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GSM Interfaced Intelligent Energy Meter for Energy Management

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Abstract

Efficient and intelligent energy management system is one the needs of the century. Energy meter reading is a tedious and an expensive affair. The proposed system provides an effective method to manage electricity efficiently. The system also proposes a method for automated bill calculation which in turn reduces human effort. It will reduce the laborious task and financial wastage if can automate the manual meter reading process and bill data entry process. The concept of load shunting is eliminated and hence the use of inverters can also be avoided. The proposed system hence is an intelligent energy management system.

Keywords: *Intelligent energy management system, automated bill calculation, manual meter reading process, bill data entry process*

1. Introduction

The main objective of the proposed system is to develop a GSM based energy management system for electricity board to efficiently manage load shunting time by disconnecting only the high current devices for a defined time. GSM module efficiently communicate with consumer and electricity board and according to the usage the message will be sent from electricity board to each and every consumers mobile according to their needs.

Nowadays decrease in power consumption is done by load shunting. During this time period user is forced to use an inverter. While using an inverter it causes more power loss (40%) while charging the battery. This is the drawback of the existing system. One of the other drawbacks is that one employee of the electricity board has to periodically take the readings by visiting each household which is very difficult.

In the proposed system only the high current devices are switched off during the load shunting time. This system eradicates the necessity of using an inverter. A high current request can be given in case of emergencies which might be granted by charging an extra amount for that period of time. Automated bill generation is yet another feature of this system. The requirement of a person to collect bill, connect or disconnect the power, etc can be done automatically through GSM network, directly from electricity board. This totally reduces human effort along with the decrease in the consumption of power.

2. Related works

In [1] paper presents a single phase electrical energy meter based on a microcontroller from Microchip Technology in PIC family. Energy consumption is stored in the microcontroller's EPROM memory. As soon as the supply is restored, the meter restarts with the stored value.

In [2], realizes the functions of prepayment management and load control that pay of energy first & use it afterwards, the data can be exchanged between Energy meters and Energy supplying department by RF cards. The information can be transmitted in a non-contact way. In this way, the purpose of automatic identification can be achieved.

3. Motivation

3.1 Real life motivation

The main real time motivation is the system is that it manages electricity efficiently. Automated bill generation in the system is yet another motivation toward this project.In the present scenario trauma faced by various users in time of load shunting is very high. Large power consumption by the inverters for charging increases the consumers bill amount. Inconvenience for the users in knowing the bill amount is yet another disadvantage. There is only very less interaction between the electricity board and the user. Increased human effort is required for periodically taking the reading from each household, which is tedious.

3.2 Technical motivation

Modern technologies based on GSM is being developed day by day. Development of a microcontroller based energy meter is an existing technology[1]. The thought of developing such an energy meter came from these technologies. There are existing energy meters which has the facility of automated bill generation and prepayment of bill[2]. By integrating the GSM technology with the existing systems an efficient energy meter could be developed.

4. Problem domain

The high consumption of power in the households is one of the major challenges faced by the electricity board these day. The proposed system manages power consumption effectively. The use of inverters is on the rise and its usage results in consumption of 40% more energy. Yet another development in the system is the two power lines one for high and the other for low. Hectic human effort is required in the current system for the meter reading and bill generation. Automated bill generation is yet another proposed feature. Communication between the user and the electricity board is very poor in the current system.

5. Problem definition and statement

GSM module efficiently communicate with consumer and electricity board.Embedded system as microcontroller helps to control the two drivers which are connected to high power and low power devices.Embedded-C as basic 'C' program is used to program this module. Direct interaction between the electricity board and the consumer takes place through the GSM module. The switch provided in the system can be advantageously used for high current request. Automated bill generation is done and an sms is send to the consumer's phone which is not done in the present system.

6. Problem issues

The proposed system eliminates the need for using an inverter in the households. Efficient and intelligent energy management can be achieved through this system. There is more interaction between the consumer and the electricity board. The consumer has the accessibility to a switch which sends a request to the electricity board for high current request during the high current shut down time period.

7. Problem capture

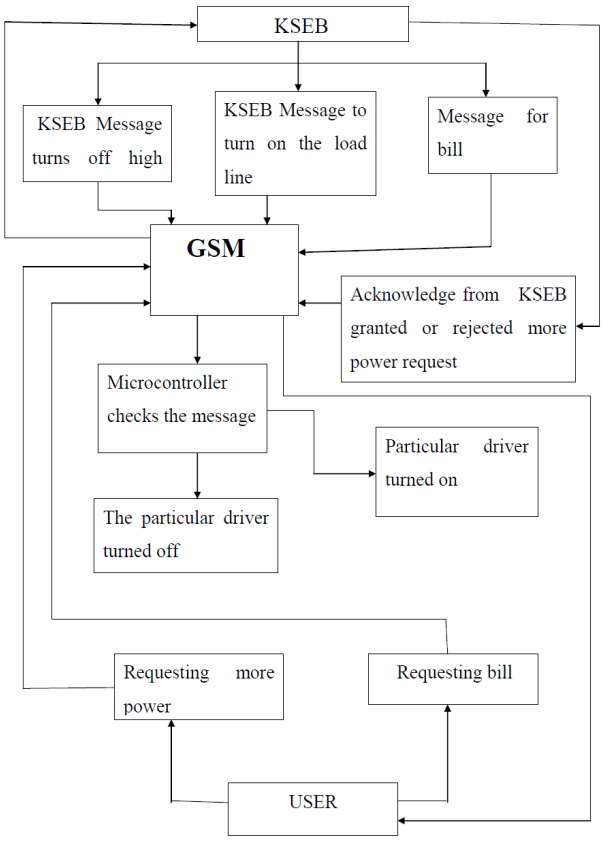

Fig.1.Block diagram of GSM interfaced energy management system

Fig. 1 shows the block diagram of GSM interfaced intelligent energy management system.The block diagram consists of micro controller, GSM, relay, driver , switch and energy meter.

ATmega8 Micro Controller is used here.12V SPDT Relay is used for switching in between the low and high voltage line. Switch used here generally is a SPST.A Single Pole Single Throw toggle switch connects or disconnects one terminal either to or from another. It is the simplest switch. GSM is the communication link used between the user, KSEB, and to and from Micro Controller. The microcontroller works in the operating range 4.5V-5.5V. It is an 8 Bit Micro Controller, the main advantage is High Performance and low power. 12V SPDT Relay is used for switching in between the low and high voltage line. This is a high quality single pole double throw (SPDT) sealed relay. Use them to switch high voltage, and/or high current devices. The coil

voltage on this relay is rated at 12VDC, and the load current is rated up to 10A. Driver is usually a BC547 Transistor, its main advantage is low noise and High Voltage. Switch used here generally a SPST.

A Single Pole Single Throw toggle switch connects or disconnects one terminal either to or from another. It is the simplest switch.GSM is the communication link used Between the user, KSEB, and to and from microcontroller. A GSM SIM300 is used here for communication. GSM MODEM TTL is built with dual band GSM/GPRS engine SIM300, works on frequencies 900/ 1800 MHZ. The Baud rate is configurable from 9600-115200 through AT command. The GSM /GPRS modem is having internal TCP/IP stack to enable you to connect with interest via GPRS. It is suitable for SMS. Voice as well as DATA transfer application. GSM - GSM Modem is interfaced with the microcontroller through RS232 converter. At first the Micro Controller check for message from KSEB, and according to the message through driver and relay the load line is connected or disconnected from main power.

There are certain commands used for the communication between the user and the electricity board. Reply messages are send through the GSM module to the user and the KSEB according to who has send in the command through the GSM module.

The commands are as follows

High power request (From user to the electricity board)
-Requesting high power during high power shut down time

Grant high power(From electricity to the user)
-Grant high power to the household during the high power shutdown

Status(From electricity board to the user)
-Request for current power usage status for the electricity board

All on(From electricity board to the user)
-Switch on both the high and the low power

Off(from electricity board to the user)
-Switch off both the high and the low power

X(From electricity board to the user)
-Clear all the current bill status values

Bill request(From user to the electricity board)
-Request the board for the current bill amount status.

In case if the consumer/user need extra current, Switch is turned on, and correspondingly an SMS is sent to KSEB. The consumer/user have to pay extra charge for units used. The Micro Controller Updates the Meter Reading regularly.If user request for current meter reading, an SMS is sent to user. The KSEB communicates to the Energy Meter via GSM.

8. Algorithm

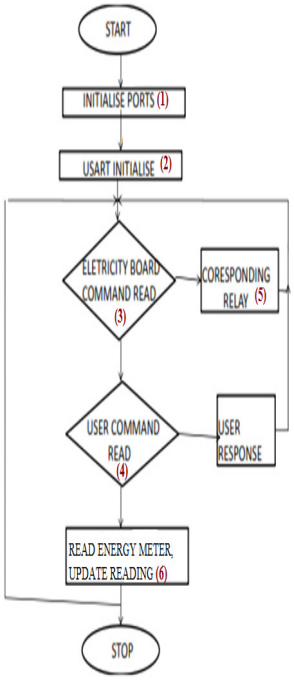

Fig 2. Algorithm for the microcontroller

9. Circuit diagram

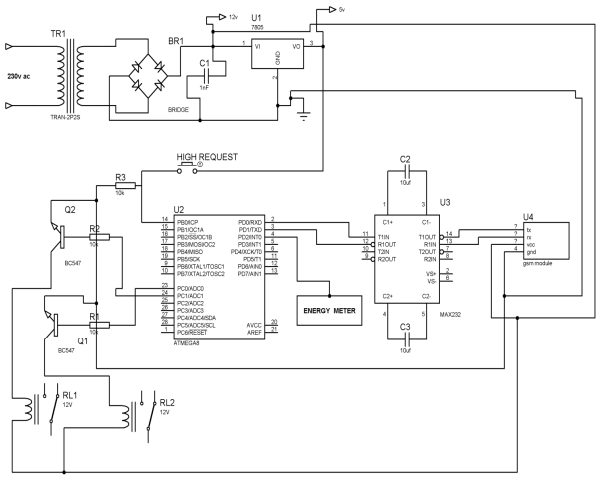

Fig.3.Circuit diagram of GSM interfaced energy management system.

The power supply unit consist of a transformer, a bridge rectifier, capacitor and voltage regulator.7805voltage regulator is used to obtain 5v for proper working of microcontroller and other components.ATMEGA8 microcontroller is interfaced with GSM module. Direct communication between GSM module and microcontroller is not possible because it works in TTL and RS232 configuration respectively.RS232 is used for connecting ATMEGA8 to GSM module for proper communication.

The message from the electricity board is received by the GSM module and it transmits the message to the microcontroller. The microcontroller initialises the ports. During load shunting time according to the message from the electricity board the high power supply is turned off .Otherwise both the high power and low power is on.BC547 transistor works as driver. When port are turned on correspondingly transistor base will conduct due to 5v power supply. Two drivers are connected to the relays. The relays in turn is connected to the high power and low power devices.

Energy meter produces pulses according to the usage of power in the household. And according to the number of pulses, meter reading is calculated. A switch is provided to the consumer for requesting high power. When the user press the switch a request is sent to the electricity board through the GSM module. If the electricity board grants the high power, correspondingly the GSM module receives a message from the electricity board and it switches on the driver in turn the relay is switched on. Charge per pulse is increased during this time period.

9.1 Microcontroller

Microcontroller ATmega8 is used, which shows high performance.ATmega8 is an 8 bit microcontroller.

9.2 Relays

It is an electromechanical switch. It can be used to control the high power circuit and low power circuits. Here two relays are used.

9.3 GSM module

Here SIM300 is used. It is used for the communication between the consumer and the electricity board.

9.4 Data communication equipment

RS232 is used. It is used for the proper communication between ATMEGA8 and the GSM module.

9.5 Energy meter

Works similar to the existing energy meter. It has an LED which keeps blinking according to the amount of energy consumed.

10. Input-output model

10.1. Power Supply

Input : 230v ac
Process : Transformer output is given to a bridge rectifier which then filters to give 12v dc output
Output : 12v rectified dc

10.2. IC 7805

Input : 12v dc
Process: It acts as voltage regulator which always gives 5v output for any input voltage
Output : 5v dc

10.3 GSM SIM300 module

Input : Command from KSEB and user
Process : It works on RS232 standard. It is used for voice communication , SMS etc. Both KSEB and user can communicate with energy meter through this
Output : Corresponding signals to microcontroller

10.4. IC MAX232

Input : Signals from GSM module in RS232 standard
Process: The drivers inside this IC converts RS232 std signals to TTL std signals and vice versa. This can be used to interface microcontroller with GSM module.
Output: Signals to microcontroller in TTL standard

10.5 SPDT RELAY 12v

Input : Signals from microcontroller through relay driver
Process: The power from microcontroller is not sufficient To control the relay. Hence relay drivers are used so that a change in driver due to controller can make the relay turn on and off
Output: Signals to high and low current loads.

11. Result

The intelligent energy meter accomplishes all the proposed features. Power management has been acquired to a very large amount. The usage of inverters has been eliminated completely. High power request ability and direct communication between the consumer and the electricity board has been achieved.

Fig. 6 Intelligent energy meter

12. Comparison of results

In the current system energy meter is just a measuring device of power. It has no other facilities or features other than this. The proposed intelligent energy meter is an efficient system which has the facility to provide with high power and low power as per requirement. High power request service is also a new feature. Automated bill generation is also an add on feature of the system.

13. Conclusion

In this paper the working of the intelligent energy meter has been verified. The switch provided for the high power request works efficiently. All the communication through the GSM module between the consumer and the electricity board has been achieved. The use of inverters has been completely eliminated. This is the innovation toward the future power management system which is the need of the century.

References

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[2] Luo Yonggang P.A.V."*The design of Prepayment Energy Meter*". 10.110/MEC.2011.6025802