UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

DEPARTMENT OF DESIGN AND TECHNOLOGY EDUCATION

A PROPOSED DESIGN OF A GLOBAL SYSTEM FOR MOBILE (GSM) COMMUNICATION BASED ENERGY METER

A THESIS SUBMITTED TO THE DEPARTMENT OF DESIGN AND TECHNOLOGY, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF TECHNOLOGY EDUCATION IN ELECTRICAL/ELECTRONIC TECHNOLOGY

BY

ABDUL ADAM LATIF

7141200018

SEPTEMBER 2016

DECLARATION

STUDENT'S DECLARATION

I, ABDUL ADAM LATIF hereby declare that this Project, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged is entirely my own original work and it has not been submitted, either in part or whole, for the award of any other degree elsewhere.

STUDENTS SIGNATURE……

DATE……..……..……..

STUDENT'S NAME; ABDUL ADAM LATIF

SUPERVISOR'S DECLARATION

I hereby declare that the presentation of this work was supervised according to the guidelines for supervision of Project work as laid down by the University of Education, Winneba.

SIGNATURE……..

DATE…….…….

SUPERVISOR'S NAME; PROFESSOR WILLIE K. OFOSU

DEDICATION

I dedicate this work to beloved daughter Fatima Abdul Latif

ACKNOWLEDGEMENT

I am very grateful to the almighty God for the protection, guidance, knowledge and challenges during the research. I am also rending my heart felt gratitude to my supervisor Professor Willie K. Ofosu for his visionary guidance, piece of advice, patience, motivation, tolerance and constructive critisms with which I emerge victorious. I also extend my gratitude to all lecturers in the M TECH Electrical Department who have contributed in a diverse ways. The encouragement you gave me and the assistant is something I will always appreciate.

ABSTRACT

The present systems of energy billing are error prone, time and labour consuming. This project present a design of GSM–based metering system for electricity utilities; to remotely connect/disconnect power supply through meter, to provide utilities access through a network application and to provide a display unit remotely from the meter itself. To implement this system an ARM controller or PLC based board is used. The energy meter has a LED which blinks for a specific number of times to indicate the energy consumed. These pulses are fed to the ARM base system which is programmed to count these pulses. The proposed system is only for single phase users which provides information to both the service provider and the consumer, bill payment through online or through mobile automatically using E-billing techniques.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF ABBREVIATIONS

CPU	Central Processing Unit
DRAM	Dynamic Read Only Memory
EDGE	Enhanced Data rates for GPRS Evolution
EEPROM	Electrically Erasable Programmable Read-Only Memory
EPROM	Erasable Programmable Read-Only Memory
FDMA	Frequency Division Multiple Access
GMSC	Gateway Mobile Switching Center
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
HRL	Home Location Register
HTML	Hypertext Markup Language
IDE	Integrated Development Environment
IEC	Dense wavelength division multiplexing
IMSI	International Mobile Subscriber Identity
IOB	Input and Output Bus
IP	Internet Protocol
LCD	Liquid Cristal Display
LED	Light Emitting Diode
LTE	Long Term Evolution
MCU	Micro-Controller Unit
MMSC	Multimedia Messaging Service Centre
MPLAB	Microchip Programing Lab

MS	Mobile Station
MSC	Mobile Switching Center
MT	Mobile Terminal
NCA	National Communication Authority
PIC	Programmable Interface Controllers
PLC	Power Line Carrier
RAM	Random Access Memory
RFID	Radio-frequency Identification
ROM	Random Only Memory
SGSN	Serving GPRS Support Node
SIM	Subscriber Identity Module
SMS	Short Message Service
SMSC	Short Message Service Centre
SRAM	Static Random-Access-Memory
UMTS	Universal Mobile Telecommunications System

CHAPTER ONE

INTRODUCTION

1.1 Background

An energy meter is a device which is used to measure the consumption of energy of any residence or other industrial establishment. In a conventional metering system, to measure electricity consumption the energy provider company hires persons who visit each house and record the meter reading manually. These meter readings are used for electricity bill calculation and this bill sent to the consumer house by persons or by post. This is sluggish and laborious. In conventional metering system people try to manipulate meter reading by adopting various corrupt practices such as current reversal or current transformer reverse tampers, partial earth fault condition, bypass meter, magnetic interference etc. There is a stark amount of revenue loss being incurred by our country. If any consumer did not pay the bill, the electricity worker needs to go to their houses to disconnect the power supply. It is an unproductive way for measuring power consumption (Mohd Yunus et.al 2009). The ZigBee devices are extremely limited in resources including processing, memory, and power, short operating range (Kwan-il Hwang 2009). GSM based automatic meter reading system is a succor. AMR eliminates any possibility of electricity theft. Automatic meter reading (AMR) system is an effective way of data collection, that allow substantial saving through the reduction of meter read, greater accuracy, allow frequent reading, improved billing, reduced tempering. It provides better customer services, by sending alert of power cuts and consummation updates (H.G. Rodney 2007). AMR is the technology for remote monitoring and to control domestic energy meter and reduces current pilfering. This project presents a network communication technology which enables energy Provider Companies to read the meter reading regularly without the person visiting each house by using GSM communication technology. AMR system is very useful for remote area or

small villages which are not connected by any means of transport such as an island or remote precinct. This GSM based data collection system can be very swift, accurate and efficient.

Electricity is the driving force behind the development of any country. With the rapid increase in residential, commercial, and industrial consumers of electricity throughout the world, it has now become imperative for utilities companies to devise better, non-intrusive, environmentally-safe techniques of gauging utilities consumption so that correct bills can be generated and invoiced. Traditionally, the electricity meters are installed on consumer's premises and the consumption information is collected by meter-readers on their fortnightly or monthly visits to the premises.

This method of gauging electricity consumption has the following disadvantages:

i. Sometimes the meters are installed inside people's homes and, if the consumer is not at home, the meter-reader cannot record the fortnightly or monthly consumption and then the utilities company has to resort to considering the average bill-amount of the previous months as an indicator of the likely consumption for the current month. This results in burden for both consumer and the electricity supply company. May be the consumer has not utilized similar amount of electricity and the current month as in the previous months for reasons such as, holidaying elsewhere or being in the hospital, etc. during the month, and sending him a bill for a larger amount based on his history of electricity consumption mat result in his/her financial hardship. This method of billing is also not suitable for the electricity supply company because it gives inaccurate in the consumer's area and may ultimately result in errors in future planning by the company.
ii. Hiring of a number of meter readers by utilities' companies and providing means of transportation to them is an expensive burden on the companies' budgets. Moreover, these visitors of the may use vehicles to reach the consumer's premises,

generatepollution in the air which has negative impact on the environment and the greenhouse effect.

iii. Dissatisfaction ofsome customers who may consider meter-readers‟ entrance to their homes as some sort of invasion of their privacy.

iv. This is especially applicable in villages, where during the day most men are outside of their homes earning a living and only women are at doing the housework.

v. The meter readers may make some mistake in reading the consumed unit which will lead to false billing due to human error.

The SMS has extended their service to content providers to deliver a wide of services to mobile phone users. SMS is one of the convenient mean of communication especially for reminder, notification and a short note when the mobile phone user is not expect to answer or respond immediately. With the advancement and booming of ICT and internet technology makes online information system application such as e-commerce are systems using Power Line Carrier (PLC) communications, Bluetooth and ZigBee were developed to address the above mention problems, but the above mentioned AMR are either short in operating distant and still require some intervention of human operators or prone to error and reliability issue due to noise and poor power quality in the transmission line, more importantly the above mentioned method does not allow control. With the rapid development of Global System Mobile (GSM) infrastructure and Information Communication Technology (ICT) in the past two decades has made wireless automatic meter reading system more reliable and possible. The GSM Power Meter Reading and Control (GPMC) System takes advantage of the available GSM infrastructure nationwide coverage in the country and the Short Messaging System (SMS) cell broadcasting feature to request and retrieve individual houses and building power wirelessly and the control system will monitor the power of the appliances which consumes more power than its

predefined limit the control system willcontrol the power by means of different techniques for different types of loads like resistive and inductive load so as to reduce un necessary power consumption of appliances and to save the energy at the same time the energy provider can connect or disconnect the power supply to the home is there is an irregularity in the payment of the electricity consumed bill with the help of the same GSM modem.

1.2 Problem Statement

Consumers have to form long queues to buy credit for their prepaid Energy Meters, consumers who do not use the prepaid meter have to wait for several days for them to be reconnected whenever there is disconnection. Fraudulent consumers could cheat without being detected for several years. This research seeks to minimize all these problems if not to eliminate them completely.

1.3 Objective of the Research

The general objective of this work is to design a GSM-based Metering System for electricity utilities.

In order to achieve the general objective the following specific objectives are set.

1. To remotely connect/ disconnect power supply through meter.
2. To provide power utilities access through a network application:
3. To provide a display unit remotely from the meter itself.

1.4 Scope of Work

The design of a GSM Energy Meter capable of receiving instructions from a central database server, and sending meter readings and credit status information to the server.

The Central Database Sever then makes available to both consumers and the power companies the information it receives from the meter upon request or based on schedule.

1.5 Limitation

The accuracy of this research would be subjected to the following challenges;

(a) This research is a propose design of GSM Base Energy Meter based on GSM technology hence virtual components are used for the simulation.

(b) This version of the Proteus 8 software Simulator used in this project work is an educational version and the results obtained are for educational purposes.

1.6 Outline of Thesis

Chapter 2 reviews literature of previous and related works on GSM Base energy metering. Some critical components of the GSM meters and their respective communication components are explored in this chapter.

Chapter 3 deals with the design methodology and gives an overview of the various systems that make up the GSM-based Metering system.

The various core components of the overall system are discussed in detail in Chapter 4 where design and implementation are presented. The testing of the implemented design is also discussed in this Chapter.

This work is concluded in Chapter 5.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews related works and presents different types of GSM based energy meters and its communication technologies. An overview of Microcontroller units and the GSM network are presented. Finally the software applications used for the design are also introduced in this chapter.

2.1 Related Works

According to (H. G. Rodney 2007), Automatic Meter Reading (AMR) technology, electrical utilities (EUs) has been exploiting their own infrastructure to bill their customers in an efficient and economical way. Since the amount of data that has to be send is quite low related to the available time to perform this task, AMR applications have been demanding low bit rates. At this moment, EUs are exploring and demanding other services as load and alarm management, remote monitoring and disconnections, etc. In this context, the Low Voltage modems should provide more throughout while keeping the cost of the hardware low. The results of this low complexity AMR technology are that in order to deploy an AMR network, the cost of the equipment on the customer premises and the added value services that the system provides are two key factors in its business case. According to (L., Shang-Wen, et al 2009),it describes the different methods by which distribution transformer loads can be allocated for power-flow studies. Individual distribution loads are calculated using four different methods of allocation. The results of the power-flow studies are compared to those determined using the actual customer meter readings

- Daily kWH
- Monthly kWh

- Transformer kVA
- REA

The purpose of enhancing the management level of the meter reading of power enterprises, web services based GPRS automatic meter reading system is put forward the characteristics of GPRS technology and Web Services technology are analyzed, and the architecture of web services based GPRS automatic meter reading system. According to (Z., Long, X., Fang-Yuan and M., Ying-Nan. 2010) the characteristics of GPRS technology and Web Services technology, described and it introduced how to build the Web Services based GPRS Automatic Meter Reading System with these technologies. This system has such merits as: real time, wide coverage, open and easy to maintenance and extension. At present, this GPRS Automatic Meter Reading System has gained good application in practical work and been proved to be correct. In (Farhangi, H. 2010), a microprocessor-based automatic meter reading system is implemented, which provides a cost-effective, reliable, and interference free data transfer between remote meter reading units and the utility control centre. The meter reading and management processes are free from human involvement. Based on the existing telephone networks, it is very flexible for the utility companies to access, service and maintain this meter reading system. A user friendly and window based user interface is designed which fully utilizes the personal computer's terminate and stay resident programming technique to achieve communications between the remote meter reading units and the personal computers in the utility control center. This paper describes the hardware design of the remote reading unit and the software implementation of the communication module and user interface. In (R., Kistler, S., Knauth and Klapporth 2008), we propose a novel Automatic Meter Reading (AMR) system using the IEEE 802.15.4-compliant wireless networks. The mesh network based automatic utility data collection system (AUDCS) provides a cost-efficient solution by

exploring the self-organization, self-healing capabilities of the mesh networks and utilizing the state-of-art semiconductor chips and the radio transceivers compliant with IEEE 802.15.4 standard. An IEEE 802.15.4 network may operate in either the star topology or the peer-to-peer topology. The peer-to-peer mode is chosen for the AUDCS system, as it is more flexible and robust than the centralized implementation based on the star topology. In the AUDCS system, each node has the capability of two-way communications and may relay or forward the data for the neighboring nodes within the transmit range, hence eliminating the need of installing dedicated communication nodes to collect data. In addition, mesh networking provides the self-healing function by automatically re-routing via other neighboring nodes. The application data characteristics are exploited in the data gathering and dissemination to achieve better energy efficiency. (Shang et al. 2009) in their work; 'Development of a Smart Power Meter for AMI Based on ZigBee.

Communication' They designed and implemented a ZigBee-based smart power meter. Though Shang's system is a good elimination of manpower requirement for meter reading, it will require ZigBee network to be deploy across the country which could be very capital intensive.

(Long et al. 2010), did a research on the impact of smart metering on energy efficiency; they concluded that smart metering when implemented with the right policies will go a long way to enhance energy efficiency. Their paper gives a comprehensive review on the benefit of smart metering in power network such as energy efficiency improvement and reduction in greenhouse gas emission. The benefit is having smart meters to enhance assets management was also highlighted. Numerous case studies worldwide were looked at in their work. International engineering practices and policy were discussed but they fail to recommend any smart metering method. (Farhangi H 2010) in his work 'The Path of the

Smart Grid' He emphasizes the rising cost of energy, the mass electrification of everyday life, and climate change as the major drivers that will determine the speed at which such transformations will occur. Regardless of how quickly various utilities embrace smart grid concepts, technologies, and systems, they all agree on the inevitability of this massive transformation. He sees smart metering as a move that will not only affect their business processes but also their organization and technologies. (Kistler et al. 2008) in their paper describes an AMR based on ZigBee to build up home area networks of interconnected smart metering devices. The work focuses on how meters can be addressed and read out using existing metering application protocols. This paper presents an AMR that utilizes ZigBee to build up home area networks of connected metering devices. They concluded that it is clear that the AMR application and its requirements really put the ZigBee technology to a serious test and the system must be secure and run autonomously for about 10 years, new devices should be integrated seamlessly and the network must automatically detect and inform in case of malfunctions.

In their work (Adrianus et al. 2011), describe how the days of a quarterly drive by meter reading fails to meet the needs of a Smart Grid that can inform the generator of real time loads and can react to the demands placed upon it by the consumer. Their paper explores what they consider to be the two main methods of data transmission between meter and central database; power line carrier (PLC) and fixed wireless network. It has also been proposed to use ZigBee technology to provide a link between the meter and links to the second aforementioned reason for AMR, consumer empowerment through information. They go on to describe how this ZigBee link will provide a two way connection between energy consumer and provider, and how, because of this, if appliances were suitably equipped the utility company could remotely control home appliances or in the case of a consumer who failed to pay their bill on time, disconnect them remotely.

(Luan et al. 2009) present the design and implementation of a smart power meter. It is based on a Microchip DSPIC30F microcontroller and on the ZigBee interface for sending the data. They designed a ZigBee system and integrated it into the proposed power meter, and used to transmit the detailed power consumption data and outage event data to rear-end processing system.

(Zhu et al. in their work 2008) a novel AMR system based on IEEE 802.15.4 compliant wireless networks is proposed. Data collection can be done in a star topology or a peer-to-peer topology.

The peer-to-peer solution was chosen due to its increased flexibility and robustness. They concluded that security issue is a major challenge for a mesh networks and needs to be addressed and that AES security coprocessor is included in CC2430, could be utilized and implemented in their current prototype. (A. Vijayarajet al 2010) the paper titled as, "Automated EB Billing system using Ad-Hoc wireless routing". In this system the central EB office has immediate access to all consumer homes in a locality with the help of the RF system. The EB meter present in each house is connected by wireless network with the EB office which periodically gets updated from the meter. The EB officer using a backend database calculates the amount to be paid according to the number of units consumed and sends it back to the meter for display and also to the user's mobile phone. (Irfan Quazi *et al* 2010) the paper titled as, "Prepaid Energy meter based on AVR Microcontroller" In this paper, the idea of pre-paid energy meter using AVR controller has been introduced and energy meters have not been replaced which is already installed at our houses. But a small modification can be done on the already installed meters. The use of GSM module provides a feature of pre-paid through SMS. (Liang Zhao 2008)The paper titled as "Development of an energy monitoring system for large public buildings". The author said that building energy conservation is one vital method for increasing the efficiency. In order to locate the

status of energy consumption for large buildings such as super market, government office buildings and hospitals, an internet based energy monitoring was developed.

(M. Trejo-Perea 2013) 'A real time energy monitoring platform user-friendly for buildings '. This study work introduces the development of user friendly quite effective energy monitoring system installed in the building. The metering and control software that process and analyses digitized signals has been developed in Integrated Development Environment (IDE) and Linux embedded server operating system with real time kernel. This system allows the measurement of electric energy parameters of within a building. The consumption of electric energy parameters are displayed by means of graphic interface which can be consulted via internet.

(AbhinandanJain2012) "Smart and Intelligent GSM based Automatic Meter Reading System". Entirely automated energy meter which can be remotely monitoring and controlling, is developed. It continuously monitors the energy meter and sends the data on request of the service provider through SMS. The data received from an energy meter has been stored in data base server which was located at electricity board station by SMS gateway. Energy provider sends electricity bills either by email, SMS, or post. This system allows the customer to pay bill online either by credit card, debit card or by net banking.

(S.H. Shete 2010) **"**GSM Enabled Embedded System for Energy Measurement and Billing". This paper revealed that development of measuring instrument that enhances the measurement of electrical parameters as well as sending these parameters to service providers by using GSM technology. The energy meter system can be incorporated with embedded microcontroller with GSM port to transmit the data. This data fed and integrated into energy management systems located at Power Company.

2.2. Unit of Measurement

The most common unit of measurement on the electricity meter is the kilowatt hour [kWh], which is equal to a load of one kilowatt over a period of one hour, or 3,600 kilojoules. Some electricity companies use the SI mega Joule (MJ) instead, usually for factories and universities.

Reactive power is measured in "thousands of volt-ampere reactive-hours", (KVARH). By convention, a "lagging" or inductive load, such as a fan, will have positive reactive power. A "leading", or capacitive load, will have negative reactive power (Dr. M., K., Khedkar 2010).

Volt-amperes measures all power passed through a distribution network, including reactive and actual. This is equal to the product of root-mean-square volts and amperes.

Distortion of the electric current by loads is measured in several ways. Power factor is the ratio of resistive (or real power) to volt-amperes. A capacitive load has a leading power factor, and an inductive load has a lagging power factor. A purely resistive load (such as a filament lamp, heater or kettle) exhibits a power factor of 1 (K., A., Bakshi, et.al. 2007). Current harmonics are a measure of distortion of the wave form. For example, electronic loads such as computer power supplies draw their current at the voltage peak to fill their internal storage elements. This can lead to a significant voltage drop near the supply voltage peak which shows as a flattening of the voltage waveform.

This flattening causes odd harmonics which are not permissible if they exceed specific limits, as they are not only wasteful, but may interfere with the operation of other equipment. Harmonic emissions (H., C., Ferreira, et al 2011) are mandated by law in EU and other countries to fall within specified limits.

2.3 Existing system

In recent times, the types of electric meter continuously operate to measure the instantaneous voltage and current and calculating the product of these to give out the instantaneous electrical power. The electric power is then integrated against time to give energy used. There are basically two types of electric meters, the Electromechanical and Electronic Electric meters. The GSM Base Smart electric meter is a hybrid of the electronic and electromechanical meters.

The electromechanical induction meter operates by counting the revolutions of an aluminum disc which is made to rotate at a speed proportional to the power consumed. The number of revolutions is proportional to the energy usage. The voltage coil consumes a small and relatively constant amount of power, typically not greater than 2 watts which is not registered on the meter.

The current coil similarly consumes a small amount of power in proportion to the square of the current flowing through it, typically up to a couple of watts at full load, which is registered on the meter (Alez, G 2012).

The metallic disc is acted upon by two coils. One coil is connected in such a way that it produces a magnetic flux in proportion to the voltage and the other produces a magnetic flux in proportion to the current. The field of the voltage coil is delayed by 90 degrees using a lag coil. This produces eddy currents in the disc and the effect is such that a force is exerted on the disc in proportion to the product of the instantaneous current and voltage. A permanent magnet exerts an opposing force proportional to the speed of rotation of the disc. The equilibrium between these two opposing forces results in the disc rotating at a speed proportional to the power being used.

The disc drives a register mechanism which integrates the speed of the disc over time by counting revolutions, much like the odometer in a car, in order to render a measurement of the total energy used over a period of time for a single phase AC electricity meter. Additional voltage and current coils are required for a three phase configuration (K., A., Bakshi 2007).

Three-phase electromechanical induction meter, metering 100 A 230/400V supply. Horizontal aluminum rotor disc is visible in center of meter. The aluminum disc is supported by a spindle which has a worm gear which drives the register. The register is a series of dials which record the amount of energy used. The dials may be of the cyclometer type, an odometer-like display that is easy to read where for each dial a single digit is shown through a window in the face of the meter, or of the pointer type where a pointer indicates each digit. With the dial pointer type, adjacent pointers generally rotate in opposite directions due to the gearing mechanism (Tooley, M. 2009).

The amount of energy represented by one revolution of the disc is denoted by the symbol which is given in units of watt-hours per revolution. The value 7.2 is commonly seen.

Electronic meters display the energy used on an LCD or LED display, and can also transmit readings to remote places. Apart from the amount of electricity used, the electronic electric meter type can also record other parameters of the load and supply such as maximum demand, power factor and reactive power used etc. some of the advanced kinds of electric meters also include electronic clock mechanisms to compute a value, rather than an amount of electricity consumed, with the pricing varying by the time of day, day of week, and seasonally. The technology used in most of the solid state electric meter type is the use of a current transformer to measure the current. The main current-carrying conductors need to pass through the meter itself and so the meter can be located remotely

from the main current-carrying conductors, which is a particular advantage in large-power installations (J., F., Manwell, et. al 2009).

2.4 Automatic Meter Reading (AMR) Electricity

AMRs offer additional functionality including a real-time or near real-time reads, power outage notification, and power quality monitoring and transferring that data to a central database for billing, troubleshooting, and analyzing (V. Daniel Hunt 2009). They allow price setting agencies to introduce different prices for consumption based on the time of day and the season. This technology mainly saves utility providers the expense of periodic trips to each physical location to read a meter. Another advantage is that billing can be based on near real-time consumption rather than on estimates based on past or predicted consumption. This timely information coupled with analysis can help both utility providers and consumers to better control the use and production of electric energy consumption. AMR technologies include PLC, ZigBee and RFID.

Power line communications (PLC) systems operate by imposing a modulated carrier signal on the wiring system (H., C., Ferreira, et al 2009). Different types of power-line communications use different frequency bands, depending on the signal transmission characteristics of the power wiring used. Since the power distribution system was originally intended for transmission of AC power at typical frequencies of 50 or 60Hz, power wire circuits have only a limited ability to carry higher frequencies. The data capacity and distance limits vary widely over many power line communication standards. This technology makes it possible for metering information be sent from a meter to a central point, usually a data concentrator.

2.5 ZigBee Based Communication

The ZigBee communication is usually a mesh network where meters themselves act as repeaters passing the data to nearby meters until it makes it to a main collector. The Swedish city of

Gothenburg is having their electric meters connected in this manner, using the ZigBee Protocol.

(R., Kistler, S. et. al 2012) A mesh network may save the infrastructure of many collection points, but is more data intensive on the meters. One issue with mesh networks it that battery operated ones may need more power for the increased frequency of transmitting. This method of communicating metering data requires that the AMR be receivers as well as transmitters potentially making individual transceiver cost higher. However, the additional cost may be outweighed by the savings of multiple collectors and repeater antennas and finding places to mount them this makes the GSM Based Smart Meter more advantageous.

2.6 RFID Based Communication

Radio-frequency identification (RFID) based AMR is the use of a wireless non-contact system that uses radio-frequency electromagnetic fields to transfer data from a meter for the purposes of automatically reading the meter by a moving vehicle or other nearby data concentrators for billing and planning purposes (V. Daniel Hunt et. al.2007). It uses a local power source and emits radio waves (electromagnetic radiation at radio frequencies). RFID enable two-way communication between the meter and the central system (V. Daniel Hunt et. al 2007).

2.7 Global System for Mobile Communications (GSM)

The creation of GSM started as far back as 1982 where a high level communication expert at the European Conference of Postal and Telecommunication Administrations. The idea then was to address cellular infrastructure in Europe, but rapidly expanded to other countries. Finally, GSM became the standard set developed by the European Telecommunications Standards Institute (ETSI) to describe technologies for second generation (or "2G") digital cellular networks.

Developed as a replacement for first generation analogue cellular networks, the GSM standard originally described a digital, circuit switched network optimized for full duplex voice telephony Data communications became part of GSM (JörgEberspächer et. al. 2009), first by circuit switched transport, then packet data transport via GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution or EGPRS).

2.8 Software Applications

In information technology, an application is a computer program designed to help people perform an activity. The MPLAB IDE Program and the Proteus 8 professional applications were used in this project work.

MPLAB IDE is a Windows Operating System (OS) software program that runs on a PC to develop applications for Microchip microcontrollers and digital signal controllers. It is called an Integrated Development Environment, or IDE, because it provides a single integrated “environment” to develop code for embedded microcontrollers.

An embedded system is typically a design making use of the power of a small microcontroller, like the Microchip PIC MCU or PIC Digital Signal Controller (DSCs). These microcontrollers combine a microprocessor unit (like the CPU in a desktop PC) with some additional circuits called “peripherals”, plus some additional circuits on the same

chip to make a small control module requiring few other external devices. This single device can then be embedded into other electronic and mechanical devices for low-cost digital control.

A development system for embedded controllers is a system of programs running on a desktop PC to help write, edit, debug and program code – the intelligence of embedded systems applications – into a microcontroller. MPLAB IDE runs on a PC and contains all the components needed to design and deploy embedded systems applications.

CHAPTER THREE

METHODOLOGY

To implement this system, an ARM controller or a PLC based board is used. The energy meter has an 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 the ARM based system which is programmed to count these pulses. The system reads these pulses to increment the internal counter by one which indicates the number of units consumed. When the service provider sends a message to read the energy meter data, the GSM modem which is connected through UART interface interrupts the ARM. This causes the ARM to read the number of units burnt and sends the data to the UART. Further, the UART sends the data to GSM modem which sends this meter reading data to service provider. If the service provider detects that the message has been sent to the consumer, the service provider can now inform the customer regarding the current bill or status using the customer's registered phone number by either a message. The system will also contain a display system which will report latest information to the consumers.

3.1 System Description

The Proposed system is to make the energy meter as a smart meter to read the energy consumed, voltage level and power factor and also auto announcement features such as power failure, power factor lagging and low voltage level. In this system a relay circuit is used to disconnect the supply to the consumer for large outstanding dues. This system minimizes the power and time wastage. Electrically Erasable Programmable Read Only memory (EEPROM) is used to store the data regularly. By using Real Time Clock (RTC) the real time date and time is maintained in off line position. A keypad is used to view and erase the EEPROM. The monthly usage is also sent to the consumer through Short

Messaging Service (SMS) and also displayed in LCD display. The announcement feature and disconnect/reconnect features are controlled by the visual basic codes. The microcontroller receives the command from server and act.

The advantage of this system is to reduce the effort of human beings. Another advantage is this system can be used in remote area or small villages.

The system also can be used to disconnectthe power supply to the house in a case of nonpayment ofelectricity bills/ have large outstanding dues. This system givethe information of power cut in particular area and power cuttime so this feature is useful for remote areas. A temperdetection unit also connects with the meter so there is nopossibility of tempering. If tempering occurs then temperingunit will be activated, and a SMS is automatically send tocentral server of the energy provider company that cut thepower of that house. So, In AMR tempering is not possible.

3.2 Design of AMR

Figure 3.1 shows a block diagram of AMR. AMR Continuously monitor and record the energy meter. This can be achieved by using microcontroller. Figure 3.2 show the microcontroller unitis interfaced with energy meter and LCD. The Microcontroller unit continuously monitors' the energy meter and pulses display on LCD that gives the information of power consumption in a house. For the information of power cut microcontroller unit is interface with RTC clock and relay. For communication purpose microcontroller unit is also interfaced with GSM modem by using MAX232.

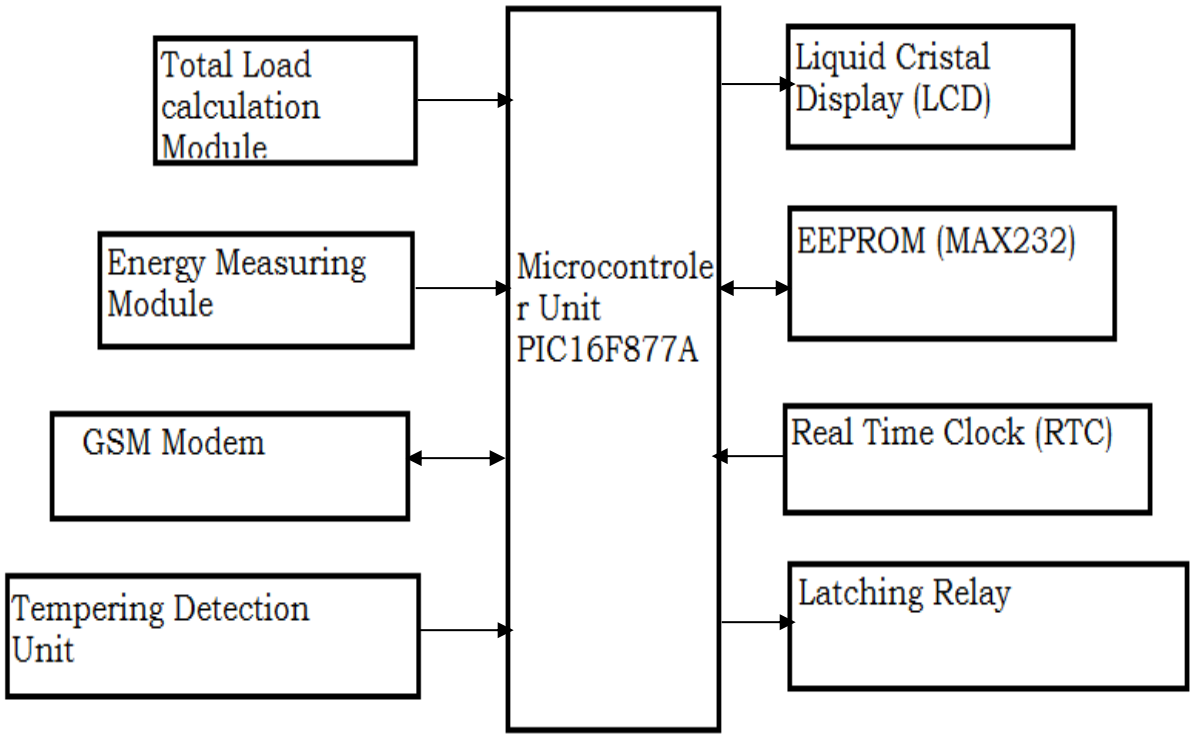

Figure 1: Block diagram of GSM based automatic energy meter reading system [4]

3.3 Functions of the Components used in the Proposed Design

Microcontroller unit is used for controlling of complete proposed AMR system. The 16F877A microcontroller was selected for this project because it has a low-power and high-performance. The 16F877A provides 256 bytes of on-chip RAM 8K bytes of flash Memory, 32 I/O lines, watchdog timer, two data pointers, three 16-bit timer/counters a full duplex serial port, on-chip oscillator, and clock circuitry.

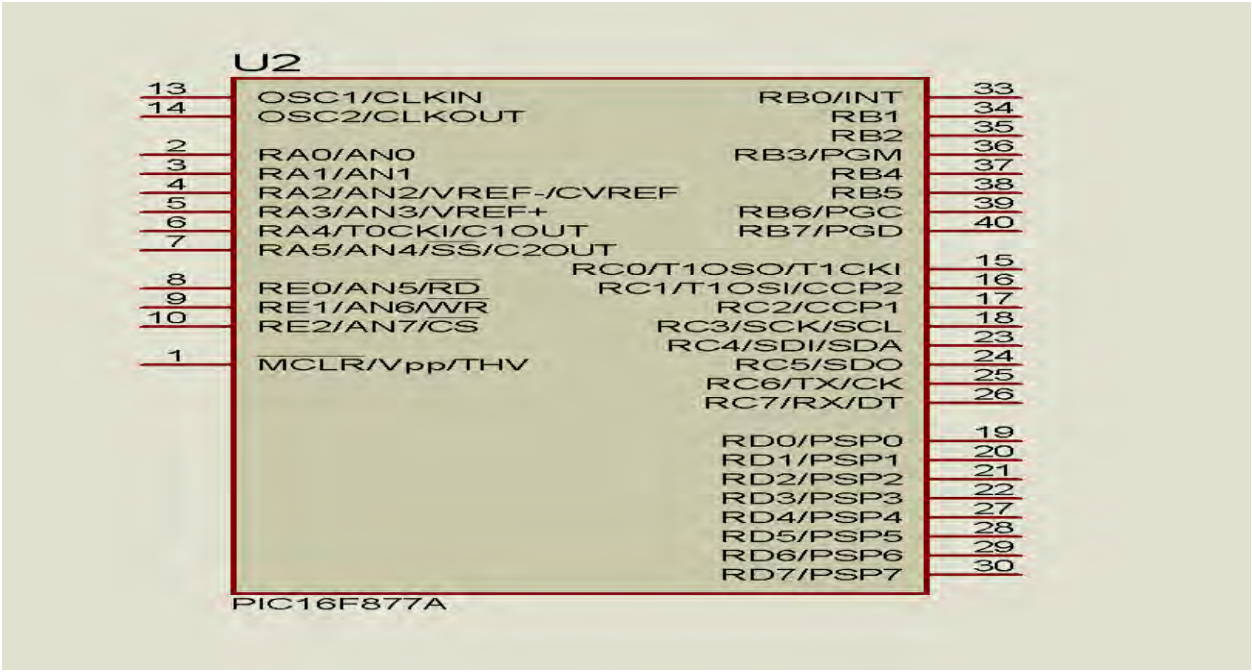

Figure 2 PIC 16F877A MICROCONTROLLER

The propose design employs an energy meter which measures the instantaneous voltage and current and finds the product of these to give instantaneous electrical power drawn by the consumer in the event of using the electricity. The meter is designed to read the power in the form of pulses and also give the information of power ON and OFF status. This data are displayed on to the Liquid crystal display of the proposed system.

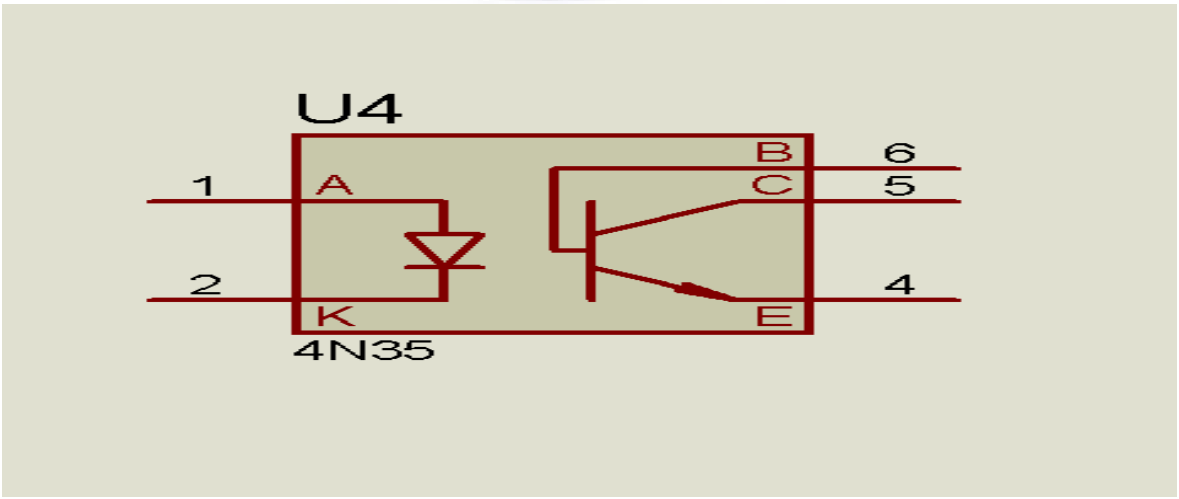

Figure 3: 4N35

In this project a DS1307 serial real time clock is used for giving the information of date and time of power cut. The DS1307 has 56 bytes RAM that is sufficient to store the data in the proposed design. The Address and data are transferred serially by 2-wire, bi-directional bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information during the usage of the system. The DS1307 has a built-in power sense circuit that detects power failures and automatically switches to the battery supply.

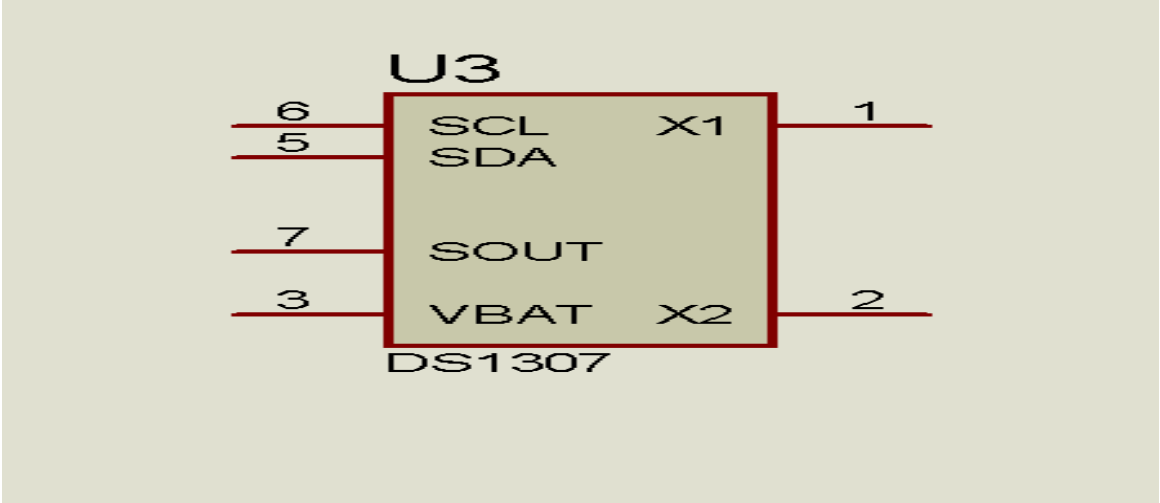

Figure 4: DS1307 Real Time Clock

Another important component used in this project is the Relay circuits, which interfaced with the energy meter and microcontroller. The Relay circuit allows switching the consumer's main consumption line between cut-off and power supply mode. The Relay circuit is a helpful feature, because the energy Provider Company can remotely switch into cut off mode from power on mode of the consumer due to nonpayment of electricity bills. It can reconnect the power supply after payment of dues.

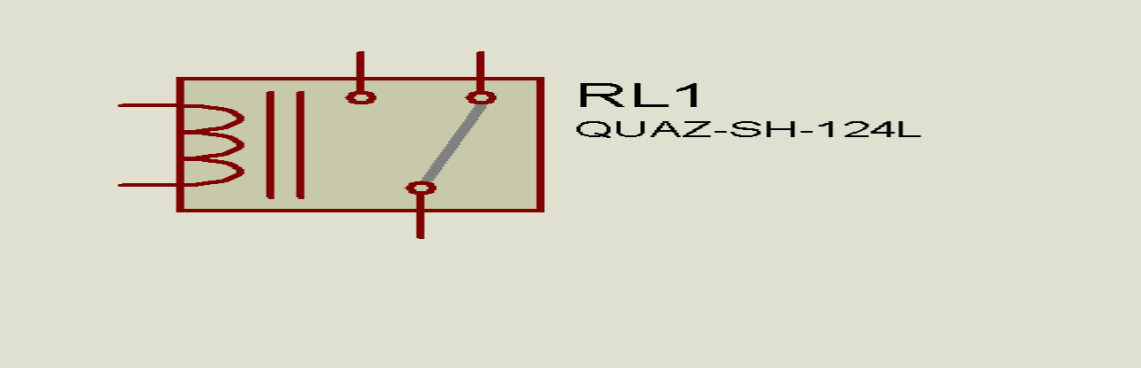

Figure 5: Relay circuit.

The Liquid crystal display is interfaced to the microcontroller unit to display the meter reading, date, time, power factor, power status and total load used.

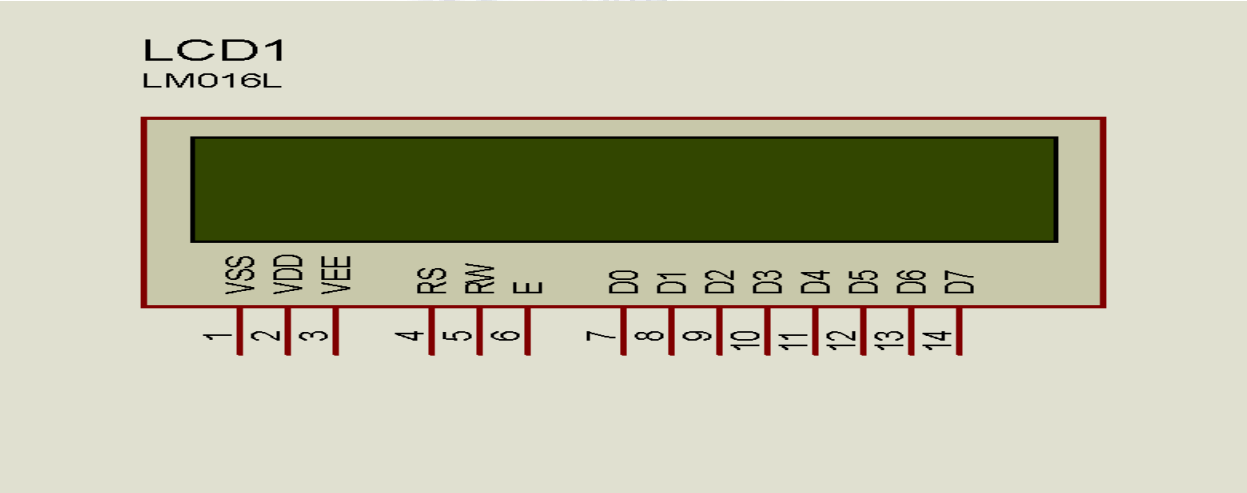

Figure 6: LCD display

The PIC MAX232used in this project work is electrically erasable programmable read only memory which is used to storedata in its 4KB Memory. The EEPROM interfaced with the microcontroller by using 2 wire serial interfaces. If power cut off the content of RAM must be stored in EEROM, and when the power comes back the energy meter will start from its previous state.

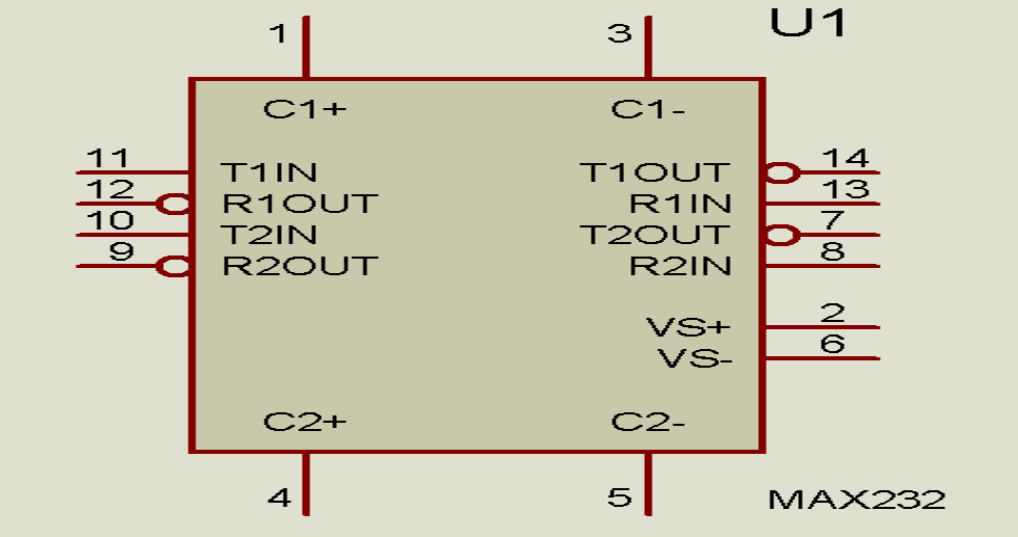

Figure 7: MAX232

The tempering unit used in this proposed design interfaces with the energy meter and the microcontroller units to send energy theft alert to energy Provider Company when tempering occurs. If any person tries to temper (such as current reversal or CTreverse tampers, partial earth fault condition, bypassing meter, magnetic interference, phase or neutral wire swapped, external tempers) with energy meter, the tempering unit will be activated and an SMS alert is sentto the energy provider company.

The Quad-band intelligent GSM/GPRS modem is suitable for long duration data transmission. To implement AMR system a GSM modem is connected to a microcontroller which would transmit data from a meter to cell phone and also receive commend from cell phone to energy meter. The modem will send unit or pulses (power consumption) on a regular interval or on a request. AT commands set which stands for attention terminal are used by energy meter to communicate with the GSM Modem.

AMR also give the information of total load used in a house on request at any time. Total load used in any house can be calculated by observed or record N number of pulse in T time that is described by equation number 1. Where Kh =Meter constant N=Number of pulse T = Total pulse time of N pulses Energy meter also sends a SMS alert to the energy provider company and customers if any persons used more than specify limit of load. The energy provider company can disconnect the power of respective customer. So customers manage their house power consumption.

3.4 Research Flow Chart

In general, all the above mentioned procedure can best be illustrated by the flowchart in figure 8.

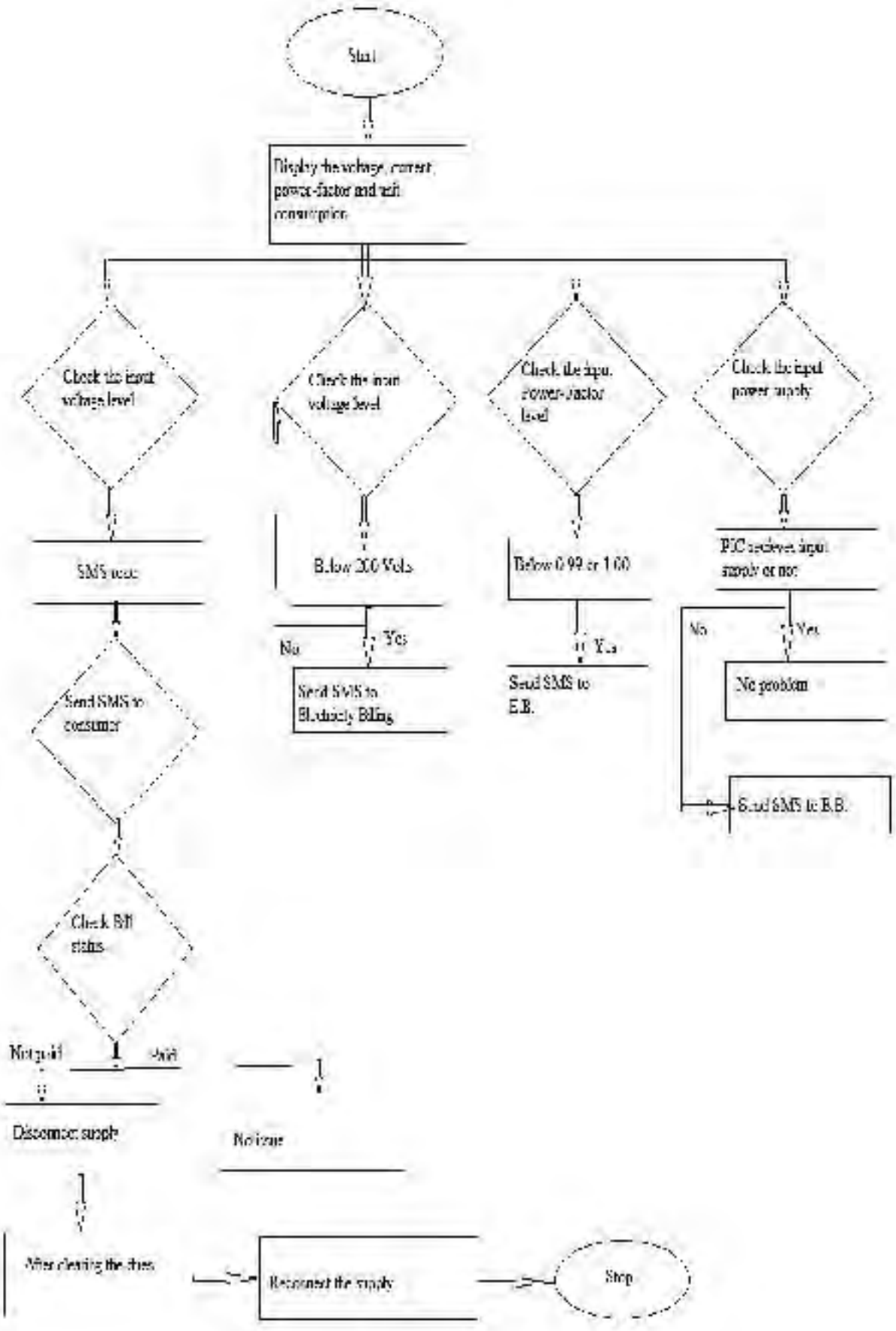

Figure 8: Flow diagram of controlling program for AMR

The microcontroller unit receives a message and it read this message and also read user mobile number and checks the authentication. If the number is authenticate; it read current data from EEPROM and sends the data to authenticated number. If system access mobile number is not authenticated; GSM based AMR sends a SMS alert to energy provider. It also provides the facility of power disconnect to customer that have large outstanding dues by sending a code to the energy meter. Microcontroller has a program of matching of this code to power disconnect code. If this code is match then power disconnect to respective meter. It also provides a facility to power re-connect due to deposit the outstanding previous bill amount by sending a code to the energy meter.

Microcontroller has a program of matching of this code to power re-connect code. If this code is matches then power reconnect to respective meter. Power cut feature perform by using interrupt signal.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

This chapter describes the detail results and discussions of results and the findings outlined forthis project work. It also describes the software used for the project work.

4.1 Proteus 8 Professional

This is a type of electrical software which is used to simulate the whole project in animated views. Proteus 8 is a single application with many service modules offering different functionality (schematic capture, PCB layout). The wrapper that enables all of the various tools to communicate with each other consists of three main parts.

Proteus 8 consists of a single application (PDS.EXE). This is the framework or container which hosts all of the functionality of Proteus. ISIS, ARES, 3DV all open as tabbed windows within this framework and therefore all have access to the common database.

The common database contains information about parts used in the project. A part can contain both a schematic component and a PCB footprint as well both user and system properties. Shared access to this database by all application modules makes possible a huge number of new features, many of which will evolve over the course of the Version 8 lifecycle.

Together with the common database the maintenance of a live netlist allows all open modules to automatically reflect changes. The most obvious example of this is wiring in ISIS producing ratsnest connections in ARES but it goes much further than that. The new Bill of Materials module contains a live viewer and the 3D Viewer and Design Explorer are also linked into the live netlist. This document covers the Proteus 8 application framework and other functionality related to the software suite as a whole. The various

application modules (e.g. ISIS, ARES) each have their own reference manuals and tutorial documentation.

4.2 System Architecture

The proteus 8 professional software is used to create the circuit for this project work. The figure 4 is the system architecture that depicts the various stages the system undergoes.

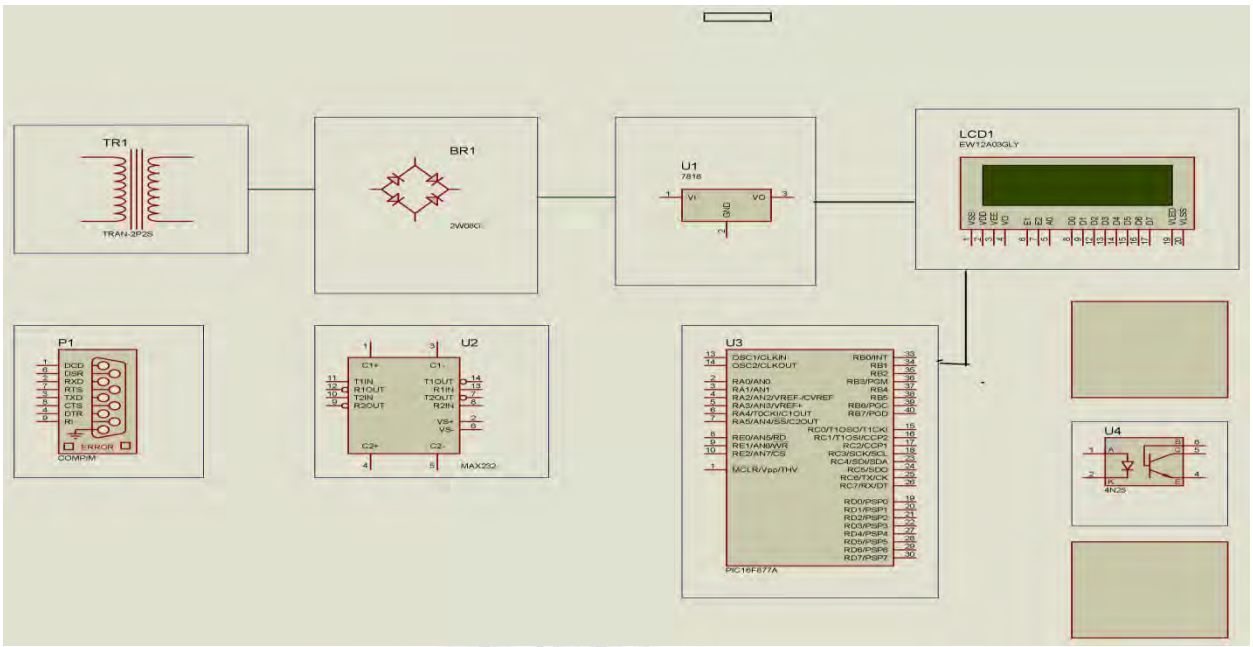

Figure 9: Block diagram of GSM based energy meter.

The complete circuit diagram of the GSM based energy meter developed using the proteus 8 professional for this project work is as shown in the Figure 5.

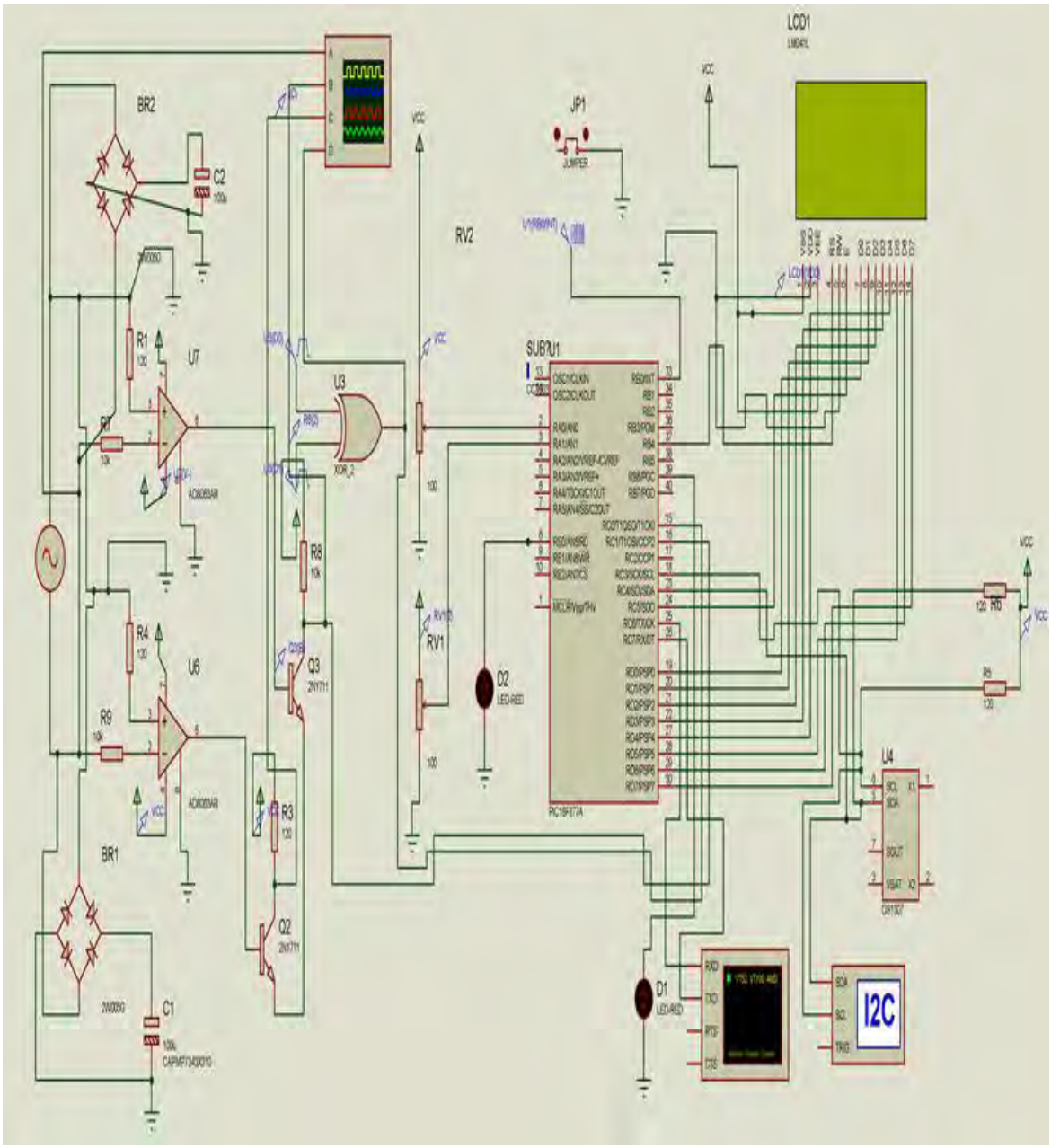

Figure 10: Product type GSM based AMR

The system shown in figure 5 & figure 6 show the circuit diagram of Consumer end and Server end respectively. The transmitter and the receiver pin of the GSM are connected to the receiver and transmitter pin of the microcontroller that will be used to have transmission of control messages between the two. The programming is made so that it counts the number of pulses that is detected by the Energy Meter and stores the count in the controller.

The LCD is used to display the count and the impulse of the energy meter. It is connected to port 0 and port 1 of the microcontroller. The register, read and write is connected to the port 1 and controls the reading and writing in the LCD.

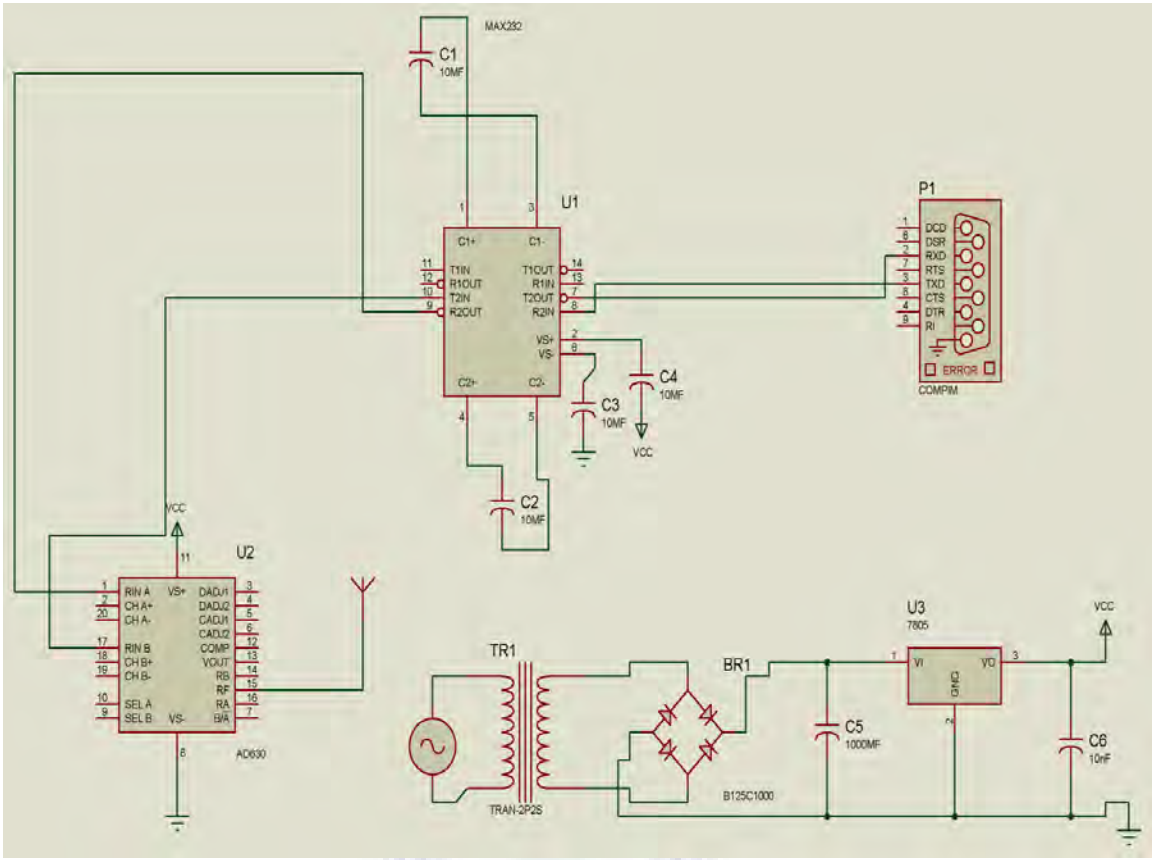

Figure 11: Server End

4.3.1 Power Supply

The microcontroller and other devices get power supply from AC to DC adapter or from direct a.c. lines through voltage regulator. The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.For ICs, microcontroller, LCD Consumes 5 voltsfor alarm circuit, op-amp, relay circuits Consumes 12 volts

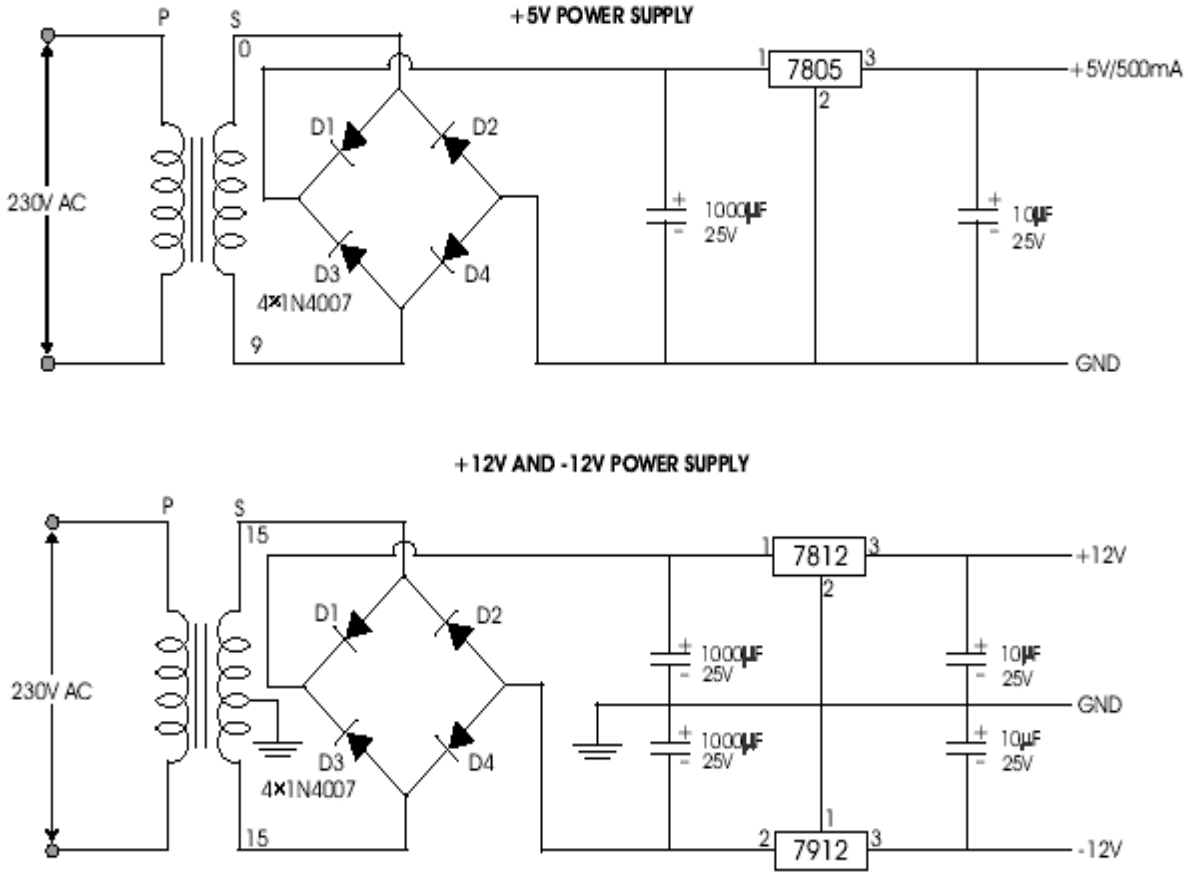

Figure 12: Power supply

4.3.2 Voltage Measurement

The circuit shown in figure 8 is designed to monitor the supply voltage. The supply voltage that has to be monitored is step down by the potential transformer whose range is 0-6Volts.

The step down voltage is rectified by the precision rectifier. The precision rectifier is a configuration obtained with an operational amplifier in order to have a circuit behaving like an ideal diode or rectifier.

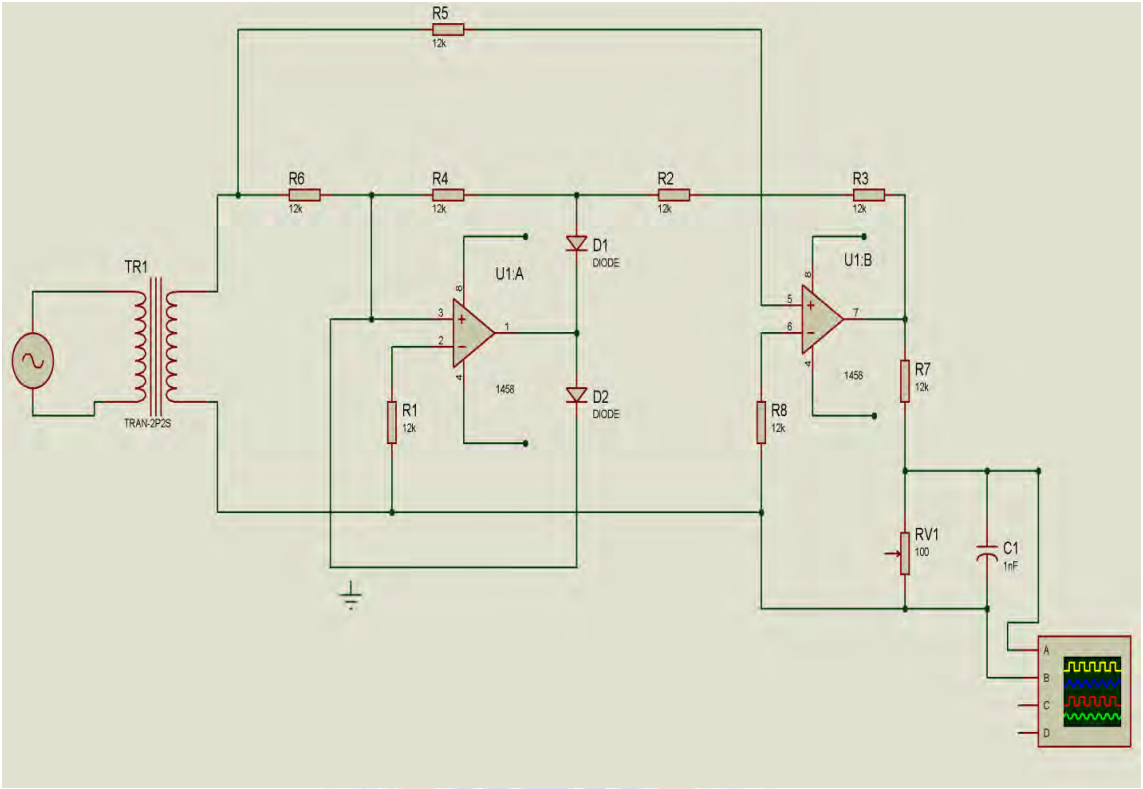

Figure 13: Voltage measurement

4.3.3 Current Measurement

The circuit shown in figure 9 is designed to monitor the supply current. The supply current that has to be monitored is step down by the current transformer. The step down current is converted by the voltage with the help of shunt resistor. Then the converted voltage is rectified by the precision rectifier. The precision rectifier is a configuration obtained with an operational amplifier in order to have a circuit behaving like an ideal diode or rectifier.

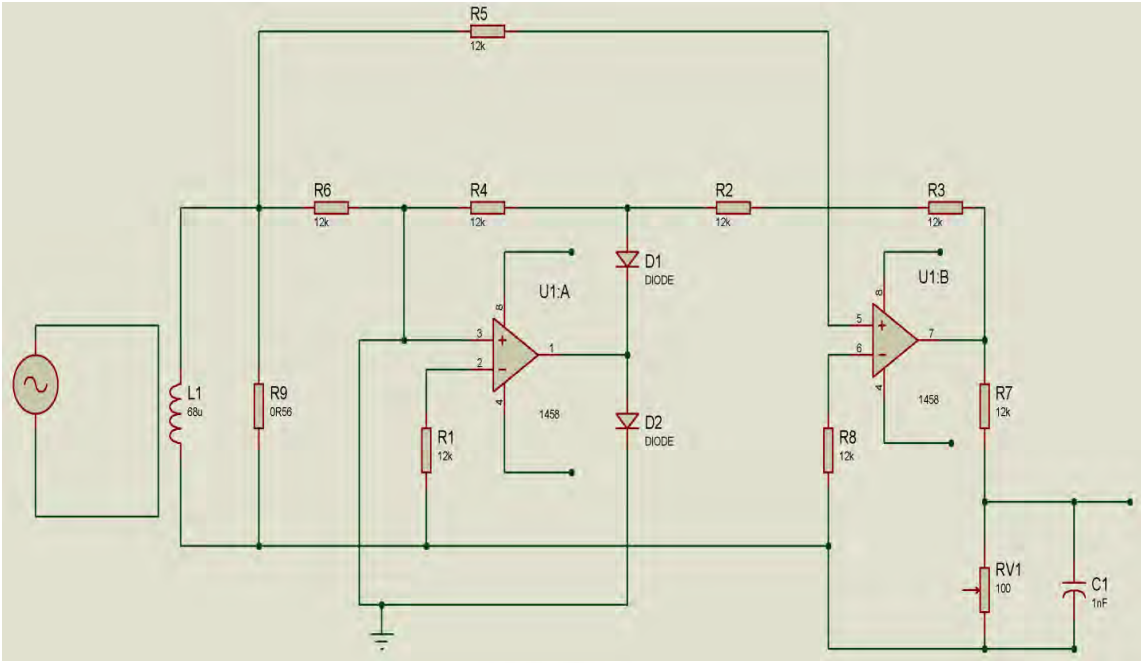

Figure 14: Current measurement

4.3.4 Power Factor Measurement

The circuit shown in figure 10 is designed to find the power factor in the power line. The power line voltage and current is monitored through the potential and current transformer respectively.

The potential transformer is used to step down the mains supply voltage to low voltage level. The voltage level is from 440V AC to 6V AC. Then the output of the transformer is given to Zero Crossing Detector. The current consumed by the load is measured with the help of a current transformer. The current transformer will convert the load current into lower values of current output that will be converted in to voltage with the help of the shunt resistor. Then the corresponding AC voltage is given to zero crossing detector. The Zero Crossing Detector is used to convert the sine wave to square wave signal. The zero crossing detectors are constructed by the operational amplifier LM 741. The inverting and non-inverting input terminals are connected to the potential transformer and current transformer terminals respectively. So the input sine wave signal is converted in to square

wave signals. The square signal is in the range of +12v to -12v level. Then the square wave signal is given to base of the BC 547 switching transistor in order to convert the TTL voltage 0 to 5v level. Then the both ZCD's outputs are given to logical XOR gate 74LS86 to find the phase angle difference between the voltage and current. The XOR gate output is given to microcontroller or PC and calculates the power factor with help of software.

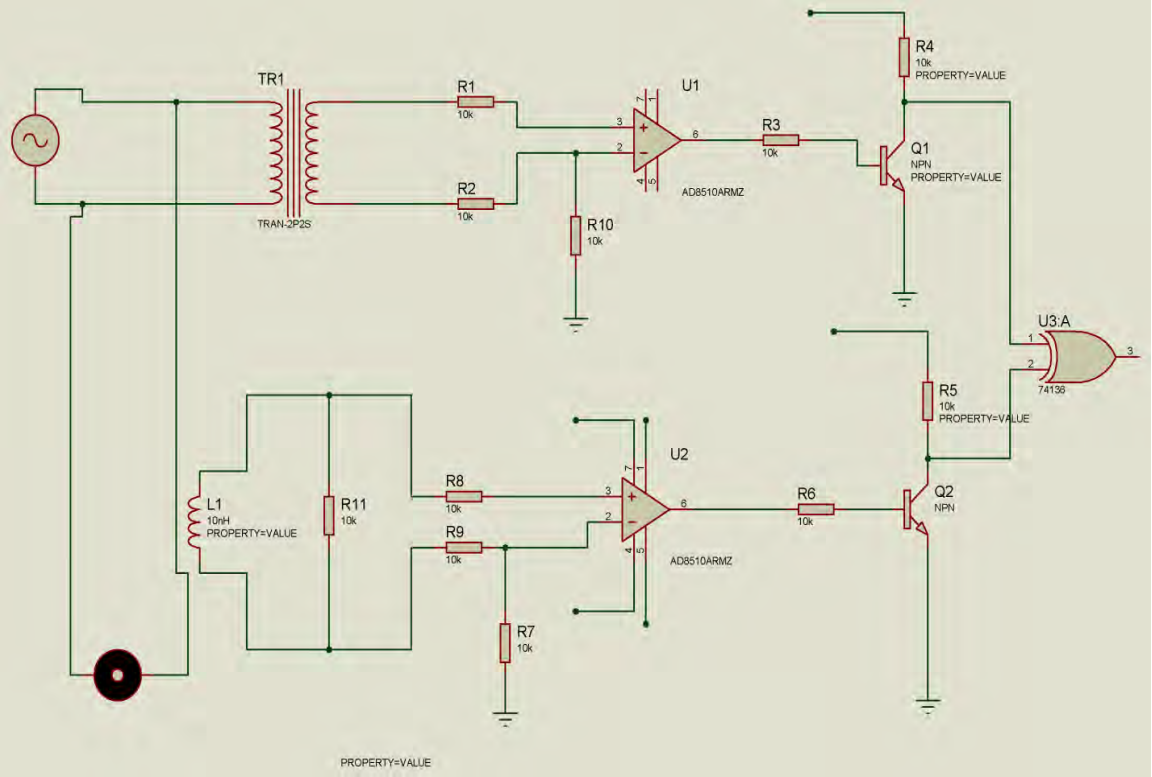

Figure 15: Power Factor Measurement

4.3.5 PIC 16F877A Microcontroller

The microcontroller used in the proposed system is PIC 16F877A. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin

count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques. Various microcontrollers offer different kinds of memories.

EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in PIC16F877 is flash technology, so that data is retained even when the power is switched off.

Easy programming and erasing are other features of PIC 16F877A.

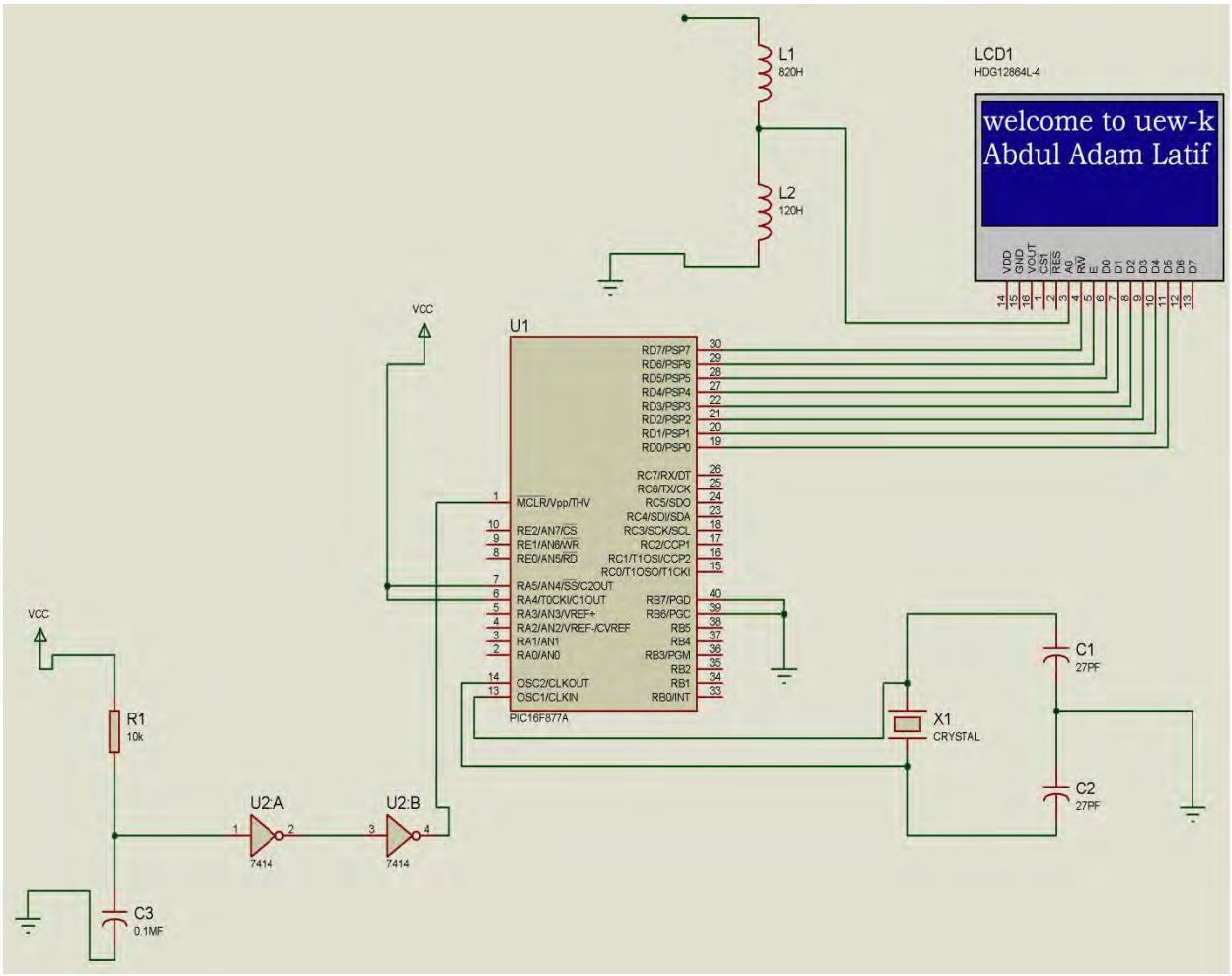

Figure 16: PIC 16F877A Microcontroller

4.3.6 Digital Energy Meter

The circuit shown in figure 12 is designed to measure the energy consumption through Digital energy meter.

The output from digital energy meter is given to the 4N35 opto coupler as IC input. The opto coupler acts as an isolation circuit. The 4N35 (short) consists of a gallium arsenide infrared emitting diode coupled with a silicon phototransistor in a dual in−line package. In that IC output will be always low. When input from energy meter comes, IC gives logic high as output. If this IC output is low means the output of BC547 is high, so the LED behind that operation is in off condition also the input given to controller also low. When the output of 4N37 is high means the output of BC547 is Low, so the LED behind that operation is in no condition also the input given to controller also high. Like this whenever the input comes from digital energy meter, the LED on board will glow, also the input to controller changes their logic from high to low. Otherwise the output of circuit remains high condition. The output logic is inverted through 74LS04 which is placed on the circuit at final point.

So the unit of consumption is measured through the changes in IC logic.

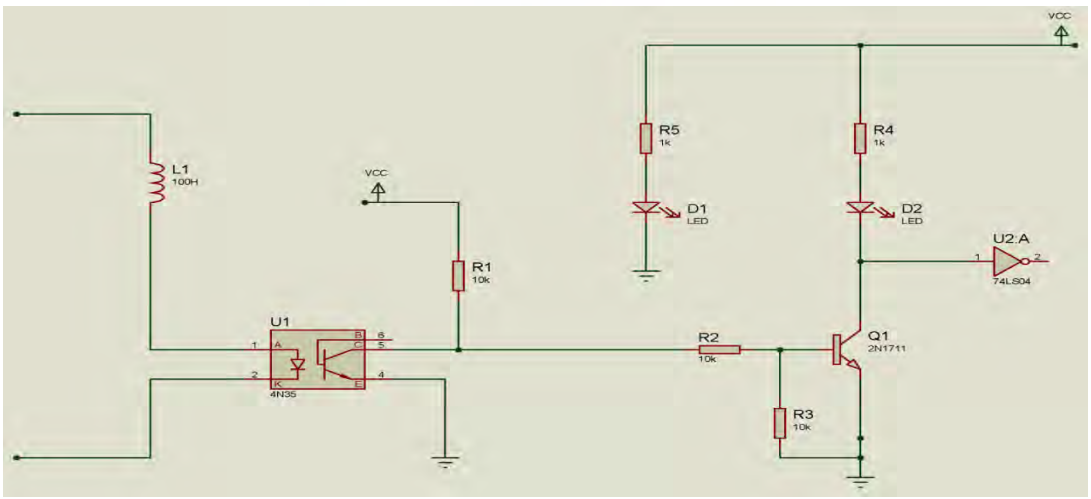

Figure 17: Digital Energy Meter

4.3.7 Relay Circuit

Relay is used to shutting off the electric power supply when the consumer has large outstanding dues. Whenever the consumer clears the outstanding dues the power supply is resumed by relay module. The circuit shown in figure 13 is designed to control the load. The load may be motor or any other load. The load is turned ON and OFF through relay.

The relay ON and OFF is controlled by the pair of switching transistors (BC 547). The relay is connected in the Q2 transistor collector terminal. A Relay is an electromagnetic switching device which consists of three pins. They are Common, Normally close (NC) and normally open (NO).

The relay common pin is connected to supply voltage. The normally open (NO) pin is connected to load. When high pulse signal is given to base of the Q1 transistor, the transistor starts conducting and shorts the collector and emitter terminal and zero signals is given to base of the Q2 transistor. So the relay is turned OFF state.

When low pulse is given to base of transistor Q1 transistor, the transistor is turned OFF. When 12V is given to the base of transistor Q2, it starts conducting and makes the relay ON. When the common and NO terminal of the relay are shorted, load gets the supply voltage through relay.

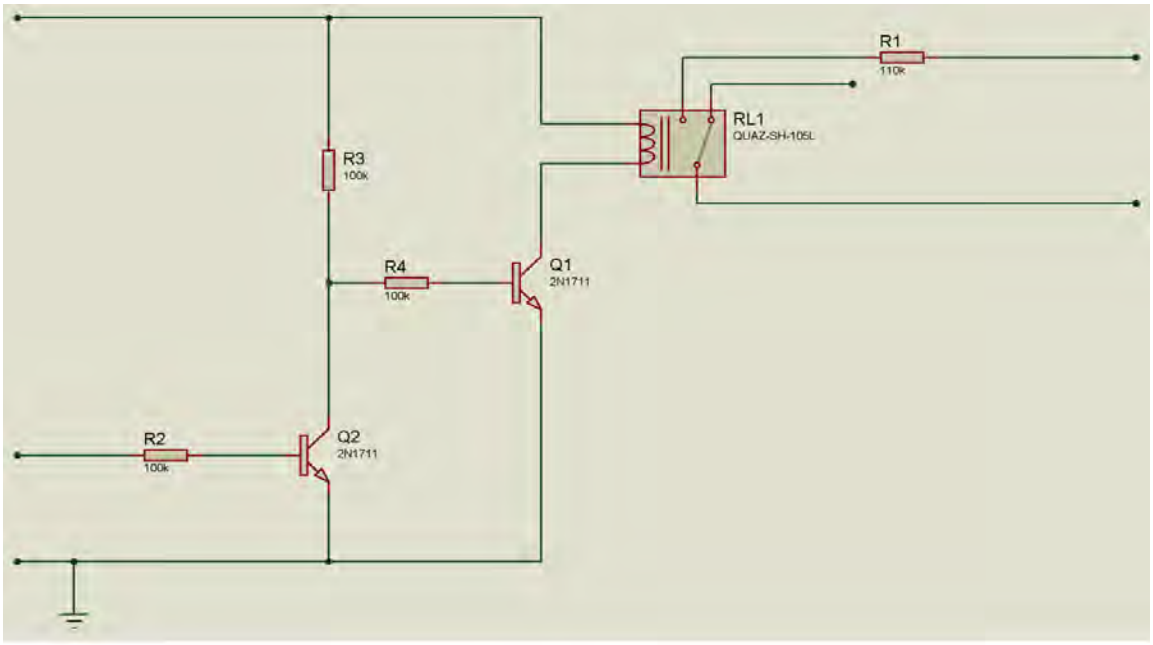

Figure 18: Relay circuit

4.3.8 LCD Display

Liquid Crystal Display is used to display the voltage, current, power factor, frequency and the number of units consumed by the consumer. Here we have used 20X4 alphanumeric LCD which has 250KHz clock frequency. The meaning for 20X4 is Number of columns is 20 and the number of rows is 4. The LCD display is interfaced with the PIC microcontroller to display all the details. The LCD's are light weight with a few mm thicknesses. Since the LCD consumes less power, they can be compatible with low power electronic circuits and can be powered for long duration.

4.3.9 Alarm Circuit

The circuit shown in figure 13 is designed to control the buzzer. The buzzer ON and OFF is controlled by the pair of switching transistors (BC 547). The buzzer is connected to the Q2 transistor collector terminal. When high pulse signal is given to base of the Q1 transistor, it starts conducting and closes the collector and emitter terminal where zero

signals is given to base of the Q2 transistor. Hence Q2 transistor and buzzer is turned OFF state. When low pulse is given to base of transistor Q1, the transistor is turned OFF. when 12v is given to base of Q2 transistor. The transistor conducts and at the same time buzzer is energized and produces the sound signal.

4.3.10 GSM Modem

To implement this system a GSM modem is connected to a microcontroller and to a personal computer which would transmit and receive data simultaneously. The specification of GSM modem is as follows: (i) Quad Band 850/900/1900 MHz (ii) Supply Voltage 3.4V to 4.5Volt (iii) low power consumption (iv) operating temperature -30C to 80C (v) class 4(2W @ 850/900 MHz).

4.3.11 EEPROM

Electrically Erasable Read Only Memory is a non-volatile memory. Selected EEPROM is Atmel24C256. This memory device is used to store the data for off line process which means it stores the amount of unit consumed by the consumer while transferring each SMS.

4.3.12 Real Time Clock

Real-time clock (RTC) counts seconds, minutes, hours, date of the month, month, day of the week, and year with leap-year compensation valid up to 2100. It is 56-byte, battery-backed, non-volatile (NV) RAM for data storage. The RTC selected here is DS1307 because of low cost and run continuously even in power failure.

4.3.13 Keypad

The numeric keypad is used to view and erase the data stored in the EEPROM. The keypad contains five keys which act as a switch for storing and clearing the data.

4.3.14 RS232 Communication

The circuit shown in figure 14 is the MAX 232 IC used as level logic converter. The MAX232 is a dual driver/receiver that includes a coactive voltage generator to supply EIA 232 voltage levels from a single 5v supply. Each receiver converts EIA-232 to 5v TTL/CMOS levels. Each driver converts TLL/CMOS input levels into EIA-232 levels. In this circuit the microcontroller transmitter pin is connected in the MAX232 T2IN pin which converts input 5v TTL/CMOS level to RS232 level. Then T2OUT pin is connected to receiver pin of 9 pin D type serial connector which is directly connected to PC. In PC the transmitting data is given to R2IN of MAX232 through transmitting pin of 9 pin D type connector which converts the RS232 level to 5v TTL/CMOS level. The R2OUT pin is connected to receiver pin of the microcontroller. Likewise the data is transmitted and received between the microcontroller and PC or other device and vice versa.

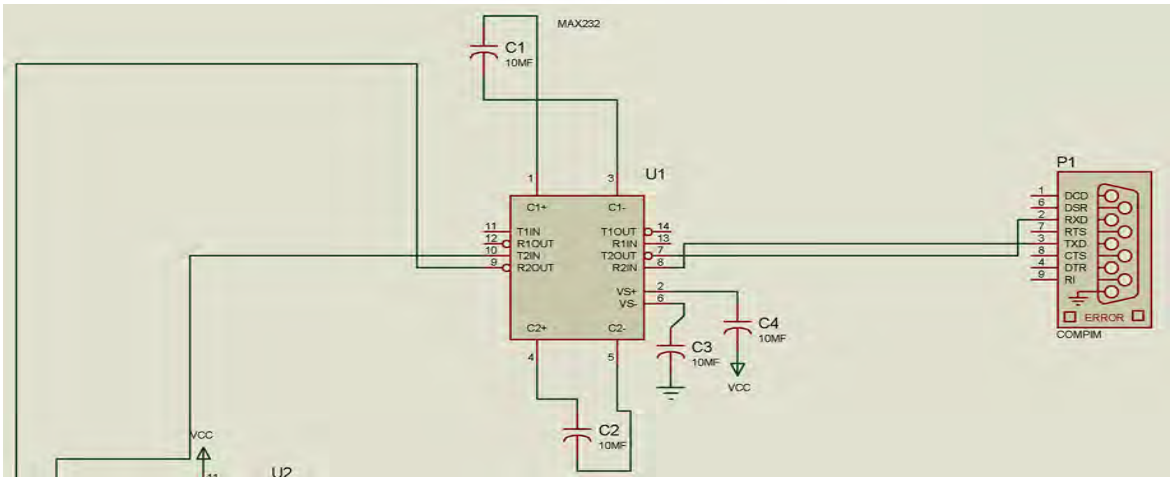

Figure 19: RS-MAX232 Communication

4.4 Simulation Results

The Simulation result of the proposed system is as follows:

Figure 15 shows the overall simulation diagram of the proposed system when the system is in the on mode. Here, the LCD displays the name of the energy provider, the location of the consumer, the meter number, the consumer's name and the consumer's SIM ID number.

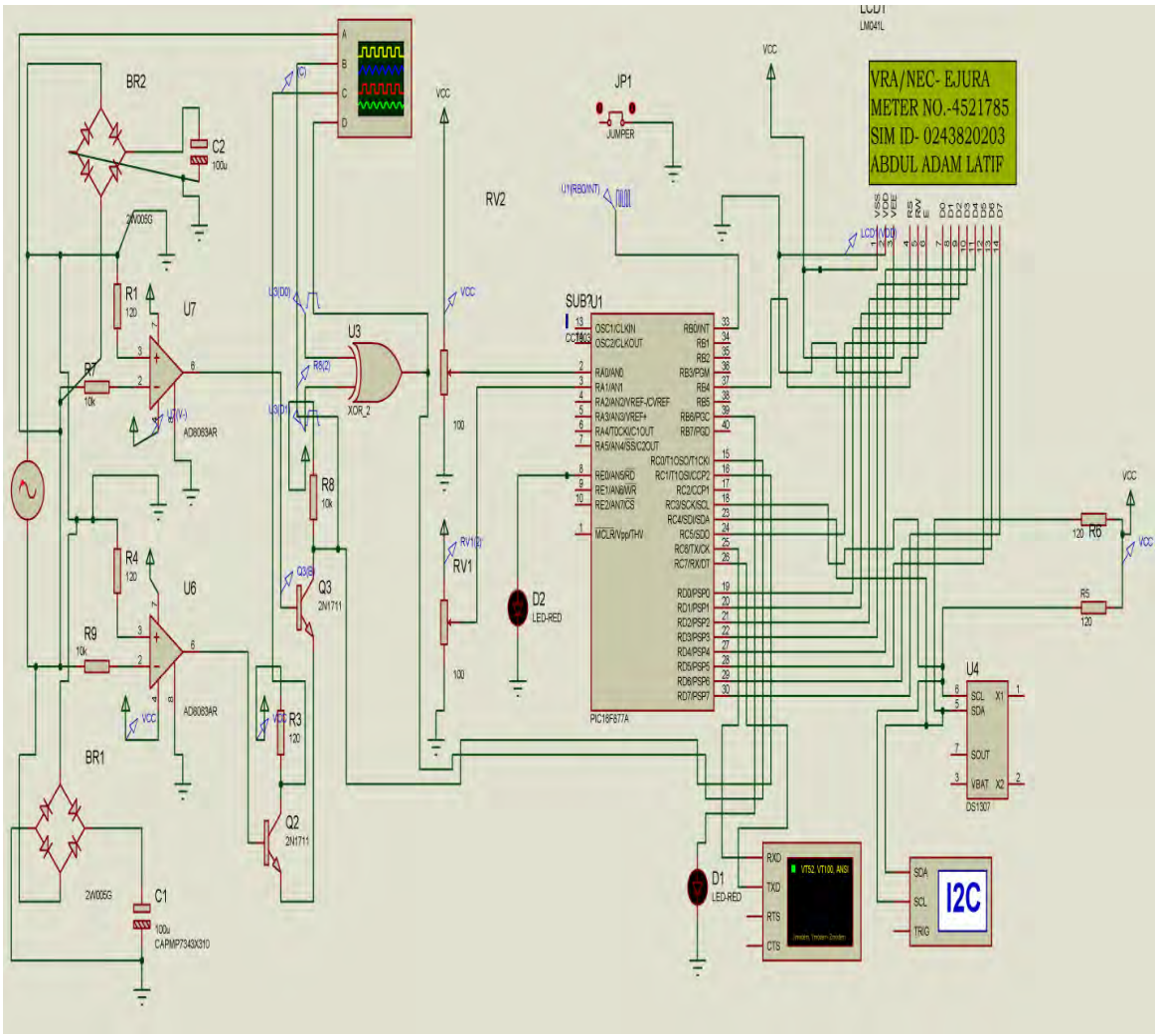

Figure 20: Simulation Diagram

Initial condition

Figure 16 shows the initial condition when the supply is given to consumer, the LCD displays the voltage, current, frequency, power factor and the unit consumption.

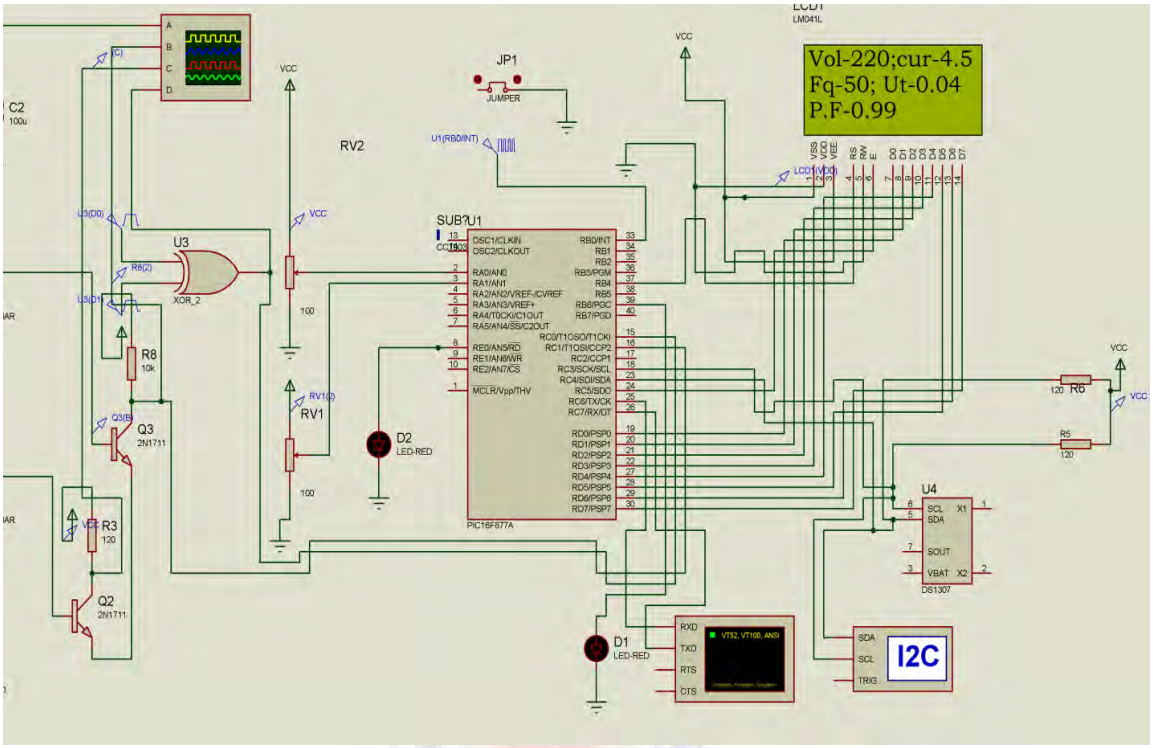

Figure 21: Initial Condition

Figure 17 shows the increase in energy consumed by the consumer as displayed by the LCD. Here the data is stored in the EEPROM.

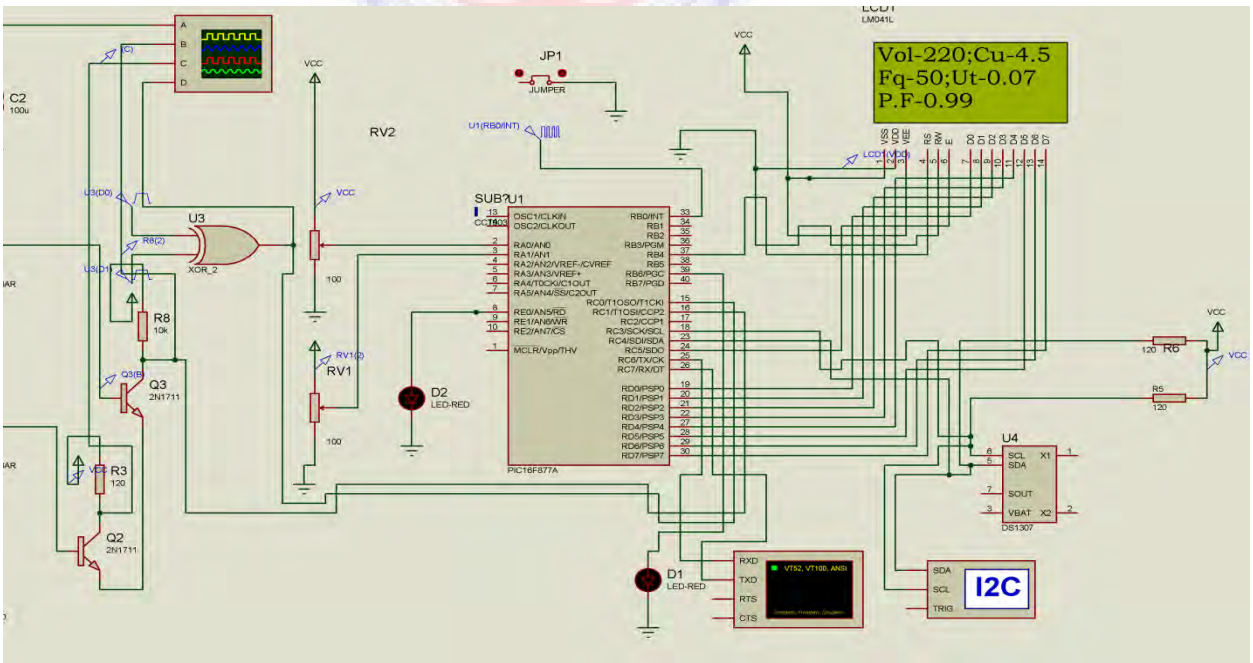

Figure 22: RTC and RAM Output

Figure 18 shows that the message is sent to the Electricity Board from the consumer to indicate the units consumed by the consumer and also to indicate that the supply voltage is in normal condition.

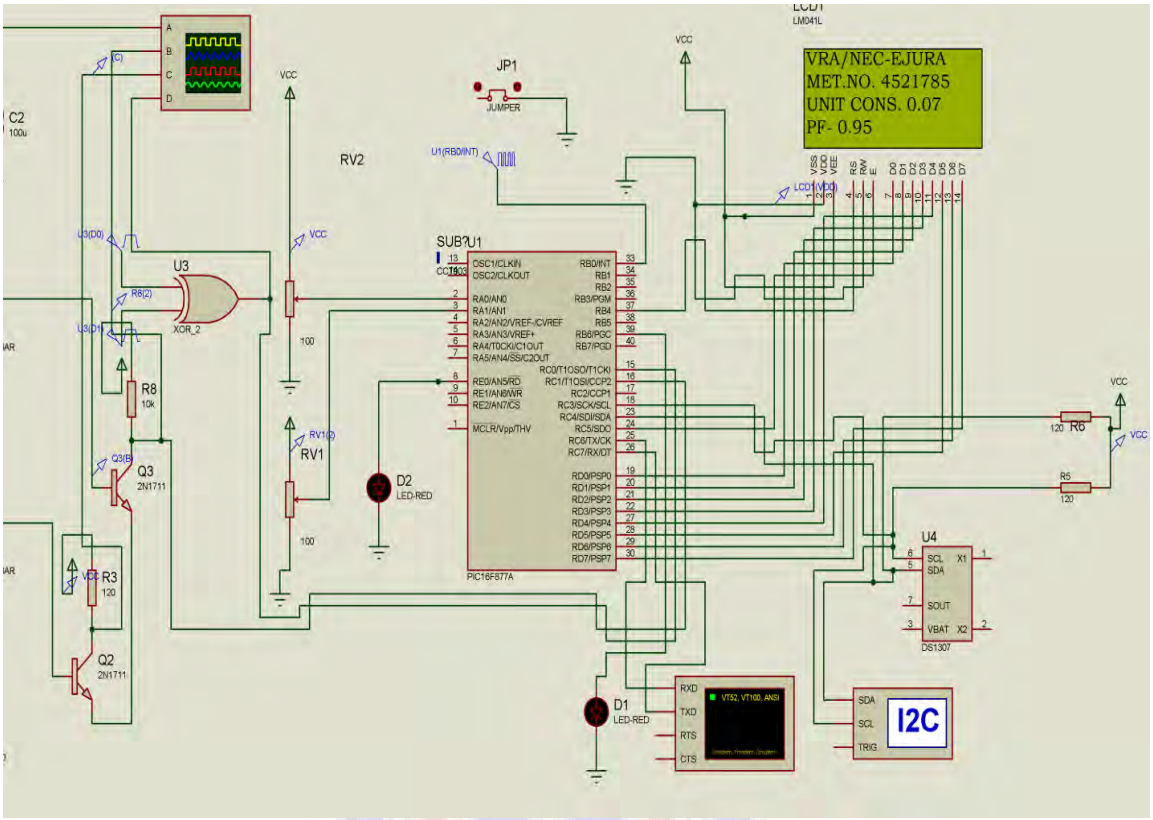

Figure 23: Normal Voltage Indication

Figure 19 shows that the Electricity Board Sends the unit consumed to the Consumer Using Short Service Message format. If the Consumer has large outstanding dues the Supply will disconnect using Relay(LED will glow OFF).

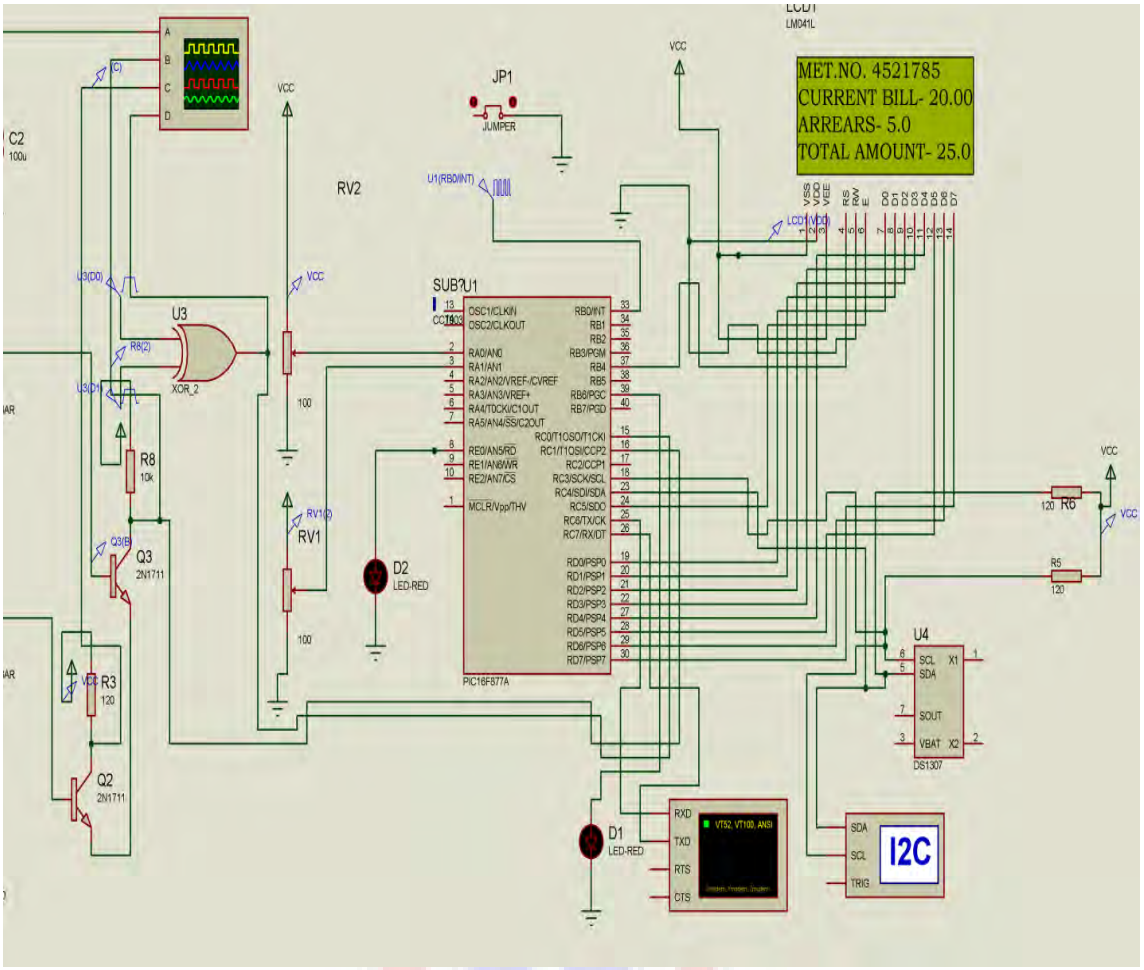

Figure 24: Unit Message

The circuit is designed such that when electricity supply low voltage to the consumer premises, an SMS is sent to the electricity board. Figure 20 shows that the message is sent to the Electricity Board from the consumer to indicate the supply voltage is in low condition.

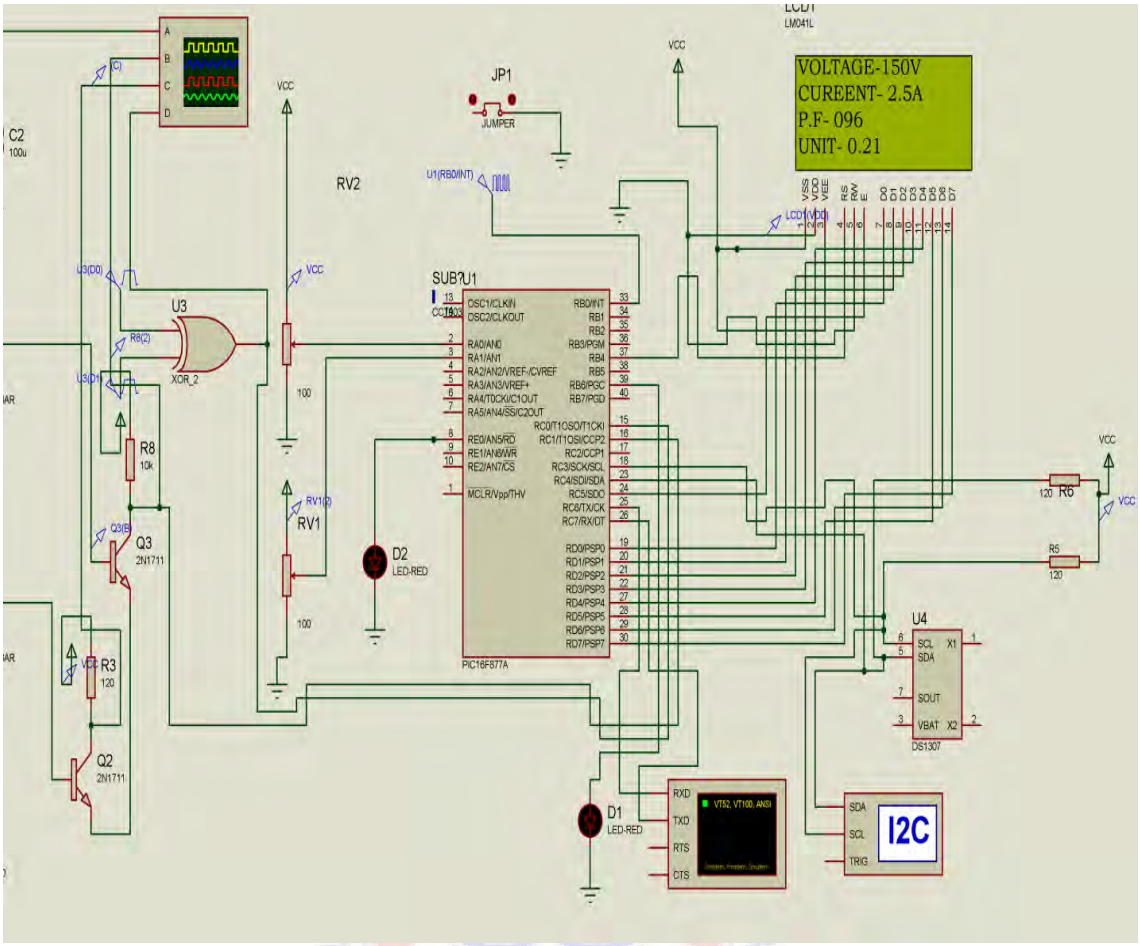

Figure 25: Low Voltage Indication

4.5 Discussions of Results

The proposed project is to design a simple low cost wireless GSM based energy meter and its associated web interface for managing the energy meter data. The system automatically reads the energy meter data and sends it to the service provider on reception of a specific message from service provider. The proposed system then provides an automatic disconnect of power supply if the bill is not paid (Out- Standing dues) and an automatic reconnect of power supply. The system also allows low voltage and power factor lagging message features to the Electricity board from consumer place automatically.

A Personal Computer with GSM receiver at the server end contains the database and act as the billing point or server. The live meter reading from the GSM enable the energy

meter to send back to the server and the details were updated in the central database as well as in the nonvolatile memory in the consumer end. The LCD display in the consumer side displayed the voltage, current, power factor, units consumed, total cost for the consumption with an alarm indication. The nonvolatile memory stores the date and time.

In this project the pulse and unit (meter reading) count continuously according to load connected. According to their demand of meter reading, the energy Provider Company sends an SMS to the energy meter. The Microcontroller received the SMS through GSM modem. The Microcontroller read the pulse and unit from EEPROM and send the same to authorized number.

Figure 6 shows the meter pulse and unit detail that is sending by AMR system to energy Provider Company. After proper reckoning, the energy Provider Company send a notification to customer by SMS. The customer then paid online through the net-banking or credit card.

Figure 8 shows another feature of this system that disconnected the power of the customer when failed to make payment of the previous month. In this case SMS was sent to the customer and the energy provider that “Power of Meter has been disconnected due to outstanding dues on Date: 14/08/16 Time: 11:28:56”. The bill was paid and the power was reconnected. All this cumbersome process is happening with the help of the relay.

Figure 9 shows total load used alert feature of this system. The Energy meter sends an SMS alert to the energy Provider Company indicating that the meter is using more energy than previous days. “Excess load use by METER ID 4521785Date: 23/08/16 Time 10:13:28”. The Energy provider also received the information of power load at that time.

4.6 Findings of Results

The development of GSM based energy meter demonstrates the concept and implementation of new power metering system. GSM based AMR have low infrastructure cost, low operating costs, more data security and less man power required. The proposed design of the GSM based energy meter does not only solve the problem of manual meter reading but also provide additional feature such as power disconnect, power connect, power cut alert and tempering alert. Customer can also pay bill via online login on authenticated web. Data base server can stored the current month data and also all previous month data for future use. So it saves a lot amount of time and energy.

Another important finding from the simulation result of this system was that it gave the information of tempering, when the meter was tempered, a signal was activated and the AMR sent an SMS to energy Provider Company that "Tempering occurs on Meter ID 4521785. Energy provider company connections will be cordoned off of this meter without visiting site.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Various electronic meters have been developed and are still being developed. However the use of GSM in this particular system provides numerous advantages over methods that have been previously used. The developed system is highly effective in the sense it is able to eliminate the draw backs of serial communication. The system also poses much less risk since human interaction has been minimized. This type of reading system is easy to install and beneficial for both energy provider and consumer. This system provide additional features such as power disconnect due to large outstanding dues, power reconnect, power cut alert, low voltage and power factor lagging alert. Any modification can be made to the code in less time. The changes in tariff or unit calculation can be done very effectively. The only drawback of this system is embedded system is purely dependent on the GSM module.

GSM based energy meter is easy to install and beneficial for both energy provider and the consumer. AMR does not only solve the problem of manual meter reading but also provide additional feature such as power disconnect due to outstanding dues, power reconnect after pay dues, power cut alert, tempering alert. AMR also gives the information of total load used in a house on request at any time. It sends a SMS alert to energy provider company whether a person using more than specify limit of load. The statistical load used and profile can help customer manage their energy consumption.

The system is secure and reliable because it can be accessed only by an authorized person. If any un-authorized person tries to access the system this system send an alert to energy provider and also give warning of that unauthorized person.

This device has the capability to revolutionize the energy meter market and will become help to country revenue by stopping the current theft and punishing the dishonest customers.

The use of different methodology in this Automatic meter reading system provides numerous advantages. GSM based AMR system is the most advantageous system than other as this system provides the consumer directly with the billing through SMS.This could make the process of meter reading quit easier. GSM infrastructure has full coverage of all houses in the country which makes the implementation of GSM power meter easier. Multiple transceivers used in automatic meter reading system incorporate no data loss. From all these proposed methodology it can be concluded that automatic meter reading system can be really proven as a boom for consumers and electricity board. The data collection and manipulation task becomes fast and easier. Any modification can be made to the code in less time. Changes in rate or unit calculation can be done very effectively.

5.2 Recommendation

The proposed system is only for single phase users. Our future scope is to make this system for three phase (Industrial and Domestic) users. Further we can concentrate on the bill payment through online or through mobile automatically using E-billing techniques. The proposed idea can be expanded to water and gas meter with desired modifications. Furthermore this can be extended towards smarter grid system.

REFERENCES

A., G., van Engelen & J., S., Collins. (2010). *Choices for Smart Grid Implementation*. Hawaii International Conference on System Sciences, 43rd Hawaii International Conference on System Sciences. pp. 1-8.

A.Vijayaraj*et al* "Automated E., B., (2010). *Billing system using Ad-Hoc wireless routing" published at International Journal of Engineering and Technology* Vol.2 (5), 343-347

Alez, G. (2012) *Electricity Meters: Units of Measurement, Electromechanical Meters*, In-Home Energy Use Displays, Smart Meters, and More. s.l.: Webster's Digital Services,

Daniel V., H., Albert P., & Mike P. (2007). *A Guide to Radio Frequency Identification*. UK: John Wiley & Sons LTD. p. 214.

Farhangi, H. (2010) *The path of the smart grid. Power and Energy Magazine*, IEEE. January-February 2010, Vol. 8, 1.

Ferreira H., C., et al. (2011). *Power Line Communications:* Theory and Applications for Narrowband and Broadband Communications over Power Lines. UK: John Wiley & Sons LTD,. p. 536 pages.

http://en.wikipedia.org/wiki/Electricity_meter. http://en.wikipedia.org. [Online] [Cited: July 23, 2011.]

http://www.theregister.co.uk/2007/10/05/zigbee_city/. http://www.theregister.co.uk. [Online] [Cited: June 21, 2010.]

I. H. Cavdar, (2004). "*Performance analysis of FSK power line communications systems over the time-varying channels:* Measurements and modeling," *IEEE Trans. Power Delivery*, vol. 19, pp. 111–117, Jan. 2004.

IrfanQuazi*etal* "Prepaid Energy meter based on AVR Microcontroller" published at International *Journal of Engineering Research and Applications* (IJERA) ISSN: 2248-9622, Vol.1, Issue 4,pp.1879-1884.

J., D., Glover, M., S., Sarma & T., Overbye. (2011). *Power System Analysis and Design*. 5. UK: Cengage Learning. p. 308.

J., F., Manwell, J., G., McGowan & A., L., (2009). *Rogers. Wind Energy Explained*: Theory, Design and Application. 2. West Sussex, UK: John Wiley & Sons LTD, p. 211.

J., Zhu & R., Pecen. (2008). *A Novel Automatic Utility Data Collection System issuing* IEEE 802.15.4- Compliant Wireless Mesh Networks. Nashville, Tennessee: IEEE. The 2008 IAJC-IJME International Conference, . pp. 17-19.

JörgEberspächer, Hans-JoergVögel & Christian Bettstetter, (2009). *Christian Hartmann. GSM - Architecture, Protocols and Services*. UK: John Wiley & Sons LTD p. 338.

K., A., Bakshi, A., V., Bakshi & U., A., Bakshi. (2007) *Electrical Measurements & Measuring Instruments.s.l.:* Technical Publications,.

Khedkar M., K., & Dhole. G., M., (2010). *Textbook of Electric Power Distribution Automation.s.l.* Laxmi Publications, Ltd,. p. 105.9380386214, 9789380386218.

Kwang-il H. (2009). *Fault-tolerant ZigBee-based Automatic Meter Reading Infrastructure.* Journal of Information Processing Systems, Vol.5, No.4, pp: 221-228.

L., Shang-Wen, et al. (2009). *Development of a smart power meter for AMI based on ZigBee communication.* Taipei: IEEE, 2-5 Nov. International Conference on Power Electronics and Drive Systems. pp. 661 - 665. 978-1-4244-4166-2.

M. Trejo-Perea"A real time energy monitoring platform user-friendly for buildings"

R., Kistler, S., Knauth & Klapporth, A. EnerBee (2008) *Example of an Advanced Metering Infrastructure based on ZigBee. Munich, Germany.* 2nd European ZigBee developers Conference, EuZDC 2008. pp. 1-11. June 24-25

Rodney H.G., Tan IEEE, C.H.Lee &V.H.Mok, (2007). *Automatic Power Meter Reading system using GSM Network.* The 8th International Power Engineering Conference, pp: 465-469.

S., Luan, et al. (2009). *Design and implementation of a smart power meter.*IEEE, International Conference on Power Electronics and Drive Systems. pp. 661 - 665. 2-5 Nov.

Sioshans, F. P., (2012). *Smart Grid: Integrating Renewable*, Distributed & Efficient Energy. USA: Academic Press, p. 568.

Sreenivasan. G., (2011). *Power theft. 2.* New Delhi: PHI Learning Pvt. Ltd.,. p. 67.

Tooley, M. *Design Engineering Manual*. 1. USA: Elsevier, 2009. p. 446.

Yunus M., Nayan1 B. & Primicanta A. H. (2009). *Hybrid System Automatic Meter Reading. International Conference on computer technology and Development*, (ICCTD -09), pp: 264-267.

Z., Long, X., Fang-Yuan & M., Ying-Nan. Qingdao (2010) *Impact of smart metering on energy efficiency.* : IEEE, 11-14 July 2010. International Conference on Machine Learning and Cybernetics (ICMLC),. pp. 3213

APPENDIX

Technical specification of GSM based energy meter

Parameter	Specification
Operating voltage	240v
Operating frequency	50Hz
Pulses	3200Imp/KWh
GSM modem	Tri band GSM modem(GSM900/1800 MHz) designed for data SMS
Power cut alert	This system provides power cut information.
Automatic reading feature	It can be remote monitoring and controlling anywhere in the world.
Auto disconnect feature	It provides remote shut-off facilities to customers that have large outstanding dues.
Auto reconnect feature	It can be reconnect the power supply after pay outstanding dues.
Total load calculation	This system gives information of total load used in particular house at any time to energy provider company through SMS.

Full secure	If any person trying to access the system then it sent an SMS alert to energy provider company for this.
Temper proof feature	Tempering unit used if tempering occurs and it sends SMS alert to the energy provider company.
Memory	Non-volatile based energy reading system.
Display system	LCD display system used for energy display, real time & date, instantaneous active load in kilowatt.