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Smart energy metering and load controlling by using internet of things

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Abstract- Meter readings were obtained from the electricity supplier. Internet of Things (IOT) represents an efficient and effective way of wireless communication and transmission of information about energy consumers and measured values. The main intention of this project is to measure the power consumption in household appliances and bill it automatically with IOT. The energy grid must be in a distributed topology that dynamically accommodates different energy sources. IOT for various grid applications with distribution energy plant meters, energy production and consumption meters, smart meters, energy demand management, and fields of energy generation. The energy consumed by the loads with digital energy meters using NODE MCU. When the energy meter is powered, the energy meter displays the voltage and current. The data collected by the NODE MCU will send the data to the server via the Wi-Fi module. And all output loads are controlled with the relay module. The total procedure is automated, and loads are on and off using a smartphone app or a website.

Keywords – NODE MCU, Relay module, Wi-Fi module, LCD, Current sensor, voltage sensor.

I.INTRODUCTION

IoT has also been identified as a catalyst for human-to-human, human-to-environment, and human-to-machine interactions. The concept of the Internet of Things (IOT) allows us to connect traditional everyday gadgets via the internet. The IOT idea allows for remote analysis of connected devices. The Internet of Things (IOT) idea provides the necessary infrastructure and opportunity for connecting the physical and digital worlds. Computer-based systems and the rest of the world The idea has gained traction. With more and more wireless devices, it has become increasingly important. devices that are rapidly growing in popularity on the market. Hardware devices communicate with one another via the internet (Internet). The Wi-Fi module utilized in the system, the ESP-8266, allows the system to connect to the internet. Nowadays, the population's demand for electricity is expanding at a steady rate, and it is used for a variety of activities, including agriculture, industry, domestic use, hospitals, and so on. As a result, managing electrical maintenance and demand is getting increasingly difficult. As a result, there is an immediate need to conserve the maximum amount of electricity possible. As the for electricity from younger generations grows, so does the need for technological advancement. The suggested method uses IOT technology to add a 180-degree technological curve to typical energy meters.

Other concerns that have been dealt with, such as electricity theft, resulted in economic losses for the country. The objectives ahead of a remote system are monitoring optimized power utilization and reduced power waste. A new technology-based energy meter with three key goals uses a Wi-Fi system. They are

i. To give instantaneous automatic load energy readings.
ii. To make the best use of electricity while staying within a budget.
iii. Minimize the amount of energy wasted. The consumer end of the system can be used to monitor the system. The

system's data is displayed on a consumer webpage.
The system is used on the ESP-8266 microcontroller. It's a low-cost wifi microchip that has a full TCP/IP protocol stack and a microcontroller. This little module allows the microcontroller to connect to a WiFi network, and the WiFi unit plays the role of sending data from the controller over the internet. The NODE MCU software IDE (Integrated Development Environment) is used to program the ESP8266 controller, which is required to use the NODE MCU.

II. LITERATURE SURVEY

We detailed a possible real time IoT-based energy management system in this research. It is designed as part of a distributed system that monitors the main power system parameters and allows grid management. Quick access to data is a feature of the gadget, and the combination of a smart meter and digital communication capability allows both local and remote access. It is possible to regulate electrical appliance power consumption and check the amount of power consumed by our devices in terms of money in this way. Overall energy usage and cost decreased as a result of the power system. Using Smart Grids, an approach for energy conservation in Smart Grids developed. The global energy demand is increasing. It is necessary to take efforts to prevent energy waste through effective metering, as stated in this paper.
The NODE MCU is controlled by an ESP8266 microprocessor, which comes preinstalled with a WIFI module. The goal of this project is to achieve real-time pricing. This is a cost-effective and environmentally beneficial option. We present the planning, design, and implementation of the project.
the Wi-Fi-enabled energy meter's implementation and address the issues with traditional energy sources meters. The energy reader has the ability to collect energy. wirelessly obtain consumption readings from the energy meter Wi-Fi technology is used. The design and execution of the energy meter using the IOT idea by NODE MCU as described in this article. Human involvement in electricity maintenance is eliminated by the suggested system architecture. The Buyer must purchase electricity regularly; if he fails to do so, the electricity transmission can be switched off remotely from a distant server. A 16*2 LCD allows the user to keep track of the energy usage in units. A real-time energy measuring and actuation framework based on the Internet of Things is developed, which can easily integrate with home monitoring systems. The IOT operation is carried out by the Wi-Fi device, which sends energy meter data to the cloud, where it may be accessed and shown on an LCD screen.

III. BLOCK DIAGRAM

The NODE MCU-based smart electricity meter can be into two sections. The first is the physical component, and the second is the website. It is made up of an ESP 8266 Wi-Fi module, an ACS712 current sensor, a 16*2 display, a voltage sensor, and a power supply. The equipment is distinguished by easy data access, and the combination of a smart meter and digital communication capability allows for both local and remote access. It is possible to manage the power in this manner. The equipment is defined by its ease of data access, and the combination of a smart meter and digital communication capacity allows for both local and remote access.
It allows us to monitor our electrical appliance's power consumption as well as check the amount of power utilized by our equipment in terms of usage.

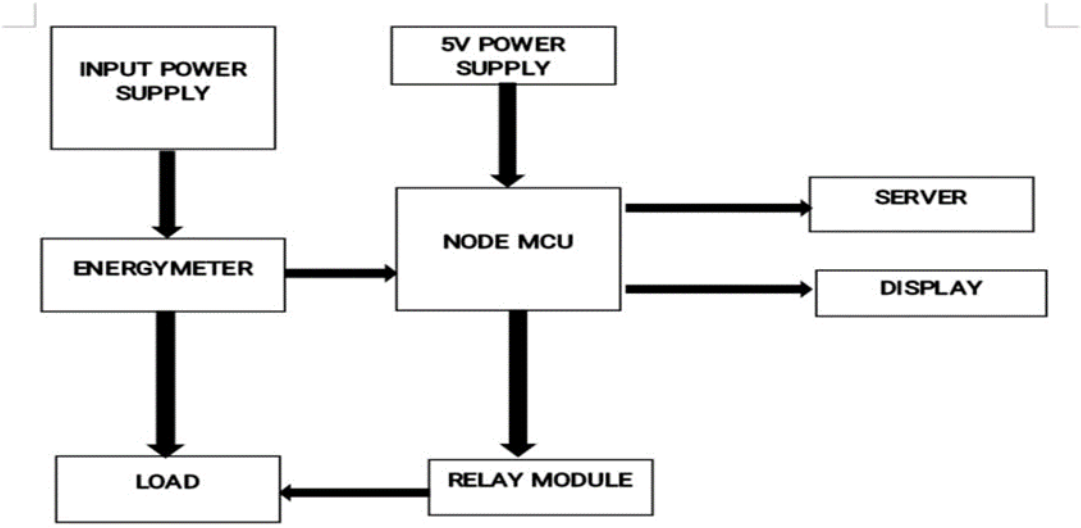

Fig. Block diagram of smart energy metering and load controlling by using IOT

IV. SMART ENERGY MONITORING AND CONTROL SYSTEM

The traditional energy meter we use in our homes to monitor energy consumption is an offline gadget that must be manually monitored. However, Smart Energy Meters are now available on the market, with readings that can be viewed from anywhere via the internet. Not only can we monitor energy consumption, but we can also monitor multiple parameters such as voltage, current, power factor, frequency, and so on using IOT on a laptop or mobile device.

We're using IOT to create a Smart Energy Meter. To measure the parameters, we'll use a NODE MCU multifunction Electric Energy Metering Power Monitor module and use a NODEMCU ESP8266 to send the data to the Blynk app.

V.COMPONENTS

Smart energy meter plays a major role in the electrical system. There are few important components are used in this project. They are;

a) NODE MCU
b) Wi-fi module
c) Relay module
d) Lcd
e) Current sensor
f) Voltage sensor
g) Regulated power supply

a) NODE MCU

Node MCU is a development board built specifically for Internet of Things (IoT) applications such as blynk or other electronic applications that may be turned on and off automatically. To monitor and operate the linked devices, we need to inject Blynk code into the Node MCU. In this setup, it serves as a Wi-Fi module.

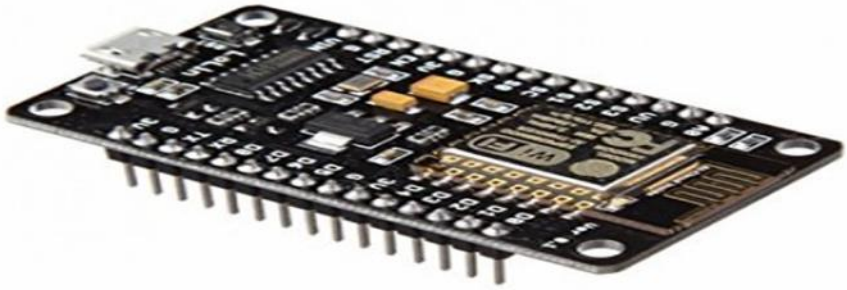

Fig .01

PINS:

Power pins: Micro-USB, 3.3V, Ground, and Vin are the power pins. Micro-USB is can be powered through the USB port. Regulated 3.3V can be supplied to this pin to power the board. Vin is an external power supply**.**

Control pins: and EN, RS T are the control pins. The pin and the button rest on the microcontroller.

Analog Pin: A0 is used to measure analog voltage in the range of 0-3.3V. GPIO Pins: GPI01 to GPI016. Node MCU has 16 general purpose input-output pins on its board.

SPI Pins: Node MCU has four pins available for SPI communication. They are SD1, CMD, SDO, and CLK**.**

UART Pins: Node MCU has two UART interfaces, UARTO (RXDO & TXDO) and UART1 (RXD1 & TXD1). UART1 is used to upload the program**.**

12C Pins: Node MCU has 12C functionality support but due to the internal functionality of these pins, we have to find which pin is 12C.

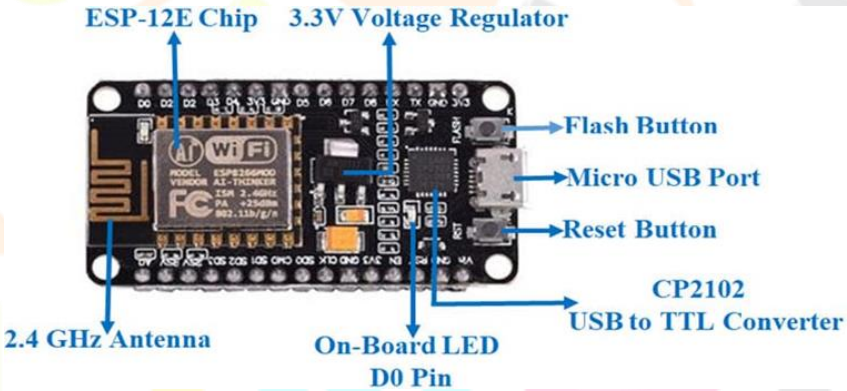

Fig.02

b)**Wifi module**

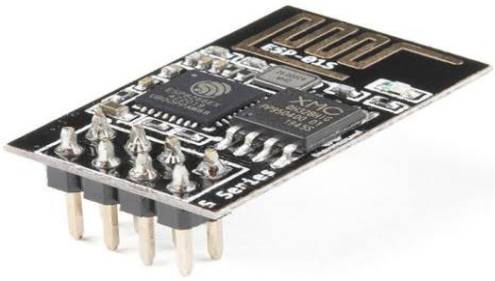

Fig.03

Wi-Fi (wireless fidelity) modules, also known as WLAN (wireless local area network) modules, are electronic components that enable a wireless connection to the internet in a variety of goods. Wi-Fi module (also known as serial to WIFI module) is a component of the IOT's transmission layer. The function is to transform a serial port or TTL

level into an embedded module that complies with the Wi-Fi wireless network communication standard and includes a wireless network protocol IEEE802.11 B.G.N protocol stack as well as a TCP/IP protocol stack.

c) Relay module

A relay is an electromechanical device that opens or closes connections to trigger other electrical controls to operate. Relays are open and close connections in another circuit to control one circuit. Relay is controlled by the NODE MCU in this project. According to the specified code, it automatically opens and closes the linked socket**.**

Fig.04

d) LCD

An LCD 162 is a type of electronic gadget that displays data and messages. It has 16 columns and 2 rows, allowing for a total of 32 characters (16 2 = 32) to be displayed, with each character consisting of 5 8 (40) pixel dots. As a result, the total pixels in this LCD are 32 x 40, otherwise 1280 pixels.

Fig.05

e) Current sensor

For measuring current in a circuit a sensor is required. ACS712 Current Sensor is the sensor that can use to measure and calculate the amount of current applied to the conductor without affecting the performance of the system. The ACS712 Current Sensor is a fully integrated linear sensor IC based on the Hall effect. This IC offers voltage isolation of 2.1kV RMS and a low resistance current conductor.

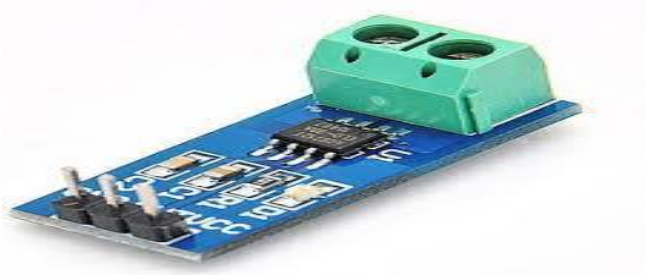

Fig.06

f) Voltage sensor

The ZMPT101B AC Single Phase voltage sensor module is based on a high-precision ZMPT101B voltage transformer that is used to measure accurate AC voltage. An excellent option for measuring AC voltage with an Arduino or an ESP32. The Modules can measure voltage within a range of 250V AC and change the analog output accordingly. The module is easy to operate, It has a multi-turn trim potentiometer for calibrating and modifying the ADC output.

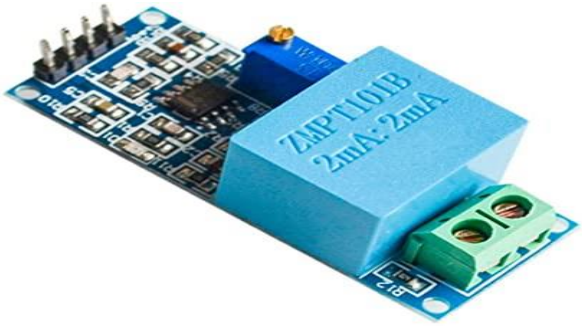

Fig.07

g) Regulated power supply

In an embedded circuit, a regulated power supply turns unregulated AC (Alternating Current) into a steady DC. It transforms AC power into DC with the help of a rectifier. Its purpose is to provide a constant voltage (or, less frequently, current) to a circuit or device that must operate within particular power supply parameters. The regulated power supply's output can be alternating or unidirectional, but it's almost usually DC (Direct Current).

Fig.08

VI. OPERATION AND WORKING

OPERATION

The load's energy consumption is measured using a digital energy meter and the NODE MCU. The data collected is saved on the server. When the energy meter is supplied with power, it displays the voltage, current, power, and energy. Using the Wi-Fi module, the data acquired by the node MCU is sent to the server. We can control the energy meter from afar and get data from the server. The entire process is automated, with loads being turned on and off via a smartphone app or website. The tariff will be presented as a function of load fluctuation.

WORKING

The Node MCU is used in this IOT-based smart energy meter. An energy meter is connected to the node MCU in digital inputs when we give 3.3 to 5 volts to the node MCU using a power-regulated supply. The wi-fi module is used to gather and send data from the energy meters to the server. The date that was collected is also displayed on the 16*2 LCD.

Here we use the real module. The relay module is used to control the device. Devices are turned on and off automatically by using the node MCU program. And these devices are also controlled manually and automatically with the help of mobiles or websites.

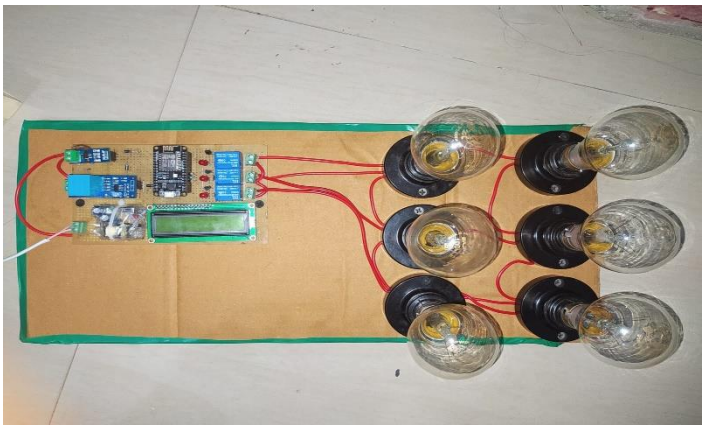

Fig.09

VII HARDWARE RESULTS

Smart energy monitoring and control by using the internet of things, when we turn on the supply without connecting any device meter should be shown in fig .10. In this project, we consider 3 cases connecting the loads. The loads are monitored and controlled automatically with help of node MCU.

And we get these results. The readings energy meter changes with corresponding loads On and off and tariff also changes.

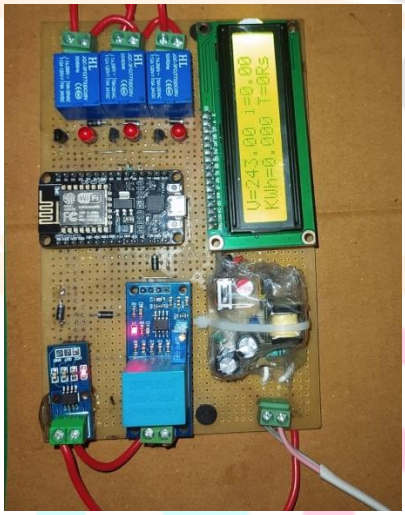

Fig .10

CASE-1: -When we connected one load then voltage, current, and tariff changes are shown in fig 11

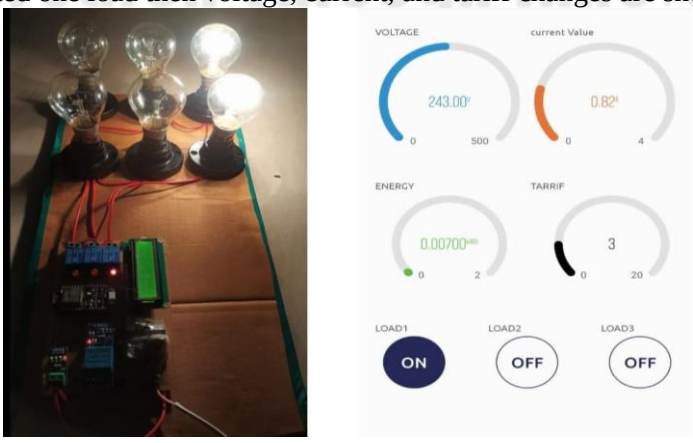

Fig 11

CASE -2:- When we connected two loads then voltage ,current and tariff changes are shown in fig 12

Fig 12

CASE-3:- When we connected three loads then voltage, current, and tariff are shown in fig 13

Fig 13

VIII CONCLUSION

Smart energy monitoring and control by using the internet of things was proposed in this paper. The system provides wireless data transmission and automatic load control. The use of NODE MCU and Wi-Fi modules increases the stability of wireless data transmission. By using this system the customer can anytime check their consumed unit and bill online or website. A smart meter is used to automatically measure energy consumption and automatically calculate the bill with the help of IoT and Node MCU techniques. The energy consumption units are measured from the user location and calculated in the bill consisting of hardware and software. The loads can be controlled from a remote location by mobile application.

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