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Hardware Implementation of IoT based Smart Power Protection Unit for Power Distribution System

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Abstract

Power protection devices are deployed to protect assets while also providing a steady supply of electricity. The importance of a power protection unit is that it maintains the security of electrical consumers connected to the electrical supply grid by interrupting the power supply in the case of a variety of problems, including overvoltage, overcurrent, leakage current, and electrical arc. Power protection systems with Arduino uno board leads to attain decreased efficiency, increased cost of internal connectivity and poor network reliability. IoT based power protection devices can overcome these difficulties in a better way. This research provides a power-system protection device that can be integrated into smart environments and is based on Internet-of-Things technology. The proposed system improves safety by rapidly disabling the power supply in the event of a disaster such as a leakage current, an electrical arc, a power surge, or an overcharge, and it is designed to be incorporated into intelligent devices such as smart buildings or green infrastructure to protect electrical equipment.

Keywords: Internet of Things, ESP32, Real Time Monitoring, Trip signal, Relay, Over current

1. Introduction

In the proposed system, a power-system protection unit is developed to be integrated in smart environments based on Internet-of-Thing’s technology. A power-system protection unit is built in the proposed system to be incorporated in smart settings based on Internet-of-

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Things technology. In this unit instead of Arduino uno microcontroller, ESP32 WIFI module is used. This Wi-Fi module has inbuilt WIFI chip and Bluetooth. ESP32 has analog pins and digital pins which are used for interfacing the current sensor and voltage sensor. The measured values through the sensors are displayed in the LCD monitor. A user- interface real time monitoring has been created using the Blynk application which can be accessed through mobile phone. Whenever, the over current trip signal is produced by ESP32 Wi-Fi module, the load is immediately cut-off from the power supply. In this work, the hardware implementation of a prototype power protection module is developed which can be extended to protect the power distribution system in larger scale.

2. Proposed Model of IoT

This model outlines the project's methodology. The project demonstrates how the microprocessor is linked to the circuit breaker. The key component for measuring and detecting the location of a malfunction is the microprocessor. Switches are used to display a new location and the monitoring system's application for tripping faults. The ESP32 Wi-Fi module is utilised in this suggested device. As a control unit, the microcontroller ESP32 will scan the current and voltage levels. To catch the data, the microprocessor application is interfaced with current and voltage sensors. In order to work in a blackout event, the microprocessor employed a battery as a backup power source. This implies that even if the energy is turned off by a protection mechanism on the distribution box, the system will continue to work. Smart circuit breakers give all of the typical protective characteristics of a standard breaker, as well as remotely coupling/decoupling and surveillance.

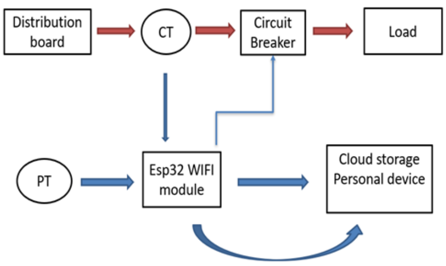

Figure 1. Proposed model of IoT in power system

3. Circuit Design

The fritzing programme is used to create the circuit. A specific sensor was used to monitor current and voltage levels. The ACS712 hall effect current sensor was utilised to determine the current value. To capture the level of current flow across the line, ACS712 is linked in series in a positive line. The reading was snap directly on 240V line using some application microprocessor and C+ language. The end line is connected with a relay for opening the circuit. Interfacing the relays and current sensor to the module. This figure 2 is power protection device circuit.

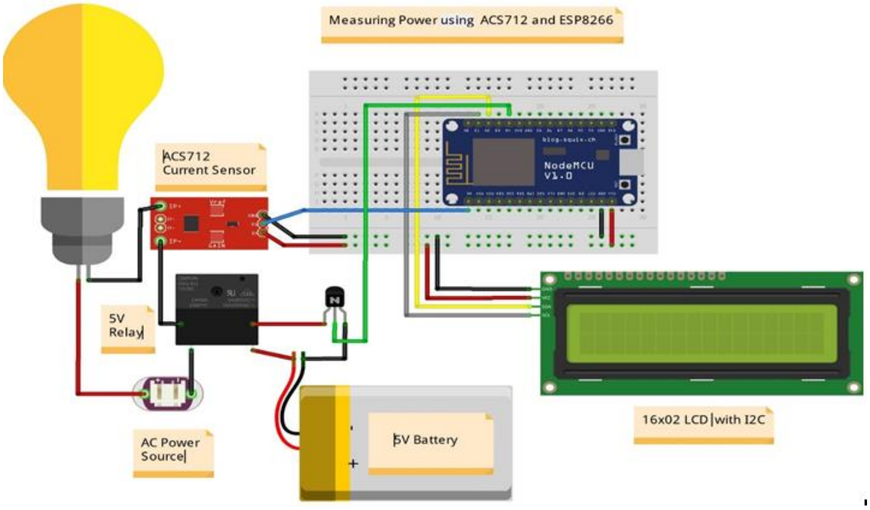

Figure 2. Circuit Diagram of the IoT Distribution board

4. Hardware Implementation and Results

The figure 3 is IoT based smart power protection unit for power distribution system in prototype. This prototype circuit has real-time monitoring system which will give the real time instantaneous current value which is measured by the current sensor used in the circuit. It also has the automatic cut off mechanism which will work in occurrence of the fault current. In this work, real time monitoring values of current is shown in the Liquid Crystal Display (LCD).

Figure 3. Real – Time Monitoring Hardware Output

4.1 Real-Time Monitoring Mobile Output Using Blynk App

The Blynk app is a tool for creating and editing apps. It enables one or more projects to be created. It may interface with one or more devices and features graphical widgets such as virtual LEDs, buttons, value displays, and even a text terminal.. In this work, the measured real time values are shown in the BLYNK mobile app which is used to control the ESP32 with the widgets and virtual buttons. The Blynk mobile application shows the measured value of the current, voltage and frequency in the virtual display in smartphone is shown in figure 4.

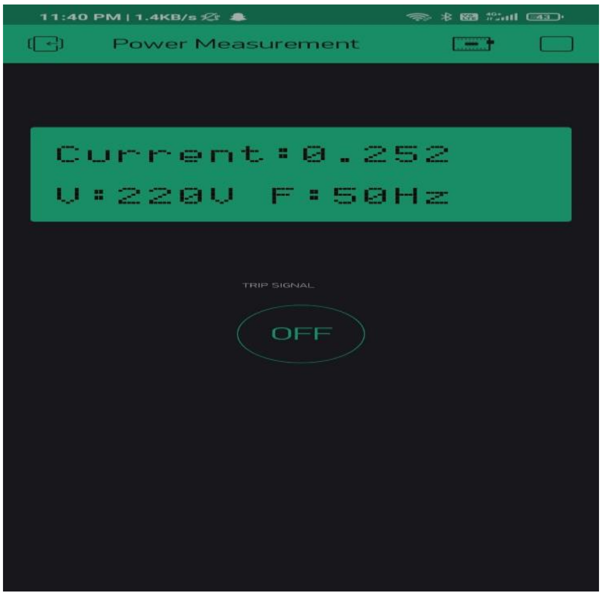

Figure 4. Real-Time Monitoring Mobile Output using BLYNK App

4.2 Output After the Cut Off Trip Signal is Generated

Figure 5. Output after cut off trip signal is generated

Supervision of the Trip Circuit Any failure in the breaker's trip coil or the trip circuit is detected by the circuit. When the Trip Circuit Supervisory Relay detects a problem, it switches its contact state to display intonation on the panel. Any breakdown or open circuit is referred to as a defect in the circuit. Relays are employed when an independent low-power signal is required to control a circuit, or when several circuits must be controlled by a single signal. During fault condition, the circuit cut off the load from the power supply. At that time the circuit will not measure and show the current and voltage value from the load. This process is shown in figure.

4.3 Mobile Output After the Cut Off Trip Signal is Generated

This blynk application is used to show the real-monitoring values which is send by the ESP 32 . This blynk application as the virtual display shows the measured value from the ESP32. During the circuit off condition the values from the load is zero so the interfaced blynk app also shows the zero values to the smart phone.

Figure 6. Mobile output after cut off trip is generated

5. Conclusion

This project discusses the design and programme verification of an upgraded power control device with IoT-based support for incorporation in smart settings such as Smart Homes. The device protects electrical customers connected to the public power grid by switching off power in the event of a variety of issues, such as overvoltage, inrush current, leakage current, and electrical arc. Not only does the proposed system go beyond the conventional tasks of a circuit breaker by providing protection against new faults, but it also becomes smart in the sense, each protection system interacts with a Web server via a concentrator-style architecture. In this project, the ESP 32 module is programmed and the circuit for IoT performing circuits is built. The protection gadget will be integrated with Brasov's smart city infrastructure in the future, particularly the smart public lighting system with LoRa (Long Range Wide-area Network) communication support. It is hoped that the coupling/decoupling component, which is a Stable Relay with an acceptable maximum current of, could be replaced with a component capable of sustaining higher currents to provide an equal protection clause against fault conditions that may result in current values higher than the SSR can handle. Finally, future research will include incorporating this device into power system networks with dispersed energy sources to identify and address any technological issues. As a result, it is believed that improving functionality is an important research route.

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