

Design and Implementation of Remotely Located Energy Meter Monitoring with Load Control and Mobile Billing System through GSM

G. Ramakrishnaprabhu and R. Karthikeyan

Abstract--- The most usable type of vitality is utilized broadly through the entire world. With the advancement of present-day innovation, the utilization of power is heightening progressively. According to their inspection, the electric bills are prepared, and most often these are prepared from an assumption which could be inaccurate, Due to the absence of regular monitoring system, sometimes consumer doesn't know about use electrical energy in their homes. Remote monitoring of energy meter and digital billing system is inaugurated through GSM. For monitoring server, major programming languages had been introduced to relate the methodologies, store data in a database and send the energy consumption monthly bill to the consumer cell phone number and finally, they will be a clear view about their energy consumption.

Keywords--- Remotely Monitoring Energy Meter, Gsm, Load Control through GSM.

I. INTRODUCTION

Information management of energy resources metering is an important part of the work in energy resources metering. By using modern network technology and wireless sensor one, for key energy-consuming industries, energy-using units and public institutions, online

monitoring and management of electric energy metering data can be implemented and the electricity metering data can be timely and accurately reported to the management departments at all levels, which can guide energy-consuming enterprises to evaluate and conduct energy-saving management. In recent 20 years, with the development of communication technology and network communication technology, according to the cost of network communication in different areas, wireless data transmission methods, such as ADSL, LAN, GPRS/CDMA and the like, can be flexibly adapted to construct the energy monitoring system. The energy data acquisition terminal/energy data gateway can support at the same time for the data collection of the metering devices for different energy using, including watt-hour meter, water meter, gas meter, heat meter, etc. There are many communication modes from the metering device to the energy data gateway, mainly including RS-485 wire mode, the way of power line carrier and Zigbee wireless mode. Different from most of the electric energy data acquisition system mainly used for metering and charging, the system is used for both the power energy monitoring and the on-line acquisition. So a high real time performance is an essential feature of the system. This paper introduces the plan and useful strategy for the electricity data real-time acquisition and monitoring system based on GPRS and power line carrier. The hierarchical network is made up of electric energy meters, intelligent data acquisition terminals, and remote management platform. These electric energy meters are responsible for measuring the energy data and sending the data to the acquisition terminals by RS-485 or Power Line

G. Ramakrishnaprabhu, M.E.,(Ph.D) Associate Professor, Department of Electrical and Electronics Engineering, Vinayaka Mission's Kirupananda Variyar Engineering College, Vinayaka Mission's Research Foundation (Deemed To Be University), Salem, Tamilnadu, India. E-mail: krishprabugovind@gmail.com

R. Karthikeyan, M.E(Power System Engineering), PG Scholar, Department of Electrical and Electronics Engineering, Vinayaka Mission's Kirupananda Variyar Engineering College, Vinayaka Mission's Research Foundation (Deemed To Be University), Salem, Tamilnadu, India. E-mail: karthisiva300@gmail.com

Carrier channel, while the intelligent data acquisition terminals are set for transmitting the data which is collected from the electric energy to the remote management platform by GPRS channel.

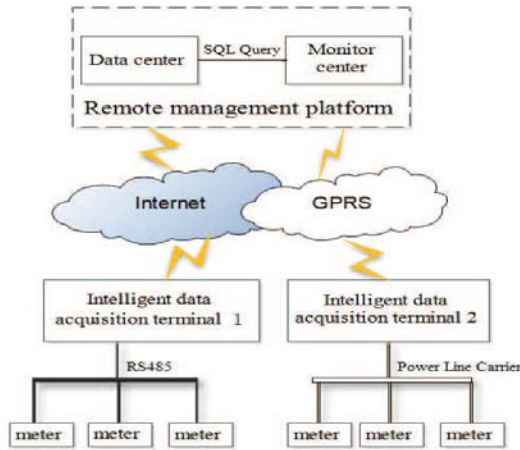


Fig. 1: Remote Monitoring of Energy Management Data

The remote management platform achieves the remote monitoring, save, analysis and management of energy data. The intelligent data acquisition terminals composed of online Data Acquisition module (including RS-485 Module and Power Line Carrier Module), Microcontroller system, GPRS DTU, and Human-machine interface. The online Data Acquisition module which uses both RSM3485ECHT made by Electronic and Power Line Carrier made by East Soft as the downlink communication interface is responsible for data acquisition and control of Electric Energy meter. Using a Human-machine interface made up of button and LCD (liquid crystal display) is to meet the needs of site management and setting. GPRS DTU implements the transmission of the remote signals by GPRS network. Microcontroller system is made up of the STM32 controller, clock circuit and resets circuit. It is used to read the data of the electric energy from the data acquisition module and exchange the data with the remote management platform by GPRS DTU. STM32 MCU is connected to RSM3485ECHT, Power Line Carrier and GPRS DTU respectively through the serial port.

II. LITERATURE REVIEW

Konark Sharma, Lalit Mohan Saini, and Power-Line Communications for Smart GRID: Progress, Challenges, Opportunities and Status, Renewable and Sustainable Energy Reviews, Vol.67, 704-751, 2017.

Power line communication (PLC) has turned out to be helpless to the cutting edge control transmission/circulation frameworks with end-to-end correspondence capacity, considered as a progressive and transformation administration of existing power grids. All the more critically, with late headways in PLC mechanical direction, institutionalization and confirmation have impelled a considerable measure of enthusiasm for the field of cutting-edge correspondence and control advances for heterogeneous systems. These headways are required to extraordinarily upgrade proficiency and dependability of future power frameworks with sustainable power source assets and conveyed insight and request reaction (DR) programs. As different national and universal associations have begun to draw PLC controls, gauges and advancements for nations, these models plan to decide essential criteria, for example, data transfer capacity, balance writes, channel coding plans, working recurrence and electromagnetic ability limits from settled indoor/outside applications to shrewd framework (SG) applications. Contingent upon the overall PLC direction, institutionalization, and mechanical advancements, security plans worked around them can wind up interoperable from a standard perspective, yet at the same time, have inconsistent arrangements or distinctive development levels, or incorporate non-institutionalized PLC capacities. Moreover, the PLC-based systems/solutions for renewable energy integration, are also surveyed regarding distributed-power system (DPS) and distributed energy resources (DERs) units monitoring/controlling and management purposes. Subsequently, a specific area is devoted to PLC-based system/arrangements usage of sustainable power sources (RESs) in SG covering all parts of a monotype. The smart grid (SG) technologies are attracting growing attention

owing to their inherent capacity to realize sustainable energy management system by using intelligent grids for prospects. SG infrastructures require an interactive, bi-directional communication technique/platform between power grid companies and consumers for enhancing the energy efficiency, safety, and reliability of electricity transmission systems. For this purpose, power-line communications (PLC) have proven to be a feasible alternative, which gives favorable promises for end-to-end communications, from the level of household electric appliances, monitoring/controlling applications to distributed generation (DG) level based management/control applications with a 'free' existing network, as shown in. As compared to wireless access technologies (i.e. general packet radio service (GPRS), the universal mobile telecommunications system (UMTS), radio frequency (RF) mesh-based system, worldwide interoperability for microwave Driven by the surging demand from electric utilities and rising investments in extensive SG infrastructures the global market for PLC is projected to exceed.

Existing underground cabling and overhead lines of SG infrastructures allow for low-cost adaptation of PLC technologies. With the latest regulation, standardization and certification in PLC technologies, worldwide growth is also projected for the PLC systems market in various end-user applications (i.e. advanced metering infrastructure (AMI), remote telemetry systems, high-speed broadband internet access equipment, vehicle automation, end-to-end communications, smart home, electric vehicle charging, as well as in micro-inverter for alternative sources of energy, lighting and temperature monitor/control). It is critical to analyze the PLC systems security threats and vulnerabilities exploited by attackers, due to the increased PLC technological standardization and certification, improved connectivity and openness to the SG networks, and increased use of PLC based hardware and software protocols, and the SG infrastructure is getting more vulnerable to internal/external security attacks.

III. PROPOSED ARCHITECTURE

Since GPRS is cost-effective compared to SMS, monitoring of energy meters at a lower cost is made possible. Daily consumption reports are generated which can be monitored through the Android application and/or web portal. Non-android users can monitor and pay their bills online. The system is more reliable, and accurate reading values are collected from energy meters. Live readings of the energy meter can be viewed through an Android application. The intensive human work is avoided, and all the values are maintained in the central server. The communication medium is secure, and tampering of energy meters can be identified easily. Hire feedback control is braved for the input of microcontroller in microcontroller using to the controller the load of the circuit.

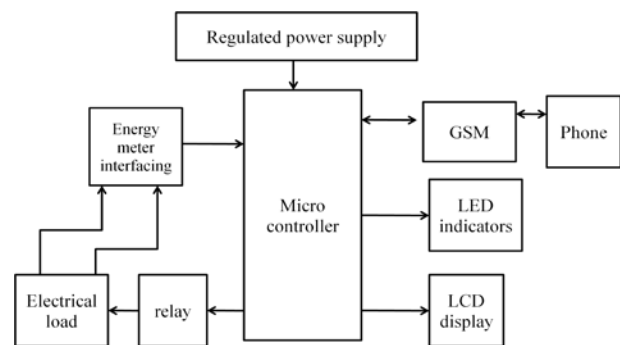


Fig. 2: Proposed Architecture

Block Diagram Explanation

- Energy meters are the basic part to measure the power consumption for the load. It is used everywhere, no matter how big or small consumption it is. It is also known as watt-hour meter.
- The microcontroller is the main part of the overall system it will collect the energy meter reading, and send that data to the consumer mobile via GSM.
- If the consumers will shut down the load system .they send SMS to the microcontroller via GSM device.
- At long last, the microcontroller will trip the heap circuit utilizing a relay.

- Transfers comprise of a coil encompassing a reed switch. Reed switches are regularly worked with a magnet, yet in a reed hand-off, current moves through the coil to make an attractive field and close the reed switch.

Regulated Power Supply

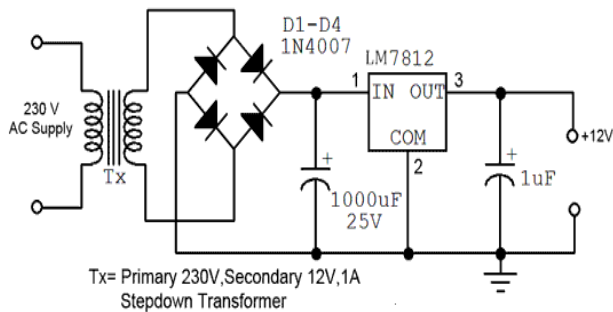


Fig. 3: Regulated Power Supply

A controlled power supply is an implanted circuit; it changes over unregulated AC into a steady DC. With the assistance of a rectifier, it turns over AC supply into DC. It can supply a constant voltage (or less regularly present), to a circuit or gadget that must be worked inside certain power supply limits.

- As appeared in the figure, the two fundamental parts of a managed control supply are a straightforward power supply and a voltage directing gadget. The power supply output is given a contribution to the voltage managing gadget that gives the result. The voltage yield of the power supply stays consistent independent of extensive varieties in the information AC voltage or yield load current.
- The potential divider is a single tapped resistor connected across the output terminals of the supply.

PIC Microcontroller Architecture

Peripheral Interface Controller (PIC) is microcontroller created by Microchip; PIC microcontroller is quick and simple to actualize program when we think about different microcontrollers like 8051. The simplicity of programming

and simple to interfacing with different peripherals PIC ended up fruitful microcontroller.

We know that the microcontroller is an integrated chip which consists of RAM, ROM, CPU, TIMERS, and COUNTERS, etc. PIC is a microcontroller which also consists of ram, rom, CPU, timers, counter, ADC (analog to digital converters), DAC (digital to analog converter). PIC also supports the protocols like CAN, SPI, UART for interfacing with other peripherals. PIC mainly used modified Harvard architecture and also supports RISC (Reduced Instruction Set Computer) by the above specification RISC and Harvard we can see easily that PIC is faster than the 8051 based controller which is made-up of Von-Newman architecture.

PIC Microcontroller Architecture

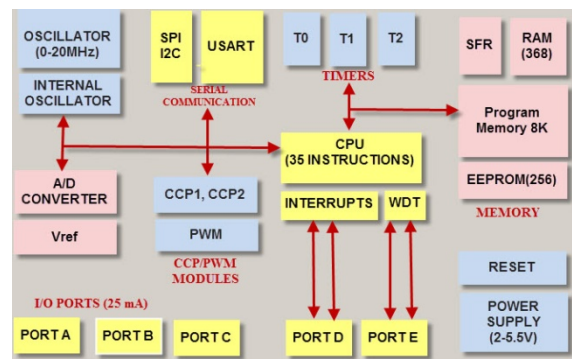


Fig 4: PIC Microcontroller Architecture

Pin Diagram for PIC 16F877A

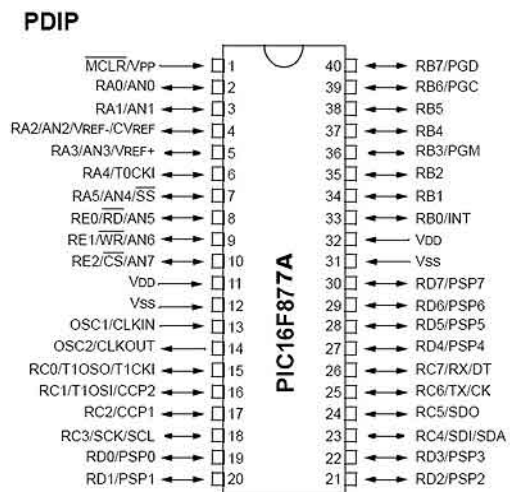


Fig. 5: PIN Details for PIC controller

GSM Module

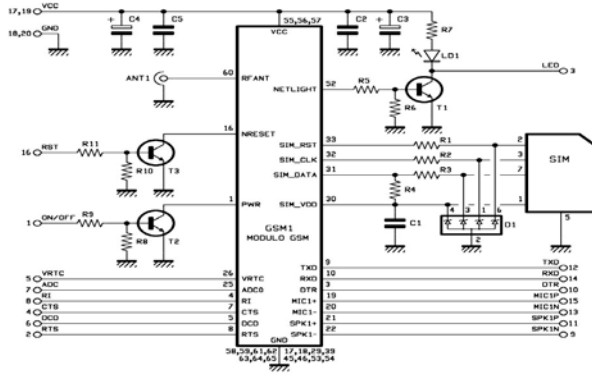


Fig. 6: GSM Module

The GSM module is used to establish communication between a computer and a GSM system. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. Is an extension of GSM that enables higher data transmission rate. GSM/GPRS module consists of a GSM modem assembled with a power supply circuit and communication interfaces (like RS-232, USB, etc.) for the computer. GSM MODEM is a class of remote MODEM device that is intended for correspondence of a PC with the GSM and GPRS organize. It requires a SIM (Subscriber Identity Module) card simply like cell phones to actuate correspondence with the system. GSM MODEM is a class of wireless MODEM devices that are designed for communication of a computer with the GSM and GPRS network. It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network.

LCD

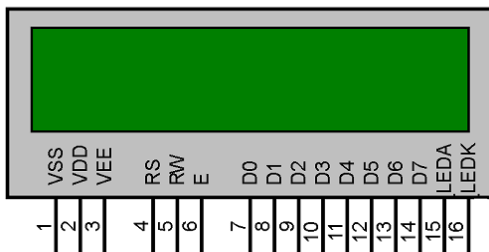


Fig. 7: LCD Display

The Flat screen LCD and plasma screens work in a completely different way. In a plasma screen, each pixel is a tiny fluorescent lamp switched on or off electronically. In an LCD television, the pixels are switched on or off electronically using liquid crystals to rotate polarized light. Short for the fluid precious stone show, a kind of show utilized as a part of advanced watches and numerous convenient PCs. LCDs use two sheets of polarizing material with a fluid precious stone arrangement between them. An electric current went through the fluid makes the precious stones adjust with the goal that light can't go through them. A fluid gem show (LCD) is a level board show or another electronically balanced optical gadget that uses the light-tweaking properties of changeable precious stones. Liquid crystal doesn't transmit light straightforwardly, rather than utilizing a backdrop illumination or reflector to create pictures in shading or monochrome.

Relay

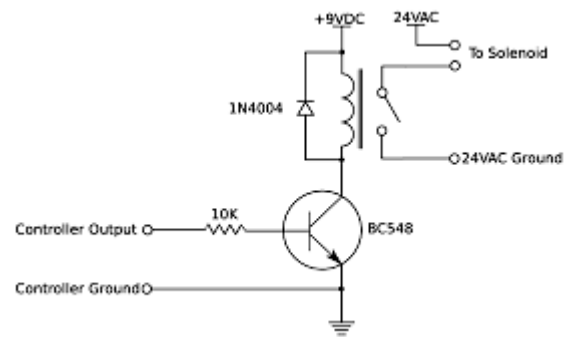


Fig. 8: Relay

The relay is the device that opens or shuts the contacts to cause the task of the other electric control. It identifies the excruciating or bothersome condition with a doled out territory and gives the charges to the electrical switch to separate the influenced region. Consequently shields the framework from harm. It deals with the guideline of an electromagnetic fascination. At the point when the circuit of the transfer detects the fault current, it empowers the electromagnetic field which creates the transitory attractive field. Rome. The magnetic field moves the armature for opening or closing the connections. The little power transfer

has just a single contact, and the powerful Relay has two contacts for opening the switch. The inward area of the transfer appears in the figure below. It has an iron center which is twisted by a control loop. The power supply is given to the curl through the contacts of the heap and the control switch. The present courses through the curl deliver the attractive field around it. Because of this attractive field, the upper arm of the magnet pulls in the lower arm. Subsequently shut the circuit, which makes the present move through the heap. On the off chance that the contact is as of now shut, at that point, it moves oppositely and consequently opens the contacts.

Energy Meter Interfacing



Fig. 9: Energy Meter Interfacing

It is the popularly known and most common type of age-old watt-hour meter. It consists of a rotating aluminum disc mounted on a spindle between two electromagnets. The speed of turn of the plate is corresponding to the power, and this power is incorporated by the utilization of counter component and gear trains. It comprises two silicon steel laminated electromagnets, i.e., series and shunt magnets. Arrangement magnet conveys a loop which is of few turns of thick wire associated in arrangement with the line while the shunt magnet conveys curl with numerous turns of thin wire associated over the supply. Breaking magnet is a perpetual magnet which applies the power inverse to ordinary circle revolution to move that plate at the adjusted position and to stop the circle while control is off.

The present flowing and shunt magnet delivers the motion relative to the voltage. These two transitions slack by 90 degrees because of inductive nature. The connection of these two fields produces a vortex current in the circle,

applying a power, which is relative to the result of momentary voltage, current, and the phase angle between them.

Vertical axle or shaft of the aluminum plate is associated with the adapt course of action which records a number, corresponding to the number of upsets of the circle. This rigging course of action sets the number in a progression of dials and shows vitality expended after some time. This sort of meter is basic in development and precision is to some degree less because of crawling and other outer fields. A noteworthy issue with these sorts of meters is their simple inclined to altering, prompting a prerequisite of an electrical vitality checking system. These are ordinarily utilized as a part of household and modern applications.

IV. CIRCUIT DIAGRAM

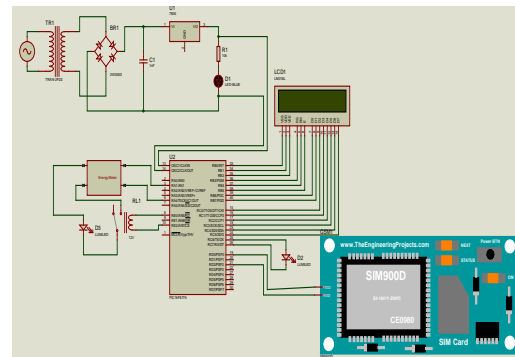


Fig. 10: Circuit Diagram

Circuit Explanation

The power will reduce the voltage from (230-12) v. Energy meters are the basic part to measure the power consumption for the load. The energy meter will measure the load value. It is used everywhere, no matter how big or small consumption it is. It is also known as watt-hour meter. The microcontroller is the main part of the overall system it will collect the energy meter reading, and send that data to the consumer mobile via GSM. If the consumers will shut down the load system .they send SMS to the microcontroller via GSM device. Finally, the microcontroller will trip the load circuit using a relay.

V. RESULT AND DISCUSSION

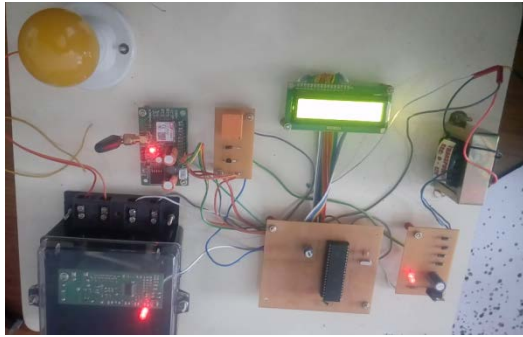


Fig. 11: Hardware Model for the GSM based EB Meter

Hardware Output

Parameters	Specification	Input	output
Power supply	Step-down	(0-230)V	(230-12)v
PIC 16f877A	Controller	(0-5)v	control
GSM	Message alert	(0-12)v Dc	Alert
Load	R load	(0-230)v DC	10 watts
LCD	Display	(0-12)v	Indication

Advantages

- Increased speed of reading
- Can save cost on labor
- It solves the problem of human error in meter reading

Application

- Industries for energy measurement.
- Home automatic control system for load system.

VI. CONCLUSION

The best possible administration of electrical vitality and additionally to raise the level of awareness among the general population about the use of electrical power definitely, smart metering is the best answer for this viewpoint. Improvement of smart metering with the utilization of GSM innovation gives huge focal points over the beforehand created in this system. The prime prospect of this venture is to actualize remote electronic observing and portable charging framework. This system will keep the power burglary by treating the vitality meter concerning customary observing it. In addition, it diminishes the required workforce for meter readings and additionally diminishing human mistake factor nearly nil, since the perusing of meter is advanced at this point. Along these lines a cost-productive and effortlessly understandable

administration of programmed meter perusing and electronic meter billing are a guarantee.

REFERENCES

- [1] K. Sharma and L.M. Saini, "Power-Line Communications For Smart Grid: Progress, Challenges, Opportunities And Status", *Renewable And Sustainable Energy Reviews*, Vol.67, Pp. 704-751, 2017.
- [2] R. Ionel, L. Pitulice and G. Vasiiu, "Implementation of a GPRS based remote water quality analysis instrumentation", *Measurement*, Vol. 65, Pp. 81-93, 2015.
- [3] D.S. Kim, S.Y. Son and J. Lee, "Developments Of The In-Home Display Systems For Residential Energy Monitoring", *IEEE Transactions On Consumer Electronics*, Vol. 59, No. 3, Pp. 492-498, 2013.
- [4] J. Kedia, A. Jain and D. Kumar, "Smart And Intelligent GSM Based Automatic Meter Reading System", *International Journal Of Engineering Research & Technology*, Vol. 1, No. 3 Pp. 1-6, 2012.
- [5] X. Wang, L. Ma and H. Yang, "online Water Monitoring System Based On Zigbee And GPRS", *Advanced In Control Engineering and Information Science*, Vol.15, 2011.
- [6] M. Lee, Y. Uhm, Y. Kim, G. Kim and S. Park, "Intelligent Power Management Device With Middleware Based Living Pattern Learning For Power Reduction", *IEEE Transactions On Consumer Electronics*, Vol. 55, No. 4, Pp. 2081-2089, 2009.
- [7] T. Jamil, "Design And Implementation of A Wireless Automatic Meter Reading System", *Proceedings of The World Congress on Engineering*, Vol. 1, Pp. 217-221, 2008.