Implementation of smart energy meter with two way communication using GSM technology

Afrin Hossain, Tajrin Jahan Rumky, *Nursadul Mamun

Abstract—To keep pace with the increased necessity of advanced metering infrastructure and near real time two way communication between the Power Distribution Companies and the consumers, a data communication technique has been devised. This work presents a single phase advanced energy meter based on a single phase energy meter IC, a microcontroller, and a GSM module to develop an automated system by which monthly power consumption will be calculated accurately and at the same time the resulting unit will be sent to a remote receiver for further calculation and an updated data also be received by the consumers about any information.

Index Terms— *Win*-AVR, GSM, Energy Unit, Data Communication, near real time.

1 Introduction

The conventional method in Bangladesh includes the electromechanical induction meter operated by counting the revolution of an aluminium disc which is made to rotate at a speed proportional to the power. The number of revolutions is thus proportional to the energy usage. Errors that are related to the existing energy billing system are electromechanical meters, human errors while noting down the meter reading etc [1].Because of energy thefts and network losses still power sector faces a serious problem in collecting revenue for the actual electric energy supplied.[2]

The current procedure of collecting the reading of energy consumption is a procedure completely dependent on human effort. And there is no doubt that human reading is time consuming, costly and may fault be calculated [3].

An advanced metering system is configured by automated energy measuring system and data communication system. The energy consumption unit is read automatically by a circuit arrangement according to the amount of consumed energy. From the liquid crystal display (LCD), we can see how many watts a device is drawing at any given moment, or how many kWh is being used since the device is turned on.

Data communication is an important issue in terms of accuracy, efficiency and relevancy. However, the whole procedure could have better executed, if some automation is applied over the system in terms of data reception from the supplier and transfer of data about the consumption of energy. Modern communication system can be used to play an important role to facilitate this service by using a GSM [4]. one more approach using GSM technolog
to communicate with the remote devices via SMS is remote metering system [5].

In the past two decades, Global System Mobile (GSM) infrastructure and Information Communication Technology (ICT) has made the data reading system more reliable and possible [6]. The coding for microcontroller have been developed in c- language and compiled by Win-AVR compiler [7].

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2 SYSTEM ARCHITECTURE

The system architecture of advanced metering system is shown in Figure 1.

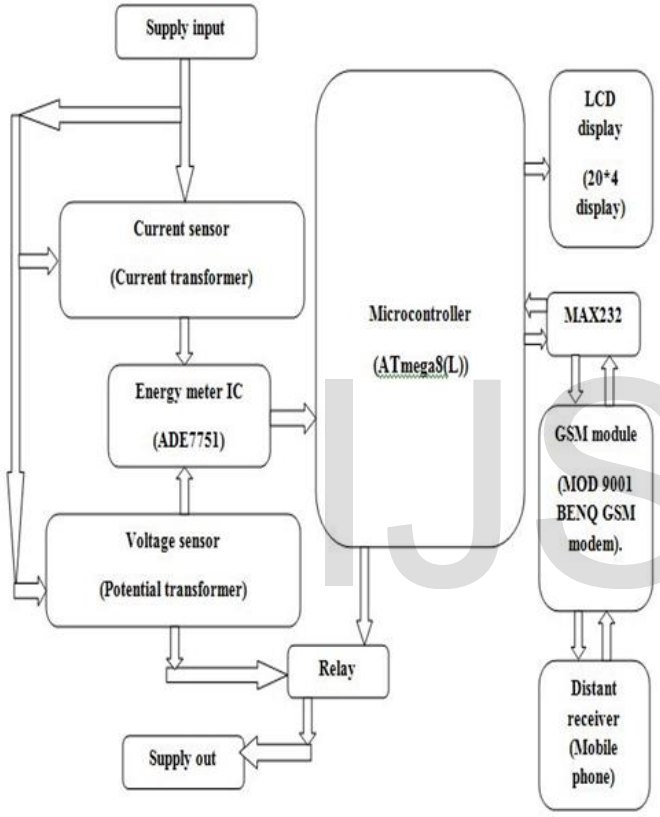

Figure:1 The advanced metering system.

The advanced metering system includes current sensor and voltage sensor unit, energy meter IC, microcontroller, relay, MAX232, GSM module and LCD display.

Step 1: Voltage and current sensor unit feeds the current and voltage signal from the supply and sends to the energy meter IC.

Step 2: The energy meter IC produces pulses after getting current and voltage signal from the current and voltage sensor unit [8].

Step 3: The pulse output is transferred to microcontroller for further calculation of unit addition and does the functions according to the program loaded in it.

Step 4: LCD display shows the total unit consumption, date, time, message and supplier number.

Step 5: MAX232 establishes a relation for data transferring between microcontroller and GSM module.[9]

Step 6: GSM module sends to or receives data from supplier end.

Step 7: Relay performs the supply continuation to the load according to the command it receives [10].

3 HARDWARE DEVELOPMENT

3.1 Pulse generating circuit:

Figure 2 is the circuit arrangement for pulse generation. Main power supply is input by jack numbered as 1 and 2 pin. CT is connected in series and the PT is connected in parallel with the main power supply.

CT will step down the current level than the supply side to a desired level at secondary side that will be in limiting range for the energy meter IC ADE7751 to sustain. IC

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ADE7751 senses the voltage equivalent to current of 40A at 4 and 6 no. pin of IC ADE7751 which can sense a maximum limit of 660mV.

PT is used to step down the voltage level from 220v to about 220mv highest at secondary side for the system that is designed and secondary side of PT is connected to the 7 and 8 no. pin of IC ADE7751.There is a maximum voltage level for which the energy meter IC can function which is 660mv. The resistances of 1k ohms are used to drop a maximum voltage in them to give minimum voltage to ADE7751. The capacitances are used to hold the voltage at the input pin of the IC.

Our necessary output of the energy meter IC ADE7751 is from the pin number of 22.This output is a pulse output that

The output frequency of 22 pin will be input to the microcontroller for performing further function.

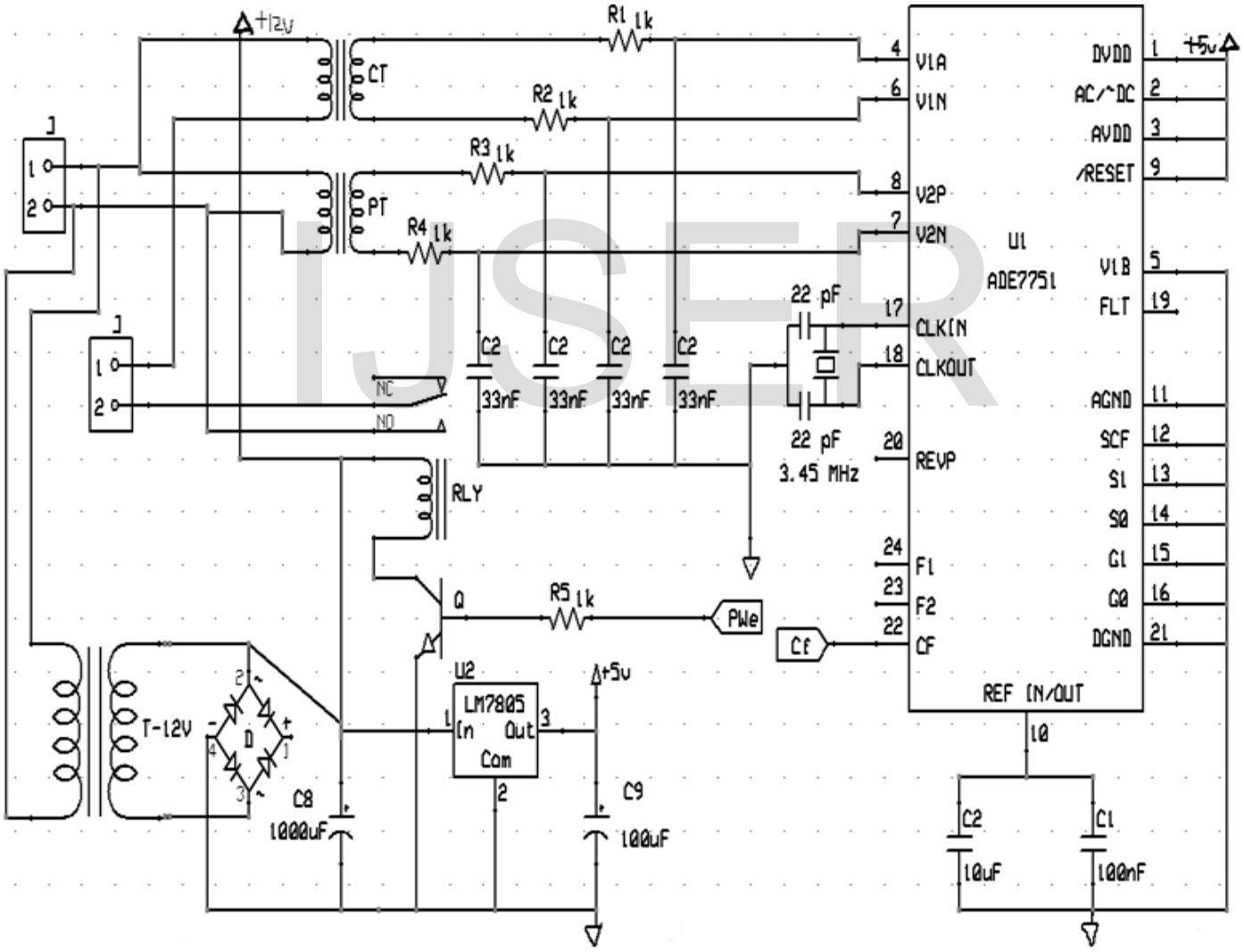

Figure 2. Pulse generating circuit diagram

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3.2 Data processing and interfacing circuit:

Figure 3 is the circuit arrangement for data processing and interfacing circuit arrangement. ATmega8 (L) is used to calculate the total unit for every month and then to send the amount of total unit to the supplier's office using GSM technology .By using this microcontroller the necessary information about the energy consumption and any important message from the supplier's office have been displayed by a LCD display for the consumer consideration.The output pulse from the energy meter IC ADE7751 from the pin number 22 is input to the micro-controller pin number 4.

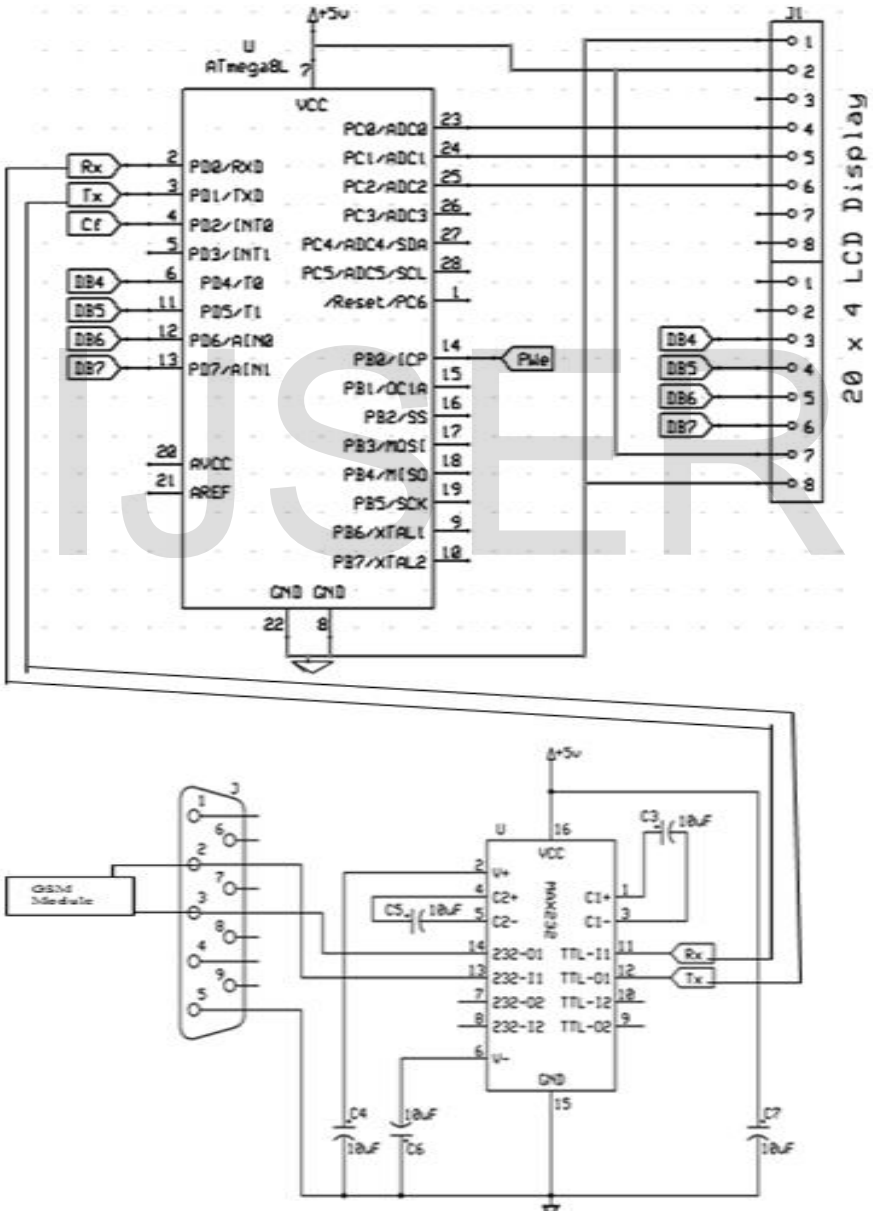

Figure 3.Data processing & Interfacing circuit diagram

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The 22 pin of ADE7751 gives pulse that carries the instantaneous real power information. After getting every pulse the microcontroller starts to add an amount of 0.000625 with the previous unit. The function of addition for unit consumption continues until a command for reset is given or relay off command is appeared.

A message will come through the GSM technology any time of a month asking for the total unit consumption during that moment of SMS received. Then the total unit amount will be sent to the supplier's office according to the information. The MAX232 will receive the signal. MAX232 will send the received signal to the ATmega8 (L) microcontroller. Next step involves the transmission of the data through GSM module. The MAX232 is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible with digital logic circuits. GSM module is connected to the MAX232 for data transfer to the microcontroller.

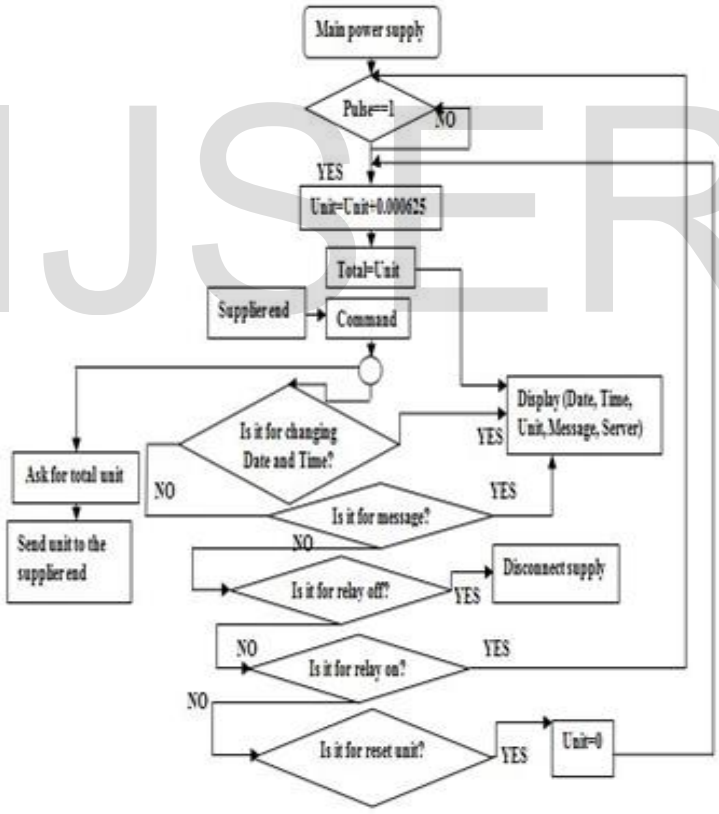

Figure 4. Data processing & Interfacing circuit diagram

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4 ALGORITHM FOR THE SMART METER

A.Unit addition

1. Start with main power supply.
2. If power is on and command for relay on is 1, the pulse in microcontroller will be 1.
3. The unit will be added to the last unit.
4. After adding, the total unit will be displayed in LCD.

B.Different logic execution for different command

1. If command for total unit, then send the unit.
2. If command for unit resetting, then unit will be reset and displayed in LCD.
3. If command for changing date and time, display in LCD.
4. If command for relay on or off, the relay will be on or off according to the command.
5. If any message for consumer, it will be displayed in LCD.

5 ENERGY UNIT CALCULATION

The energy meter IC produces frequency impulse for per unit power consumption. Its rating for per unit power consumption is 1600impulse/kWh.

So,

1600 impulse for electricity consumption = 1 kWh

1 impulse for electricity consumption=1/1600=0.000625 kWh

And for,

16 impulse for electricity consumption =1/1600*16=0.01 kWh.

6 RESULT AND ANALYSIS

The smart energy meter was tested in the Electronics laboratory of Chittagong University of Engineering and Technology. The rating of the meter is 40A and 220V to 230V depending upon the current transformer used in the meter. In this arrangement mobile phone has been used as remote receiver. As supplier deals with a large number of consumers, every month a lot of unit information is received by mobile phone as SMS.

We have used 400W bulb as load. This load draws 1.8A current. As the rating of IC ADE7751 is 1600imp/kWh, so 400W load will generate 4000 impulse. According to the impulse from ADE7751, microcontroller will add an amount of 0.0133kWh in 2 minutes of power supply. But in laboratory it was 0.013kWh. We have used 400W bulb as load. This load draws 1.8A current. As the rating of IC ADE7751 is 1600imp/kWh, so 400W load will generate 640 impulses. According to the impulse generated from ADE7751, microcontroller will add an amount of 0.0133kWh in 2 minutes of power supply. But in laboratory it was 0.013kWh. After lengthening observation period the percentage of error was getting low.

In Table 1 the results of test is given in brief. applications and extensions. Authors are strongly encouraged not to call out multiple figures or tables in the conclusion—these should be referenced in the body of the paper.

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TABEL: TEST RESULT IN LABORATORY

Period (sec)	Expected unit(kW-sec)	Resultant unit(kW-sec)	Error (%)
0	0	0	nil
20	0.0022	0.002	9.1
40	0.0044	0.0041	6.8
60	0.0066	0.0064	3
100	0.0111	0.011	9
120	0.0133	0.013	2.3
140	0.0155	0.0153	1.2
180	0.02	0.02	0
200	0.0222	0.0223	-0.45
240	0.0267	0.0268	-0.37

REFERENCES

[1] Richa Shrivastava, Nipun Kumar Mishra, "*An embedded system for wireless prepaid billing of digital energy meter*" , International Journal of Advances in Electronics Engineering Vol1 No.1,pp.322-324.

[2] Parul Ranjan, Namita Mehra, Prof. T.A. More, Shripad Bokand, "Wireless design for power theft monitoring", International Journal of Computer Technology and Electronics Engineering ,Vol. 2, no.2,pp.119-122

[3] Amit Jain and Mohnish Bagree, "A Prepaid Meter Using Mobile Communication," International Journal of Engineering,Science *and Technology*, Vol. 3, No. 3, pp. 160-166, Apr 2011.

[4] H.G.Rodeny Tan,C.H.Lee and V.H.Mok, "Automatic power meter reading system using GSM network", IEEE , pp.465-469, The 8th International Power Engineering Conference (IPEC 2007).

[5] R.Ramani, S. Selvaraju, S.Valarmathy, P.Niranjan," Bank Locker Security System based on RFID and GSM Technology" , *International Journal of Computer Applications, Volume 57– No.18,pp.15-20.*

[6] Mr.Rahul Ganesh Sarangle, Prof.Dr.Uday Pandit Khot, Prof. Jayen Modi ", Gsm Based Power Meter Reading And Control System", Journal of Engineering Research and Applications, Vol. 2, Issue 4, pp. 664-671

[7] Md. Mejbaul Haque,"Microcontroller Based Single Phase Digital Prepaid Energy Meter for Improved Metering and Billing System". International Journal of Power Electronics and Drive System Vol.1; No.2,pp.139-147

[8] B Dieme and W Badenhorst , "Multiplug energy meter with control and protection", University of Pretoria, Pretoria, South Africa,unpublished.

[9] Omkar Natu, Prof. S.A.Chavan, "GSM Based Smart Street Light Monitoring and Control System", Vol. 5 No. 03,pp. 187-189.

[10] Sunil S. Rao, "Switchgear Protection and Power System", Khanna Publishers, India, (1973