SMART ENERGY METERING USING IOT TECHNOLOGY

Srishti Chopra
Department of Electronics and
Communications Engineering
Vellore Institute of Technology
Vellore, India
srishti.chopra2020@vitstudent.ac.in

Abstract -**Efficient energy utilization plays a very vital role for the development of smart grid in power system. So, proper monitoring and controlling of energy consumption is a chief priority of the smart grid. The existing energy meter system has many problems associated to it and one of the key problem is there is no full duplex communication. To solve this problem, a smart energy meter is proposed based on Internet of Things (IoT). The proposed smart energy meter controls and calculates the energy consumption using ESP 8266 12E, a Wi-Fi module and uploads it to the cloud from where the consumer or producer can view the reading. Therefore, energy analyzation by the consumer becomes much easier and controllable. This system also helps in detecting power theft. Thus, this smart meter helps in home automation using IoT and enabling wireless communication which is a great step towards Digital India.**

Keywords—Energy Meter, IOT, Communication

I. INTRODUCTION (*HEADING 1*)

The internet of things (IoT) is a network of connected smart devices enabling to transfer data. The 'thing' in IoT could be a person with a heart monitor or an automobile with built-in sensors, i.e. objects that have been assigned an IP address and have the ability to collect and transfer data over a network without manual assistance or intervention. The embedded technology in the objects helps them to interact with internal states or the external environment, which in turn affects the decisions taken. With rapid growth and development, energy crisis has become a very big issue. An applicable system has to be made in order to analyze and control power consumption. The existing system is error prone, labor and time consuming. The values that we get from the existing system are not precise and accurate though it may be digital type but it is always necessary that a concern person from the power department should visit the consumer house in order to note down the data and error can get introduced at each and every step. Therefore, the remedy for this solution is smart energy meter. The smart grid plays a great role in our present society. Tens of millions of the people's daily life will be degraded dramatically because of the unstable and unreliable power grid [2]. Smart meter is a reliable status real time monitoring, automatic collection of information, user interaction and power control device [3]. It provides a two way flow of information between consumers and suppliers providing better controllability and efficiency [4]. It provides real time consumption information providing energy consumption control [5]. Whenever the maximum load demand of customers crosses its peak value, the supply of electricity for the customers will be disconnected with the help of smart energy meter [6]. In ideal environment with normal work load condition, the life span of the smart meter is about 5 to 6 years [7- 8]. But in reality smart energy meter suffers environmental issues and decreases its life span with abnormal consumption of energy [9]. The factors affecting lifespan of a smart meter consists of life expectancy (LE), genetics (GE), environment factors (EF), change over time (CT) and limited longevity (LL) [10]. IoT based energy meter system mainly consists of three major parts i.e. Controller, Wi-Fi and Theft detection part. Whenever there is any fault or theft, the theft detection sensor senses the error and circuit response according to the information it receives. The controller plays a major role in the system making sure all the components are working fine. Therefore, IoT can improve the performance and efficiency of the smart grid mostly in the three phases. Firstly, it increases the reliability and durability. Secondly, it focuses on enablement i.e. collection and analyzation of data to manage active devices within the smart grid. Lastly, controlling can be done by analyzing the result obtained from the second phase which helps the grid department to make fine decision for future upliftment. The energy meter available till now can only control and monitor the energy consumption of customers. Smart energy meter developed using power line communication (PLC) helps in power loss [11]. Several system using Arduino as well as microcontroller have been developed though the efficiency to measure power consumption drastically increased but due to cost effective it may not be considered as the suitable one. The consumer cannot have a good and accurate track of the energy consumption on a more interval basis . The conventional meter has some of the common errors like [12] • Time consuming. • Chance of theft. • Error while taking the information and extra human involvement. • Consumer cannot have daily update of his/her usage. Thus, we proposed a smart system which enables the consumer as well as producer to monitor and control the energy consumption on more immediate basis.

II. DIFFERENT METHODS OF CURRENT SENSING

There are many ways to measure the current flowing through a wire, the popular **current sensing methods** are discussed here. The current sensing is done in two ways, namely the Direct sensing method and t9he indirect sensing method. **Direct sensing method** uses Ohm's law to measure the voltage drop occurring in a wire when current flows through it, but ACS712 uses **indirect current sensing method** (which is measured by calculating magnetic field by applying either Faraday's Law or Ampere's Law), hence there will be no external load on the current-carrying wire and no direct contact is needed. It is similar to how clamp meter works. We will discuss more on **ACS712 working** later in this article.

Another popular method for Current sensing is using a **Current Transformer (CT)**. It is also an indirect current sensing method. It also works in the same way where the carrying wire passes through the center hole of CT transformer and the CT transformer consists of a coil that will pick up the magnetic flux generated by the current-carrying wire. By measuring the voltage induced in this coil, we can calculate the current that passed through the wire. A typical current transformer is shown below.

III. ACS 712 CURRENT SENSOR

ACS712 is based on the theory of **Hall effect** which was discovered by Dr. Edwin Hall in 1879. According to the principle, when a current-carrying conductor is placed in the magnetic field, a voltage is generated across its edges perpendicular to the direction of both current and the magnetic field. This voltage is known as hall voltage and its typical value is in the order of few millivolts. So by measuring the Hall voltage, we will be able to calculate the amount of current flowing through the sensor. A typically ACS712 Current sensor is shown below.

When an electron flows through a wire or path, it creates a magnetic field in its surroundings. This magnetic field is sensed by the Hall effect IC and a voltage output is produced which can be directly fed into the microcontroller or ESP board. This sensor is located at the surface of the IC on a bold copper conducting path from phase input-output.

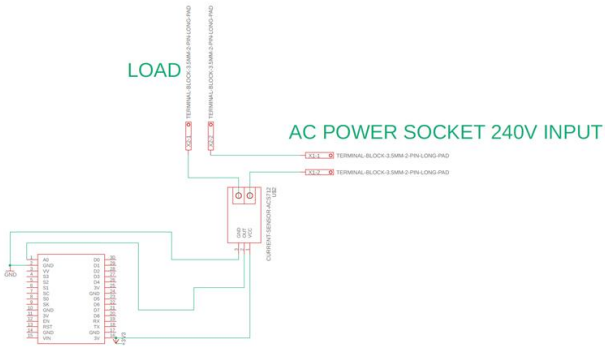
ACS712 sensor has 4 variants (185mV=5A module,100mV=10A & 66mV for 20A & 30A module) and each variant is rated is for a different current value. You can choose any of them as per your requirement but for better calibration, millivolts per Amp value should be correctly assigned to the coding. Note that as the current rating of the sensor increases, the accuracy will decrease.

IV. LITERATURE REVIEW

S.No.	TITLE	AUTHOR /YEAR	INFERENCE
1.)	IOT BASED SMART ENERGY METER FOR EFFICIENT ENERGY UTILIZATION IN SMART GRID	Bibek Barman, Sadhan Gope(2021)	This paper provides wireless meter reading system that can monitor and analyze the data at every interval providing accurate results with less error. Some of the advantages of this smart system are: - • Energy conservation. • Lots of time and power saving from power department. • Automatic control of energy meter. • To make consumer keep the track of energy meter. • Power theft detection. Some of the disadvantages are:- • Sometime the system takes time to upload the data depending on the Internet Speed and Module baud rate. The IoT concept can also be implemented in various working environment such as home automation, automatic water level detector and traffic control system etc
2.)	IOT based Smart Energy Meter Monitoring and Controlling System	Rishabh Jain , Sharvi Gupta , Chirag Mahajan , Ashish Chauhan(2019)	The main cause for the design of IOT based E-meter is to reduce the power consumption in house. It avoids the human intervention reduces the cost, save human power. It works both automatically and manually. This meter sends billing directly to mobile before due date without causing human intervention. This computerization for diminish the work costs as well as makes the framework more effective and exact. The system is mainly intended for smart cities with public Wi-Fi hotspots. The project is based on the internet of things concept. This is aimed at replacing the old energy meters with an advanced implementation. It can be used for automatic power reading by which one can optimize their power usage thereby reducing the power wastage. The readings from the meter are uploaded to Thingspeak.com where a channel with the energy usage for a

			particular energy meter can be viewed by both the service end and the customer.
3.)	DESIGN OF IOT BASED SMART ENERGY METER FOR HOME APPLIANCES	M RUPESH AND N ANBU SELVA N (2021)	This proposed smart meter is used to automatically measure energy consumption and automatically calculate the bill with the help of IoT and GSM techniques. This work deals with the energy consumption units measured from the user's location and calculates the bill consisting of hardware and software parts. After the calculation process, the controller sends the bill to the concerned user. Simultaneously, the bill will be updated on the user's website using the Wi-Fi module. An advanced energy meter accurately measures electrical energy consumption and provides extra information because compared to a conventional energy meter; the system is developed by the Aurdino microcontroller. The smart meter's main advantage is it alerts us when our energy consumption crosses the actual limit by sending a message. These smart meters can measure the reading and send the information to the customers within a small-time interval.

V. CIRCUIT DIAGRAM



We have used **NodeMCU with ACS712 Current Sensor**, the current sensor will measure the current consumed by our AC load and the NodeMCU will measure this current, calculate the power (assuming the voltage is constant) and send the power value to a cloud platform like Adafruit IO.

As you can see the NodeMCU will be powered through the USB port using a 5V mobile charger and the AC load will be connected to the 220V AC mains through our ACS712 current sensor. The sensor has a maximum input voltage on VCC is 5V but it also works fine in lower voltage. Please note that the ASC712 output offset voltage is dependable on its operating voltage (generally half of the operating voltage). Since we powered up the module from the ESP 3V output pin the ACS712 module output offset voltage is 1.5 volt (1500 mv) when there is no current flowing. ESP has an on-board voltage divider circuit internally, so we are giving direct input from ACS712 output to the A0 input pin.

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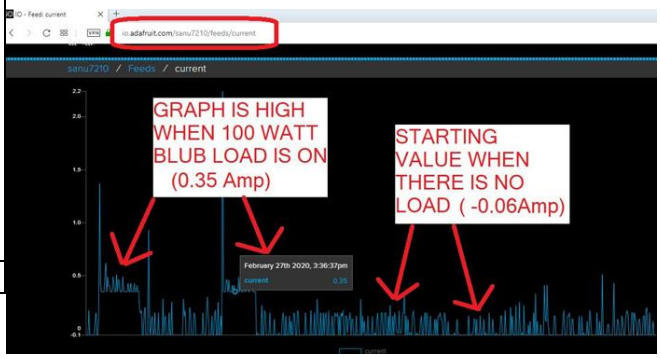
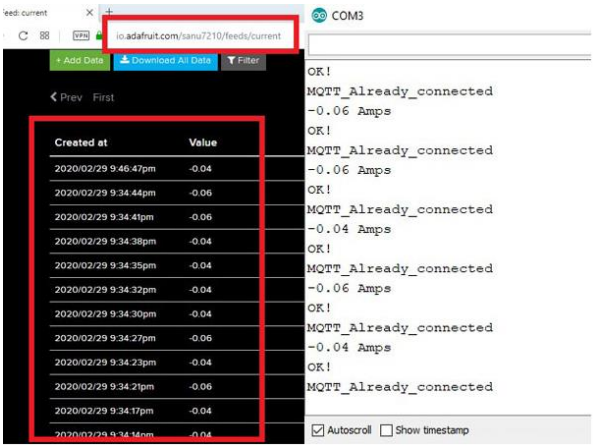
VI. RESULTS AND DISCUSSIONS

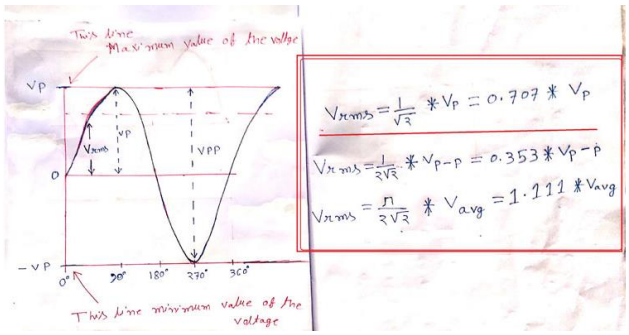
We have tested it on different load conditions like with a 100-watt bulb, with 200-watt Blub, and with 500 watts halogen, etc. Here is the screenshot with zero to 100-watt load conditions on the MQTT IoT platform.



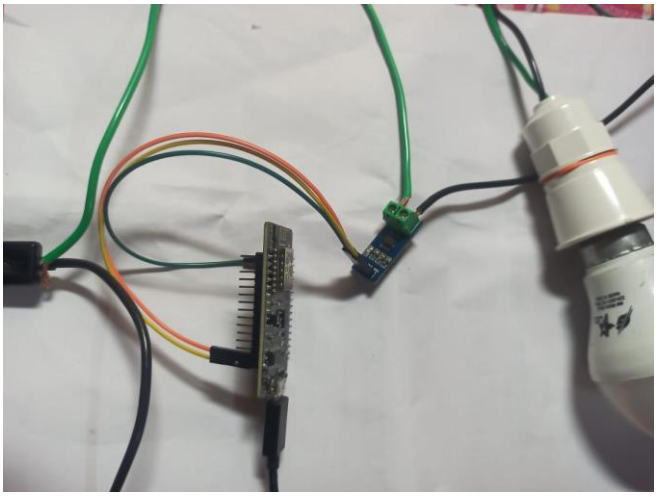
Along with the graph, the value is also printed on MQTT and it is compared with the serial monitor as shown below.



If you go through the handmade diagram, we have prepared for you all, you can see that there are two lines, the top line which is the name we have given (Vp) indicates the maximum value of the voltage and bottom is (–Vp) which indicates the minimum value of the voltage. If you take the difference between those two lines, you will get the (Vpp) voltage peak to -peak value.



Then we return to the main function. Under the loop, you can see we are going to **convert peak voltage to RMS value** using the formulae explained above. Note that we have divided the measured voltage by 2 to get the value of either the positive or negative side.



Make the connections as shown in the circuit above

VII. CONCLUSION

This provides wireless meter reading system that can monitor and analyze the data at every interval providing accurate results with less error. Some of the advantages of this smart system are: -

- Energy conservation.
- Lots of time and power saving from power department.
- Automatic control of energy meter.
- To make consumer keep the track of energy meter.
- Power theft detection.

Some of the disadvantages are:-

- Sometime the system takes time to upload the data depending on the Internet Speed and Module baud rate.

The IoT concept can also be implemented in various working environment such as home automation, automatic water level detector and traffic control system etc.

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