Automated EB Billing and Supply Control using Power Line Communication

G. Sujatha
Assistant Professor
Institute of Food and Dairy
Technology,
Koduvalli, Chennai.

D. Murali
Assistant Professor / EEE
Government College of
Engineering, Salem-11.

R. Ram Kishore
Engineer trainee- level - 1
Odyssey Technologies Ltd.
ARJAY Apex Centre,
Nungambakkam, Chennai.

ABSTRACT

This paper deals with the implementation of power line network in the field of electricity billing. In the present scenario power line communication (PLC) is one of the economical ways of communication of data. Even though there are new methods of wireless communication methods, practically it is very much time consuming to install such a system, and also it is highly cost consuming method .But the power lines which already exist and connect every household in a particular area is more advantageous as it does not require any new installation or erection for establishment of communication channels, and thus is not a time consuming one . One biggest advantage of this system is that it can be readily implemented, unlike the other modern methods. The power line network can also be used for creating emergency response networks. This project eliminates the need for employing EB meter readers and this set of employees can be used elsewhere. The long queues in the billing counter can be avoided by implementing this model. Also the control of the system is fully automated by this technique. The most important feature in this system is the use of digital meters consisting of micro controllers and real time clock, thus eliminating the loss of meter data during power failure.

General Terms

Security, Algorithms, Power line communication, Latch relay, Relay contactor, Personal Computer, Serial communication cables, Multi functional digital energy meter et. al.

Keywords

Concentrator modem, Node modem, Power line modem, STALON 3000A microcontroller.

1. INTRODUCTION

Though many technological innovations are taking place in this world, existing electricity consumption billing process seems in India to be very obsolete and does not meet the latest technology available. In this paper, the above said process is totally automated and the communication is made possible entirely through the power line [1]. Not only the billing, even the control of system is fully automated by this technique i.e. when a consumer fails to pay his consumption bill within a given period of time the supply automatically gets cut off to his house and the restoration is done only when the bill is cleared. The currently prevailing system involves the user to go up to the EB office to manually pay his bills. The readings are taken using the analog meter present in the customer's house. The readings are taken using an employee working at the EB office. This system has some disadvantages like erroneous readings, easy manipulation, manual labour and time consuming. In the proposed system, the analog energy meters are replaced by digital meters. The meter readings in the form of digital data are transferred from the customer end to the EB office through power line [2]. The meter readings

are collected at the regular time intervals (t) and the present reading (t) is compared with previous reading (t-1) and the bill is made ready as per the slab for the consumed units by the customer [2]. At the EB end a computer maintains a data base of its entire customer. Once the bill is generated, the customers are provided with some grace period for the payment of bill. If a customer fails to pay his/her bill, a trip signal is sent to the trip circuit connected to the meter, through the same network. Once when the bill is paid, the supply is restored back. Thus the above system does not require any person from the beginning of recording the meter reading to, till the supply control when he/fails to pay the bill. The advantages of this system are less labour, no more queues, quick updates, no manipulation and cost effective. Hence no more a EB personnel is required to come to the consumer house to remove the fuse to cut off the supply which is the oldest EB tradition followed, even at the present stage.

2. PRINCIPLE OF POWER LINE COMMUNICATION

Each household is allocated a particular ID so that they can be uniquely identified. There is no chance of manipulation in the proposed system. The network path is also not fixed. This helps in creating a dynamic environment as there is no fixed path in the network. The data sent by the home unit then and there is automatically stored in the back end database at the EB office. This saves hours and hours of manual data entry needed for entering the data into the central system. The power line communication used here is a bi-directional communication enabling data transfer at a faster data rate through long distances. Also power lines may be noisy at certain times due to interference. In such a case the data transmission may be disrupted. Hence a dedicated micro controller is used to enable data transmission even   in   the noisiest power line and also at any weather condition [3]. By digitizing, the   currently used analog energy meter has been completely transformed to a digital one. Hence it is beneficial to the customers as the system is made very user friendly. The automated EB billing procedure has the ability of fulfilling a set of needs for the user and the EB workers [2].

1. The automated EB billing system eliminates the need to pay the bills at the EB office.
2. This system allows the user to get updated regarding the details of the power used in his house.
3. The user can also verify if the bill received is the right one or not.
4. Automatic supply tripping and restoring under the case of failure in bill settlement by the customer.
5. The new system is readily adaptable and hence less time is consumed to implement this system.

This paper being advancement to the proposed project of sending the details to the customer house, it has a few objectives which have to be met.

1. Presence of a meter ID at each house and a node ID to

which the meter is connected.

2. Encryption techniques present at each house for securely sending the data

3. Tripping circuit at the customer end.

4. A consistent database of all the details of each house under a given zone.

5. A Concentrator PLM under each EB office that is connected to nodes through power line.

In the proposed project each EB office consist of a computer and a concentrator PLM is connected to the computer through RS 232 cable. The concentrator is connected to various nodes PLM placed at the customer side through power line. A single concentrator can be connected to 2256 nodes. Hence practically a single concentrator is capable of connecting the entire house under a zone. And further more each node MODEM can further be connected to 256 meters serially using RS 485[4]. Thus the data from each meter is transmitted to the computer in the EB office which consists of the entire database of its entire customer. Also for each month the bill details are calculated and customers are provided with the bill detail through SMS or e-mail. The node MODEM provides the trip signal to the trip circuit at each house when the bill is not cleared by the customer in the given time [4].

3. PROTOTYPE HOUSING

The hardware prototype of the node module, which is to be installed at the consumer end should be well protected from mechanical damage and also should ensure safety, since there is flow of high voltage. Hence the node module is enclosed inside a sheet steel enclosure of 1.2 mm thickness. The various devices like the PLM, Contactor, latch relay etc. have been mounted on a steel plate which provides mechanical support to the components inside the enclosure. The enclosure and the plate are powder coated with epoxy powder, and the shade is RAL 9005. The powder coating prevents the enclosure from corrosion as well as acts as scratch proof. Since the use of various electronic components inside the enclosure, there are chances of heating. Over heating might cause number of problems like damage of components, malfunction of devices, Loss of data, error in data etc. Hence to avoid these short comings, ventilating slots are provided for the circulation of air. Thus natural cooling takes place.
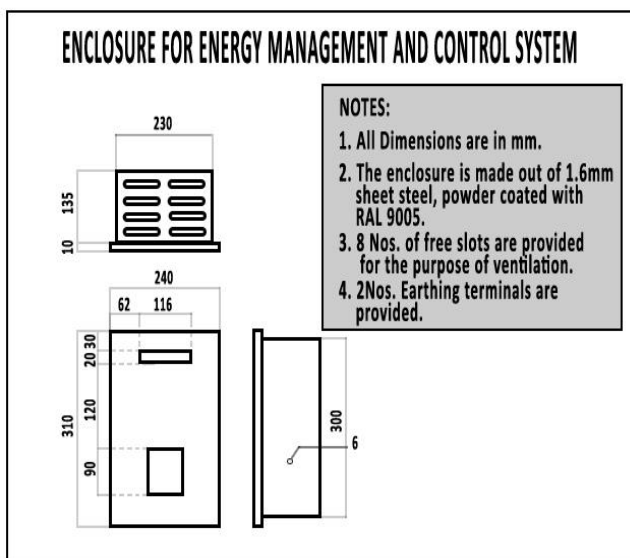
Fig.1: Prototype Enclosure design

4. ARCHITECTURE OF THE PROPOSED SYSTEM
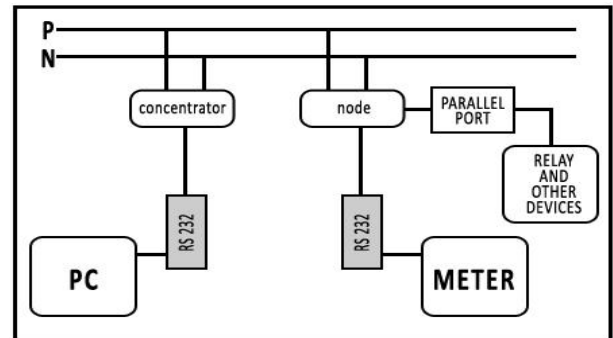

Fig.2: Proposed system architecture

The prototype of the power line communication consist of two modules,

✓ Concentrator module
✓ Node module

These two modules are connected to each other through the existing power line which conducts the sinusoidally varying supply. The A.C supply is modulated as per the input data during the zero crossing of the alternating supply through the power line. The data transfer takes place at a frequency ranging between 67 kHz to 131 kHz at a baud rate of around 4000 bits per second. The modems are programmed to retry until the desired data is obtained, hence loss of data is eliminated completely.

4.1 Concentrator module

The concentrator module is the one that is situated at the EB office side. This module contains a Central PC connected to the PLM called the concentrator. These concentrators are connected to various nodes PLM through the power line that are established between substation and consumers. A single concentrator can be connected to 2256 nodes. Thus a single concentrator will be able to cover all the houses in zone under the EB office. From the economical point of view, it sounds very positive as the number of MODEMS required becomes less. The figure below shows the connections in the concentrator module. A detailed explanation is also provided along with the diagram. The way how data is transmitted as well as received by this module is explained in the following section.
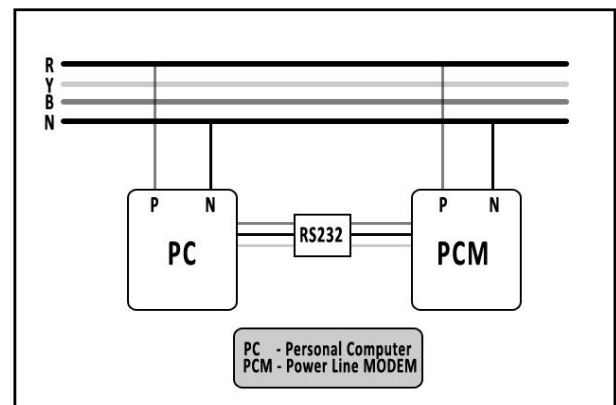
Fig. 3: Concentrator module

In this module the power line modem called as the concentrator is connected to the computer through a RS-232

cable which is used for serial data transmission. Thus the connection between the computer and the PLM is in the form of serial data transmission with a start byte and end byte attached to the data. In the prototype software a specially designed binary enables the power line modem to get the KWh readings from each energy meter on the consumer end. A protocol is sent from the PC to the meter requesting the meter reading. The meter in turn sends back the meter reading value. A data base management system is maintained in the PC to store the power consumption details of the customers. These details are processed to obtain the bill that is to be paid by the customers. As soon as the bill is generated the grace time for the consumer is given for paying the bill. The computer continuously monitors, whether the bill is cleared in time. If not, the PC sends the trip signal via concentrator, through the power line, to the node at the consumer end. The supply is again restored back only when the bill is cleared [4]. The various protocol sent and received by the concentrator are listed below and a brief explanation of each protocol is also given [5].

4.1.1 Protocol details sent from Concentrator
A) To get KWh

1) Sending protocol to get KWH:-

3A 00 02 01 14 08 00

3A	->	Start byte.
00	->	No. of Router.
02	->	Meter ID.
01	->	Pay load size.
14 08	->	ID of the destination node.
00	->	Function code.

1) Response protocol :-

3a 14 08 00 02 00 00 00 f0 0d

3A	->	Start Byte.
14 08	->	ID of the destination node.
00	->	Function code.
00	->	Meter ID.
00 00 00 F0	->	Payload (Actual KWH data in 10-2
0D	->	End Byte.

B) To get status.

1) Sending protocol to get status :-

3a 00 00 01 14 08 03

3A	->	Start byte.
00	->	No. of Router.
00	->	Unused byte.
01	->	Pay load size.
08	->	ID of the destination node.
03	->	Function code

2) Response protocol for ON:-

3a 14 08 01 00 0d

3A	->	Start Byte.
14 08	->	ID of the destination node.
01	->	Indicates ON.
00	->	Un used Byte.
0D	->	End Byte.

2) Response protocol for OFF :-

3a 14 08 00 00 0d

3A	->	Start Byte.
14 08	->	ID of the destination node.
00	->	Indicates OFF.
00	->	Un used Byte.
0D	->	End Byte.

C) To switch ON :-

3A 00 00 01 14 08 01

3A	->	Start byte.
00	->	No. of Router.
00	->	unused byte.
01	->	Pay load size.
14 08	->	ID of the destination node.
01	->	Function code.

D) To Switch OFF :-

3A 00 00 01 14 08 02

3A	->	Start byte.
00	->	No. of Router.
00	->	Unused byte.
01	->	Pay load size.
14 08	->	ID of the destination node.
02	->	Function code.

4.2 Node Module
Node module is the module that is present in the consumer side. This module consists of a power line modem connected to 256 individual energy meters along with the relays. Around 2256 nodes are connected to the concentrator PLM which is present in the EB office. Thus these node PLMs act as a router between the concentrator and the energy meters. The below figure shows the connections in the node module. A detailed explanation is also provided along with the diagram. The way how data is transmitted as well as received by this module is explained in the following section.
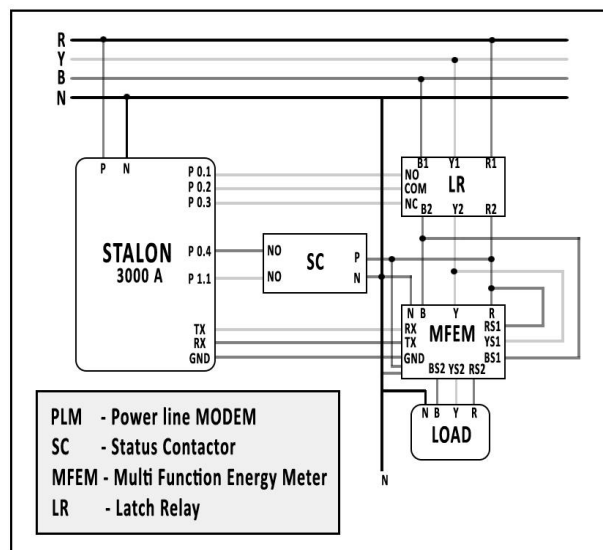

Fig. 4: Node Module

In this module the microcontroller STALON 3000A is connected to the latch relay and contact relay through the parallel ports [5]. The serial port Rx, Tx, Gnd of the microcontroller is connected the energy meter, which displays the load parameters. To get the kWh reading form the energy meter the request is transmitted serially through from the PLM to the energy meter. The relay contactor here is used to obtain the status of the supply. As the port P 0.4 remains high, port P 1.1 would be high only if the supply is ON due to the connection with the relay contactor. Thus the status of the supply system is communicated by the relay contactor to the STALON 3000A through the parallel ports P 0.4. When a consumer fails to pay the bill a latch OFF command is passed to the latch relay through the parallel ports, which would cut off the supply to the consumer [4]. After the payment of the bill the latch ON command is passed to the latch relay which would restore the supply. All the commands that are passed

on through the node PLM to the energy meter are obtained from the concentrator PLM. Hence the node PLM acts as a router between the energy meter and the concentrator module and ensures the reception of data without any losses.

Fig. 5: Power line Modem
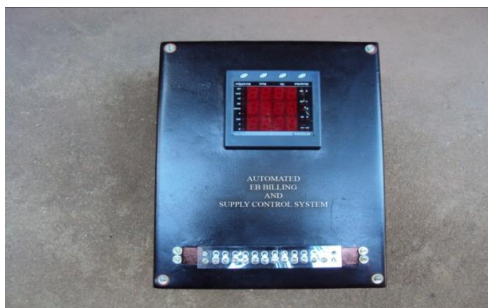
Fig. 6: Node side meter box

5. HARDWARE ORIENTATION

With the proposed system to be designed certain hardware components are required. These are as follows,
1. PLM.
2. Multi functional digital energy meter.
3. Latch relay.
4. Relay contactor.
5. Personal Computer.
6. Serial communication cables.

5.1 Power line Modem

POWER LINE MODEM uses existing power line as a medium for electronic communication. It uses the most advanced Digital Signal Processing (DSP) techniques to enhance the signal to noise ratio. PLM provides ultra-reliable communication even in the noisiest power line networks. The technology also includes robust Error Checking to ensure reliable data transmission.   The MODEM is equipped with a dedicated PLC chipset and software with full communication protocol stack to control and manage its operation. Some of the main features of PLM are listed as follows.

3) **Reliability:** The modem is enhanced with Ultra-reliable communication capabilities even in the noisiest power line networks. Hence reception of unreliable data is eliminated.

2) **Versatility:** The PLM chip has embedded flash and can be programmed for many uses with the power line as a

communication medium. This feature of PLM is utilized for automatic meter reading of the customers.

3) **Extended Voltage Scope:** The MODEM system can carry signals on low voltage power lines from 110 Volts to 240 Volts and on medium voltage power lines to 10,000 Volts. The communication distance is several hundred meters on low voltage and several kilometres on medium voltage. MODEM can also carry signals on twisted pair.

4) **Security:** MODEM is equipped with Triple DE encryption to ensure the security of the customer's data.

5) **Open Standard:** MODEM has got a 32-bit processor to process application code and network traffic. Its embedded protocol conforms to ANSI/EIA 709.1, the Lontalk Control Network Protocol.

The diagram shows the various blocks present in the power line MODEM.
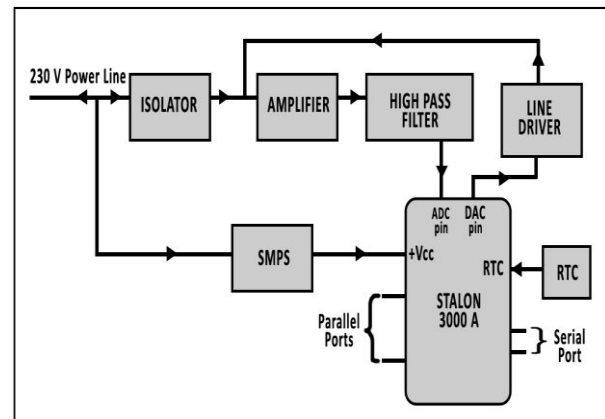
Fig 7: Block diagram of PLM

5.1.1 Signal Isolator

The signal isolator is used to provide galvanic isolation from one signal (input) to another (output) and usually combines the converter function. The isolator input, output and power supply are electrically isolated from each other making these units ideal for solving signal incompatibility and earth loop problems during process control system commissioning. This communication and broadcasting equipment come in three versions such as input signal powered, output loop powered and externally powered. Input signal powered isolators are used as a quick fix to unexpected isolation problems or as supplies, drive capability are higher than a two – wire transmitter.

5.1.2 Amplifier

An amplifier is a device which is used to increase the signal level; i.e. to get a larger signal output from a small signal input. When a sinusoidal signal is given as input to the amplifier, the output would remain sinusoidal in waveform, with the frequency same as that of the input.

5.1.3 High pass filter

A high-pass filter, or HPF, is that which passes high frequencies well but attenuates (i.e., reduces the amplitude of) frequencies lower than the filter's cutoff frequency. It is sometimes called a low-cut filter or bass-cut filter

5.1.4 Power supply unit

The power supply unit consists of a full wave rectifier circuit which is required to bias the various modules present within the power line modem. The rectifier circuit is supported with the suitable filter circuit so as to ensure pure DC output.

5.1.5 Line driver

A line driver is an amplifier used to improve the strength of an analog or digital signal at its source by driving the input to the transmission line with a higher than normal signal level. This increases the quality of a transmission over a long run of cable.

5.1.6 Microcontroller STALON 3000 A

The STALON 3000A is a microcontroller that is used in the power line communication [3]. It consists of parallel ports, serial ports and transreceiver pins for the purpose of data transmission across the power line. The internal block diagram of the micro controller is shown below.
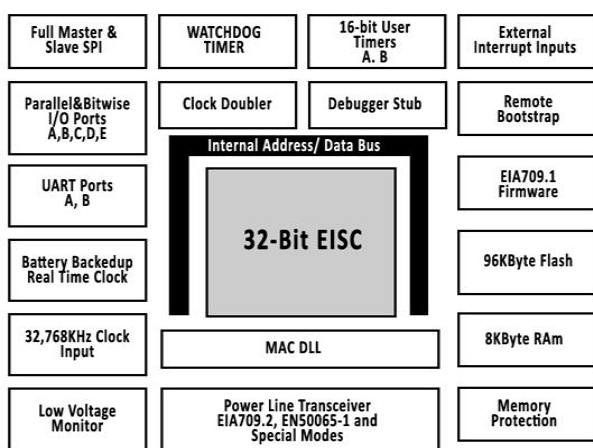
Fig 8: Block diagram of Power line modem

5.2 Multifunctional Energy meter

We use a digital energy meter here using which we can send the meter reading data in the digital form [2]. The meter consists of a 8051 core microcontroller which efficiently manipulates the measured consumption values and the various parameters are obtained. The node PLM is connected with the energy meter through serial port. Thus the meter data are sent serially from the TERIDIAN microcontroller. The energy meter connection is shown below.
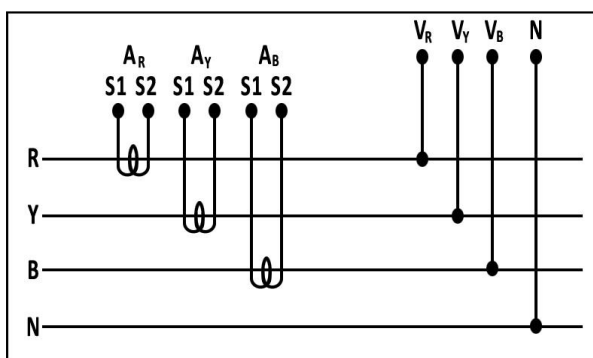
Fig 9: Energy meter connection diagram

5.2.1 Introduction Teridian IC (71M6513/71M6513H)

The TERIDIAN 71M6513 is a highly integrated SOC with an MPU Core, RTC, FLASH and LCD driver. TERIDIAN's patented Single Converter Technology with a 21-bit delta-sigma ADC, 6 analog inputs, digital temperature compensation, precision voltage reference and 32-bit computation engine (CE) supports a wide range of poly-phase metering applications with very few low cost external components. A 32 KHz crystal time base for the entire system and internal battery backup support for RAM and RTC further reduce system cost. Maximum design flexibility is supported with multiple UARTs, I2C, a power fail comparator, a 5V LCD charge pump, up to 22 DIO pins and an in system programmable FLASH. Easy conversion to ROM offers unprecedented cost structure for high volume applications. The device is offered in high (0.1%) and standard (0.5%) accuracy versions for multifunction residential/ commercial meter applications requiring multiple voltage/current inputs and complex LCD or DIO configurations. A complete array of ICE and development tools, programming libraries and reference designs enable rapid development and certification of meters that meet most demanding worldwide electricity metering standards.

5.2.2 Calculation of Parameters

The IB input offers full accuracy and can be used to implement a 3 wire single-phase meter for the second current input. The multiplexer function has to be modified by selecting the proper meter equation in order to accept this input. This is a quite common methodology with most of the metering chips for measurement. If another signal faults by connecting to neutral, high current could result from this, but only to the extent it is provided by the power supply, which is limited to a few 50mA.

The voltage is measured using voltage divider circuit. And other parameters are calculated by the formula:

$$P=VI \cos \acute{o}$$

$$Q=VI \sin \acute{o}$$

$$S=VI$$

The phase shift is measured from voltage and current wave form at zero crossing. Apparent power, measured in VAh, can be calculated from V2 and I2. However, it is more accurate for low currents, to use Wh and VARh, i.e. SQRT (Ws x Ws + VARs x VARs). This method of computation is less sensitive to broadband noise than V2 and I2. The demo firmware accumulates V2h and calculates average VRMS over the last 1-second interval. This is the same technique used for the power calculation. Thus, ripple rejection depends on a sufficiently long measurement interval. The compute engine has a frequency locked loop for generating a square wave of the same frequency as the fundamental input signal. This square wave signal is used by the measurement module of the compute engine for signal processing routines. The accumulated volt squared and current squared values are used by the MPU to calculate RMS voltage and current from the previous measurement interval. The MPU divides by the number of samples and takes the square root. These values are also used to calculate VAh. V2h and I2h are also useful quantities to provide the amount of time the meter has run continuously without disruption. For example, a meter with 220V input running for 31 days a month continuously will result in a count of (31*24*220 *220). The diodes in the 651x

part ensure that all pins will be just a few volts from each other. Thus, if one of the pins is tied to neutral, and neutral is hot, there could be a hazard. Any part that uses resistive dividers for voltage sense must have one of its pins connected to neutral. Our baseline CE code uses a bilinear integrator to shift voltage 90 degrees for VAR measurements. An all-pass filter along with 1/fo multiplication provides the accurate VAR measurement.

On using the formula above the following parameter are calculated.

- ✓ Phase voltage
- ✓ Line voltage
- ✓ Apparent Power
- ✓ System Frequency
- ✓ Phase Sequence
- ✓ Maximum Demand
- ✓ Rising Demand
- ✓ Reactive Power
- ✓ Active Power
- ✓ Power factor

5.2.3 Latch Relay

A relay is a type of electromechanical switch used in power supplies, counting systems and many other applications. Latching relay uses a pulse to move the switch, and then stays in position, slightly reducing the electric power requirement. The latching relay has a small metal strip which can pivot between two terminals. The switch is magnetized, or attached to a small magnet. On either side of that magnet are small coils of wire called solenoids. The switch has an input and two outputs at the terminals. It can be used to turn one circuit on and off, or to switch power between two different circuits. The two coils are used to control the relay. When electric current flows into the coils, it generates a magnetic field, which turns off again when they do. Because the magnetic strip is suspended between the two coils, it is also subject to their magnetic field. When the circuit generates a pulse of electricity through the coils, it pushes the switch from one side to the other. The strip stays there until it receives a magnetic pulse in the opposite direction, pushing the switch back to the other terminal.

5.2.4 Relay Contactor

The relay which is used to switch a large amount of electrical power through its contacts is called a contact relay. The contacts of the contact relay is normally open so that the power to the load is shut off when the coil is de-energized. The purpose of the contact relay is to report the status of the supply to the power line modem, weather it is latched ON or OFF.

5.2.5 Serial Communication Cables

RS - 232:

The RS-232 is used for connecting the power line modem with the computer on the concentrator side.

RS – 485:

The RS – 485 is used for connecting various digital energy meters to the node (power line modem). The purpose of using RS – 485 on the node side is that, up to 256 energy meters can be connected to each node. A RS-485 network can be constructed as either a balanced 2 wire system or a 4 wire system. If a RS-485 network is constructed as a 2 wire system, then all of the nodes will have equal ranking. A RS-485 network constructed as a 4 wire system has one node designated as the master and the remaining nodes are designated as slaves. Communication in such a system is only between master and slaves and never between slaves. This approach simplifies the software protocol that needs to be

used at the cost of increasing the complexity of the wiring system slightly.

6. SOFTWARE ORIENTATION

The proposed model consists of microcontrollers being used which are to be programmed to perform the required tasks. The PLMs consist of a dedicated microcontroller called the STALON 3000 A. This micro controller is programmed using eclipse C language based software [7]. Apart from the programming of microcontrollers a prototype of the end user software is also been included in the project. The flow charts, algorithms and programs of this software are given in the following sections. Below the algorithm for displaying the meter data in the seven segment display of the energy meter is specified.

6.1 Algorithms

6.1.1 Algorithm for Display function

Step 1. Start,
Step 2. Output 1 and 0 to P1.1 and P1.2 respectively.
Step 3. Output data in port P0.
Step 4. Output 0 and to P1.1 and P1.2 respectively.
Step 5. Stop.

6.1.2 Algorithm for main function

Step 1. Start.
Step 2. Initialize data, I = 0, j= 0.
Step 3. Call delay routine.
Step 4. If I >=10.
Step 5. J++, I = 0.
Step 6. If j >= 10.
Step 7. I = 0, j=0.
Step 8. If time > = 64.
Step 9 .I++, time=0.

6.1.3 Algorithm for delay function

Step 1. Start.
Step 2. Declare TMOD to 16 bit timer mode.
Step 3. TH0=0xDB, TL0=0xFF.
Step 4. Enable the interrupt enable register.
Step 5. TR0=1.
Step 6. Time++.
Step 7. TF0=0.
Step 8. TR0=1.
Step 9. Stop.

6.2 PLM Software Routine

In the proposed system two power line MODEMs are used. One at the EB office called the CONCENTRATOR and the other at the consumer end called the NODE. These two MODEMs are similar in the circuitry aspect but their internal functions differ. This difference is brought down in the way the two MODEMs are programmed. The function of the concentrator is to send the requests, trip commands, restore command etc to the node. Whereas the function of the node is to receive the data from concentrator and based on the received data, the node does the requested function like obtaining meter reading, or getting status of supply etc.

6.3 End User Software Prototype

This software links the computer in the EB office with the proposed system and as well as the consumer. This software prototype has been divided in to two sections. The first section is the one which connects the consumer and EB office thus supporting in the billing process. The second is the one

that provides the automatic meter reading and monitoring and controlling of system. The above software being a prototype is programmed using turbo C. As stated above there are two executable files. They are as follows.

6.3.1 USER exe:

This exe does the following functions.
- ✓ Obtain the meter readings from the data base and calculate the bill.
- ✓ The user is prompted to pay the bill.
- ✓ The user's data base is modified as per the payment status of bill.

6.3.2 Control and Monitor exe:

This exe does the following function.

- ✓ Send request to node and obtain the meter reading at regular time intervals (say every one month).
- ✓ Store the meter reading values in the DBMS.
- ✓ As per the bill status in the data base, control of the supply of customer is done.
- ✓ Also check the status of supply, before sending latch ON/OFF signal.
- ✓ Thus the function done by both the executable files have been discusses in the previous section.

6.4 Algorithm of end user application

6.4.1 Algorithm for user exe:

Step 1.Start.
Step 2. Obtain meter reading from "test.txt".
Step 3.Calculate bill amount as per tariff.
Step 4.Change status of bill generation to 1 in the text file test.txt.
Step 5.Prompt user requesting bill payment.
Step 6.If yes change bill paid status to 1 in the text file.
Step 7. Else go to step

6.4.2 Algorithm for control and monitor exe:

Step 1. Start.
Step 2.Delay 10 secs.
Step 3.Send meter reading protocol through serial port.
Step 4.Obtain the meter value from the received data through the serial port.
Step 5.Write the meter reading value in the text file 'test.txt'
Step 6.Check for bill generation status to be 1 in text file.
Step 7.If no go to step 6, else go to 8.
Step 8.Delay 20 secs.
Step 9.Check for bill status to be 1 in text file.
Step 10. If yes go to step 2.
Step 11.Else send trip signal through serial port.
Step 12.Check for bill status again in text file.
Step 13.If yes send restore signal and go to step 2.
Step 14.Else go to step 12

7. CONCLUSION

The proposed automated system saves time and money, increases customer satisfaction, reduces complaints and worker injuries and can pay for itself in a handful of years. Utilities should look beyond basic meter reading expenses to determine how an automated system will drive efficiencies and savings throughout many departments in the organization. This proposed Automated EB model includes an office module which has a PC with its back end connected to a database. The other module is the customer home module which is present at the home this module is used to make note of the amount of power consumed by the customer and after a period of 1 month it sends to the PC in the EB office. This EB office module calculates the data and sends it to the customer along with the due date. The customer also gets details of the bill on his mobile phone through which he can pay the bill. If the customer fails to pay the bill the automated system, cut OFF the customer's supply and the restoration takes place only after the bill is cleared. Even though there are new modern methods of communication of billing data, the use of existing power line seems to be the most economical one and readily adaptable system, when compared to the other methodologies. Thus this system proves to be very advantageous as well as efficient, the one which might become the bench mark in the history of automation.

9. REFERENCE

[1] Raja, G.T. "Electricity consumption and automatic billing through power line", Power Engineering Conference, 2007, PP. 1411 – 1415, 2007.

[2] Bharath, P "Wireless automated digital energy meter", Sustainable energy technologies, International conference, 2008, PP. 564 – 567,2008.

[3] Al-Qatari, S.A. " Microcontroller – based automated billing system", Industrial automation and control: Emerging Technologies, 1995, PP. 517 – 523, 1995.

[4] Anatory, J " Broadband Power line communications. The Channel capacity analysis", IEEE tran. On Jan 2008, PP 164-170.

[5] The 8051 Microcontroller and Embedded system using Assembly and C-Muhammad Ali Mazidi, Janice Gillispe Mazidi, Rolin D.Mckinlay.

[6] Microprocessor and Microcontroller-Gaonkar.A.S

[7] Let Us C- Yashwant Kanetkar

[8] Home Automation Using Power Line communication Karim Shah, Zeshan SikandarNiazi, M Abdul Haq

[9] Youbing Zhang, and J. Nguimbis, "Home Network Power–Line Communication Signal Processing Based on Wavelet Packet Analysis "