International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 10 (2015) pp. 26435-26446

http://www.ripublication.com

An Intelligent Power Meter System

Krishna Gandhi P[1]
Assistant Professor, Department of EEE,
Nandha Engineering College, Erode, Tamilnadu, India
krishneceee@gmail.com
Prabhakaran S[2]
Associate Professsor, Department of EEE,
Nandha Engineering College, Erode, Tamilnadu, India
sprabhakaran2006@gmail.com

Abstract

Nowadays Electronics energy measurements are replacing conventional electro-mechanical meter technologies. A modern digital energy meter provides flexible energy read metering purposes. In Energy meter, which produce 3200 pulses for each and every unit consumed. The pulses were measured electrically by an LED in the meter through a blink. When the server sends a request to the client through GSM module, which reads this request and sends back the current reading through the wireless module. When the server sends the corresponding bill will be displayed on the LCD and also bill sent to the mobile clients. This paper focusses on GSM transmission protocol to establish connection between client and server develops on Embedded C, MPLAB and Visual C# software packages.

Keywords: GSM, Energy Meter, LED, LCD.

Introduction

In the modern era we preferably use an electric meter or energy meter as a device that measures the amount of electrical energy supplied to a consumer's. Commonly uses as a kilo watt-hour meter, Public Utilities Board record the values measured by these meters to generate an invoice for the electricity. The meter reading processes are free from human involvement. In the telephone network, which access the service and maintain the reading system for households [2]. Master station system should implement the web services technology [4]. Energy meter sends the recorded power consumption of household in certain interval period wireless Bluetooth technology [5]. In this system, the hardware consists of Peripheral Interface Controller, power meter, transmission technique (GSM) and an output display; the software consists of a program that is used for the working of the system usually written in embedded C.

The proposed system is designed to attach to the existing meter in our house. This energy meter measures the consumption of electricity and interrupts the micro-controller. Wireless module is used to communicate with the server and saves it in a non-volatile memory. This system is used for duplex transmission of data. The input to the PIC is the pulse received from the Electronic meter and unit is transmitted to a server as when a requested by the server. Thus the consumer is updated on energy usages instantaneously. GSM transmission protocol to establish the connection between client and server. The micro-controller counts these interrupts and saves it in a non-volatile memory and it also displays these counts and units on the LCD. The micro-controller reads this request and sends back the current reading through the same protocol. When the server sends the corresponding bill and then it will display on the LCD with alarm.

On the server side, an application program on visual C# frequently sends the requests to the clients, and whenever it gets the reply, it calculates the bill and sends it back to the corresponding user. The main advantage of the system is to help the customers by an online contact with the electricity board by getting the correct bill for the corresponding readings from the meter and the final bill on client mobile.

Proposed System

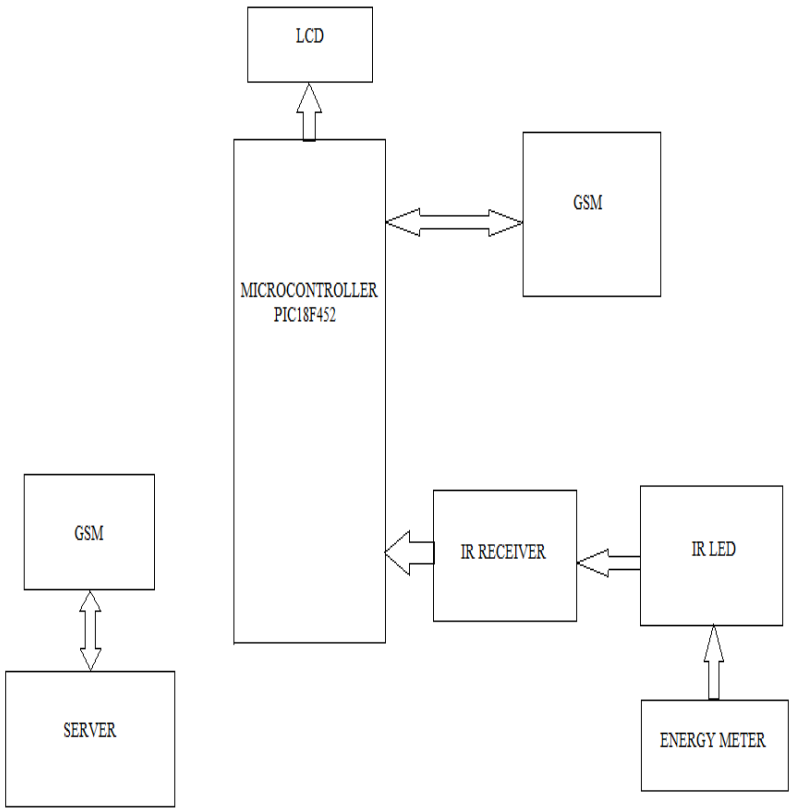


Figure 1: Schematic Representation of the system

Transmission Protocol

The GSM transmission is used to establish connection between client and server. The consumer's energy meter is on real time conversation with the server. To transmit data over a distance of many kilometers, GSM proves to be very efficient.

Transmitter section

This section transmits the amount of energy consumed in units. For this, we connect the pulses from digital energy meter output as input of the controller. An IC present inside the meter generates pulses that exactly represent the amount energy consumed. The output of IC is connected to the counter input of the controller through an IR LED and an IR receiver. Here we use a PIC 18F452 Microcontroller to count the pulses and after a specific preset number of pulses it increments the unit. MAX232 is used as an interface between PIC and the GSM module. This is to ensure that the data is transmitted serially to the GSM. The unit value is transmitted through GSM. An LCD module interfaced with the PIC connected to the meter displays the pulses as count, instantaneous units consumed and the bill.

Receiver section

This section deals with the processing of data received from different consumers. The server sends a request to the module installed at the consumer's end along with the specific address from where unit details have to be transmitted back. When the required information is transmitted back, the server reads and stores it. It then issues appropriate billing function. This bill is then transmitted back to the consumer where the bill details are displayed on an LCD and 5V power supply is used.

Client Side

The client side consists of the Electronic meter and the embedded system designed by us interfaced with it. The system consists of a PIC18F452 micro controller used as an interface between Meter and the GSM module. GSM module accepts data from PIC and sends it to the system synchronized to it on the server side. The data is then processed here and transmitted back.

SERVER SIDE

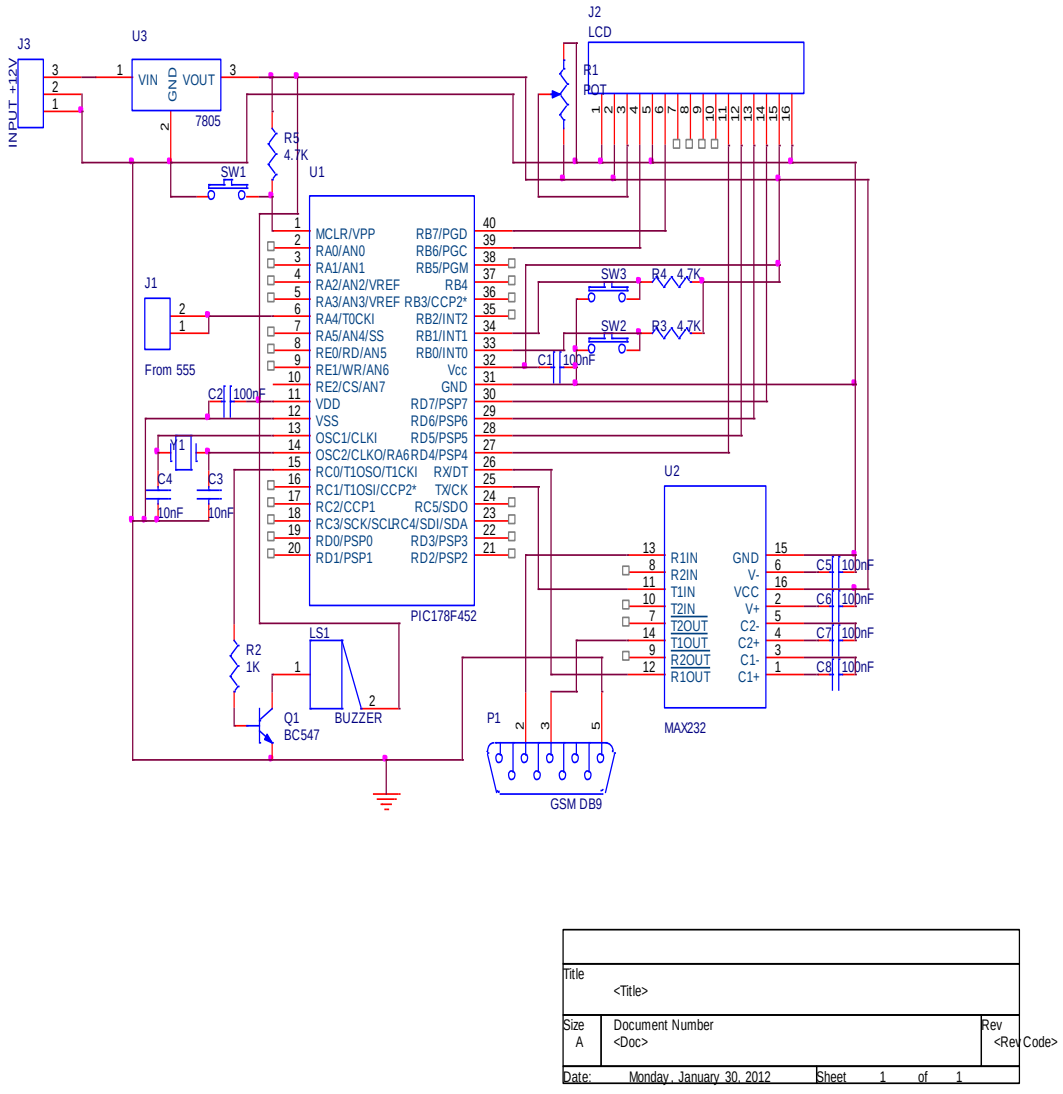
The server side has the GSM reception module interfaced directly to a computer (server).

The server is programmed to display all necessary details. After receiving data, the server processes it and sends it back to the client for display on client side.

Circuit Description

The circuit diagram for GSM based energy meter as shown in figure 2. It contains PIC Microcontroller, LCD, MAX232, GSM, IR LED and IR Receiver. The system consists of a PIC18F452 micro controller used as an interface between energy Meter and the GSM module. GSM module accepts data from PIC and sends it to the system synchronized to it on the server side. The data is then processed here and transmitted

back. The energy meter is not direct contact with the micro-controller it is connected to the IR LED and an IR Receiver. Its output is connected to the 6th pin on the pic micro-controller. MAX232 is used as an interface between PIC and the GSM module. This is to ensure that the data is transmitted serially to the GSM. The unit value is transmitted through GSM.



Title <Title>		
Size A	Document Number <Doc>	Rev <Rev Code>
Date: Monday, January 30, 2012	Sheet 1 of 1	

The 25th pin of pic18F452 is connected to 11th pin of MAX232.The signals produced by the micro-controllers are in the form of TTL. In order to interface the micro-controller with the server these TTL signals are to be converted to RS 232 signals, as the communication is serial and the serial port of the PC supports only RS232 signals. Each component is working with +5V supply. The output of the MAX232 is connected to GSM through a DB9 connector. That GSM communicates with the server by using a SIM. The server side has the GSM reception module interfaced directly to a computer (server). The server is programmed to display all

necessary details. After receiving data, the server processes it and sends it back to the client for display on client side.

Energy Meter

An energy meter is a device that measures the amount of electric energy consumed by a consumer. Energy meters are typically calibrated in billing units and most common one being the kilowatt. Periodic readings of electric meters establish billing cycles and energy used during a cycle. When energy savings during certain periods are desired and then maximum use of power in some interval. In some application areas the energy consumers are higher during certain times of the day, reflecting the higher cost during peak demand time periods. Also, in some area meters are use relays to turn off nonessential equipment.

IR Transmitter

By blinking an infrared LED the signal becomes more unique and therefore more discernible from other light. Although the intensity varies based on lighting, angle, distance, and the constant rate of blinking can be relied upon for recognition. The rate of LED blinking should be sufficiently fast so that the signal can be quickly recognized as being "on". Since it takes a few blinks to detect the signal, then delivering a message with a slow blink would be very time consuming. But the rate of LED blinking shouldn't be so fast that expensive high-speed electronics are necessary.

An IR LED also known as IR transmitter and it is a special purpose LED that transmits infrared rays in the range of 760 nm wavelength. LEDs are usually made of gallium arsenide or aluminium. They are, along with IR receivers and commonly used as sensors. Generally, the human eye cannot see the infrared radiations however, it is not possible for a person to identify whether the IR LED is working or not. To overcome this problem, the camera on a cell phone can be used. The camera shows the IR rays being emanated from the IR LED in a circuit.

IR Receiver

TSOP 1738 is an Infrared receiver which is widely used a large number of electronic products for receiving and demodulating infrared signals can be easily decoded by a Microcontroller. The TSOP 1738 is a member of IR remote control receiver. It consists of a PIN diode and a pre amplifier which are embedded into a package. The output of TSOP is active LOW and it gives +5V in OFF. When IR waves from a source with a center frequency of 38 kHz incident on it thereafter output goes to LOW. Lights coming from sunlight and fluorescent lamps may cause disturbance due to this undesirable output even when the source is not transmitting IR signals. A band pass filter contains an Integrator stage and an automatic gain control are used to suppress such disturbances.

GSM

GSM (Global System for Mobile Communication) is a wireless transmission protocol method. The GSM RF module is interfaced to a host device through an asynchronous serial port. Through this port, the module can communicate with any logic and

voltage compatible UART or through a level translator through a serial device.GSM is a cellular network, which means that mobile phones connect to it by searching for cells in the immediacy. There are five different cell sizes in a GSM network such as macro, micro, Pico, Femto and umbrella cells. With Coverage area of each cell varies according to the implementation environment.

Network Structure

The basic station subsystem (the base stations and their controllers).The network and switching subsystem (the part of the network most similar to a fixed network). This is also just called the core network. The GPRS Core network (the optional part which allows packet based internet connections). The operations support system (OSS) for maintenance of the network.

Subscriber Identity Module (SIM)

One of the key features of GSM is the subscriber identity module commonly known as a SIM. The SIM is a detachable smart card containing the user's subscription information and phone book. This allows the user to retain information after switching handsets. On the other hand, the user can also change operators retaining the handset simply by changing the SIM. Few operators will block this by allowing the phone to use only a single SIM or only a SIM issued by them; this practice is known as the SIM locking and is illegal in some countries.

AT Commands

The interface between modem and host is a textual protocol called AT Commands. These commands enable phone setup, dialling, text messaging etc.

AT Command Set

The following section describes the AT Commands Set. The commands can be tried out by connecting a GSM modem to one of the PC's COM ports.

SIM 300 GSM Modules

SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900MHz, DCS 1800MHz and PCS 1900MHz SIM300 provide GPRS multi-slot class 10 capability and support the GPRS coding schemes are CS-1, CS-2, CS-3 and CS-4. With a tiny configuration of 40mm x 33mm x 2.85mm and then SIM300 can fit almost all the space requirement in application such as Smart phone, PDA and other device. The physical interface of the mobile application is made through a 60 pins board-to-board connector which provides all hardware interfaces between the module and customers' boards except the RF antenna interface.

- *The keypad and SPI LCD interface will give the flexibility to develop customized applications.
- *Two serial ports can help you easily develop applications.
- *Two audio channels include two microphone inputs and two speaker outputs. This can be easily by AT command.

SIM300 provide an RF antenna interface with two alternatives are antenna connector and antenna pad. They are antenna connector is MURATA MM9329-2700 and customer's antenna can be soldered to the antenna pad respectively.

The SIM300 is designed with power saving technique and the current consumption to as low as in SLEEP mode. It is integrated with the TCP/IP protocol Extended TCP/IP AT commands are developed for customers to use the TCP/IP protocol easily which is very useful for those data transfer applications.

The power supply of SIM300 is from a single voltage source of 3.4V-4.5V. In some cases, the ripple in a transmit burst may cause voltage drops when current consumption rises to typical peaks of 2A then the power supply must be able to provide sufficient current up to 2A.

PIC 18F452

In 1989, Microchip Technology Corporation introduced an 8 bit micro-controller called the PIC which stands for the Peripheral Interface Controller. This controller has made small amounts of data RAM, a few hundred bytes of ON chip ROM for the program, one timer, a few pins for IO ports and all on a single chip with only 8 pins. PIC families contain are 10xxx, 12xxx, 14xxx, 16xxx, 17xxx, and 18xxx.

They are all 8 bit processors that the CPU can work on only 8 bits of data at a time. The PIC 18 is a RISC architecture that comes with some standard features such as on chip program ROM, data RAM, data prom, timers, ADC, USART and IO ports.

LCD

Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes and two polarizing filters, the axes of transmission of which are (in most of the cases) perpendicular to each. No actual liquid crystal between the polarizing filters and then light passing through the first filter would be blocked by the second (crossed) polarizer.

Before applying an electric field, the orientation of the liquid crystal is determined by the alignment at the surfaces of electrodes. In a twisted pneumatic device (still the most common liquid crystal) the surface alignment directions at the two electrodes are perpendicular to each other and so the molecules arrange themselves in a helical or twist structure. This reduces the rotation of the polarization of the incident light and LCD appears gray.

If the applied voltage is large enough, the liquid crystal molecules in the center of the layer are almost completely untwisted and the polarization of the incident light is not rotated as it passes through the liquid crystal. This light will be mainly polarized perpendicular to the second filter and it was blocked, then the pixel will appear black color. By controlling the voltage applied across the liquid crystal in each pixel, then light can be allowed to pass through in varying amounts thus constituting different levels of gray.LCD with top polarizer removed from device and placed on the top and bottom polarizer's are parallel.

MAX 232

The signals produced by the receiver are in the form of TTL. In order to interface the receiver with the personal computer these TTL signals are to be converted to RS 232 signals. So the output of the PIC is connected to the Rx D pin of the MAX232 and the serial data output from the MAX232 is fed to the serial port of the PC VIA db9 connector. The main advantage of the MAX 232 is that it uses only 5v to generate nearly about 10v. So the same power supply can be used for the controller operations and the serial data transfer between the receiver and the system.

The MAX220-MAX249 has two internal charges –pumps that convert +5V to+10V for RS 232 driver operation. The first converter uses capacitor C1to double the +5v input to +10v on C3 at the V+ output. The second converter uses capacitor C2 to invert +10v to -10v on C4 at the V – out. A small amount of power may be drawn from the +10 (V+) and -10 (V-) outputs to power external circuitry, except on the MAX225 and MAX 245 – MAX247, where these pins are not available. V+ and V- are not regulated, so the output voltage drops with increasing load current. Do not load V+ and V- to a point that violates minimum +5V EIA / TIA -232E driver output voltage when sourcing current from V+ and V- to external circuitry. When using the shutdown feature in the MAX 222 and MAX 225, avoid using V+ and V- to power external circuitry. When these parts are shutdown, V- falls to 0V, and V+ falls to +5V. For applications where a +10 V external supply is applied to the V+ pin, (instead of using the internal charge pump to generate +10 V 0, the C1 capacitor must not be installed and the SHDN pin must be tied to VCC. This is because V+ is internally connected to VCC in shutdown mode.

Limit Switch

Limit switches are two-position devices actuated with a button that is pressed and released. Most PUSH button switches have an internal spring mechanism returning the button to its “OUT” or “UNPRESSED” position for momentary operation. Some PUSH button switches will latch alternately on or off with every push of the button. Other push button switches will stay in their “IN” or “PRESSED” position until the button is pulled back out. This last type of PUSH button switches usually has a mushroom-shaped button for easy push-pull action.

Software Tools

The entire software for the paper is developed in MPLAB IDE which is available from MICROCHIP.INC for every micro-controller program developed. The whole coding was developed using C language. The device used for the project is PIC18F452.The compiling of the source code was done using HITEC_C.

Simulation Responses

Figure 3: Login Page

The above response shows the login page. On this page, register which enables for providing a Registration with customer details. After filling all data, click ON save button, then all data will be saved on the server.

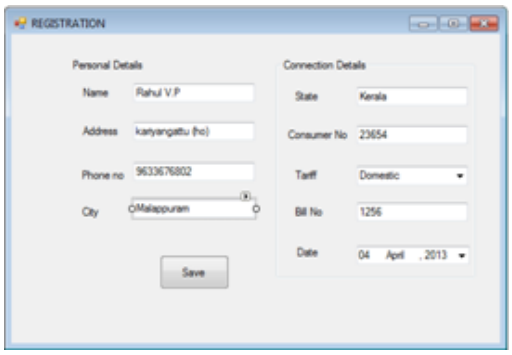


Figure 4: Registration Page

Fig.4 response shows the registration page which will be open with two tabs. One is personal details and other is connection details.

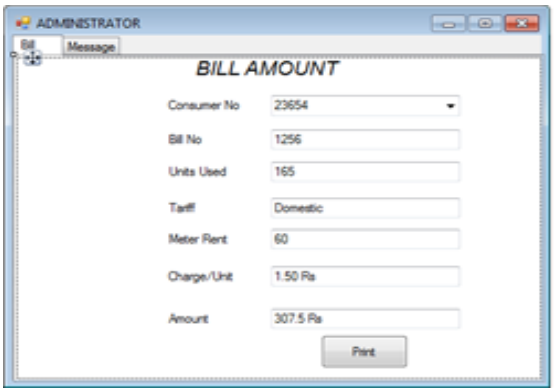


Figure 5: Administrator Bill Page

The above response shows the administrator bill amount page. In “Bill” page we can check all details by selecting the consumer number from the list. And there is another option for printing this bill amount.

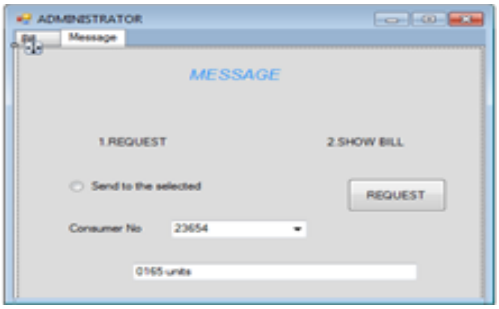


Figure 6: Administrator Message Page

Fig.6 shows the request for an administrative message page. The message page consisting of a request button. By selecting any consumer number from the list and press the request button, then the “REQUEST” message will send to the consumer side modem and the number of pulses should be referred back as a message to the server side and it will calculate the how much unit and total price. And by clicking “show Bill” the bill amount will be sent to the mobile customer.

Figure 7: Request Message from server side

Figure 8: Message received customer side

Figure 9: Server Side

Figure 9: Client side

Conclusion

In this paper, an Intelligent Power Meter system is implemented, get a bill from the electricity board through the display interfaced to the energy meter by GSM communication. This system is several excellent performances such as less manual work, fast rate transmission data and less expensive. Using embedded system technology, improves the stability data transmission and its utilization due to any condition.Within certain periods this system is implemented and replace the conventional ordinary meter system

References

[1] R. Aquilue ;M. Deumal ; J.L. Pijoan ; L. Corbeira; ” A Low Complexity Multicarrier Proposal for Medium Rate Demanding Automatic Meter Reading Systems ", IEEE International Symposium June 2007.

[2] Shi-Wei Lee ; Cheng-Shong Wu; Meng-Shi Chiou; Kou-Tan Wu; 'Design of an automatic meter reading system [electricity metering]', Proceedings of 22nd International Conference on Industrial Electronics, Control, and Instrumentation, IEEE IECON-96, Volume: 1, pp. 631 – 636.

[3] Kersting W.H Phillips W.H ., " Load allocation based upon automatic meter readings" Transmission and Distribution Conference and Exposition, IEEE/PES, 2008, pp. 1 – 7

[4] Wu Kehe Zhang Xiaoliang; Wang Yuanhong; Xu Yuan,” Design and Implementation of web services based GPRS automatic meter reading system”, 3rd international conference Aug 2010.

[5] Koay B.S Cheah S.S Sng Y.H Chong P.H.J Sham P.Tong Y.C Wang X.Y Zuo Y.X, Kuek H.W., 'Design and implementation of Bluetooth energy meter', Proceedings of ICICS and Pacific Rim Conference on Multimedia, ICICS 2003, Volume 3, 2003, pp.1474 - 1477.