Smart Energy Meter Using GSM

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Abstract: *As per the central electricity authority of India, more than 27% of all power produced is either lost due to power theft or unpaid electricity bills. This paper proposes a smart meter that deals with the issue of power theft and pending bills. In the proposed system GSM module is used for establishing a Bi-directional communication between utility and consumer. Microcontroller controls the supply to the consumer by sending commands to solid state relay (SSR). In the proposed system energy meter IC is used for calculating the power consumption by the load. This data is stored in EEPROM of microcontroller. The proposed system has the provision of sending SMS to the user at the end of every billing cycle. Consumer can also connect and disconnect the power supply with just a SMS. Proposed meter in this paper is developed with a power theft logic that not only detects the power theft but also immediately disconnects the power supply of that particular consumer and also alerts the distribution company by sending a SMS. The energy meter proposed in this paper eliminates the disadvantages of conventional billing by eliminating human errors and proposes a prepaid energy billing system that is more accurate, reliable and user friendly.*

***Index Terms*-** *EEPROM, Energy* **meter IC, GSM, and Microcontroller.**

I. INTRODUCTION

The meter which we use to measure the energy utilizes by the electric load is known s the energy meter. Conventionally electromechanical or digital energy meters are being used as the energy metering device but there are a lot of problems in these types of energy meter such as:

- Higher dependency on meter reader
- Human error
- High chances of energy theft and bribery specially during events
- Meter readings can be altered using software tools
- Employees are required for taking meter reading which increases the expenses of company
- If energy meter is installed inside the house there is possibility of non-checking due to lock
- Consumer doesn't receive updates of his/her energy usage
- Consumer may not receive his/her energy bill in stipulated interval of time

Due to these problems, energy distribution companies are suffering huge losses. As per the data of Central Electricity Authority, over 27% of all power produced in India is either lost through dissipation from wires or theft. That's immensely huge power nearly about 261,130 Gigawatt/hour of power annually- enough to illuminate whole New York city for nearly two years. According to PricewaterhouseCoopers (PwC) India estimates, India's power supplying boards are going in loss due to problems like pending electricity bills, power theft, inaccurate bills, meter tampering and leakage due to faulty equipment.

These issues are very often prevalent in Indian power distribution system if these losses are minimized, a huge amount of electrical power can be saved and thus the economy of the country will boost up.

These issues can be overcome using a smart energy meter. In this paper a smart energy meter is proposed which consists of a GSM module, microcontroller, energy meter IC, solid state relay etc. In this paper a strong mechanism is proposed which prevents electricity theft and also ensures bidirectional communication between consumer and distribution authority.

II. LITERATURE SURVEY

The history and evolution of energy meter starts from 1880s, a little before the widespread use of electricity. The era of gas lamps also contained the energy measurement system where the amount of energy consumed per household was calculated. With the discovery and use of electricity, the electric lamps rapidly replaced the gas lamps, proving to be brighter and more cost efficient. A new system for consumption measurement was required. DC meters measured charge in the unit ampere-hours. With time the DC meters proved to be insufficient. Then came Edison's meters classified as electrolytic and electrochemical meters. The electrochemical meters, though suffed the purpose, were labor intensive to read. Thus, not welcomed by users. It was in 1889, that a Hungarian named Otto Blathy created and patented the first AC meter using kilowatt-hour as the standard unit, whose operating principle is used till date. [1]

III. PROPOSED SYSTEM

Proposed meter will work on communication directly with wireless data protocol, so there will be precise reading & there's no necessary for a meter reader to take energy meter reading in consumer premises. The proposed energy meter will be able to operate in divergent ways with GSM Module.

As soon as the power is switched ON the Arduino and GSM module will turn on the SSR and connect the energy meter to the load then the current data stored in EEPROM of microcontroller will be displayed.

Proposed energy meter will take the help of energy meter IC to calculate the number of units consumed. The energy meter IC produces pulses proportional to the energy consumed using the output of current and voltage transformer and sends it to microcontroller. Then the microcontroller will calculate number of units consumed by counting the output of energy meter IC on an interrupt basis and store it in EEPROM of microcontroller. In the proposed system the power utility will maintain a server and every consumer will be provided with a smart energy meter. The Bi-directional communication will be established between server and smart meters with the help of GSM modem on server side and a GSM module at meter side. [2]
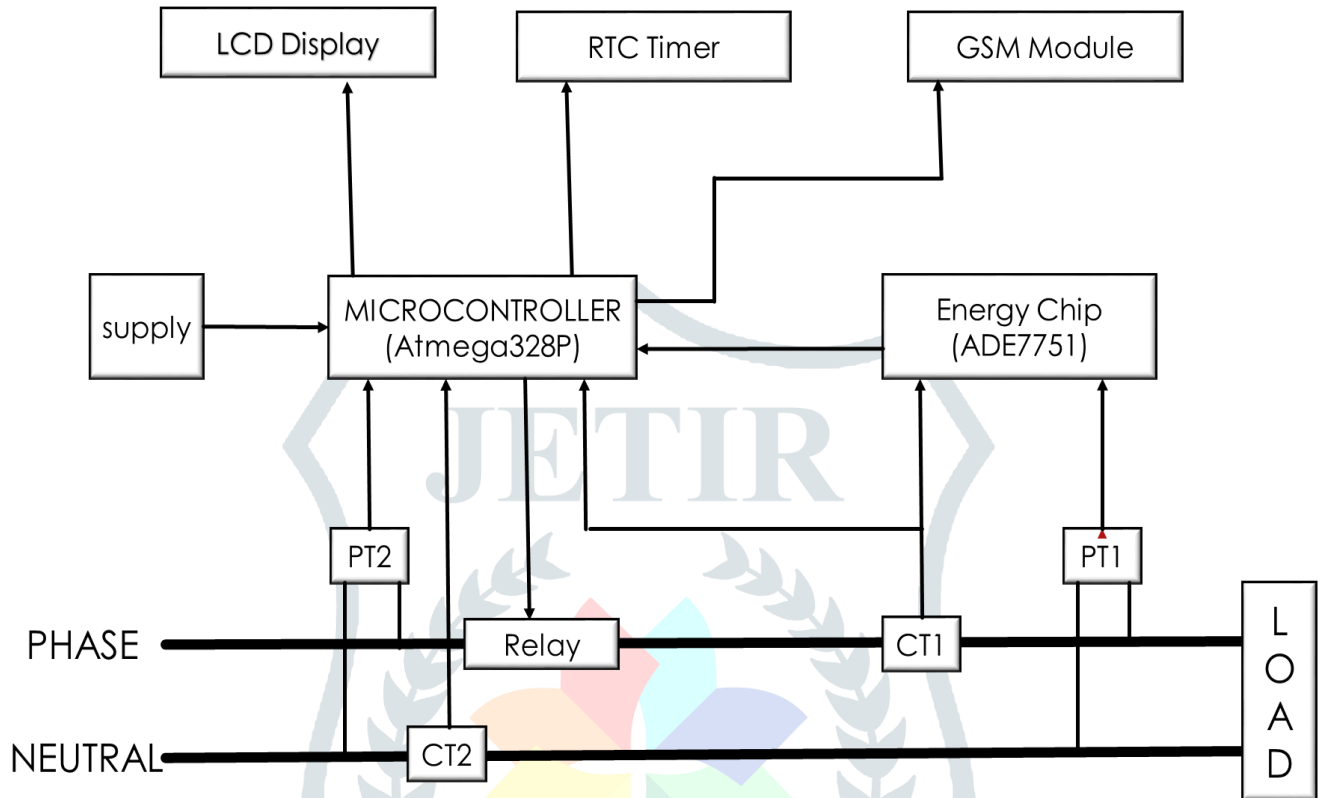
IV. BLOCK DIAGRAM

Fig.1. Functional Block Diagram of Complete System.

4.1 Microcontroller

Microcontroller will be used to govern the whole system. . As soon as supply is given to the microcontroller it will turn on the relay and display the current data. Firstly, microcontroller will store the number of units consumed in its EEPROM. The interrupts of microcontroller will help in sending messages to consumer as well as utility. Microcontroller will be interfaced with Arduino to make circuitry and program more simplex Microcontroller will also be interfaced with single phase energy meter IC to calculate energy consumption by counting the pulses generated by IC which are proportional to power consumed.

4.2 Energy Chip

Energy chip is an accurate fault tolerant electrical energy measurement IC. It will warn the theft condition and allows to continue accurate billing during theft condition. It comes in dual in line package (DIP) with 24 pins. It will be connected to CT's and PT's of required rating to calculate energy consumption and instantaneous power based on the readings from sensors it will generate pulses proportional to power consumed. This output will be given to Arduino to calculate the units consumed. Energy measuring IC has a unique feature of on chip theft detection. Two CT's of same rating measures phase and neutral currents and are connected to two inputs of IC. If these readings differ by more than 12.5% than theft pin of IC goes high indicating power theft but during this condition also the measurement is continued using CT with giving higher current. The study comprised of non-financial companies listed at KSE-100 Index and 30 actively traded companies are selected on the bases of market capitalization. And 2015 is taken as base year for KSE-100 index.

4.3 GSM Module

GSM module will be used to establish wireless, Bi-directional communication between consumer and utility.GSM will be connected to arduino through MAX232 which converts RS232 logic levels of GSM to TTL logic levels of microcontroller.Energy bill will be sent to consumer every month or at any time as demanded by consumer through GSM module and also consumer will be able to continue and discontinue the supply through an SMS. If power theft occures SMS will be sent to utility through GSM module.

4.4 Relay

A solid-state relay will be used to connect or disconnect the supply from the load. Solid state relay is preferred here because of its ability to switch ON and OFF swiftly with low power consumption. Systematic risk is the only independent variable for the CAPM and inflation, interest rate, oil prices and exchange rate are the independent variables for APT model.

4.5 CT's and PT's

Current and voltage transformers will be used to sense the line current and phase voltage respectively. Two current transformers will be connected, i.e. one in phase line and the other in neutral line. Secondaries of these transformers will be connected to input of energy meter IC.

4.4 RTC Timer

Real time clock is a digital device that keeps track of the current time. In this project there is a need to send SMS regarding energy consumption to the consumer at the end of every billing cycle. Therefore, RTC timer will generate interrupt at the end of the month and accordingly Arduino will send the energy bill to the consumer.

4.5 LCD Display

It will be used to display the following data:

- Status of supply
- Units consumed
- Date and time
- Load consumption (KW)

V. POWER THEFT LOGIC

Power theft is usually done by following methods
- A. Shorting the phase line.
- B. Disconnecting the neutral line.
- C. Bypassing the whole meter.

A commonly used method to bypass conventional meter is shorting the phase line as shown in Fig2. If only one current transformer is used and connected in the phase line energy measured by the meter will be zero. Another method of bypassing is to disconnect the neutral line as depicted in Fig.3.

In this case potential transformer will measure zero voltage and no energy consumptions will be registered by the meter. To overcome these bypassing problems, we will separately use two current transformers in the phase and neutral line in our proposed system. The output voltages of these current transformers will be provided to the ADC inputs of the energy chip. If the phase line is shorted or the neutral line is disconnected then there will be contrast between the output voltages of the two current transformers. If this difference exceeds by 12.5% then a signal will be sent to the Arduino by energy chip and that will disconnect the load immediately using the relay. In such events the energy meter will warn the server of the corresponding bypassing through SMS. Upon receiving SMS, the server will isolate the energy meter and will inform the authority. Then the authority will be able to take legal action against the accused consumer. In extreme cases the whole meter can be bypassed as shown in Fig4.In this condition, the meter will detect no energy consumption. To prevent this kind of theft, our proposed energy meter will take several steps. The output of potential transformer will be converted to 5V dc and given to the interrupt pin of the microcontroller/Arduino. When the whole meter is bypassed that potential transformer will detect no voltage and an interrupt is sent to the Arduino. Then the energy meter will request the power status of the area, where the meter is located, to the server. If the server confirms that the power supply is available in that area, then the meter will immediately disconnect the load and will inform the server regarding the electricity theft through SMS. During the whole operation there will be a backup available from a rechargeable battery. [5-6]
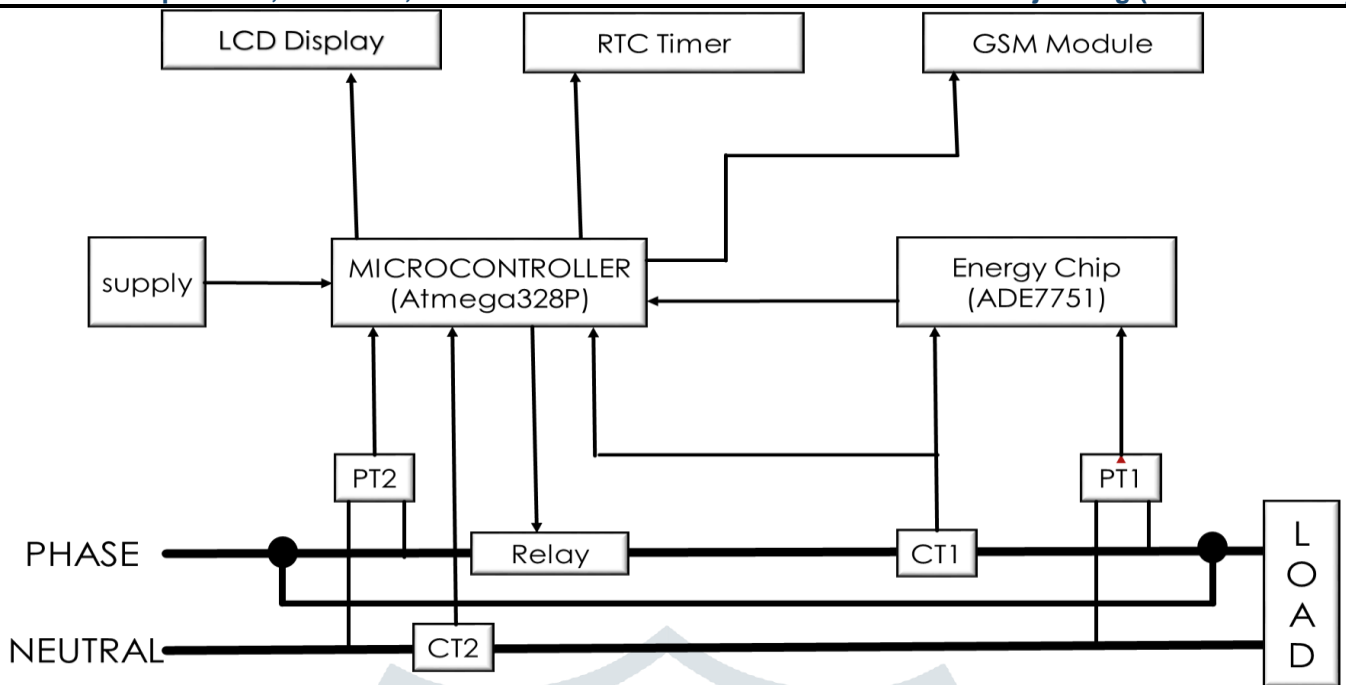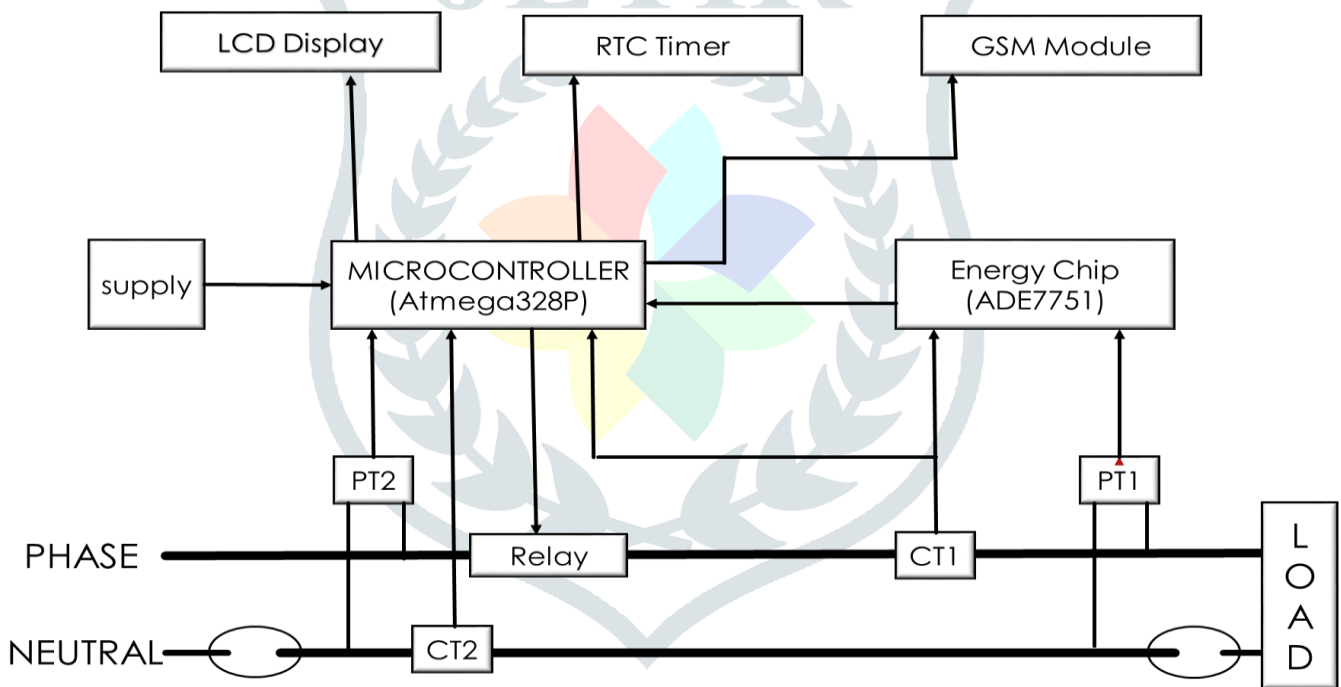
Fig.2. Shorting of phase line.
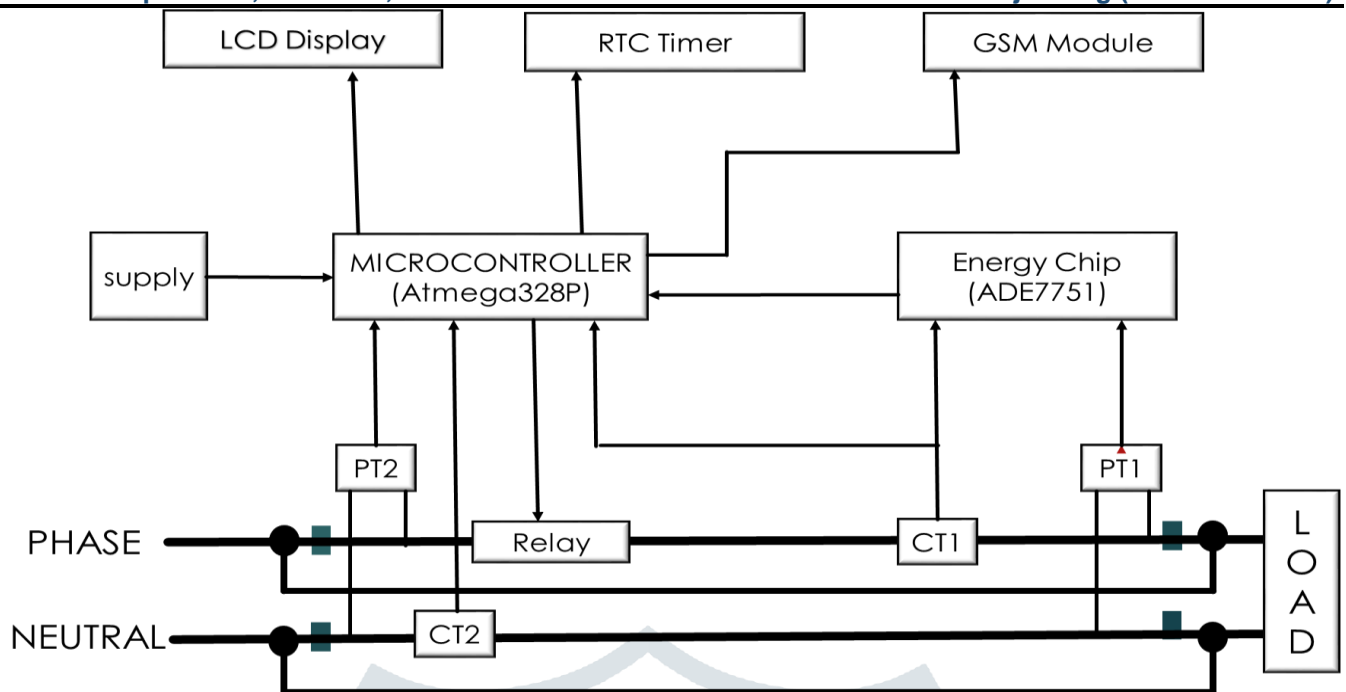
Fig.3. Disconnecting the neutral line.

Fig.4. Bypassing the whole meter.

VI. CONCLUSION

As we know our current distribution system has many problems such as human errors which results in inaccurate billing, power theft due to which distribution companies suffer huge losses, lack of communication between consumer and supplier etc. The system proposed in this paper over comes all these problems to ensure quality power and accurate billing. Proposed system in this paper takes advantage of GSM network that has virtually access to every household and area across different countries.

The proposed system in this paper uses single phase energy meter chip that calculates amount of energy consumed and through microcontroller program this data is sent to consumer as well as supplier at the end of every billing cycle. Proposed system in this paper establishes Bi-directional communication　between consumer and supplier which will ensure the consumer satisfaction with Distribution Company.

Consumer can not only check the power consumed at any time but also can connect or disconnect the power supply with just an SMS. Proposed system will build a strong mechanism against power theft. If power theft is detected from a consumer then with the help of our system power can be discontinued for that consumer immediately through solid state relay (SSR) and an SMS is sent to the utility.

Therefore, utilities can take immediate legal action against the accused consumer and hence control electricity theft up to a greater extent. As well as if electricity bill is not paid by the consumer for a particular period then supply will automatically be discontinued. The proposed meter is thus highly useful for power utilities for reducing electricity theft and ensuring recovery of pending bills.

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