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Real Time Energy Monitoring Using Energy Meter

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Abstract:

Today's world has changed by technology in a way human-initiated it with the physical world. The Internet of things provides the flexibility to connect our physical world to an automated dream world. We can connect things to things with the internet to automate the world. This report proposes a system that eliminates manpower by self-regulating meter readings reducing the flaws which are one of the major causes of energy-related corruption. The demand for transparency in the domain of energy estimation has emerged as there isn't a verification facility. We are building an energy meter which can read the Electricity consumption. The effort of collecting electricity utility meter reading. Internet of Things (IoT) present an efficient and co effective to transfer the information of energy consumer wirelessly as well as it provides to detect the usage of the electricity. We can see the real-time power consumption, the total electricity consumption of the current date as well previous month or Year.

Keywords- **Node mcu, energy meter, optocoupler, consumption, cloud, IOT.**

Introduction

The energy consumption can be monitored by using an electric device called energy meter. The cost and the regular usage of Power consumption are informed to the user to overcome high bill usage. The Energy meter shows the amount of units consumed and transfers the data to both the customer and to the electrical board, so this helps in reducing manpower. The user can check their Power usage from anywhere and at any time interval. The IoT is used to Turn on/off the household appliances using relay and microcontroller interfacing. The objective of this system is to monitor the amount of electricity consumed. The distributer and the consumer both will be benefitted by eventually reducing the total Power consumption.

Technology is being implemented into the physical world's objects every moment. With the advancement in it, we can make objects to respond to our presence, motion, and other automatic physiological behaviour. At present, there are many methods of energy metering. From recent works, there have been overall two types of metering systems, one is counting the led blinking of the meter present in the traditional conventional meter measuring the actual voltage and current usage. The energy meter plays a very important role in this energy industry. This device will be in turn connected to the main server with the help of IoT. The algorithm is such that the meter is measuring the data and showing it to the LCD and sending it to the cloud server in real-time. Users can monitor the data like Voltage, and Energy Consume in real-time and they can also the daily and previous energy usage. At the end of each month, the device will generate the rate of units and send it to the user's smartphone along with the bill. The android application will be connected to the Blynk server where the smart meter is connected. One person can on and off the main supply when they need it.

System overview

the system consists of two major devices which is a conventional energy meter and a ESP32 microcontroller. This system uses records from blinks of our primary energy meter, and uses that as a medium for calculating units consumed, as 1units is equals to 3200 blinks and this blinks rate depends upon different meters also. Now this data is taken to Node MCU at pin D4 with PC817 Optocoupler. This data is also saved in the EEPROM this is how data management system collects and store the data and upload it to internet. Node MCU ESP-32 connects to the internet and send data to a cloud- based service or a local server like here we used BLYNK application.

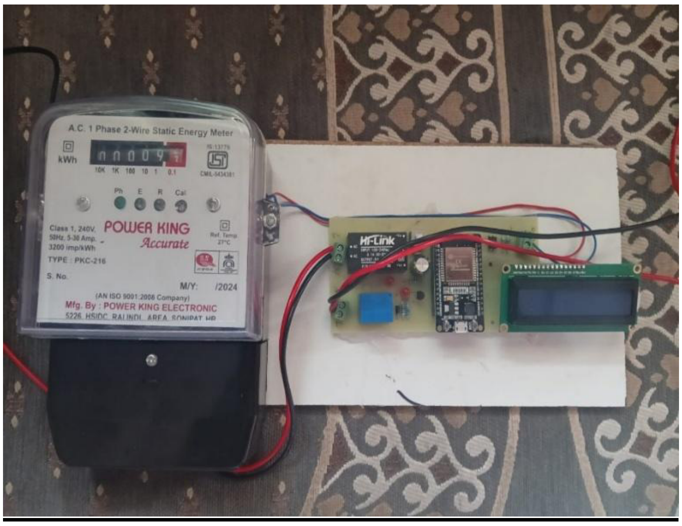

Figure 1: hardware of the device

Working flow

1. Powering the System: AC Supply: The system is powered by an AC supply connected to the input terminal (J2). The switch (SW1) is a Double Pole Double Throw (DPDT) switch used to control the AC power flow. The AC supply is converted to DC using an SMPS (Switched Mode Power Supply), which provides a stable DC voltage to power the ESP32 and other components. Capacitors (C1, C2, and C3) filter and stabilize the voltage.The LED (D1) indicates the system is on.

2. Reading the Meter Signal:

The energy meter sends pulses or signals to the optocoupler, which isolates and transfers them to the ESP32. The ESP32 processes the incoming signals to calculate power usage or detect anomalies. The ESP32 is the core of the project, handling the data processing and control logic. It receives inputs, processes the data, and controls the relay and the display. The ESP32 has Wi-Fi and Bluetooth capabilities..

3. Controlling the Load:

Based on the power consumption data or predefined conditions, the ESP32 controls the relay. The transistor circuit allows the low-power ESP32 to switch the high-power relay safely. The relay is used to control the AC load. It can turn ON or OFF the connected device (e.g., appliance or light) based on signals from the ESP32. The ESP32 controls the relay through a BC547 NPN transistor. When the ESP32 sends a HIGH signal to the base of the transistor (via resistor R2), the transistor conducts, activating the relay coil. The diode (D2) across the relay protects against back-EMF, preventing damage to the circuit.

4. Optocoupler and Meter Interface:

Optocoupler (U3 - PC817): The optocoupler isolates the high-voltage meter signals from the low-voltage ESP32 side. It allows the ESP32 to safely read signals from the energy meter without being directly exposed to high voltage. When the meter sends pulses or signals, the optocoupler activates, sending a corresponding pulse to the ESP32. These resistors limit the current to protect the optocoupler and ensure proper signal levels.

5. Displaying Data:

LCD Module (U4): The display shows real-time power consumption and system status. It uses an I2C interface (SCL and SDA lines) to reduce the number of connections to the ESP32, making the wiring simpler and more efficient. Also this data is accessed through the blynk application on your mobile or computer devices.

Blynk is a platform that enables us to remotely monitor and control your ESP32 project through a mobile app or web dashboard. With Blynk, you can visualize real-time data, trigger alerts, and control appliances from anywhere. The ESP32

connects to your local Wi-Fi network by using the SSID and password provided in the code.

Wi-Fi Initialization (ESP32): It acts as a client that sends data to and receives commands from the Blynk server via the internet. The ESP32 communicates with the Blynk cloud server using Blynk authentication tokens, which link your project to the app.

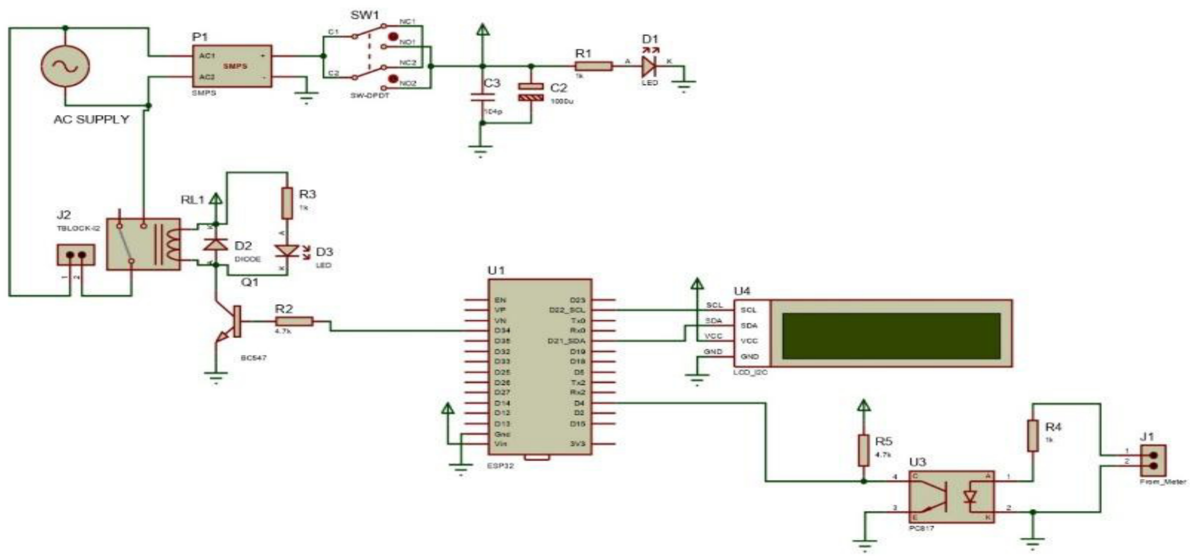

Figure 2. Schematic circuit diagram of the device

Result

Energy consumption and real-Time Power Monitoring The system accurately monitors power consumption from the energy meter. It displays real-time data (energy consumption in units) on: The LCD display for local monitoring. The Blynk app for remote monitoring. The data is displayed in real-time with periodic updates, giving you precise information on your power usage.

Remote Control of Electrical Load The relay module controlled by the ESP32 allows you to remotely switch appliances ON/OFF using the Blynk app. From anywhere, you can turn the load. ON or OFF, adding convenience and improving energy efficiency. The visual representation energy consumption is shown form the graphs and charts also the number of counts of the blink.

This is the output interface where we access the daily energy consumption in units at real time also the data is being saved in EEPROM integrated with ESP 32 and we can remotely operate with the switch provided. The clear data button is provided for erasing all data.

Figure: output result

Figure 4: during load condition

Conclusion

Energy consumption and real time monitoring system successfully achieves its objectives of real-time power monitoring, remote control, and enhanced energy management.

By leveraging Wi-Fi connectivity and the Blynk platform, the system provides: Real-time data visualization on both the LCD and the Blynk app. Remote control of electrical loads, allowing you to turn appliances ON or OFF from anywhere. Electrical safety through optocoupler isolation, ensuring protection from high-voltage circuits.

Key Benefits

Improved energy efficiency by identifying and managing power-hungry appliances. Convenience through remote access and control using the Blynk app. Cost savings by reducing unnecessary power consumption. Scalability, making it adaptable for both residential and industrial applications.

Future scope

We have Implement smart automation, such as turning off appliances during peak hours to save energy. Also we can Integrate with home automation systems like Google Home or Alexa.

Enhanced Safety and Protection Features: Add overvoltage, overcurrent, and short-circuit protection. Implement auto-disconnect features in case of fault detection.

Scalability: Expand the system to monitor and control multiple appliances or industrial equipment. Use multiple ESP32 modules communicating with a central server or gateway.

These enhancements would make the project more versatile, efficient, and applicable to both home and industrial environments. Let me know if you'd like detailed guidance on any of these extensions

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