# Design and Implementation of Prepaid Smart Energy Meter

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*Abstract—* **Energy meters in India have dominantly been electronic as well as mechanical in nature but in the recent times the trend is shifting towards a more advanced and accurate energy meters which are electronic in nature. Due to electricity theft, consumer not paying their bills on time, incorrect readings leads to loss of high percentage of electricity. This can be reduced by using smart energy meters. A correct billing system will solve this problem of unpaid bills and reducing human errors which ensures correct revenue. We also have heard of cases where during the situation of high voltage or if there is a spark then the consumer is not intimated on time which can cause serious concerns like fire. In the current system, the energy meter reading is done at consumers location by the supplier. This will consume more time and more labor. There also some cases where printed bills gets lost. If the users are not paying bills on time the supplier will have to disconnect the power supply which is also very time and labor consuming.**

*Index Terms:* **Smart grid, efficient, Privacy, Smart meter, Smart card.**

## I. INTRODUCTION

Modern day technology which forms a major part of smart grid technology focuses especially on two way communication between control center and load generation. The process of billing consumes more time if the user is not present in their houses while the supplier is noting down the readings. This requires a lot of manpower and time to solve this problem especially the generation of the bill. Also if user is not paying bill on time the supplier has to personally go to their houses to cut-off their power supply. This makes situation difficult to handle. The situation of power grid collapses is ensured to be secured in a smart grid technology. To protect this infrastructure and to enable an uninterruptable power supply to the consumers, the security system of smart grid technology is gaining importance in current times. Weakness in the security system can cause a serious concern for both supplier and consumer. Smart energy meter is an integral part of smart grid technology. Our main focus is to create an efficient smart energy meter that can be utilized by all the sections of the society at an economical price.

Manual billing is sometimes restricted and postponed by harsh weather conditions and in isolated areas. In the first section we discussed the abstract and problem statement that occurs with the traditional meters. In the next section we discussed all the previous related work that had already been done and how can we improve. In the third section we explained our system architecture along with it we have shown the circuit and model diagram. In the next section we explained all the results we got on our 16*2 LCD screen which is followed by conclusion and then in appendix we have shown the programming we did for phone recharge. We have also mentioned the references we have used in making of this project.

## II. RELATED WORK

In the earlier power grid systems, the control and load centers are confined to each other both visually and physically. In current times, the smart grid technology relies heavily on real time data from advanced metering infrastructure for proper distribution [1]. The cases of equipment malfunction and power grid collapse can be reduced by using a secure smart grid technology. The GSM technology along with the use of Arduino has already been implemented in smart energy meters. These meters can record energy readings and are capable to record other information like power factor, power outage, harmonics, etc [2]. The energy grid needs to be

managed in a distributive manner the absorbs different sources of energy. The feedback from consumer helps in recognizing the difference in usage between authorized and unauthorized users. GSM technology can be used to send SMS to concerned authorities regarding the cases of the theft. The major drawback of postpaid system is that there is no control of electricity usage in consumers point of view[3]. Advancement in technology has led to a fast information exchange at a very high speed. This will prevent wastage of excessive power and reduces human labor and time in the current metering system.

### III.MODEL DESCRIPTION

We will be designing a smart energy meter that can calculate load and units consumed automatically and also manually of a bulb connected to it[4]. It will be a prepaid meter that can be recharged by two ways firstly by a smart card which when will be swiped will recharge the meter again and secondly by your phone when you call the operator for which we will make a different circuit and also do coding[5]. The LCD will show the user if there is spark , over voltage or if your balance is low. In this project for every 5 load,1unit will be consumed that would take Rs.2. We are taking the  total  recharge balance to be Rs.20. A prepaid smart energy meter will enable the users to pay electricity bills on time. The components used here are : 16x2 LCD screen , diodes, capacitors, resistors, optocouplers, oscillators, comparators, etc [6]. The DTMF frequency through your phone keypad will pass through your handsfree and eventually will pass through microcontroller to enable recharge command[7].

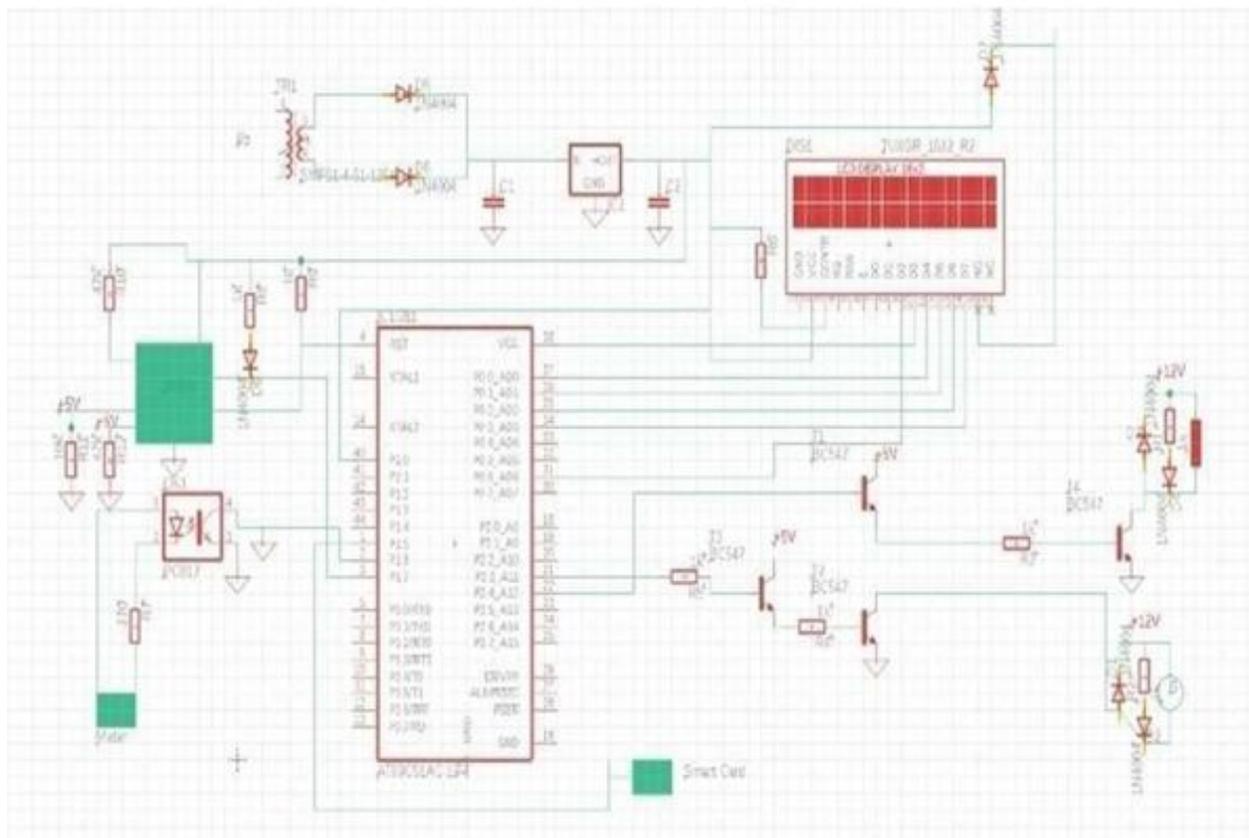### IV SYSTEM MODEL

#### A.MAIN SYSTEM ARCHITECTURE



Fig. a. Main System Architecture

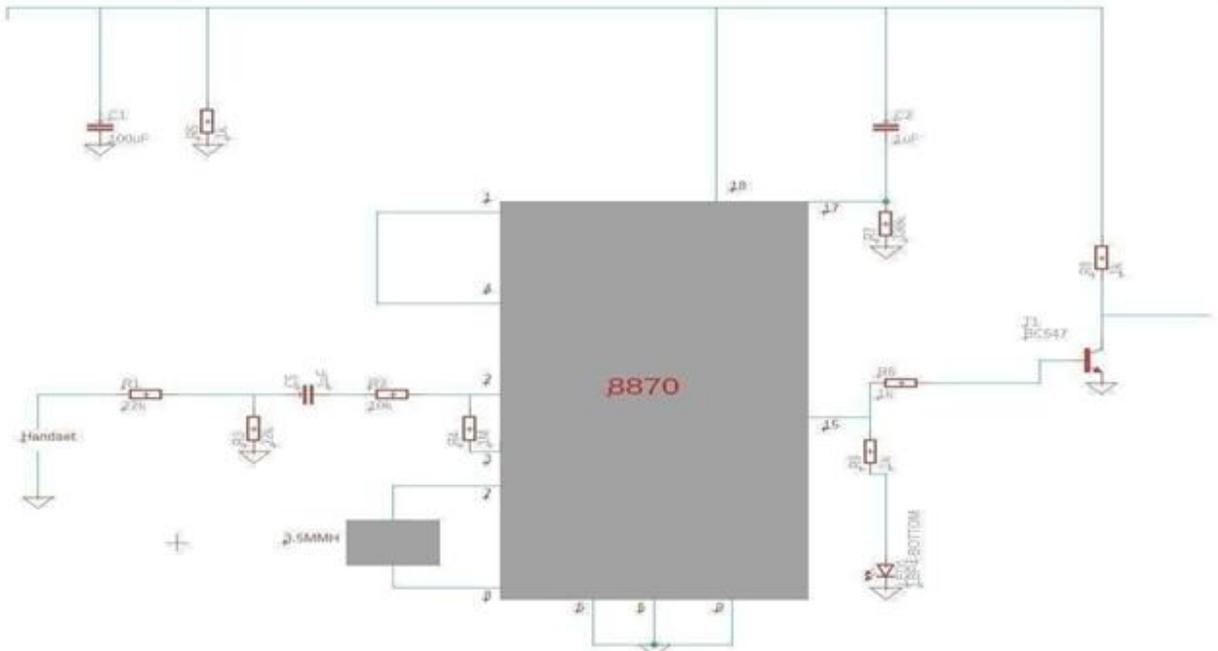#### B. PHONE CONNECTIVITY ARCHITECTURE

Fig. b . Phone Connectivity Architecture

The step-down transformer converts 220 volts into 12 0 V. 12v dc is made through diode and capacitor.7805 regulator provide 5v of power supply[8]. There is 89s52 microcontroller which is of 8051 family which has 4 ports. LCD is connected through port 0. load is connected through port 2. port 1 is connected to meter. Ceramic capacitor blocks unwanted signal from the air. The DTMF frequency through phone keypad whenever we call through a handsfree and is given to pin 2 of 8870 controller which convert signal to a voltage form which we get through 15 and which indicate using led and then is given to pin 1 of 89S52 microcontroller which understands that it is given a recharge option. The energy meter will show the

## V.RESULT



Fig. 1    OUTPUT DISPLAY



Fig. 2 DISPLAY BULB ON



Fig. 3    FIRST OUTPUT



Fig. 4    SECOND OUTPUT







Fig. 5 LOW BALANCE OUTPUT



Fig. 6 ZERO BALANCE OUTPUT



Fig. 7 HIGH VOLTAGE OUTPUT



Fig. 8 SPARKS OUTPUT

Figure 1 shows output on the LCD screen once you switch on the main circuit with bulb being switched off. Figure 2 depicts the output switch on the bulb The first one shows the load consumed and /the next one depicts the units[10]. We have taken the total balance to be Rs.2. Figure 3 shows as the bulb remains switch on and electricity is consumed so the load is 5 which will consume 1 unit and simultaneously deduct Rs.2. Figure 4 depicts a different reading when the bulb is on for a good amount of time. Figure 5 displays when your balance is low

i.e. Rs.2 this will be shown on your screen and the bulb will remain on. Figure 6 depicts that your balance is low and the bulb is switched off automatically. you need to recharge it by smart card or by calling the operator. Figure 7 shows whenever there is an overvoltage condition this will be shown and the bulb will switch off automatically. Figure 8 displays the case of spark to avoid fire this message will show up which will also disconnect the bulb automatically

## VI.CONCLUSION

The smart energy meter design using our technology will enable the users to pay for electricity consumption before they have consumed according to their budget. So, in this way the user will hold the credit and can use the electricity until their balance is exhausted which will eventually cut by a relay when their balance is finished. This is an innovative solution that can be afforded and utilized by all sections of the society. The usage of micro controllers ensures regular recording of the data which can benefit both supplier and consumer. This will in turn reduce human efforts and will save a major amount of time. It will also create an awareness on unnecessary wastage of power. Also ensuring such a secure connection, will somewhat reduce electricity theft which is a serious concern in our society.

## VI.DISCUSSION

We will be designing a smart energy meter that can calculate load and units consumed automatically and also manually of a bulb connected to it[11]. It will be a prepaid meter that can be recharged by two ways firstly by a smart card which when will be swiped will recharge the meter again and secondly by your phone when you call the operator for which we will make a different circuit and also do coding[12]. The LCD will show the user if there is spark, over voltage or if your balance is low. In this project for every 5 load , 1 unit will be consumed that would take  Rs.2. We are taking the total recharge balance to be Rs.20[13]. A smart energy meter will motivate the users to pay electricity bills on time which in case reduces the burden of the suppliers by delivering as much electricity as they have paid for[14]. Once your meter is out of balance, relay will cut-off the power supply, which can be remotely recharged by using phone on the request of the consumers[15].

## VII.APPENDIX

```
#include<reg51.h
> #include "lcd.c"
sbit switch1 = P1^0 //for turning load on sbit switch2
= P1^1 //for pulse sbit led_load = P2^0 //load
sbit led_buzzer = P2^1 //buzzer here sbit led_call =
P2^2 // for sending call unsigned int pulse
unsigned int units unsigned int
balance,count,flag void main() start:
pulse=count=units=flag= 0 balance=20
lcd_init()
lcd_out(1,1," PRE PAID "); //for showing starting
msg lcd_out(2,1," ENERGY METER ")
while(1)
if (switch1 == 0) // CODE FOR TURNING LOAD
ON
(switch1 pressed) label:
if (switch1 == 1){led_load = 0 lcd_clear()
lcd_out(1,1," LOAD   ON   ")   delay_ms(1000)
while(1){lcd_out(1,1,"PULSE   UNITS   BAL   ")
lcd_out(2,15,"Rs")
lcd_print(2,1,pulse,2)           lcd_print(2,7,units,2)
lcd_print(2,13,balance,2
)
if (balance == 0) //[ZERO BALANCE] lcd_out(1,1,"
ZERO BALANCE ") lcd_out(2,1," LOAD SHUT
DOWN ")
led_load = 1
led_buzzer = 0
led_call  =  0   delay_ms(100)   led_call  =  1
delay_ms(2000
) led_buzzer = 1 goto start
if (balance == 2 && flag ==0) //[LOWBALANCE]
lcd_out(1,1," WARNING ")
lcd_out(2,1," LOW BALANCE ")
led_buzzer = 0 delay_ms(2000
) led_buzzer = 1 flag=1 lcd_clear()
if (switch2 == 0) //CODE FOR COUNTING
PULSES,
UNITS AND BALANCE (switch2 pressed)

if (switch2 == 1) pulse++
count++
if (count == 5)//FOR CALCULATING UNITS
units++ // 1 UNIT = 5 PULSES

balance=balance-2         // 1 UNIT DEDUCTS 2
RUPEES FROM THE BALANCE
count=0 else
goto label1
if (switch3 == 0) //[HIGH VOLTAGE] CODE FOR
TURNING LOAD OFF , TURNING ON BUZZER
&
CALLING (switch3 pressed)
{led_load = 1
led_buzzer = 0
led_call = 0 delay_ms(100) led_call = 1
if (switch3 == 1) led_load = 0 lcd_clear()
```

else
goto label2
if (switch4 == 0)// [OVERHEATING] CODE FOR TURNING LOAD OFF, TURNING ON BUZZER & CALLING (switch3 pressed)
{led_load = 1
led_buzzer = 0
led_call = 0 delay_ms(100) if (switch4 == 1)
led_load = 0 lcd_clear() else
goto label3 else
goto label

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