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Automatic energy meter reading for multiple devices employing prepaid alerting system

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***Abstract*---** This paper intends to establish a system which advises to keep an eye on the readings from an energy meter and regulating the switching of energy meter. The proposed system has maximum demand concept, to alert the user when the energy consumed crosses beyond the set limit in the form of text message. In this we have designed the system in such a way that if the maximum demand for the industries under load conditions exceeds the allotted demand then the Electricity Board will insist penalty for that consumer.

***Keywords*---**Regulated power supply, Voltage regulator, Microcontroller, LCD, Relay, GSM Modem, LED indicators.

Introduction

NOWADAYS the demand for energy has been increasing drastically. In this regard many renewable energy sources have come into picture. A famous quotation says "Energy saved is energy produced". Following this quotation many measures have been taken to carefully use energy such as "Energy conservation week" etc. In this regard the customer can install an alerting system which alerts the customer after the energy consumed by the customer crossed the specified limit [2,3] and he/she can regulate the energy consumption. In this paper we have designed a system which alerts the user when the energy consumed crosses beyond the specified limit.

Block Diagram

We have designed a system in which customers gets alerted when he/she crosses the allotted demand. The electricity board can also penalize the customer in case

the allotted demand exceeds and if anyone tampers the system. The different parts of the systems are Regulated Power Supply, LCD Display and Microcontroller. In this continuous monitoring and recording the data of energy meter is done[4]. This is achieved with the help of microcontroller.

Regulated Power Supply (RPS)

A regulated power supply is an ingrained system which transforms unregulated alternating voltage into a consistent DC voltage. The primary function of a rectifier is to rectify AC to DC. Its responsibility is to feed a balanced voltage, to a load that must be operated not beyond specified power limits[8]. The response of the rectifier may be alternating or unidirectional, but is nearly always DC. The different parts available in power supply are: i) Transformer (ii) Rectifier (iii) Filter (iv) Voltage Regulator. Fig 1 represents the schematic diagram of RPS

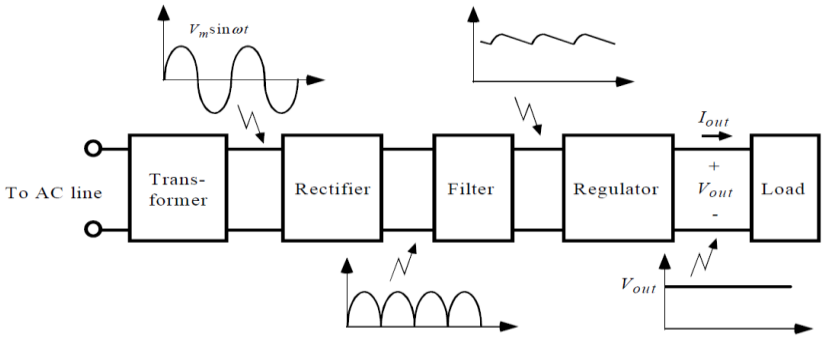

Fig 1: Schematic diagram of RPS

Transformer

A transformer is a static arrangement that alters voltage without any change in energy. The transformer works on the principle of electromagnetic induction. As it alters voltage it is mainly used to increase or decrease alternating voltage in certain applications. We have two species of transformers a) Step Up transformer

Step down transformer

Step Up transformer- In a step up transformer secondary voltage is greater than primary voltage. As the voltage has been stepped up it is named as “Step Up transformer”. Step Down transformer- In a step down transformer secondary voltage is less than primary voltage. As the voltage has been stepped down it is named as “Step Down transformer”.

Rectifier

It is the most influential subset of RPS which is used to convert alternating voltage to DC voltage with the usage of semiconductor devices. This process of conversion is known as rectification. By the usage of semiconductor devices the output of the rectifier is usually a rippled DC and it is further smoothed by a filter which is generally a capacitor. By the combination of semiconductor device and

filter the response of the rectifier is a steady voltage and current. For a single phase supply, depending on the number of rectified cycles, rectifiers have been classified as a) Half wave rectifier b) Full wave rectifier [8]

Half Wave Rectifier- The rectifier is named as half wave rectifier because it rectifies one half cycle of the supply voltage and it uses only one semiconductor device. Fig 2 indicates the schematic diagram of half wave rectifier and its corresponding output.

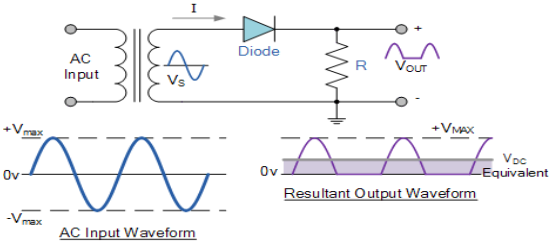

Fig 2: Half Wave rectifier and its output

Full Wave Rectifier- The rectifier is named as full wave rectifier because it rectifies both half cycles of the supply voltage and depending on the number of semiconductor devices they have been again classified as a) Bridge rectifier b) Centre tapped full wave rectifier. Fig 3 and 4 indicates the circuit diagram of bridge rectifier and centre tapped full wave rectifier and its corresponding outputs.

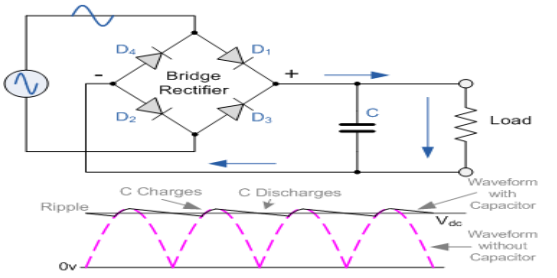

Fig 3: Bridge rectifier with filter and its output

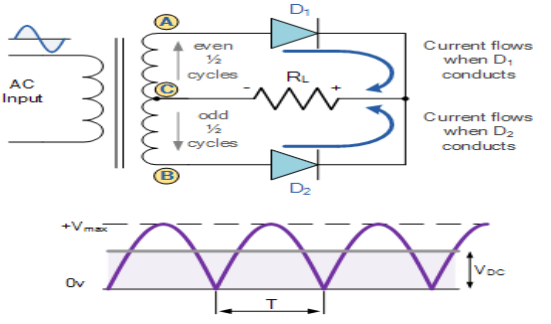

Fig 4: Centre tapped full wave rectifier and its output

Filter-Filter is used to decrease the ripple content in the output of the rectifier by converting pulsating DC to pure DC and is usually connected in parallel with the load so as to decrease the ripple content. Generally capacitor, inductor (or) combination of both L and C are used as filter. The different types of filters are: a) Inductor filter b) Capacitor filter c) LC or L section filter d) CLC or Π section filter. Fig 3 indicates the bridge rectifier with capacitor filter and its corresponding output.

Voltage Regulator – As the components used in a RPS gives us the unregulated output whereas the load always requires a constant output, for this purpose voltage regulator has to be used. This has been specially designed to automatically maintain a constant voltage level. Basically a voltage regulator uses electromechanical mechanism or electronic components. The output of the voltage regulator uses depends on the input unregulated dc voltage, load current and temperature.

Microcontroller

A microcontroller comprises of a processor core, memory and programmable input/output peripherals on a single integrated circuit [6,5]. It is much preferred when compared to a system consisting of microprocessor, memory and input/output devices as it is economical and easy to control digitally.

LCD Display

LCD abbreviated as Liquid Crystal Display is a display unit which uses the light modulating properties and basically combines the properties of the solid and the liquid. It consists of a thin layer of liquid crystal sandwiched between glass sheets. These crystals do not emit light directly but it is due to illumination effect. LCDs are preferred when compared to other display devices because they consume less amount of power, thinner and lighter [10].

Relay

A relay is an electrically operated switch. Most of the relays handle electromagnet to operate a switch. Apart from electromagnet other principles can also be employed. Relays are employed where the motive is to control a circuit by a low power signal or several circuits must be controlled by one signal [10].

GSM Modem

A modulator demodulator has been called as modem in our day to day life. It is basically a network hardware device whose function is to modulate one or more carrier signals for encoding digital information and then to convert the digital information into used format it is then demodulated [7]. A GSM modem is basically a wireless modem that works with a GSM wireless network. [9,1, 8]

Initialization of proposed system

The proposed system consists of RPS segment, Energy meter, PIC microcontroller mother board, Relay, load, LCD display and GSM modem. As our desired function is to measure the energy consumed by a consumer the proposed system has to be installed at consumer side (may be domestic or industrial) and the user in our case power generation and distribution corporation officer will check the entire system by a simple text message (SMS). Fig 5 indicates the hardware set up of the proposed system.

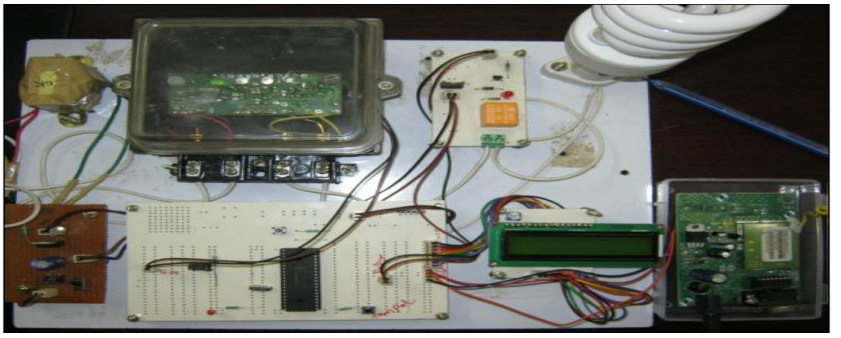

Fig 5: Indicates the hardware set up of the proposed system

Fig 6: LED glowing indicates the insertion of SIM of card to the GSM modem

Insertion of SIM Card

As to start the operation we need to insert SIM card to the GSM modem and switch on the power supply to modem. As soon as we switch on the power supply a red color LED will glow (as shown in Fig 6) to indicate that the supply has been switched on. After a span of 1-3 sec a yellow color LED starts to blink to indicate that the GSM modem has started initializing. After the GSM modem has been initialized again the yellow color LED starts to blink to indicate that the modem has been set up. The user can be relaxed by calling the number it will start ringing.

Initializing the microcontroller

After the successful insertion of SIM card the RPS is switch on with the supply. The step down transformer (placed at the left hand side of the kit as shown in Fig 5) will receive 230V AC from the main supply. Slide the switch to provide to RPS. As discussed earlier in section 2.1 RPS has to deliver regulated output, the RPS incorporated here delivers 5V DC. As soon as RPS delivers the output the white colored LED starts glowing (as shown in Fig 7). The output of the RPS is provided to the microcontroller and to indicate this red color LED glows (connected at pin D1) with the help of microcontroller program (shown in Fig 8). This LED is to indicate that the microcontroller has been initialized properly. As the whole process gets completed the LCD display a start up message "GSM based Energy Meter" (as shown in Fig 9) [5].

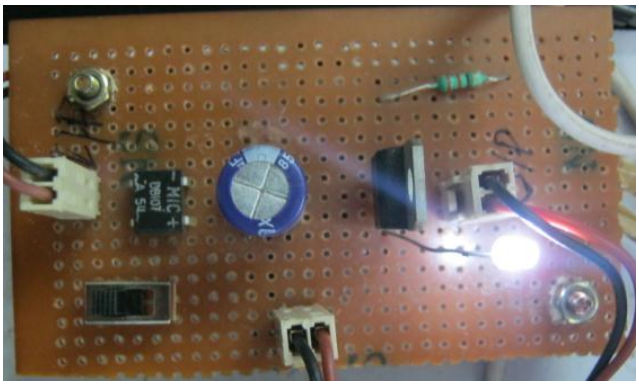

Fig 7: LED indicating the functioning of RPS

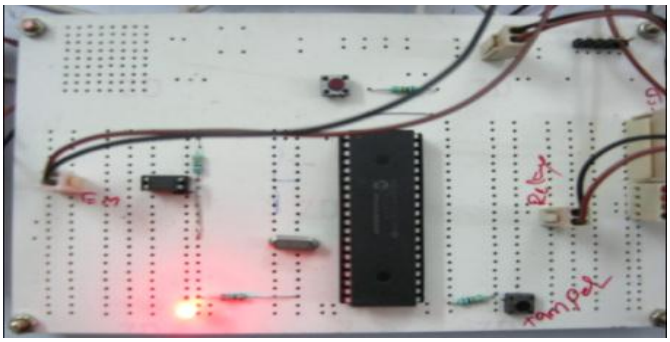

Fig 8: LED indicating the functioning of microcontroller

Fig 9: Start up message indicating the successful set up.

Different modes of operation

The proposed system calculates the amount of power consumed and displays it as a message. Along with that it displays the amount of bill to be paid and a message is sent to pay the bill. Other than displaying the power consumed and amount of bill, if any tampering is done or any interruption in the power supply, it displays the message.

Reading the energy consumed and payment reminder

For calculating the energy consumed, load is connected to the energy meter. The energy meter is connected to the microcontroller at pin no A4 via PC817 Optocoupler. One LED is installed in the energy meter. According to the power rating that energy meter led blinks (if the value of power consumed is high it blink fast or else slow). Microcontroller reads the pulses at pin no A4. Depending on the number of pulses the microcontroller calculates the amount of power consumed and displays the power consumed in LCD display. Fig 10 shows the amount of power consumed in KWH[4]

Fig 10: Indicating the amount of power consumed

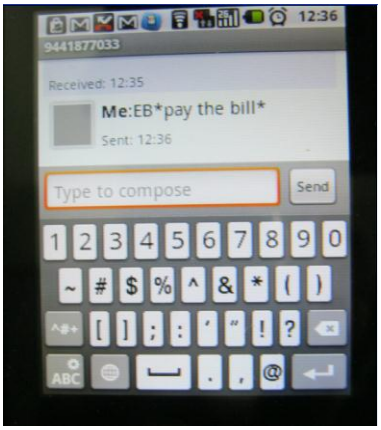

Fig 11: Text message to the consumer to pay the bill

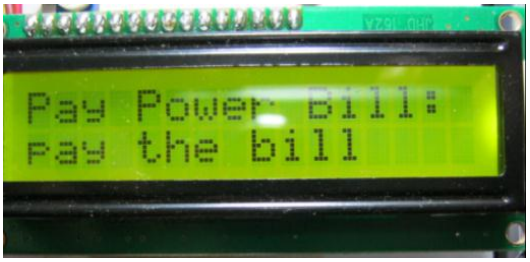

Fig 12: LCD display showing consumer to pay the bill

Now suppose the electricity generation and distribution corporation officer i.e. the user wants the consumer to pay the bill. He will type “EB*Pay the bill*” and send it to the consumer number (as shown in Fig 11). Microcontroller will receive this message via GSM modem and it will display a message on the LCD screen “Pay Power Bill: pay the bill” (as shown in Fig 12)[5].

Detection of tampering

To alert the user i.e. electricity generation and distribution officer we have incorporated a system which indicated the tampering of energy meter [7]. In order to achieve this one pushbutton is connected to PIN D2 to inform the energy meter box status. The push button alerts the micro controller. The microcontroller displays message (as shown in Fig 14) which is sent to the user to take appropriate measures (as shown in Fig 13) and LCD will display a message to alert the consumer.

Fig 13: Indicating the tampering of energy meter

Fig 14: Display showing the tampering of energy meter

Conclusion

The paper aimed at designing a system which helps to keep an eye on the readings from an energy meter and regulating the switching of energy meter. The proposed system also has maximum demand concept, which alerts the user when the energy consumed crosses beyond the set limit in the form of text message.

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