DOI: https://doi.org/10.56815/IJMRR.V3I3.2024/166-173

ISSN: 2945-3135

Peer Reviewed -Referred-Open Access-Scholarly Journal

Kumar, Praveen S R et al. (2024). IOT Based Smart Energy Meter, International Journal of Multidisciplinary Research & Reviews, Vol 03, No. 03, pp. 166-173.

INTERNATIONAL JOURNAL OF
MULTIDISCIPLINARY RESEARCH & REVIEWS

journal homepage: www.ijmrr.online/index.php/home

IOT BASED SMART ENERGY METER

Praveen Kumar S R[1], Rohan K[2], Ujvala R[3], Chandana K R[4], Rajath G R[5]

[1-4] Scholar, Department of Electrical and Electronics Engineering, Dayananda Sagar Academy of Technology and Management, Kanakapura Road, Bengaluru, Karnataka, India.

[5] Assistant Professor & Supervisor, Department of Electrical and Electronics Engineering, Dayananda Sagar Academy of Technology and Management, Kanakapura Road, Bengaluru, Karnataka, India.

Submitted: July 18, 2024 Revised: July 26, 2024 Accepted: July 30, 2024

How to Cite the Article: *Kumar, Praveen S R et al. (2024). IOT Based Smart Energy Meter, International Journal of Multidisciplinary Research & Reviews, Vol 03, No. 03, pp. 166-173.*

Keywords

IoT,ESP32,

Energy,

Current Transformer,

Blynk

Abstract

In recent years, the Smart Energy Meter has attracted a lot of attention from all over the world. In this paper a design and prototyping a low-cost IoT energy monitoring is presented, which may be utilized in a variety of applications such as power billing, smart grid energy management, and home automation. The system is based on a low-cost ESP32 microcontroller that is interfaced non-invasive Current Transformer (CT) sensors, and voltage sensor to get data from sensor nodes and deliver it to a Blynk server over the internet. The studies' findings showed that the system for monitoring energy consumption can precisely record voltage, current, active power, and cumulative power consumption.

1. Introduction

Electric energy use has surged in recent years. As a result, a large increase in energy supply was required. due to population growth and other factors in the coming decades development of the economy as a result, there is a demand-supply imbalance. According to the current scenario, the power generated, which is mostly derived from fossil fuels, will be depleted within the next 20 years. Electronic energy monitoring solutions are currently available on the market that are extremely accurate. In the case of residential applications, the majority of these monitor the power utilized in a domestic household. Consumers are frequently disappointed with their power bills since they do not display the power used at the device level . The Internet of Things (IoT) is a new sector, and IoT-based devices have ushered in a revolution in electronics and

DOI: https://doi.org/10.56815/IJMRR.V3I3.2024/166-173

ISSN: 2945-3135

Peer Reviewed -Referred-Open Access-Scholarly Journal

Kumar, Praveen S R et al. (2024). IOT Based Smart Energy Meter, International Journal of Multidisciplinary Research & Reviews, Vol 03, No. 03, pp. 166-173.

information technology. Energy usage, particularly electricity consumption, is one of the most critical issues we face today. An effective technique to monitor this energy consumption is required . The Internet of Things (IoT) offers a solution to these issues. Hardware, software, and the cloud are all interconnected. As a result, we offer an energy consumption model. Household appliance monitoring system that can be used to calculate energy consumption of the family and to keep the user up to date on his or her electricity usage and be able to make informed decisions.With the advent of Internet of Things (IoT) technology, an existing energy meter with an industrial communication protocol can be adapted to improve connection and observability of power and energy consumption. This can be accomplished by utilizing IoT technology . As a result, this study presents an approach that incorporates IoT technology so that current digital energy meters in buildings can be modified to enable for online monitoring. Traditionally, monitoring electricity consumption involves manual meter readings, which can be time-consuming and inconvenient. The Internet of Things provides a solution by automating remote data collection, thereby saving time and money. The concept of a Smart Energy Meter has gained significant popularity worldwide in recent years, making this an excellent opportunity to build our own IoT-based electricity energy meter.

2. Problem Statement

- Lack of real-time monitoring: Customers find it difficult to adequately monitor their usage because traditional energy metres cannot provide them with information on their energy consumption in real-time.
- Manual reading of energy use is required by current energy metres, which delays invoicing and increases the risk of human mistake during data collecting and calculation.
- Ineffective energy management: When users don't have access to accurate and timely information about energy consumption, they can't identify opportunities for energy savings and decide how to best manage their energy usage.

3. Aim And Objectives Of Smart Energy Meter:

The aim of a smart energy meter is to monitor and measure energy consumption in real-time and provide consumers with information about their energy use to promote more efficient and sustainable energy practices. The main objectives of smart energy meters can vary depending on the context and goals of the particular project or system, but here are some common objectives: Accurate measurement of energy consumption: Smart energy meters aim to provide accurate and reliable measurements of energy consumption, which can help consumers understand their energy use and make more informed decisions about how to reduce their energy consumption and costs. Real-time monitoring and feedback: Smart energy meters can provide real-time monitoring and feedback on energy consumption, allowing consumers to see how much energy they are using and identify opportunities for energy savings. Improved energy efficiency: Smart energy meters can help consumers and businesses identify areas of energy waste and inefficiency, allowing them to take action to reduce energy use and costs. Demand response and load management: Smart energy meters can enable demand response and load management programs, which can help to balance energy supply and demand, reduce peak demand, and avoid power outages. Integration with renewable energy sources: Smart energy meters can enable the integration of renewable energy sources such as solar and wind power, allowing consumers to generate their own energy and sell excess energy back to the grid. Improved billing and payment systems: Smart energy meters can enable more accurate and transparent billing and payment systems, allowing consumers to pay for the energy they use rather than estimated bills based on historical consumption. Overall, the aim and objectives of smart energy meters are to promote more efficient, sustainable, and cost effective energy practices, while improving the reliability and efficiency of the energy system as a whole.

DOI: https://doi.org/10.56815/IJMRR.V3I3.2024/166-173 ISSN: 2945-3135

Peer Reviewed -Referred-Open Access-Scholarly Journal

Kumar, Praveen S R et al. (2024). IOT Based Smart Energy Meter, International Journal of Multidisciplinary Research & Reviews, Vol 03, No. 03, pp. 166-173.

4. Existing Smart Energy Meter Technology In India:

Smart energy meter technology is being widely adopted in India as a means of monitoring and managing energy consumption. The government of India has set a target of installing 250 million smart meters in the country by 2025, and various state electricity distribution companies have already started implementing smart metering solutions. There are several types of smart energy meters available in India, including:

Prepaid Smart Meters: These meters are designed to work on a prepaid basis and require users to pay in advance for their electricity usage. They offer benefits such as real-time consumption monitoring and alerts for low balance.
Postpaid Smart Meters: These meters work on a postpaid basis, where users are billed based on the irmonthly usage. They also offer real-time consumption monitoring and allow users to track their electricity usage and costs.

Advanced Metering Infrastructure (AMI) Meters: These meters "Smart metering and electricity demand: Technology, economics, and international experience" by F. Sioshansi (2011): This book provides an overview of smart metering technology and its impact on electricity demand, including the potential benefits and challenges of smart meters in different context.

5. Hardware Equipments:

1. SC – 013 CURRENT TRANSFORMER:

Fig.1 SCT-013 Current Sensor

SC-013 is a type of current transformer that can be used for monitoring AC currents in electrical power systems. Here are some of its specifications:

1. Primary Current Rating: SC-013 has a primary current rating of up to 20 A, meaning it is designed to measure AC currents up to 20 amps.
2. Secondary Current Rating: The secondary current rating of SC-013 is 5A, which means it produces a 5A output signal proportional to the measured primary current.
3. Frequency Range: The frequency range of SC013 is 50-60 Hz, which makes it suitable for use in most standard electrical power systems.
4. Accuracy Class: The accuracy class of SC-013 is 1.0, which means it has an accuracy of ±1% of the rated current.
5. Burden: The burden of SC-013 is 2.5 VA, which means it can handle a maximum load of 2.5 voltamperes at the secondary side.

6. Insulation Level: SC-013 has an insulation level of 1 kV, which means it can safely operate at a voltage of up to 1000 volts.
7. Physical Dimensions: SC-013 has a compact and lightweight design, with a diameter of 13 mm and a length of 13 mm. It has a split-core construction, which allows it to be easily installed on existing electrical wiring without the need for rewiring or interrupting the circuit.

2. ZMPT101B AC VOLTAGE SENSOR:

Fig.2 ZMPT101B AC Voltage Sensor

ZMPT101B is a voltage sensor that can be used for measuring AC voltages in electrical power systems. Here are some of its specifications:

1. Input Voltage: ZMPT101B is designed to measure AC voltages in the range of 0-250 VAC.
2. Output Voltage: The output voltage of ZMPT101B is 1-5 VDC, which is proportional to the measured AC voltage.
3. Frequency Range: The frequency range of ZMPT101B is 50-60 Hz, which makes it suitable for use in most standard electrical power systems.
4. Accuracy Class: The accuracy class of ZMPT101B is 1.0, which means it has an accuracy of ±1% of the rated voltage.
5. Phase Shift: The phase shift of ZMPT101B is less than 2 degrees, which ensures accurate measurement of AC voltages. 6. Insulation Level: ZMPT101B has an insulation level of 2.5 kVAC, which means it can safely operate at a voltage of up to 2500 volts.
6. Physical Dimensions: ZMPT101B has a compact and lightweight design, with a diameter of 1.5 cm and a height of 2.2 cm. It has a built-in voltage divider circuit and can be easily connected to microcontrollers or other digital devices.
7. Overall, ZMPT101B is a reliable and accurate voltage sensor suitable for a wide range of applications in electrical power systems, including energy management, power monitoring, and protection.

DOI: https://doi.org/10.56815/IJMRR.V3I3.2024/166-173 ISSN: 2945-3135

Peer Reviewed -Referred-Open Access-Scholarly Journal

Kumar, Praveen S R et al. (2024). IOT Based Smart Energy Meter, International Journal of Multidisciplinary Research & Reviews, Vol 03, No. 03, pp. 166-173.

3. ESP32 MICROCONTROLLER:

Fig.3 ESP32 Microcontroller

ESP32 is a microcontroller chip designed for IoT applications. Here are some of its specifications:

1. Processor: ESP32 is based on a dual-core Ten silica Xtensa LX6 processor, with a clock frequency of up to 240 MHz
2. Memory: ESP32 has 520KB SRAM and 448KB ROM, along with 4MB flash memory for program storage.
3. Connectivity: ESP32 supports Wi-Fi 802.11 b/g/n and Bluetooth v4.2 BLE. It also has a builtin Ethernet MAC with dedicated DMA.
4. GPIO: ESP32 has 34 GPIO pins, which can be used for digital input/output, PWM, and other functions.
5. Analog Input: ESP32 has 18 analog input pins, with a resolution of up to 12 bits.
6. Peripherals: ESP32 has a range of peripheral interfaces, including UART, SPI, I2C, I2S, SD/MMC, and CAN.
7. Power Consumption: ESP32 has low power consumption, with various power modes to conserve energy.
8. Operating Voltage: ESP32 operates on a voltage range of 2.2V to 3.6V.
9. Development Environment: ESP32 can be programmed using the Arduino IDE, MicroPython, or other programming languages.
10. Overall, ESP32 is a powerful and versatile microcontroller chip that can be used for a wide range of IoT applications, including smart energy meters, home automation, and industrial control systems.

6. Software Requirement

Arduino IDE:

It is an open source Arduino software that allows you to build and test instructions that compose a program or a sketch for Arduino boards. It facilitates the writing of code. It's simple to use and allows you to upload sketches to the microcontroller boards.Before designing the programming for the ESP32, various considerations were considered in this study. To begin, the ESP32 package has been added to the IDE. Secondly, an EmonLib and Blynk libraries has been added.

EmonLib Library and Blynk Library:

The Emonlib Library is utilized by Electricity Energy Meter.EmonLib, a Continuous Monitoring of Electricity Energy, repeats a series of voltage and current measurements .The voltage and current input channels are continuously measured in the background by EmonLib, which then determines a real average value for each channel and notifies the sketch when the measurements are ready to be read and processed. Blynk is the most popular Internet of Things platform for connecting any hardware to the cloud, designing apps to control them, and managing your deployed products at scale. With Blynk Library you can connect over 400 hardware models including Arduino, ESP8266 & ESP32 to the Blynk Cloud.

Working:

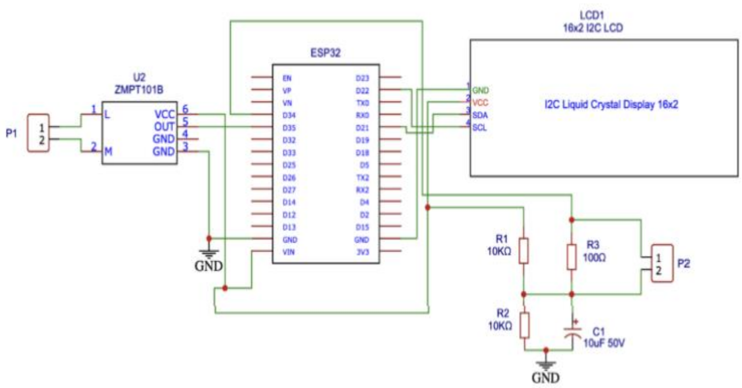

Fig.4 Circuit Diagram of IOT Based Smart Energy Meter

Connection: The circuit schematic diagram's link is simple to understand. Both the SCT-013 Current Transformer and the ZMPT101B Voltage Sensor VCC are connected to the ESP32's 5V supply, Vin. The ESP32's GND is connected to the GND pins of both modules. The ESP32's GPIO35 is connected to the analog output pin of the ZMPT101B Voltage Sensor. The analog output pin of the SCT-013 Current Sensor is connected to ESP32's GPIO 34 in a similar manner. The voltage divider and filter circuit consist of a 10uF capacitor, two 10K resistors, one 100-ohm resistor, and two 10K resistors. The input AC terminal of the voltage sensor is wired with the AC wires that need to be measured for current and voltage. The current sensor clip is similarly unconnected, with only a single live or neutral wire is put within the clip

DOI: https://doi.org/10.56815/IJMRR.V3I3.2024/166-173

ISSN: 2945-3135

Peer Reviewed -Referred-Open Access-Scholarly Journal

Kumar, Praveen S R et al. (2024). IOT Based Smart Energy Meter, International Journal of Multidisciplinary Research & Reviews, Vol 03, No. 03, pp. 166-173.

Working Model:

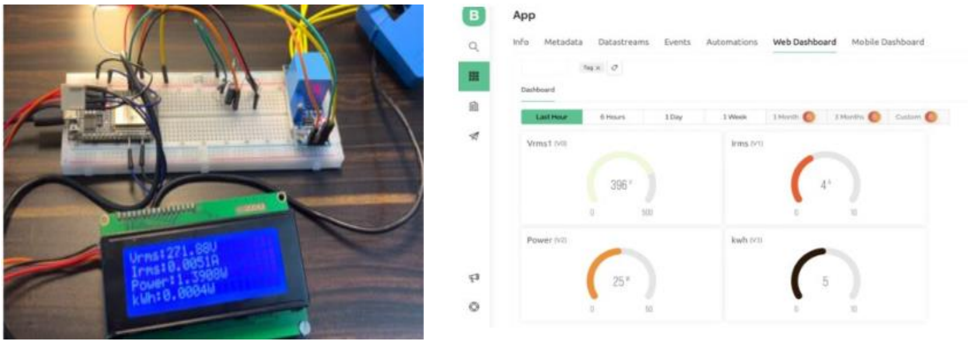

Fig.5 Smart Energy Meter Compact Size Model

7. Advantages

The smart energy meter system has several advantages, including the following:

1. Improved energy efficiency: By monitoring energy consumption in real-time, the smart energy meter system can help users identify areas where energy is being wasted and make changes to reduce energy consumption.
2. Cost savings: The smart energy meter system can help users reduce their energy bills by providing detailed information about energy consumption and identifying areas where energy is being wasted.
3. Remote monitoring: The smart energy meter system can be monitored remotely, which means that users can access real- time data about their energy consumption from anywhere in the world.
4. Potential Applications: The smart energy meter system has several
5. potential applications, including the following: Residential: The smart energy meter system can be used in residential buildings to monitor energy consumption and reduce energy bills.
6. Commercial: The smart energy meter system can be used in commercial buildings to monitor energy consumption and improve energy efficiency.
7. Industrial: The smart energy meter system can be used in industrial application to monitor the consumption and reduce the waste.

8. Conclusion

The smart energy meter system is an innovative technology that can help users reduce their energy bills, improve energy efficiency, and monitor energy consumption in real-time. With its many advantages and potential applications, the smart The energy meter system has the potential to revolutionize the way we use and consume energy.

9. Future Scope

This is the 21st century and there is no space for errors or faults either in any technical system or in general applications. Prepaid energy meters are a beneficial concept for the future. It's facilitating the remission from electricity bills. Electricity vouchers will be available at nearby shops. The word prepaid means "pay before use" . One of the beneficial features of this concept prepaid energy meter is used to prepaid the current supply of electricity to homes, offices etc.

10. Authors Contribution

The writers affirm that they have no connections to, or engagement with, any group or body that provides financial or non-financial assistance for the topics or resources covered in this manuscript.

11. Conflict Of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

12. Plagiarism Policy

All authors declare that any kind of violation of plagiarism, copyright and ethical matters will taken care by all authors. Journal and editors are not liable for aforesaid matters.

13. Sources Of Funding

The authors received no financial aid to support for the research.

References

[1] "Smart Energy Meter Based on IoT" by Ayush Kumar Singh, Shivam Sharma, and Vivek Singh. International Journal of Advanced Research in Computer Science, vol. 8, no. 5, 2017.

[2] "IoT-Based Smart Energy Management System for Residential International Conference on Advanced Computing & Communication Systems (ICACCS), Coimbatore, India, 2019.

[3] Yaghmaee M.H., Hejazi H., (2018). Design and Implementation of an Internet of Things Based Smart Energy Metering, In 2018 IEEE International Conference on Smart Energy Grid Engineering (SEGE), IEEE, Canada.

[4] Wu B., Tan N., (2019). An energy metering and measurement SoC with a novel lowpower DSP architecture, IEEE Internet of Things Journal, 6(2), 3298–3308.

[5]Woong Hee K, Sunyoung L., Jongwoon H., (2011). Real-time Energy Monitoring and Controlling System based on ZigBee Sensor Networks, Procedia Computer Science, 5, 794-797.