

## An Electrical Energy Consumer Load Monitoring and Control System Through SMS Based

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**Abstract:** This study presents an SMS based Consumer Load Monitoring and Control System (CLMCS) incorporating the widely used GSM network to facilitate the communication of electrical energy consumption by the user to his mobile phone. Its operation is centered on an AT89C52 microcontroller programmed in assembly language. A dedicated GSM modem with a SIM card is interfaced to the ports of the microcontroller through a PNP transistor (BC557) and a Normally Closed (NC) relay to send SMS notification alert to user's mobile phone when power supply is restored to his premises and whenever the energy consumed exceeds the maximum value set by the end user in this case 1 kW. This enables the consumer to respond promptly by cutting off power supply to his load unit when not needed. With this, a great deal of energy is saved and the consumer enjoys maximum satisfaction of the electrical energy paid for; hence an improvement, stability and utilization of electrical energy are achievable.

**Key words:** Control, electrical energy, GSM modem, load, meter, microcontroller, monitoring, SMS

### INTRODUCTION

As commercial activities in the electrical industry increases, it became increasingly important to develop smart electric energy meters to properly measure and bill consumers for the amount of energy consumed and also to ushered in proper power management system leading to energy efficiency. To achieve this, many experimental types of meter were developed (Graeme, 2004; Shoeb and Sharma, 2011). However, the design and implementation of this work helps in the improvement on the performance of the prepaid energy meter in favor of energy consumers. Exploiting the wide proliferation of wireless communication system discussed in (Malik *et al.*, 2009; Taha *et al.*, 2009). An SMS based consumer load monitoring and control system is aimed at helping the user to remotely monitor and control the energy consumed via his mobile phone, other application of GSM for remote monitoring system is found (Chen and Jiang, 2008). Using this system, the user cut his peak energy usage; disconnect his appliances from power supply when they are not needed. These drive energy conservation and enable efficient utilization of electrical energy we produced and hence, reduced global green house-gas emission.

### SYSTEM DESCRIPTION AND ANALYSIS

Figure 1 shows the block diagram of the system, it consists of the power/load monitoring unit; this unit is made up of a comparator and a sensor. It takes the power output from the prepaid meter and supplies the load unit. It also monitors the condition of the load to send signal to the microcontroller unit when power is restored to the user's premises and when the consumer's load exceeds the maximum set value. The microcontroller unit in turn decodes the received signal and performs the function by controlling the buttons of the GSM modem to communicate with the user. The GSM modem has an already stored SMS which is sent to the user's mobile phone as an alert about the load condition. The SMS send is either informing the user that power is being restored to his premises with the load being active or that the maximum load value is being exceeded. The user can at this point take action to disconnect the high energy consuming load or cutoff supply to the load via his mobile phone.

**The power/load monitoring unit (PMU):** This unit as shown in Fig. 2 is primarily responsible for the monitoring of the power restoration to the premises, the

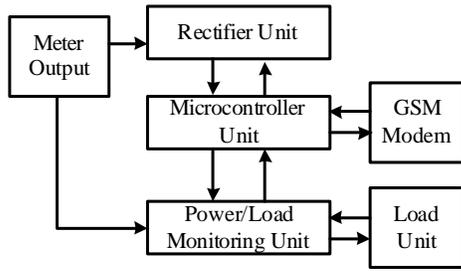


Fig. 1: Block diagram of the system

energy consumed and also to communicate with the microcontroller unit. It is made up of an LM358 OP-AMP Comparator, a sensor and relays. The comparator has 8 pins, but only pins (1, 3, 4 and 8) were used. The power supplied to the load is monitored by the comparator using the positive terminal (pin 3) at 0V while the negative terminal is kept fixed at 1.27V by default. It compares the voltage between the positive and negative terminal and when the positive voltage goes higher than the negative due to loading, gives an output by putting ON LED connected to its pin 1. The sensor used is an LDR whose action depends on the drop in resistance. As the LED

comes ON, it causes the resistance of the LDR to drop immediately from 600kΩ to 400Ω and this drop in resistance is utilized by the microcontroller unit. The PMU also uses the relay controlled by the microcontroller to connect or disconnect the load.

**Microcontroller unit:** This is an intelligent unit and the heart of the system designed. It receives all the signals from the PMU and GSM modem and does the decision making based on the condition of the load. It also triggers the sending of SMS to the consumer. It was designed using an AT89C52 Microcontroller that operates at 12MHZ Oscillator frequency, three transistors and two relays. The AT89C52 microcontroller controls, coordinates and directs all the activities and behavior of the design. Most control applications require extensive inputs/outputs and need to work with individual bits (Yelaran and Emery, 2010). The microcontroller addresses these needs by having 32 inputs/outputs, performing bit manipulation and bit checking. The microcontroller carries out its control operation using port 1 and 2 as in circuit diagram Fig. 3. Whenever power is restored, the microcontroller initializes the system, connects the load and then notifies the user about the status of the load by triggering the sending of an SMS

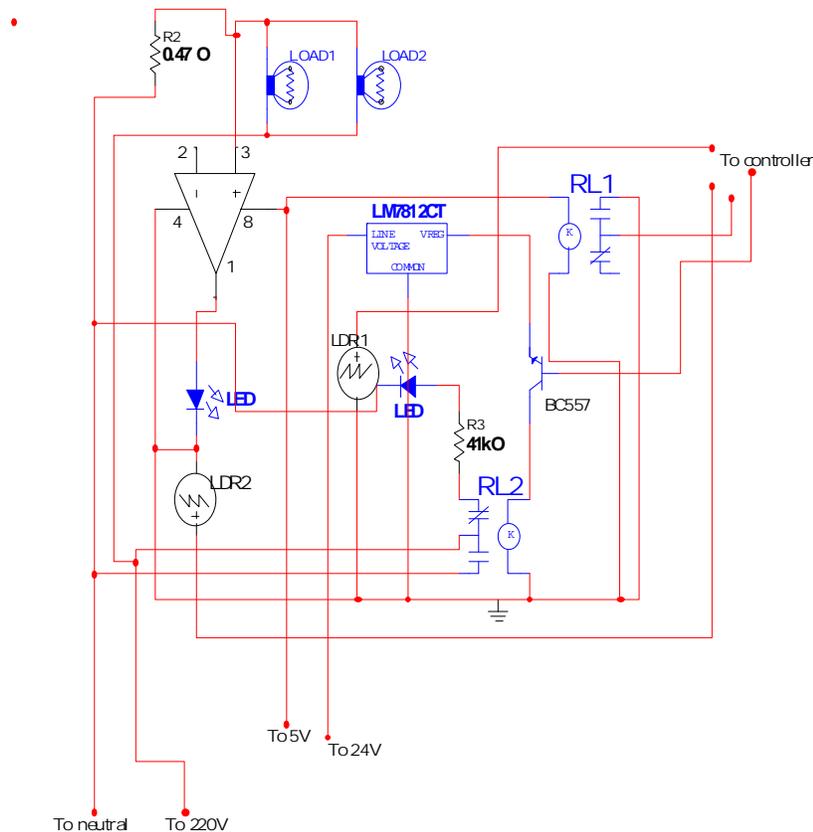


Fig. 2: Power/load monitoring circuit diagram

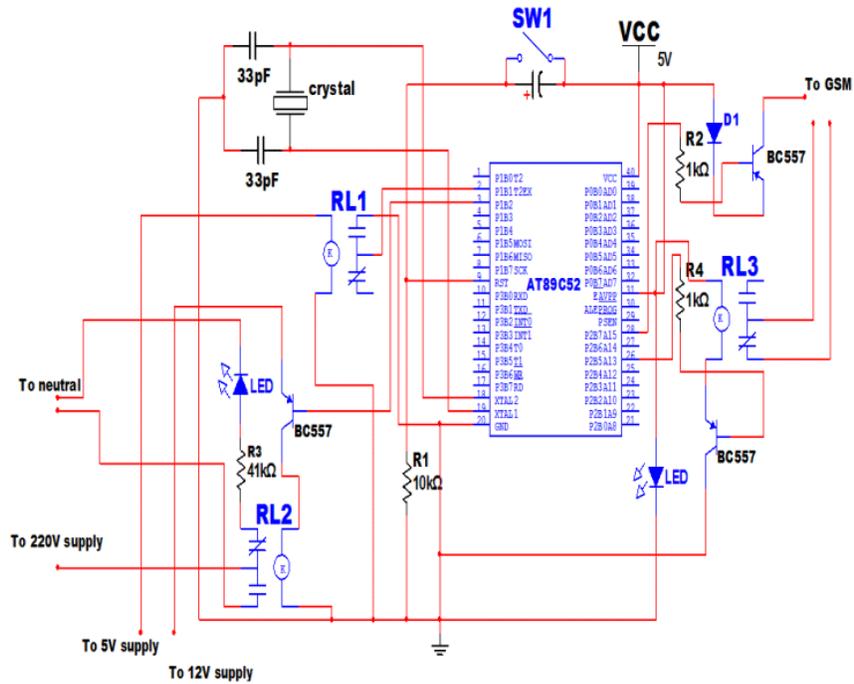


Fig. 3: Circuit diagram of the microcontroller unit

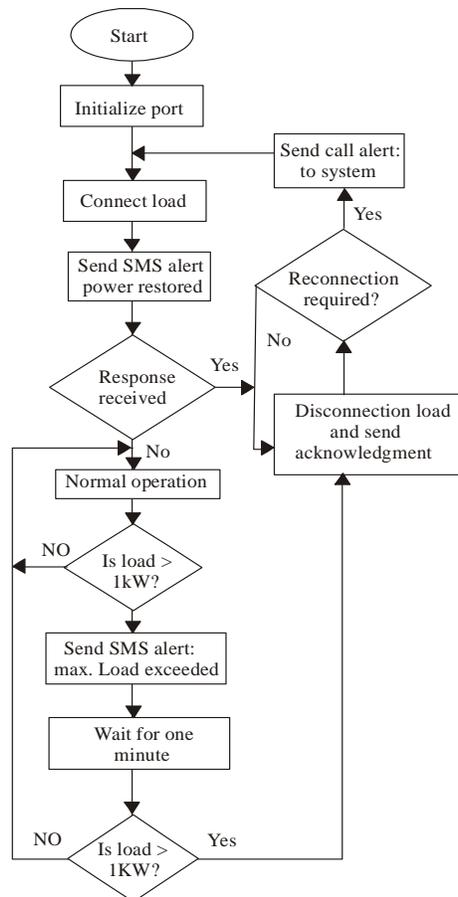


Fig. 4: The system flowchart

Table 1: Results obtained from the tested carried out on the system

Action performed by user	Response from the system	Interpretation of the response
Socket outlet switched ON	Send SMS alert to user's phone	Utility power has been restored
Load (electric bulb) of 60 W connected	No response	Normal operation
Electric iron of 1200 W connected	Send SMS alert to user	Maximum load value exceeded
Alert sent from user's mobile phone	Cuts-off or reconnects supply to load	Response depends on load status

alert from the GSM modem. Also, when the maximum set value of power is exceeded, it receives the signal from the sensor attached to the comparator and alerts the user that maximum power is exceeded via SMS another scheme of this nature is proposed in (Wowe *et al.*, 2009). If the user does not respond within 1 min, the microcontroller automatically disconnects the supply to the load.

**The GSM modem interface unit:** The GSM modem (Nokia 1220) was used to interface between the user and the microcontroller. It is responsible for the bidirectional operation of sending an alert to the mobile phone of the user about the status of the load and communicating the user's command to the microcontroller. These alerts sent to the user are in the form of an SMS that are already stored in the draft of the phone modem. Whenever the microcontroller triggers the transistor connecting to the GSM modem, it will either request for the SMS in the draft to be sent to the user or to put ON the GSM phone.

**Software design:** The software was designed in Assembly Language. The microcontroller is a programmable chip, which needs to be programmed to perform the desired functions (Yelaran and Emery, 2010). The source code was first compiled on the notepad. Proper attention was paid to the code during compilation so as to avoid any form of logical and syntax error. The generated hex file after compilation was then transferred into the microcontroller chip with the aid of an EDSIM programmer. The flowchart of the developed software is shown in Fig. 4.

## RESULTS AND DISCUSSION

The system was tested at its completion for functionality (Table 1). The power supply was taken from the wall socket that serves as the output of the prepaid meter. When the socket was turned ON, the microcontroller switched the phone ON and connects the load within 10 sec. Then, an SMS was sent to the predetermined mobile number confirming power restoration and load being active as shown in Fig. 5. An electric bulb of 60 W was connected to the system outlet and there was no response obtained. As soon as an electric iron of 1200 W was connected to the outlet of the



Fig. 5: Alert message received by the user when power is restored

system, it caused the amount of energy consumed to exceed the set value of 1000 W; another SMS was sent to the mobile number stating load condition. The power supply to the load was cut off after 1 min has elapsed with the load still connected. Finally, during operation of the system, an alert was sent from the mobile phone to the system and the power supply to the load was cut off.

## CONCLUSION

The design and implementation of an SMS based consumer load monitoring and control system presented in this paper exported the proliferation of wireless communication system and advanced applications of microprocessor technology. The system has many significant advantages, it enhance the performance and utilization of prepaid energy meter. Hence, helping the electricity consumers to efficiently utilized electrical energy. It has also provided a lee-way to proper power management system leading to power system stability.

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