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Voltage, Current and Cost Monitoring of Energy Meter by IOT

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ABSTRACT

Currently, IOT-based applications are gaining popularity due to their ability to offer effective solutions for various real-time issues. This research paper introduces a novel IOT-based electric meter monitoring system that utilizes an android application. The main objective of this system is to minimize the need for manual labor in measuring electricity units and raise awareness among users regarding excessive electricity consumption. The system employs ESP32, voltage, and current sensors to retrieve the power flowing through the electric meter. To mitigate human errors and reduce energy consumption costs, a cost-effective wireless sensor network is implemented for the digital energy meter. Additionally, a mobile application is developed to automatically interpret the meter units.

We want to choose the ongoing Transformer as well as the voltage Transformer with the goal that the current and voltage can be estimated and subsequently we can be aware of the power utilization and absolute power consumed. The ongoing Transformer is utilized in this undertaking is ZMPT101B. This is ZMPT103C AC Current Transformer can be utilized to gauge AC current. Also, the voltage Transformer is utilized in this undertaking is ZMPT101B. The ZMPT101B AC Voltage Transformer can be utilized to gauge the precise AC voltage .

Utilizing the ZMPT103C AC Flow Transformer and ZMPT101B AC Voltage Transformer, we can gauge the all expected boundaries required for Power Energy Meter. We will interact the ZMPT103C Current Transformer and ZMPT101B Voltage Transformer with ESP32 Wifi Module and Send the information to I2C module. The I2C module Dashboard will show the Voltage, Current, Power, absolute unit consumed in kWh and related cost.

Keywords- IoT energy monitoring, IoT networks, Real-time energy monitoring, Voltage and current measurement, Billing accuracy

INTRODUCTION

Energy generation companies provide electricity to households through controlled power transmission hubs called Electricity Grid. Issues can arise when the grid fails, causing a blackout in the area supplied by that grid. The project's goal is to address this problem by utilizing IoT for communication and addressing other issues that a smart system can handle to prevent unnecessary energy losses. The IoT smart energy grid is controlled by an ESP family controller, managing various system activities. Communication is done via Wi-Fi technology over the internet. A bulb is used to represent a valid consumer, while another bulb represents an invalid consumer. One key feature of this project is the reconnection of the transmission line of an active grid. If one grid fails and there is an alternative grid available, the system switches the transmission lines to ensure uninterrupted electricity supply to the affected region. Information on the active grid is updated on the IoT Gecko webpage, where authorities can log in to view updates. In addition to grid monitoring, the project can monitor energy consumption and detect electricity theft. The amount of electricity used and the estimated cost are displayed on the IoT Blynk webpage, along with Energy Grid information. Theft scenarios are simulated in the system using two switches.

REVIEW OF LITERATURE

A review of the literature on energy meters based on the Internet of Things (IoT) reveals the increasing significance of these systems in addressing challenges related to energy management, promoting sustainability, and enhancing user awareness of power consumption patterns. The literature highlights several key themes and findings:

1. **IoT in Energy Management:** Numerous studies emphasize the crucial role of IoT in energy management by offering real-time monitoring, control, and optimization of energy consumption. Energy meters based on IoT enable efficient utilization of resources and contribute to the development of smart grids [5].

2. **Sensor Technologies:** The use of sensors, such as voltage and current sensors plays a fundamental role in IoT energy metering. The literature emphasizes advancements in sensor technologies, including improvements in accuracy, miniaturization, and cost-effectiveness. These advancements lead to the development of more robust and reliable energy monitoring systems [6].
3. **Microcontroller Platforms:** ESP32 and similar microcontroller platforms are widely adopted in IoT-based energy meters. These platforms provide the necessary computational power, connectivity options (Wi-Fi), and ease of programming to develop intelligent and connected energy monitoring solutions. Overall, the literature review highlights the growing importance of IoT-based energy meters in addressing energy management challenges, promoting sustainability, and enhancing user awareness of power consumption patterns. The advancements in sensor technologies and the availability of microcontroller platforms further contribute to the development of efficient and intelligent energy monitoring systems.

NECESSITY

Cost Management Monitoring energy consumption allows for better control over electricity costs. Resource Conservation Efficient use of electricity contributes to resource conservation and sustainability. Preventive Maintenance Monitoring voltage and current levels can help identify potential issues in the electrical system before they become critical. Remote Monitoring If the energy meter is in a location that is not easily accessible, remote monitoring becomes essential.

THEME

If you are working on a project with a specific theme, it would be helpful to identify the central theme or purpose guiding your efforts. The theme often reflects the overarching goal or focus of the project. Here are some possible themes that could align with a voltage, current, and cost-monitoring project for an energy meter using IoT [9].

ORGANIZATIONS

If you're working on a project related to voltage, current, and cost monitoring of an energy meter using IoT for organizations, it likely aligns with specific organizational goals and needs. Here are several potential perspectives through which you might view this project in the context of organizations Energy Management for Operational Efficiency The project could focus on helping organizations optimize their energy consumption, reduce costs, and enhance operational efficiency. Cost Reduction and Financial Sustainability Organizations often seek ways to reduce operational costs. Compliance with Environmental Standards If there are regulatory or environmental standards that organizations need to adhere to, the project could emphasize how IoT-based energy monitoring aligns with and supports compliance with these standards.

OBJECTIVES

A project's objectives focused on voltage, current, and cost monitoring of an energy meter using IoT can vary based on the specific goals and needs of the organization or individual undertaking the project. Here are common objectives such a project might aim to achieve real-time Monitoring Develop a system that monitors voltage and current levels in an energy meter. This allows for immediate awareness of any deviations or anomalies in electrical parameters. Energy Consumption Analysis Implement the ability to analyse historical and real-time data to understand energy consumption patterns. This helps identify peak usage times, potential areas for optimization, and trends over specific periods.

System Development

System development for a project focused on voltage, current, and cost monitoring of an energy meter using IoT involves several stages. Hardware Design Select appropriate sensors for voltage and current measurement and design the hardware interface with the ESP8266. Design a cost estimation module, considering tariff rates and energy consumption calculations [10-13].

Software Design Choose a programming language (e.g., Arduino C++) for the ESP8266.Design algorithms for data processing, cost calculation, and communication with the cloud.

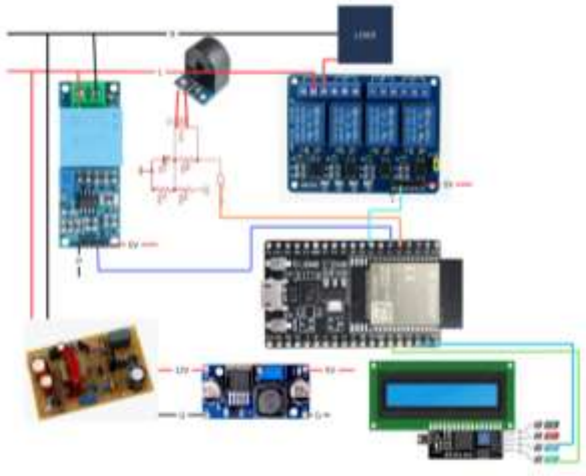
Testing

Unit Testing: Test individual components, such as sensor readings, data processing, and communication functions.

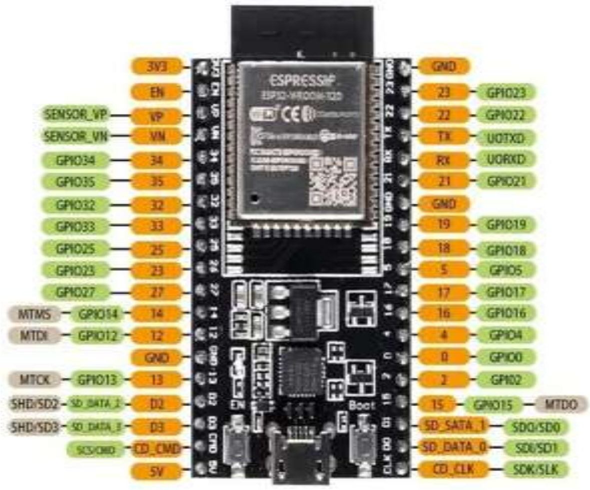
Integration Testing: Verify the integration of hardware and software components.

System Testing: Conduct comprehensive testing of the entire system in a controlled environment.

WORKING OF HARDWARE



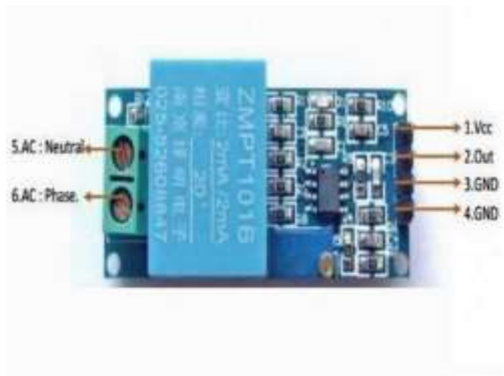
i. **ESP32 Microcontroller:-**



ESP32-WROOM-32D

The ESP32, a highly adaptable microcontroller from the ESP chip series created by Espressif Systems, has become a favored choice among makers and IoT enthusiasts for its advanced functionalities and wide range of applications

ii. **ZMPT101B Voltage Sensor:-**

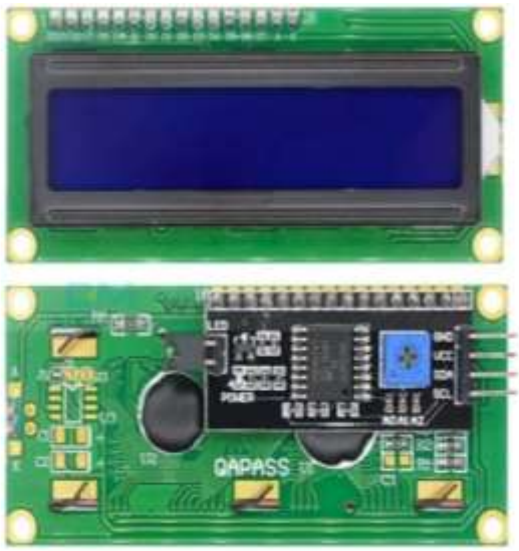


The ZMPT101B is a voltage sensor module designed for measuring alternating current (AC) voltage. It is commonly used in electronic projects and applications where monitoring AC voltage is necessary.

iii. **ZMCT103C current transformer**

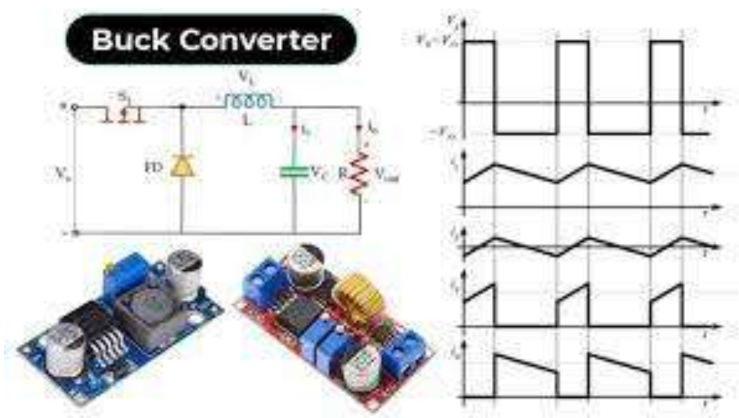
The ZMCT103C is a widely utilized current transformer module designed for the measurement of alternating current (AC) in various electronic projects and applications. It is important to acknowledge that the specifications and particulars of this module may differ, hence it is advisable to consult the manufacturer's specific datasheet for the most precise and current information.

iv. 16 X 2 LCD display With I2C module



The utilization of a 16x2 LCD with an I2C (Inter-Integrated Circuit) module is widespread in electronic projects as a favored display component. By incorporating the I2C module, the process of interfacing is streamlined as it diminishes the number of pins needed and enables the connection of multiple devices to a single I2C bus.

v. LM2596 Buck Converter



The LM2596 is a widely used voltage regulator IC that functions as a step-down (buck) converter. It is designed to efficiently convert higher input voltages to a lower regulated output voltage, making it suitable for various electronic applications.

vi. AC-DC converter

A 12V 2A AC to DC Switch Mode Power Supply (SMPS) module is a circuit that converts an alternating current (AC) input into a direct current (DC) output with a stable voltage of 12V and a maximum current capacity of 2A

vii. Relay

Relays are most commonly used switching devices used in electronics. It can be used to switch high current loads easily unlike transistors which are limited by the maximum current that can flow through them and also can't switch AC loads. This 5V/3.3V Four Channel 10A Relay Module can switch both AC and DC loads. It is an Electromagnetic switch, when the coil inside is energized with a small current, it can switch ON or OFF the high current circuit. It has PCB screw terminals to directly connect. They can be used in Home automation to switch ON or OFF the appliances, in Electronic circuits to perform switching operations, in safety circuits to disconnect or connect the heavy loads in case of any dangerous situation, in Automobile applications like turning on windscreen wipers, power windows fuel pump, cooling fan etc.

FUTURE DEVELOPMENT

- Incorporate machine learning algorithms to predict energy consumption patterns, allowing the system to adapt and optimize based on historical data.
- Enhance data analytics capabilities to provide more detailed insights into energy usage trends, enabling better decision-making for efficiency improvements.
- Explore the use of blockchain technology to enhance the security
- Implement edge computing to process data locally on the ESP8266 device, reducing latency and dependency on continuous cloud
- Integrate the system with smart grid technologies for more dynamic and responsive energy management, allowing for bidirectional communication between the energy grid and the monitoring system.

ADVANTAGES

- Enables organizations and individuals to identify opportunities for energy cost savings through real-time monitoring and analysis.
- Facilitates the optimization of energy consumption patterns, leading to increased operational efficiency
- Supports predictive maintenance by detecting abnormalities early, reducing the risk of equipment failures and downtime.
- Allows for remote monitoring, providing users with access to critical energy data from anywhere in the world.
- Facilitates data-driven decision-making by providing insights into energy usage trends and patterns.

DISADVANTAGES

1) The initial setup cost, including sensors and IoT devices, can be a barrier for some individuals or organizations.
2) Developing and implementing an IOT-based system can be complex, requiring expertise in hardware, software, and networking.

APPLICATIONS

1. Homeowners can monitor and optimize their energy consumption to reduce costs and environmental impact.
2. Organizations can implement the system in factories, offices, and warehouses to manage energy usage efficiently.
3. Municipalities can deploy the monitoring system across city infrastructure to optimize energy consumption in public spaces, street lighting, and government buildings.
4. Apartment complexes or shared living spaces can implement the system for transparent and fair energy cost distribution.

CONCLUSION

In conclusion, the development and implementation of an IoT-based energy meter using the ESP32 microcontroller represent a significant stride towards intelligent and efficient energy management. This project leverages advancements in sensor technologies, microcontroller platforms, and integration with IoT platforms to offer real-time monitoring, control, and optimization of energy consumption.

The inclusion of sensors such as the ZMPT101B voltage sensor and CT current sensor allows for accurate measurement of voltage and current, enabling precise calculation of power consumption. The ESP32 microcontroller serves as the central processing unit, providing computational power, connectivity options, and a platform for programming intelligence into the energy meter.

The integration with the Blynk IoT platform extends the functionality of the energy meter by enabling remote monitoring and control. Users can access real-time energy data, visualize consumption patterns, and receive alerts, contributing to informed decision-making and encouraging energy-efficient practices.

The user interface, featuring a 16x2 LCD, provides a local means of displaying critical parameters such as voltage, current, total power consumed, and associated costs. This not only enhances user awareness but also promotes responsible energy use.

Throughout the project, key considerations such as security, scalability, and compliance with regulatory standards have been addressed. Security measures, including robust encryption protocols, help protect sensitive energy consumption data. The system's scalability ensures adaptability to various applications and energy infrastructures, from residential to industrial settings. Compliance with regulatory standards ensures interoperability and legal adherence.

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