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Design and Implementation of Cloud based Digital Energy Meter using ESP8266

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Abstract*: *Increasing cost in energy sector demands for structured use of energy. It is vital to understand the rate of energy consumption during specific period utilizing Energy Meters. Energy consumption can be measured using a traditional energy meter; however, their use is restricted in inaccessible areas or in occasion of poor visibility resulting in limited functionality. Also, the main drawback is that a person has to take readings area by area from every house and institute make it time consuming. We propose a Cloud based Wireless Energy Meter [1] which can send data via wireless communication (cloud computing) to a PC or mobile phones in the form of E-mails or mobile application notification or through web page; where surveillance and analysis of the data will be made. This computational system can be used to measure energy quantities of transformers and high voltage towers at remote locations, industries, domestic area, and institutions.

Keywords*: *Arduino, Current sensor, Energy meter, IOT, Node MCU, Voltage sensor.

I. INTRODUCTION

In recent days tracking of the electricity usage in traditional Energy meter is impossible and also analysis of data on the periodic basis is also complex. The consumer is facing severe problem like receiving the pay bill which is already paid, sometimes paying extra charges due to error while taking energy reading [2] and it is impossible to measure in inaccessible area. To overcome this problem and also to keep tracking, currently developed "Design and Implementation of Cloud based Digital Energy meter using ESP8266" this is addressable for both consumer and the electricity board. The paper mainly deals with the embedded system of hardware and software enabled system on the basis of cloud computing with Node MCU module as source of Wi-Fi access.

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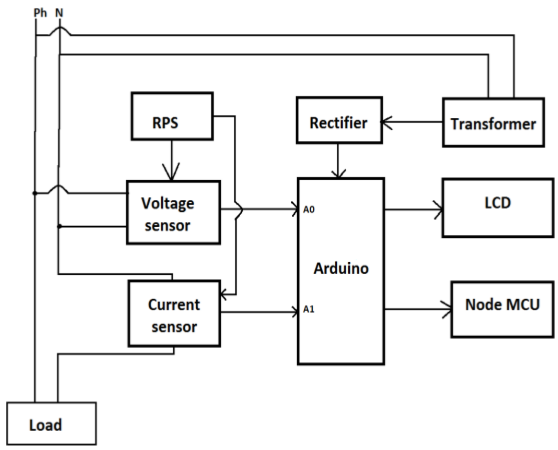
With the help of Node MCU the data can accessed through both mobile application and Web page.
The usage notification can be sent in the form of E-mail and application notification. This system will read the monthly energy usage of a consumer automatically and send the information to Electricity board. This can be achieved through Wi-Fi Module and Arduino that can continuously monitor the electricity usage with cloud storage. This can be displayed on web page and E-mail on customer request.

II. OBJECTIVES

The main objectives of using IOT based Wireless Energy Meter is to save energy and also in this modern appliance we can send the data using wireless communication where the monitoring and analyzing of data will be made much easier. In this device data, can be stored and retrieved whenever the data is required. This project can be used in remote locations and this has more advantages than traditional energy meter.

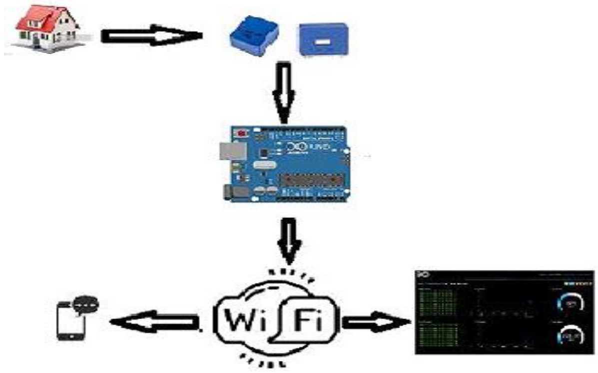
III. BLOCK DIAGRAM



IV. METHODOLOGY

Here, we describe a Wireless Digital Energy meter using Arduino and ESP8266 NODE MCU [3] which can monitor the energy usage in real time and can send Emails of electricity bill to any location at a single touch point. MQTT Dashboard Android App can be used to monitor our Energy usage. Cloud Based Digital Wireless Energy Meter can be used to monitor using from anywhere in the world and also triggers an alert Email when the Electricity consumption is high.

V. ARCHITECTURAL DIAGRAM



VI. ENERGY METER AND SENSORS

A. Digital Energy meter

The quantity of electrical energy used by the consumers can be measured by energy meter. Electricity board is responsible for installing the energy meter at consumers' location to calculate the electricity consumption. By measuring the V and I, the instrument will calculate the power value (V*I). This value of power is calculated over a time period, which is used to find energy consumed over that time period.

B. Current Sensor

Current sensor is a sensing unit which can measure a physical phenomenon and compute the values. A current sensor (closed loop current transducer) is a device which identifies the current in the system, using the Hall Effect method. By completely filling the primary hole with a single bar, best dynamic performances can be achieved. The ideal model to accomplish efficient magnetic coupling is by running the primary winding over the top edge of the quipment.

C. Hall Effect Sensor

For high frequency measurements, Hall Effect is the ideal sensing technology. The Hall element is created using a thin sheet of conductive material with output connections perpendicular to the direction of current flow. Upon application of a magnetic field, a proportional output voltage response can be obtained. Thus, obtained voltage output is very small (µV) and can be converted to useful voltage levels using additional electronics. Finally, Hall Effect Sensor is formed, when the Hall element is combined with the associated electronics.

D. Voltage Sensor

Voltage division method is widely used for voltage sensing with the help of voltage sensor LEM LV-25P [5].The obtained value is in the form of Analog value which will be converted by specific calculation.

VII. CONVERSION FORMULA

A. Formula For Voltage Conversion

float volSen = readvoltage(A1); // voltage sensor reading, LEM connected to A1

Vout Voltage(mV) = (volSen/ Vconv)*IoffSet; // Calibration as per multimeter values)

B. Formula For Current Conversion

float curSen = readvoltage(A0);

//current sensor reading, LEM connected to A0

//Calibration as per multimeter values float Voffset;

curSen = curSen + 3ffset;

float amps = curSen*Iconv;

//calibration may vary as per conditions

VIII. TABULATIONS

Table-I: Parameters and symbols used

Parameters	Symbol	Value
Input voltage	Vin	220V
Output voltage	readvoltage	220-260V
Offset current	VoffSet	As per multimeter
Offset voltage	IoffSet	As per multimeter
Input current	Iin	10A
Read current	cursen	5-10A
Vconversion	Vconv	204.8
Iconvertion	Iconv	48(Calibration Value)

Table-II: Current value with no load

Analog value(mv)	Current through wire(A)
1.11	0.43
1.12	0.54

Table-III: Current value with R-load

Analog value(mv)	Current through wire(A)
1.75	1.10
1.77	1.11

Table-IV: Voltage value with no load

Analog value(mv)	VOLTAGE through wire
4.7	265
4.9	250

Table-V: Voltage value with R-load

Analog value(mv)	VOLTAGE through wire
4.8	265
4.7	250

IX. WAVEFORMS

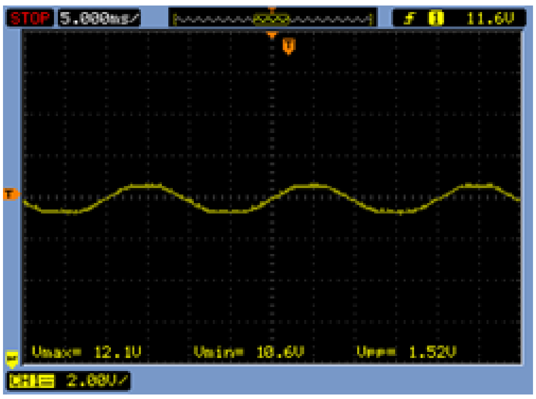


Fig.1 Output waveform of Voltage wave

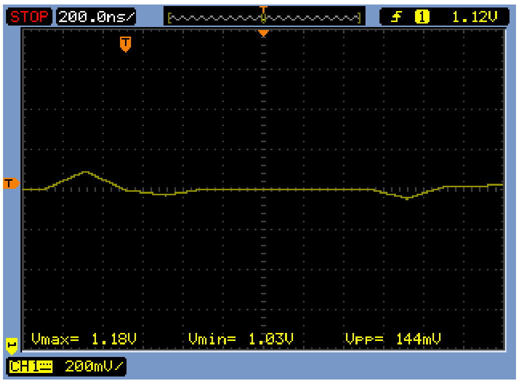


Fig.2 Output waveform of Current wave

X. HARDWARE AND SOFTWARE SETUP

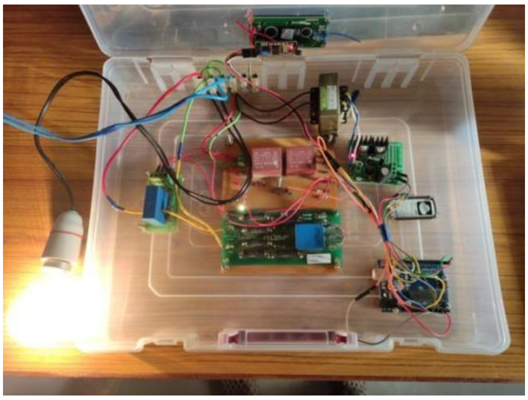


Fig.3 Hardware Prototype

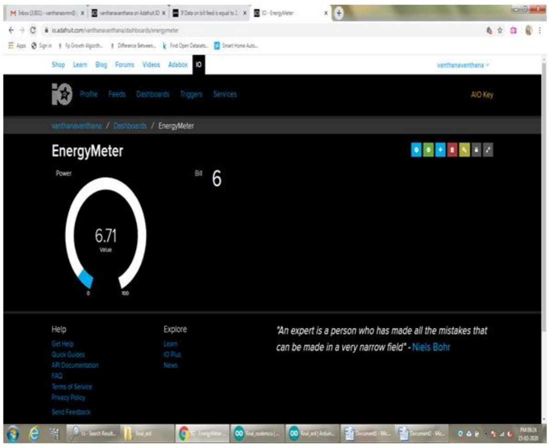


Fig.4 IOT Dashboard result

XI. ARDUINO AND NODE MCU

A. Arduino Uno

Arduino board is the vital component of our system. Entire system functionality depends on this controller. Arduino [8] responses to the 5v given by RPS source, thus, calculating the power consumed as well as the cost. The data is constantly stored on cloud, which is accessible to the user at any time. The system can be programmed to reacts like message sending, receiving, retrieve data.

B. Node Mcu (Esp8266)

Wi-Fi means Wireless Fidelity. Wi-Fi acts as source for IoT [4]. Thus, using Wi-Fi the consumer can view the bill; he can modulate or control the energy meter. Time to time the data canbe programed to be displayed on mobile application as well as website. Consumer also has accessibility to the Arduino board and the meter with help of Node MCU as source.

Features

- Integrated 10-bit ADC
- Integrated low power 32-bit MCU
- Integrated PLL and power administration units
- Sustained antenna multiplicity
- Support Smart Link Function for both Android and iOS devices
- Wi-Fi 2.4 GHz, support WPA/WPA2
- SDIO 2.0, (H) SPI, UART, I2C, I2S, IR Remote Control, PWM, GPIO
- Profound current < 5uA
- Reserve power consumption of < 1.0mW (DTIM3)
- awaken and transmit packets in < 2ms
- -40°C ~ 125°C, wide operating temperature range
- +20 dBm output power in 802.11b mode

C. Internet Of Things

An organized unit of computing devices, digital and mechanical machines, animals, people or objects with unique identifiers (UIDs) is called Internet of Things (IoT)[8]. IoT has potential to transfer data, without human-to-computer or human- to-human interaction, over a network.

XII. CONCLUSION

The proposed system emphasized an inexpensive and reliable Cloud Based Digital Energy Meter. With the proposed energy meter; measurement as well as wireless transmission of data are attainable through E-mail and Application notification at single touch point is possible. Enables even comparison and monitoring are made simple with the data received from the Node MCU. Above described system will be cost effective with reduced time consumption compared to traditional energy meter. Future work may include reduction of harmonics distortion, correction of power factor, compact design in sensors; reduction in size; improve data security, Artificial intelligence platform will be proposed.

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