

Automatic meter reading and energy data extraction of Multifunction transducer using GSM

Jambay Dorji¹, TandinBidha², Tashi Yangki³, SrijanaGajmer⁴, Karma Kelzang Euden⁵

Department of Electronics and Communication Engineering, College of Science and Technology.

* E-mail: ¹ece2011002@cst.edu.bt, ²ece2011024@cst.edu.bt, ³2011027@cst.edu.bt, ⁴2010105@cst.edu.bt, ⁵karmakelzang.cst@rub.edu.bt

Abstract

This paper presents on two systems: the automation of energy meter reading based on GSM and on the data extraction from multi-function transducer (MFT). A model based on the automated energy meter reading system for billing purpose, using a multi-function transducer is designed. For the automation of energy meter reading system, the energy consumption of consumer's utility is read by energy meter and calculates the cost of the consumed energy and the data is send to GSM which transfers the message to the consumers via SMS. For the data extraction from MFT, the data is being extracted from the MFT and then the energy and the cost is calculated and displayed on the LCD. MFT is a device that can read up to 48 different electrical parameters from 30-32 electrical devices that are identified with a specific device address. On a practical field, the different energy meters from a location can be connected to a single MFT unit also consisting of a GSM transmission section. This system cuts down the cost of installing individual GSM units in every house hold and requires a single MFT to read the data from some 30 devices. The PIC which is the core of this project identifies the various devices connected to the MFT and sends a master-slave command to the MFT which follows Modbus protocol, for serial communication initialization. After identifying the register which holds the Energy data units, the MFT sends it to PIC16F877A where the cost of the energy consumption is calculated. The PIC then sends the information to the LCD display and EEPROM for backup data storage.

Key words: GSM, Energy meter, Multi-function Transducer (MFT), PIC.

1. INTRODUCTION

Automation of technologies has eased the service utility of the consumers and also enabled them in saving time and resources. Automatic meter reading system is the remote collection of consumption data from customer's utility and is used for collecting, reading and billing purposes. Automatic meter reading system is an advent in the existing technology which is tedious and inefficient many times.

This project incorporates the automation of energy measuring devices and collection of data from energy meter and its wireless transmission using GSM technology for disseminating the information to the user and also for monitoring the power for the electricity department. The energy measuring device used if Multi-function transducer which commonly follows MODBUS protocol.

The types of technologies being used are:

1. Meter reading and data acquisition works on serial communication between a PIC and the peripheral device. The PIC acts as a master to initiate the serial communication and the peripheral here is MFT which becomes the slave to execute instructions from the master. Master_send instruction through the MAX485 connected to MFT, asks the peripheral for data from it which is located in various registers identified by a specific location code. The master receive instruction extracts the data from the peripheral and stores it in the PIC which undergoes further program instructions. The slave works on the instructions from master and the PIC is initiated as master most of the times for the ease of programming.

2. Global system for Mobile communication also called GSM in short. The GSM technology is easily available and widespread in Bhutan. There are no problems for the deployment and

application of the GSM facilities in the country. GSM network can offer more coverage and is efficient, meaning it can also be effective in rural areas. This approach of measuring energy that uses GSM technology/network is more relevant in transferring the energy data. In this project, the data from the multi-function transducer is collected, calculated and transmitted to the Energy supply department and users with the help of GSM modem over the mobile network through SMS. The SMS would comprise the units of energy consumed and consequently the amount payable.

This system consists of a microcontroller which takes the input from energy measuring device and calculates the number of units consumed. Micro controller then sends the calculated information which is displayed on the LCD which is programmed using Embedded C language.

The technology is a breakthrough in overcoming the obstacles and the disadvantages that the old and conventional energy metering and billing system has been with. The MFT used can be integrated to several conventional energy meters with a specific device address for each user. The MFT reads data from several energy meters which cuts down the need of using GSM modem in each unit as it was required in the project that is build with energy meter. The disadvantages associated with conventional metering system were:

1. Intrusion of privacy at homes for the meter reading purposes.
2. Economic disadvantage for the electricity department to hire meter readers.
3. Late and inaccurate collection of data.
4. Data tampering or exploitation with the meter's reading or unauthorized alteration in the reading of the meter.

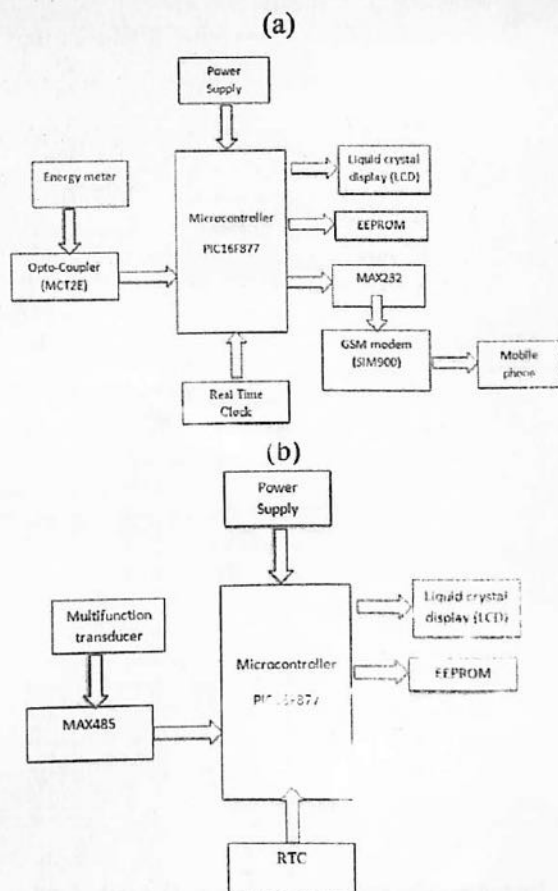


Fig.1 : Block Diagram representation of the proposed automatic meter reading (a) and energy data extraction from MFT (b) using GSM

2. SYSTEM DESIGN

This project on automated meter reading using GSM consists of Power supply unit, Data supply unit, Micro controller unit, Real time clock, Display unit, Storage unit and Communication unit.

2.1 Power supply unit

Power supply is the most important unit of the entire circuit. The function of the power supply is to take in the electrical energy in one form and convert it into another. In this proposed project we have used the power supply which converts high voltage AC to a low voltage DC. The power supply unit consists of a 230V-12V transformer, rectifying diodes, filter (consisting of a parallel RC circuit) and a voltage regulator.

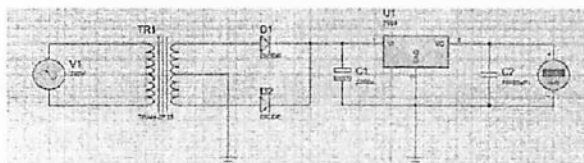


Fig.2: Power supply unit

2.2 Data supply unit

For the conventional metering system, energy meters are used. Energy meters are devices which are used to enable the pricing of energy consumed by individual consumers since they measure the energy consumed by the consumers or electrical devices. In general, energy meters were typically operates by continuously measuring the instantaneous voltage in volts and current in Amperes and finding the instantaneous power by multiplication of the voltage and the current. Then it is integrated against time to give the energy consumed in kwhr (Ahmed, 2013). Figure 3 shows an image of digital energy meter.



Fig.3 Static watt energy meter

However, in this paper a model on the extraction of data from MFT is designed. Rish master 3430 W/D is used from where the energy data is extracted. MFT is a transducer that measures physical quantities and transmits the information as coded digital signals rather than continuously varying current or voltage. Rish master 3430 W/D is shown in figure 4.

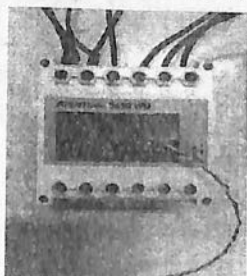


Fig.4: RM 3430 WD MFT

2.2 Display unit Liquid crystal Oscillator (LCD)

A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being are LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments) and animations (Anonymous, n.d).



Fig.5: Liquid Crystal Display

2.4 Storage Unit

EEPROM shown in figure 6 is a memory device used to store the data for off line process which stores the amount of unit that the user consumes while transferring each SMS.

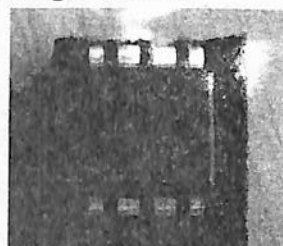


Fig.6: EEPROM ATMLU740

2.5 Micro controller unit

PIC 16F877A is one of the most advanced microcontroller from Microchip. This controller has many applications due to its low price, high quality and ease of availability. It is suitably applicable in machine control applications, measurement devices and study purposes.

PIC 16F877A is a 40-pin 8-Bit CMOS FLASH Microcontroller which is shown in figure 7. It has a high-performance RISC CPU with 35 single word instructions where all single cycle instructions take only one instruction cycle except for program branches which take two cycles. It has 3 operating speeds with 4, 8, or 20 MHz clock input (Abhinandan J, Dilip K, Dilip K, 2012).

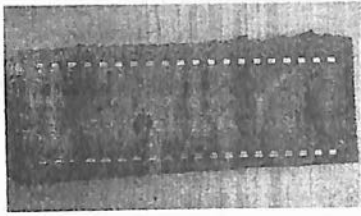


Fig.7: PIC 16F877A

2.6 Real time clock

The DS1307 is a Serial Real-Time Clock which has a low-power, full binary-coded decimal (BCD) clock/calendar and 56 bytes of non-volatile SRAM. It is used to maintain the current time in off line processing. Address and data are transferred serially via a 2-wire, bi-directional bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. It automatically adjusts the dates at the end of the month for months with fewer than 31 days, including corrections for leap year. The clock can be operated in either the 24-hour or 12-hour format with AM/PM indicator. The DS1307 has a built-in power sense circuit that detects power failures and automatically switches to the battery supply (Deshmukh V. V., n.d.).

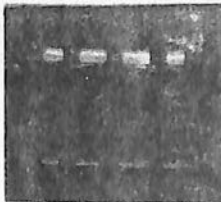


Fig.8: RTC Ds1307

2.7 Communication Unit GSM modem (SIM900GPRS+GSMQUAD-Band Module)

The GSM modem is interfaced with the microcontroller's serial (RS232) port for sending and receiving SMS. The GSM modem is used to receive or collect the data of energy consumed using the existing cellular network and the modem has its own SIM which helps in communication. In this project, SIM900 GPRS+GSM QUAD-band module is used which is shown in figure 9. SIM900 delivers GSM/GPRS 850/900/1800/1900 MHz performance for voice, SMS, data and fax in a small form factor with low power consumption (Babu, 2012). With the help of MODBUS

protocol, the microcontroller sends different commands to the modem and the GSM modem sends SMS frames to the microcontroller.

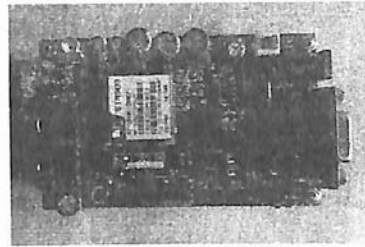


Fig.9: SIM 900 GPRS+GSM QUAD-band module

3. OVERVIEW OF THE DESIGNED PROTOTYPE FOR DATA EXTRACTION FROM MFT

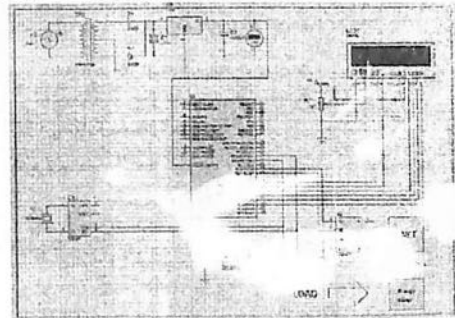


Fig.10: Circuit diagram for the extraction of data from MFT

A load is given to the energy meter as an input and then the output is fed to the Live and Neutral connections of MFT. The A and B connection of the RS485 from the MFT is connected to the pin 6 and 7 of MAX485 for transferring the energy data to PIC16F877A. The Rx and Tx pin of MAX485 is connected to pin Tx and Rx pin of PIC respectively. The microcontroller then receives the energy data. The PIC is given a power supply of 5V. The microcontroller is programmed in Mikro C software using the Modbus protocol (Master-Slave protocol) to receive the energy data from MFT, calculate the cost of the energy consumed and displaying the two units on LCD.

An RTC is also connected to the PIC in order to display second, minute, hours, day, date, month and hour information on the LCD. The EEPROM is initiated with the PIC to store the continuous flow of data from MFT.

4. SOFTWARE DEVELOPMENT

4.1 Proteus

Proteus is one of the most famous simulators because of availability of almost all microcontrollers in it. It can be used to simulate almost every circuit on electrical fields. It is easy to use because of the GUI interface that is very similar to the real Prototype board. Moreover, it can be used to design Printed Circuit Board (PCB). It is also used tin code checking. It is categorized as ISIS (Intelligent Schematic Input System) and ARES (Advanced Routing and Editing Software). Proteus combines advanced schematic capture, mixed mode SPICE simulation, PCB layout and auto routing to make a complete electronic design system. It can be compiled in MikroC with C based program.

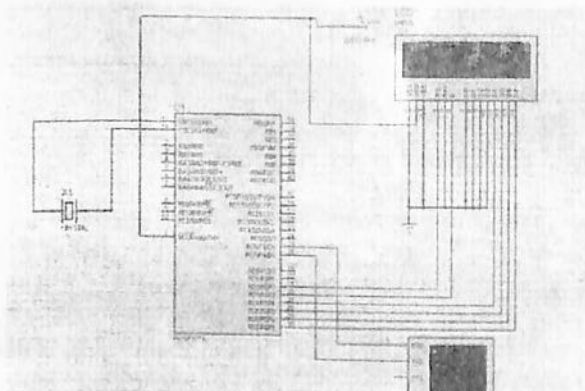


Fig. 11: Circuit connection for PIC-LCD interface

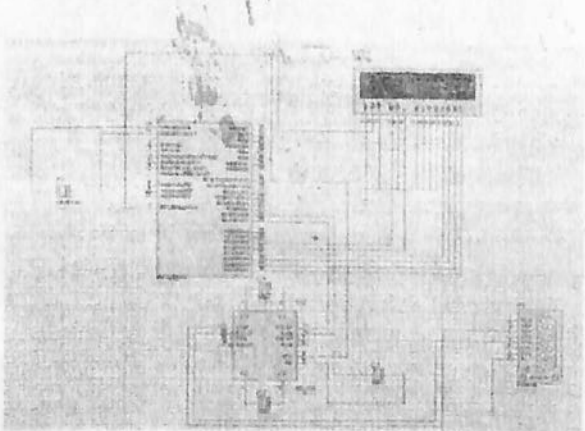


Figure 12: Output for PIC-LCD interface

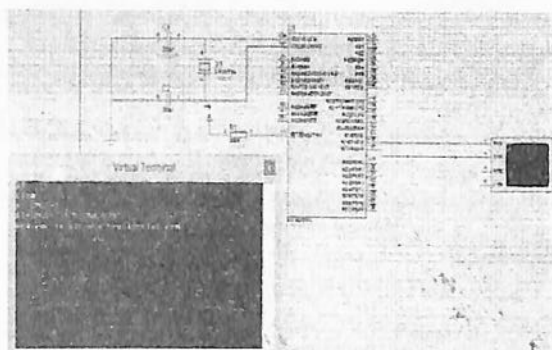


Fig.13: Interfacing PIC with GSM via MAX232

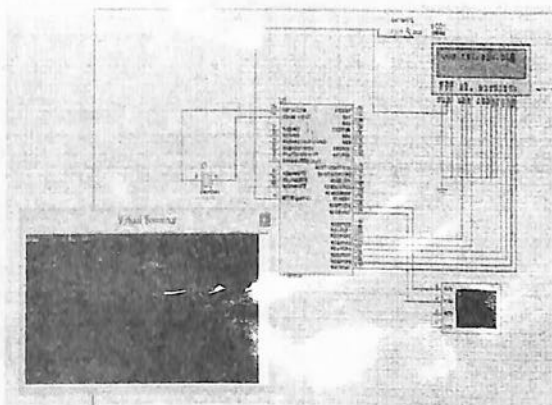


Fig.14: Interfacing PIC with virtual hyper terminal

4.2 Mikro C

This software is the easiest solution for developing applications for embedded systems, without compromising performance or control. It is powerful tool for microcontrollers with rich developmental feature. It provides a successful match since it has highly advanced IDE, ANSI complaint compiler, broad set of hardware libraries, comprehensive documentation, and many examples which are ready to run. It allows us to develop and use complicated application in a quick manner.

5. CRITICAL ANALYSIS

The proposed system functions to extract the energy parameters that reports from various energy meters in a locality where a number of energy meters can report to a single MFT.

It makes use of serial communication between the PIC and MAX485 that drives the RS485 interface from the MFT. The PIC acts as the master to initialize the master commands to the RS485. The master commands to read the holding registers of the MFT that is connected to the MAX485. The master-send command requests the MAX485 to give the contents of the specified register that holds the information of energy parameters. The MAX485 sends the data of the particular register to the PIC where the calculation of total cost using the energy tariff per unit is done (Abhinandan J, Dilip K, Dilip K, 2012).

The PIC16F877A that was used in the system has a 1 USART port that is connected to the MAX485 for serial communication, and the LCD that displays the units and the cost of energy incurred. The system could also be connected to a GSM unit if a PIC having 2 USART pins such as PIC18F23K22 could be used in place of PIC16F877A. Due to unavailability of the PIC18F23K22, we regarded the MFT-PIC interfacing as the prime purpose and executed it with PIC16F877A and the GSM transmission unit that also uses USART pin was successfully executed in the software Proteus. (Abhinandan Jain, 2012) The system could efficiently eliminate the use of GSM module in every household and still serve the purpose of automation of energy metering device. The MFT-PIC-GSM unit can be used to extract any kind of data from any Electrical measuring intelligent device that follows Modbus protocol.

6. FUTURE WORKS

There are number of future plans development for the proposed system to aid further improvement and advancement as follows:

- For the same purpose, MFT can be used instead of energy meter to read 48 parameters like power factor, current reading, voltage reading, power reading etc. One MFT can be able to replace multiple energy meters which will reduce the installation cost.
- To improve the proposed system by using other alternative PIC microcontroller for the better performance.
- To develop a program using the same software that will track the account balance and credit value of customers by the service provider.

7. CONCLUSION

The proposed model aims to be an improvisation of the existing conventional energy meter reading

system. The automation of the conventional energy meter used an LCD display and a GSM unit that served to send the collected data to the Energy Supply Department. The brain child of the model was a background study of the automatic energy meter reading system that used GSM technology that was mainly deployed in Industries and on a small scale. The automatic energy meter reading unit could not be exercised on commercially large scale because every unit required a GSM module for the transmission of the collected information. The proposed system has an MFT which is a multi-function transducer and it is capable to read some 48 electrical parameters from 30-32 devices using different addresses for each device. The Energy meter from a cluster of houses can be connected to a single MFT which has a GSM unit. The overall cost of installation of GSM unit in individual household as demanded by the conventional automatic energy meter system can be omitted. The system is cost efficient and can be programmed to read various other parameters and can be considered a better and advanced management solution for the problems and limitations posed by the olden system.

8. ACKNOWLEDGMENT

We would like to extend our deepest gratitude to every faculty of Electronics and Communication engineering department, College of Science and Technology under Royal University of Bhutan for the lending us with full support in every step involved in the completion of this proposed project.

9. REFERENCES

- Abhinandan J, Dilip K, Dilip K. (2012). Design and Development of GSM based Energy Meter. *International Journal of Computer Applications*.
- Ahmed, M. I. (2013). *Single Phase Intelligent GSM Based Prepaid Energy Meter*.
- Babu, K. B. (2012). Remote Wireless Automatic Meter Reading System Based on GSM. *National Conference on Electrical Sciences*.
- Deshmukh, V. V. (n.d.). Automatic Energy Meter Reading System Reviews. *The International Journal of Science & Technology*.
- H. G. Rodney Tan, C. H. *Automatic Power Meter Reading System Using GSM Network*.