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IOT Based Energy Meter with Billing System and Load Prioritization

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Abstract

To build our own IoT-based electricity energy metre with billing system and load prioritization using ESP32 and monitoring data in this project. We enabled a smart energy metre that can communicate in both directions and display different parameters on both its built-in display and a web-based Head-end-System application software. The metre calculates the current, voltage, and power output as well as the amount due in real time. With this metre, data collection and bill generation no longer require manual verification. The essential metre data can be viewed by a variety of parties, including consumers, linemen and power distributors, thanks to the IoT enabled meter's ability to simultaneously communicate this data to many devices. Additionally, having access to real-time data will assist electricity distributors better manage their grid and reduce energy waste by enabling them to examine user usage trends and successfully implement strategies like load balancing and shedding. Applying effective power restoration methodology, which must also include a systematic load prioritisation strategy that takes into account a number of practical issues that make the process of load prioritisation difficult and complex, is one important technique for enhancing system reliability. A dynamic load prioritisation model for service restoration is presented in this paper. The process places loads in order of priority and gives each load in the system a computed weight. The process places loads in order of priority and gives each load in the system a computed weight. These weights can be utilised as an input for any restoration optimisation issue because they are dynamic (i.e., time dependent).

Keywords: Internet of Things, Thingspeak, Energy Meter, Arduino UNO, ESP32, Potential divider, LCD, Web page.

I. Introduction

The IoT-based energy meter with billing system and load prioritization project is a smart energy management system that uses IoT technology to monitor and control energy consumption in homes and industries. The system consists of an energy meter that continuously measures the energy usage of various devices and appliances in real-time. The data is then transmitted to a cloud-based billing system that calculates the electricity consumption and generates bills for the user [1]-[4]. The system also includes a load prioritization feature that enables users to prioritize the devices or appliances that receive power during peak demand periods. The system can be programmed to automatically switch off non-essential devices during peak periods, reducing energy consumption and costs. The system is designed to provide a convenient and cost-effective way of managing energy usage. It offers several benefits, including increased energy efficiency, reduced energy costs, and enhanced environmental sustainability. The system is easy to install and can be customized to suit the specific needs of each user. By using IoT technology, the system enables remote monitoring and control of energy consumption, making it possible to identify and rectify energy wastage and inefficiencies. The system can also be integrated with other smart home devices, enabling users to control their energy consumption and costs through a single, centralized system. Overall, the IoT-based energy meter with billing system and load prioritization project is a highly innovative and practical solution for energy management that offers significant benefits to users, including cost savings, convenience, and environmental sustainability [5]-[10].

II. Block Diagram

The block diagram consists of AC source and DC source from which we get power for loads, one current sensor, Arduino Uno, ESP32, LCD, Potentiometer, two relay modules and two loads. The load can be operated by pressing push buttons. Two relays are used to connect the respective load with controller. These relays will help to control overloading situation and prevent load from the damage. In the system, current sensors are used to measure the incoming and outgoing current flowing through energy meter. The relay module is used to control loads.

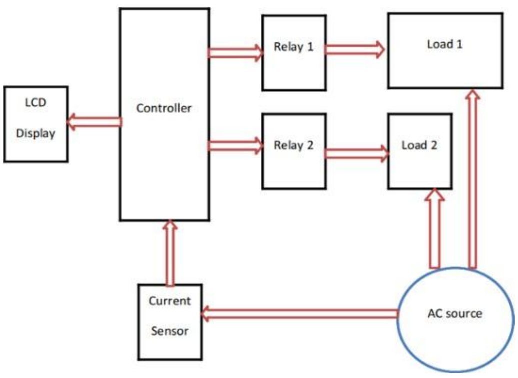

Figure 1: Block Diagram of smart energy meter

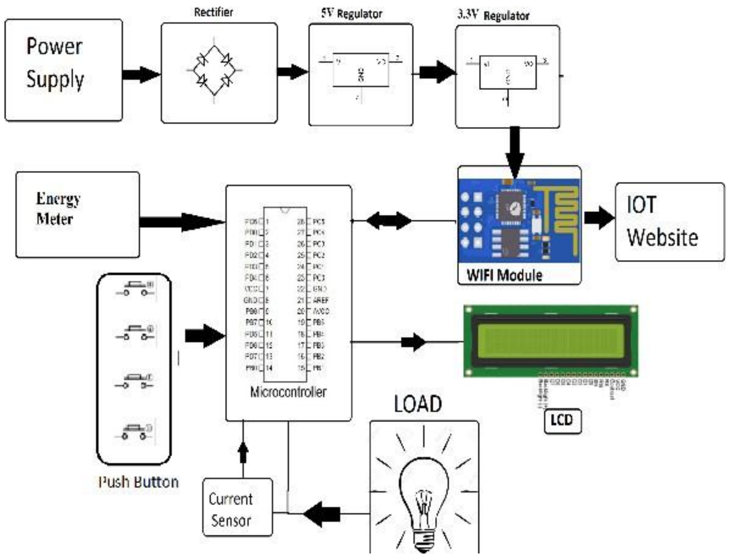

Figure 2: Block Diagram of smart energy meter

III. Hardware Implementation and working

IoT is crucial since it allows for remote control and real-time data monitoring. For operation, the load is connected to an AC power supply. We are utilizing an adapter that comprises of a bridge rectifier to change 12V AC current into 12V DC current and a step-down transformer to change straight 230V AC current into 12V AC current. The hardware kit receives the 12V DC supply from here and passes it through a 1000 microfarad capacitor to the voltage regulator. The capacitor smooths out the ripples in the 12V DC supply, and the voltage regulator converts the 12V DC feed to a 5V constant output DC supply. A voltage regulator has a heat sink attached to it to dissipate any extra power that might get into the regulator. Since the heat sink distributes the extra power as heat, excess voltage is kept from damaging and overheating the voltage regulator. At the voltage regulator's output, a second capacitor is employed to smooth out any residual supply ripples. All components, including the Arduino Uno, LCD, ESP32, current sensor, relay, potentiometer, and push button, are supplied with 5V DC from this point. The circuit is split into two sections here. One component uses a 230V AC supply, while another uses a 5V DC supply. The heart of the hardware configuration is an Arduino Uno. It gathers data or information from every component and transmits the necessary signal to it for monitoring and control. To connect to the internet, we used the ESp32 controller, which has built-in Wi-Fi capability. The IOT dashboard will receive data from this facility controller. Utilizing a website called thingSpeak, we were able to interact with the IOT dashboard. We will have access to a user interface through this website to track loads, usage, billing, etc. Pressing the push buttons will enable the consumer to use the load. The consumer can turn on lamp 1 by pressing the first push button, and lamp 2 by pressing the second push button. The lamp current is measured by the current sensor. Relays are used to control lamp on/off and to shield loads from excessive current. He can manage the power consumption with the aid of a potential divider by adjusting the usage cap. The power consumption starts when both lamps are turned on, and it is displayed on the LCD and the ThingSpeak cloud [11]-[12]. It shows how much they used, light status, a bill, and a control set limit on an LCD. If the set value for power consumption is reached. The low priority bulb is then switched off, leaving the high priority bulb alone in the ON position. He can raise the limit value if he wants to use both lamps. As he is now only utilizing one lamp, the consumption value decreases. After some time, the consumption will likewise reach the limit set in terms of time. Following that, both lamps will be switched off. Thus, we may restrict how much power we use based on our priorities, which will cut down on electricity use and help with demand side management.

IV. Result

A 230V AC supply and 5V DC is given to the proposed system, but all the loads are at Off position. Thus, no power is consumed by the loads.

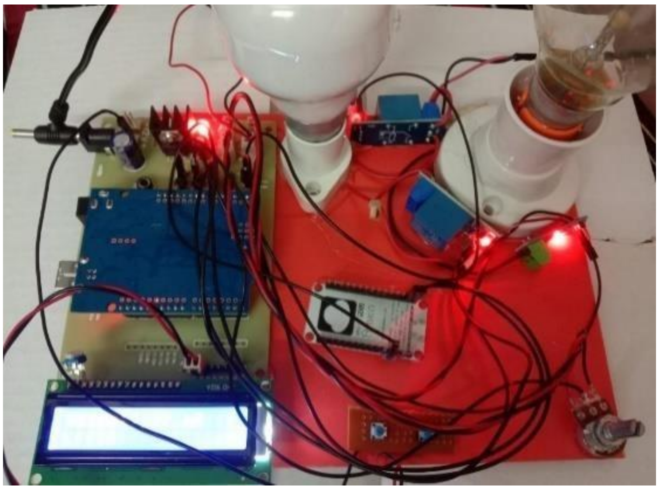

Figure 3: System on Ideal State

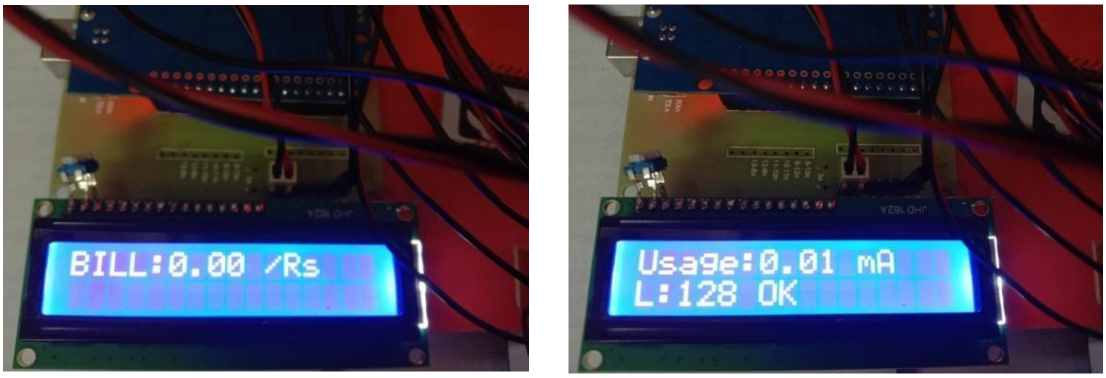

Figure 4: Electricity Bill under Ideal state

As the consumption by loads are Zero. No current or voltage is drawn by the loads, so the energy consumption of loads i.e. bill is Zero as shown in LCD display.

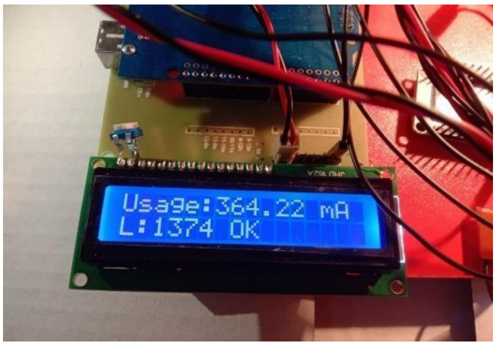

Figure 5: system current usage and set limit value

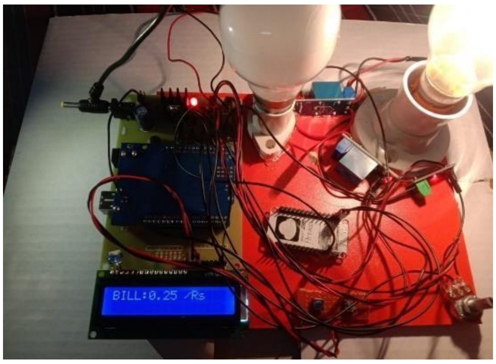

Figure 6: System in turn ON State

A 230V AC supply and 5V DC is given to the proposed system, Now the loads are at ON position. Thus, power is consumption takes place by the loads.
As loads are connected the voltage or current drawn by the loads and usage value of current and limit set value will be display on the LCD screen.

Figure 7: Electricity Bill under ON state

As the power consumption takes place by loads has some value. So, the energy consumption bill of loads will be displayed as shown in LCD display.

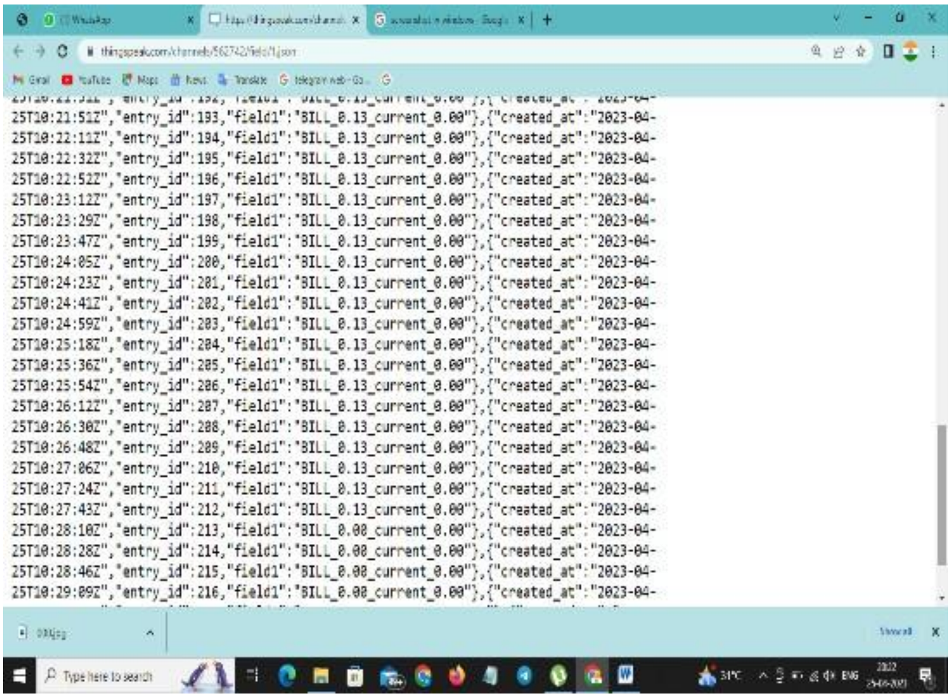

Figure 8. Electricity consumption data on web page.

V. Conclusion

This paper explains how energy meters are made and function as well as how they can be utilized for automatic meter reading. In our technological age, it is the most cost-effective way to advance humanity. It is an effective and useful use of current networks given the current advancement in technology's application to benefit mankind. Additionally, this project demonstrates how load works with an energy meter. It makes using the technology for getting precise meter readings simple. Arduino and WI-FI are features of a smart energy monitoring system. The system prioritizes loads and automatically reads the energy meter. The Internet of Things (IoT) connects everything throughout the universe. It can communicate with nearly everything on the planet. The information is sent to the energy meter to turn on/off objects after being saved in the cloud. We are able to centralize the office and the consumer by directly receiving energy usage from a remote location. By doing this, we lower the amount of human labor required to record the meter readings, which were previously recorded by visiting each home separately. The values for hourly energy usage used in this work were obtained from the energy supplier. These benchmark values make it easier for consumers and energy utilities to understand their hourly reported energy use. In fact, consumer conduct may be examined, and the results, particularly when associated with a potentially fluctuating price, can aid customers in modifying their behavior.

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