GSM Based Energy Meter Billing With Load Control

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Abstract: Today the energy meter is placed in the domestic or commercial sites and collects the data of the energy consumed and displays it on either a number dial or digital display. At the end of every billing cycle the person from the service provider has to visit the place where the meter is placed to get the reading and to note it down for further bill generation. The present system of energy charge is fallible and also long. So the purpose of this project is to develop an energy meter which is used to measure the consumer's power consumption in kWh but also enable and support real consumption and, so meter reader does not need to visit each customer for the consumed data collection and to distributed the bill slip. The energy consumption is calculated using the measurement of voltage and current. It also continuously reads the energy meter readings and automatically sends some updates like low-balance alert, zero-balance alert, recharge alert when necessary, to the registered number through GSM modem. Illegal usage of power is detected and alert message is sent to the authorities immediately. The calculations of power and energy are executed by Arduino programming and message will send to the corresponding consumer regarding units' consumption and the bill amount .

Keywords: GSM, Energy Meter, Load Control, Arduino Project, Smart Billing System .

I. INTRODUCTION

Smart electrical energy meter technologies have been investigated and developed for approximately 10 years. Various technologies have been developed and used to measure the electrical consumptions. For the billing, the users will get the bill from the energy board after they generated and provided using the several methods. At the moment, most of the residences in Malaysia for example use the traditional electro - mechanical watt meters and the readings are not automated. The users will have to wait the bill of energy consumptions for every month to pay their energy bill. Normally, at the end of the month, a staff from the meter board billing will visit every house to read the meter reading and at the same time, give the bill to the users. An electricity meter or energy meter is a device that measures the amount of electric energy consumed to residence or business. There are two types of Domestic Ordinary Power Consumers meters single phase and three phases. The energy consumption is measured by all electrical services using kilowatt- hours meter with refer to kilowatt-hours (kWh). Then electronic meters were introduced with similar function with the electro-mechanical, but it replaces from analog to digital system. With this system users can note down the voltage, power reading unit, current and the time, date of the energy consumption. This system just gives some advantages over the previous meter reading. After the electronic ones, the meter reading developed with the Bluetooth based technology which is the wireless communication and also known as Automatic Meter Reading (AMR). This system is wireless and the personal computer could be used to record the power consumption of energy meter. The reading meter will be saved to the database and bill will be generated. The latest technology is using a Global System for Mobile Communication (GSM) based system. This system replaces the Bluetooth technology and the data sent using Short Message Service (SMS) to the customer and the energy board.

II. OBJECTIVES

1. To get the status of balance units at any instant of time by the user .
2. If the per day consumption of the user crosses the limit then an alert message will be sent to them .
3. Load control by the user through SMS.
4. The user can get the per day consumption of units for energy conservation .
5. The user will get bill through message.
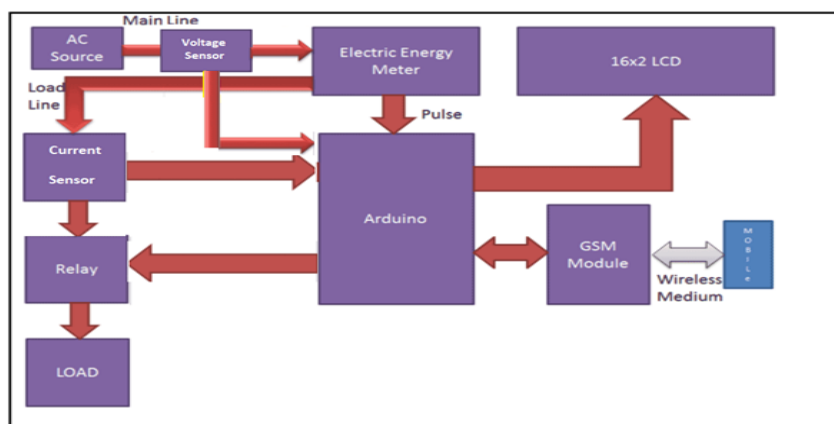
III.PROJECT METHODOLOGY

Fig.1 Block diagram of GSM based energy meter

In this project the microcontroller is powered with 5V supply from voltage regulator which provides constant voltage of 5V.The microcontroller is interfaced with 16*2 LCD display through four data pins which D4, D5, D6, D7 are connected to (9,8,7,6) digital pins of microcontroller respectively also with other pins are E and RS are connected to (10,11) digital pins of microcontroller respectively. The 16*2 LCD display is powered from 5V through VDD pin and VSS is connected to common ground of circuit. The VEE is connected to common ground through 1K resistor to maintain the proper brightness of LCD display. The R/W is kept low for write operation. The 16*2 LCD display is used here to monitor the parameter like voltage, current, power and unit balance. A GSM SIM800L module has been used for wireless SMS alert and information.. A GSM module is connected to Arduino microcontroller through serial communication ports. Arduino microcontroller has hardware serial ports assigned on digital pin 0 and 1, however a software serial library can be used in Arduino code for making any digital pins out of 14pin as serial pin (Rx,Tx) for serial communication purpose. The Rx and Tx pins of GSM module are connected to digital pin 2 and 3 of microcontroller respectively. An ACS712 current is used for measurement of load current which flows from distribution transformer. The current sensor used in project is of 30A rating. The current sensor has 3 pins viz. VCC, GND and Output. The current gives voltage output ranging from 0 to 5V which analog in nature. The output from current is connected to analog A4 pin of atmega328P IC in Arduino board. For measurement of voltage of AC power supply, a circuit is designed which gives the output in dc form which can be measured by Arduino microcontroller, the step-down transformer of rating 240/9V is used to step down the voltage in range of 9-10V then further it is connected to bridge rectifier. The Arduino microcontroller cannot read the analog voltage more than 5V. Hence a resistor divider circuit is implemented for getting voltage value less than 5V A 5V DC relay switch is used for controlling power to the load through microcontroller. Under normal condition the relay switch is set to normally closed (NC) condition by giving LOW signal from microcontroller to it. Whenever relay with gets HIGH signal from microcontroller it switches to the normally open (NO) condition. For project demonstration purpose, a basic energy meter has been used which has 3200imp/kWhr. The output of calibration LED of meter is given to the microcontroller via 4n35 optocoupler. The opto-isolator helps to isolate the low voltage side i.e. microcontroller end from high voltage AC side. The entire microcontroller and other auxiliary circuit is powered using a AC-DC bridge rectifier circuit. A 230/9V, 750mA transformer is used and the outage of this is given to the diode made bridge rectifier circuit for converting the AC voltage into DC, also a capacitor of 10µF is used as a filter. This gives the output DC voltage of 9V therefore for getting constant 5V DC to provide power to entire circuit a 7805-voltage regulator IC is used. In this project, when the power supply to the circuit gets turned ON the Arduino microcontroller starts executing the program code which initializes all the sensors, devices connected to it as per connection with the Arduino microcontroller. The program code initializes the LCD display after that it initializes the GSM module by setting the baud rate of 9600. The microcontroller gets the status of all pins one void setup loop runs. In the beginning the LCD display shows the name of the project. Also, it allows to GSM module to remain in ready condition for sending and receiving the live SMS. As per program code, we have kept the default value of unit balance in energy meter as '4' unit which is equivalent to 40Rs as we have set the tariff as 10Rs/unit. The microcontroller continuously monitors the amount of energy consumption for household load and keep updating the unit balance which can be used for giving alert messages to the mobile phones. The voltage sensor formed by voltage divider circuit, a 9V DC input given to series connected two resistor of values 100Ω and 220Ω. The outage from voltage divider circuit is taken across 100Ω resistor and gives voltage value around 2.9 V. It is connected to the analog pin A3 of the microcontroller. For measurement of voltage of power supply, a factor of value 80 is to be used for getting actual AC side voltage.
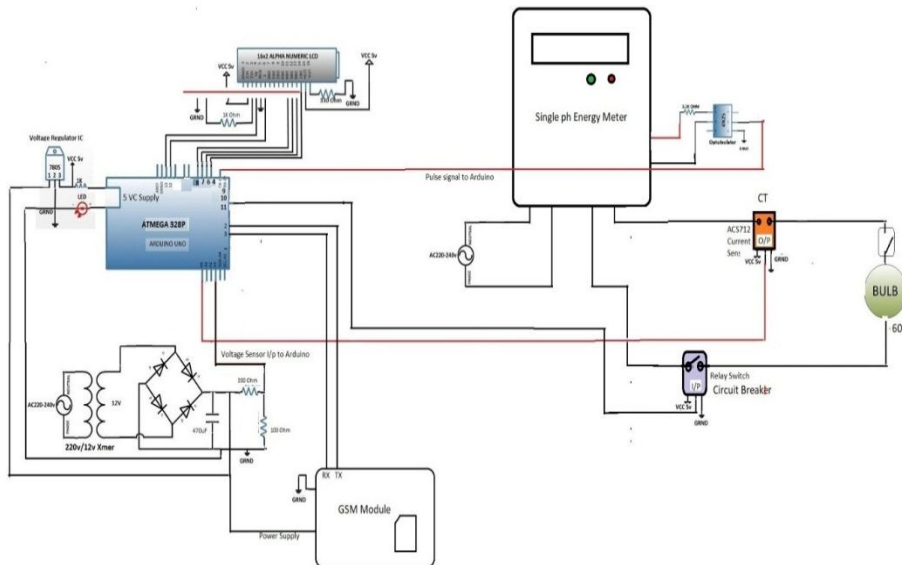
IV. WORKING OPERATION

Fig.2 Circuit diagram of GSM based energy meter

The value of voltage in volts stored in float variable called 'voltage' and it is continuously displaying on LCD for monitoring purpose also microcontroller uses the value of voltage stored in variable for power and energy consumption calculation. The ACS712 current sensor is connected to analog A4 pin of microcontroller and gives output in millivolts corresponds to the current flows through the load. A conversion factor 66 is to be used for getting actual amount of current flows in the circuit. The Atmega328p microcontroller has 10bit inbuilt ADC which converts input 0-5V analog signal to digital in range from 0 to 1024. The value of current in ampere stored in float variable called 'current' and it is continuously displaying on LCD for monitoring purpose also microcontroller uses the value of current stored in variable for power and energy consumption calculation. The GSM module connected to Arduino microcontroller receives AT command from microcontroller to begin the connection. The received AT commands allows the GSM modem to set in both sending and receiving the SMS. The microcontroller calculates the power and energy consumption by using the inputs from current and voltage sensors then it calculates the unit balance in the energy meter which has default balanced unit of value '4'. When the unit balance reduces to less than 4 units, microcontroller sends command to GSM modem for sending the low balance alert SMS to mobile phone to make a recharge of any designated recharge plans. If consumer fails to make a recharge upon receiving alert SMS then after reducing the unit balance in energy meter to less than 2 units, the microcontroller send a HIGH signal to relay to cut off the power supply a to the household loads and sends an SMS to mobile phone of consumer stating the power supply has been disconnected due to low balance. Once we made a recharge of some amount by sending text SMS 'Recharge_100' to the GSM modem, then it sends the SMS to the microcontroller reads the message and take necessary action as per the code. Thus, the microcontroller sends a LOW signal to relay to resume power supply, also microcontroller sends a return recharge confirmation SMS to the mobile phone via GSM module. The consumer also has a facility of getting the current unit balance in energy meter along with the current load connected the energy meter. For getting these details , consumer has to send 'Get_Status' to the GSM modem of energy meter, microcontroller reads this SMS via serial port serially and gives a return SMS to the GSM modem stating the current unit balance and amount of load in MW. This smart energy meter has a provision of controller household power supply remotely using GSM modem. To turn OFF the main power supply of house, consumer has to send a SMS 'Supply_OFF' to the GSM modem and consumer gets a confirmation SMS from energy meter mentioning the turning OFF status. To turn ON the power supply, consumer has to send SMS 'Supply_ON' to the GSM modem of energy meter, consumer receives confirmation SMS for the same.

V. RESULTS & DISCUSSION

The result is obtained , energy billing is obtained on phone through message, load is controlled through SMS , an alert message is received after the set units consumption value is exceeded , display all parameter values (i.e. balance units , power consumption) .

OBSERVATION TABLE :

Sr.no	Condition	Command	Message Received
1.	When the daily limit is crossed	-	Dear customer, Alert! Low balance in your energy meter having consumer no. 12341234.Please recharge to avoid disconnection of power supply, Thank you .
2.	When the supply is disconnected	-	Dear Customer, power supply has been disconnected of consumer no.12341234.Please recharge to resume the connection. 20.00Rs/- bill amount for your energy meter.
3.	When user wants to recharge	Recharge_100	Dear Customer, Recharge of Rs100 is successful on your energy meter . The power supply has been resumed.
4.	When user wants to check the status	Get_Status	Dear Customer, 7.64 units balance remained in your energy meter.
5.	When user want to Turn On the load.	Supply_ON	Dear Customer , power supply has been resumed by consumer no.12341234,Thank You.
6.	When user want to Turn Off the load.	Supply_OFF	Dear Customer ,power supply has been disconnected by consumer no.12341234,Thank You

RECHARGE COMMANDS TABLE :

Sr.no	Command	No. of units recharged
1	Recharge_50	5 unit
2	Recharge_100	10unit

VI. CONCLUSION

After the implementation of the GSM based energy meter billing with load control, it fulfils all the objectives of as proposed and all the results are obtained successfully .The proposed system would go a long way in making people conscious of the amount of energy they spend and help to conserve the conventional depleting resources .

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