Prepaid Electric Smart Metering Scheme with GSM and Microcontroller

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Abstract: Electricity consumption in different countries especially in the developing are suffering huge losses due to electricity theft and many other losses which are happened at the time of power transmission and due to another factor of power transmission. In developing countries, the utilities of electricity are facing difficulties in collecting electric bill in full scale. So, the prepaid metering system is becoming popular for ensuring the collection of bills in advance. In this paper, the structure of a smart system for prepaid electricity metering scheme has been developed. This is based on collection of electric energy data from consumer ends to the source end vice-versa it means it is a two-way communication system between source and consumer This process for power utilization is secured electricity and reduce the theft and losses and also control them and provide better efficiency of power at the consumer end and the source end.

Keywords: Energy Meter, Prepaid Meter, Electric Meter Scheme, Power System.

I. INTRODUCTION

In the electric power system, losses of provided electricity from the power grid or stations at the transmission and distribution time consist of technical losses and Non-Technical Losses (NTL) and commercial losses, Technical losses and non-technical losses include certain dissipation of electric energy into the equipment, losses in winding and conductors. Due to metering/ billing errors, and the shameful behavior of consumers are the major reasons for non-technical losses. This NTL's improve the costs to services, unaffected consumers and states [1]. The prepaid/postpaid electric energy meter is a determination towards enhancing the revenue collection for the scheduled supply is a fully efficient manner, in this, the proposed smart energy meter has uses which improved his efficiency in the measurement of rated load, power factor, output voltage, output current and system behavior. It is efficient for controlling and monitoring of energy consumption by the end of the consumer. If prepaid or postpaid energy meter is installed fully then the loses will reduce and overall effect on the nation's economy increase due to better power utilization [2].

These issues are frequently predominant in Indian power distribution network. On the off chance that misfortunes are limited, a great deal of electricity can be spared, and then the economy of the nation will increment as expanding the income. This is mostly conceivable utilizing a savvy meter. Since keen vitality meter allows the power service organization to gather the bill of utilized electricity from the consumers. the new brilliant vitality meters are being set rather than the traditional vitality meters to improve the accuracy, towards the updated capacity to control capricious billing and power theft [4].

The smart prepaid meter is also providing us with some benefits like it provide accurate billing, real-time data tracking, automatic outage information, automatic disconnection in case of dues.

II. PREPAID SMART ENERGY METER

In the old-style system, the billing includes gathering the reading physically from the energy meter installed in each and every consumer's house, office, hotels etc., this has the high possibility of physical error with an increase in the number of consumers. This type of physical process is much problematic due to the increase in the development of residential and commercial building.in the prepaid energy meter system, the balance must be in positive if the balance is positive then the continuity of supply is maintained and in another case, the balance is zero or negative then the supply will be shut down by the station due to use of latch relay[4]. In this system, manual work is replaced with automatic meter reading along with GSM module and RS-232 cable, controller, radiofrequency making the meter easy to read reading of meter and helps to control the electricity theft and losses.

The block diagram for the working of the prepaid energy meter consists of some important part their the most part is the energy meter, power utility company, etc.
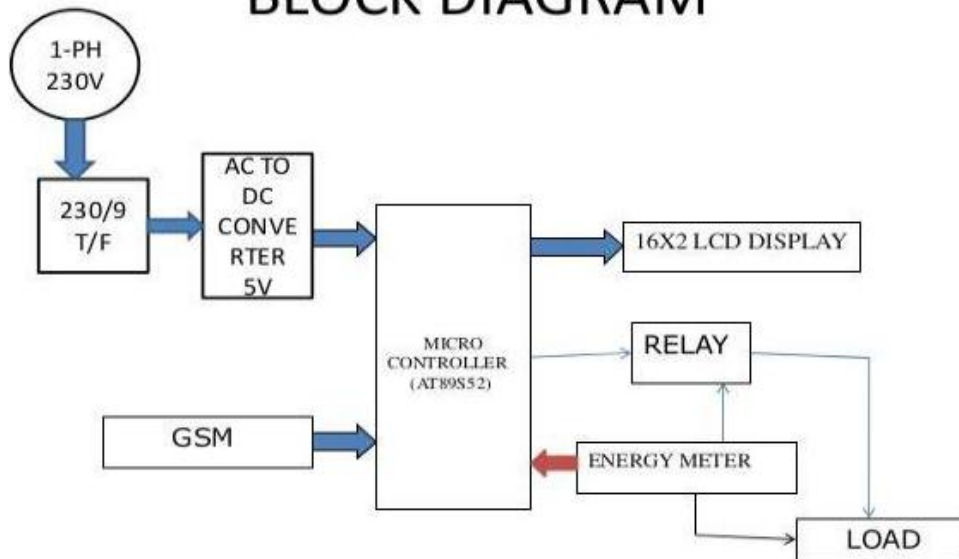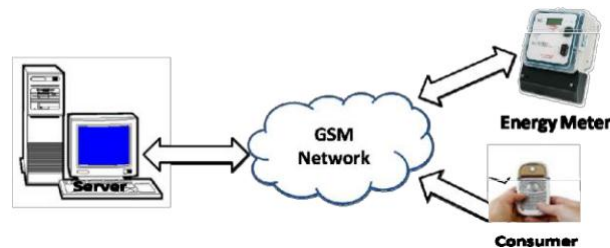
A. Block diagram of smart prepaid meter

Figure 1. Impression of proposed prepaid metering system.

(i) Energy Meter: Energy Meter or Watt-Hour Meter is an electrical measuring instrument that measures the amount of electrical energy used by the consumers. These instruments are installed at every place like homes, industries, organizations, commercial buildings to provide the used electricity for electricity consumption by loads. The energy meter mostly activates in two modes, i.e., prepaid and postpaid. So, the customer has the freedom to choose the prepaid or postpaid mode as per their requirement. This energy meter consists of the following components:

Sensors: a proposed model of electrical meter, voltage and current sensors are used to quantify the voltage and current from the power supply.

Latching Relay: A relay is an electromechanical switch used in power supplies, electrical systems and many other applications. the latching relay is connected from the consumer's load to power utility supply companies. Their two-coil used to control relay. When an electric current flow into the coils, it generates a magnetic field. Then opening and shut down of relay rely upon the equalization or time present in the smart card. In the prepaid mode type meter, the smart card has adequate equalization then it stays shut and keeps the power supply consistent to the consumer and when the card comes up short on balance, it opens and segregates the heap from the supply. However, in case of postpaid m if the smart card has adequate time it stays shut and keeps the power supply nonstop to the client. Exactly when the smart card has inadequate time, this works and segregates load from the supply. at the point when the vitality meter gets the voltage supply it fills in as its necessity. the hooking relay likewise expends some measure of electrical vitality, it has been remembered for the calculations made by the meter and smart card [4].

Smart Card: The smart card is the most important part of the model. It is the smart card which is used in the smart meter for the recharge meter.

DC Power Supply: The DC power supply gives the working voltage of 5volts for running the Microcontroller unit, Buzzer and LCD display etc. Circuit diagram of DC power supply is shown in Fig.2
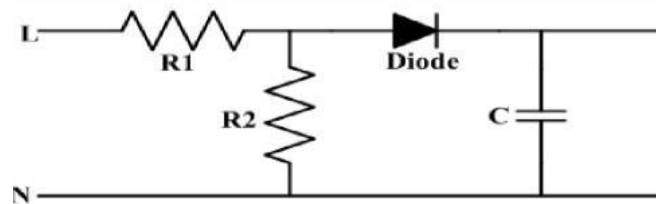
Fig 2.DC Power supply for MCU and electronics

LCD Display: if there should arise an occurrence of prepaid type of electric meter, vitality consumption (KWh), load consumption (KW), remaining time for next recharge (M:D:H:m), meter ID, recharged balance (KWh), remaining equalization (KWh) and prepaid mode are displayed on the LCD Display. On account of postpaid type mode, supply, vitality consumption (KWh), load consumption (KW), remaining time for charge payment (M:D:H:m), meter ID, duty rate in Rs, monthly power consumption charge (Rs) and postpaid mode are displayed on the LCD Display.

Buzzer: buzzer is the device which provides the audio sign to us when the requirements are not filled completely. the customer needs to proceed to check the vitality meter to confirm the amount of power. This circumstance isn't appropriate for occupied individuals. To overcome this problem a buzzer has been added into the design. On account of prepaid type mode, when the equalization is low in the smart card, the buzzer is turned on and indicates to the consumer about its low parity. And if there should be an occurrence of postpaid type mode, it makes the consumer mindful that he has less time to take care of the monthly tab. To overcome this type of problem, the LCD display likewise shows the remaining time at each moment in the "M: D: H: m" format.

(ii) Recharge Model: On the off chance that there should be an event of prepaid mode, when a smart card has nil balance, stimulate model gives the total sum of revived equalization and reset the vitality meter remotely dependent on customer demands. In the event that there should emerge an event of postpaid mode when a smart card has no adequate time it sends demand rate to the smart card for computation of month to month use bill and resets the vitality meter dependent on customer demands.

Transformer: For connecting, the interfacing of prepaid smart vitality meter with GSM modem framework to the power supply a stage down transformer is required for step down the 220 V air conditioning into 12 V air conditioning. The transformer chips away at the standard of mutual induction and comprises two windings, primary and secondary.

Voltage regulator: This interfacing of prepaid vitality meter with GSM modem framework comprises of microcontroller LDC show, GSM modem and max 232, which are worked at 5 V dc. For providing the 5 V dc a voltage controller is utilized right currently yield of scaffold rectifier. LM 7805 voltage controller is utilized right at this point.

(iii) Power Utility Company: This all type of smart or normal energy meter provide the data to the power utility company through wireless communication or wire and it is stored by the power utility company at each instant for generating the postpaid type bill. But in the case of prepaid type meter, it reduces the balance as the electricity consumption happened from the company. Utility company always monitors the energy meter remotely.

A. Protection against electricity theft

• Power theft is one of the difficult issues looked by power utility companies. It keeps the power utility companies from bringing insufficient money from the offer of power. In developed countries, power utilities expect lost 15% however all out misfortune in India is around 30% of the all-out age, which is about 1.5% of GDP of India. 33% of these are specialized misfortunes; while, the vast majority of the rest is because of power burglary. At present, there are roughly 146 million customers in the nation. Money related misfortune, because of power burglary, is around $16 billion every year [1]. There are a few different ways of power robbery embraced by the purchaser [3]. The proposed configuration assists the power utility organization with preventing the accompanying kinds of power theft:-

   • Phase and neutral interchange
   • Disconnecting the neutral line
   • Meter bypassing
   • External tampers

B. Mathematical modelling

Relationships from (1) - (5) show mathematical modelling of energy.

Metering and measurement of the related parameters of a meter system for electricity or power consumption and transfer of power to the consumer are below: -

$$S = Vrms \times Irms \quad (1)$$

$$Cos\theta = P/S \quad (2)$$

$$E = Pavg \times t \quad (3)$$

$$Rbal = Ra/TR \quad (4)$$

$$Tr = Rbal/Pavg - t \quad (5)$$

where,
S = Apparent power
P = Active power
Cosθ = power factor
Pavg = Average active power
E   = Energy consumption in t time
Rbal = Total balance
Tr   = Remaining time for next recharge
Ra   = Recharged amount
TR   = Tariff rate

The average of the active power is net energy transmitted yet the normal of reactive power is zero, i.e., no net energy is transmitted. Consequently, it clear that the reactive power continues wavering from the source to load and the other way around. It is otherwise called fanciful power. In this way, the private customer just pays for active power; while, service organization applies charges for reactive power (in the type of punishment over poor power factor) for business shoppers.

III. WORK PRINCIPLE PREPAID ENERGY METER WITH GSM MODEM

The working of this interfacing of prepaid vitality meter with GSM modem framework would be clarified by partner the lamp as a heap at the yield side of the vitality meter. In any case, when we would be switch on this framework then this would demand a modem in a statement. For modem in a statement, we would dial the modem no. from any mobile phone and send the message to the framework. By doing this the framework has enrolled the versatile no. After this, the framework uncovers to us altruisticly swipe the card. For card swiping, we use the press catch and set the cost. The cost setting is basically the beats setting of the vitality meter. We should assume we set the cost 20 rupees and express the cost of 1 heartbeat is 2 rupees then truly, we have settled 10 heartbeats. By and by we switch on the yield load that we have associated a lamp. Right when the lamp is on then the microcontroller, which is interfaced with the vitality meter, counts the beats of the vitality meter and hang tight till for 10 heartbeats. Right when the 10 heartbeats have gone, by then the microcontroller switch off the yield load and send the message to the customer wireless through the GSM modem, that your leveling has terminated considerately invigorate your card. This framework additionally sends the update or alert message to the customer versatile before the evening out lapsed.

IV. THE DRAWBACKS OF EXISTING PREPAID METERING SYSTEM

There is some number of drawbacks of the prepaid metering scheme so we are introducing and dealing with the prepaid type vitality meter that is described previously. They are as: -

It is a bundled system with the vending system (VS) and the system master station (SMS). The ability of VS and the SMS is limited and if there somebody needs to add other meters beyond the limits of the system another arrangement of VS and/or SMS has to be recognized.

The All computation and monitoring and control is made on the meter itself. On the off chance that a meter transforms into flawed all data information may be lost of a specific period. Since the data is transferred in the middle of the interim of charging the smart card.

Dynamic information can't be refreshed in the current framework. For example, if load shedding information is required to be refreshed there is no system to refresh the information to the meter.

At present, the buyer has no simple methods for watching, observing and controlling the meter and in this manner enhancement of the utilization of his power.

V   SIMULATION RESULTS AND DISCUSSIONS

The values of resistances from 100 Ω to 1500 Ω are associated with the proposed energy meter the customer loads of various load are connected into the system of electricity consumption. The estimations are charted in Table 1

Table 1. chart of power on different resistance

Resistance (Ω)	Vin (V)	I (A)	p.f. (cosθ)	POWER (VI cosθ)
1500	220	0.147	1	32.34
1400	220	0.16	1	34.57
1300	220	0.17	1	37.23
1200	220	0.18	1	40.33
1100	220	0.20	1	44.00
1000	220	0.22	1	48.40
900	220	0.24	1	53.78
800	220	0.28	1	60.50
700	220	0.31	1	69.14
600	220	0.37	1	80.67
500	220	0.44	1	96.80
400	220	0.55	1	121.00
300	220	0.73	1	161.30
200	220	1.10	1	242.00
100	220	2.20	1	484.00

Above results depict the effectiveness of this energy meter and suitability for Industrial and household billing system. by the proposed system, enhance metering and charging exactness and proficiency,

VI. APPLICATIONS AND ADVANTAGES OF PREPAID ENERGY METER WITH GSM MODEM

By using this interfacing of prepaid vitality meter with GSM framework we can deal with our load through wireless, by checking the load status.
By this system, we can without much of a stretch decrease the charging of our homes load.
By this system, we can diminish the vitality misfortunes.
By this system, we can switch on or off the home loads through mobile phone.
By this system, we can spare vitality from theft.

VII.   CONCLUSION

This paper shows knowledge on Prepaid Electric Smart Metering Scheme with GSM and Microcontroller on prepaid/postpaid energy meter utilizing remote correspondence. This is an exertion towards upgrading the income assortment for the scheduled supply. With the outcomes got, it is concluded that proposed smart energy meter has a superior proficiency in the estimation of rated load, power factor, yield voltage, yield current and framework conduct. It is proficient for checking, monitoring and controlling of energy utilization. On the off chance that this smart energy meter will be completely executed all through the conveyance zone, power theft and unpredictable charging forced by the providers on their buyers for the electricity consumption will stop and income misfortune through unpaid bills endured by the power supply organization will be enormously decreased. Moreover, this will overall affect the country's economy, as an income assortment will increment whenever actualized across the nation.

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