

NATURAL GAS PREPAID DIGITAL GAS METER

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Abstract- Energy conservation is the basic and urgent need for our developing country. It is very much essential for us to maintain the proper utilization and distribution of natural gas (NG) as the resources of NG are limited. The aim of this research project is to design and fabricate a NG prepaid digital gas metering system (under the research fund of UGC). This NG digital gas meter is connected with a mobile phone network with the help of a GSM module and microcontroller. The consumer can easily recharge their required gas units by same process as they recharge their mobile phone bill. The design is more advanced compared to the prepaid digital metering system developed by BUET in collaboration with TGTDCCL. In that metering system, there is a fixed prepaid smart card for every individual meter. The card is taken to the nearest vending station to recharge the card. The card is then taken back and is punched on the gas meter. Then the charged unit of gas is transferred to the meter automatically. It is a time consuming and costly system. The consumers have to go through the lengthy process of bill recharging system. Bangladesh has a well developed mobile network with maximum mobile connectivity. If we use the networking system carefully we can remove the drawbacks in the previous smart card based metering system. And, enhanced security or maintaining features can be more useful for the proper and safe use of valuable gas. According to the aim of the research project (as a part of the MSc degree requirement), a digital gas metering system is developed including electric circuit and interfacing of mobile network with the gas meter also has been done successfully. The metering system is also capable of central monitoring of gas usages. The security system is also very much uncompressible. The microcontroller based system is well capable of counting and controlling the gas flow rate. Finally the meter is calibrated in the KGDCL meter testing laboratory and found satisfactory results.

Keywords: Natural gas, UGC, BUET, TGTDCCL, KGDCL, Smart card, GSM.

1. INTRODUCTION

As natural gas (NG) is the cleanest burning fossil fuel, it can help in maintaining the quality of air. NG is supplied to homes, where it is used for many purposes such as cooking, natural gas-powered cookers/ovens, heating of home/buildings which may include boilers, furnaces and water heaters, etc. CNG is used in natural gas vehicle system (NGVS) and in rural homes without connections to public utility services. Natural gas is the major feedstock for the production of ammonia, via the Haber process, for use in fertilizer production. Natural gas is also used in the manufacture of fabrics, glass, steel, plastic, paints, and other products. Factories, electric power plants and householders may get NG directly from the pipeline using arrangements made through a local distribution company or utility. In our country, as 83% electricity is gas fired, with rapidly depleting gas reserves the country may suffer serious energy crisis if appropriate steps are not taken immediately[1]. Again about 11.5% NG is used in house hold purpose and about 24.5% NG is system loss. Most of the domestic

consumers are not conscious about usage of NG because of the fixed payment (for single/double burner). They show less care about the economic use of the NG, they keep the oven on unnecessarily and the NG is burnt without any reason which causes a huge wastage of NG.

If we can install prepaid gas meter in every home and different zone of the NG distribution network, then this problem can be recovered easily[1]. We can get exact data of NG consumption. The householders must take care for NG uses. Every time he will get the information of NG uses and its prices, which can save a significant amount of NG by minimizing the wastage of gas. The main objective of this research is to design and fabrication a model NG digital pre-paid gas meter that can be used in NG distribution line, in houses and in industries.

1.1 Prepaid Digital Gas Meter

Prepaid gas meter is a system for implementing pay as specially for the household level. The concept behind prepayment meters is simple - instead of paying after

using gas, one pay before using. Prepayment meters are usually installed by the gas supplier, if it feels that the customer cannot keep up payments on their energy bill. However, they can also be requested by the customer themselves - and are often seen as a good method of budgeting. Generally speaking they are used by lower income households, such as people on welfare benefits, lone parents or those with no bank account. This type of 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 reading[1].

1.2 Importance of Prepaid Digital Gas Meter

In a huge populated country like Bangladesh this type of meter can play very important role on the structure of energy supply. A large number of work forces involving meter reading job can be minimized. As the system can be controlled with a central monitoring system it is possible to reduce the corruption that may happened behind the meter reading phase. Energy scarcity is now very common and we are suffering for a long time. With adaptation of this system loss and misuse of gas can be minimized. The system will also help to estimate our national yearly energy budget and keep our country safe from huge gas loss and corruption[1].

1.3 Application of Prepaid Digital Gas Meter

There is a wide range of use of the gas meter, such as:

- On the house hold purpose.
- On industrial gas measuring system.
- This kind of design can be used to centralize the gas distribution system.
- For monitoring the overall gas use of consumer.
- On gas distribution line[2].

1.4 Prepaid Gas Meter Installed by BUET in Collaboration with TGTDC

Titas gas transmission and distribution Company Limited (TGTDC) with Dhaka Gas Distribution Company has already started Pre-paid gas metering systems with domestic customers. Those Prepaid gas meter (as shown in Fig. 1) has been provided by BUET. They inaugurated the program in January 2011 with a expectation of setting up 4,500 meter. On basis of report published in THE DAILY STAR dated 11.01.2012[3].

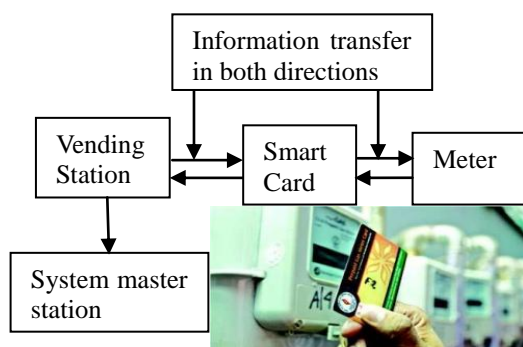


Figure 1: Architecture of BUET Prepaid Gas Meter

They successfully installed all meters and are expecting for the phase two of the program. The meters has been

designed and manufactured under the supervision of the BUET's Institute of Information and Communication Technology which has assembled the meters with parts imported from local and foreign countries, mostly China. In this type of meter a smart card is given to every pre-paid consumer.

From the vending station every customer should buy the required amount of service. The amount is written in the smart card. After that when the card is entered in the meter the charges gas unit is transferred to the meter and the meter writes its various information in the card. When the card is brought to vending station the station retrieve the information from the card and maintain a central database which is than send to system master station[4].

The Prepaid meters will make it unnecessary for the consumers to queue up in banks to pay their bills, said officials. Each consumer will be given a smart card to recharge the meter but the connection will not be snapped on the weekends even if the balance is exhausted, sources added.

1.5 Drawbacks of the Existing BUET Prepaid System

- Consumer have to go to the Vending Station for purchasing Smart Card .
- Consumer s are not able to recharge the smart card in any time.
- Consumer cannot get update balance information from any time and any where.
- Require additional Vending Station.
- Initial setup cost is high .

1.6 A Prepaid Smart Metering Scheme Based on WiMAX Prepaid Accounting Model

Prepaid energy meters have been widely adopted by utilities in different countries across the world as an innovative solution to the problem of affordability and consumption management. However, the present smart card based systems have some inherent problems like added cost, low availability and lack of security. In the future Smart Grid paradigm, use of smart meters can completely overhaul these prepaid systems by introducing centralized accounting, monitoring and credit-control functions using state-of-the-art telecommunication technologies like WiMAX [5].

This paper represents a prepaid smart metering scheme for Smart Grid application based on centralized authentication and charging using the WiMAX prepaid accounting model.

2. PROPOSED NG PREPAID DIGITAL GAS METER

We want to design a NG prepaid gas metering systems with GSM Module which can minimize the present existing problems of the consumers and cost, where consumers can refill/recharge required amount of gas unit using Mobile Scratch Card/Flaxi. So that they don't need to go the vending station for purchasing and refill smart card. In this system there will be a defined value (Taka). If the user refill above this limit then the gas flow is on. Otherwise the gas connection automatically cut off. So, 'no pay' means 'no use' or 'no

use' means 'no pay'. This gas metering systems can be installed without any Vending station.

2.1 Main Components

For connection the gas meter with GSM Module using Micro-controller following equipments/materials are used (Table 1):

Table 1: Electronic materials

PCB Board	LCD Display
Microcontroller (16F877A)	LED
Diaphragm Type gas meter	GSM Module
Mobile Battery, 3.7 Volt (2)	Op-amp(LM 324)
LM 7805 Voltage Regulator	MAX 232
Axial Lead Resistor:	Capacitor
Cristal oscillator (20 MHz)	Diode
5/2 way solenoid valve	Potentiometer

2.2 Flow Diagram of the Gas Metering System with GSM Module

The flow diagram of the gas metering system developed by the authors is shown in Fig. 2 and Fig. 3. In the design, meter is interfaced with microcontroller which is connected to GSM module for communicating with mobile phone network. A digital counter gives the data of gas flow volume. The gas unit is recharged by sending SMS to the module. The microcontroller receives SMS and parses it to get the unit value. Then microcontroller operates till the unit remains[6].

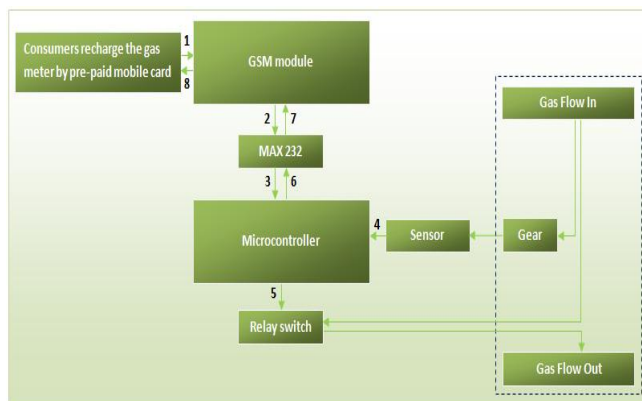


Figure 2: Flow diagram of the developed gas metering system

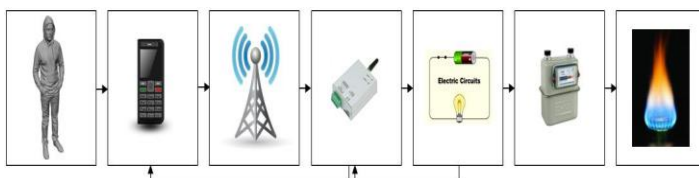


Figure 3: Architecture of the developed gas metering system using GSM module

2.3 Circuit Diagram

The designed circuit diagram and PC board is shown in Fig.4 and Fig.5

The microcontroller 16F877A [7] is connected to the GSM module mod 9001 [8] through a USART connection. The gas meter is interfaced with a encoder

for converting manual meter to the digital signal. The flow rate is calculated by controller by the program installed. The LCD shows the value of unit and the command or any other kind of information needed for enquiring the present condition of meter and so on. The circuit here is the mother circuit on a prototype board which can be replaced by designing professional PCB layout and compact system.

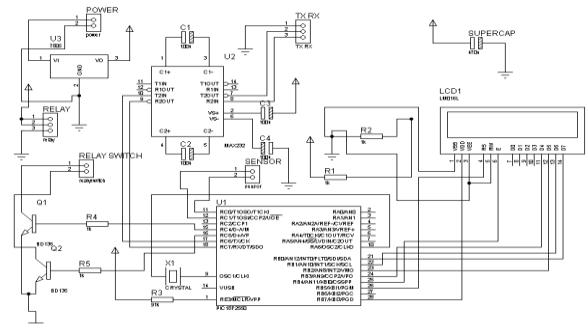


Figure 4: Designed circuit and pin diagram[9]

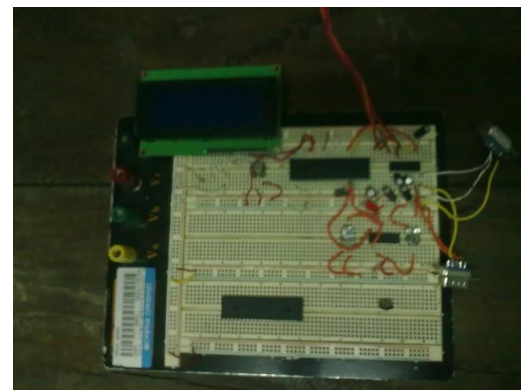


Figure 5: Developed circuit in PC board

3. WORKING PRINCIPLE

The working principle of the gas metering system is represented by the Fig.6 and Fig.7.

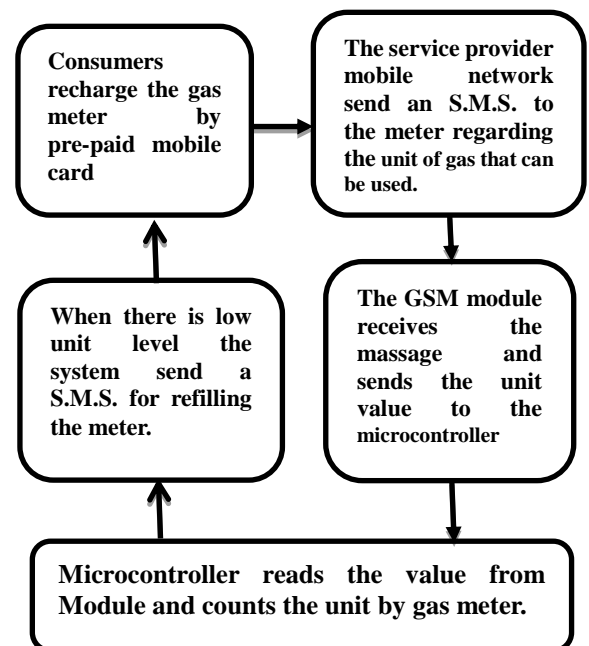


Figure 6: Working flow diagram

Here the gas meter is interfaced with a digital counter which is designed by using mouse wheel encoder. The encoder is attached to the manual counter with gear mechanism. As the counter rotates so the wheel. The wheel gives the count of exact revolution of gear to the interfaced microcontroller. The gas meter is attached to the micro controlling unit and the LCD shows the counts for unit recharged.



Figure 7: Complete hardware of the Pre Paid Gas Meter.

4. DISCUSSION

The pre paid digital gas meter model has been fabricated which is interfaced with microcontroller and is connected to GSM module for communicating with mobile phone network. The digital counter gives the data of gas flow volume. The gas unit is recharged by sending SMS to the module. The microcontroller receives SMS and parses it to get the unit value. Then microcontroller operates till the unit remains. One full revolution= 0.001m^3 of gas flow. The unit is calibrated as three full revolution= 1m^3 of gas. The output from the gas meter is shown in the attached LCD (as in Fig.7). There is also an analog system for the manual checking. The unit calibration is to be set with discussion to the mobile operator provided. It can be adjusted as per requirement. The system is designed so that it will only receive SMS from specific number, so it is fully secured in data communication. If there is no leakage of gas in meter the system is full capable of counting and measuring the total unit flow. The system can be monitored remotely by sending only one feedback SMS. There can be developed a system for providing full featured database software to store and regulate the gas consumption of the consumer.

5. CONCLUSION

The NG prepaid digital gas meter will be one great step to the most sophisticated means of gas network maintaining in Bangladesh. It will also help to reduce the cost in many dimensions as the requirement for manpower in meter reading and monitoring will be reduced greatly. In this system the labor and time of consumer is also saved by intelligent use of mobile phone network. This system is also capable of central monitoring of gas usages. The security system is also

very much uncompressible. The microcontroller based system is well capable of counting and controlling the flow rate of the gas.

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