

## GSM-Based Smart Energy Meter with Arduino Uno

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**Abstract**—The demand for power has increased exponentially over time. One avenue through which today's energy problems can be addressed through the reduction of household energy consumption. This has increased the emphasis on the need for accurate and economic power measurement methods. The objective of providing such data is to optimize and reduce their energy consumption. This paper presents a smart energy meter for an automatic and superior meter and billing system. The integration of Arduino and GSM Short Message Service (SMS) provides a meter reading system with some predefined automatic functions. The proposed energy meter system can be integrated with an embedded controller and a GSM modem to transmit data such as energy consumed in kWh, generated billing, security services (line Cut / On) over a GSM mobile network, such as data that can then be fed and integrated into existing energy management systems located in power companies or organizations to provide services to customers without manpower.

**Keywords:** Energy Meter, Global System for Mobile Communication (GSM), Arduino, Short Message Services (SMS), and Real Time

### I. INTRODUCTION

Smart electrical energy meter technologies have been studied and developed for approximately 10 years. Various technologies have been developed and used to measure electrical consumption. For the billing, users will receive the bill from the Energy Board after it has been generated and provided using a number of methods. At present, for example, most residences in Malaysia use traditional electro-mechanical watt meters and readings are not automated. Users will have to wait a month for the bill of energy consumption to pay their energy bill. Usually, at the end of the month, the meter billing staff will visit every house to read the meter reading and, at the same time, give the bill to the users. An electrical meter or an energy

meter is a device that measures the amount of electrical energy consumed for residence or business purposes. There are two types of single phase and three phase meter Domestic Ordinary Power Consumers. Energy consumption is measured by all electrical services using a kilowatt-hour meter with reference to kilowatt-hours (kWh)[1].

Electronic meters were then introduced with a similar electro-mechanical function, but are replaced by an analog to a digital system. This system allows users to note down the voltage, the power reading unit, the current and the time, the energy consumption date. This system only has some advantages over the previous meter reading. After the electronic ones, the meter reading was developed using Bluetooth based technology, which is wireless communication and is also known as Automatic Meter Reading (AMR). The system is wireless and the personal computer could be used to record the energy consumption of the energy meter. The reading meter will be stored in the database and the bill will be generated.

The latest technology uses a system based on the Global Mobile Communication System (GSM). These systems replace the Bluetooth technology and the data sent to the customer and the energy board using the Short Message Service (SMS).

### II. OVERVIEW OF THE SYSTEM

The system consists of a hardware and software component. Fig 1, hardware parts, shows a block diagram of the energy meter project that users can monitor their home power consumption at anytime and anywhere. As for the software part, the whole program is located in Arduino UNO, using the C language. Arduino UNO, as the main controller, connects the energy meter, the GSM module, and other sensors / peripherals so that they can communicate with each other. And Arduino UNO can only work after we've uploaded the designed program to it.

### III. HARDWARE SYSTEM

According to [2], the Automatic Meter Reading System (AMR) continuously monitors the energy meter and transmits data via SMS at the request of the service provider. It saves enormous human labor. The data received from the energy meter was stored in a database server located at the power station through the SMS gateway for further processing by the energy provider. The Automatic Meter Reading System helps customers and energy service providers to access accurate and up-to-date energy meter data. The AMR system may deliver energy consumption on an hourly, monthly or on request basis.

This data is sent to a central system for billing and troubleshooting. These data are stored into the database server for processing and recording. This technology mitigates labour cost, collection time, energy theft, avoids late payment. Adding to this it increases data security, improved customer service, reduced revenue losses. This system provides

freedom for electricity companies to take action against lenient customers who have outstanding dues, otherwise companies can disconnect the power of customer [3]. The energy meter that chosen and suitable for this project is single phase meter from Smart Meter Technology

#### A. Smart Meter

This will modify our traditional meter with Arduino and GSM, leading to advantages and eliminating traditional meter errors. This meter sends us accurate, [3] regular information about your energy use. So your bills will be accurate and you'll end up having to submit meter readings. This energy monitor shows you how much energy you use in money. So, by the minute, you can see what you spend. Knowing more about how much energy things are using will help you choose the way you use them. If you want to get the most out of being a smart meter customer, let us know and update your smart meter to record readings from time to time.

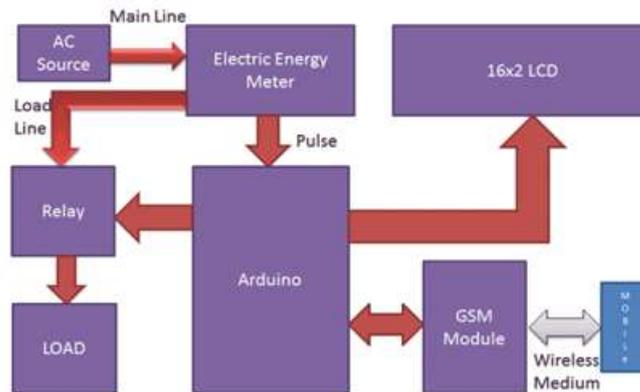


Fig. 1: Block Diagram of the System

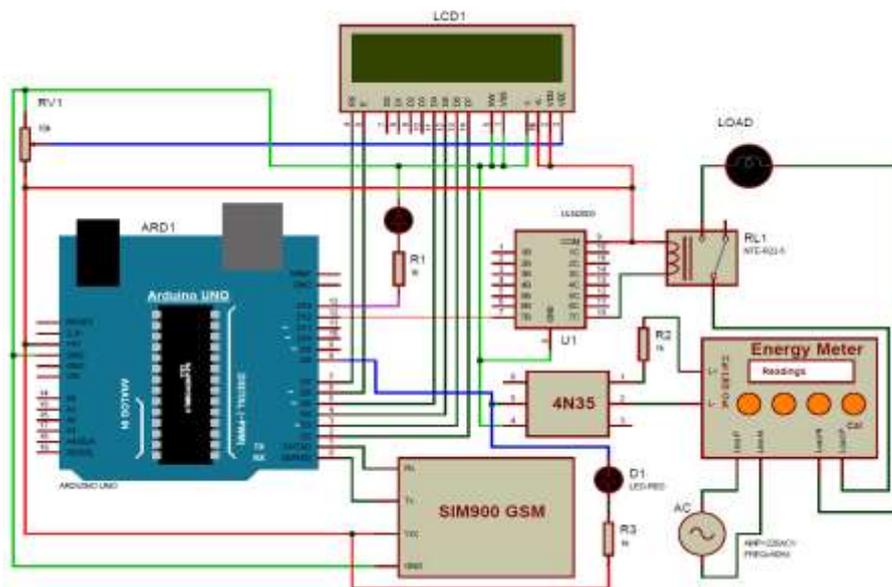


Fig.2 Circuit Description

### B. Arduino Controller

Arduino is an open-source platform used for projects in electronics. Arduino has a few advantages over the other controller boards. [6,2] It consists of both physical boards. One is a programmable circuit board (often referred to as a microcontroller) and the other is a piece of software or IDE (Integrated Development Environment) that runs on our computer, used to write and upload computer code to the physical board. Easy programming language than C, C++, etc. No additional hardware is required. As such, Arduino is a basic member of electronics. It consists of RAM, ROM, supply and analog and digital pins required for the operation of the electronic system.

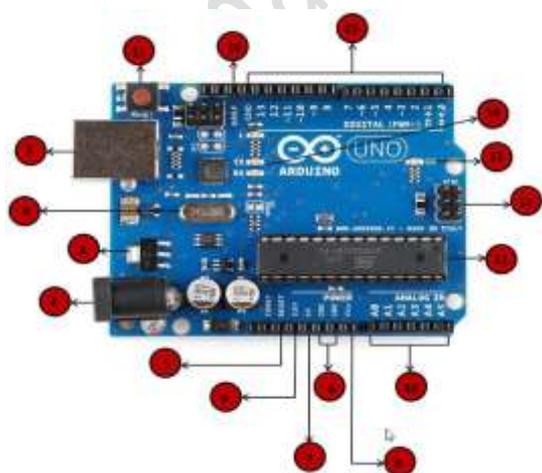


Fig. 3: Board Description

### C. Optocoupler

Optocoupler is a device commonly used to galvanically separate microcontroller electronics from any potentially hazardous current or voltage in its surroundings. Optocoupler usually have one, two or four light sources (LED diodes) at their input, while at their output, opposite to diodes, the same number of light-sensitive elements (phototransistors, photo-thyristors or phototriacs) are present. The point is that the Optocoupler uses a short optical transmission path to transmit the signal between the circuits elements while keeping them electrically isolated.

### D. GSM Module

GSM module is used to establish communication between a computer and a GSM system. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. GSM MODEM is a class of wireless MODEM devices that are designed for communication of a computer with the GSM network. It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Also they have IMEI (International Mobile Equipment Identity) number similar to mobile phones for their identification. A GSM MODEM can perform the following operations:

1. Receive, send or delete SMS messages in a SIM.
2. Read, add, search phonebook entries of the SIM.

3. Make, Receive, or reject a voice call.

GSM module will interact with Arduino board and send and receive data to communicate with system through

the receiving and transfer pin of GSM to Arduino Uno.

#### E. RTC (Real Time Clock)

A Real-time clock (RTC) is a computer clock (most often in the form of an integrated circuit) that keeps track of the current time. It has some advantages as follows: Low power consumption (important when running from alternate power). Frees the main system for time-critical tasks. More accurate than other methods.

### IV. RESULT AND DISCUSSION

There are two parts that was combined to make the system. The two parts that was combined were circuit for interfacing energy meter to Arduino and interface from GSM module to Arduino. Circuit operation was in good condition with the right sequence of program that uploaded into microcontroller.

For the light to voltage sensor part, Arduino with microcontroller ATmega238 was used to count the input, calculate the bill and store it into EEPROM. Real Time Clock was used to set the reset counter every month. LED indicator was blinking when input from sensor detected. The value of unit and bill price was display at the LCD display as set in the microcontroller.

At the program, the number of mobile phone user was set to receive a message when limit reach. In GSM network, the network plan SIM card was used to transmit message to mobile phone. To combine this two part system, the GSM module Tx and Rx was connected to pin 2 and 3 respectively to Arduino while RTC used analogy pin A4 and A5 at Arduino for CLOCK and RS. The other components such as LCD, LED and light to voltage sensor were connected to digital port 4 to 13.

If the users want to check their current bill, they just type command 'my meter' and send it to energy meter, and the energy meter will send the current bill as shown in Figure.



Fig.4 GSM-Based Smart Energy Meter with Arduino Uno



Fig. 5 SMS (Consumption & Charge) on Mobile

## Procedure

1 We can switch on the kit press the reset button.

Enter the consumer mobile number.

To send the conformation message for consumer.

To set time for monthly or some days or number of hours.

Total energy is recording with energy meter as show in LCD Display

A: Total Amount;

U: Total Units

H: Hours

M: Minutes

S: Seconds

To send the message for total bill by the consumer.

## V. CONCLUSION

Arduino Power Estimation is an advanced form of power determination that uses a controller and is more useful because programming is simpler than C-language. It is free source tech. This approach ensures that domestic energy use is reliable, safe and up-to - date fairly quickly. This program enables consumers to control and track their use. Energy usage information helps users minimize energy use and save both money and resources, and we have interfaced Arduino with Energy Meter (analog) via Optocoupler and RTC to a GSM module to send data (unit usage) to the customer via SMS.

This system provides the domestic power consumption accurately, safely, and with a relatively fast update rate, thus helping the user optimize and reduce their power usage. In this project, the data communication is through a mobile network which is done by GSM system with respect to time. This is designed to convert analogue data of electromagnetic energy meter to digital data. The GSM module can be replaced with IOT (Internet of Things).If it implements in real world, then it can help us to reuse the analogue meter

## VI. REFERENCE

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