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# Industrial Smart Energy Metering Controlling and Automation with the Help of Android

**Ammar Oad[1*], Muhammad Ibrar-Ul-Haque[2], Jeffrey Ali Rizvi[2], Hammad Shamim[2], Manzar Ahmed[2] Huang lei[1]**
[1]Faculty of Information Engineering, Shaoyang University, Shaoyang 422000, China,
[*]ammar_2k309@yahoo.com, 87431539@qq.com
[2]Department of Electrical Engineering, Sir Syed University of Engineering & Technology, Karachi, Pakistan,
mihaque@ssuet.edu.pk, jarizvi@ssuet.edu.pk, hammadshamim642@gmail.com, manzara@ssuet.edu.pk

## ABSTRACT

In this research a special type of meter is developed which can measure various important parameters of electrical energy and as well as give users the access to cntrol the appliances which are connected to it through the designed android application. Initially measurement of the current is performed with the help of Hall Effect sensor, as this method is very accurate. In second part supply voltage is calculated with the help of transformer and DC biasing method. This method is also very accurate for measurement of voltage. By multiplying the above measured current and voltage, apparent power is obtained. Finally, the energy parameter is obtained. In this research, a special type of meter is designed which can measure electrical current, voltage, power and energy with accuracy around 99%. These obtained parameter results will be directly uploaded to Google firebase which is connected to our android app. Any user having this application installed will take this reading live to their smart phones as well as their web browser.

**Key Words:** Smart Energy Meter, Hall Effect, Transformer, Power, Energy.

## 1. INTRODUCTION

An Energy Meter is a device which is used to measure the flow of Power. There are two types of energy meter used which are listed below:

- Mechanical Energy Meter
- Electronic Energy Meter

In Mechanical Energy Meter we have current coil and potential coil which measures the current and voltage of appliances current coil connected in series with load hence it calculates current and potential coil which calculate voltage in between there is a disk on which eddy current induces and it rotates as it rotates there is dial connected it with gears hence these dial rotates with different angular velocity hence by that way energy shown on these dials these type of meters obsolete now a days due to their bulky design and inappropriate results after some years. On second type which is electronic their working is quite simple they have current and voltage sensors which sense current and voltage and send appropriate signal to chip which calculates power and energy by summation of all the readings of power flow. Electronic energy meter is further divided into the following types [1]:

- Simple Electronic Energy Meter
- Smart Energy Meter

Both are quite similar the difference is that smart energy meter is connected wirelessly to internet through which you can observe reading of your appliances through anywhere which quite handy for both the clients and for the electric supply company and this is also quite economical because charges of energy observer men is cut out.

## 2. OBJECTIVES

The main objective of smart meter are listed below [1-3]:

- To Display Current, Voltage, Power and Energy
- Efficient and User Friendly
- Wireless Meter Reading
- Display Results in a Smartphone
- Low operating cost and production cost is reduced

Number of researchers is using smart energy meters for power grids and Internet of Things (IoT) based applications [4-7]. This research covers all the objectives which are listed above as well as, new dimensions are given to smart meter on which users also have a control of their appliances as well. Several functions of the designed smart energy meter are listed below:

| Measures Current | Measure current using Hall Effect |
|---|---|
| Measure Voltage | Measure voltage using small transformer |
| Measure Power | By taking product of measured current and voltage |
| Calculate Energy | Calculate energy by taking product of power and time (per second) and integrate value each second |
| Calculate Bill | By taking product of energy and price of single unit |
| Self-Power in Case of Power Failure | Our smart meter has built in 5000mah lion battery which can lasts long up to over a month. Show result on android mobile app |

## 3. MEASUREMENT OF MAJOR PARAMETERS OF ELECTRICITY

In this section we discuss the measurement of major parameters of electricity.

**Measurement of Current:** The ACS 712 module uses the Hall Effect Principle for Measuring Current. The ACS 712 measure current in two directions. The ACS 712 measures current in AC or DC Ranges from positive 5A to negative 5A, positive 20A to negative 20A and positive 30A to negative 30A. Analog Output Voltage (AOV) is 0-5V depends upon the current flowing through the wire. We sure we will have to find the peak in positive Direction and the peak in negative direction. In ACS 712 have 5 micros second in response to step input current. We measured the AC Current of 50 Hz Frequency. 20m second cycle per and almost we get 1000 samples in one cycle.

**With Both Peaks Known:** For calculating current at first find the shape of waveform. In case of Power mains or line we know that the shape is a sine wave. Fig. 1 showing how voltage is generated using Hall effect.

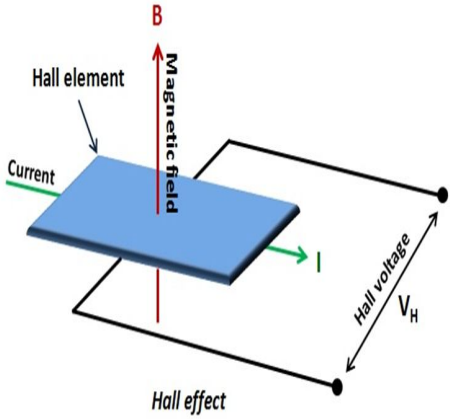


**Figure 1:** Voltage is Generated Using Hall Effect

**Measurement of Voltage Using ZMPT101B:** Zmpt101b voltage sensor module is a voltage sensor made from the small Voltage Transformer [1]. It has high Accuracy, precision Efficient and it is good for power and voltage and measure up to 250V AC. It is Simple to Use and it has potentiometer to adjust Apparent Diffusion Coefficient (ADC) Output. The Operating Temperature of this module is 40-70$^o$ Celsius.

First we have to ensure that trim pot value is rightly set then we need to observe ADC value of sensor after that put that value in polynomial equation to find the Risk Management Solutions (RMS) value of voltage. For this we to first convert analog signal into digital signal with the help of arduino a DC converter. Fig. 2 shows how analog voltage can be converted in digital value [8].

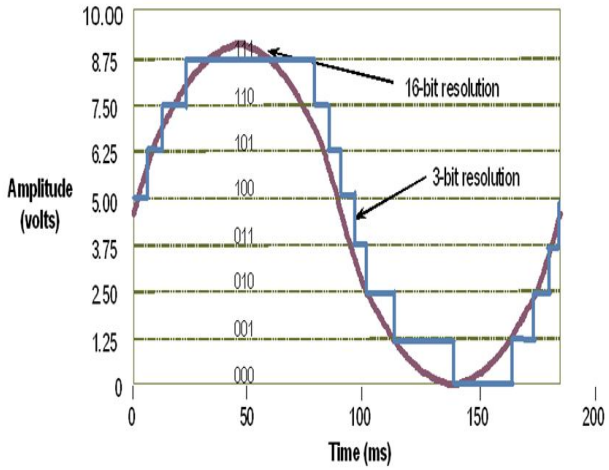


**Figure 2:** Analog voltage can be converted in digital value [8]

Polynomial equation to find values of $V_{rms}$:

$$y = -2.709x - 8.35 \quad (1)$$

$$y = 0.0007711x^2 + 2.506x + 0.2662 \quad (2)$$

$$y = 0.00000412x^3 - 0.000857x^2 + 2.675x - 3.198 \quad (3)$$

$$y = 0.00000004888x^4 + 0.00002986x^3 - 0.005183x^2 + 2.922x - 6.08 \quad (4)$$

$$y = 0.0000000001278x^5 + 0.00000003529x^4 + 0.00001023x^3 - 0.003271x^2 + 2.853x5.57 \quad (5)$$

The above polynomial values are very helpful in finding the correct value of Voltage Regulator Modules (VRMs). According to research equation is most helpful and give very precise result.

## 4. MEASUREMENT OF POWER

The most important parameter of electrical equipment is power which can be measure with the help of measure current and voltage. The unit of power is watts

Our smart meter is work up to 7500 watts. For measuring power, we use simple technique we simply take product of voltage and current

$$P=V*I \quad (6)$$

## 5. ENERGY CALCULATION

For calculating electricity electronically, we have required two main things current sensor which is connected parallel to load and current sensor which is connected in series with load and by taking these sensors value and some calculation we can calculate energy consumed. Fig. 3 shows block diagram of our smart energy meter.

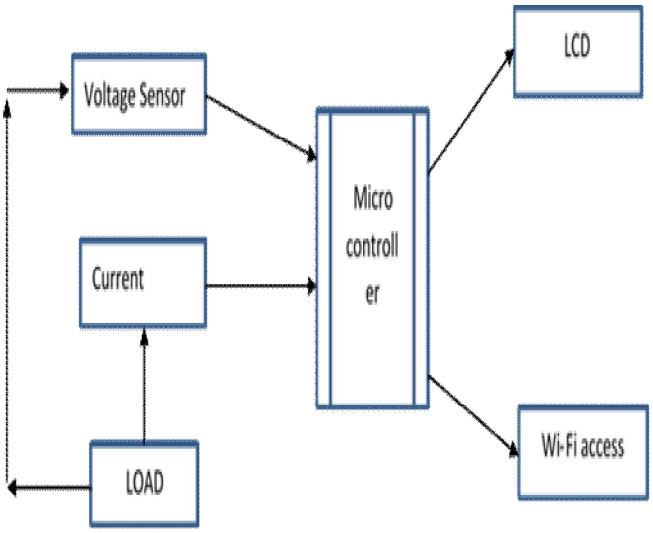


**Figure 3:** Block Diagram of Our Smart Energy Meter

Figure 4 block diagram of algorithm shows for calculating the energy.

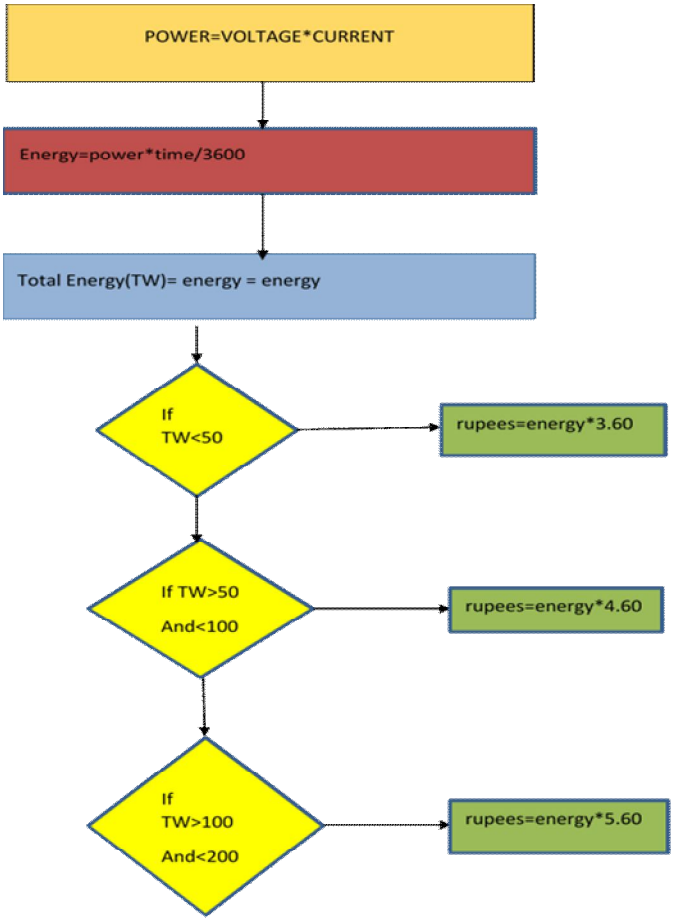


**Figure 4:** Algorithm of Calculating Energy

## 6. WIFI CONNECTIVITY AND GOOGLE FIRE BASE

For sending our data to firebase or any third party cloud service or real time data base system you need an active internet connection from your arduino gives data to ESP8266 and ESP8266 requires Wireless Fidelity (Wi-Fi) connectivity from either your router or from your mobile hotspot so all of this task it is very necessary that you have active internet connection [9]. Fig. 5 shows high level architecture diagram of connection of your data to firebase.

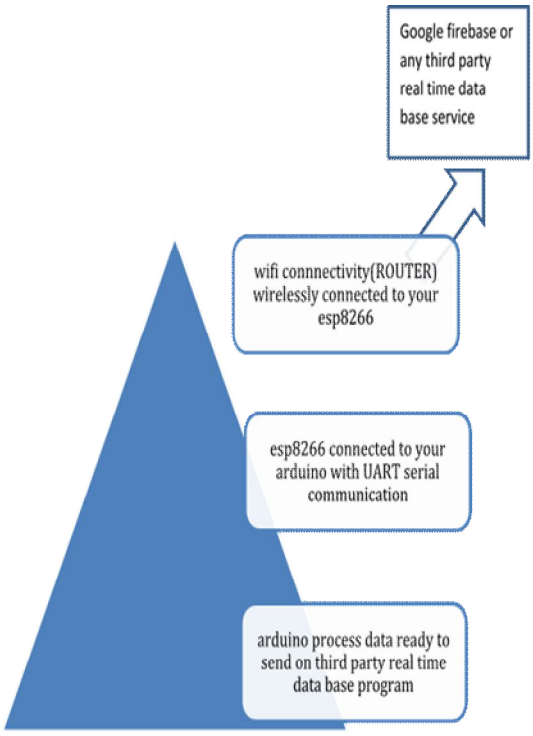


**Figure 5:** High Level Architecture Diagram of Connection of Your Data to Firebase

In the designed smart meter, all the data from Wi-Fi device sent to the real time data base, after this which can be accessed by any of devices such as web, mobile phone or tablet.

## 7. CREATING ANDROID APP FOR CONTROLLING DATA

In this research all the user interface side programming is done. Here, we just need to join blocks to make a stunning app. Fig. 6 shows how to connect blocks to design the application.

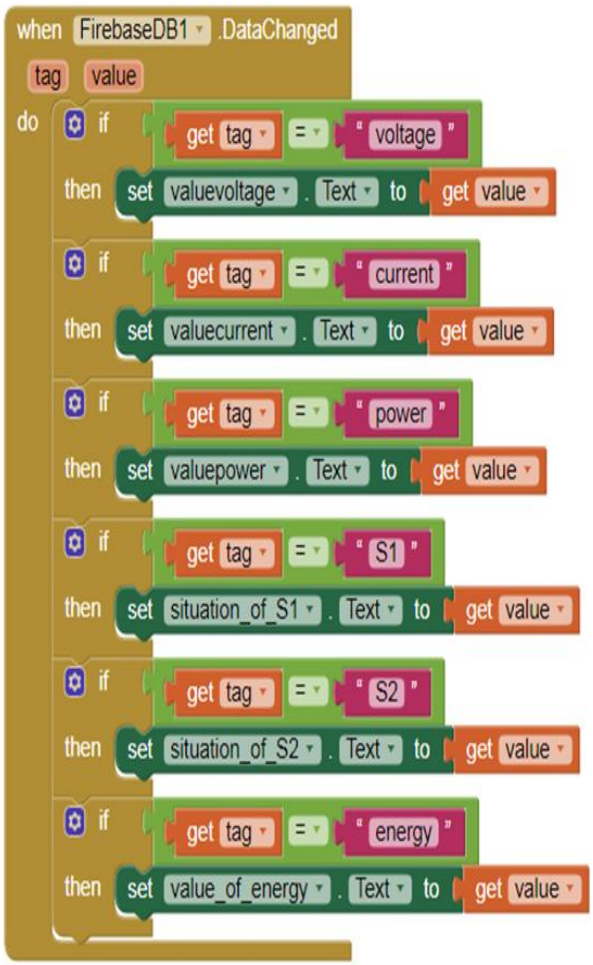


**Figure 6:** Connect Blocks to Design the Application

The format of file which is built in MIT is. aia after completion and building process it converts this file into .apk. Fig. 7 shows high level architecture diagram of conversion of .aia file into .apk.


**Figure 7:** High Level Architecture Diagram of Conversion Of. .Aia File Into .Apk

## 8. CONCLUSION

The designed application for Smart energy metering is very convenient and this meter can easily replace traditional energy meter. The traditional meters not show the major electrical parameters such as current, voltage, power and we cannot control the different appliances through it. While the proposed design of smart energy meter can display all the stated parameters and can be used for industrial applications and exchange the existing meters without much investment.

## 9. FUTURE WORK

In future can further advance this research work by using Radio Frequency (RF) control connections for wires hence, do not require low voltage wirings around the house. Further we can improve the app which increases user interface. We can also make another meter from supplier side Karachi Electric Supply (KES) which can cut off supply when desired number of units burned. We can also have installed big Thin-Film-Transistor (TFT) display on meter instead on 16*4 Liquid-Crystal Display (LCD) which increases graphical user interface and also give users to input commands.

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## REFERENCES

1 Abubakar, I., Khalid, S.N., Mustafa, M.W., and Shareef, H., “Calibration of ZMPT101B Voltage SENSOR Module Using Polynomial Regression for Accurate Load Monitoring”, ARPN Journal of Engineering and Applied Sciences, Volume 12, No. 4, pp. 1076-1084, January, 2017.

2 Arif, A., Al-Hussain, M., Al-Mutairi, N., Al-Ammar, E., Khan, Y., and Malik, N., "Experimental Study and Design of Smart Energy Meter for the Smart Grid”, International Renewable and Sustainable Energy Conference, pp. 515-520, [DOI: 10.1109/IRSEC.2013.6529714], Ouarzazate, 2013.

3 Vadda, P., and Seelam, S.M., “Smart Metering for Smart Electricity Consumption”, Economics, pp.1-74, 2013.

4 DeCapua, C., Lipari, G., Lugarà, M., and Morello, R., "A Smart Energy Meter for Power Grids", Proceedings of IEEE International Instrumentation and Measurement Technology Conference, pp. 878-883, [DOI: 10.1109/I2MTC.2014.6860868], Montevideo, 2014.

5 Amutha, A., Archana, K., Gajapriya, R., Kavipriya, K., and Kaviya, K., “Smart Energy Meter Using GSM for Home Automation”, Asian Journal of Applied Science and Technology, Volume 1, Issue 4, pp. 48-49, May, 2017.

6 Asha, R., Aruna, R., Divya, J., and Balasaranya, K., “Smart Energy Meter for Advanced Metering and Billing Alert Framework”, International Journal of Engineering Science and Computing, Volume 8, No. 3, pp. 16541-16544, March, 2018.

7 Shapiro, A., Balamurugan, A., Kumar, D.S., and Swaminathan, G., “IoT Based Smart Energy Meter”, International Journal of Advance Research, Ideas and Innovations in Technology, Volume 5, Issue 2, pp. 2071-2073, 2018.

8 https://www.globalspec.com/learnmore/data_acquisition_signal_conditioning/signal_converting/analog_to_digital_converters

9 https://firebase.google.com/docs/databas