AMI MESH NETWORK ENERGY THEFT DETECTION AND POWER MANAGEMENT

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ABSTRACT:

The power management system is consists of Zigbee Digital power meters installed in every consumer unit and an Electricity e-Billing system at the energy provider side.Human operator billing or prone to reading error as sometime the houses electric power meter is place in a location where it is not easily accessible. In this paper we present AMI method used to detect energy theft and also management power by using Zigbee method .We can moniter energy theft and power management. Slicing of interrupt timings is also discussed which can be used to improve the performance .The highest priority task is serviced more number of times and with lesser time period. If power will be less in grid, automatically power will be manage. Our proposed system when low power generation automatically goes to power management.

Index Term: Energy Theft Detection-billing, Zigbee, and Power Management.

I. INTRODUCTION

The Advance Metering Infrastructure (AMI) is changing the way electricity is measured, consumed, and even distributed. Digital smart meters remotely report not only fine-grained energy consumption data, but also logs of events indicating malfunctions, misconfigurations, and potential physical tampering. These monitoring capabilities, coupled with large-scale AMI data aggregation promise to significantly mitigate the problem of energy theft, an especially pervasive problem in developing countries.

Electricity is now more than a necessity. The need of electricity is increasing day by day. With increasing need of electricity the power theft is also increasing. It has become a must to develop a system to avoid the increasing theft. With the development of mesh network and its increasing popularity, Zigbee module and Short Message are gradually used to transmit information but there are still a few shortcomings, such as the unsatisfactory real-time ability to control the theft of electricity when user is not at home.

The objective of this project is to design a system in order to avoid the displeasure for the users from paying hefty bill irrespective of use of the electricity due to theft .Utility companies are under pressure. Growing populations are using increasing amounts of power, which is putting a strain on existing supplies. In many countries the increase in demand is growing at a faster rate than transmission capacity and the cost of providing power is also increasing due to higher fuel prices and increases in the cost of construction and capital expenses. This project provides an overview of Wireless Sensor Network for Power Management, including the cost savings as well as theft indicator cum prevention system it can provide. Our project uses PIC microcontroller along with relay drivers, sensors and Zigbee module to detect power theft as well as wastage of energy in malls and hotels and power management in low power generation period.

II. MARKET SURVEY

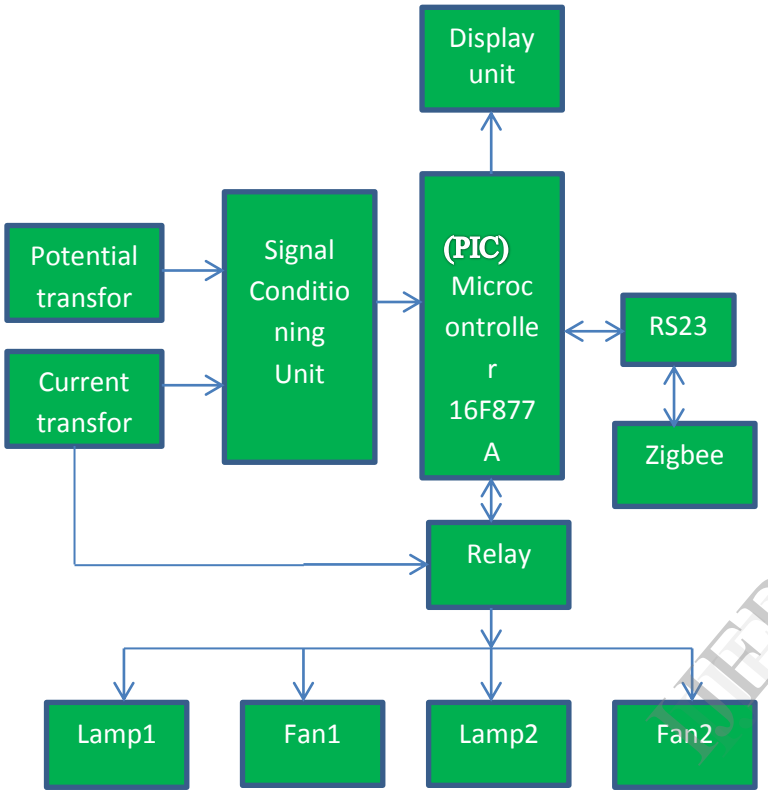
Such system is not available in the market but it has only manual system. Microcontroller based system is not available yet it's prototype system what are trying to develop since the microcontroller and Zigbee is an exciting,challenging ,and growing field; it will pervade industry for decades to come. To meet the challenge of this growing technology, we will have to conversant with the programmable aspect of the microcontroller .Programming is a process of problem solving and communicating in a strange language of mnemonics. The project could be developed significantly faster and much easily using a microcontroller.

III. BLOCK DIAGRAM

In this project you start or stop the meter by command via zigbee module. This command is sent to microcontroller. Here the microcontroller is the flash type re programmable microcontroller. Which we have already programmed with codeing. So the typed code is compared with stored code if the code is valid the microcontroller activates the relay driver circuit. The microcontroller also connected to the Relay. Now we can start the meter. This is for the purpose of theft identification and prevention. The microcontroller is also programmed to limit the power consumption to a certain limit for particular periods of time. The node section display unit is used to display the amount of energy consumed and price also display. This amount of energy and price is send to the admin section through zigbee then it stored in PC. When low power generation occur at the time the admin section command will be send through zigbee the node section zigbee receive. Then the microcontroller compare stored program if the command is valid then switch off all device except one fan and light. If the consumption limit is exceeded for a particular time of the day. If power will be less in grid, automatically power will be manage. Our proposed system when low power generation automatically goes to power management. All the devices controlled depends upon the priority based and timing based control the devices when low power generation. When switch off the device except

fan and light at the time the need of power will be increase.so the power theft also increase. After switch off the device the consumer again switch on the device the microcontroller command will send to the admin section. Then total power cut will occur in particular theft area.

NODESECTION:



ADMIN SECTION:

Brief methodology:

The project is designed with:

- Current and Voltage transformer
- Zigbee module
- Pc interface
- Lcd display
- Pic 16f877A

IV. HARDWAREAND SOFTWARE

A.CURRENT AND VOLTAGE TRANSFORMER

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. Each of the blocks is described in more detail below:

- Transformer – step down high voltage AC mains to low voltage AC
- Rectifier-converter AC to DC ,but the DC output is varying.
- Smoothing –smooth's the DC from varying greatly to a small ripple.
- Regulator-eliminates ripple by setting DC output to fixed voltage

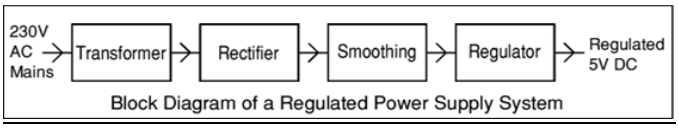


Figure 4.1 Power supply Diagram

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC. Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage. The input coil is called the **primary** and the output coil is called the **secondary**. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.

B. MICROCONTROLLER PIC 16F877A

Peripheral Interface Controllers (PIC) is a family of microcontrollers introduced by Microchip Technology. PIC microcontrollers (16C/FXXX series) have attractive features and they are suitable for a wide range of applications. PIC microcontrollers are RISC processors and uses Harvard architecture. It is a newer concept and it came out of the requirement to speed up the processor. Harvard architecture makes use of a separate program and data memory. PIC 16F8XX is a family of CMOS 8-bit flash controllers. Apart from the flash program memory there is a data EEPROM.

DESCRIPTION:

1. PROGRAM MEMORY

PIC microcontrollers have separate program memory and data memory with separate address and data buses. The flash program memory of 16F877A is 8k and is 14-bit wide. Therefore, to access this 8k memory, 13-bit address is needed and hence the program counter is 13-bit wide. Again after reset, the program counter points to 0000H and the interrupt vector is 0004H. 0004H is loaded in the program counter automatically if interrupt are enabled. 13-Bit program counter of 16F877A can address 8k-program memory. Upper two bits come from PCLATH<4:3> to form 13k effective address. Page select

bits must be programmed to make it possible to address a desired program memory page.

2. DATA RAM

The data memory of PIC 16F877A is divided into 4 banks. And STATUS register bits IRP, RP1 and RP0 are used to select any of the banks. Size of each of these 4 banks is 128 bytes. Further, the lower locations in every bank are reserved for SFRs. Then there are general-purpose registers implemented as static RAM. Some of the SFRs also appeared in multiple banks. Register file map of PIC16F877A is shown in fig. In abroad sense one can classify a different registers as per their functions.

There are SFRs port A, port B, port C, port D and port E in bank0- corresponding to the five I/O ports. Associated with this five I/O ports in bank1 there are direction registers, namely, TRISA, TRISB, TRISC, TRISD, TRISE. STATUS register, file selection register (FSR), PCL, PCLATH, INTCON are mirrored in all the four banks.

OPTION_REG register contains the bits corresponding to the prescaling of TMR0, and watchdog timer, timer 0 source edge selection, external interrupt edge selection, PORTB pull-up enable. There are three timer/counters. Timer 0 is an 8-bit timer with 8-bit prescaler. TMR0 is an 8-bit timer0 register in bank 0 and mirrored in bank 2. Timer 1 is a 16-bit timer with prescaler.

3. DATA EEPROM

Data EEPROM memory allows to read and write. There are 256 bytes of EEPROM data memory in 16F877A. This EEPROM is not located in the register files. For the data EEPROM memory can also be protected from external reading/writing. Micro controller can, however, read or write independent of the status of the protection configuration bit.

4. INTERRUPTS

16F877A supports 14 interrupt sources. There is an external interrupts RB0/INT, PORTB change interrupt, timer 0 overflow interrupt and peripheral interrupts. Peripheral interrupts are corresponding to the parallel slave port, USART, timer1 and timer2 overflows, AD converter, synchronous serial port and CCP1 (capture compare1), CCP2, SSP bus collision and EEPROM write operation interrupt. The interrupts flag are in PIRX registers.

C. ZIGBEE MODULE

Zigbee is a wireless technology developed as an open standard to address the unique needs of low-cost, low power, wireless sensor network. The standard takes full advantage of the IEEE 802.15.4 physical ratio specification and operates in unlicensed bands worldwide at the following frequencies: 2.400-2.484GHz, 902-928MHz and 868.0-868.6MHz

1. The power level (down from 5v to 3.3v)to power the Zigbee module
2. The communication line (TX, RX, D/N and DOUT) to appropriate voltage

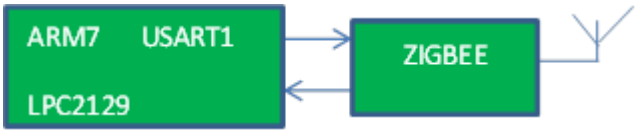


Figure 4.2 asynchronous data transmission

The zigbee module acts as both transmitter and reciver.The RX and TX pins of Zigbee are connected to TX and RX of PIC controller respectively. The data's from PIC controller is serially transmitted zigbee module via USART port. Then Zigbee transmits the data to another Zigbee .The Zigbee transmitted from Dout pin. The Zigbee from other side receives the data via Din pin

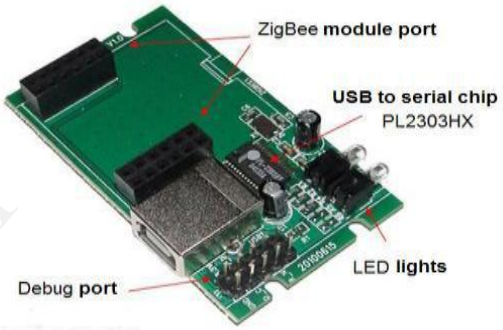


Figure 4.3 Zigbee Module

1. OVERVIEW

Zigbee is a low-cost, low-power, wireless mesh networking proprietary standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range.
The Zigbee Alliance, the standards body that defines Zigbee, also publishes application profiles that allow multiple OEM vendors to create interoperable products. The current list of application profiles either published or in the works are:

- Home Automation
- ZigBee Smart Energy
- Commercial Building Automation
- Telecommunication Applications
- Personal, Home, and Hospital Care
- Toys

The relationship between IEEE 802.15.4 and Zigbee is similar to that between IEEE 802.11 and the Wi-Fi Alliance. The Zigbee 1.0 specification was ratified on 14 December 2004 and is available to members of the Zigbee Alliance. Most recently, the Zigbee 2007 specification was posted on 30 October 2007. The first Zigbee Application Profile, Home Automation, was announced 2

November 2007.

Zigbee operates in the industrial, scientific and medical (ISM) radio bands; 868 MHz in Europe, 915 MHz in the USA and Australia, and 2.4 GHz in most jurisdictions worldwide. The technology is intended to be simpler and less expensive than other WPANs such as Bluetooth. Zigbee chip vendors typically sell integrated radios and microcontrollers with between 60K and 128K flash memory, such as the Jennic JN5148, the Free scale MC13213, the Ember EM250 and the Texas Instruments CC2430. Radios are also available stand-alone to be used with any processor or microcontroller. Generally, the chip vendors also offer the Zigbee software stack, although independent ones are also available.

Because Zigbee can activate (go from sleep to active mode) in 15 m sec or less, the latency can be very low and devices can be very responsive — particularly compared to Bluetooth wake-up delays, which are typically around three seconds. Because Zigbee can sleep most of the time, average power consumption can be very low, resulting in long battery life.

2. Zigbee/IEEE 802.15.4 - General Characteristics:

- Dual PHY (2.4GHz and 868/915 MHz)
- Data rates of 250 kbps (@2.4 GHz), 40 kbps (@ 915 MHz), and 20 kbps (@868 MHz)
- Optimized for low duty-cycle applications (<0.1%)
- CSMA-CA channel access Yields high throughput and low latency for low duty cycle devices like sensors and controls
- Low power (battery life multi-month to years)
- Multiple topologies: star, peer-to-peer, mesh
- Optional guaranteed time slot for applications requiring low latency
- Fully hand-shaked protocol for transfer reliability
- Range: 50m typical (5-500m based on environment)

3. Zigbee/IEEE802.15.4 - Typical Traffic Types Addressed

- Periodic data
- Application defined rate (e.g., sensors)
- Intermittent data
- Application/external stimulus defined rate (e.g., light switch)

D. MAX232

A standard serial interfacing for PC, RS232C, requires negative logic, i.e., logic '1' is -3V to -12V and logic '0' is +3V to +12V. To convert a TTL logic, say, TxD and RxD pins of the uC chips thus need a converter chip. A MAX232 chip has long been using in many uC boards. It provides 2-channel RS232C port and requires external 10uF capacitors. This I.C. also includes two receivers and two transmitters in the same package. This is useful in many cases when you only want to use the Transmit and Receive data Lines. You don't need to use two chips, one for the receive line and one for the transmission.This is very essential for continuous monitoring of the power consumed. It will be essential for linking
the computer with the microcontroller. Below shows the connection diagram of max 232.

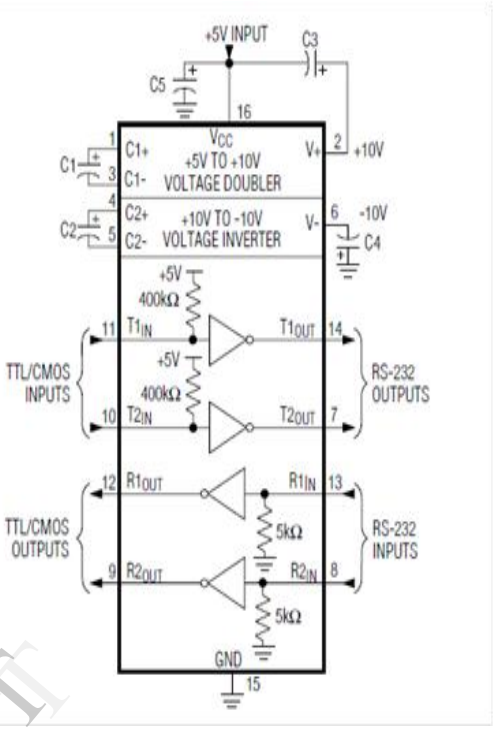


Fig 4.4Pin Description of MAX232

E. 16X2 LCD DISPLAY

Features:

- Maximum input voltage: 5.3VDC
- Operating input voltage: 5VDC
- 8-bit interface data bus
- Controller: HD47780 equivalent
- Character font size: 0.125"W x 0.200"H
- 16 pin/terminals
- Display size: 2.5"L x 0.7"W
- Module size: 3.4"L x 1.2"W x 0.5"T

Description

This is a 16 character by 2 line display, with the standard HD44780 chipset. It works great with any microcontroller and it is very easy to interface. This LCD has 8-bit parallel interface. It is possible to use all 8 bits plus 3 control signals or 4 bits plus the control signals.LCD is used as a backup for computer. It is essential for displaying the provider and users power consumption. Below shows the pin diagram of lcd display.

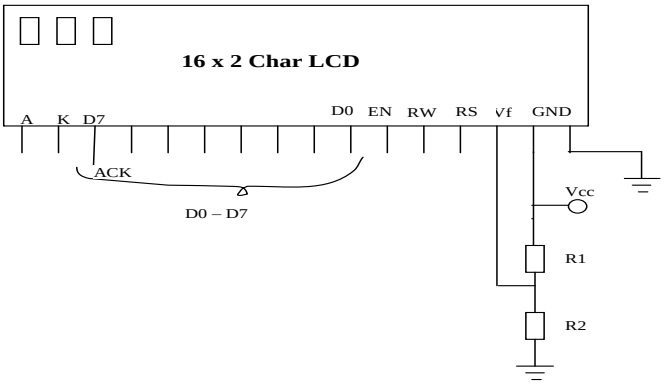


Figure4.5 LCD pin configuration

For an 8-bit data bus, the display requires a +5V supply plus 11 I/O lines. For a 4-bit data bus it only requires the supply lines plus seven extra lines. When the LCD display is not enabled, data lines are tri-state which means they are in a state of high impedance (as though they are disconnected) and this means they do not interfere with the operation of the microcontroller when the display is not being addressed. The LCD also requires 3 "control" lines from the microcontroller.

When the LCD is initialized, it is ready to continue receiving data or instructions. If it receives a character, it will write it on the display and move the cursor one space to the right. The Cursor marks the next location where a character will be written. When we want to write a string of characters, first we need to set up the starting address, and then send one character at a time.

F. RS 232

The most common communication interface for short distance is RS232. RS232 defines a serial transmission for one device to one computer communication port, with speeds up to 19,200 baud. Typically 7&8 bits (on/off) signal are transmitted to represent a character or digit. A 9 pin connector is used. In RS-232, user data is sent as a time-series of bits. Both synchronous and asynchronous transmissions are supported by the standard. In addition to the data circuits, the standard defines a number of control circuits used to manage the connection between the DTE and DCE. Each data or control circuit only operates in one direction that is, signaling from a DTE to the attached DCE or the reverse. Since transmit data and receive data are separate circuits, the interface can operate in a full duplex manner, supporting concurrent data flow in both directions. The standard does not define character framing within the data stream, or character encoding.

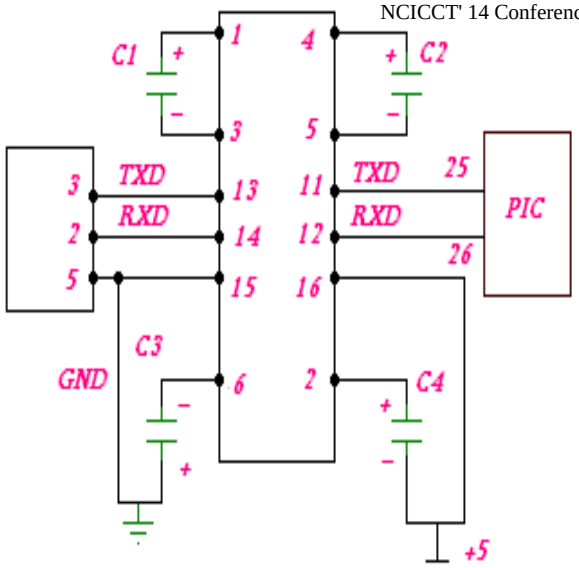


Figure4.6 RS232 Circuit diagram

G. RELAY

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can sup
without amplification.

Figure 4.7 Relay Image

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. Most relays are designed for PCB mounting but

you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay. The animated picture shows a working relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

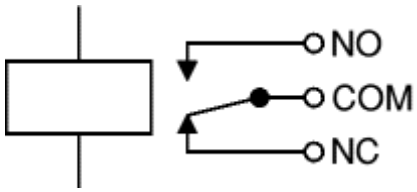


Figure 4.8 Pin Description

The relay's switch connections are usually labeled COM, NC and NO:

- **COM** = Common, always connect to this, it is the moving part of the switch.
- **NC** = Normally Closed, COM is connected to this when the relay coil is **off**.
- **NO** = Normally Open, COM is connected to this when the relay coil is **on**.

V. SOFTWARE

MPLAB

MPLAB IDE is an integrated development environment that provides development engineers with the flexibility to develop and debug firmware for various Microchip devices.MPLAB IDE is a Windows-based Integrated Development Environment for the Microchip Technology Incorporated PIC microcontroller (MCU) and ds PIC digital signal controller (DSC) families. In the MPLAB IDE, you can:

- Create source code using the built-in editor.
- Assemble, compile and link source code using various language tools. An assembler, linker and librarian come with MPLAB IDE. C compilers are available from Microchip and other third party vendors.
- Debug the executable logic by watching program flow with a simulator, such as MPLAB SIM, or in real time with an emulator, such as MPLAB ICE. Third party emulators that work with MPLAB IDE are also available.
- Make timing measurements.
- View variables in Watch windows MPLAB Simulator

MPLAB SIM is a discrete-event simulator for the PIC microcontroller families. It is integrated into MPLAB IDE integrated development environment. The MPLAB SIM debugging tool is designed to model operation of Microchip Technology's PIC microcontrollers to assist users in debugging software for these devices.

PROTEUS Simulation The process of creating and editing a new session includes the following basic steps:

- Create and name a New File
- Insert segment(s)into that file
- Editeach segment
- Test segments in real-time using PC mode (optional)
- Save the finished session
- Transfer it to Proteus, alone or as part of an Album.

This powerful feature, introduced with the release of version 1.6 of the Proteus operating system, is used for two primary functions: real-time preview of sessions you are editing with Proteus Editor, and for setting Proteus to be controlled via biofeedback . To use this mode, just press Mode Select until PC is displayed, and follows the instructions in your software documentation for proper use of this mode. Users of ARES, or indeed other PCB software will find some of the following PCB design specific features of interest: · Sheet Global Net Properties which allow you to efficiently define a routing strategy for all the nets on a given sheet (e.g. a power supply needing POWER width tracks). · Physical terminals which provide the means to have the pins on a connector scattered all over a design. · Support for heterogeneous multi-element devices. For example, a relay device can have three elements called RELAY A RELAY:B and RELAY:C. RELAY:A is the coil whilst elements B and C are separate contacts. Each element can be placed individually wherever on the design is most convenient. · Support for pin-swap and gate-swap. This includes both the ability to specify legal swaps in the ISIS library parts and the ability to back-annotate changes into a schematic. · A visual packaging tool which shows the PCB footprint and its pin numbers alongside the list of pin names for the schematic part. This facilitates easy and error free assignment of pin numbers to pin names. In additional, multiple packaging may be created for a single schematic part.

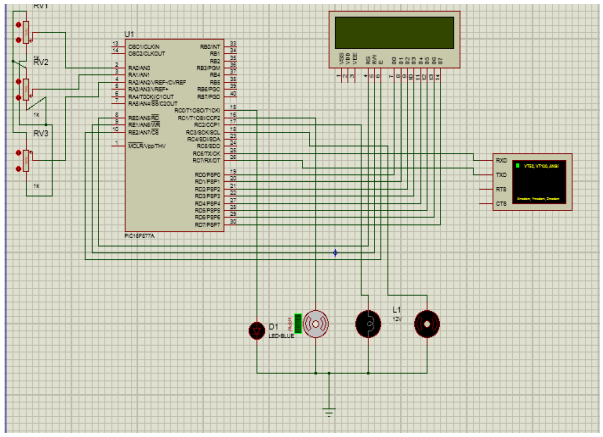


Figure 5.1Load Normal Condition

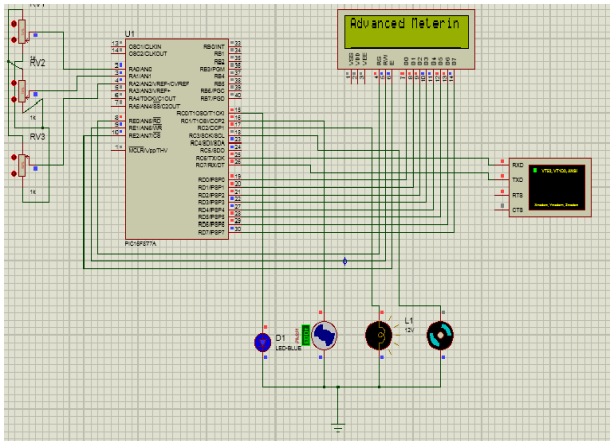


Figure5.2 Load ON Conditions

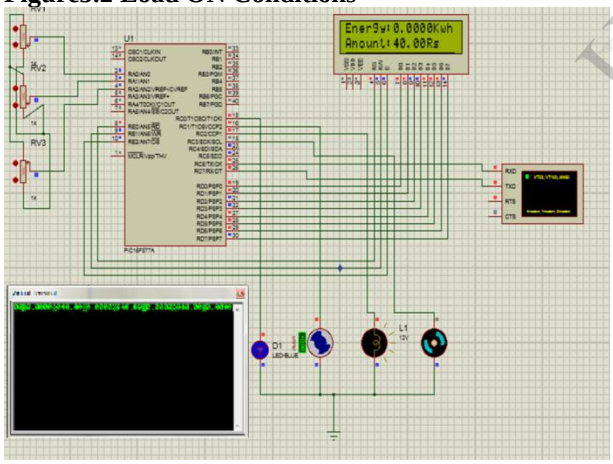


Figure5.3 Advanced Meter reading

VI. RESULT

The successful development of the prototype hardware has been done and correctly tested for the purpose it is being implemented. Here are two types of cases –

1. Normal condition- The two of the LED will glow and the meter displays that "meter is OK".

Figure8.1 Initial Condition LCD Display

2. Bypassing condition- The resistance change is monitored by the microcontroller and the load will cut out by showing the message that "meter is tempered".

Figure 8.2LCD Display for Bypassing

This system now cannot be resetby the consumer i.e. it now needs a person from the authorised agency to reset the whole of the system. The microcontroller conveys the information to the relay and switches fromON to OFF and power supply to the meter is cut down by the system. Hence the LCD displays the message, "Meter is tempered" and this message is conveyed to the authorised official.

VII. ACKNOWLEDGEMENT

I feel elated to keep on record my heartfelt thanks and gratitude to **Mrs.N.LAKSMIPRABA,M.E.,(Ph.D)..,** Professor Head of the Department, Electrical and Electronics and Engineering , for her valuable guidance and timely help during the period of the project.I would like to take this opportunity to thank my **Internal supervisor Mr.J.SUBRAMANIYAN,M.E.,** Assistant Professor Department of Electrical and Electronics Engineering for his steadfast inspiration and assiduous encouragement during the entire span of the project. Finally, I wish to thank my family members who have provided me persistent support and goal all these years of study.

VIII. CONCLUSION

The challenges and "green" legislation that utilities are facing today, combined with increased demand from consumers for more flexible offerings and cost savings, make this project both timely and inevitable. Wireless open standard technology is being selected around the world as the energy management and efficient technology of choice. Implementing this project with an open standard such as Zigbee helps to keep costs down, ensure interoperability, and future-proof investments made by both utilities and consumers. Consumers and businesses will see changes they never dreamed possible.

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