

# Online Monitoring of Energy Consumption and Remote Operation of Switches

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**Abstract**—Cognitive energy management is the need of the hour. Today, we are in the dilemma to minimize the energy consumption, while at the same time we have to catch up with the economic developments happening worldwide. A lot of focus has been given recently to bridge that gap between the ever increasing power demand and the necessity to meet that at reasonable rates in a reliable manner. A considerable change could be brought about if the user is totally aware of his consumption. And this could be done, if there is a cost effective, efficient online monitoring system that could surveil this squander, measure the real-time electricity usage and intimate the user of an excess usage beyond the prescribed limits. Further, it would be an icing in the cake if this system can also identify any unnecessary wastage and would allow the user to even remotely switch off the causing equipment. The data stored with the system can also serve different other purposes. It can be used for studying the load distribution patterns and power factor at various locations and instants, helping in energy auditing. Also the user now being aware of the sources of unwanted wastage in his premises, can take actions to ameliorate the situation. The system may be used anywhere: homes, commercial establishments, educational institutions or government buildings.

**Keywords**—Digital Power Meter, Ebus, Ethernet, Microcontroller, Online Monitoring System, Printed Circuits, Remote Switching

## I. INTRODUCTION

The economic well-being of a nation is directly or indirectly related to electricity made available for the country. With an exponentially increasing population, and a consequent rise in demands for power throughout the world, be it for industrial or household or mercenary requirements, the power sector faces a mammoth task to put together safe, sound, low-profile techniques so as to maintain a correctly recorded and audited data consumption accounts.

Today, the GSM (Global System for Mobile Communications) technology has become so typical of mankind. The acceptance and spread out coverage of mobile networks have rendered the society so enslaved to make calls or send SMS every now and then, that a life without cell phones is totally inconceivable. In a way, today, they form the

pinnacle of wireless communications. There are around 3.3 billion subscribers to mobile networks today. So, when it comes to energy conservation, if GSM can play some role, then it sure would be a priceless factor.

These days quotations are put up everywhere asking the people to make the nation 'Power-full' by reducing the power consumption; or maybe to save energy for the future generations. But often the masses are caught up in several impasse situations like when they leave their homes to a distance, after forgetting to turn off their electric/electronic appliance and is too far away to come and back switch it off upon realizing their irresponsibility.

Taking this idea into account, this paper therefore, considers the potentialities in the realization of a GSM-Based Online Monitoring of Energy Consumption and Remote Operation of Switches. The proposed exemplar incorporates a low powered Microcontroller which is simultaneously interfaced with an external memory, a power meter, a Liquid Crystal Display (LCD), a GSM communication Module, an ADC and a Relay Circuit. The execution of this design shall aid in better energy management, save power and also helps in dismissing any inessential disputes over any mistaken billing. This completely automated system will keep an eye on the real time usage of power and there is negligible room for conflicts on consumption and billing.

To sum up, the intentions of our work are to: i) Design a system that would keep track of the real time consumption of power of the residence and intimates the user periodically or in case of an abnormality; ii) To facilitate remote switching of the power of the residence.

## II. MERITS OF THE RECOMMENDED PROPOSAL OVER THE PREVAILING ARRANGEMENT

In the current scenario, the consumer is hardly aware of his daily/weekly consumption until the monthly/bimonthly bills are being issued to him. If he is conscious of his usage and cost, he can employ precautionary tactics to maintain a balance. The proposed module based on GSM allows for the

implementation of SMS alert to the consumer based on his cumulative power consumption at the end of each day. This is a very economical and feasible way of communication. GSM also is a very secure means for communication as it can run on various cryptographic algorithms. In addition, the system can also facilitate the switching of the load from a remote location. This would be helpful in situations wherein the user forgets to switch off the power but later comes to his senses but unfortunately is at a distance to turn them off. This in turn could eliminate the possibilities of potential electric/electronic hazards from occurring. Anxious thoughts of a powered iron box left unattended, or a 'switched on' motor left abandoned can be finally put to an end with this proposal. The alarms that are triggered based on the previously logged data helps the user to be acquainted with any abnormal usage. Moreover, the errors due to inaccuracy while taking the readings can also be minimized.

### III. ARCHITECTURE

#### A. Energy Meter

The electronic energy meter has been an important invention in the Power Energy Measurement System, by providing an effective electricity-stealing defense [1]. The energy meter measure line voltage, current and calculates active, reactive apparent power, energy, power factor, and RMS voltage and current [2]. The electrical energy which is consumed by the load is measured based on the rotating disc. The ordinary electronic meter is incorporated with the micro controller in order to perform the specific functions. [3] PowerLogic PM800 series meters combine accurate, 3-phase energy and power measurement with, data logging, power quality analysis, alarm and I/O capabilities, which are not typically available in a compact meter. The meters are ideally suited to local and remote monitoring of low or high voltage electrical installations in industrial facilities, commercial buildings, utility networks or critical power environments. Facility and operations personnel will benefit in reducing energy-related costs while avoiding power quality conditions that can reduce equipment life and productivity.

#### B. Microcontroller

The microcontroller AT89S52 is a high-performance, low power CMOS 8-bit microcomputer, performs all the energy measurement functions and interacts with the various components. It is programmed to execute the tasks of reading and storing the data from the energy meter, and for the remote switching action. The given microcontroller is chosen considering its high precision, reliability, efficiency and cost.

The features of this microcontroller are [10]:

- 8K Bytes of In-System Programmable (ISP) Flash Memory Endurance: 10,000 Write/Erase Cycles
- Compatible with MCS®-51 Products
- 4.0V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 33 MHz
- Three-level Program Memory Lock

- 256 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/Counters
- Eight Interrupt Sources
- Full Duplex UART Serial Channel
- Low-power Idle and Power-down Modes
- Interrupt Recovery from Power-down Mode
- Watchdog Timer
- Dual Data Pointer
- Power-off Flag
- Fast Programming Time
- Flexible ISP Programming (Byte and Page Mode)

#### C. Relay Control Unit

The relay control unit is used as the protective element between the supply mains and the consumer load. The switching action of the relay is based on the message sent to the AT89S52 microcontroller. It will send an appropriate pulse for the disconnection, and another pulse for the establishment of the load from the supply. The voltage supply does not reach the load even if it receives the pulse, if the relay control unit is open.

#### D. GSM Module

The Global System for Mobile communications, GSM, is a pan-European Mobile communication system in the 900 MHz band which was first introduced in the early years of this decade. A module based on this technique is used to send the power and cost to the user's mobile number on a weekly basis. Furthermore, a message is send when there is an overload. The overall cost and power is also send on a bimonthly basis for a long term assessment.

### IV. APPROACH AND METHODOLOGY

The basis of the operation of the system relies on the interaction of the microcontroller with the relay, the power supply which is connected to the energy meter, the GSM communication module and LCD Display and the buzzer. Fig.1 shows the block diagram of the proposed model. Fig. 2 and Fig. 3 explain the flow of the working of the system.

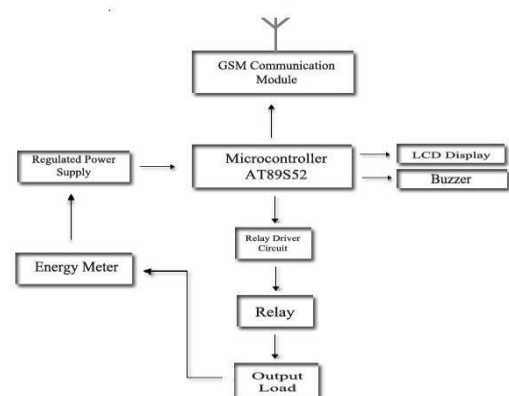


Fig. 1 : Block diagram

The scheme covers mainly three areas:

*A. Remote switching application*

It often happens that we leave our homes and forget to switch off lights and fans other electrical appliances. This causes a lot of electrical energy wastage.

The aforementioned scheme enables the user to have their main supply switched off from anywhere. They just have to send a message saying a 'yes' using the GSM module.

A 'Yes' implies that the user wants the system to open the circuit and switch off the main supply.

*B. Information about billing per week*

The system is programmed in such a way that after every two months, it sends the information about power consumed per week to the user on their mobile. In this way the user has knowledge of the power consumption and this eliminates the need of manual measurement and bill payment. Henceforth it solves the problem of electricity bills not paid due to lack of knowledge.

*C. Inspection for overload*

After every two months the data related to power consumed is stored and a threshold is set. The system compares every new value with the threshold and if it finds that the value is greater than the threshold, a message is sent to the user regarding the information. Accordingly the user can apply the remote switching scheme and the main supply can be switched off.

Similarly, a lot of areas could be included in the module. The uniqueness of the scheme is that it can be installed in the already existing energy meters and there is no need of mounting of new 'Smart meters' which majority of people in the developing nations cannot afford.

V. FLOWCHART

*A. Algorithm for Remote Switching Operation*

1) Start.

2) Initialize the display.

3) Using the GSM Module, user sends a signal to AT89s52.

4) The microcontroller checks if the mains is connected to the load or not.

5) If the mains is not connected, then leave it as it is and end the operation.

6) If the mains is connected, then the relay circuit is signaled to trip the circuit and thus the power is switched off. Refer Fig. 2.

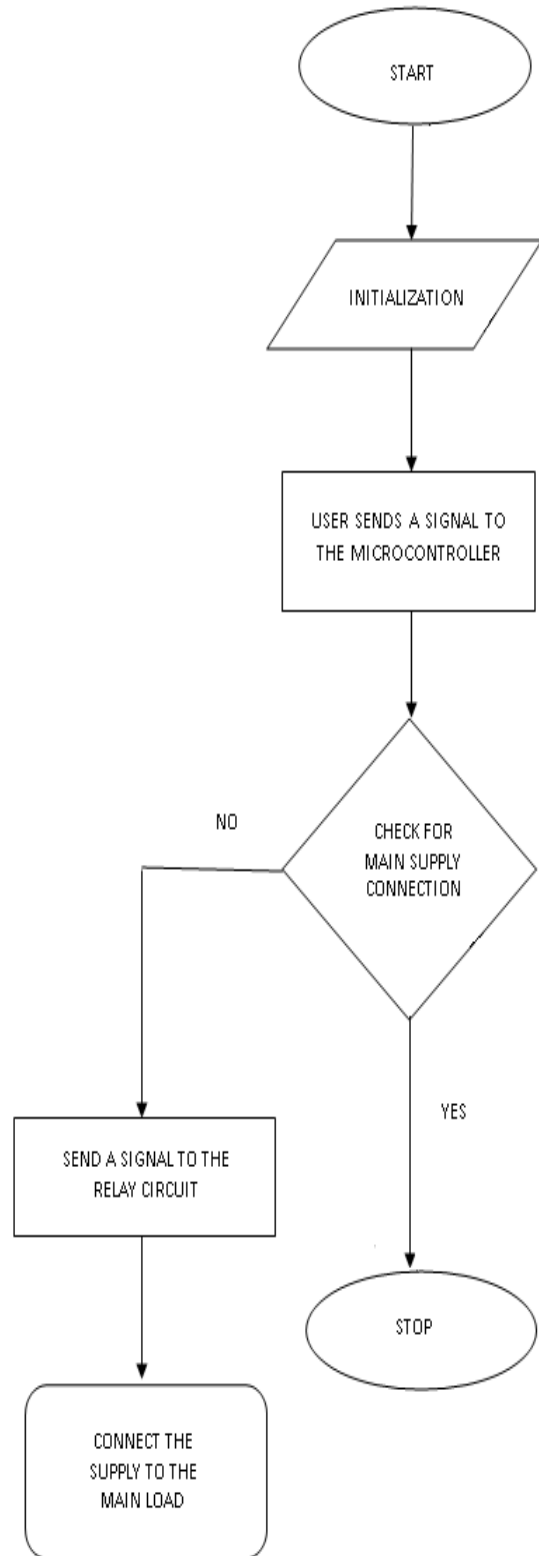


Fig. 2 : Switching Side Program Flow

B. Algorithm for Remote Switching Operation

Ref. Figure 3.

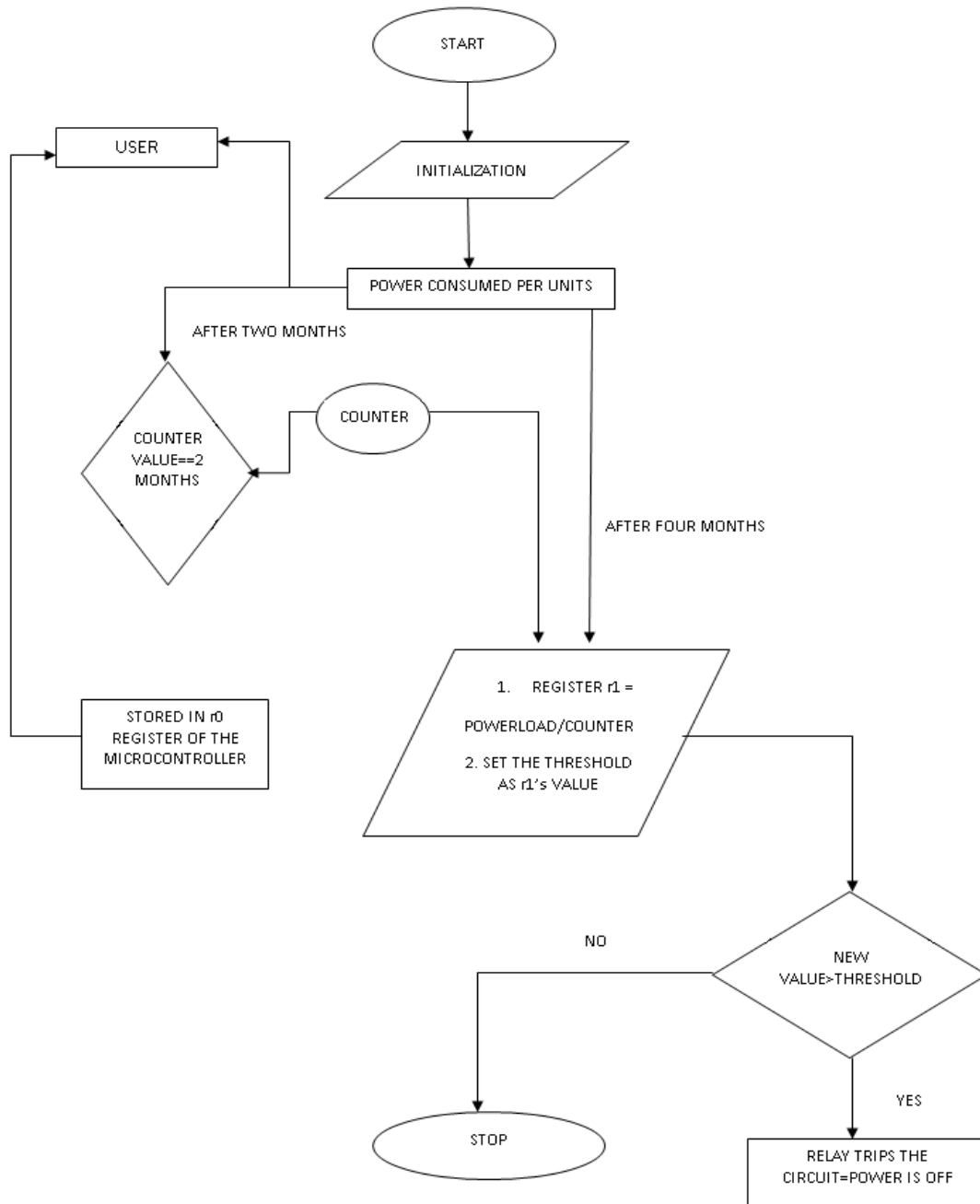


Fig. 3: Online Monitoring and Billing Program Flow

- |  |   |
|--|---|
| <p>1) Start.</p> <p>2) Initialize the display.</p> <p>3) Measure the power consumed per units and stores the readings continuously in the EEPROM of AT89s52.</p> | <p>4) Count the time using counter of AT89s52.</p> <p>5) If the count is equal to 2 months (approx. 60 days), the reading is sent to the user and the value is stored in register r0.</p> <p>6) Repeat step 4 for another 2 months.</p> |
|--|---|

7) After this count, calculate  
 (value in r0) / (counter value).

This is the threshold.

8) For every new entry after count==2 months, AT89s52 compares it with already set threshold.

9) If new value > threshold, the relay circuit trips the circuit otherwise it is left as it is and this information is sent the user.

10) End

## VI. SIMULATION

The simulation of the project was done using the Keil  $\mu$ Vision 3 and the AT89s52 development kit. The 'Remote Switching' action of this microcontroller was analyzed in this environment by considering the pin 3 of port 0 as the input pin connected to the GSM Module and pin 1 of port 2 as the output pin connected to the relay circuit. Figure 2 shows the screen shot of the I/O (Input/Output) port peripherals environment during the simulation. The Keil environment is basically used to test the simultaneous interfacing of the microcontroller with GSM Module and the relay circuit, and the measure of response of the switching action occurring in the power supply. Fig. 4 and Fig. 5 shows the state of input and output pins before and after the switching action.

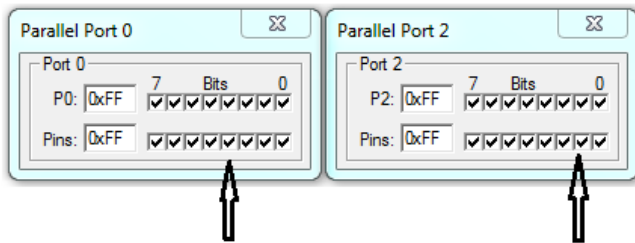


Fig. 6 : I/O pins before switching

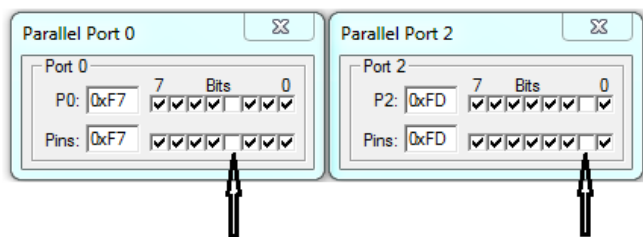


Fig. 7 : I/O pins after switching

## VII. APPLICATIONS

Online monitoring system and remote switching scheme eliminates the need to install new smart energy meters which not everyone could afford. It finds its application particularly in residential areas where people tend to forget to switch off the lights knowingly or unknowingly. It is also useful at times of power overload and assists you to pay off the electricity bills on time. The system enables Remote system maintenance. In this way you can save up to 25% of electrical energy. It is suitable for existing buildings and need not need much of installation costs. It redeems you from the tedious work of measuring the energy consumption every now and then. Rather you get all the information at your hand. Thus, the system meets essential energy measurement needs with a simple metering solution. The entire system can also be used in industries, hospitals, schools etc. The applications are wide and the system is quite versatile.

## VIII. CONCLUSION

As per the statistics, in another 40 years we would be suffering from energy crisis. If there is anything that could be done to preserve the energy, it should be done. The discussed scheme is an easy to apply scheme that could solve many energy problems. Developed nations are still doing their bit by implementing smart grids and micro grids; on the other hand developing nations are at a loss. It is like richer becomes rich and poor remains poor. Looking at the scenario, it might happen that the countries like Fiji, Chile, Pakistan would remain poor in energy and even if they do have reserves due to lack of affordability they could not implement it. This paper has proposed a new methodology of remote switching without completely changing the presently used technology. This new energy meter could act as an alternative to the conventional energy meters used. Taking into account its less installation cost the developing nations could find it of great use.

## IX. ACKNOWLEDGMENT

The authors acknowledge the support rendered by VIT University throughout the study. The authors also sincerely thank them for their technical support throughout the period.

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