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IOT based Smart Energy Meter Using ESP32

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Abstract : This paper presents the design and development of a energy metering device that can be used for monitoring, recording energy consumption by various home appliances.The device uses Node MCU ESP 32 as the central controller and a voltage sensor - ZMPT101B as well as a current sensor - ACS712 as its major components. Besides these, for displaying the voltage and current consumption and other parameters an 128*64 OLED screen is used. Also the device is interfaced with the IoT based Blynk mobile application. This facilitates transmission of the sensor data to Blynk cloud storage through ESP32 Wifi module. Real time monitioring of energy consumption thus becomes possible. The device is tested to measure power consumption by AC as well DC loads. The real time measurement readings can also be shared to other devices over the internet. The design provides an efficient means to monitor the energy consumption by AC and DC powered appliances.

IndexTerms **- Energy Meter,ACS712,ESP 32,ZMPT101B,OLED,Monitoring**.

I. Introduction

Today's world is heading towards miniaturization of devices which provides two important advantages - reduce power consumption and increse efficiency. Recently owing to rise in usage of number of electronic components that consume small quantities of power in industries, measurement of power consumption has become an important concern. To improve the efficiency of electronics, firstly we need to measure the power used by the components and based on that data, develop future technologies for better efficiency. The design of energy meter proposed here helps to measure energy consumption and facilitates real time monitoring. Using this we can measure DC power in the range of few mW to 80W and DC power in the range of 20W to 1kW. The real time measured ratings can be shared to other devices over internet. The meter is designed using ESP32 as the central controller with ACS712, ZMPT101B and INA219 sensors.

II. Energy meter design

Using this meter we can measure DC power in the range of few mW to 80W and DC power in the range of 20W to 1kW. The real time measured ratings can be shared to other devices over internet. The meter is designed using ESP32 as the central controller with ACS712, ZMPT101B and INA219 sensors.

III. Block diagram

Our goal is to measure wattage from the range of few milli-watts to 1kW. As shown in Figure 1, a single ESP32 microcontroller and two separate circuits. Firstly, for measurement of AC power in the range of 20 – 1000W, ACS712 and ZMPT101B sensors are used .Both the sensors provide an analog output based on the sensed parameters and send it to analog pins of the ESP32. The inbuilt ADC in ESP32 converts the analog values in digital. From the measured voltage and current values, we can calculate instantaneous power, energy, electricity units and cost of electricity used at Rs. 6.50 per unit. Secondly, DC power is measured using INA219 in the range of milli-watts to 70W. It has a selectable range to change the resolution of the parameters ranging from 400mA at 0.1mA resolution to 3.2A at 0.8mA resolution from 0 - 26V DC. It communicates with the ESP32 via I^2C protocol.

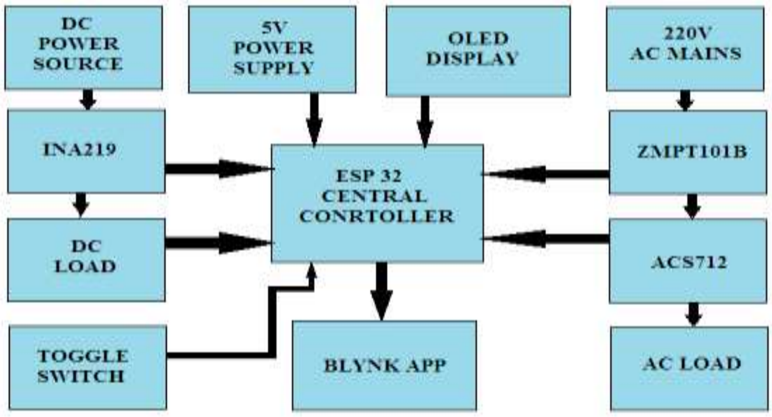

Fig.1 Block diagram of Smart Energy Meter

A common 0.96-inch 128X64 OLED display for both the circuits is used. It also communicates via I^2C protocol. To switch from AC to DC or vice versa, a toggle switch is used which switches the code to be run to measure AC or DC. The data can be shared over WIFI to our mobile phones on the Blynk app. We can measure both AC and DC parameters using a single system and the components used are readily available with their libraries on the Arduino IDE software.

IV. Hardware

Figure 2 and Figure 3 shows the photographic views of the hardware prepaerd using the ESP32 controller, current and voltage sensors, and a common 0.96-inch 128X64 OLED display.

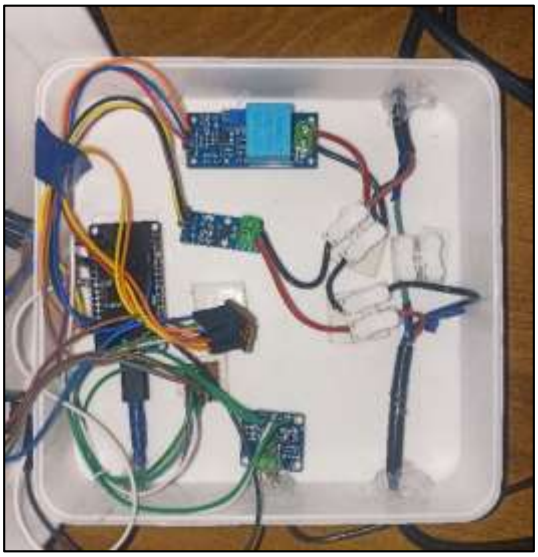

Fig. 2 Internal view of meter circuit

Fig. 3 External view of meter circuit

V. Calculation

We can measure current and voltage for both AC and DC. To calculate rest of the parameters, we are relying on the measured current and voltage itself. Figure 4 shows DC power consumption measured and displayed on OLED screen for a RED led.

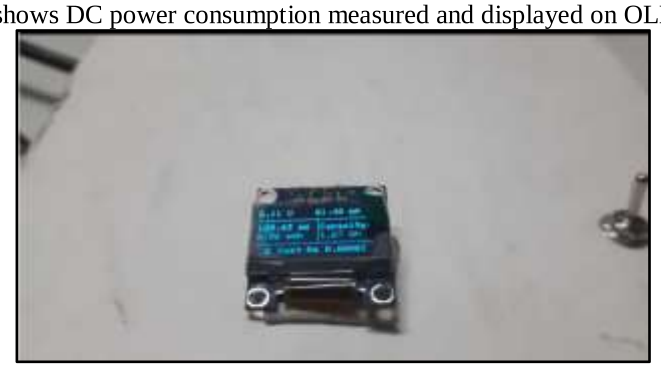

Fig. 4 Power consumption display on OLED screen

For DC Load:

Power (W) = Current * Voltage

Energy (mWh) = Energy + Power / 3600

Capacity (mAh) = Capacity + Current / 1000

Cost (Rs) = Cost + (6.50 / 1000000 * Energy Difference)

For AC Load:

Power (W) = Current * Voltage

Energy (Wh) = Energy + Power / 3600

Units = Energy / 1000

Cost (Rs) = Cost + (6.50 / 1000 * Energy Difference)

VI. TESTING AND RESULTS

AC LOAD TESTING

To test our AC part of Wattmeter, we connected a 800W Iron to it. To measure the AC power, we must switch the toggle switch to AC mode and then measure power consumption. Figure 5 shows an electric iron connected to the Smart Energy meter and acts as an AC load. Figure 6 shows the Blynk mobile application screen. The AC voltage, current and power consumed by Electric iron is available on the Blynk screen along with readings of energy consumed in Whr, total units of power consumed, price per unit in INR and total cost of power consumed in INR. Figure 7 shows the same information on the Blynk application dashboard on a computer screen.

Fig. 5 Testing AC circuit of the energy meter with electric iron

Fig. 6 Blynk mobile phone app screen showing readings of power consumption readings and total cost in rupees

Fig.7 Blynk dashboard

DC LOAD TESTING

To test our DC part of the wattmeter, we connected a LED with a 9V battery. The positive of the battery is connected to the negative of INA219 and positive of INA219 is connected to the positive of the LED. Then we switch the toggle switch to DC mode and measure the power consumption.

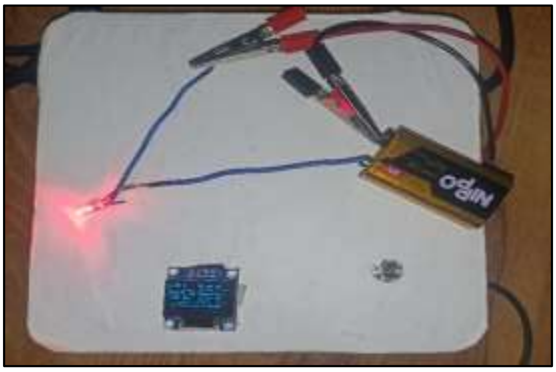

Fig. 8 Red LED connected to the Energy meter as a DC load

Fig. 9 Blynk Application screen shot

VII. CONCLUSION

Billing process for electricity consumption still involve manual efforts in india specifically. the process comprise of a person roaming around the houses, taking meter reading manually and generating bill a particular house. along with that, if a house is solar powered and connected to grid, two separate bills are to be generated, which is a tedious task and require a lot of manual efforts and energy. the proposed meter addresses the issue and describes a methodology for automatically generating the bills. further the bills can be shared with the consumer for their electricity consumption over the text message and email, which reduces the generation of hard copy of bill to make the system paperless. as a future scope, the consumer can be provided with mobile application so that the energy uses for a given month or year can be accessed at any point of time, which may help to compare the monthly /yearly uses patterns.

This methodology can save time human efforts and money and effective billing system can be there in place. further, as a future development in the project, some of the security features can be incorporated to avoid hacking and other cyber crimes over the internet.

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