2012 International Conference on Industrial and Intelligent Information (ICIII 2012)
IPCSIT vol.31 (2012) © (2012) IACSIT Press, Singapore

Self-Automated Efficient Energy Saver in Domestic Environments

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Abstract: Energy crisis is the commonest cry of the world today and the techniques ensuring the conservation of it are better suited than those preventive measures. This project basically concentrates on "phantom loads" also called as standby power which consumes power while the device is effectively not in use and also resolves the menace caused by load shedding by an efficient "power scheduling" scheme which optimizes the power distribution even during peak hours. For both these issues this paper presents a comprehensive smart self- automated system that conserves power lost due to 'Phantom Load' consumption on one hand and also schedules the power usage based on priority during the peak time. A simple sensor - relay drive circuitry is the heart of this reflexive implementation guided by the preprogrammed controller. The result of such an implementation brings about savings not only on the energy front but also cuts down the cost.

Keywords: phantom load cut off; power scheduling

1. Introduction

Energy is the most important natural resource, while the lack of it is an ongoing condition and the solution of it shall be our future. The ever increasing population all over the world results in a proportional increase of the demand for energy. Also, the advancements in various fields have shifted their work pattern from manual working to an automated working style. This again adds on the pressure upon the energy requirements. It's the primary concern of the industrial, agricultural, residential and transport sector. Thus the economic growth of a country is at the mercy of its energy resources and this shall be resolved by developing constructive measures in conserving and managing the available resources. The present scenario concentrates majorly on the different methodologies invested to harvest energy from various sources in different ways. As in previous years, during the year 2010-11, demand for electricity in India far outstripped availability, both in terms of base load energy and peak availability. Base load requirement was 861,591 (MU) against availability of 788,355 MU, an 8.5% deficit. During peak loads, the demand was for 122 GW against availability of 110 GW, a 9.8% shortfall [1]. The noted fact is that nobody ever uses energy with an eye for concern on our future. Electricity is the most commonly used form of energy and the conservation of it shall be better than the development of conversion techniques designed in the long run.

A true depiction of how everything is usually left in the house as obtain from a brief survey taken from an article is given below [8]:

TABLE I POWER CONSUMPTION STATISTIC

Device	Power (W)
Low-Power Tablet PC (Off)	2
LCD Monitor (Standby)	3
5.1 Home Theatre Receiver	4
5.1 Computer Speakers	6
Laser Printer	8
Bookshelf CD Audio System	10
VCR	10
Powered Subwoofer	10
Nintendo Wii (Standby)	11
CRT Monitor (Standby)	12
Secondary Desktop Computer	15
Main Desktop Computer	16
Grand Total	**107**

Hence our proposal focuses on devising a circuitry that shall efficiently be retrofitted to the existing electricity main boards, so that constant monitoring and switch off of the high powered devices may happen in a customized way. Hence, by having a configurable system that can be programmed to the convenience of the user, we assure to save the cost on electricity which shall otherwise not be wisely used instead be wasted unknowingly.

2. Components

1. Current sensors
2. Signal conditioning circuit
3. Microcontroller
4. Voltage conversion circuit
5. Zigbee - RF transceiver
6. RF remote

3. System Description

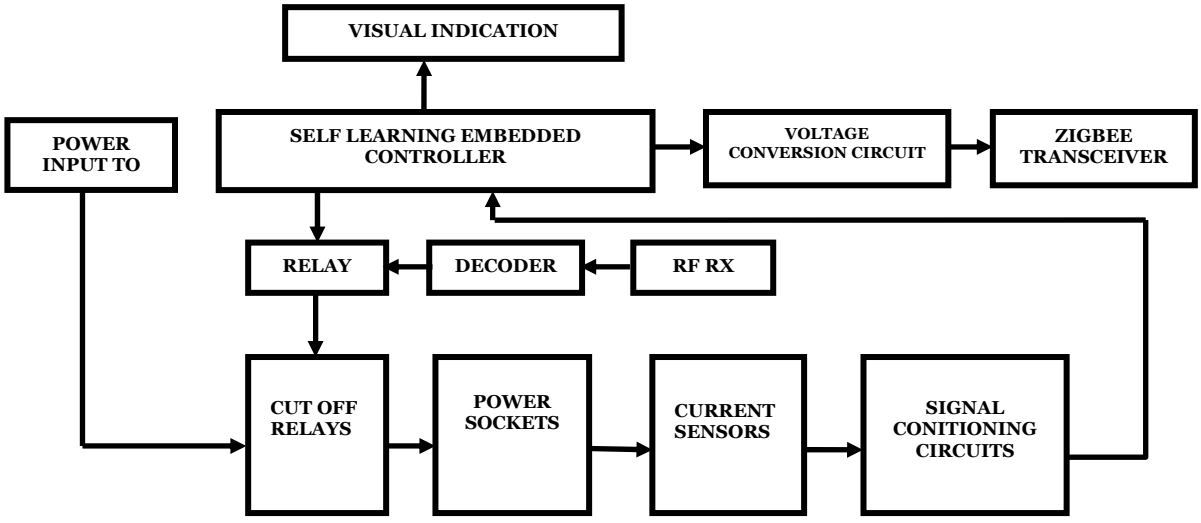

Figure. 1: Block diagram of the main unit

3.1. Current sensing

The first step in determining the amount of power consumed through each socket shall be to measure the amount of AC current flowing through the primary line. For this a current transformer shall be used to detect the load at the wall socket end which results in a constant monitoring of the current flow from the mains. A current transformer acts similar to a voltage transformer; however unlike a regular one it makes no physical contact with the measured line.[4] It uses the magnetic field generated by the AC current flowing through the primary wire which in turn is responsible for inducing a secondary current. It is designed so that the primary

and secondary sides are efficiently coupled to bear an accurate relationship to one another. Hence this provides the scaling of a large primary current into a smaller, manageable output current for measurement [5].

3.2. Signal conditioning

Once the sensed input is received it should be scaled to suit the levels of our sensor circuitry. So it goes through initial rectification stage where in a bridge rectifier is used. The reason for the choice of a bridge rectifier is that it provides full wave rectification from a two wire AC input resulting in a lower cost and weight. The essential feature of using this diode bridge is that the polarity at the output terminal is the same irrespective of the polarity at the input terminal [3].

3.3. Microcontroller

The controller functions as the intelligent mind behind the automated energy saving environment. The PIC16F877A CMOS FLASH-based 8-bit microcontroller is upward compatible with the PIC16C5x, PIC12Cxxx and PIC16C7x devices. It features 200 ns instruction execution, 256 bytes of EEPROM data memory, self-programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port. The output of the signal conditioning circuit goes as the input to the microcontroller. As it has many input pins, a single microcontroller may simultaneously monitor several wall sockets parallel manner. The programs coded into the controller memory calculates the power consumed and provides a visual display and also sends information to the corresponding relays through the relay drives to switch on/off the mains supply to that particular device being monitored. Also a separate program is written to automate control during the peak hours thus shutting down the high powered devices.

3.4. Voltage conversion circuit

Different devices works on different logic systems (i.e.) have different voltage specifications for the logic '0' and logic '1' levels. In our design the conversion of voltage happens between the zigbee transceiver and the devices. To satisfy this purpose we use an **IC MAX232**, which conveys the logic levels without any disturbances by suitably modifying the voltage to meet the logic level specification. The **MAX232** is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits.

The **MAX232** is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS- 232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case. Initially a transistor circuitry is employed with a zener diode having 3.3V as its zener voltage to suit the zigbee transceiver specifications while conveying information from the controller functioning at 5V. This IC MAX232 plays a role in communicating with the devices working at +/- 12V.

3.5. Zigbee transceiver

This wirelessly transmits information about the load availability from either a local substation or a local transformer to its residential receiver during peak hours. In our proposed system it is used for the communication between the microcontroller and the computer. The advantage of using zigbee shall be short range wireless transfer of data at relatively low rates. The frequency of operation is in the license free ISM band - 2.4GHz and shall cover a distance of 100 meters. It has a defined rate of 250kbps best suited for periodic or intermittent data or a single transmission from a sensor input. It is simpler and economical than Bluetooth and is majorly targeted at radio frequency applications whose requirements shall be low data rate, long battery life and secure networking [6].

3.6. Local sub-station unit

The relays which are used to cut off the power supply of the devices consuming phantom load can also

be used to shutdown high power circuitry during peak hours. This peak hour information is received from the EB office using a wireless communication medium. When received that information is used by the microcontroller to cut off high power devices and the user cannot switch it on during that time. The controller can be programmed for various timer delays on when to turn off a device or for how long to wait before turning off a device. For programming this information the controller can temporarily be connected to a computer. Once the settings are made the computer is not needed the device can operate independently.

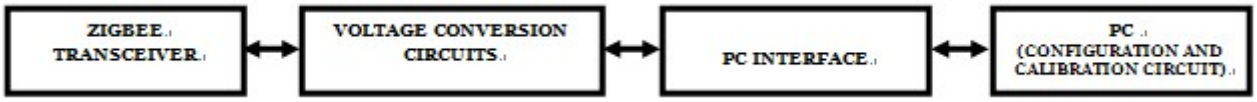

Figure. 2: Block Diagram of the Local Sub-Station Unit

3.7. RF remote

This circuit utilizes the RF module (Tx/Rx) for making a wireless remote, which could be used to drive an output from a distant place. RF module, as the name suggests, uses radio frequency to send signals. These signals are transmitted at a particular frequency and a baud rate. A receiver can receive these signals only if it is configured for that frequency. A four channel encoder/decoder pair has also been used in this system. The circuit has been used for designing Remote Appliance Control system. The outputs from the receiver can drive corresponding relays connected to the controller. This remote is used for the convenience of the user to control the devices as to whether cut off or switch on the devices when needed [7].

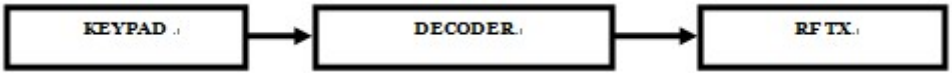

Figure. 3: Block Diagram of the RF remote

4. Advantages

This automated system offers several basic advantages which acts as an add-on to our day to day convenience.

1) Mainly it reduces power wastage and hence save the cost on unutilized electricity.
2) It reduces the conditions of automatic trip due to power overloading.
3) It also reduces manual intervention in case of power fluctuation situations and comes in as a self - learning automated embedded system.

5. Future Scope

This ideology may be extended to be integrated with another energy supplying system to compensate for the shortage caused during power scheduling. The supporting system may be aided by a solar power system or an inverter or a generator depending upon the amount of the excessive demands of the consumer. It may also be implemented as a customized embedded system functioning along with the internal wiring system cable of being re - programmed by the user.

6. Conclusion

This focuses on ways to cut down power wastage rather than mechanizing new methodologies to automate reduced power consumption. Thus it may be easily retrofitted to the existing electrical circuitry to monitor and control the power utilization. Thereby it reduces the cost on electricity saving energy and ensures that the demands of the users are their actual needs. This system also proposes to be a solution to the frequent power cut scenario ruling out the need for inverters. A better suited alternative to home environments when compared with power strips and expensive generators.

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