International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 04, April 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

SMART ENERGY METER READING SYSTEM USING GSM

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ABSTRACT

The demand for energy is increasing as a result of the growth in both population and industrial development. To improve the energy efficiency, consumers need to be more aware of their energy consumption. In recent years, utilities have started developing new electric energy meters which are known as smart meters. A smart meter is a digital energy meter that measures the consumption of electrical energy and provides other additional information as compared to the traditional energy meter. The aim is to provide the consumer and supplier an easy way to monitor the energy. Smart meters are considered a key component of the smart grid as these will allow more interactivity between the consumers and the provider. Smart meters will enable two-way and real-time communication between the consumers and the provider. Considering the increase of electricity demand in Saudi Arabia, smart meters can decrease the overall energy consumption. This paper presents the development of a GSM and ZigBee based smart meter. This meter can measure the energy and send the information to the service provider, who can store this information and notify the consumer through SMS messages or through the internet.

I INTRODUCTION

1.1 Overview

Smart meter is an advanced energy meter that measures the energy consumption of a consumer and provides added information to the utility by using a two-way communication scheme. Consumers are better informed in their consumption of their energy, so they can make better decisions when they are using the energy. Suppliers on the other hand won't need the old fashioned way of manually reading the energy consumed as they would get this information automatically.

The system that utilizes one-way communications to collect the data is referred to as automated meter reading system. While the system that utilizes two-way communications with the ability to control and monitor the meters is referred to as advanced metering infrastructure system. The combination of automatic reading and two-way communication are the reason why the meter is called smart and they are also the difference between the traditional energy meter and the smart meter.

The idea of Smart Meter Reading System (SMRS) is to do the meter reading automatically and accurate. The benefit of (SMRS) is reducing the meter cost to the supplier and billing the customers with actual meter readings. In addition,

ISSN (O) 2454-9665
ISSN (P) 2454-0663

SMRS will increase the accuracy of the readings and it can allow frequent reading .smart meters are able to send the readings over communication lines and recognize their addresses and to activate/deactivate internal modules. To have that capability, SMRS requires a specific infrastructure which would make it bidirectional. Such an infrastructure is called SMRS.

The communication medium in an SMRS must ensure the communication between the smart meters and the central computer at the service provider. The communication structure can be wired like Power Line Communication (PLC) or wireless like Global System Mobile (GSM). The chosen way must take into account the distances between the devices and the existing infrastructure .GSM is a digital mobile telephony system that digitizes and compresses data before sending it. The main advantage of the GSM is its widespread use throughout the world and the use of subscriber identity module (SIM) cards to send short message service (SMS) messages.

1.2 Brief Description

The conventional metering system requires the supplier company to send personnel who manually read and record the energy consumption, so billing can be done accordingly. The manual reading system suffers from a wide variety of disadvantages, which tenders it inefficient. It requires a large number of meter readers to collect reading from all consumers, hence the frequency of meter reading acquirement is low, that is, usually once a month. Moreover, with human involvement, it is prone to human errors as well as tampering of records.

This leads to non-transparency in the metering system. To devise an efficient metering system, the concept of Automatic Meter Reading (AMR) and Energy Profiling System originated, which provide an effective means of energy consumption information collection, and its analysis, for accurate billing. A plethora of technologies can be utilized for the implementation of such a system, each having its own pros and cons. Radio frequency based EPS can make use of Handheld, Mobile, and Fixed network. In handheld and touch based EPS, a handheld computer equipped with a transceiver is used (radio frequency or touch) to collect readings, but it does not make optimum use of the AMR capable meters, as meter reading personnel are required.

Mobile or Drive-by meter reading is another approach where a reading device is installed in a vehicle. Due to the short range of mobility, it again requires a team for collection of meter readings. AMR can also be implemented by making use of Power Line Communication (PLC) [3-4], but it has an inherent disadvantage of interference and noise, which deems it unreliable. Wi-Fi, ZigBee and 3G technologies [5-6] have also been used for transmission of metering information, but have not being widespread as they require installation of facility/ access points to cover the designated areas and thus do not provide a cost effective solution in existing environments. Our indigenously developed GSM transmission module induce transparency in the current meter reading system, by facilitating low cost real time monitoring of consumer energy consumption.

Automation would lead to an efficient energy metering system by removing human errors. Our system also allows the energy supplier company to remotely control the consumer energy meter. A major feature is the inclusion of a user consumption profiling system, accessible to users and the energy supply company. By incorporating control coupled with profiling, the project aims at creating some degree of awareness among users, encouraging them towards

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ISSN (P) 2454-0663

conservation of energy. An additional feature explored is the traffic profiling using Global Positioning System (GPS) to indicating the location of consumers which is extremely beneficial if used in collaboration with sensor circuits to indicate meter theft. Most of these features were not available with system developed in

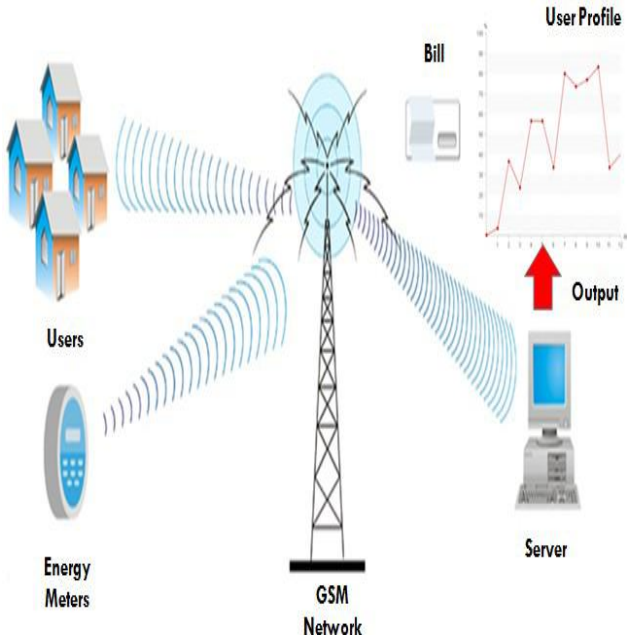

Fig:1.2.1 GSM Profiling Energy System

1.3. Problem Definition

The demand for energy is increasing as a result of the growth in both population and industrial development. To improve the energy efficiency, consumers need to be more aware of their energy consumption. In recent years, utilities have started developing new electric energy meters which are known as smart meters. The Smart meter is a system which sends information about consumption of energy. A smart meter is a digital energy meter that measures the consumption of electrical energy and provides other additional information as compared to the traditional energy meter. The aim is to provide the consumer and supplier an easy way to monitor the energy. Smart meters are able to send the readings over communication lines and recognize their addresses and to activate/deactivate internal modules. It will help to the servers' side admin to monitor and controlled the system without visiting to the client side. The main problem of collecting the clients

Meter readings and generating the bills is gets solved by collecting the bills with help of GSM Module so that system can easily generate the bill and inform to the client by sending the message.

1.4 Applying Software Approach

We are Design our Website in Advanced java technology for that we used incremental Model for the processing. Because with the help of incremental model all the phases of software design Life cycle can implement in incremental way and all the queries or problems can easily get sort out.

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In incremental coding model communication, planning, modeling, and deployment phases of software design life cycle can process by depending in each other so it will helps in designing a small scale of operations or applications.

II LITERATURE SURVEY

Several studies approached the problem of designing a smart energy meter. Numerous amount of research focused on using GSM based meters. In GSM energy meter was developed and a database that provides the information to the costumer. The paper in designed a power meter based on GSM network, with the main communication way is GPRS and SMS as secondary. the meters are equipped with Zigbee that sends the data to a data collector device which uses GSM to communicate with the central computer. In addition, the paper in developed a Zigbee based smart meter that collects the data and acquire outage event data. Furthermore, research on other communication technologies for designing smart meters have been done like PLC in and Wi-Fi in. In our work, a complete system from smart meter to data management system is developed in addition to a mobile application and a website. The smart meter is a GSM-Zigbee based developed using Adriano microcontroller. The data is provided to the user through the website, SMS and mobile application

III SOFTWARE REQUIREMENT SPECIFICATION

3.1 Introduction

3.1.1 Intended Audience and Reading Suggestion

We design our system for the Electricity Billing Office that is (MSEB) billing office So all the employees or members of the MSEB office can handled the system of at Server side all the operations of automatically controlling and managing the data of the client done At Server side.

The admin of the system need to do the registration of the client and their meter description with their meter reading count as well as meters status. At the client side basically we proving one managing admin and another one is controlling Admin (Sub-Admin). This sub-admin helps in collecting the bills of the customer with online banking and check the details of the customers that is if they pay the bills in given date or not Then sub-admin can have a facility to cut their electricity connection without going to the place of client.When client pay the bill through online banking then system will send the confirmation letter of successfully bill paid by the user or customer so our system is helpful to both the client and server side users.

3.1.2 Project Scope

Consumers are better informed in their consumption of their energy, so they can make better decisions when they are using the energy. Suppliers on the other hand won't need the old fashioned way of manually reading the energy consumed as they would get this information automatically. The combination of automatic reading and two-way

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communication are the reason why the meter is called smart and they are also the difference between the traditional energy meter and the smart meter.

3.1.3 Assumptions and Dependencies

The user is expected to have Android Mobile phones and should be able to send and receive data when connected to wifi range. First the user has to register to wifi network to use the service. Network gives the functionality to login and registration facility. The registered user uses this network to send and receive messages when connected to wifi network.

IV IMPORTANT MODULE IN HARDWARE

4.1. 8051 Microcontroller

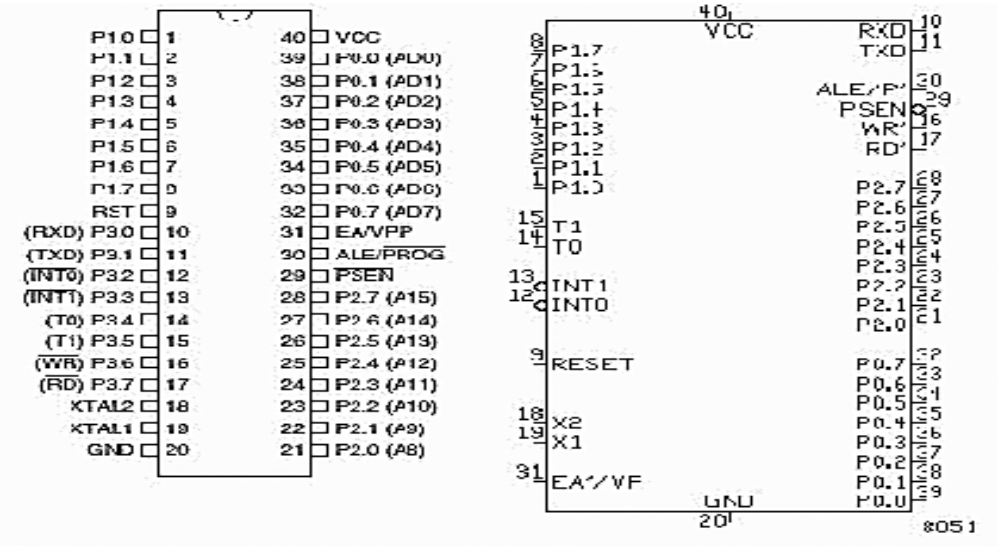

Fig. 4.1 Pin diagram of 89C51

The AT8051 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT8051 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications

Features

- Compatible with MCS-51™ Products
- 4K Bytes of In-System Reprogrammable Flash Memory
- Fully Static Operation: 0 Hz to 24 MHz

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- Three-level Program Memory Lock
- 128 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Two 16-bit Timer/Counters
- Six Interrupt Sources
- Programmable Serial Channel.
- Low-power Idle and Power-down Modes

PinOut

- Power - Vcc, Vss
- Crystal - XTAL[1,2]
- External device interfacing
- EA, ALE, PSEN, WR, RD
- I/O Port
- P0[7;0], P1[7:0], P2[7:0], P3
- P3 is shared with control lines
- Serial I/O RxD, TxD,
- external interrupts INT0, INT1
- Counter control T0, T1
- P0 and P2 are multiplexed with Address and Data bus

4.2 Oscillator Circuit

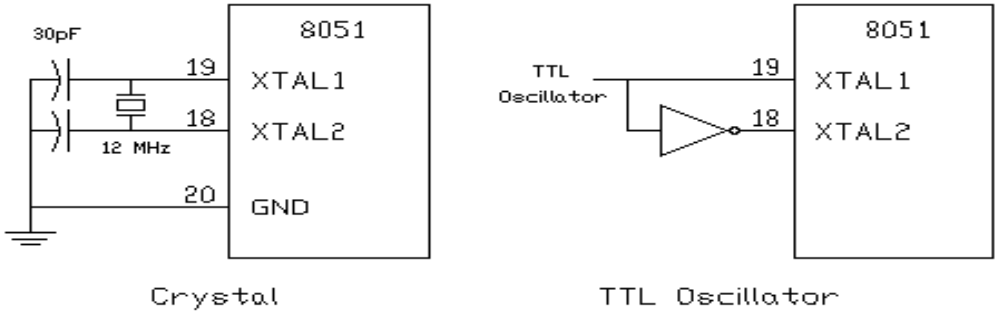

Fig4.2 .Diagram of crystal oscillator

The 8051 uses the crystal for precisely that: to synchronize its operation. Effectively, the 8051 operates using what are called "machine cycles." A single machine cycle is the minimum amount of time in which a single 8051 instruction can be executed. 8051 has an on-chip oscillator. It needs an external crystal that's decides the operating frequency of the 8051. This can be achieved in two ways; the crystal is connected to pins 18 and 19 with stabilizing capacitors. 12

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 04, April 2017
www.ijirse.com
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ISSN (P) 2454-0663

MHz crystal is often used and the capacitance ranges from 20pF to 40pF. The oscillator can also be a TTL clock source connected with a NOT gate as shown above.

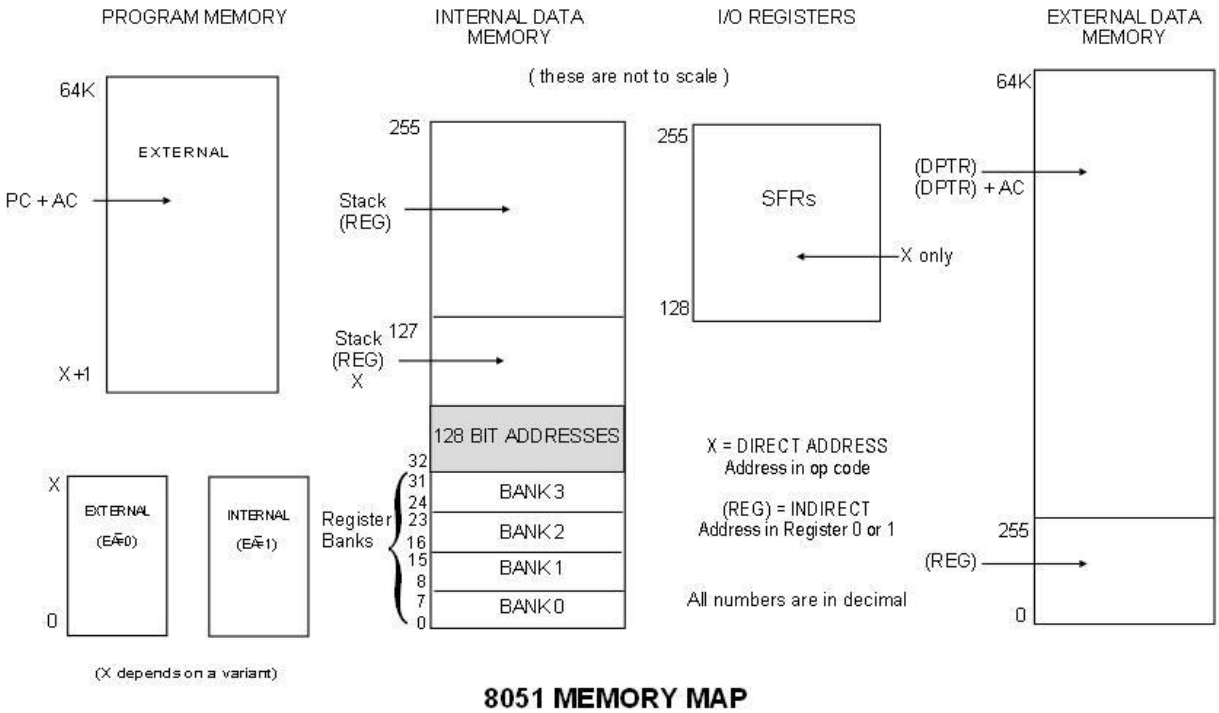
4.3. Memory and I/O

The 8051 family can address bytes in separate 64Kbyte code (read only) and 64Kbyte data (read/write) spaces, these may be internal to the chip or external or a combination of the two. If it is to be used off-chip memory is accessed via up to 20 pins. Up to 8 address high pins and then always 8 pins that are used for both the 8 address low signals during the address setup phase and for the 8 data signals during the data transfer phase. 4 pins are used for control.

4.4. Internal Memory

The original 8031/8051 chip provides 128 bytes of on-chip R/W memory; the 8052 has increased this to 256 bytes. Four banks of eight 8 bit Registers 16 Bytes (128 bits) for which individual bits may be set, tested and cleared with a single instruction Variable space - especially if no off-chip RAM is included in the design A stack which grows upwards and whose size is limited to the lesser of the remaining internal memory or 256.

I/O ports and peripherals will appear as one or more registers in the 128 Special Function Register (SFR) space. Single instructions can read write registers or set/clear/test single bits in all the standard 8051 chips I/O registers.



8051 MEMORY MAP

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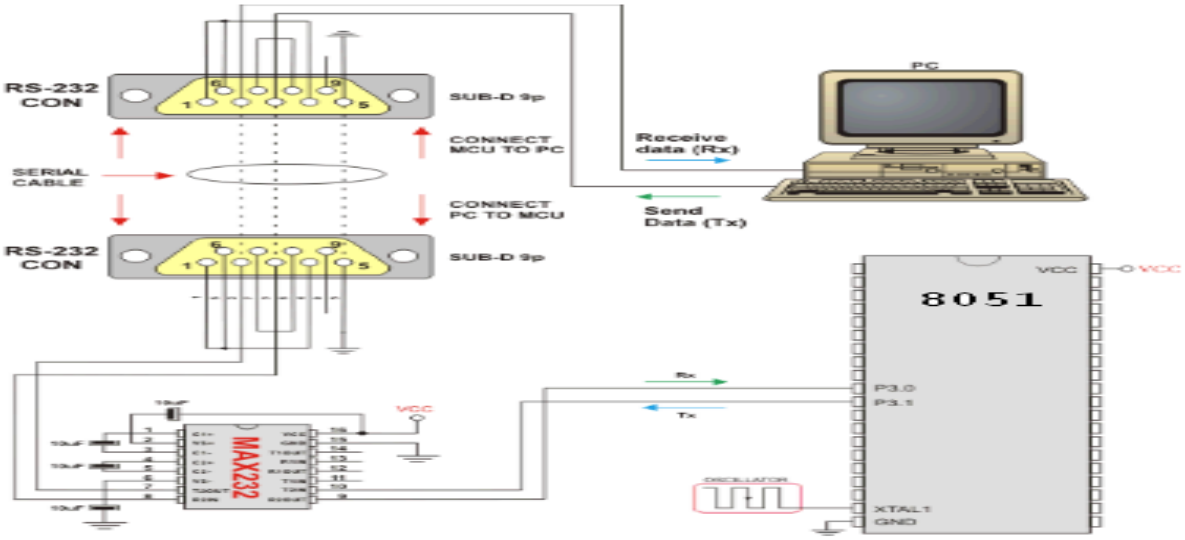

Fig8.4 8051 Microcontroller

V RS232 BIT STREAMS

The RS232 standard describes a communication method where information is sent bit by bit on a physical channel. The information must be broken up in data words. The length of a data word is variable. On PC's a length between 5 and 8 bits can be selected. This length is the netto information length of each word. For proper transfer additional bits are added for synchronisation and error checking purposes. It is important, that the transmitter and receiver use the same number of bits. Otherwise, the data word may be misinterpreted, or not recognized at all.

With synchronous communication, a clock or trigger signal must be present which indicates the beginning of each transfer. The absence of a clock signal makes an asynchronous communication channel cheaper to operate. Less lines are necessary in the cable. A disadvantage is, that the receiver can start at the wrong moment receiving the information. Resynchronization is then needed which costs time. All data received in the resynchronization period is lost. Another disadvantage is that extra bits are needed in the data stream to indicate the start and end of useful information. These extra bits take up bandwidth.

RS232 Physical Properties

The RS232 standard describes a communication method capable of communicating in different environments. This has had its impact on the maximum allowable voltages etc. on the pins. In the original definition, the technical possibilities of that time were taken into account. The maximum baud rate defined for example is 20 kbps. With current devices like the 16550A UART, maximum speeds of 1.5 Mbps are allowed.

a). Voltages

This might be a bit confusing, because in normal circumstances, high logical values are defined by high voltages also. The voltage limits are shown below.

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RS232 voltage values		
Level	Transmitter capable (V)	Receiver capable (V)
Space state (0)	+5 ... +15	+3 ... +25
Mark state (1)	-5 ... -15	-3 ... -25
Undefined	-	-3 ... +3

The maximum voltage swing the computer can generate on its port can have influence on the maximum cable length and communication speed that is allowed. Also, if the voltage difference is small, data distortion will occur sooner. For example, my Toshiba laptop mark's voltage is -9.3 V, compared to -11.5 V on my desktop computer.

b). Maximum Cable Lengths

Cable length is one of the most discussed items in RS232 world. The standard has a clear answer, the maximum cable length is 50 feet, or the cable length equal to a capacitance of 2500 pF. The latter rule is often forgotten. If for example UTP CAT-5 cable is used with a typical capacitance of 17 pF/ft, the maximum allowed cable length is 147 feet.

RS232 cable length according to Texas Instruments	
Baud rate	Maximum cable length (ft)
19200	50
9600	500
4800	1000

c). Error Detection

It is the frame detection mechanism which is used to test if the incoming bits were properly surrounded by a start and stop bit pair. For further error checking, a parity bit can be used. The use of this bit is however not mandatory. If the existence of wrong bits is rare () or if a higher level protocol is used for error detection and correction (Z-modem, RAS, etc) communication speed can be increased by not using the parity feature present on the UART.

d). Even parity

Basically, the parity bit can be calculated in two ways. When even parity is used, the number of information bits sent will always contain an even number of logical 1's. If the number of high data bits is odd, a high value parity bit is added, otherwise a low bit will be used.

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e). Odd parity

The odd parity system is quite similar to the even parity system, but in this situation, the number of high bits will always be odd.

5.1 Disadvantages of the parity system

The parity system using one bit for each data word is not capable of finding all errors. Only errors which cause an odd number of bits to flip will be detected. The second problem is, that there is no way to know which bit is false. If necessary, a higher level protocol is necessary to inform the sender that this information must be resent. Therefore, on noisy lines, often other detection systems are used to assure that the sent information is received correctly. These systems mostly do not operate on single data words, but on groups of words.

VI GSM MODEM

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves.

Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in order to operate. As mentioned in earlier sections of this SMS tutorial, computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. You can use a GSM modem just like a dial-up modem. In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, you can do things like:

- Reading, writing and deleting SMS messages.
- Sending SMS messages.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.
- Power Supply for 8051 Microcontroller

The power supply section is the important one. It should deliver constant output regulated power supply for successful working of the project. A 0-12V/500 mA transformer is used for this purpose. The primary of this transformer is connected in to main supply through on/off switch& fuse for protecting from overload and short circuit protection. The secondary is connected to the diodes to convert 12V AC to 12V DC voltage. And filtered by the capacitors ,Which is further regulated to +5v, by using IC 7805.

International Journal of Innovative Research in Science and Engineering
Vol. No.3, Issue 04, April 2017
www.ijirse.com
ISSN (O) 2454-9665
ISSN (P) 2454-0663

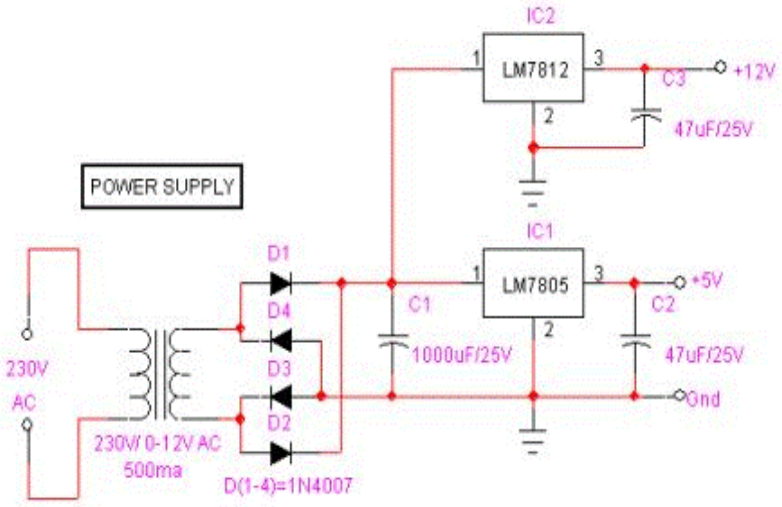

Fig. 6.1 Power supply for 8051 microcontroller

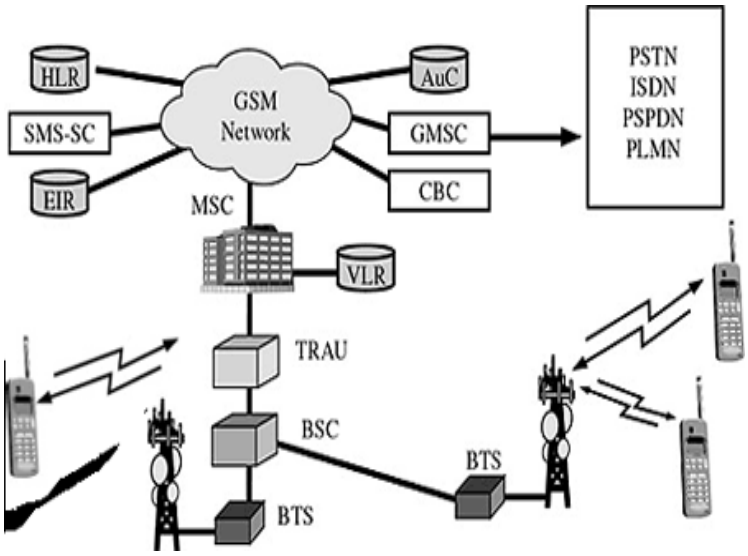

Fig6.2 GSM Network

GSM, SMS and AT Commands

The added components of the GSM architecture include the functions of the databases and messaging systems:

- Home Location Register (HLR)
- Visitor Location Register (VLR)
- Equipment Identity Register (EIR)
- Authentication Center (AuC)
- SMS Serving Center (SMS SC)
- Gateway MSC (GMSC)

ISSN (O) 2454-9665
ISSN (P) 2454-0663

- Chargeback Center (CBC)
- Transcoder and Adaptation Unit (TRAU)

The MS and the BSS communicate across the Um interface, also known as the air interface or radio link. The BSS communicates with the Network Service Switching center across the A interface. SMS was designed to deliver short bursts of data such as numerical pages. To avoid overloading the system with more than the standard forward-and-response operation, the inventors of SMS agreed on a 160-character maximum message size.

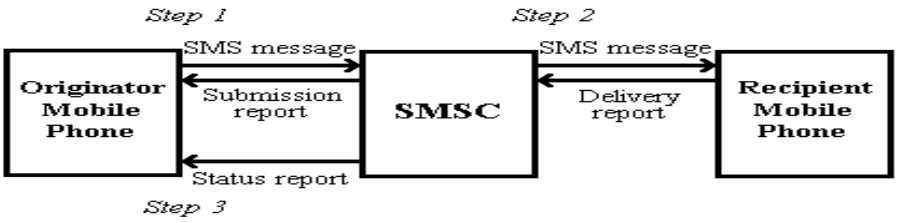

Fig. 6.3 Sending and Receiving Messege

Here are some of the tasks that can be done using AT commands with a GSM/GPRS modem or mobile phone:

- Get basic information about the mobile phone or GSM/GPRS modem. For example, name of manufacturer (AT+CGMI), model number (AT+CGMM), IMEI number (International Mobile Equipment Identity) (AT+CGSN) and software version (AT+CGMR).
- Get basic information about the subscriber. For example, MSISDN (AT+CNUM) and IMSI number (International Mobile Subscriber Identity) (AT+CIMI).
- Get the current status of the mobile phone or GSM/GPRS modem. For example, mobile phone activity status (AT+CPAS), mobile network registration status (AT+CREG), radio signal strength (AT+CSQ), battery charge level and battery charging status (AT+CBC).
- Establish a data connection or voice connection to a remote modem (ATD, ATA, etc).
- Send and receive fax (ATD, ATA, AT+F*).
- Send (AT+CMGS, AT+CMSS), read (AT+CMGR, AT+CMGL), write (AT+CMGW) or delete (AT+CMGD) SMS messages and obtain notifications of newly received SMS messages (AT+CNMI).
- Control the presentation of result codes / error messages of AT commands. For example, you can control whether to enable certain error messages (AT+CMEE) and whether error messages should be displayed in numeric format or verbose format (AT+CMEE=1 or AT+CMEE=2).
- Get or change the configurations of the mobile phone or GSM/GPRS modem. For example, change the GSM network (AT+COPS), bearer service type (AT+CBST), radio link protocol parameters (AT+CRLP), SMS center address (AT+CSCA) and storage of SMS messages (AT+CPMS).
- Save and restore configurations of the mobile phone or GSM/GPRS modem. For example, save (AT+CSAS) and restore (AT+CRES) settings related to SMS messaging such as the SMS center address.

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www.ijirse.com
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VII RESULTS

Snap Shots of the Results

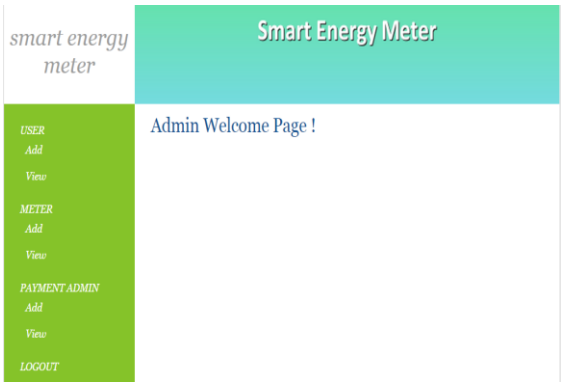

Fig.7.1 Admin login page

Fig.7.2 Registration of new user, meter and payment admin.

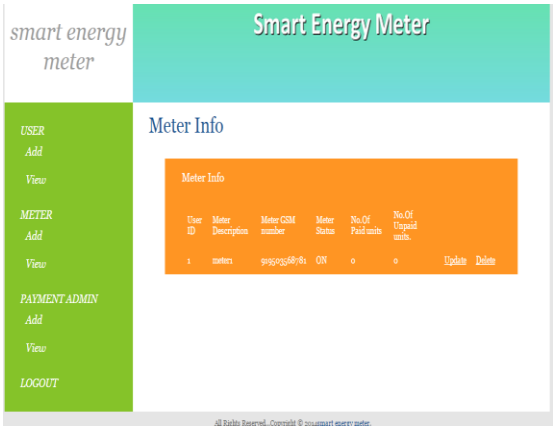

Fig.7.3 Showing the Meter information

Fig.7.4 Information about readings and meter status

Fig.7.5 Showing the meter status

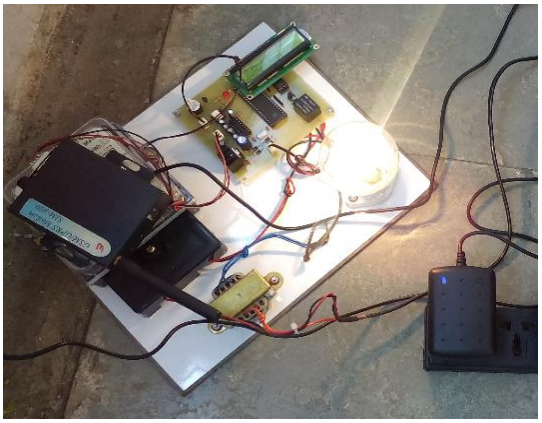

Fig.7.6 showing the result with the help of bulb.

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ISSN (P) 2454-0663

VIII CONCLUSION

The aim was to design and develop a device that monitors the energy consumed and then sends the data by a wireless transmission system. The data is collected by a data management system which can provide the energy usage information to the user in through the internet. The GSM protocols were used for wireless communication. The device works online so all the data are received in real time. In our project GSM module is used by the receiver to test this technology and provide the ability to communicate with in house equipments and other smart meters. These GSM features will be further exploited in future work. Other future work will consider the use of a different way for reading the energy. Also, future work will include building new prototypes and testing the device in real scenarios such as installing it in a house.

This device enables consumers to easily monitor and track their energy usage. Nowadays, people are checking their energy usage by manually reading their electricity meters, which is inefficient and provides very little information. There is a growing concern over the amount of energy consumed and the awareness of the community. By using this device, consumers will be able to use the internet or the smart phone application to monitor and economize their energy consumption. With more information people have about their energy usage, they will be able to reduce their energy consumption and therefore save both energy and money.

IX FUTURE SCOPE

- we can developed the android application for the smart meter reading system.
- we also provide the instant another banking applications to the clients.

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