International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 12 Issue 1 –DECEMBER 2014.

Smart Energy Meter with GSM Technology and Self Thermal Printing Technology

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***Abstract*— This paper presents a design and development of a Global System for Mobile communication (GSM) based energy monitoring, profiling and control system. Our system integrates digital energy meters installed at consumer unit with an electric supply company's energy monitoring system. Single phase or three phase digital electric meter can be used to take the meter reading. The Global System for Mobile communication (GSM) network is utilized to transmit the energy usage reading with help of Short Message Service (SMS) back to the energy supplier. The thermal printer is used to collect monthly bills at the end by pressing single button on consumer. Also after paying the bill on electricity board (EB) the confirmation bill will generated automatically on the consumer end. The proposed system replacing the manual work with automatic meter readings coupled with Global System for Mobile communication (GSM) modem technology which simplifies the task of collecting reading, creating database for individual users generating, issuing warnings and intimations beforehand by Short Message Service (SMS). Also, print monthly bills on consumer end by pressing the button on thermal printer attaches with the meter and the paid bills will generated on consumer meter. These are all controlled by Peripheral Interface Controller (PIC) microcontroller and Global System for Mobile communication (GSM) modem. Using Peripheral Interface Controller (PIC) embedded C the programming language, Visual basic 6.0 and MS access for developing this work. Implementation of this paper 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 with the help of Thermal Printing Technique.**

I. INTRODUCTION

The Global System for Mobile communication (GSM) technology is applied so that the consumer could 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 paper 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 advantages over existing systems. The present power usage reading is made manually by moving to the consumer locations. [1] This requires large number of labor 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 Global System for Mobile communication (GSM) infrastructure in past two decades made meter reading system wireless

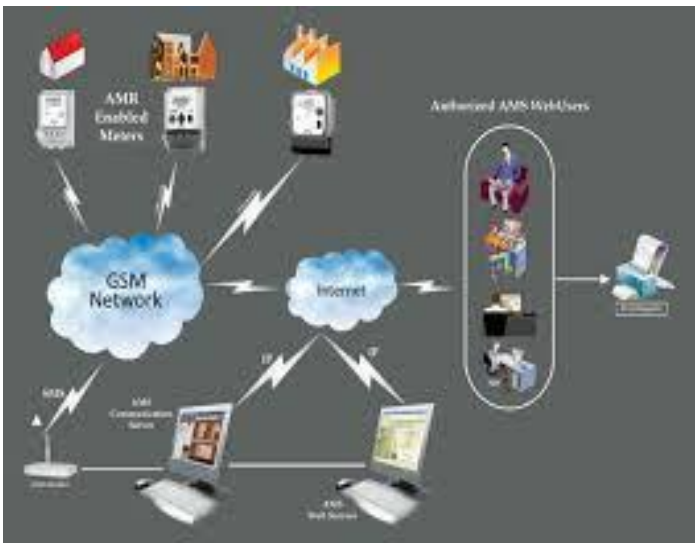


figure 1 GSM Network Topology Model

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. 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.

The rest of the paper will be organised as follows: In section 2, we see about the related works of the paper. In section 3, we discuss about the proposed method. The conclusion of our paper is in section 4.

II. RELATED WORK

This paper presents [3] a single phase electrical energy meter based on a microcontroller from Microchip Technology Inc. PIC family. This electronic meter does not possess any rotating parts, and the energy consumption can be easily read from a four-digit display. Besides that, energy consumption is stored in the microcontroller's EPROM memory. This action is necessary to ensure a correct measurement even in the event of an electrical outage or brown out. As soon as the supply is restored, the meter restarts with the stored value. As this meter is compatible with the electromechanical ones, no additional costs will be incurred by the utility companies in their replacement. A single-phase energy meter prototype has been implemented in the lab to provide measurement up 10 A load current from a 127 V line voltage. The observed accuracy was better than 97%.

This paper presents [4] a single phase digital prepaid energy meter based on two microcontrollers and a single phase energy meter IC. This digital prepaid energy meter does not have any rotating parts. The energy consumption is calculated using the output pulses of the energy meter chip and the internal counter of microcontroller (ATmega32). A microcontroller (ATtiny13) is used as a smart card and the numbers of units recharged by the consumers are written in it. A relay system has been used which either isolates or establishes the connection between the electrical load and energy meter through the supply mains depending upon the units present in the smart card. Energy consumption (kWh), maximum demand (kW), total unit recharged (kWh) and rest of the units (kWh) are stored in the ATmega32 to ensure the accurate measurement even in the event of an electrical power outage that can be easily read from a 20×4 LCD. As soon as the supply is restored, energy meter restarts with the stored values. A single phase prepaid energy meter prototype has been implemented to provide measurement up to 40A load current and 230V line to neutral voltage. Necessary program for microcontrollers are written in c-language and compiled by Win-AVR lib c compiler.

This thesis [5] presents the development of a microcontroller based smart energy meter with data logging capacity. The electronic meter consists of a voltage sensor and a current sensor to measure the supply voltage and load current respectively. An ARM9 processor with a built-in analog-to-digital converter has been used as the main controller. A Secure Digital High Capacity (SDHC) card is used to store the meter data in a FAT32 file format. The communication between the ARM processor and the SD card is through the Serial Peripheral Interface (SPI) protocol. The rms values of the voltage and current and the energy consumption are displayed periodically on a LCD screen. The voltage and current signal from the sensors are sampled and digitized by the ADC and transferred serially to the microcontroller. The microcontroller then computes the rms values of voltage and current and hence, the energy consumption. The values so obtained are stored periodically in the data logger. For the data logging, the Secure Digital (SD) card interface has been used. The microcontroller is able to send data over the SPI to the SD card. However, for the data to be stored in the SD card in a meaningful and retrievable format, it becomes necessary to maintain an appropriate file format in the card. The Windows FAT32 file system has been used for this purpose to store data in the files within the SD card. The meter data is maintained in a simple excel file in the SD card, where the 10-minute rms values of voltage and current and average power for the time duration is stored against the date and time of day. A visual representation of the energy consumption data against time is thus possible, which will in turn enable utilities to study consumer behaviour and allow control over non-critical loads. In the event of occurrence of power quality variations such as voltage dips, overvoltages, interruptions, magnitude variations and harmonic distortions, a second file is used to store the relevant information like time of occurrence, duration and magnitude of the event.

The proposed [6] e-metering is a special class of distributed data network. The e-metering data possess unique characteristics and the network needs innovative technology to record, monitor and process the data. The data are processed to collect information of defaulting customers, power usage profile of an area and of a consumer, supply outage time and losses incurred in distribution system. This system is capable of measuring and estimating the quality of power supplied to the consumers. It consists of data acquisition, transmission and processing components among the energy meters, local area stations and base stations. The application of the e-metering system is extended to streamline

power distribution with online monitoring of power quality, real time theft detection and automatic billing. The facility can be extended to connect water and gas meters to this system using the meter interface units (MIUs) to develop a remote unified billing system.

III. Proposed Thermal Printing

In an existing system for energy billing involves manually collecting readings from energy meters installed at the customer's house, office etc. There is a higher probability of manual error and with increase in number of customers this process becomes more tedious. In the remote energy meter with GSM technology but without self printing technology. We address this above issue; we propose an automatic thermal printing in this paper. In our proposed system we are replacing the manual work with automatic meter readings coupled with GSM modem technology which simplifies the task of collecting reading, creating database for individual users and issuing warnings and intimations before hand by SMS.

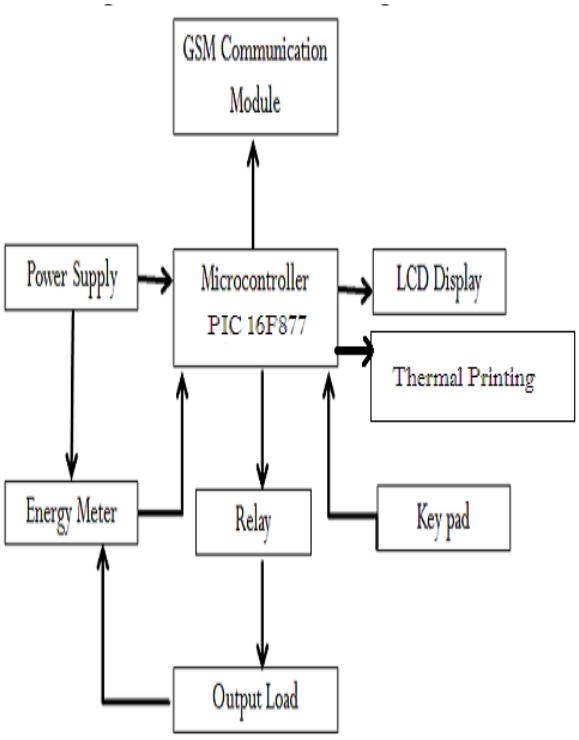


Figure 2 Our Proposed System Block Diagram

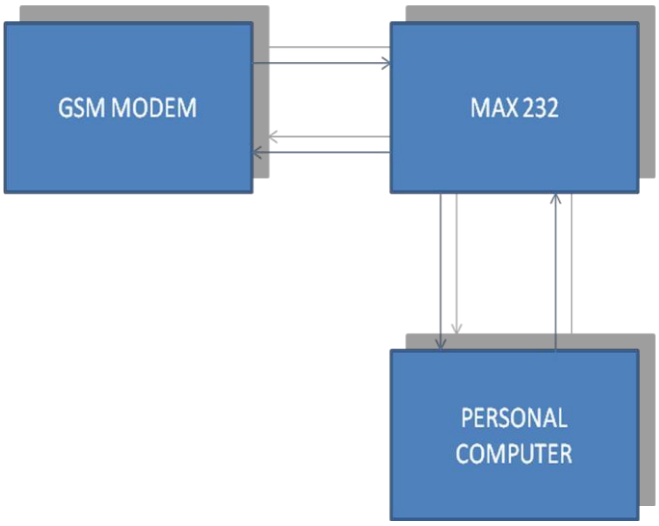


Figure 3 Block diagram for GSM Module

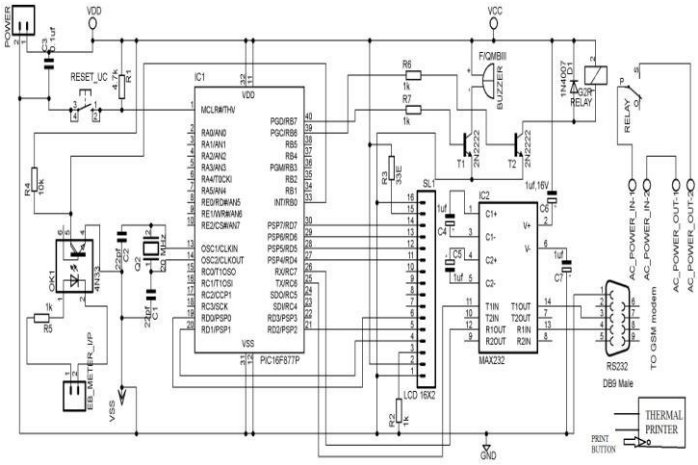
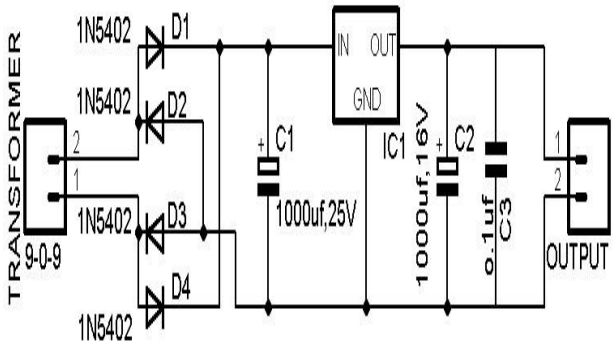


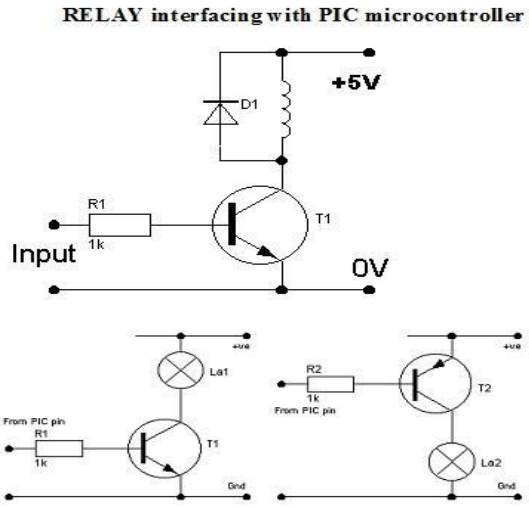
Figure 4 A Schematic Diagram For Proposed System,

We can also print monthly bills on consumer end by pressing the button on thermal printer attaches with the meter. Then after paying the bill on EB the conformation bill will automatically generated on consumer end.

Figure 5 Our Proposed System Diagram

Power Supply Units:





IV. SYSTEM REQUIREMENTS

A. *HARDWARE USED:*

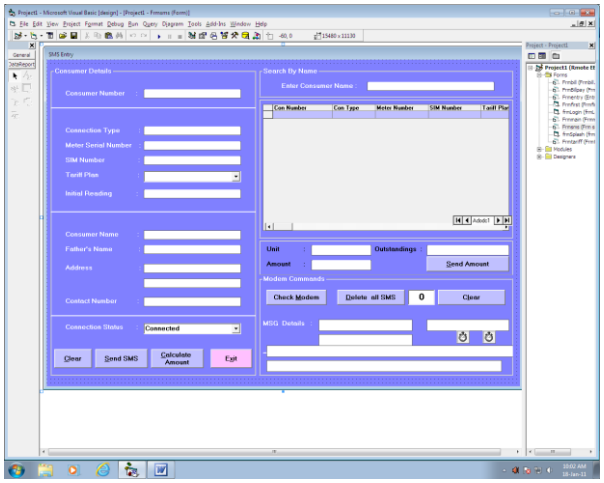
1. GSM modem for remote communication.
2. Electromagnetic relay and relay drive for power supply control.
3. Digital energy meter.
4. LCD display to display the meter readings.
5. Personal computer
6. Thermal Printer

B. *SOFTWARE USED:*

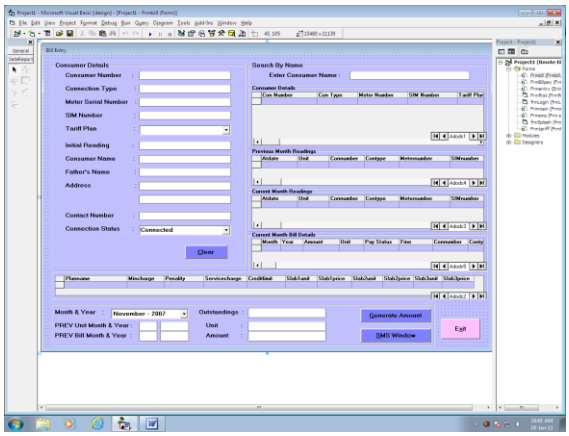
1. PIC C the programming language for microchip's.
2. PIC programmer software.
3. Visual basic 6.0
4. MS access.

V. RESULTS

Input from Electricity board By SMS window



Bill entry and Bill generating window



Output

VI. CONCLUSION

The design of Smart Energy meter using GSM technology can make 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 cutoff by a relay. An arrangement is also made to intimate the user with the help of GSM communication module when their credit in their balance goes low. This system has been proposed as an innovative solution to the problem of affordability in utilities system. Since a microcontroller based system is being designed, the readings can be continuously recorded. This reduces human labour and at the same time increases the efficiency in calculation of bills for used electricity. Smart energy meters will bring a solution of creating awareness on unnecessary wastage of power and will tend to reduce wastage of power. This module will reduce the burden of energy providing by establishing the connection easily and no theft of power will take place. Our implementation of this paper 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 with the help of Thermal Printing Technique. Our proposed scheme works efficiently when compared to the previously proposed systems.

Acknowledgments

To begin with, I would like to express our gratitude to our beloved Principal, Dr. P. K. Pratap Chandran., M.E, Ph.D., for his support and encouragement throughout.

We are deeply indebted to our beloved HOD, Mr. K. Ramash Kumar., M.Tech., (Ph.D)., Associate professor., Department Of Electrical and Electronics Engineering, for having given us an opportunity to pursue our academic interests and for the insightful comments and support throughout.

We profusely thank our project guide, MR. R. Prabhu., M.Tech., Assistant Professor, Department Of Electrical and Electronics Engineering, Miss. A. Geetha., M.E., Assistant Professor, Department Of Electrical and Electronics Engineering and Mrs. M. Kavitha., M.Tech., Assistant professor, Department Of Electrical and Electronics Engineering We are grateful for his constructive criticism during the course of the project, which helped us make the necessary improvements.

I would be failing in my duty if i don't acknowledge the immense help from my family members Mr. R. Palaniraj, Mr. R. Hariharan., B.tech., MR. D. Kumaresan., B.Tech., M.E., Mr. R. Jeeva., Mr. R. Parasuraman., they furnished support and encourage to completing this project.

I also thank my friends and others who directly or indirectly were a source of help for accomplishing this project

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