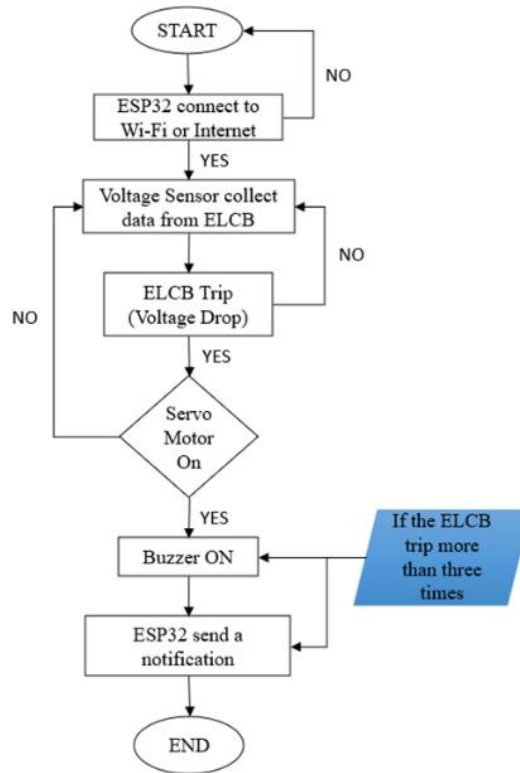


Figure 2.1 System Flowchart

### 2.3 System Block Diagram

The Voltage Sensor is the primary input required in the Automated Trip Alert system. The Voltage Sensor reads the voltage value before the supply is connected to the load, specifically at the Earth Leakage Circuit Breaker (ELCB). The data is then transmitted to the microcontroller and processed by the ESP32. The ESP32 sends the data to the Blynk software, allowing users to view the data through the Blynk application.

During the data transmission process, the ESP32 relies on Wi-Fi or Internet connectivity to ensure proper functioning. If the ELCB experiences a short circuit, the voltage value drops to 0V, and this data is received by the ESP32. The ELCB be reset automatically by a servo motor. Figure 2.2 shows the System Block Diagram of the project.

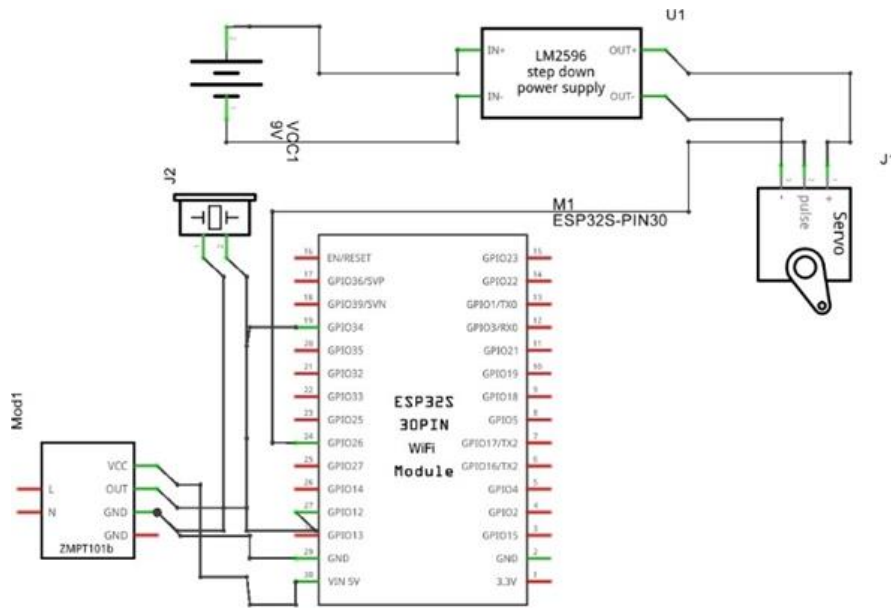


Figure 2.2 System Block Diagram

### 3. Results and Discussion

The results and discussion section presents data and analysis of the study, the discussion revolves around the results and findings of creating a system capable of automatically resetting an Earth Leakage Circuit Breaker (ELCB) after a trip occurs. This system utilizes the Internet of Things (IoT) to communicate with users. The prototype's ability to function effectively has been tested for durability, operational capability, and accuracy in real-life situations. The results are presented in the form of figures, data, and the initial design shown. Figure 3.1 shows the complete circuit connection of the project.

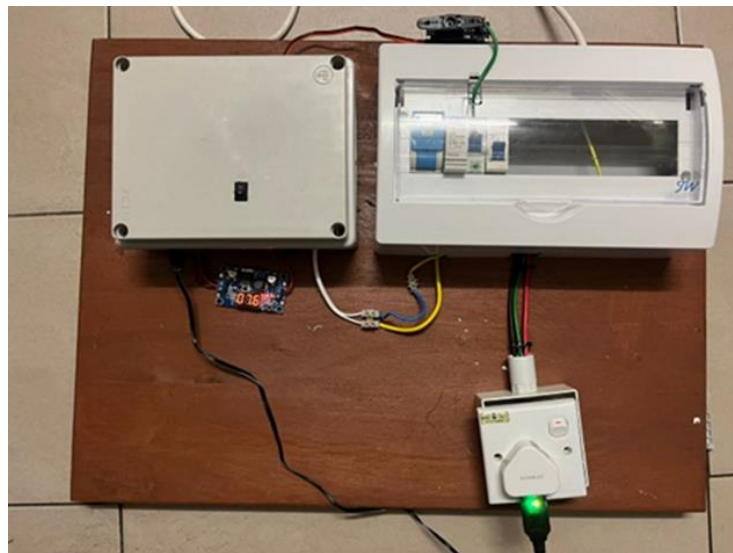


Figure 3.1 Circuit Connection for wiring system

#### 3.1 Results

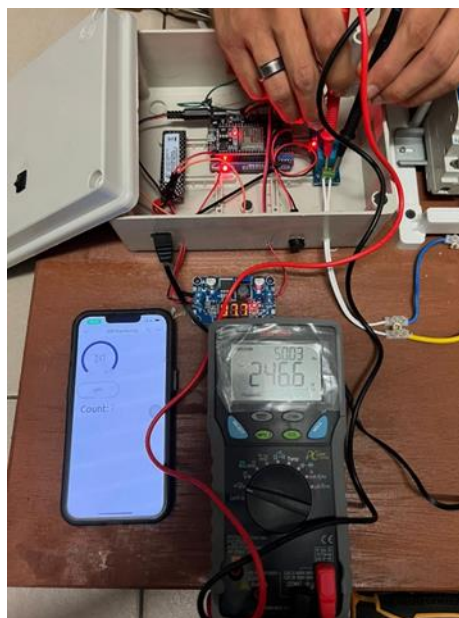
This chapter contains the results of the project to identify the concepts of the development of this project including data on the objective of this project, such as the design of a basic circuit structure and the operation of the circuit connections.

### 3.2 Component Functionality Testing

The components that impact the decision be tested. The results of conducting this testing determine whether the components are to be utilized or not. The components to be tested are the ZMPT101B Voltage Sensor and the servo motor.

#### 3.2.1 ZMPT101B Voltage Sensor Testing

On the Internet of Things (IoT) system, the use of sensors is often incorporated into the system, and their functions are fully utilized. In this project, a voltage sensor is employed to capture voltage values periodically to operate this system. In this testing phase, the voltage sensor is directly connected to the Earth Leakage Circuit Breaker (ELCB) to monitor the highest voltage value and ensure that the voltage sensor captures values greater than 240V, which is the voltage provided by the national power company (TnB). After the direct connection is established, a multimeter is used to measure the voltage values at the ELCB and the voltage sensor. The Blynk application is also utilized as part of this testing, and the voltage values are compared. Figure 3.2 shows the voltage measurement using multimeter and Blynk application.



**Figure 3.2: Voltage Measurement using Multimeter and Blynk Application**

In Figure 3.2, there is a difference in voltage readings between the Blynk application and the multimeter. The voltage value read in the Blynk application is 241V, while in the multimeter is 246.6V. The difference in readings of 5.6V does not have a significant impact on this system, and this test has successfully demonstrated that the voltage sensor used is capable of accurately assessing voltages as high as 241V. Table 3.1 shows the result of voltage sensor testing.

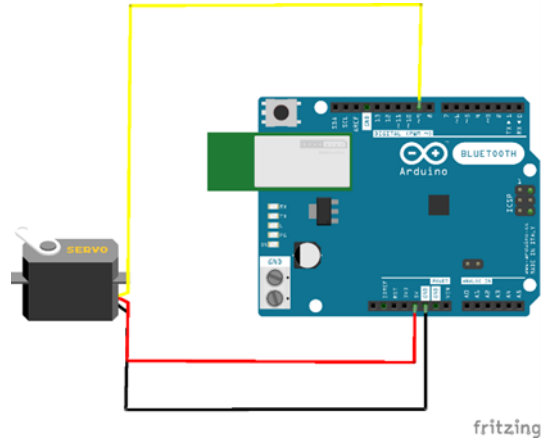
**Table 3.1: ZMPT101B Voltage Sensor Testing**

Blynk Application	Multimeter
241V	246.6V

#### Table 3.1 Result of voltage sensor testing

Servo motor testing is conducted to determine whether the motor rotation is functioning properly or not. The servo motor rotation is set within the coding, specifying the angle of rotation. In this project,

a 45-degree rotation is required, which reactivates the ELCB. Figure 3.3 illustrates the servo motor testing conducted using the Arduino UNO. The Arduino UNO is employed in this testing phase to ensure the proper functioning of the servo motor. Subsequently, the ELCB is also tested to confirm that the servo motor utilized can turn on the ELCB after a short circuit occurs.



**Figure 3.3: Servo Motor Testing using Arduino UNO**

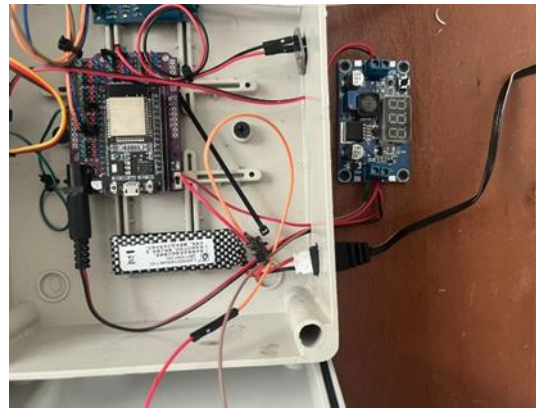
The method used to turn on the ELCB is by utilizing a 1.5mm wire that is already in place, by pulling back the ELCB switch. The ELCB switch is punched to insert the wire, and the distribution box is also punched to facilitate the lifting of the ELCB switch by the servo motor. In this way, the ELCB is successfully reactivated without any obstacles. The length of the wire is also measured to facilitate the process of replacing the wire when there are loose or detached connections. The measured wire length is 15 cm, and only 5cm of insulator is removed. Figure 3.4 shows the wire length between the Servo Motor and ELCB.



**Figure 3.4: Wire length between the servo motor and ELCB**

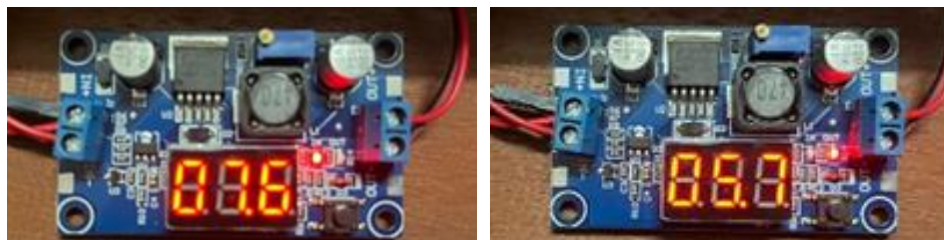
### 3.3 Power Source

This system utilizes a 7.4V LiPo battery to ensure an adequate power supply. The purpose of this battery is to ensure the efficient operation of the system without the need for an MCB power supply. The battery is charging using a nearby socket outlet, thus maintaining a constant full charge. Additionally, since the ESP32 requires a lower voltage, a step-down voltage regulator is employed to reduce the voltage to meet the ESP32's requirements. Figure 3.5 shows the connection of Battery LiPo 7.4V and Step-Down Voltage Regulator.



**Figure 3.5: Connection of Battery LiPo 7.4V and Step-Down Voltage Regulator**

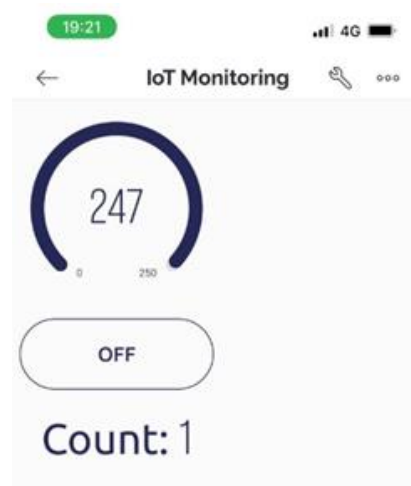
The Voltage Regulator indicates the voltage values before step-down and after step-down. Prior to step-down, the voltage value ranges from 7.2V to 7.7V. The provided voltage value before step-down is intended for the servo motor, which requires 7.2V to ensure proper motor operation. The voltage output after step-down ranges from 5.2V to 5.7V, and these voltage values meet the requirements for the proper functioning of the ESP32. Figure 3.6 shows the value of voltage before and after step-down.



**Figure 3.6: Value of voltage before and after step-down**

### 3.4 Faults Detection in Blynk Application

The voltage sensor detects the voltage value emitted by the ELCB and transmit it to the ESP32 as information for further response. When the voltage value provided is 230V or above, the ELCB not trip, and the servo motor does not receive the information to lift the ELCB. With the use of the voltage sensor, the received voltage value is accurate. Users can view the voltage value through the Blynk application, which facilitates their ability to leave the house. Figure 3.7 shows the voltage value at Blynk Application.



**Figure 3.7: voltage value at Blynk Application**



When the Earth Leakage Circuit Breaker (ELCB) trips, the voltage value immediately drop, providing information to the ESP32 to reset the ELCB. As a result, electrical appliances that require voltage not experience any damage. Additionally, this system only reset the ELCB a maximum of three times, and all three tripping events be notified through Blynk notifications. When a fourth trip occurs, Blynk send an email to the user, indicating that the ELCB has tripped four times. This email requirement ensures that the user is alerted to the state of the house and can arrange for someone nearby to check the house when the user is outside the area. Figure 3.8 shows the Blynk sends an alert to User. Figure 3.7: voltage value at Blynk Application.

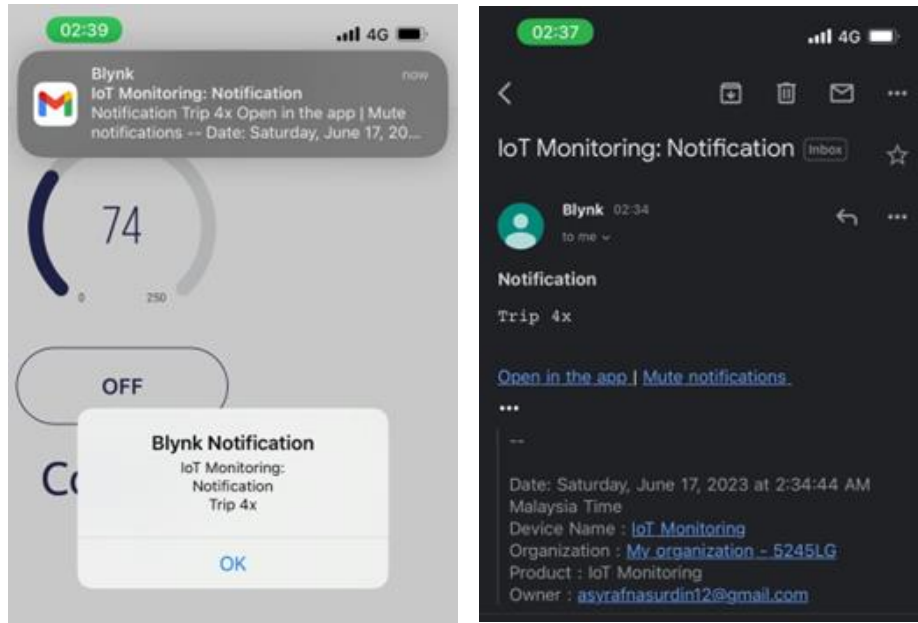


Figure 3.8 Blynk alerts the user

#### 4. Conclusion

The Automated Trip Alert System has started to be conducted in Bachelor Degree Project 1, beginning with proposing the project's title to be implemented from Bachelor Degree Project 1 and continue until completed in Bachelor Degree Project 2. Fault detection has been chosen as the primary focus for developing an effective system. Several observations and ideas have been made to support the progress of this project, such as searches for previous projects that have been implemented and be compared to the project. The automated system has been designed to make the work more reliable. To ensure that the trip can be detected early, the Automated Trip Alert system's component must in good condition.

Based on the first objective, electrical trips by short circuit were investigated. Faults classification was observed by previous study in fault detection system. An IoT system has been chosen as a power monitoring system since the system can connect via the Internet from almost everywhere. This system has been widely used for monitoring data.

Furthermore, the second objective is to design and construct the monitoring of the trip detection system and monitoring system for the residential wiring and fault detection using the NodeMCU ESP32 based on IoT application. This objective was achieved by controlling the servo motor and notification on faults from the code in Appendix A.

The last objective is to the functionality of the trip detection system and the performance of the automated trip alert system via experimental setup. This objective has been met by documenting by operation of ELCB trip. The system has been used throughout many experiments to achieve this objective.

## **Acknowledgement**

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