International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 3, pp: 496-500 www.ijaem.net ISSN: 2395-5252

Prepaid energy meter using Arduino with intelligent monitoring of loads

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Date of Submission: 25-07-2020 Date of Acceptance: 05-08-2020

ABSTRACT - The present electricity billing system in India is error prone and time consuming. Errors get introduced at every stage of energy billing like errors with electro-mechanical meters, human errors while noting down the meter readings and errors while processing the paid bills and the due bills. One of the remedies for these drawbacks is implementation of a prepaid energy meter.

The project is on the development of a prepaid energy meter which is having capabilities like remote monitoring and controlling of energy meter. Here the consumer pays the electricity bill well in advance before the energy consumption which would be entitled as pay first and then use it. Each consumer has varying load demands thus depending on those load demands suitable amount of units (kWh) are recharged.

The present system of energy billing is facing the problem about collecting electrical revenue from their consumer by metering and billing. This results in high cost per unit as the expenses for metering, billing and collecting dues is becoming complex and also it is inaccurate and slow. To overcome this problem a prepaid energy meter using Wi-Fi module is designed. This is based on the concept in which we can recharge its balance, like we do in our mobile phones and also we can monitor the power consumption of each load operated in home. By this consumer will be able to maintain the energy usage on particular loads and can control the wastage of power consumption.

Keywords- Prepaidenergy meter, monitoring, controlling, electricity bill and recharge.

I. INTRODUCTION

With the growing population of India and its rising electric power needs, the power system has grown rapidly over past 50 years. At present, at the end of every month a person from electricity board goes to every house and take the meter readings manually which are used for electricity bill calculations, this is a sluggish and laborious process. In this conventional billing system people try to manipulate the meter readings by adopting various corrupt practices such as bypassing supply, magnetic interference etc. Thus the conventional billing method is inaccurate, costlier, time consuming and has lack of transparency, hence this is causing a stark amount of revenue loss to the distribution companies.

Therefore, several attempts were made to overcome all these drawbacks of conventional billing system. Even though the meters are made digital, the methodology of billing is same. Therefore the scope of the project is to design and develop a prepaid energy meter with intelligent monitoring of loads that will help us in knowing the units consumed by the loads in the form of graph and also we can recharge the energy meter and control the loads through the application designed.

Usually the buyer will pay for the usage of electricity on schedule. Wi-Fi [1] unit performs IOT operation by sending energy meter data to webpage. In this system Wi-Fi module sends information to server and consumer get it through android application. The information is being sent and received by short message service [SMS] [2] in parallel with Android application. Priority based control system [3] can be used in this to control the loads automatically through Android application.

II. DESCRIPTION OF THE COMPONENTS

1 Power supply unit

Power supply unit is main part of every project. Power supply is a vital part of all electronic system. Most digital IC's including microcontroller and memory IC's operate on dc volt +5 V, hence conversion is made from ac to dc.

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2 Arduino Uno

The Arduino Uno is an open-sourcemicrocontroller board based on the MicrochipATmega328P microcontroller and developed by Arduing.cc.The board is equipped with sets of digital and analoginput/output(I/O) pins that may be interfaced to various expansion boards(shields) and other circuits.The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE(Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

Fig 1:Arduino UNO

3 Relay

Relays are the switching devices operated by currents and employed to control large power or to perform switching operations

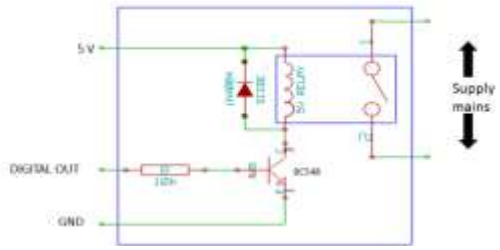

Fig 2: Schematic diagram of relay.

The circuit diagram shows the connection of Relay Driver Circuit. When the logic signal from controller or any other circuits like timers, op amps is applied to base of the transistor through resistor 1 KΩ .When base signal is high, transistor saturates and it energizes the relay. The transistor act as a small signal amplifier resistor of 1 KΩ is used to provide proper emitter base voltage to turn the transistor to ON state from OFF state.

Relay is an electromechanical switch & it works on the principle of energizing an electromagnet. It consists of primary coil, 2 contacts, one is normally open contact "NO" & the other is normally closed contact "NC"& pole normally identified a common. When relay is in off state the pole (common) is connected to normally closed (NC contact). The load may be a fan or dc motor or heater coil, when transistor starts conducting current starts flowing through the coil. Which develops its own magnetic flux when the strength of current is suitable; whenever a sufficient flux is produced it attracts the pole to make contact with normally open position 'NO'. Hence the load connected to it performs its operation until the contact is broken. A diode connected in parallel across the primary coil is to eliminate the effect of back EMF on the transistor. Relays have great application in industry. Using the principle of energizing an Electromagnet we can handle large voltages & current application. Without the risk of shocks.

4 Wi-Fi module

Fig 3: Wi-Fi module

The ESP8266 is a low-cost Wi-Fi microchip, with a full TCP/IP stack and microcontroller capability, produced by Expressive Systems in Shanghai, China.

5 Energy meter

The meter which is used for measuring the energy utilizes by the electric load is known as the energy meter. The energy is the total power consumed and utilized by the load at a particular interval of time. It is used in domestic and industrial AC circuit for measuring the power consumption.

- Working of the Energy Meter

The energy meter has the aluminium disc whose rotation determines the power consumption of the load. The disc is placed between the air gap of the series and shunt electromagnet. The shunt magnet has the pressure coil, and the series magnet has the current coil.

The pressure coil creates the magnetic field because of the supply voltage, and the current coil produces it because of the current.

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The field induces by the voltage coil is lagging by 90º on the magnetic field of the current coil because of which eddy current induced in the disc. The interaction of the eddy current and the magnetic field causes torque, which exerts a force on the disc. Thus, the disc starts rotating.

The force on the disc is proportional to the current and voltage of the coil. The permanent magnet controls their rotation. The permanent magnet opposes the movement of the disc and equalises it on the power consumption. The cyclometer counts the rotation of the disc.

III. PROPOSED SCHEME

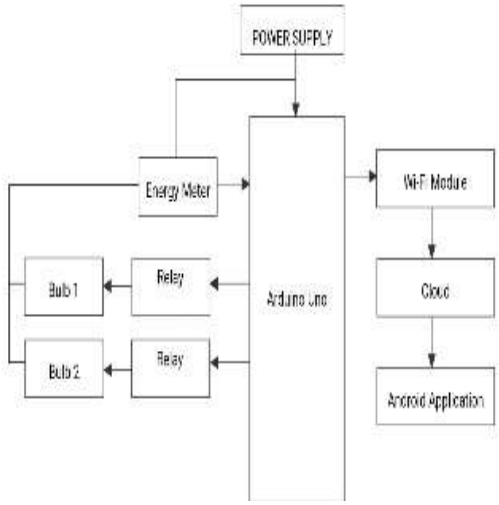

Fig. 4: Block diagram of the Project

This system will have energy meter with load bulbs and Wi-Fi Module, these load bulbs can be controlled from the android application with server.Wi-Fi module gets the values from the server using Internet. These values will have recharged amount and Bulb state (Either On or OFF).System will update the values to server with present balance and power consumed by the loads. These will display on Android application.Android application will have manual and automatic control. In Manual mode each load can be switched ON/OFF. In Automatic mode user has to give the time in minutes to switch ON/OFF automatically, in the time delay of user specified.In android application Recharge can be done, display the power consumed by the loads and also displays the remaining amount and the units consumed will be shown in the form of graphs.

- Android Application can be operated as follows: Connect the kit (Smart meter) to the internet or to the Wi-Fi model

1. Refresh the phone and open the Android application

2. a) To recharge select the 'Recharge' option
b) To Switch ON/OFF, select the 'Control' option. (Can choose the manual or automatic option in the application)
3. To check the unit consumption of the meter, select the 'Graph' option.

IV. CONCLUSION

4.1 Hardware kit

Fig 5: Picture of hardware kit

4.2 Features available in the application.

Fig. 6: The figure of Features available in the application.

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4.3 Recharging the Energy Meter

Fig. 7&8: The figure of Recharging the Energy Meter

4.4Notification of recharge and Low balance

Fig 9: Message received when energy meter is recharged.

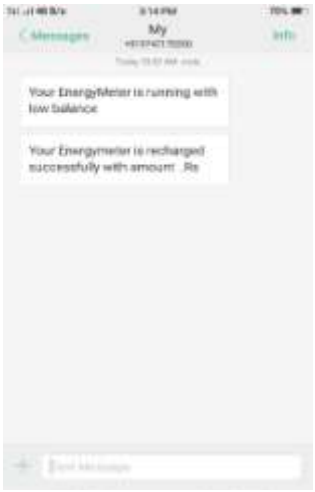

Fig 10: message received

When energy meter gets low balance

4.5 Automatic controlling of Loads

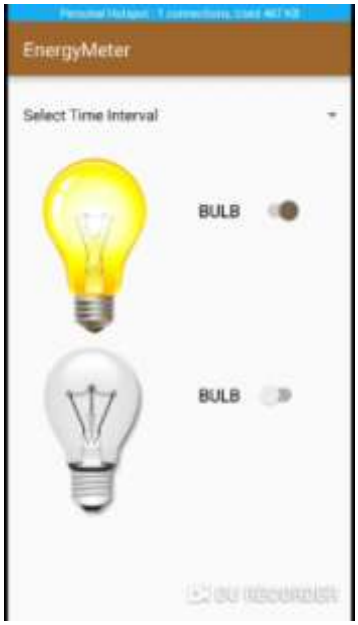

Fig 11: Controlling of loads through application.

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4.6 Unit consumption by the loads.

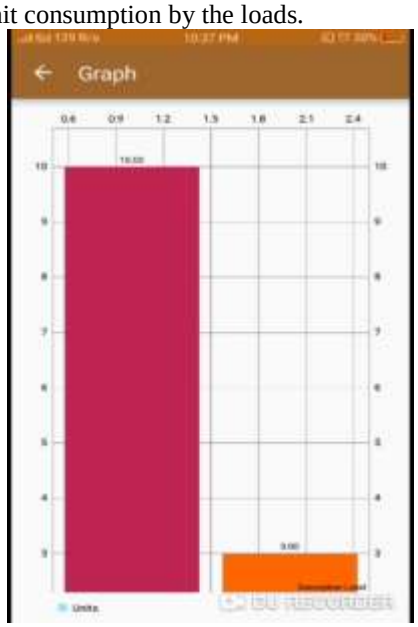

Fig 12: status of the graph showing the units consumed by the loads for each interval of switching ON and OFF.

AKNOWLEDGEMENT

The authors wish to thank the HESCOM to providing technical knowledge concern to this project.

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International Journal of Advances in Engineering and Management
ISSN: 2395-5252

IJAEM

Volume: 02 Issue: 01 DOI: 10.35629/5252

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