

# Detection of Tampered Energy Meter with Prepaid Billing using GSM

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**Abstract**— In this paper, The main objective of this project is to send a message in the event of energy meter being tampered. As electricity consumption is increasing, so it is the attempt for tampering the energy meter. Identifying a tampered meter is only possible when the electricity board's authority manually checks it, which is a time consuming and costly method. This proposed system is a possible solution to detect meter tampering. Energy meter is integrated with the system in such a way that if anybody opens the cover of the meter, an IR sensing arrangement sends a command to the microcontroller (8051 family). Microcontroller then senses a change in the logical input from IR sensor and gives command to the GSM modem to send an SMS to the designated mobile phone number stored in the controller's memory. This information also gets displayed on an LCD. The idea of Prepaid energy meter using an AT89S52 microcontroller has been introduced. This concept provides a cost efficient manner of electricity billing. The present energy billing systems are discrete, inaccurate, costly and slow. They are also time and labour consuming. The major drawback of traditional billing system is power and energy theft.

**Key words:** IR sensors, Prepaid Billing using GSM

## I. INTRODUCTION

The Electrical metering instrument technology has come a long way from what it was more than 100 years ago. From the original bulky meters with heavy magnets and coils, there have been many innovations that have resulted in size & weight reduction in addition to improvement in features and specifications. Resolution and accuracy of the meter have seen substantial improvements over the years. Starting with Voltmeters and Ammeters, the digital meter has conquered the entire spectrum of measuring instruments due to their advantages like ease of reading, better resolution and rugged construction. Now a days, the energy consumption and energy distribution has become a major problem because of huge difference in energy production and consumption. In this regard, energy consumers are facing so many problems due to the frequent power failures and the un-limited energy consumption of rich people. Due to increased demand, Automatic Meter Reading [1],[4] systems which collects meter readings electronically, and its application is expanding over industrial, commercial and utility environment. Electro-mechanical meters, still widely used today, are prone to drift over temperature and time as a result of the analog and mechanical nature of the components in these meters. Here a new method of pre-paid electronic energy metering is introduced in this project which will automatically sense the used energy, records these reading continuously, then sends it to the billing point through the existing GSM [1],[2] and [6] network. Finally after processing the collected data bill is generated using a web based system software and is send back to the customer as SMS.

## II. ENERGY METER

Energy meter or Watt hour meter is an instrument which measures amount of electrical energy used by the consumers. Utilities install these instruments at every place like homes, industries, organisations to charge the electricity consumption by loads such as lights, fans and other appliances. Most interesting type are used as prepaid electricity meters. The types of energy meters are as shown in fig 1.



Fig. 1: Types of Energy Meters

### A. Types of Energy Meters

If we use one kilowatt in one hour, it is considered as one unit of energy consumed. These meters measure the instantaneous voltages and currents; calculate its product and gives instantaneous power. This power is integrated over a period which gives the energy utilised over that time period. These may be single or three phase meters depending on the supply utilised by domestic or commercial installations. For small service measurements like domestic customers, these can be directly connected between line and load. But for larger loads, step down current transformers must be placed to isolate energy meters from high currents. Some types of energy meters are as follows,

- Electromechanical Induction Type Energy Meter
- Electronic Energy Meters [7]
- Analog Electronic Energy Meters:
- Digital Electronic Energy Meter
- Smart Energy Meters

### B. Classification of Energy Meters

Energy meter or watt hour meter is classified in accordance with several factors such as:

- Type of display like analog or digital electric meter.
- Type of metering point like grids secondary transmission, primary and local distribution.
- End applications like domestic, commercial and industrial.

- Technical like three phase, Single phase, HT, LT and accuracy class meters.

### C. Applications of energy meters

- Domestic usage
- Commercial usage
- Appliance energy meters
- In-home energy use displays
- Time of day metering
- Power export metering
- Multiple tariff (variable rate)meters

### III. PRE-PAYMENT METERS

The standard business model of electricity retailing involves the electricity company billing the customer for the amount of energy used in the previous month or quarter. In some countries, if the retailer believes that the customer may not pay the bill, a prepayment [3] meter may be installed. Prepayment Meters are as shown in fig(2).



Fig. 2: Pre-payment Meters

This requires the customer to make advance payment before electricity can be used. If the available credit is exhausted then the supply of electricity is cut off by a relay.

### IV. PROJECT OBJECTIVE

The main objective of this project is to send a message in the event of energy meter being tampered. The alert message is sent via GSM [1] modem to the concerned authority. As electricity consumption is increasing, so it is an attempt for tampering the energy meter. Identifying a tampered meter is only possible when the electricity board's authority manually checks it, which is a time consuming and costly method. This proposed system is a possible solution to detect meter tampering.

#### A. Prepayment from Supplier Point of View

- Pay before use.
- Keep customers on supply.
- Recover money owed (debt).
- Lower overhead.
- No bill production.
- No bill distribution.
- No need to chase payments.
- No further actions such as disconnections.
- Social acceptability.
- Customer responsible for disconnection.
- Load and demand side management.
- Limit load.
- Load based.
- Time based.

#### B. Prepayment from Customers Point of View

- Less than 80% mobile phones used in India are prepaid.
- Flexible payment solution.
- Pay to suit your income status.
- Daily, weekly, monthly budgeting.
- Show true cost of consumption and money left.
- Reduce consumption when income is tight.
- Make money last.
- Reduce waste – conserve energy.
- No bills.
- No billing errors.
- No socially unacceptable disconnections.

The overview of this project is to send a message in the event of energy meter being tampered. As electricity consumption is increasing, so it is the attempt for tampering the energy meter. Identifying a tampered meter is only possible when the electricity board's authority manually checks it, which is a time consuming and costly method.

Now, coming to the problem statement and analysis, in developing countries like India, power theft is one of the most prevalent issues which not only cause economic losses but also irregular supply of electricity. It hampers functioning of industries and factories, due to shortage of power supplied to them. It causes shortage of power supply to homes. It leads to loss of revenue by Government as individual enterprises may opt to install their own power generators, increases corruption in form of bribes and many more. Ultimately it is the country's economy which suffers along with the country's political reputation.

### V. EXISTING SYSTEM

In existing system either an electronic energy meter or an electro-mechanical meter is fixed in the premise for measuring the usage. The meters currently in use are only capable of recording kWh units. The kWh units used then still have to be recorded by meter readers monthly, on foot. The recorded data need to be processed by a meter reading company. For processing the meter reading, company needs to firstly link each recorded power usage datum to an account holder and then determine the amount owed by means of the specific tariff in use.

### VI. PROPOSED SYSTEM

The present power usage reading is made manually by moving to the consumer locations. This requires large number of labour operators and long working hours to accomplish the task. Manual billing is sometimes restricted and delayed by bad weather conditions. The printed billing also has the tendency of getting lost. Over the last few years, Smart (Prepaid) Energy Meter has been proposed as an innovative solution aimed at facilitating affordability and reducing the cost of utilities. This mechanism, essentially, requires the users to pay for the electricity before its consumption. In this way, consumers hold credit and then use the electricity until the credit is exhausted. If the available credit is exhausted then the electricity supply is cut-off by a relay. Readings made by human operators are prone to errors. This project addresses the above mentioned problems. The development of GSM infrastructure in past two decades made meter reading system wireless. The GSM infrastructure, which has

national wide coverage, can be used to request and retrieve power consumption, notification over individual houses and flats. Apart from making readings using GSM communication, billing system is needed to be made prepaid to avoid unnecessary usage of power.

The use of Prepaid Energy meter is still controversial. On the one hand, those that support the diffusion of prepaid meters claim that they benefit both consumers and utilities because they help users to consume more efficiently and to improve the management of their budget, while allowing firms to reduce financial costs.

The present traditional billing systems have many problems like problem of payment collection, energy thefts etc. due to which the traditional billing system is slow, costly and unreliable. The present billing system has chances of error and it is also time or labour consuming. A paper suggests a design of digital energy meter for improved metering and billing system. Poly-phase prepaid energy metering system has also been proposed and developed based on local prepayment and card reader. Another paper suggests prepaid energy meter using a microcontroller from microchip technology. In PIC family, used due to low cost of microcontrollers. So it is essential to develop a billing system which solves the problem of billing manually and also reduces the manpower. In the present time of 21st century we have no space for errors or faults either in any technical system or in general applications. Prepaid energy meter is an advantages concept for the further. It's facilitates the exemption from electricity bills. Electricity coupons will be available at nearby shops. The word prepaid means "pay before use" one of the advantageous features of this concept prepaid energy meter is used to prepaid the ongoing supply of electricity to homes, offices etc. The proposed technique would be of a digital energy meter which can send the bill of the customer directly to the cell phone of the customer as an SMS and also when he has to pay the bill he can pay it via the meter itself with the swiping of his debit card against the card reader followed by his secret code. Based on the review, it was found that integrating the GSM [2] module is a complex process as for the output of the energy meter has to be transferred to the GSM module and not only that, a real time counter has to be maintained which triggers the GSM [6] at the end of every month to send the message to the customer as well as to the energy providing corporation. This whole process is taken into care by the microcontroller.

Having the GSM integrated with the energy meter, we then shift our entire focus onto integrating the meter with the card reader and a number pad having keys via which we can enter the debit card information. A card reader has to detect the debit card by which the customer will pay the bill. The card reader will then be connected in such a way that when a card is swiped against the swiping console and the secret pin being entered, the card reader sends the card information to the microcontroller which then sends the data along with the secret pin being achieved from the number pad, to the revenue department via GSM. And once the card information is received by the electricity department server the card information is then verified with the respective banks and the required fund is transferred to the revenue department of the energy provided, thing which has to be kept in mind is the encryption of the card information before sending over the GSM [1] to the electricity department. The same

decryption technique has to be adopted in order to decode the information.

$$\text{Total load used} = k_b * N * 1000 / T$$

Where,  $k_b$  = Meter Constant

N= Number of pulses

T= Total pulse time of N pulses.

The purpose of this project is to remote monitoring and control of the Domestic Energy meter. This system enables the Electricity Department to read the meter readings regularly without the person visiting each house. This can be achieved by the use of Microcontroller unit that continuously monitors and records the Energy Meter readings in its permanent (non-volatile) memory location. This system also makes use of a GSM [2] modem for remote monitoring and control of Energy Meter. The Microcontroller based system continuously records the readings and the live meter reading can be sent to the Electricity department on request. This system also can be used to disconnect the power supply to the house in case of non-payment of electricity bills.

## VII. TAMPERING TECHNIQUES

In order to minimize the cost of electrical energy consumption, many consumers try to tamper the energy meters. Today energy theft is a worldwide problem that contributes heavily to revenue losses. Consumers have been found manipulating their electric meters, causing them to stop, under-register or even bypassing the meter, effectively using power without paying for it. Some of the tampering techniques are as follows,

- Reverse Tampering
- Open Cover Tampering
- Magnetic Tampering

### A. Advantages of Proposed Methodology Over Existing Methodology

The present power usage reading is made manually by moving to the consumer locations. This requires large number of labour operators and long working hours to accomplish the task. Manual billing is sometimes restricted and delayed by bad weather conditions. The printed billing also has the tendency of getting lost. Over the last few years, Smart (Prepaid) Energy Meter has been proposed as an innovative solution aimed at facilitating affordability and reducing the cost of utilities. This mechanism, essentially, requires the users to pay for the electricity before its consumption. In this way, consumers hold credit and then use the electricity until the credit is exhausted. If the available credit is exhausted then the electricity supply is cut-off by a relay. Readings made by human operators are prone to errors.

This project addresses the above mentioned problems. The development of GSM infrastructure in past two decades made meter reading system wireless. The GSM [14] infrastructure, which has national wide coverage, can be used to request and retrieve power consumption notification over individual houses and flats. Apart from making readings using GSM communication, billing system is needed to be made prepaid to avoid unnecessary usage of power.

The use of Prepaid Energy meter is still controversial. On the one hand, those that support the diffusion of prepaid meters claim that they benefit both consumers and utilities because they help users to consume

more efficiently and to improve the management of their budget, while allowing firms to reduce financial costs. On the other hand, those that are against prepaid meters argue that their adoption is expensive for firms and risky for low income consumers, as the insecurity and volatility of their income may force them to make little use of the service, or ultimately, bring about involuntary self-disconnection.

### VIII. BLOCK DIAGRAM OF PROPOSED SYSTEM

Wireless energy meters are wireless technology based electricity consumption meters. They are used for measuring power or electric energy and also to monitor using wireless communication. Wireless communication modules (such as GSM) enable the conventional energy meters to become wireless energy meters. These wireless meters eliminate manpower for metering and billing the customer's electricity consumption. The electricity consumption meter shown in the figure facilitates the billing of energy meter using wireless GSM technology. This is a microcontroller based wireless energy meter, as 8051 microcontroller is used for controlling the entire system.

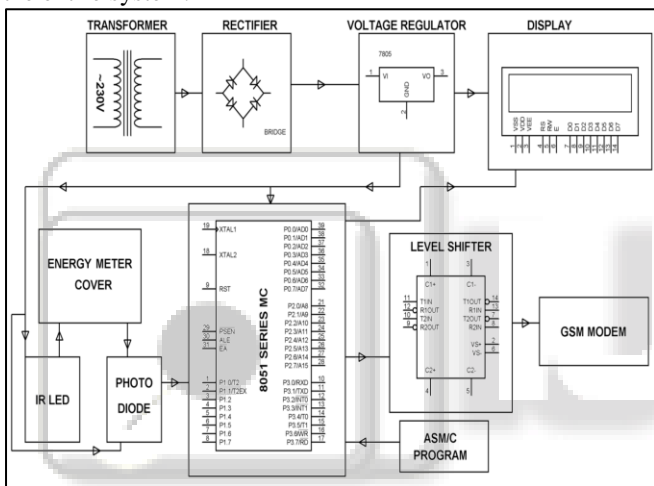


Fig. 3: Block Diagram of Proposed System

The block diagram of the proposed system is as shown in fig(3). This microcontroller based wireless energy meter consists of major components or blocks such as microcontroller, relay, LCD display, power supply circuit, GSM modem,

Power supply block is basic block in every electrical and electronics projects circuit, which is used for providing the required power to the microcontroller and other components in the circuit. Generally, this power supply block consists of step-down transformer, bridge rectifier, and IC 7805 voltage regulator. Thus, the required 5V DC power supply is given to the microcontroller.

The microcontroller block can be considered as the main block of the entire circuit, as it is programmed to control all the components to perform the desired operation. Here, in this project microcontroller of 8051 family is used and programmed using Arduino software.

The microcontroller [3] is programmed to give control commands to the relay driver such that to switch on or off the relays. By using registered mobile number, we can send appropriate commands to the GSM modem as per requirement, which are further used to switch on or off the loads using relays through relay driver. Thus, same information regarding the status of the GSM modem

communication with energy meter, the status of the load whether it is on or off, the energy consumed by the loads, SMS sent to the GSM modem, the mobile number registered with the GSM modem will be displayed on the LCD display connected in the circuit.

In this wireless energy meter, GSM modem SIM sends message to the registered mobile number (user mobile number has to be registered to get the electricity bill via SMS) for every regular time interval. Thus, we can check electricity bill in our registered mobile itself by staying anywhere (even though we are far away from residential areas). The wireless electricity consumption meter reduces the manpower for electricity billing to each and every home or office. This wireless meter system facilitates the user to check the electricity bill over regular intervals based on the requirement. By using this microcontroller based wireless energy meter we can check and pay our electricity bills online from anywhere (even we can get reminded about electricity bills via SMS), so that we can pay bills and avoid the electric power supply disconnections. With the advancement in technology, most advanced types of electricity consumption meters are being designed and used for various applications. These advanced types of electricity consumption meters include prepaid energy meters which are almost similar to prepaid mobile phones we use in our daily life. These prepaid meters are used for paying the electricity bill in advance; based on the prepaid amount the electricity is supplied. After the completion of the prepaid amount, the electricity supply is automatically stopped until furthermore, money is paid for reactivating the power supply.

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- Easy to use, Self-explanatory kit.
- Extensive audio-visuals available.
- Pre-programmed Microcontroller.

### IX. HARDWARE IMPLEMENTATION

#### A. Schematic Diagram

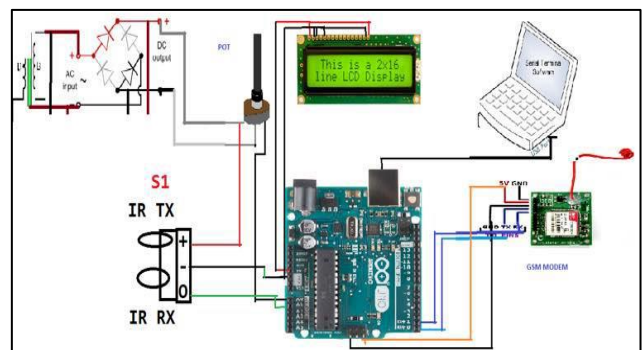


Fig. 4: Schematic Diagram of the Proposed System

Fig 4 shows the schematic diagram of the project. The supply voltage of 230V is stepped down to 30V by the transformer. Rectifier gives a voltage of 12V DC. The equipment in the project work with 5V DC supply, so a voltage regulator 7805 is used.

The schematic diagram of the proposed system is as shown in the fig(4).

The components used in the project implementation are,

- Transformer
- Rectifier
- Voltage Regulator
- Liquid Crystal Display
- Microcontroller(AT89S52)
- IR Sensor
- Level Shifter
- GSM Modem
- Recharge Card
- Arduino Board
- Energy Measuring Module

#### B. Features of AT89S52

- 8K Bytes of Re-programmable Flash Memory.
- RAM is 256 bytes. 4.0V to 5.5V Operating Range.
- Fully Static Operation: 0 Hz to 33 MHz's
- Three-level Program Memory Lock.
- 8-bit Internal RAM.
- 32programmable I/O Lines.
- Three 16-bit Timer/Counters.
- Eight Interrupt Sources.
- Full Duplex UART Serial Channel.
- Interrupt recovery from power down mode.
- Watchdog timer.
- Dual data pointer.
- Power-off flag.
- Fast programming time.

### X. RESULTS AND DISCUSSION

The following Table 1 represents the output result of the proposed system.

S. No.	Tampering Technique	Output Message	Control Room/ Billing Message
1	Open Cover Tampering	Received	Received
2	Reverse Tampering	Received	Received

Table 1: Result Description



Fig. 5: Prototype of the proposed system

The prototype of the proposed system is as shown in the fig(5), kit explains about the project "Detection of Tampered Energy Meter [2] with Prepaid Billing using GSM." In this project when the kit is ON it displays a

message on the LCD as "Welcome to Wireless Billing System" and it sends a message in the event of energy meter being tampered. As electricity consumption is increasing, so it is the attempt for tampering the energy meter. Identifying a tampered meter is only possible when the electricity board's authority manually checks it and sends a message to the authorised number.



Fig. 6: LCD Result Display

Fig 6 shows the important features of this system is that, the system gives the information of energy meter at the initial condition i.e., minimum of zero(0) units and zero(0) price.



Fig. 7: LCD Result Display

Fig 7 shows the other important features of the proposed system. The important feature of the system is that, when the potentiometer is varied, the system gives information of tampered energy meter at the maximum condition i.e., 44 units.

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