Scheming A Model For Smart Energy Meter Using IoT

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***Abstract*— For power engineers, bill calculation has always been of prime concern. Initially, conventional energy meters were in use that contain a rotating disc for calculating energy consumption. These days, smart meters have been in common use because of their certain advantages in the power distribution sector. They have introduced innovative and effective ways of calculating bills for the consumers. Moreover, with the invention of smart meters, energy theft and other corrupt practices have been prevented to a greater extent. This study aims to propose a smart meter that will indicate real time values of phase voltage, current, instantaneous power, and energy consumption by any user. Furthermore, this real time data will be informed to users through SMS. This proposed system is a novel approach to curtail energy theft, over-billing, and departmental corruption.**

***Index Terms*— Energy Usage, GSM, Smart Energy meter.**

I. INTRODUCTION

AN electric or energy meter is an instrument which is used to measure power consumed by consumers [1]. In Pakistan, electromechanical energy meters were used a lot. These meters work on the principle of a rotating disc. Revolutions of discs are counted and then translated into power consumption to generate the bill for users. Later, electromechanical energy meters were displaced by digital meters. It is so because digital meters have certain advantages to traditional electromechanical meters such as high reliability, efficiency, and low losses etc. Furthermore, electromechanical meters are easy to exploit by simple reversing the direction of the revolving disc. These days digital meters calculate voltage and current. In result, we obtain instantaneous power in watts. Again, digital meters are quite slow at measuring consumer electricity usage. This leads us to the need for Smart Energy Metering. Smart meters are leading traditional meters [5]. They have overcome the various problems associated with conventional metering such as human blunders in manual meter reading, theft on distribution lines or departmental corruption, etc. Smart energy meter is a simple framework that permits organizations to note down readings and ascertain bills without visiting the consumers' premises [7]. Smart energy meters incorporate different procedures like GPRS, SCADA, PLC, Radio frequency (RF), GSM etc. [4]. Among these all, GSM is the best innovation accessible since it has various clients and gives a decent reach for the information to be communicated. This will improve the conventional meters with Arduino and GSM which gives us benefit while eliminating errors of conventional meters

II. COMPONENT DESCRIPTION

A. Arduino UNO

It is a micro controller board that contains an ATmega328 microcontroller chip. It has 14 digital and 6 analog input/output pins. Out of 14 digital pins, 6 can be used as PWM (pulse width modulation) pins for output. Arduino UNO has 16MHz crystal oscillator and USB (universal serial bus) connection and one push start button. In all, it consists of everything which is essential for a microcontroller. Arduino can be taken as an open-source platform which may be employed for building electronics projects. The principal benefit of Arduino is that it does not require any separate equipment, it can be easily associated through a USB port. The microcontroller can be programmed through a software called Arduino IDE, using a blend of C, C++ languages for programming.

B. GSM Module: SIM900

Among numerous advancements being utilized for Smart Energy meters are Power Line Carrier (PLC) correspondences, Supervisory Control and Data Acquisition (SCADA), Internet, Ethernet, Wi-Fi, Bluetooth, Embedded RF Module, and ZigBee. Power Line Carrier (PLC) and Telephone Line Network are the cases of wire-based Smart Energy framework whereas GSM, Bluetooth are examples of remote Smart Energy Meter framework. The transmission arrangement of the Smart Energy Meter uses GSM Technique. A GSM modem is utilized as portable Data Communication Equipment to send data regarding the number of units of electricity consumed to a programmed number. A SIM card is inserted in the SIM900 module to provide the required GSM signals.

III. SIMULATION MODEL

The developed model of smart meter reading that provides real-time data can be seen in Fig.1.

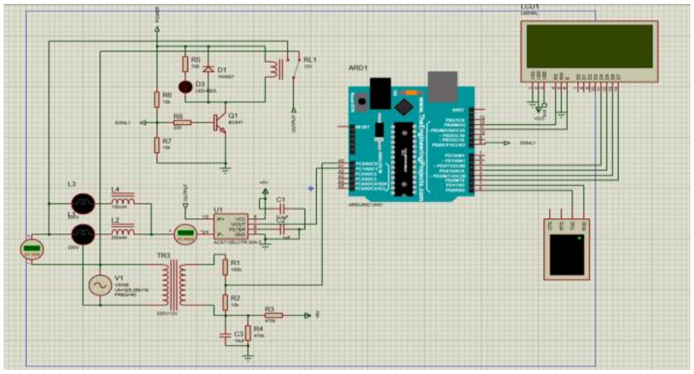

Figure 1. Developed model of proposed system

This circuit is divided into two sections:

A. Voltage Measuring Unit:

The voltage measuring unit is an integral part of this system that can be seen in Fig.2.

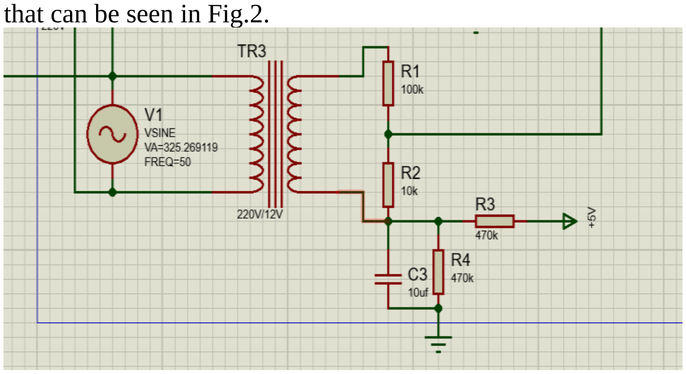

Figure 2. Voltage measuring unit

It consists of a step-down transformer (220V/12V) that steps down the standard 220V, 50Hz to 12V to be fed to the analog pin (A0) of Arduino UNO through a resistive dividing circuit.

B. Current Measuring Unit:

The current measuring unit can be seen in Fig.3.

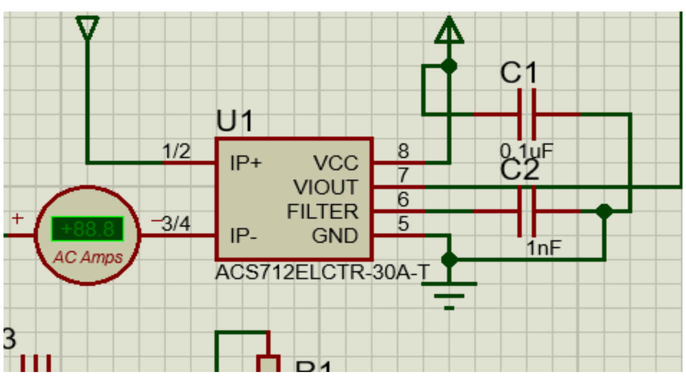

Figure 3. Current measuring unit

It consists of an ACS712 current sensor connected to the main voltage source. It senses the current drawn by load and outputs this value to analog pin (A1) of Arduino UNO.

IV. SYSTEM DESCRIPTION

The proposed framework is made out of a detecting unit, a communicating unit, and a charging unit. The system comprises an Arduino microcontroller, voltage and current measuring units, a GSM modem, and load. As soon as the load draws any current, the current sensor detects this current and sends a signal to Arduino. The Arduino processes this data to calculate energy bill. The GSM module is used to inform the consumer about their usage of electricity.

V. RESULTS AND DISCUSSIONS

The Fig.4 shows the values of Current, Voltage and power factor on the output screen, while Fig.5 shows the same on an LCD that is fitted on the system

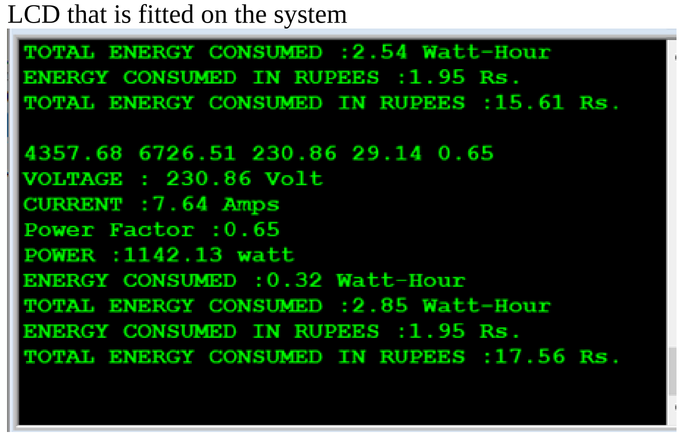

Figure 4. Output of the model

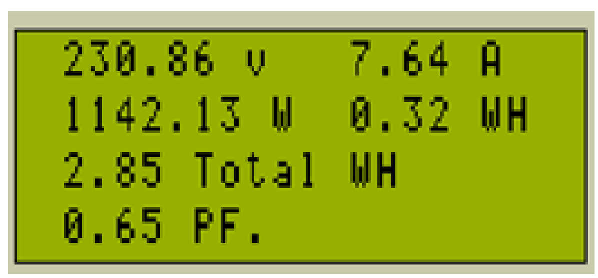

Figure 5. Output of the model on connected LCD

Total power is displayed in Watt-hours.
The meter also shows load power factor which commonly indicates real power being utilized. It is a known fact that increasing load reactance will decrease power factor, this can be shown by varying the load reactance and observing the results.
Fig.6 shows the circuit when reactance of LOAD1 is 15.71Ω, and that of LOAD2 is 31.42Ω.

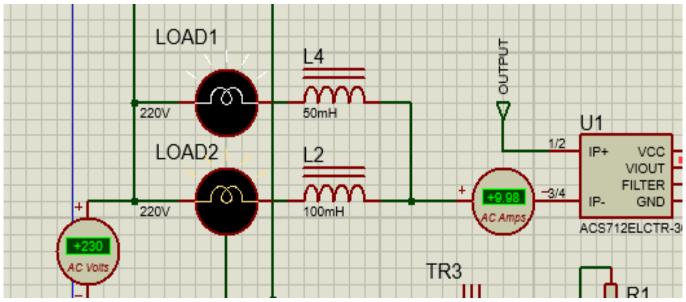

Figure 6. Circuit showing reactances of loads (150.71Ω and 31.42Ω)

Fig.7 shows the power factor for this case, which is 0.85.

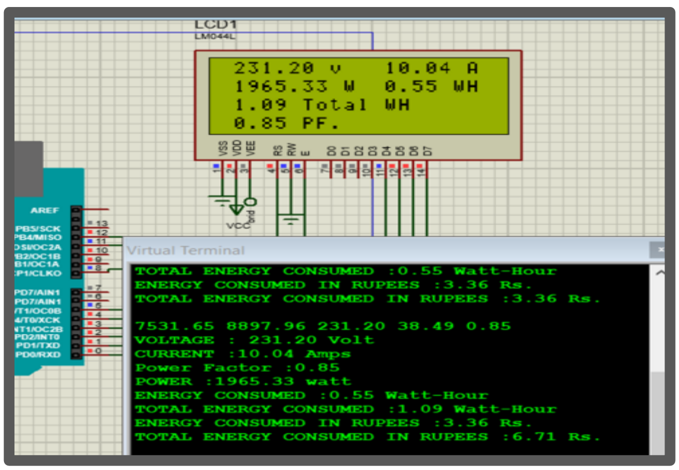

Figure 7. Circuit showing power factor (0.85)

On another hand, Fig.8 and Fig.9 show that when reactance of both loads is increased to 157.1Ω, the power factor becomes 0.19.

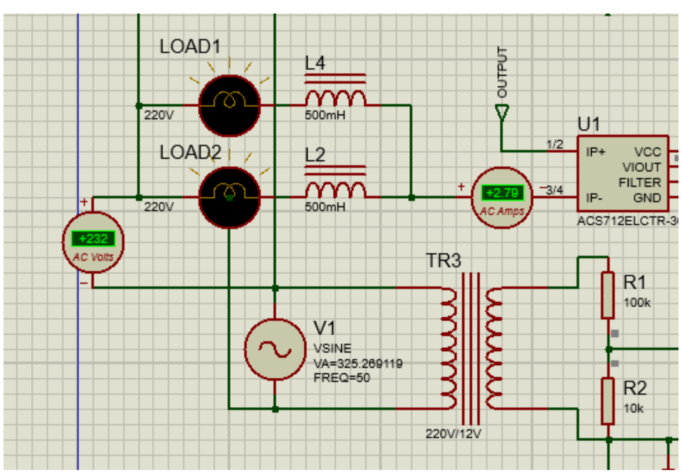

Figure 8. Circuit employing new load reactance

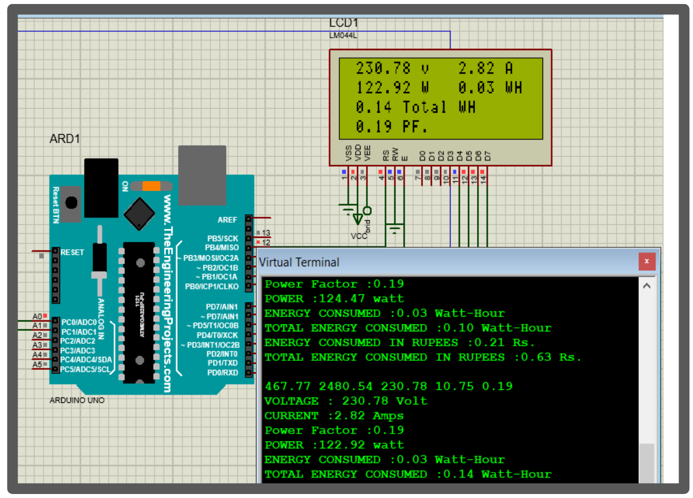

Figure 9. Power factor after changed reactance

VI. CONCLUSION

To sum up, power distribution engineers use energy meters for bill calculation of end users. In earlier days, traditional meters were in use. However, in current times, smart energy meters have replaced the conventional meters. This study aims to develop such a smart energy meter that indicates real time values of basic data such as phase voltage, current, power factor, instantaneous power and energy that is consumed by users. Along with this, this study presents a unique approach to theft detection and over-billing. In addition, the developed meter also shows power factor which consequently determines behavior of the consumer.

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