

# GSM Based Automatic Meter Reading System Using Raspberry PI Controller

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**Abstract:** *The aim of the project is to minimize the queue at the electricity billing counters and to restrict the usage of electricity automatically, if the bill is not paid. The project also aims at proposing a system that will reduce the loss of power and revenue due to power thefts and other illegal activities. The work system adopts a totally new concept of "Prepaid Electricity". The GSM technology is used so that the consumer would receive messages about the consumption of power (in watts) and if it reaches the minimum amount, it would automatically alert the consumer to recharge. This technology holds good for all electricity distribution companies, private communities, IT parks and self-containing housing projects. The implementation of this project will help in better energy management, conservation of energy and also in doing away with the unnecessary hassles over incorrect billing. The automated billing system will keep track of the real time consumption and will leave little scope for disagreement on consumption and billing.*

**Keywords:** Energy meter, GSM technology, Raspberry pi Microcontroller, relay, LCD

## 1. Introduction

The present system of energy metering as well as billing in Tamilnadu which uses electromechanical and somewhere digital energy meter is error prone and it consumes more time and labor. The conventional electromechanical meters are being replaced by new electronic meters to improve accuracy in meter reading. Still, the Indian power sector faces a serious problem of revenue collection for the actual electric energy supplied owing to energy thefts and network losses. One of the prime reasons is the traditional billing system which is inaccurate many times, slow, costly, and lack in flexibility as well as reliability [1]. Meters, in the past and today in a few countries, were electromechanical devices with poor accuracy and lack of configurability. Theft detection was also a challenge. Recent developments in this direction seem to provide opportunities in implementing energy efficient metering technologies that are more precise, accurate, error free, etc. [2]. A Prepaid Energy Meter enables power utilities to collect electricity bills from the consumers prior to its consumption. The prepaid meter is not only limited to Automated Meter Reading but is also attributed with prepaid recharging ability and information exchange with the utilities pertaining to customer's consumption details. The use of electronic token prepayment metering has been widely used in UK for customers with poor record of payment [3]. A paper suggests a design of a system which can be used for data transmission between the personal computer and smart card [4]. Poly phase prepaid energy metering systems have also been proposed and developed based on local prepayment and a card reader [5]. Wireless prepaid energy metering system has been proposed which incorporate RF based system [6]. Digital energy metering system as an alternative for the electromechanical system has been proposed and developed with the Peripheral Interface Controller (PIC) and necessary software [7]. Due to the low cost of microcontrollers, Prepaid Energy Meter has been developed using a microcontroller from the Microchip Technology Inc. PIC family [8].

The proposed system automatically reads the energy meter data and sends it to the customer and service provider on reception of a specific message from service provider. It uses a GSM modem for this purpose. The system can also provide the facility to disconnect the supply of a customer in case of any payment related issue and also if the amount falls below certain amount, then it will be indicated by the microcontroller through buzzer and also send message service to the customer by using GSM modem.

## 2. Proposed Work

To implement this system, an Raspberry pi microcontroller based board is used. It is low cost ARM11 processor in this proposed system we are used model B Raspberry pi. It is 700 MHz ARM processor with 512 MB RAM with on-chip ADC, timer/counter module, PWM and UART module to interface a GSM modem and energy meter. The energy meter which generates the pulses as well as count the energy consumed is used. The digital energy meter is having a LED which blinks for a specific number of times to indicate the energy consumed (e.g. 1 Unit = 1600 pulses). These pulses are fed to ARM11 based system which is programmed to count these pulses. The system reads these pulses and after counting specific number of pulses it increments the internal counter by one which indicates the number of units consumed and LCD display is used to display the balance amount. To recharge the meter, consumer needs to buy electricity in advance according to his/her requirement. The consumer can buy electricity through recharge card. This will be in form of a scratch card with a code printed on it. The consumer punches the code into the meter using a key pad which is interfaced with the controller. The meter is credited with the amount of recharge bought and supply is switched on automatically at load side. As the consumer's balance reaches the below the emergency limit provided by the utility, meter issues an alarm and also send message to the consumer. The consumer needs to recharge the meter at this point. If recharged in time then the load is not disconnected. However, if even after warning, a consumer

does not recharge their meter and all available balance is exhausted then meter automatically disconnects the supply at load side. The controller instructs the relay to disconnect load.

### 3. System Architecture

The high level block diagram of the prepaid meter reading system is shown in the Figure.1. The Power Supply section supplies all other components with required Power. The Raspberry pi microcontroller module takes the data from the energy meter and performs the necessary control operations like breaking the circuit through Relay control unit and the required information to the mobile phone via the communication module GSM. The UART is a serial communication interface for the GSM modem for transmitting the data from the controller to the mobile phone. The recharge unit is stored in IC AT24C02 which is an EEPROM and has volatile memory and this recharge unit is display in Liquid Crystal display (LCD) and a message "recharge successful" also display balance reaches the below the emergency limit then the buzzer starts indicating that we should recharge our meter soon and the controller send the message to customers.

### 4. System Hardware

The basic hardware components used in the Project are listed below:

- A. Raspberry pi Microcontroller
- B. Energy meter.
- C. GSM Modem.
- D. Relay control unit
- E. Power Supply

#### A. Raspberry Pi

The Raspberry Pi is a low cost single-board computer which is controlled by a modified version of Debian Linux optimized for the ARM 11 architecture. We are using model B ,700 MHz ARM processor with 512 MB RAM. The Ethernet is 10/100 BaseT Ethernet socket. The CPU of the microcontroller is 700 MHz Low Power ARM1176JZFS Applications Processor.



Raspberry PI Model B

#### B. Energy Meter

Energy meter module is composed of ADE7757 which is energy metering IC with integrated oscillator and load and which produces the analog signal can be converted into digital signal and that digital signal in the form of pulses and ADE7757 outputs average real power information based on the load. These outputs are interfaced with the microcontroller .One of the feature in ADE7757 to enhance the capability of this work is having a power supply monitoring circuit on the VDD supply pin of the ADE7757. Due to this, proper device operation [6] is achieved at power up and power down modes. High degree of immunity to false triggering from noisy supplies is attained due to built in hysteresis and filtering operations in power supply monitor of the ADE7757.



ADE7757 Energy Meter

#### C. GSM Modem

The Communication Module consists of GSM Modem. It is used to transfer the data of the user meter from raspberry pi controller to remote station by GSM wireless module [7]. The serial communication with the modem is full duplex 8 bits, no parity, 1 stop bit and at 115200 bauds. We have used Subscriber Identification Module (SIM) in the modem.

Specifications:

- Tri-Band GSM/GPRS 900/1800/1900 MHz
- Supply voltage range is 3.4V to 4.5V
- Low power consumption
- Operating temperature is -20°C to +60°C
- Serial interface and debug interface
- LCD interface
- Keypad interface
- Antenna connector and antenna pad



SIMCOM 300 GSM Modem

#### D. Relay Control Unit

Relay control unit is used to shutting off the electric power supply when the due date is over. Whenever the user pays the bill the electric power supply is resumed by the relay module. The relay is driven by the raspberry pi controller. The user can monitor power consumption details on LCD. The control operations like breaking the circuit through Relay control unit.

#### 5. Advantages

The system designed reduces the efforts of manual data collection of energy meter. The users are not bound to pay excesses amount of money, users have to pay according to their requirement. Prepaid energy meter is more reliable, accuracy and user friendly.

#### 6. Conclusion

The paper is intended to present an overview of prepaid energy meter, which can control the usage of electricity on consumer side to avoid wastage of power. Prepaid energy meter is a concept to minimize the Electricity theft with a cost efficient manner. From all these we can conclude that if we implement this prepaid energy meter then it can become more beneficial.

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