

Smart Energy Meter and Fault Detection

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Abstract: This paper presents a GSM based smart energy metering system and line fault detection method which will replace traditional meter reading method. they can monitor the meter readings regularly without the person visiting each house and the bill is automatically send via SMS to each user and if the consumer fails to pay the bill the supply can be cut off by the service provider. This system will prevent the illegal usage of electricity known as power theft and also find out the line fault location without any human control quickly and accurately.

Keywords : Automatic Meter Reading(AMR,)ATmega328, Current Transformer(CT), GSM module ,Real Time Clock(RTC)

I. Introduction

Global energy crisis are increasing every moment . Everyone has the attention towards more and more energy production. A lot of new technology has been introduced to satisfy the user demands. Automation in the energy distribution is also necessary to enhance people's life standard. The traditional method of electricity billing system involves meter readers to periodically visit every house to take readings and calculate the bill. There are many issues related to this method such as taking wrong readings, lack of meter readers, and houses in very remote areas, meters in inconvenient location etc. One of the advanced and convenient method is automatic meter reading (AMR). In this method, the Energy Meter sends the details about the total units consumed by household in the certain interval of time to a wirelessly connected network, which could be a personal computer or server of power distribution companies. The power theft is also increasing which will affect the economy of our country. Development of advanced electronic meter with theft detection scheme can be used to prevent the electricity stealing by the household. The customer needs power without any interruption, hence a reliable system should be established to ensure the continuity of power supply. Therefore fault identification and fault elimination should be done quickly.

This paper proposes a smart energy metering system and an effective fault detection method which periodically updates the energy consumption details of the households and send it to the authority side by using GSM, and it sends the bill to the user through SMS .The provision to disconnect the load automatically is also established to the system when the user fails to pay the bill. The fault detection part monitors the type of fault and sends the details about the type and location of fault to the authority. The GSM technique enhances speed of communication with distance independency. This technology saves human life from this electrical danger by providing the fault detection and automatically stops the electricity to the damaged line and also conveys the message to the electricity board to clear the fault. An Embedded based hardware design is developed and must acquire data from electrical sensing system. A powerful GSM networking is designed to send data from a network to other network. Any change in parameters of transmission is sensed to protect the entire transmission and distribution.

II. Literature Survey

The traditional metering systems has many disadvantages as manual reading has shortcomings such as errors in taking reading, inaccuracy, external conditions affecting readings ,delayed work and location of consumers .This metering techniques also requires huge manpower. In order to overcome the problems of the traditional meter reading system, automatic meter reading technique should be established. The three key elements in an automatic meter reading (AMR) system are: consumption measurement, meter reading, transmission of measured data, and data processing and billing.

In case of fault detection, now a days we use impedance relay or reactance relays to locate the fault. But this requires long time to calculate the distance of faulty part and repair the faulty phase, the system will be in OFF state and the supply to the consumers is unreliable. This paper concludes that the GSM technology used for the fault detection of three phase line through calls and messages is provided to the incharges of that

location, by the means of communication protection schemes. The Messages of fault location will send to the all In-charges at a same time by the internal programming of microcontroller connected to GSM Module. To get the exact faulty phase under abnormal condition has been occurred, the RYB Indicators are also provided for faulty phase indication purpose.

1. AUTOMATIC METER READING

a) MICROCONTROLLER

The high-performance Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed. Today the ATmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed. Perhaps the most common implementation of this chip is on the ever popular Arduino development platform, namely the Arduino Uno and Arduino Nano models.



Fig.no: 2.1 ATmega328

b) RELAY

A relay is an electrically operated switch. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults;

c) CURRENT TRANSFORMER

A current transformer (CT) is used for measurement of alternating electric currents. A current transformer isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays in the electrical power industry.

d) LCD

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

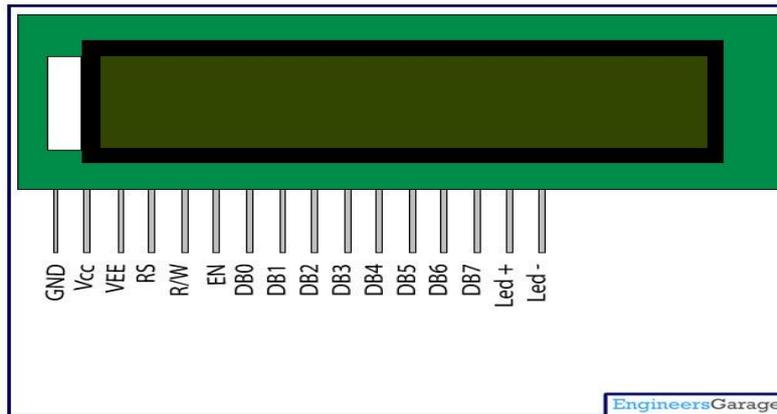


Figure 2.2: LCD Display

2. AUTOMATIC FAULT DETECTION

a) CURRENT TRANSFORMERS

In LFD, we use the Current transformer (C.T.) of good sensitivity. The C.T. is connected or Clamped on each phase and the secondary terminal of each C.T. is connected to three single bridge rectifier.

b) BRIDGE RECTIFIER CIRCUITS & I-V CONVERTERS

Rectifier circuits rectify the ac current to dc current and converter converts the dc current into respective voltage values. Here some reference voltages are set to the input of microcontroller.

c) MICRO CONTROLLER UNIT

The microcontroller circuit acts as the zero crossing detector, if the voltage of any circuit exceeds the reference voltage then the microcontroller sends the command to the GSM module and relay of phase indication lamp.

d) GSM MODULE

The GSM module creates the message using microcontroller which reads the faulty phase and the location of feeder and sends it to the Operator, Sub Engineer and Junior Engineer of that location. After these the operator will receive the location of fault and faulty phase and alerting calls at certain period. If that operator does not respond the clearing of fault or reset the abnormal condition to normal condition in between the period of calls. The next call will be transferred to the area Sub Engineer; similarly if Sub Engineer does not respond to the Operators work then further call will be transferred to the Junior Engineer. By this process the work or clearance of fault will be done quickly with their responsibility.

e) BATTERY SUPPLY

After the fault is occurred the supply to the circuit is disconnected, So the external battery source with battery charging circuit is provided to keep the TPLFD circuit continuously in operation

III. Methodology

The goal of our project is to automatically read the consumed energy during every month and to calculate the bill. The bill thus generated is sent to the consumers' mobile phone as an SMS via a GSM module. The project also helps in detecting fault in transmission lines.

3.1 AUTOMATIC METER READING (CONSUMER SIDE)

3.1.1 BLOCK DIAGRAM

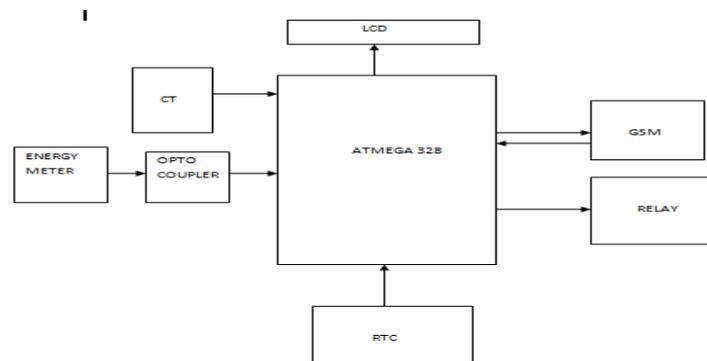


Figure 3.1: Block Diagram of automatic meter reader (Consumer side)

The blinking of LED (provided in the energy meter to indicate the amount of unit consumed) is sensed using opto coupler. Hence the amount of unit consumed during a period is provided to the ATmega328 from opto coupler. RTC (Real Time Clock) determines the period of consumption (1 or 2 months). The total unit consumed during a specific period is provided to the KSEB via message with the help of GSM module under the control of a micro controller. Also unit consumed is displayed using LCD display. If the current consumed is more than the permissible value it will be sensed by a CT and the information about theft is transmitted to KSEB via GSM module.If the consumer did not pay the bill amount within a specific period KSEB can cut off the supply with the help of relay provided at the consumers' side.

3.1.2 AUTOMATIC METER READING (KSEB SIDE)



Figure 3.2: Block Diagram of Automatic meter reader(KSEB Side)

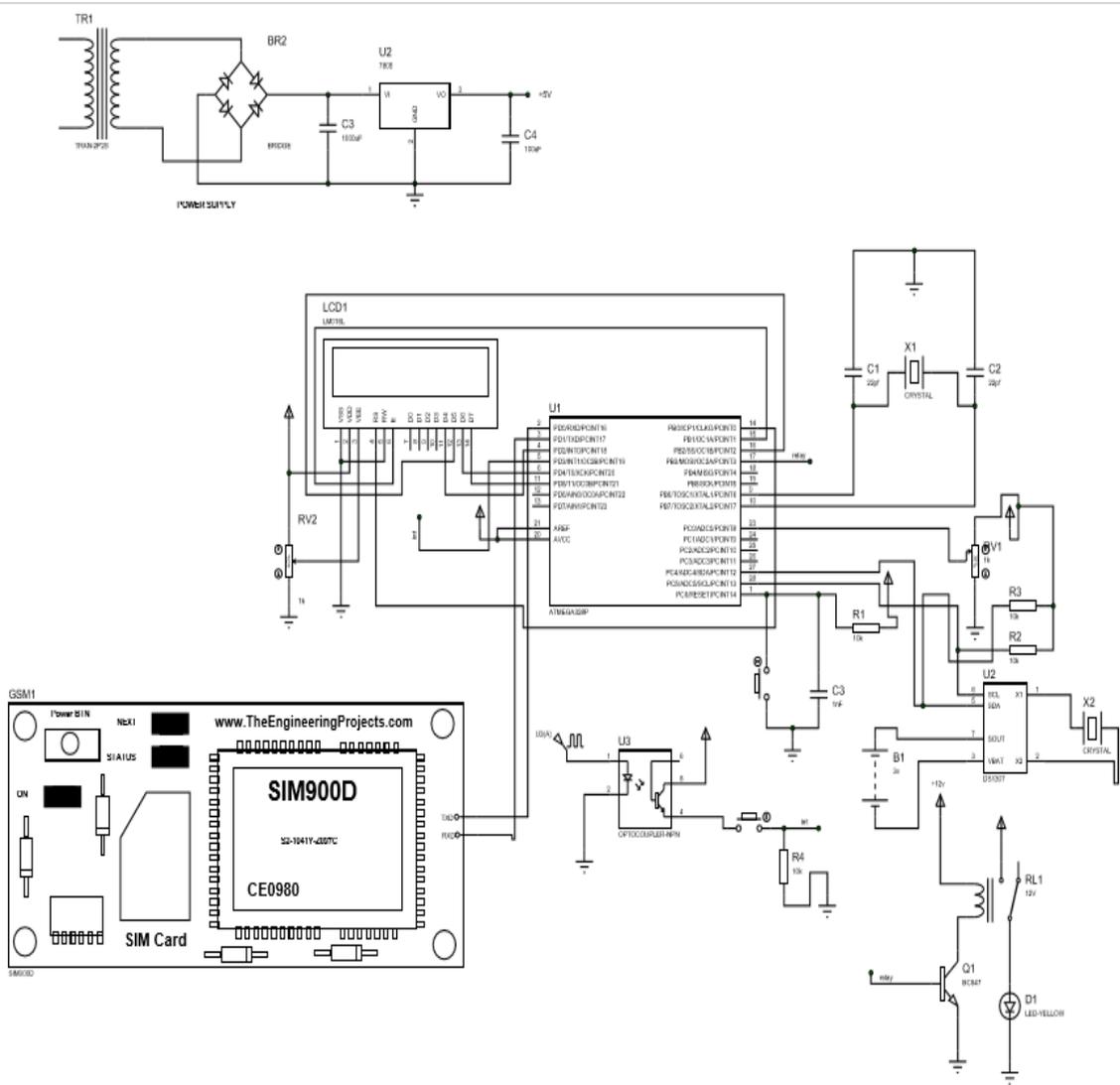


Fig: 3.3 Circuit diagram

The data (unit of energy consumed in a period) that send from the consumer side GSM will be received by KSEB and they could calculate the bill amount according to the tariff.

3.2 FAULT DETECTION

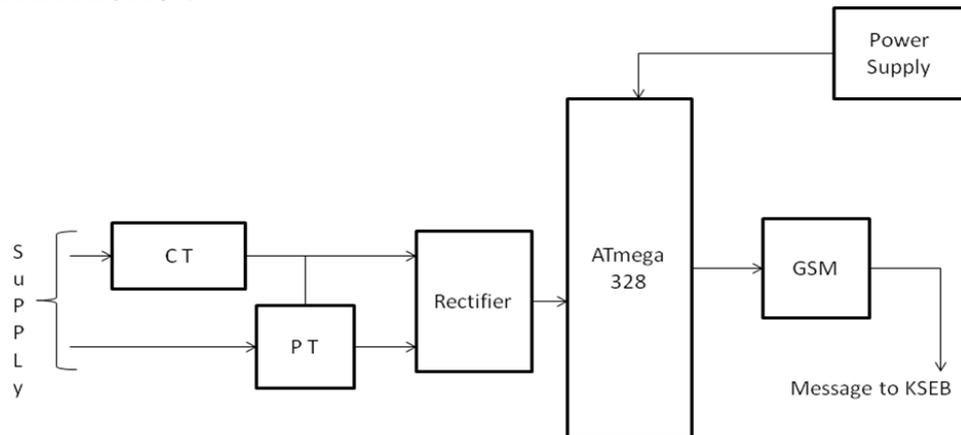
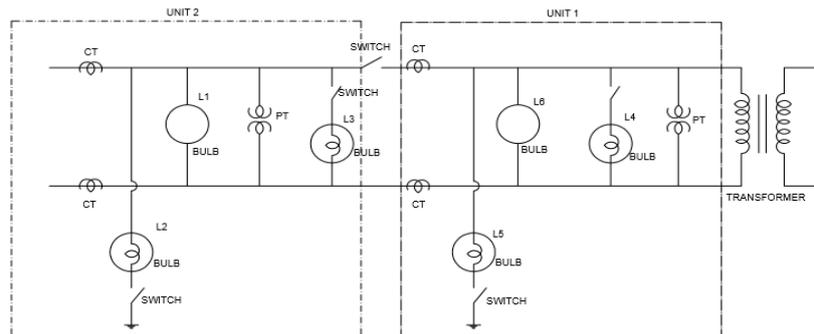


Figure 3.4: Block diagram of fault detecting system

The GSM module creates the message using microcontroller which reads the faulty phase and the location of feeder and sends it to the Operator, Sub Engineer and Junior Engineer of that location. After these the operator will receive the location of fault and faulty phase and alerting calls at certain period. By this process the work or clearance of fault will be done quickly with their responsibility.

The CT measures the current and step down to a measurable value and the PT measures the voltage element and step down to measurable value. The measured CT value is rectified using the rectifier unit and given to the micro controller. ATmega328 compares the measured value with the pre-set value. when a fault occurs, the current through the lines will be a high value, greater than the pre-set value. Hence the fault is detected and notification is send to the authorities via SMS with the help of GSM module.



3.5 Circuit diagram

IV. Conclusion

Human interaction is minimized by the present system, so it have high accuracy .at the end of a specific time period the cost of energy consumed is send to the consumer's phone via SMS. Relay operation for cutting and re-establishing the power supply can be controlled by a programmed system . consumer will be more aware about the energy consumption by the provided warning messages about consumption and power theft detection notifications .when a fault occur in the distribution system, the exact location and type of fault is send to the authority via SMS with the help of a GSM module. Future works will include the implementation of AMR in every households .In case of fault detection, RYB indicators and buzzer can be provided at top of the transmission poles to determine the faulty phase.

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