Smart Energy Metering System

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Abstract-The objectives of this paper are to develop a system which can transmit the reading of energy meter to the nearest electric meter billing[11][12] and controlling station, to minimize tampering of the reading[20], to identify energy meter breakdown , to minimize administrative expenses, identify excessive power consumption[22] and to facilitate the customer to find its overall consumption of energy continuously. For this we replace analog electric meter with the digital circuitry to provide real time billing & reading to the customers by using Liquid Crystal Display (LCD)[13]. There are basically two ends, one is user end and the other is server end. Either the meter can be prepaid or postpaid, which is completely monitored and controlled by the server end using GPRS connectivity. The user can check its consumption pattern of its usage by login to the website. The unit of measurement is KVA because the Indian power sector faces a serious problem of lean revenue collection for the actual electric energy supplied in VA owing to losses of revenue. One of the prime reasons is the traditional billing system which is inaccurate many times[12], slow, costly, and lacking flexibility as well as reliability. The key elements of this research are micro controller, GSM/GPRS communication module, data sensing network. The whole system is revolving around the GSM/GPRS module and the microcontroller, where GSM/GPRS module is used for the wireless data transmission[7] and controller controls the whole operation of the system[23][24].

Keywords: *LCD Display, GSM/GPRS Module,*

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I. INTRODUCTION

India is the largest country in the world and there are about one billion households with electric meters. All of these meters are manual and meter reading are manually recorded. A person takes the meter reading and then it is to be submitted to the appropriate office. This procedure contains lots of error and reading problems. This research propose very simple and effective method for automatic meter reading and it is a good combination of computer and electronic engineering, where its scenario is the set of different components linked together to transmit the meter reading from one end to the other end that is server and user end.

A number of relevant authors conceptualize this technological evolution[17]. Traditionally because installed energy meters where purely electromechanical systems, energy metering has been addressed by manual methods with few automated processes. In recent years a number of new electronic interface meter have been installed. These modern meter equipments are able to store, process and communicate using digital data formats [1][9].This processed data can be transmitted using wireless technologies such as Zeeg Bee network protocol, which is a short-range, low-rate wireless sensor network and has low cost, low power consumption, fast auto-configuration and auto recovery of network in radio frequency transmission [2][27][25]. This can also be done with WI-FI wireless communication technology used in this system is also called 802.11 standards and has the advantages of high transmission rate, convenient networking, bestrow scope, strong anti-interference capability, and low price [3].but this type of networks has relative limits in transmission distance and transmission rate. As mobile communication technology develops, mobile terminals popularize, and the level of application increases, due to the realization of global roaming networking of GSM network, its GPRS has two very important data services--calling and SMS[23][24].GPRS service combines mobile communication and Internet, letting terminal users to connect to Internet mobile communication network [4].

The main purpose of this research is to develop simple and cost effective system which makes the whole process of consumer power distribution and billing free of error[12]. In this research, different fields of engineering are combined to transmit the meter reading using latest advancement in automation, wherever is possible, the manual system has converted into automatic system[. Engineers are trying harder and harder to create complex and efficient system by the mathematical modulation of the electronic devices, or by the combination of different field of engineering like computer, electronics, electrical and biomedical etc. This research is also a combination of different fields of engineering, where we are transmitting the electric meter reading via electronic circuitry and manage the data base using software. There are three basic parts of this project, first part is the user end and the major Component involved in this end are electric meter, microcontroller, GSM Module and LCD[13]. Second part consists on the circuitry of the server end which is either used to receive the data sent by the user or to send the control instruction to the user through GPRS. Finally in third part, all the data is being maintained at the server end using a database.

II.PROPOSED SYSTEM MODEL

The hardware of the system is divided into two main parts, named as user end and the server end. At user end, circuitry is directly connected to the electric meter and it is either used to send meter reading or to receive the control instruction using the electronic component like microcontroller, GPRS module,MAX232 and LCD. On the other i.e. the server end, GPRS module, microcontroller, MAX232 and a personal computer are combining to perform the task. The complete model of the system can be seen in the Fig.1

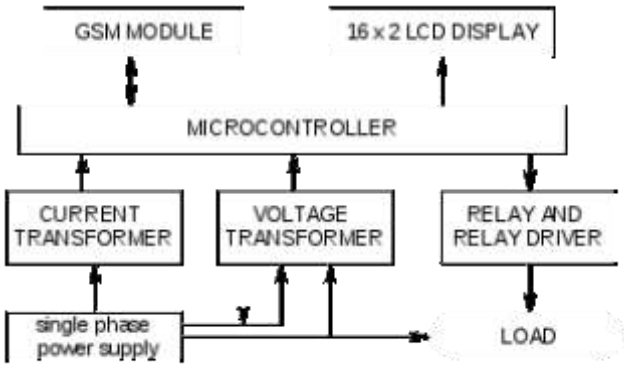

Fig1.System Architecture User End

A. Microcontroller

A Controller is chip which contains a processor, having a non-volatile programming memory called as (flash or ROM), and also a volatile memory for input and outputs called as (RAM), moreover a clock and I/O control unit called as a "computer on a single chip". Billions of this is embedded each year to use in a product for automation. A microcontroller is available in all sizes for the purpose of their usage. Basically the microcontroller High Performance, Enhanced flash Microcontrollers with 10-Bit A/D

B. Data sensing network

This section comprises of current transformer to sense the current and potential transformer to sense the voltage both of them are drive by single-phase 230volts power supply. The current transformer is designed to connect in series with the line to transform the line current to the standard 5 amperes suitable for the meter or relay. The voltage transformer is designed to connect in parallel with the line to transform the line voltage to 5 volts suitable for the meter or relay. To keep the voltage at the meters and relays at a safe value, the secondary circuit must be grounded.*Current transformers* reduce high voltage currents to a much lower value and provide a convenient way of safely monitoring the actual electrical current flowing in an AC transmission line using a standard ammeter. The principal of operation of a basic current transformer is slightly different from

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that of an ordinary voltage transformer as shown in fig.2.

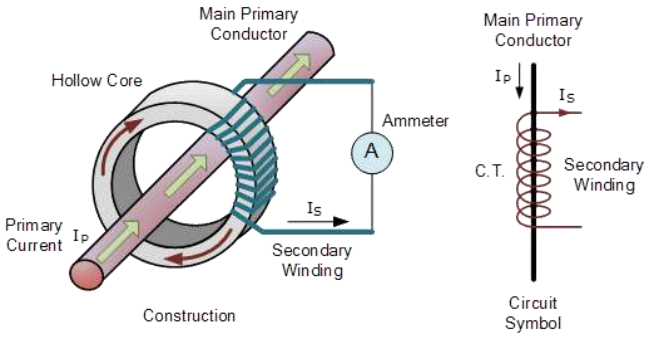

Fig.2 Current Transformer

A current transformer, like any other transformer, must satisfy the amp-turn equation and we know from our tutorial on double wound voltage transformers that this turns ratio is equal to:

$$T.R. = n = \frac{N_P}{N_S} = \frac{I_S}{I_P}$$

from which we get:

$$\text{secondary current, } I_S = I_P\left(\frac{N_P}{N_S}\right)$$

Potential transformer is a voltage step-down transformer which reduces the voltage of a high voltage circuit to a lower level for the purpose of measurement. These are connected across or parallel to the line which is to be monitored. The basic principle of operation and construction of this transformer is similar to the standard power transformer[14]. In common, the potential transformers are abbreviated as PT.

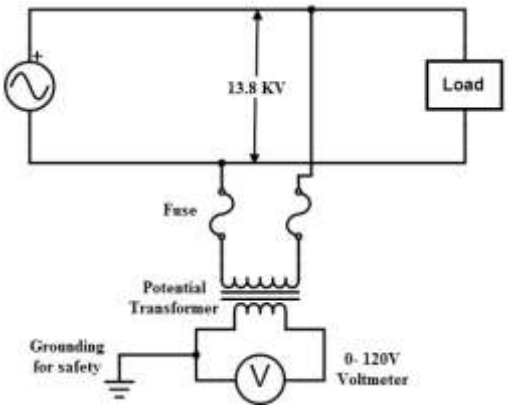

Fig3.Potential Transformer

The primary winding consists of a large number of turns which is connected across the high voltage side or the line in which measurements have to be taken or to be protected. The secondary winding has lesser number of turns which is connected to the voltmeters as shown in fig. 3, or potential coils of wattmeter and energy meters, relays and other control devices. These can be single phase or three phase potential transformers. Irrespective of the primary voltage rating, these are designed to have the secondary output voltage of 220 V.Since the voltmeters and potential coils of other meters have high impedance, a small current flows through the secondary of PT. Therefore, PT behaves as an ordinary two winding transformer operating on no load. Due to this low load (or burden) on the PT, the VA ratings of PTs are low and in the range of 50 to 200 VA. On the secondary side, one end is connected to the ground for safety reasons as shown in figure. Similar to the normal transformer, the transformation ratio is specified as V1/V2 = N1/N2From the above equation, if the voltmeter reading and transformation ratio are known, then high voltage side voltage can be determined.

C. Relay and relay driving circuit:

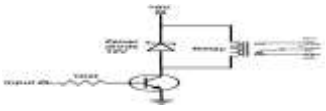

Fig4. Relay driving Circuit

This circuit is used to facilities one of the objectives of this paper that to identify excessive power consumption. Here the relay operates accordingly. Whenever power consumption is within limit it is connected to the NC of the relay and whenever it finds more than the specific limits then switch to the NO contact and the same will be inform to the user this can be realized with help above circuit as shown in above fig 4.

D. Liquid Crystal Display

A liquid crystal display (LCD) is a thin flat panel device used for displaying information, such as text, images, and moving pictures. It is an electronically-modulated optical device and can be made up of any number of pixels which is filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images or text either in color or monochrome. Among its many advantages some are its lightweight construction, its portability, and low power
consumption which makes it more feasible for battery powered electronic equipments.

E. General Packet Radio System

It is also known as GPRS is a 2.5 generation step toward internet access. GPRS is also known as GSM IP that is a Global - System Mobile Communications Internet Protocol as it keeps the users of this system on-line, allows to make voice calls, and access internet on the go. Even Time Division Multiple Access (TDMA) users get benefit from this system ,as it provides packet radio access.GPRS also permits the network operators to execute an Internet Protocol (IP) based core architecture for integrated voice and data applications , which continues to be used and expanded for 3G services. GPRS supersedes the wired connections, as this system has simplified access to the packet data networks like the internet. The packet radio principle is employed by GPRS to transport user data packets in a structural way between GSM mobile stations and external packet data networks[16]. These packets can be directly routed to the packet switched networks from the GPRS mobile stations. In the current versions of GPRS, networks based on the Internet Protocol (IP) like the global internet or private/corporate intranets and X.25 networks are supported.Always online feature Removes the dial up process, making applications only one click away.Upgrade to existing systems Operators do not need to replace their equipment; rather, GPRS is added on top of the existing infrastructure. An integral part of future 3G systems GPRS is the packet data core network for 3G systems EDGE and WCDMA.

F. GSM Modem

GSM (Global System for Mobile) / GPRS (General Packet Radio Service) TTL -Modem is SIM900 Quad-band GSM / GPRS device, works on frequencies 850 MHZ, 900 MHZ, 1800 MHZ and 1900 MHZ. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3V3 and 5V DC TTL interfacing circuitry, which allows User to directly interface with 5V Microcontrollers (PIC, AVR, Arduino, 8051, etc.) as well as 3V3 Microcontrollers (ARM, ARM Cortex XX, etc.). The baud rate can be configurable from 9600- 115200 bps through AT (Attention) commands[29]. This GSM/GPRS TTL Modem has internal TCP/IP stack to enable User to connect with internet through GPRS feature. It is suitable for SMS as well as DATA transfer application in mobile phone to mobile

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phone interface. The modem can be interfaced with a Microcontroller using USART (Universal Synchronous Asynchronous Receiver and Transmitter) feature (serial communication)[29].

III. WORKING OF THE SYSTEM

The overall working of the system is explained in this section. To understand the complete system, we divide our system in two modules, i.e. hardware module and the software module, so that the rest of the discussion becomes simple. Hardware and software module is represented in the Fig 5 and Fig 6 below.

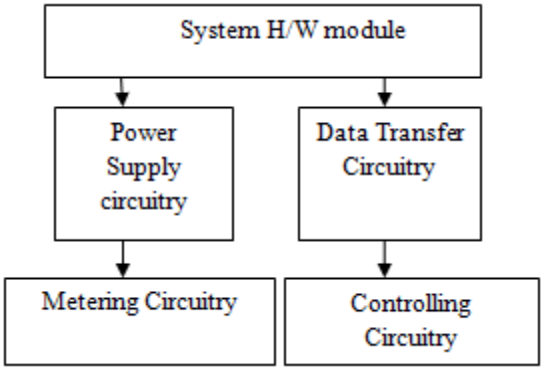

Fig5 H/W details User End

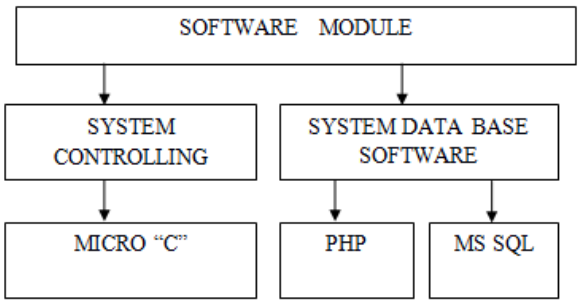

Fig6. S/W details Server End

We have four basic component of this module, which can be seen in the hardware module block diagram.In the metering circuitry we have used an LCD, to display the number of VA units either consumed by the post paid user or the remaining units of prepaid user[18]. In the hardware module the second main part is its controlling circuitry, the major part of this circuit is controller, it receive the data from CT and VT send it to the server end using data transfer circuit, control circuit also respond for every command sent by the server end, either to cut off the electricity, or to send the units to their prepaid customer. The data transfer circuit section consists of the components which are used to communicate the user end to server end and vice versa, it includes GSM Module used to transmit data wirelessly and receive between these two ends by using the GPRS service, if customer use a smart phone it can access data anywhere, customer can also be get the idea of its usage by login into the site ,again the customer come to know about power consumption,billing[15],billing dates, excessive power consumption through SMS[10]. We use it for the serial communication between the server end pc and the GSM module. This section is interconnected with the controlling circuitry and the power supply circuitry. The final circuitry is the power supply circuitry. The devices used in this circuitry comprises of many electronic devices working altogether to convert the current and voltage according to the needs of circuit components. This circuit converts AC to DC, steps- down the voltage from 220 volts to 5 volts a which is required by the digital components to function properly. By using the above circuitry, we can transmit our data from one end to another but to teach microcontroller how to perform this whole operation, we use micro C language, and to maintain a complete database and for its designing at the server end, we use two other language which are PHP and MS SQL

IV. SOFTWARES

A. The micro C PRO for PIC it is a powerful, feature-rich development tool for PIC microcontrollers. It is designed to provide the programmer with the easiest possible solution to developing applications for embedded systems, without compromising performance or control.

B. SQL

Microsoft SQL is a relational model database produced by Microsoft. It is a very useful software to manage a data base[28].

C. PHP

PHP is a server-side, HTML-embedded scripting language that may be used to create dynamic Web pages. It is available for most operating systems and Web servers, and can access most common databases, including MySQL. PHP may be run as a separate program or compiled as a module for use with a Web server[27][28].

V. SUMMARY

From the above discussion we can say that is possible to transmit energy meter reading from the customer end to the nearest billing center with help of advanced communication technique such as GPRS/GSM to ease the life of customer and electric power suppliers and to minimize the tampering of reading as well as administrative expenses.

There are economical loses face by power generation due to real power measurement. It is also been possible to take meter reading in KVA so that the customer will charge for the apparent power rather than the real power consumption so that these losses can minimize at large extent.

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