IOT BASED SMART METER USING ESP-32 & BLYNK APPLICATION

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* **Abstract:**

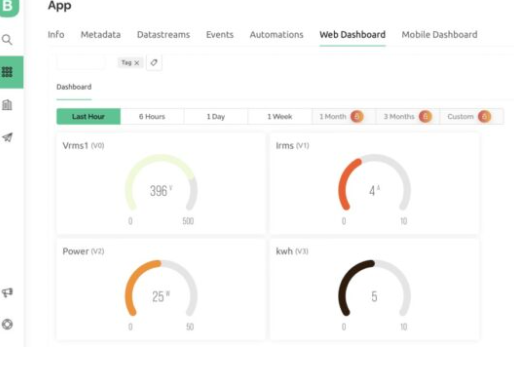
This report presents the design and implementation of an IoT-based smart meter using an ESP32 module, SCT-013 current sensor, ZMPT101B AC single-phase voltage sensor, Blynk application, and a 16x2 LED display. The objective of this project is to develop a system that can monitor and transmit real-time data of electrical parameters such as current and voltage, enabling remote monitoring and analysis of energy consumption. The project utilizes the ESP32 module as the main controller, the SCT-013 current sensor to measure current, the ZMPT101B sensor to measure voltage, and Blynk application for data upload. Additionally, a 16x2 LED display is used to provide a visual representation of the data. This report details the methodology employed in building the system, presents the results obtained, and concludes with the overall outcomes and potential FUTURE.

* **Introduction:**

Traditional energy meters lack the ability to provide real-time data and remote monitoring capabilities, making it challenging for users to effectively manage their energy consumption. In this project, we propose the design and implementation of an IoT-based smart meter to address these limitations. By utilizing the ESP32 module, SCT-013 current sensor, ZMPT101B AC single-phase voltage sensor, and Blynk application, we aim to develop a system that can monitor and transmit real-time data of electrical parameters to a mobile device or computer. This will enable users to remotely monitor and analyze their energy usage, leading to more efficient energy management and potential cost savings. A picture containing electronics, electronic engineering, circuit

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* **Methodology:**

The methodology employed in this project involves several steps. First, the hardware components are assembled, including the ESP32 module, SCT-013 current sensor, ZMPT101B AC single-phase voltage sensor, and 16x2 LED display. The ESP32 module acts as the main controller, responsible for data acquisition, processing, and communication. The SCT-013 current sensor is connected to the main power line to measure the current flowing through it, while the ZMPT101B sensor is used to measure the voltage. These sensors provide analog output signals, which are then processed by the ESP32 module. To interface with the Blynk application, the ESP32 module is connected to the internet via Wi-Fi. Blynk is a user-friendly platform that allows for easy data visualization and remote access. The ESP32 module communicates with the Blynk server and uploads the measured current and voltage data. The Blynk application is installed on a mobile device or computer, providing the user with real-time data and control over the smart meter. The 16x2 LED display is connected to the ESP32 module to provide a local visual representation of the data. The module processes the acquired data and displays it on the LED display, allowing for immediate feedback without relying solely on the Blynk application*.* 

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**Source code:**

<https://github.com/hanzlakamboh/Ena-project-Iot-based-meter-source-code/commit/ed0faf6f99ab74ba6428cfc4591e88d8371ee801>

* **Results and Discussion:**

The implementation of the IoT-based smart meter using the ESP32 module, SCT-013 current sensor, ZMPT101B AC single-phase voltage sensor, Blynk application, and 16x2 LED display was successful. The system accurately measured and displayed the current and voltage values. The data was transmitted to the Blynk application in real-time, enabling remote monitoring and analysis of energy consumption. The Blynk application provided an intuitive interface for users to visualize the data and monitor their energy usage. It allowed for the setting of thresholds or alerts, enabling users to receive notifications if their energy consumption exceeded a predefined limit. The 16x2 LED display served as a useful local display option, providing immediate feedback without the need for a mobile device or computer.

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1. **Pros of the project**:

* **Energy Monitoring:**

The IoT-based smart meter enables real-time monitoring of energy consumption, allowing users to track and analyses their energy usage patterns. This promotes awareness and facilitates more informed decisions regarding energy conservation.

* **Remote Access and Control:**

The integration of the Blynk application enables users to remotely access energy data and control electrical appliances. This feature enhances convenience and flexibility in managing energy consumption, even when away from home.

* **Energy Efficiency:**

By providing users with detailed information about their energy consumption, the smart meter encourages energy-efficient behaviour. Users can identify areas of high energy usage and take proactive measures to reduce wastage, leading to potential cost savings.

* **Integration Potential:**

The ESP32 module and selected sensors offer compatibility and integration potential with other smart home devices and systems. This allows for the expansion and customization of the smart meter within a broader home automation framework. User-**Friendly Interface:**

* The 16x2 LED display serves as a simple and intuitive interface, presenting energy consumption data in a clear and easily understandable format. Users can quickly access essential information without relying solely on the Blynk application.

1. **Cons of the project:**

* **Limited Scope:**

The project focuses primarily on energy monitoring and control within a single-phase electrical system. It may not be suitable for more complex or three-phase electrical installations, limiting its applicability in certain contexts.

* **Accuracy and Calibration:**

The accuracy of the SCT-013 current sensor and ZMPT101B voltage sensor can be influenced by various factors, including calibration, electrical noise, and environmental conditions. Ensuring accurate measurements may require additional calibration and maintenance procedures.

* **Reliance on Internet Connectivity:**

The functionality of the IoT-based smart meter is dependent on a stable internet connection. Disruptions in internet connectivity may temporarily limit remote access and control capabilities.

* **Security Considerations:**

As with any IoT device, security measures must be taken to protect the smart meter from potential cyber threats. Robust authentication, encryption, and secure network configurations should be implemented to safeguard user data and system integrity.

* **Cost Considerations:**

The implementation of an IoT-based smart meter may involve additional costs, including the purchase of components, development boards, and potential subscription fees for cloud services. These costs should be considered in the overall feasibility and budgeting of the project. It is important to evaluate these pros and cons in the context of specific project requirements and the intended application to make an informed decision about the suitability and potential challenges of implementing the IoT-based smart meter.

* **Conclusions:**

The project focused on the design and implementation of an IoT-based smart meter using the ESP32 module, SCT-013 current sensor, ZMPT101B AC single-phase voltage sensor, Blynk application for data uploading, and a 16x2 LED display.

* **IoT-enabled Smart Meter:** The utilization of the ESP32 module provided the necessary connectivity and processing power to develop an IoT-enabled smart meter. This allowed for real-time monitoring and control of energy consumption remotely.
* **Current and Voltage Sensing:** The SCT-013 current sensor and ZMPT101B voltage sensor were employed to accurately measure the current and voltage levels in the electrical system. These sensors provided reliable data for energy consumption analysis.
* **Blynk Application:** The integration of the Blynk application facilitated the seamless transfer of data from the smart meter to a cloud-based platform. This enabled users to access and monitor energy consumption information remotely through their smartphones or tablets.
* **Energy Data** **Visualization:** The 16x2 LED display served as a user-friendly interface, presenting essential information about energy consumption in a clear and concise manner. It allowed users to quickly access real-time data without relying solely on the Blynk application.
* **Energy Efficiency**: The IoT-based smart meter project aimed to promote energy efficiency by providing users with insights into their energy consumption patterns. With access to real-time data, users can identify areas of high energy consumption and make informed decisions to optimize their energy usage.
* **Remote Monitoring and Control:** The implementation of IoT technology in the smart meter allowed for remote monitoring and control of energy consumption. Users could access energy data and even control certain electrical appliances remotely, enhancing convenience and energy management capabilities.
* **Potential for Integration:** The ESP32 module and the chosen sensors provided a flexible platform for further integration with other smart home devices and systems. This opens possibilities for future expansion and integration of the smart meter into a broader home automation ecosystem.

**In conclusion,** the project successfully designed and implemented an IoT-based smart meter using the ESP32 module, SCT-013 current sensor, ZMPT101B AC single-phase voltage sensor, Blynk application, and a 16x2 LED display. The integration of these components allowed for real-time energy monitoring, remote access, and control, promoting energy efficiency and empowering users to make informed decisions about their energy consumption. The project also demonstrated the potential for further expansion and integration into a larger smart home ecosystem.

**Group Members:**

1. Hanzla Sajjad
2. Amna Siddiqui
3. Mian Tahir Nadeem

* **Introduction:** The project aimed to design and implement an IoT-based smart meter for monitoring and controlling energy consumption. The key components utilized in the project were the ESP32 module, SCT-013 current sensor, ZMPT101B AC single-phase voltage sensor, Blynk application for data uploading, and a 16x2 LED display. Each group member made significant contributions to different aspects of the project.
* **Contributions:**

**Hanzla Sajjad**:

Hanzla played a crucial role in the hardware development and integration. His contributions include:

**Researching and selecting the appropriate components**:Hanzla thoroughly studied various options and selected the ESP32 module for its wireless connectivity capabilities, the SCT-013 current sensor for accurate current measurement, and the ZMPT101B voltage sensor for precise voltage sensing in single-phase systems.

**Designing the circuit schematic:** Hanzlacreated the circuit schematic, ensuring proper connections between the ESP32 module, current sensor, voltage sensor, and LED display. He considered the power supply requirements, pin configurations, and signal conditioning for accurate readings.

**Prototyping and testing:** Hanzla assembled the hardware components, developed the necessary interface circuits, and conducted extensive testing to verify the functionality and reliability of the smart meter. He calibrated the current and voltage sensors to ensure accurate measurements.

**Amna Siddiqui:**

Amna primarily focused on the software development and integration of the Blynk application. Her contributions include:

**Developing the firmware:** Amna worked on the firmware development for the ESP32 module. She programmed the microcontroller to read data from the current and voltage sensors, process the information, and establish a connection with the Blynk cloud server.

**Implementing the Blynk integration:** Amna integrated the Blynk library into the firmware code to enable seamless communication between the smart meter and the Blynk application. She programmed the ESP32 module to upload energy consumption data to the cloud platform for remote access and control. **User interface design:** Amna collaborated with the team to design a user-friendly interface on the Blynk application. She created virtual buttons, graphs, and widgets to display real-time energy data, historical consumption trends, and control options for managing connected appliances.

**Mian Tahir Nadeem:**

Tahir contributed to the overall project management, documentation, and system testing. His contributions include:

**Project planning and coordination:** Tahir facilitated effective communication within the group, ensuring that everyone understood their roles and responsibilities. He managed the project timeline, organized regular meetings, and monitored progress to keep the team on track.

**Documentation and report writing:** Tahir took charge of documenting the project's progress, including the system design, implementation details, and test results. He compiled the final report, ensuring that it contained all the necessary information about the project, including contributions from each group member.

**System testing and validation:** Tahir conducted extensive testing to validate the smart meter's functionality and reliability. He worked closely with Hanzla and Amna to identify and resolve any hardware or software issues, ensuring that the final product met the project's objectives.

References:

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Attached photograph of our project:

