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Programmable Electronic Circuit Breaker with Password Protection

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***Abstract*— Advancement in circuit breaker control is an important concept that needs to be addressed. Conventional circuit breakers are limited in many functionalities. For sensible loads, the importance of threshold value is at its peak and the value varies from one equipment to another. Safety is often neglected during maintenance which may result in loss of life. The Programmable Electronic Circuit Breaker with Password Protection is a big step in the world of circuit control. It involves using the latest technologies which helps in designing a much faster, more reliable and secure circuit breaker. The ESP32 Microcontroller acts as a heart in this circuit. The solid state relay, capable of fast switching and the SCT013 sensor comprising of split core technology combine to form a modified circuit breaker. The password verification and real-time current tracking are achieved using a 4x4 keypad. This project goes beyond its usual features by adding an Android app with a simple interface embedded to this circuit to change the threshold value of tripping current based on diverse electrical applications and password for maintenance reasons. This introduction fits perfectly with the current trend of smart home technology, setting up preparatory work in the world of smart systems.**

***Keywords*— Adjustable trip current, Auto monitoring, Customisation, Electronic circuit breaker, Password protection**

I. INTRODUCTION

Circuit Breakers play a crucial role in switching for the reasons of both the routine network operation and protection of other devices in power system [6]. Electronic circuit breakers found in industries and homes varies from small devices that protect low-current circuits or individual household appliances, to large switchgear designed to protect high voltage circuits feeding an entire city. In the case of sensible loads, a precise tripping mechanism is required to minimize the risk of damage and to ensure reliable operation. These kind of circuit breakers have a fixed trip current which cannot be varied. Also, it contains manual operation using physical switches, lacking security features. The programmable electronic circuit breaker with password protection presents modern features encompassing password-based access control, adjustable tripping current and real-time current tracking. The project comprises modern technologies including the powerful ESP32 microcontroller which is used for various applications, including wireless communication. In a smart home consisting of several connected devices like refrigerator, air conditioner, home theatre and light bulbs, instead of using basic circuit control, we can increase flexibility by the property of adjustable tripping current. For instance, we could set low tripping current for sensitive devices while maintaining it high on overall household load. The need for physical access is eliminated by using android app interface, providing remote control and monitoring, enabling convenient management of multiple breakers. The password protection safeguards from unauthorized access and tampering. The interaction of solid state relay and SCT013 current sensor combines to form a strong and user friendly circuit breaker system. The user-friendly app lets users customize fault current and password. The project reacts to an important call for secure and adaptable circuit breaker systems. It also stands as a testament to the growing field of 21st-century electrical systems.

II. MATERIALS AND METHODS

A. List of Materials

SL. NO	Name of Component
1.	ESP32 Microcontroller
2.	Solid State Realy
3.	SCT013 Current Sensor
4.	4×4 Keypad
5.	LCD Display
6.	I2C Module
7.	Resisitor
8.	Capacitor
9.	Adaptor
10.	Ammeter
11.	Socket
12.	Connecting Wires

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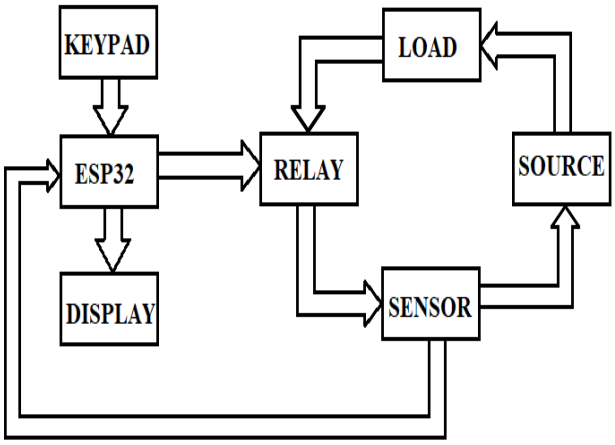
B. Algorithm

1. Turn on Microcontroller and other necessary components.
2. Set up a communication protocol to interact with the components.
3. Set up the default password using Android application to the circuit breaker system.
4. Prompt the user to enter the password using a 4x4 keypad.
5. Verify entered password against the stored password.
6. If the entered password is incorrect, display 'incorrect password' on the LCD and prompt the user to enter the password again.
7. If the entered password is correct, initialize access.
8. Monitor and read current value from SCT013 Current sensor continuously.
9. Calculate the current and voltage values using sensor readings and compare the value to the current threshold value.
10. If current value exceeds threshold value, display 'overload' on LCD and cut power to load by turning off relay.
11. Otherwise maintain the power supply to load and display the value of current on ammeter and interface.
12. Listen to updates on the interface.
13. If the ampere value or password is updated, apply the new value and reset the system.
14. Monitor keypad input continuously.
15. If input is detected, display it on LCD for password masking.
16. Continuously loop through the algorithm to monitor and update the system based on user input and try again.

C. Block Diagram



D. Working

The working of the circuit is that the supply is directly connected to the solid state relay through a switch. From the relay, it is connected to the phase of a 3-pin socket to which the load can be connected. The earth and neutral are directly connected to the 3-pin socket. From the phase coming into the switch and neutral, a connection to an indication light is provided which indicates whether the circuit breaker is functioning or not. The required vcc and ground to all the required components which includes esp32, lcd display, relay and the sensor are provided from the adaptor. The second indication light is provided from the phase and neutral of the 3-pin socket so that the indication light lights during normal operation and when an overload occurs, the relay is tripped and the load is cut off, which is shown by the indication light turned off.

An app is provided for the user to set the tripping current and to set the password that he desires. This provides additional safety by ensuring the operation to authorized personnels only. Additionally, the board also includes a 4x4 keypad to set the password and an LCD display for displaying the entered password and the current load status. Once supply is turned on, the esp32 needs to be connected to wifi. Once a new password and a tripping current is set on the display, the current sensor continuously senses the current through the circuit and sends the value to esp32. If the value is greater than pre-set value, the esp32 will send a signal to relay to trip the circuit, thereby the circuit will become open, protecting the system from overload.

III. RESULTS

The execution of the programmable electronic circuit breaker with password protection has shown promising results (refer to figure 1). Secure access is achieved through password protection, bolstering its safety. Users can easily change password and adjust tripping current using an android application (refer to figure 3). The overload and password correct/incorrect conditions has shown us consistent performance. Internal connection is shown in figure 2. User awareness is enhanced by using LCD display, ammeter and mainly a simple interface in android application, making it an ideal solution for applications requiring customization and accuracy.

Fig. 1. Proposed System

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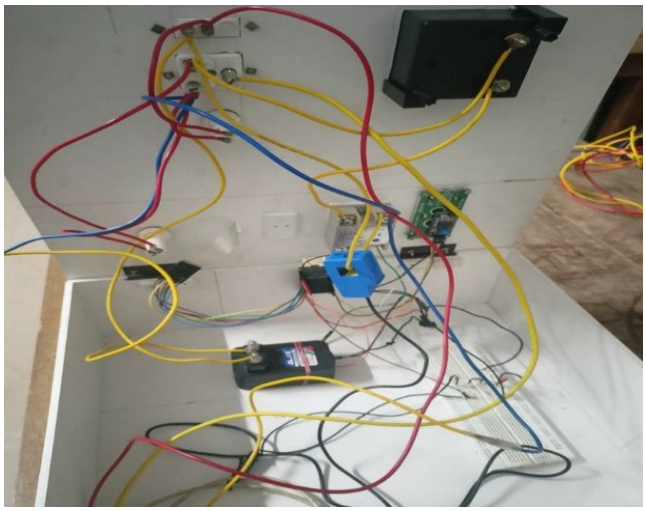

Fig. 2. Internal Circuit Diagram

A. Future Scope

1. Advanced cybersecurity for heightening protection against cyberattacks.
2. IOT integration for centralized monitoring and remote control.

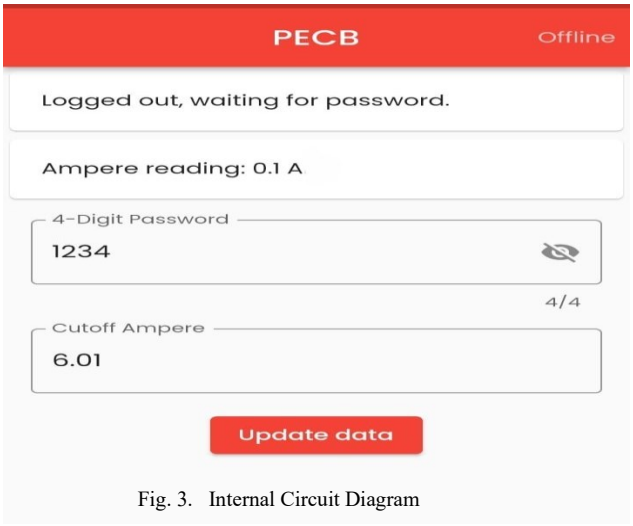

Fig. 3. Internal Circuit Diagram

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