

Pre-paid Remote Energy Meter monitoring and Overvoltage Protection through Electricity using GSM Network

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Abstract- The aim of this paper is to develop a billing solution for energy consumption just like pre-paid taxi, mobile phone, petro card etc. The major drawback by using post paid system is there is no control of usage from the consumer's side and lot of wastage of power due to the consumer's lack of planning in electrical consumption. Since the supply of power is limited, there is a need to utilize electricity in efficient way. To overcome this, we are using pre-paid energy meter billing which deals with GSM for domestic power billing and transaction. In this project GSM technology is used for reading power consumption and updating the consumed units and available units at consumer point. In this the current is measured through an analog sensing circuit. The output of the sensing circuit is given to a combination of analog and digital circuitry whose output is given to the micro controller. The total number of units consumed is displayed on ARM9. By using GSM we can also recharge the units required, and complete the units till power gets disconnect. At the same time consumer will receive message if the units come to end.

Keywords- ARM9, ARM7 LPC2148, GSM Module, Energy meter.

I. INTRODUCTION

The billing process of electricity consumption which we are using at present is very long process and requires lot of man power. Many attempts have been made to design the energy meter with instant billing but till now the designed energy meters did not give any replacement for the system where the user has to connect the recharge card to recharging unit, and then the units will be loaded into recharge card [1]. In this proposed work we are implementing a prepaid electricity meter which utilizes the features of embedded system which is combination of hardware and software in desired functionality.

We connected the energy meter to electricity office which is interfaced through GSM network [5] and compares between the microcontroller and complier. With the use of GSM modem one can recharge the energy meter [2] with the help of mobile. Also the amount left for usage will be

continuously displayed on ARM9 and if the amount fall below certain minimum values then it can be indicated with the help of buzzer or through alert message to the authenticated number. By this, the consumption of units is purely based on the amount recharged. In this system over voltage detection [3] and protection takes place using current transformer which is interfaced to the controller through ADC with this whole process is done automatically. Hence, the probability of occurrence of error is negligible.

II. SYSTEM ARCHITECTURE

The old electromechanical induction meters are being replaced by more modern electronic instruments, which are more suitable for implementing modern tariff policies, such as different hourly tariffs. In the proposed work, the ARM7 & GSM unit is interfaced with the Energy meter of each house. Every house has a separate number, which is given by the corresponding authority. One GSM modem is present at the consumer side and another at electricity board office.

The block diagram of pre-paid electricity billing is shown in the Fig 1.

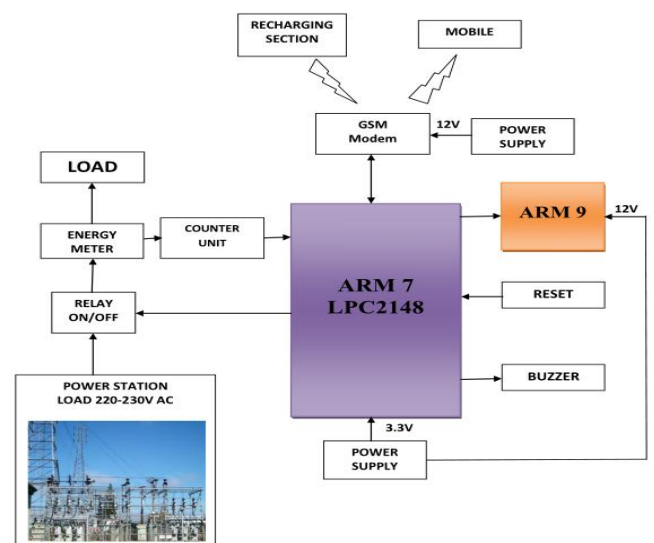


Fig 1: Block diagram

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A. Circuit description

The pre-paid functionality can be implemented using an electronic meter [2], which consists of LED, which blinks according to the power consumption. If the consumption is more, then LED will blink with a faster rate for which overvoltage [3] is detected and the power gets off due to excess amount of load given and if the consumption is less then LED will blink with slower rate. The LED blink receives train of pulses which is applied to one of the interrupt pin of ARM7.

The counter is activated at the interrupt pin, which counts the number of pulses that ARM controller while receiving and thus controller measure the amount of energy consumed in the household. With the help of GSM modem [4] one can recharge energy meter through mobile by SMS which can load the recharge amount in one of the register of controller.

For each pulses received at interrupt pin, the controller decrement the content of the register which is equivalent to the recharged amount left. If the content of the register falls below some level the controller activate the buzzer which indicate that amount left in the meter is low. If the contents of the register becomes zero then with the help of relay driver controller drive the relay which will disconnect the supply from the household [3].

On recharging the meter the controller connect the supply to the load with the help of relays. Thus, prepaid remote energy meter controls the power supplied to the household on the basis of amount recharged [7]. The ARM9 is also connected to ARM7 controller which displays the amount available.

III. SYSTEM HARDWARE

The basic hardware components used in the Project are shown below in Fig 2&3.



Fig 2: Power & Over load Protecting & Controlling section based on ARM7



Fig 3: Power & Over load monitoring Section based on ARM9

3.1 ARM 7 LPC2148 & ARM 9 Microcontrollers

ARM9TDMI based high-performance 32-bit RISC micro-controller with thumb extensions. 16kb on-chip ROM, 256kb SRAM, 32kb instruction cache, 32kb data cache, clock up to 208 MHz 3 channel multiplexed 10-bit ADC, RTC, and 32-bit general purpose high speed timer.

ARM7TDMI based on high performance, 32-bit RISC microcontroller with thumb extensions. 512kb on-chip flash ROM with in-system programming (ISP) & in-application programming (IAP), 32kb RAM, vectored interrupt controller [1]. Two ADC'S with 14 channels, USB 2.0 full speed device controller. Two UART'S, one with full modem interface, two I2C serial interfaces, two SPI serial interfaces. CPU clock up to 60 MHz

3.2 Relay

Relay circuit is interfaced with the energy meter and ARM7. Relays allow one circuit to switch on and second circuit which can be completely separate from the first. Relay circuit are used for switching the consumer's main switching line between cut-off mode or power-off mode and power supply on mode. It is proved to be very helpful feature for energy, which can remotely switch into cut-off mode from power on mode of any consumer energy meter due to overvoltage or number of consumed units remaining. It can reconnect the power supply after the consumer units gets recharged.

3.3 Energy Meter

An energy meter is a device that measures the amount of electrical energy consumed by a residence, business or an electrically-powered device.

Electric meters are typically calibrated in billing units [6]; the most common unit of measurement on the electricity meter is the kilowatt hour, which is equal to the amount of energy used by a load of one kilowatt over a period of one hour, or 3,600,000 joules. By convention a 'lagging' or inductive load such as a motor will have positive reactive power, A 'leading' or capacitive load will have negative reactive power. The meters fall into two basic categories, electromechanical and electronic. The electromechanical

induction meter operates by counting the revolutions of aluminum disc which is made to rotate at a speed proportional to the power. The number of revolutions is thus proportional to the energy usage. It consumes a small amount of power, typically around 2 watts.

3.4. GSM modem

GSM module is mainly used to introduce the pre-paid remote energy meter where GSM stands for Global System for Mobile Communication which is widely used for mobile communication architecture in most of the countries. The module that we use for GSM is SIM300 mini GSM Module for Communication [1]. We basically use this modem for Text sending and Receiving. GSM modem is suitable for long duration data transmission. To implement automatic meter reading system a GSM modem is connected to a microcontroller which would transmits data from a meter to cell phone and also receive command from cell phone to energy meter.

The modem will send unit or pulses (power consumption) on a regular interval or on a request. The voice pin in this modem is shorted and thus cannot be used. The AT command for Attention terminal are used by energy meter to communicate with the GSM modem [4]. It works from 3.6 - 4.6V maximum and consumes 250mA current in normal mode which can increase up to 1A when transmitting. It needs a heat sink in order to dissipate the heat that is developed.

IV. SYSTEM IMPLEMENTATIONS AND RESULTS

Fig 4 shows GSM based pre-paid remote energy meter Controlling & monitoring. In this the unit pulses (meter reading) count continuously according to load connected. Accordance to meter reading [5] the authorized number sends a SMS to GSM modem where an interrupt signal is occurred. ARM7 reads the pulse and unit from EEPROM and send the status of pulse and units to same authorized number and also displays on ARM9.



Fig 4: GSM based pre-paid remote energy meter when the power is ON

Fig 5 shows the meter pulse and unit detail in authenticated number that sends by remote energy meter reading [7]. After the proper reckoning the GSM will send a notification to authenticated number through SMS.



Fig 5(a)

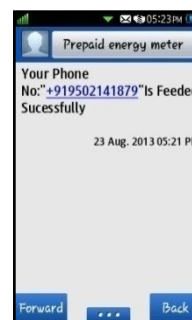


Fig 5(b)

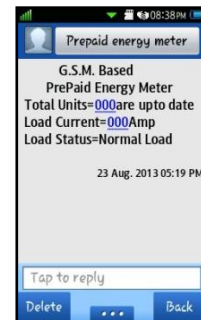


Fig 5(c)

**Fig 5: (a) Initialization of GSM
(b) Conformation message is received after giving a missed call to the GSM based energy meter
(c) Initial count of the units & Load current**

Fig 6 shows once recharge is done, corresponding units will be allotted according to the amount recharged [6] and depending upon the user power consumption, units will be decremented.

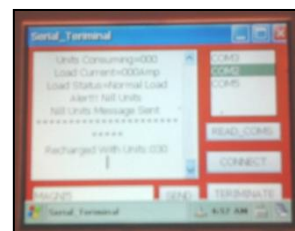


Fig 6(a)

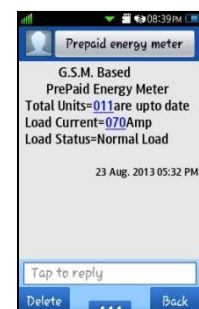


Fig 6(b)

**Fig 6: (a) Once the recharge is done the available units are displayed on ARM9 screen
(b) Instantaneously we can know the consumed units through SMS by giving a missed to the GSM modem**

Fig 7 shows, if over voltage occur [6] immediately the buzzer activates & simultaneously devices will switch OFF and the followed information is send as SMS to authenticated number.

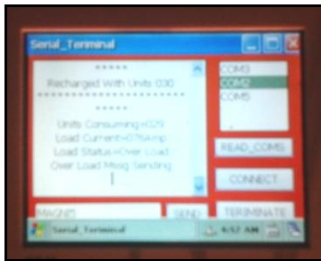


Fig 7(a)

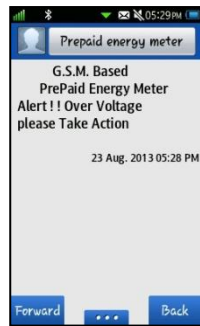


Fig 7(b)

**Fig 7: (a) if over voltage occur it display on ARM9 screen
(b) Simultaneously an Alert message is send to the authenticated number**

Fig 8 shows, if the total units completed immediately then the devices will switch OFF and an alert message to authenticated number.



Fig 8(a)

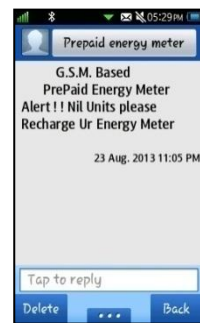


Fig 8(b)

**Fig 8: (a) If the recharged units are totally consumed the load gets OFF and the information will display on ARM9
(b) Simultaneously an Alert message is send to the authenticated number**

Algorithm:

Algorithm of pre-paid remote energy meter:

- Step 1.** Initialize ARM7, Energy meter, GSM & ARM9.
- Step 2.** Give a missed call to the authenticated number in GSM modem through mobile phone.
- Step 3.** Once the number gets registered through GSM modem to the electricity board office, the conformation message is sent to the mobile phone.
- Step 4.** If the authorized number is authenticated then it shows on ARM9 as “recharge your pre-paid account to attain the corresponding units”.
- Step 5.** Once the recharge is done according to the amount recharged the available units are displayed on ARM9 and also simultaneously, a message is sent to the authenticated number.

- Step 6.** When the power consumption is taken place the available units are decremented. The decremented units are known as “consumed units”.
- Step 7.** When it reaches the limited units, then the buzzer is activated & sends a alert message to authenticated number as “your recharge amount is very low, so please recharge your account to retain the units”.
- Step 8.** If the units are totally consumed, the relay gets activated & then the power supply turns OFF.
- Step 9.** Alternatively, if the overvoltage occurs, then the microcontroller activates the relay circuit so that the particular device (load) turns OFF.
- Step 10.** After the processing of STEP 8 & STEP 9 simultaneously, the required information is displayed on ARM9 screen as well as it sends an SMS to the authenticated number.
- Step 11.** If the above all process is not done accordingly to the authenticated number the system remains in stand-by-mode.
- Step 12.** Stop the process!

V. CONCLUSION

Paper is intended to present an overview of pre-paid energy meter, which can control the usage of electricity on consumer side to avoid wastage of power. Since there is need to utilize energy in better and efficient way, so this pre-paid meter proves to be a boon in the power sector.

This system is secure and reliable because it can be accessed only by authorized number. The distribution company has to receive huge amounts in the form of pending bills, which results in substantial revenue losses and also hurdles to modernization because of lack of funds.

Thus, the device has the capability to revolutionize the energy meter market and will become help to the country revenue by stopping current theft and punishing the dishonest customers.

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Bibliography:

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