

Energy Management Automatic Vigilant Strandless Metering System Employed with GSM

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Abstract

The energy meter technology used presently in India is not highly reliable and requires substantial labour and time to read calculate and distribute bills. The need to digitize the existing analogue meter and the increasing demand for smart energy compatible meter necessitated. In this paper, design and fabrication of a low-cost multifunction smart energy meter, is proposed for domestic electricity consumers. The proposed design of smart energy meter has been first implemented in software environment and then a prototype model has been developed, which communicates the consumed energy data through GSM network. In addition to this, time of use (TOU) metering, data logging and the Demand Side Management (DSM) during peak hour's techniques are utilized in proposed design which will help utility consumer to make electricity metering system more efficient. The meter tampering detection feature is also added to handle power theft challenges. The design methodology is presented with other details in the body of this paper.

Keywords - DSM, GSM, TOU.

INTRODUCTION

In recent year, smart grid is evolved to enhance the sustainability of energy consumption. This technology uses computer to improve the function of the power system. The smart grid is associated with ensuring the availability of high quality energy and meeting out the increasing demand of electricity [1]. It allows the consumer to play a more active role in managing their energy consumption. A technology used to achieve this smart grid is the Home Energy Management system [2]. Home Energy Management System is a combination of both hardware and software which are integrated to monitor energy consumption and it gives feedback to the consumer. It helps in controlling home appliances and devices. It allows the consumer in managing the consumption of energy more effectively [5]. Thus HEMS provides monitoring, controlling and managing the house environment in fulfillment of user's lifestyle. The Hybrid Automated Meter Reading (HAMR) system it

is a combination of ZigBee and GSM technology. In this system ZigBee module is attached to the electric meter by using interface board and the data collector will be connected to the central computer by using GSM [4]. The wireless automatic water-meter reading system found on ZigBee technology. The wireless automated water-meter reading system presented here uses ZigBee networking to avoid difficulties and problems inherent to other meter reading techniques in all above models either single parameter is used for developing AMR i.e electricity and water or give general idea about designing of AMR. Designed model gives detailed design of AMR which will measure electricity and water for each house and will forward recorded data to central station and will also send SMS to user using GSM communication, regarding due dates and bills [6].

According to Automated Meter Reading (AMR) technology, Electrical Utilities (EUs) have been exploiting their own infrastructure to bill their consumers in an efficient and economical way [7]. 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[9][10]. 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 [11][12]. 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. ARM system and several related works are available. Many metering systems have been proposed, based on GPRS, Bluetooth, GSM are explained as explained [13][14]. Design of an Electric energy meter for long- distance data information transfers which based upon GPRS is proposed. This system can't be implemented so easily because regular use of GPRS is still a dream to the common people. A GSM energy meter with instant billing facility is introduced, but still the problem of missing SMS will degrade the accuracy and performance [15].

A more reliable and user friendly system with web portal with multiple access using the advanced visual studio dot net frame work is created in this work which will manage the data efficiently even if there is a loss of SMS. It makes the design different from the previous proposals. The GSM/GPRS is a very useful means of communication as sending data as SMS turns out to be a very handy tool, due to its good area coverage capability and cost effectiveness. Different state electricity boards in INDIA started using GSM facility for fault management and so there is increased demand for this method.

I. PROBLEM IDENTIFICATION

In existing system, the energy meters are installed in consumer’s premises. The energy consumed in residential areas is collected by the meter readers twice a month. The collected data is used for the calculation of electricity bill by the human operator manually. The meter readers may make mistake in reading the consumed unit, which account to false billing. The consumers are blind on high consumption of electricity which allows them to spend more money on the billing. Due to increase in residential area large number of meter readers is hired by utilities, which come up with more labour cost. In some cases, meters are installed inside the home so that the meter readers are facing difficulties in electricity reading and billing. Meter reading and billing are interrupted during bad weather. The consumer is not at home the utility will consider the average bill amount of the previous months for the current month consumption. These results in burden for consumer by sending a bill from large amount based on their history of electricity consumption.

II. PROPOSED WORK

The aim of the proposed system is to help consumers in monitoring and intimating the energy consumption and gives monthly information about the number of units consumed along with its cost through Short Message Service (SMS). This proposed work uses PIC16F877A microcontroller, which digitized and process the energy value taken from the energy meter. Then the processed data is serially interfaced with SIM900A Global System for Mobile Communication (GSM) module using MAX232 IC. This Global System for Mobile Communication (GSM) channel is used to communicate with both consumers and utility by sending Short Message Services (SMS).

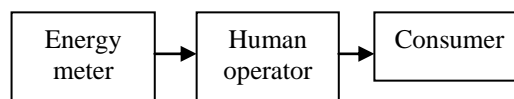
III. METHODOLOGY

A. Design and Implementation

An energy meter is required for this project. The circuit is designed in order to intimate the consumer on high energy consumption and notify

both the consumers and utility periodically about the amount of energy consumed and rate of energy. The circuit includes PIC microcontroller and GSM. The connections of the circuit are connected as shown in the diagram.

Module 1



Module 2

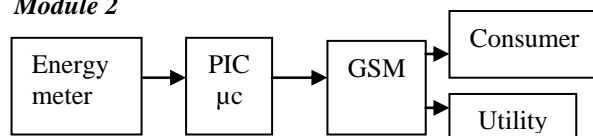


Fig 1 shows the module diagram for the proposed system.

The Whole system has various components such as energy meter, PIC microcontroller, GSM module, buzzer, MAX 232, current transformer, and supply board.

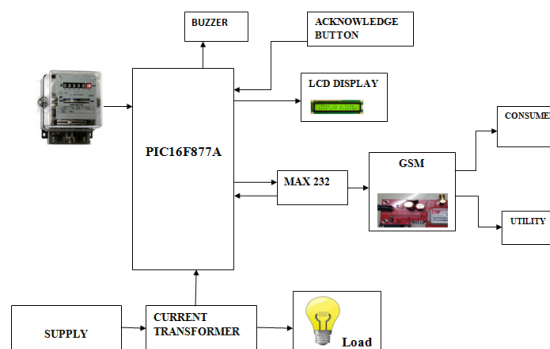


Fig 1.1 shows the block diagram for proposed system.

IV. HARDWARE TOOLS

A. Global System for Mobile Communication

GSM SIM900A is a excessively firm and reliable wireless module. It is a complete dual-band global system for mobile communication or general package radio services solution in surface mount technology module which can be embedded in the consumer application. The SIM900A works on frequencies 900-1800MHz. The modem is coming with RS232 interface, which allows connecting TC as well as microcontroller with RS232 chip (MAX232).The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS modem is having internal TCT/IT stack enables to connect with internet via GPRS. It is suitable for

SMS, Voice as well as data transfer application in M2M interface.

The modem is manufactured with automatic pick and place machine with high quality standard. This modem used for making audio calls, SMS, read SMS, attend the incoming call and internet etc through simple AT commands. It allows benefit from small dimension and cost effective solutions.

Table 1: Shows the description for GSM

Modem interface	RS232 Serial interface
Power requirement	4.5 to 12V
Current requirement	<590mA
Operating temperature	-40°C to +85°C
Weight	40g



Fig 2 shows GSM module

B. PIC16F877A

The controller used in this project is PIC16F877A. It used to give command signal to buzzer, LCD and processed signals to GSM via MAX232. This PIC microcontroller has 40 pin dual-inline packages. It is a 8-bit microcontroller .It has on chip data memory (RAM) and on chip program memory (ROM). This controller is supported by RISC architecture. It uses only 35 instructions. It has processor, memory and peripheral devices. It can execute the instructions within 200 nanoseconds. The PIC microcontroller features 256 bytes of EEPROM, data memory, self programming, 2 comparators, and 8 channels of Analog to Digital converter (ADC), 2 capture/compare/PWM functions. The synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI) or 2-wire Inter Integrated Circuit (I²C) bus and a Universal Asynchronous Reciever Transmitter (USART). The PIC microcontroller operates at high speed with low cost, occupies less space, more compact and reliable.



Fig 2.1 shows PIC microcontroller

C. Max 232

It is an interfacing device used to interface PIC microcontroller to the GSM modem and to transmit the data which have been collected by the PIC microcontroller from energy meter. The data from the energy meter is transmitted to the GSM through PIC microcontroller to intimate both consumers and utility. To interface PIC microcontroller with GSM using MAX232, we need three basic signals namely RXD (receive), TXD (transmit), GND (ground).

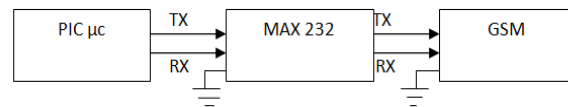


Fig 2.1 shows the interfacing of Max232 with PIC microcontroller

D. Interfacing PIC microcontroller with GSM and LCD:

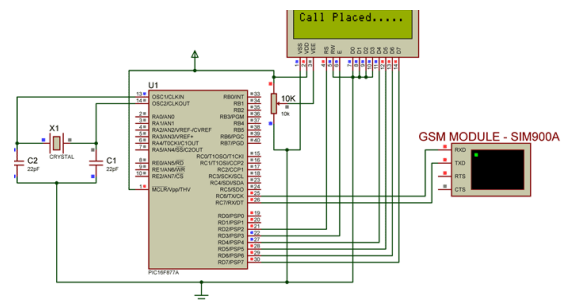


Fig 2.2 shows the interfacing of PIC microcontroller with GSM and LCD

In GSM module TX and RX pins are interfaced with RX and TX pins of PIC microcontroller unit for serial communication and status of the GSM module is displayed in the LCD.

E. Interfacing LCD with PIC microcontroller:

The PIC microcontroller unit and the LCD are interfaced with the data bus (DB0 – DB7) and they shares data and command through the same bus.

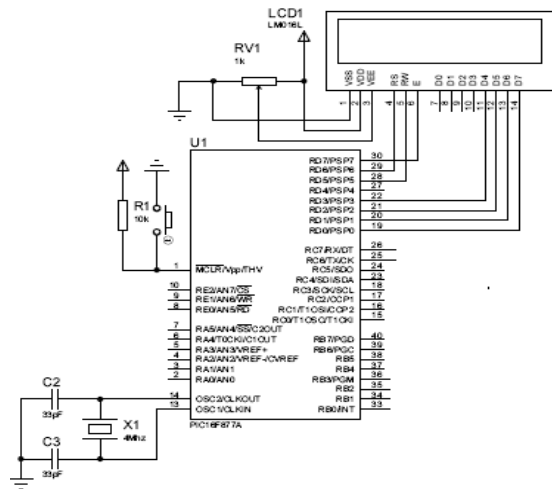


Fig 2.3 shows the circuit diagram for interfacing LCD with PIC microcontroller

F. Source code

The interfacing of LCD with PIC microcontroller is easy, which displays a text in LCD from microcontroller.

G. LCD display

The LCD used in this project is HD1234 alphanumeric type. 7 to 14 pins are used as data pins, 11 to 14 pins are connected to port D of PIC microcontroller, 3 control bits RS-PD.19, RW-PD.20 and EN-PD.21. LCD is powered from 5V power supply.

Table 2: Pin configuration

Pin	Signal	Description
Pin 1	GND	Ground
Pin 2	V _{CC}	Supply voltage +5V
Pin 3	V _O	Contrast adjustment
Pin 4	RS	0-control input 1-data input
Pin 5	R/W	Read/Write
Pin 6	E	Enable
Pin 7-14	Do to D7	Data
Pin 15	VB1	Backlight +5V
Pin 16	VB0	Backlight ground

V. SOFTWARE TOOLS

A. MPLAB Software

In this system to interface MAX 232 and PIC microcontroller MPLAB is used. The MPLAB has enormous features and merits that help to successfully develop an embedded application. It is user friendly in achieving the goals. MPLAB IDE is a 32-bit single unified graphical user interface. MPLAB IDE makes use of ICE tools which are offered by microchip in debugging. The In circuit Emulators is MPLAB ICE2000, MPLAB ICE4000 and REAL ICE.

VI. CIRCUIT DIAGRAM

The operation of power supply circuit is built using transformer, rectifier, capacitor (filter), regulator and resistor. The AC supply is given to the step down transformer and it is rectified by the diode. The rectified AC is given to the bridge rectifier. The DC voltage is appeared across the output terminals of the bridge rectifier. Filter circuit is used to short the ripple with frequency of 120Hz to ground and to leave the frequency of DC to appear at the output. The voltage regulator aids the rectifier and filter circuit in providing a constant DC voltage to the device.

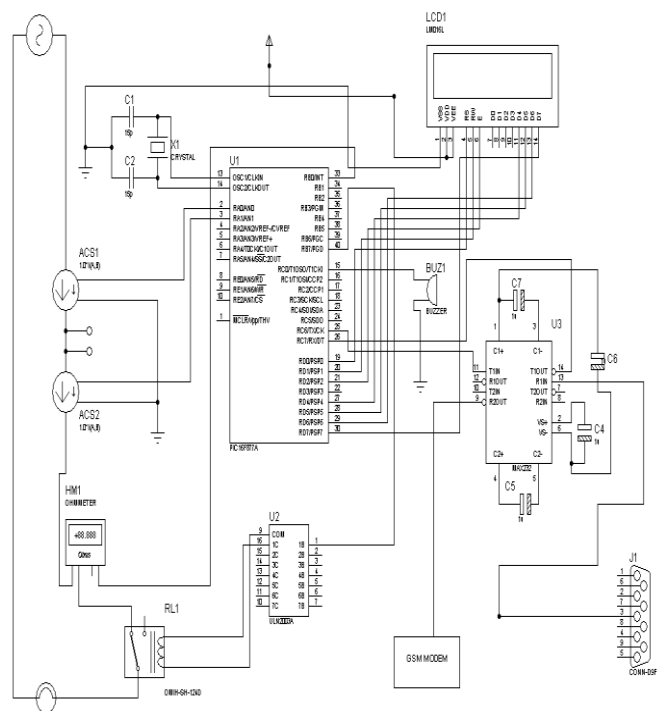


Fig 3 shows the overall circuit diagram

VII. EXPERIMENTAL RESULTS

Energy meter has a blinking LCD to count the pulses and are fed to the microcontroller. The energy values taken from the energy meter are digitized, processed and stored in an external memory of the microcontroller. If the meter receives a reading request then it sends the current status along with the energy consumption and price to the user through SMS by using GSM modem and to stores the data in the database. The corresponding energy value is determined and fixed. If the energy consumption level exceeds the fixed value then the user is notified by the buzzer. Consumer can take care of the electrical energy consumption in their premises. The bill severity, due to minor changes slab categories can be greatly reduced.

Table 3: comparison of different loads conditions

No	Different Loads	Unit Constrain limit	Utilized unit	Notification
1	Domestic [x]	$101 \leq x \leq 200$	x=75	No SMS alert
			x>100	SMS alert
2	Commercial [y]	$201 \leq y \leq 500$	y = 175	No SMS alert
			y > 200	SMS alert
3	Industrial [z]	z > 501	z = 400	No SMS alert
			z > 500	SMS alert

In the above table, the units utilized by the domestic consumer is x=75 which does not exceed the limit 100, so the user is not notified with SMS alert. For commercial consumer the unit utilized is y=201 which is greater than the limit 200, then the user is notified with SMS alert. The industrial consumer z utilizes 400 units which does not exceed the limit 500, so the user is not notified with SMS alert.



Fig 4 shows the SMS notification sent by the Strand less Energy Meter

VIII. CONCLUSION AND FUTURE WORK

This research paper express in detail about the design and development of strand less energy metering system. It precisely measures the real time energy consumption and transmits it to the utility consumer. It performs an important role in saving energy during the off peak hours. The application of

Time Of Use (TOU) metering will grant the service company to implement the multiple tariffs. In extension to this SMS alert provide utility consumer. We end this by saying if consumer didn't pay the bill within stimulated period then the power will be automatically cut down or by storing the (Energy consumption and amount) data and handling the data through cloud that is full automation without man power.

REFERENCES

- [1] Md.Wasi-ur- Rahman, Mohammad Tanvir Rahman, TareqHasan Khan and S.M. LutfulKabir “Design of an Intelligent SMS Based Remote Metering System” Proceedings of the IEEE International Conference on Information and Automation 2009, pp: 1040- 1043.
- [2] H.G.Rodney, Tan IEEE, C.H.Lee and V.H.Mok, IEEE “Automatic Power meter Reading system using GSM Network” Proceeding of the 8th international Power Engineering Conference (IPEC- 07) 2007, pp: 465- 469.
- [3] Dr.MohdYunusBNayanI,AryoHandokoPrimicanta “Hybrid System Automatic Meter Reading” Proceeding of the International Conference on computer technology and Development,(ICCTD - 09),2009.pp:264- 267.
- [4] Tanvir Ahmed, Md Suzan Miah, Md. Manirul Islam and Md.RakibUddin “Automatic Electric Meter Reading System: A CostFeasible Alternative Approach In Meter Reading For Bangladesh Perspective Using Low- Cost Digital Wattmeter And Wimax Technology” Proceeding of the International Journal of Engineering and Technology Volume 8 Issue 3 2011,pp: 800- 807.
- [5] Bharath P, Ananth N, Vijetha S, JyothiPrakash K. V. “Wireless Automated Digital Energy Meter” Proceeding of ICSET 2008 IEEE International Conference on Sustainable Energy Technologies, 2008, pp: 564- 567.
- [6] Vinu V Das “Wireless Communication System for Energy Meter Reading” Proceeding of International Conference on Advances in Recent Technologies in Communication and Computing 2009, pp: 896- 898.
- [7] Syed Shahbaz Ali, MadihaMaroof, SidrahHanif “Smart Energy Meters For Energy Conservation &Minimizing Errors” Proceeding of Joint International Conference on Power Electronics, Drives and Energy Systems (PEDES) & Power India, 2010 pp: 1- 7.
- [8] Liting Cao JingwenTianYanxia Liu “Remote Real Time Automatic Meter Reading System Based on Wireless Sensor Networks”,Proceeding of 3rd International Conference on Innovative Computing Information and Control, 2008 (ICICIC - 08), pp: 591 - 591.
- [9] SubhashisMaitra “Embedded Energy Meter- A New Concept To Measure The Energy Consumed By A Consumer And To Pay The Bill” Proceeding of Joint International Conference on Power system Technology and IEEE Power India Conference 2008 pp: 1- 8.
- [10] YujunBao and Xiaoyan Jiang, “Design of electric Energy Meter for long-distance data information transfers which based upon GPRS”, ISA International Workshop on Intelligent Systems and Applications, 2009.
- [11] Bharat Kulkarni “GSM Based Automatic Meter Reading System Using ARM Controller “International Journal of Emerging Technology and Advanced Engineering Website, Volume 2, Issue 5, May 2012
- [12] Vivek Kumar Sehgal, NiteshPanda, NipunRaiHanda, “Electronic Energy Meter with instant billing”,UKSim Fourth European Modelling Symposium on Computer Modelling and Simulation.
- [13] Bharath P, Ananth N, Vijetha S, JyothiPrakash K. V. ,“Wireless automated digital Energy Meter”, ICSET 2008.
- [14] P.K. Lee and L.L. Lai, Fieec, “A practical approach to wireless GPRS on-line power quality monitoring system”, Power Engineering Society General Meeting, 2007.
- [15] SubhashisMaitra, “Embedded Energy Meter- A new concept to measure the energy consumed by a consumer and to pay the bill”, Power System Technology and IEEE Power India Conference, 2008.