

Microcontroller and GSM Based Digital Prepaid Energy Meter

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ABSTRACT:-A scheme of Electricity billing system called PREPAID ENERGY METER can facilitate in improved cash flow management in energy utilities and can reduces problem associated with billing consumer living in isolated area and reduces deployment of manpower for taking meter readings. Every consumer can buy a memory card (is nothing but an EEPROM IC) with a password stored inside it using a MC program. The memory card is available at various ranges (i.e. Rs 50, Rs 100, Rs 200 etc).In our project we have given the name for memory card as smart card. When the consumer insert a smart card into the card reader which is connected in prepaid energy meter with tariff indicator kit. The card reader will read the stored information and delete the information from the EEPROM IC (smart card) using the MC program. So that the smart card cannot be reused by others. Suppose if a consumer buys a card for Rs.50/- so on. He / She can insert this amount through the card reader so that prepaid energy meter with tariff indicator kit will be activated. According to the power consumption the amount will be reduced. When the amount is over, the relays will automatically trip, there is buzzer which will used to indicate user that you will recharge as early as possible. Another facility in this project is that if any one break the meter, the message will directly sent to the control room along with the meter number and will shutdown the whole electricity.

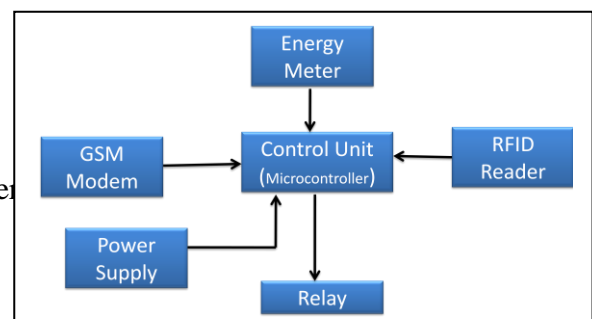
Keywords:-Microcontroller,GSM,LCD, Energy Meter,Relay,Load,RFID Reader

I. INTRODUCTION

Electronic energy meter has got numerous advantages over the conventional electromechanical meter and due to this; many countries of the world have switched to electronic metering system.[1] The present system of energy billing in India is error prone and also time and labour consuming. In order to achieve revenue improvement, it is essential to measure the energy consumed accurately, render bills quickly and collect the amount promptly.[2] Errors get introduced at every stage of energy billing like errors with electro-mechanical meters, human

errors while noting down the meter reading and error while processing the paid bills and the due bills. There are many cases where the bill is paid and then is shown as a due amount in the next bill. There is no proper way to know the consumer's maximum demand, usage details, losses in the lines, and power theft. The remedy for this drawback is prepaid energy billing, which could be titled "Pay first and then use it". Smart metering is such a complete end to end solution which minimizes the several errors[3].There are clear results from many countries, where prepaid system has reduced the wastage by a large amount. Another advantage of the prepaid system is that the human errors made during reading meters and processing bills can be reduced to a large extent. In this paper, the idea of pre-paid energy meter using ATMEL AT89S52 controller have been introduced. In this paper, energy meters have not been replaced which is already installed at our houses, but a small modification on the already installed meters can change the existing meters into prepaid meters, so this meters are very cheaper. The use of GSM module provides a feature of pre-paid through SMS. One can recharge meter with the help of mobile through SMS, on the basis of recharge amount, ATMEL controller count the amount of energy consumed and display the remaining amount of energy on the LCD. If the amount falls below certain minimum amount, then it will be indicated by the controller through buzzer, so the user can recharge rapidly. If the power consumption exceeds the predefined limit then the user will be informed through SMS so that he can take the required action. The entire system is designed with the state-of-the-art digital and information technology.

BLOCK DIAGRAM:-



Microcontroller calculates the energy consumed by the consumer utilizing the output of ADC through load section and programs loaded on the microcontroller.

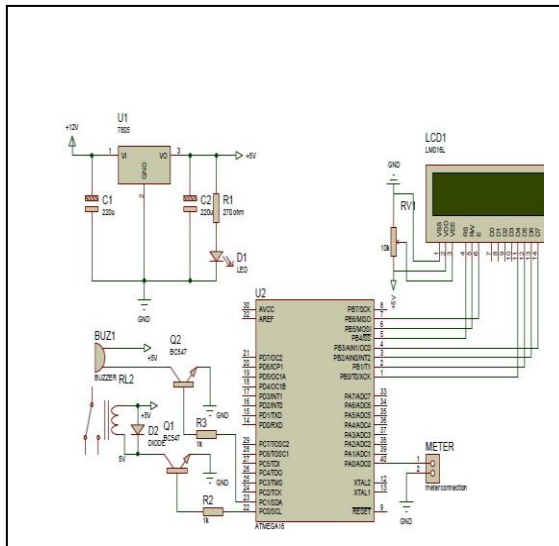
Voltage and Current controlling unit feeds the actual current and voltage of load connected to consumer side to the energy meter chip.

GSM interfaces with the microcontroller unit in which the number of units recharged by the consumer are written.

Relay mainly performs the opening and closing of a connection between energy meter and load through supply mains depending upon the number of units present at a moment.

Liquid Crystal Display shows the energy consumption, number of unit recharged by the consumer, rest of the unit and maximum demand.

CIRCUIT DIAGRAM:-



CIRCUIT DESCRIPTION:-

The circuit diagram of prepaid energy meter contains two parts (a) energy meter circuit (b) LDR circuit

(a) Energy Meter Circuit

The circuit diagram of energy meter circuit is shown in fig. (iii). it consists of a regulated power supply. The IC 7805 is a voltage regulator which is a 3 pin IC and is used to convert +12V into +5V. Now in our project where we need +5V supply we take it from output of IC7805 and where we required +12V supply we take from the input of IC7805. When the microcontroller atmega16 which is a 40 pin IC gets signals as soon as we smash the card from the RFID reader the system get activated and recharge is done for this purpose we used RFID tag as a smart card used for recharge

purpose. The recharge unit is stored in microcontroller and this recharge unit is display in Liquid Crystal display (LCD) and a message “recharge successful” also displays. Since the current produced by the microcontroller is only 50 mA which is very low to drive a relay that is why we are using transistor which is switched ON the relay. As the power is consumed the reading in the single phase energy meter (connected across X2-1 and X2-2) is increased and the unit in LCD is decreased by accordingly. When the balance reaches to certain amount then the buzzer starts indicating that we should recharge our meter soon. And if balance is nil then the relay is switched off and no electricity flows.

(b) LDR Circuit

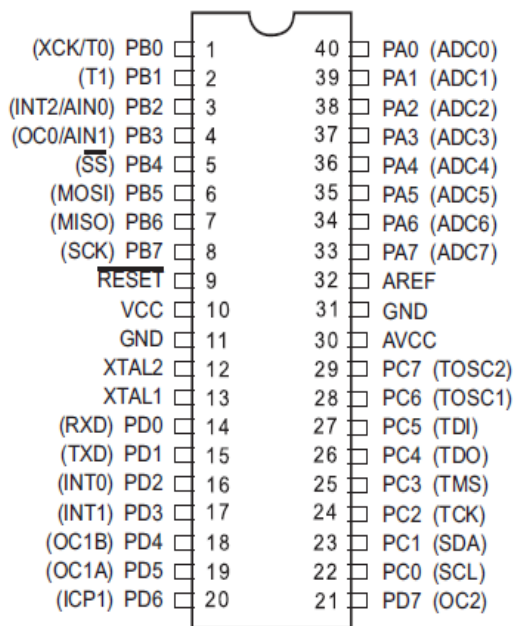
LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 10 MΩ, but when they are illuminated with light resistance drops dramatically. When the light level is low the resistance of the LDR is high. This prevents current from flowing. Consequently the LED does not light. However, when light shines onto the LDR its resistance falls and current flows. LDR Circuit is used to count the unit pulses. When the LED blinks for 10 times it counts the energy unit as 1. This will show in LCD of the main circuit and the recharge amount in the LCD is decreased. And accordingly to that reading is count and controller takes the decision.

II. WORKING:-

The present traditional billing systems have many problems like problem of payment collection, energy thefts etc. due to which the traditional billing system is slow, costly and unreliable. In this project we proposed and designed a prepaid energy meter using microcontrollers and smart card. When the consumer insert a smart card into the card reader which is connected in prepaid energy meter with indicator LCD. Then the card reader will read the stored information using the MC program. That smart card cannot be reused by others. Suppose if a consumer buys a card for Rs.50/- he / she can insert this amount through the card reader so that prepaid energy meter with indicator will be activated. According to the power consumption the amount will be reduced. When amount is reached at a certain level according to the program then it will automatically indicate the person by using buzzer. It gives alarm to alert them so that he/she can done his recharge on time. When the amount is over, the relays will automatically shutdown the whole system. In our project we also have another

provision to display remaining amount so that he can done his recharges on time also.

PIN DIAGRAM:-



PIN DESCRIPTION DISCRPTION:-

- VCC Digital supply voltage.
- GND Ground.
- Port A (PA7.....PA0) Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running
- Port B (PB7...PB0) Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running .Port B also serves the functions of various special features of the ATmega16.
- Port C (PC7..PC0) Port C is an 8-bit bi-directional I/O port with internal pull-up

resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5 (TDI), PC3 (TMS) and PC2 (TCK) will be activated even if a reset occurs. Port C also serves the functions of the JTAG interface and other special features of the AT mega

- Port D (PD7..PD0) Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated.
- Port D (PD7..PD0) Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated

III. COMPONENTS USED.

RFID

Radio Frequency Identification (RFID) systems were originally developed in the 1960's for automatic data capture based on radio frequency transmissions to identify rail carriages, personnel, and animals. Radio Frequency Identification (RFID) used electromagnetic energy as a medium for communication. The two basic components, a reader and a transponder, are connected to a host computer that controls the reader. The transponder consists of a single unit containing a radio receiver and transmitter. When the transponder receives a signal from the unit reader, it responds by transmitting its unique identification code and any other data that is requested in the form of a serial data stream. . The object of any RFID system is to carry data in suitable transponders, generally known as tags, and to retrieve data at a suitable time and place to satisfy particular application

needs. Data within a tag may provide identification for an item in manufacture, goods in transit, object location information, the identity of a vehicle, or animal identification. In addition to tags, the system requires a means of reading or interrogating the tags, and some means of communicating the data to a host computer.

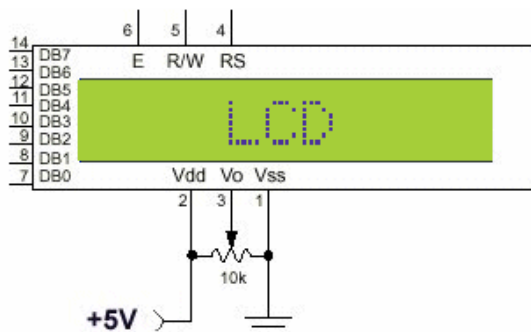
MICROCONTROLLER

➤ **atmega16 microcontroller:-**

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. AVR is a modified Harvard architecture 8 bit RISC single chip microcontroller which was developed by Atmel in 1996. AT mega 16 is high performance low power Atmel AVR 8bit microcontroller with 8kb of in system self programmable memory. There are 131 powerful instructions present in ATmega16. Most of single clock cycle execution and 32*8 general purpose working register, fully static operation.

LIQUID CRYSTAL DISPLAY

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other. Many microcontroller devices use 'smart LCD' displays to output visual information



RELAYS

A relay switch can be divided into two parts: input and output. The input section has a coil which generates magnetic field when a small voltage from an electronic circuit is applied to it. This voltage is called the operating voltage. Commonly used relays are available in different configuration of operating voltages like 6V, 9V, 12V, 24V etc. The output section consists of contactors which connect or disconnect mechanically. In a basic relay there are three contactors: normally open (NO), normally closed (NC) and common (COM). At no input state, the COM is connected to NC. When the operating voltage is applied the relay coil gets energized and the COM changes contact to NO. Different relay configurations are available like SPST, SPDT, DPDT etc, which have different number of changeover contacts. By using proper combination of contactors, the electrical circuit can be switched on and off.

GSM MODEM:

A GSM modem is a wireless modem that works with a GSM wireless network. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. There are several types of modems out there. Some are shown below.



Figure 18

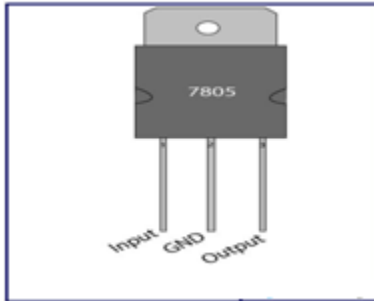
Fig. Wavecom GSM Modem Fig. SIMCON

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. GSM/GPRS module consists of a GSM/GPRS modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc) for computer. The MODEM is the soul of such modules.

VOLTAGE REGULATOR(7805)

7805 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed

voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.



BUZZER or BEEPER :-

A buzzer or beeper is an [audio](#) signaling device, which may be [mechanical](#), [electromechanical](#), or [piezoelectric](#). Typical uses of buzzers and beepers include [alarm devices](#), [timers](#) and confirmation of user input such as a mouse click or keystroke.

RESULT:-

A scheme of Electricity billing system called PREPAID ENERGY METER can facilitate in improved cash flow management in energy utilities and can reduce problem associated with billing consumer living in isolated area and reduces deployment of manpower for taking meter readings. Prepayment systems have been proposed as an innovative solution to the problem of affordability in utilities services. Installing this system over the conventional system may cause lots of changes, during this problems may occur.

CONCLUSION AND FUTURE SCOPE:-

VI. CONCLUSION

GSM based energy meter is to install and beneficial for both energy Provider and Customer. This reduces revenue cost, the human errors and problems like over running of the meter and over load. This leads to reduction of outstanding dues. This device improves usage level and energy monitoring. In the present work prepaid energy meter system is designed to continuously monitor the meter reading and to shut down the power

supply remotely whenever the recharged units become zero. It avoids the human intervention, provides efficient meter reading, avoid the billing error and reduce the maintenance cost. It displays the corresponding information on Mobile for user notification.

IV. FUTURE SCOPE

- The users are not bound to pay excesses amount of money, users have to pay according to their requirement.
- It can reduce problems associated with billing consumers living in isolated areas and reduce deployment of manpower for taking meter readings.
- Prepaid energy meter is more reliable and user friendly

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