

A PROJECT REPORT
ON
“SMART ENERGY METER”

Submitted to
UNIVERSITY OF MUMBAI

In Partial Fulfilment of the Requirement for the Award of

BACHELOR'S DEGREE IN
ELECTRICAL ENGINEERING

BY

KHAN YUSUF JAMAL (15DEE23)
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UNDER THE GUIDANCE OF
PROF. SHRADDHA HULE

DEPARTMENT OF ELECTRICAL ENGINEERING
Anjuman-i-Islam's Kalsekar Technical Campus
SCHOOL OF ENGINEERING TECHNOLOGY
Plot No. 2 3, Sector - 16, Near Thana Naka,
Khandagaon, New Panvel - 410206

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CERTIFICATE

This is certify that the project entitled

“SMART ENERGY METER “

submitted by

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is a record of bonafide work carried out by them, in the partial fulfilment of the requirement for the award of Degree of Bachelor of Engineering (Electrical Engi-neering) at Anjuman-i-Islam's Kalsekar Technical Campus, Navi Mumbai under the University of MUMBAI. This work is done during year 2017-2018, under our guidance.

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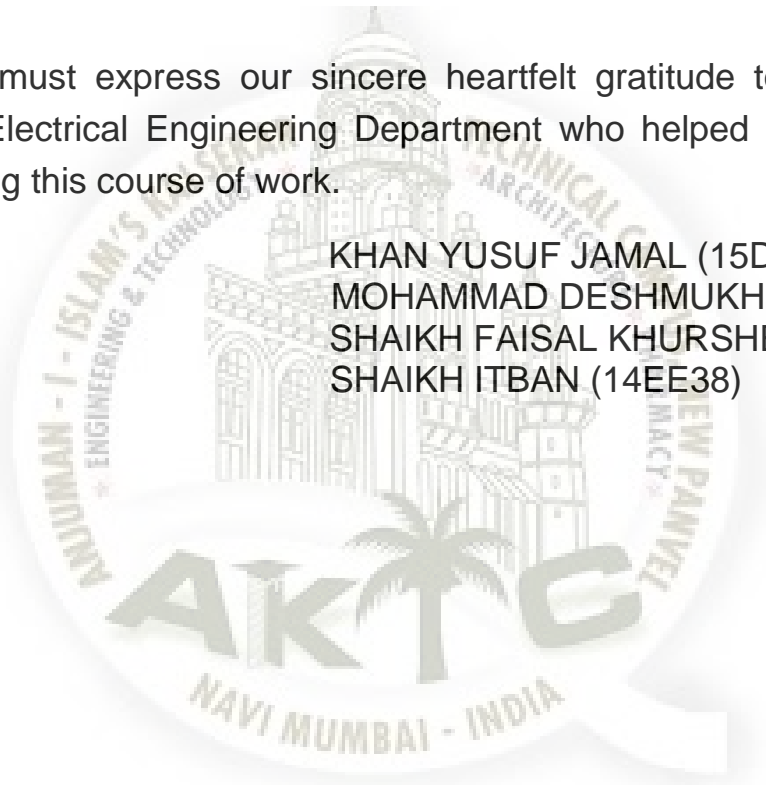
Acknowledgements

We are profoundly grateful to Prof. Shraddha Hule for her expert guidance and continuous encouragement throughout to see that this project rights its target since its commencement to its completion.

We would like to express deepest appreciation towards DR. ABDUL RAZAK HONNUTAGI, Director, AIKTC, Navi Mumbai, Prof. Sayyed Kaleem, Head of Department of Electrical Engineering and Prof. Gulrez, Project Coordinator whose invaluable guidance supported us in completing this project.

At last we must express our sincere heartfelt gratitude to all the staff members of Electrical Engineering Department who helped me directly or indirectly during this course of work.

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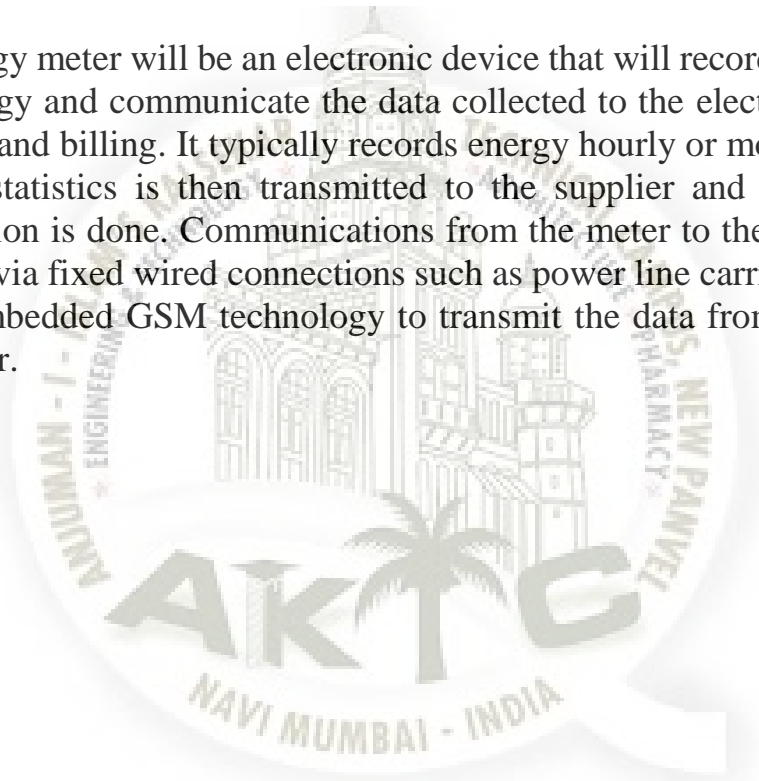




ABSTRACT

It is a difficult job for the electricity board officials to manually take meter readings and calculate bill as it is time consuming and requires man power. Billing consumers for energy consumption is not uniform. It is a tedious job for the electricity board official to manually go and take meter readings of big industrialists and reset their maximum demand after recording it. Even the latest energy meter is not tamper proof. Hence considering all these factors it is possible to design an energy meter that is tamper proof, supports automatic metering and billing system. Also at the same time helps in finding the energy theft in transmission lines. Considering all these features that can be done by a single energy meter it is called a SMART ENERGY METER.

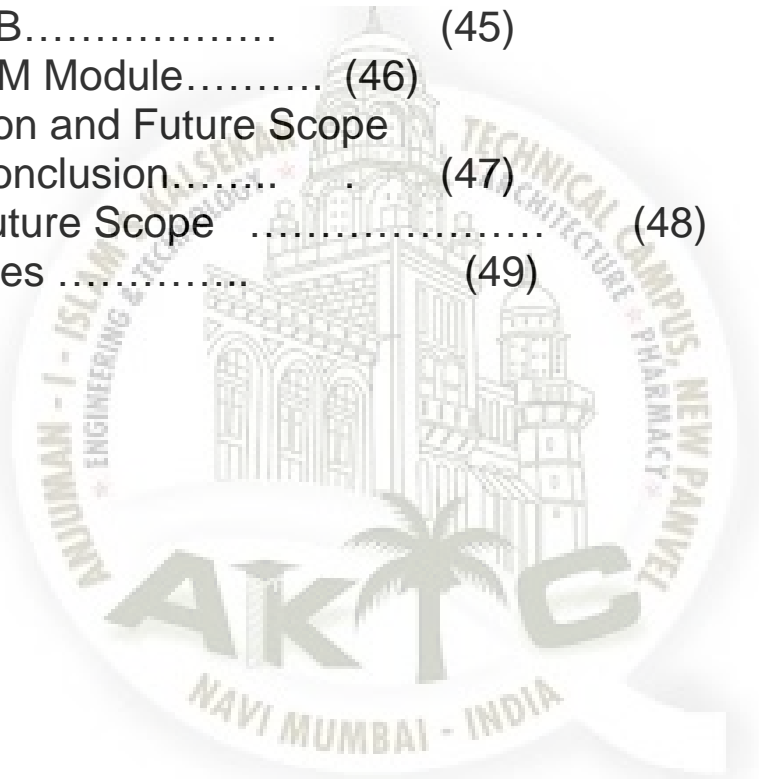
The smart energy meter will be an electronic device that will record consumption of electric energy and communicate the data collected to the electricity supplier for monitoring and billing. It typically records energy hourly or more frequently. The gathered statistics is then transmitted to the supplier and corresponding billing calculation is done. Communications from the meter to the network may be wireless, or via fixed wired connections such as power line carrier (PLC). Our project uses embedded GSM technology to transmit the data from meter to the service provider.



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Chapter 1

Introduction

1.1 OVERVIEW

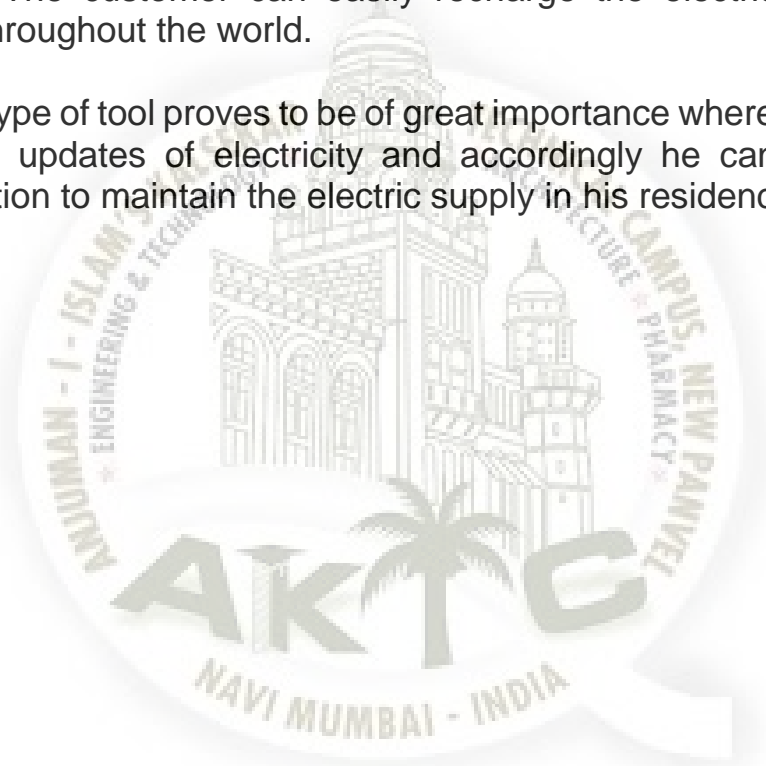
In present time Electricity is the necessary thing in the world for human life. Today every home, offices, companies, industries have electricity connection. Today we are here to discuss about next Atmega328 based project namely Prepaid Energy Meter using Atmega328 and GSM. In this project we first recharge our electricity meter just like prepaid mobile phone and then we can use electricity in our house or offices. This system is automated. It will disconnect the home power supply connection, if there is low or zero balance in the system. And this system will send some updates to user mobile phone like low balance alert, zero balance cut off alert and recharge alert.

1.2 IMPORTANCE

Smart Energy Meter is a very useful tool in today's world and proves to be of great importance. It keeps the consumer alert about the behaviour of electric supply in home.

For example when there is a low balance remaining, the GSM module sends a signal to the consumer via sim connection to the mobile. It also gives a message when the system is ready or if the system is being cut off due to zero balance. As a result the consumer always has an update about the electric supply in his home which is achieved through wireless communication which proves to be very handy and easy way to be connected. The customer can easily recharge the electric supply from anywhere throughout the world.

Hence this type of tool proves to be of great importance where the customer gets all the updates of electricity and accordingly he can achieve the communication to maintain the electric supply in his residence.



1.3 FEATURES

- (1) Wireless communication achieved
- (2) Two way communication between the customer and the supplier
- (3) Easy recharge of the module through anywhere in the world
- (4) Notification of alert to the consumer
- (5) Energy theft reduced
- (6) Smart usage of electricity with the help of notifications



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Chapter 2

Literature Survey

In traditional electricity billing a meter reader goes from home to home to get the readings and write down it, manually. These readings are brought to Electricity administration office. As per the standards, utility billing is applied on the numbers of units consumed. The employee of the utility goes from home to home again and gives the bill slips of the utility to the every consumer. There are many flaws in traditional billing system. Some human error may also occur in manual billing .Analysing the traditional billing some of the common observed errors and flaws are: It is a time consuming procedure. There is a possibility of human error and flaws while taking the manual meter reading.

SMART ENERGY METER

There is no procedure for balanced verification of meter reading. There is always a possibility of theft and corruption. Consumer may not get the bill slip within the due date. As traditional billing contains wastage of time and resources as well, in auto billing system there is no more need of the manual meter readings and bill slips. Home energy management system (HEMS) that we developed takes plain energy management mechanism, so that it can be realized more easily. It needs user's minimal decision and activity for correct judgment. It also uses Automatic Meter Reading (AMR) network based on power line communication (PLC). In order to share information with customer ZigBee module is also used. A ZigBee advance metering infrastructure is a present one for automatic meter data collection and energy auditing and management. In the ZAMI, the system works with multiple channels and frequency hopping and coexists with potential interferers. In this method if any tariff variation is present then, the new tariff rate will be changed only through reprogramming the microcontroller otherwise the previous tariff rate will be displayed on the LCD display. This may cause errors in billing. No intimations are given by the electricity board to the customer regarding the status of energy consumption. There is no information about the previous month's consumption and the amount of bill paid. We are going to focus about these draw backs and overcome in our paper.

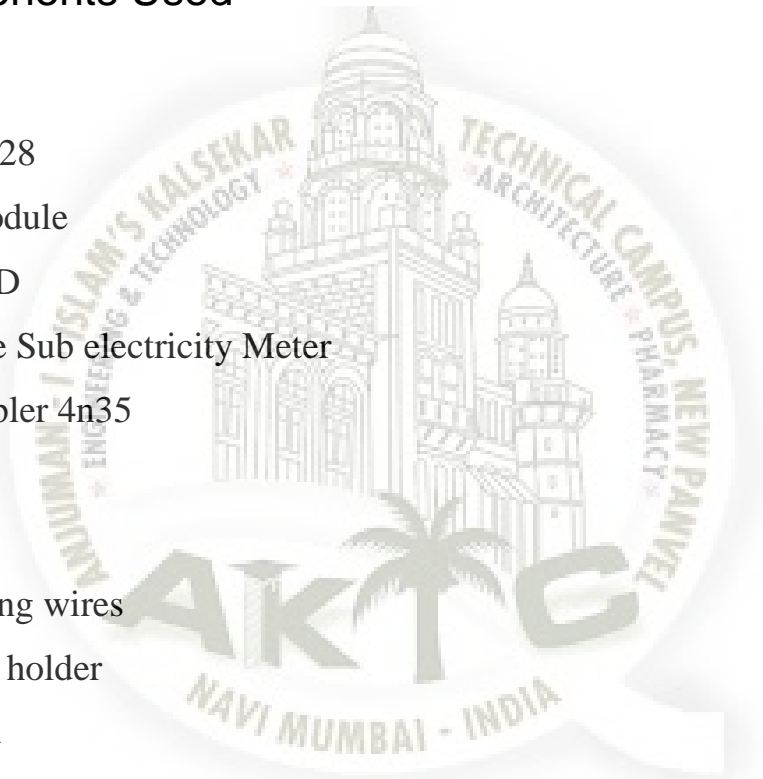


Chapter 3

Software Requirements Specification

(3.1) Components Used

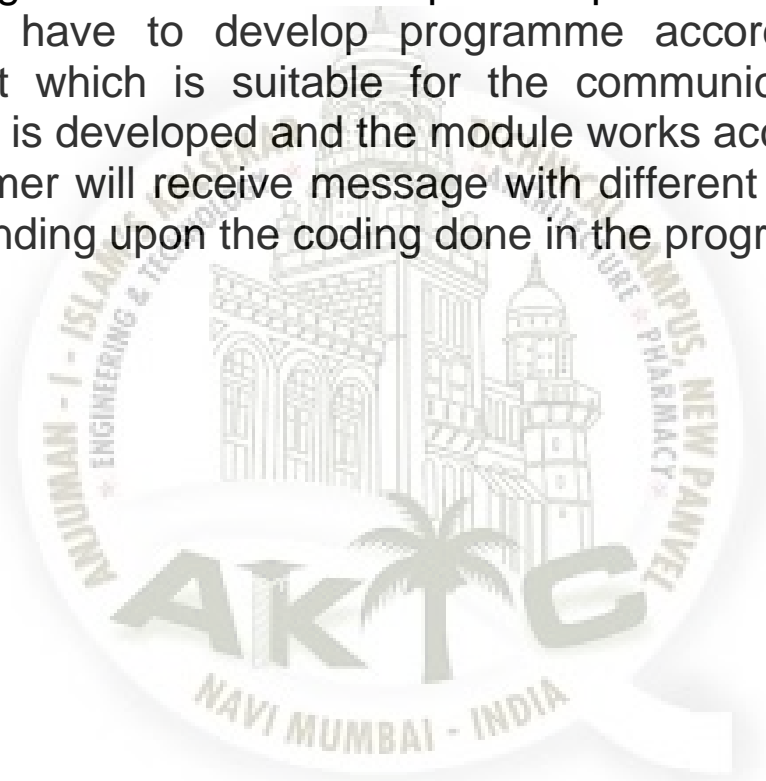
1. Atmega328
2. GSM Module
3. 16x2 LCD
4. Analogue Sub electricity Meter
5. Optocoupler 4n35
6. Resistors
7. POT
8. Connecting wires
9. Bulb and holder
- 10.SIM card
- 11.Power supply
- 12.Mobile Phone



(3.2) Technology Used

For smart energy meter we use the GSM module which consists of RX and TX pins . With the help of these pins we can achieve communication between the gsm and the energy meter. GSM has a sim card installed in it which helps to send the notifications of alert to the consumer

The working of GSM module depends upon the programme setup. We have to develop programme according ti the requirement which is suitable for the communication . So programme is developed and the module works accordingly. The consumer will receive message with different intervals of times depending upon the coding done in the programme.





SMART ENERGY METER

3.3 Block Diagram

The block diagram of the smart energy meter using the GSM module is shown as follows

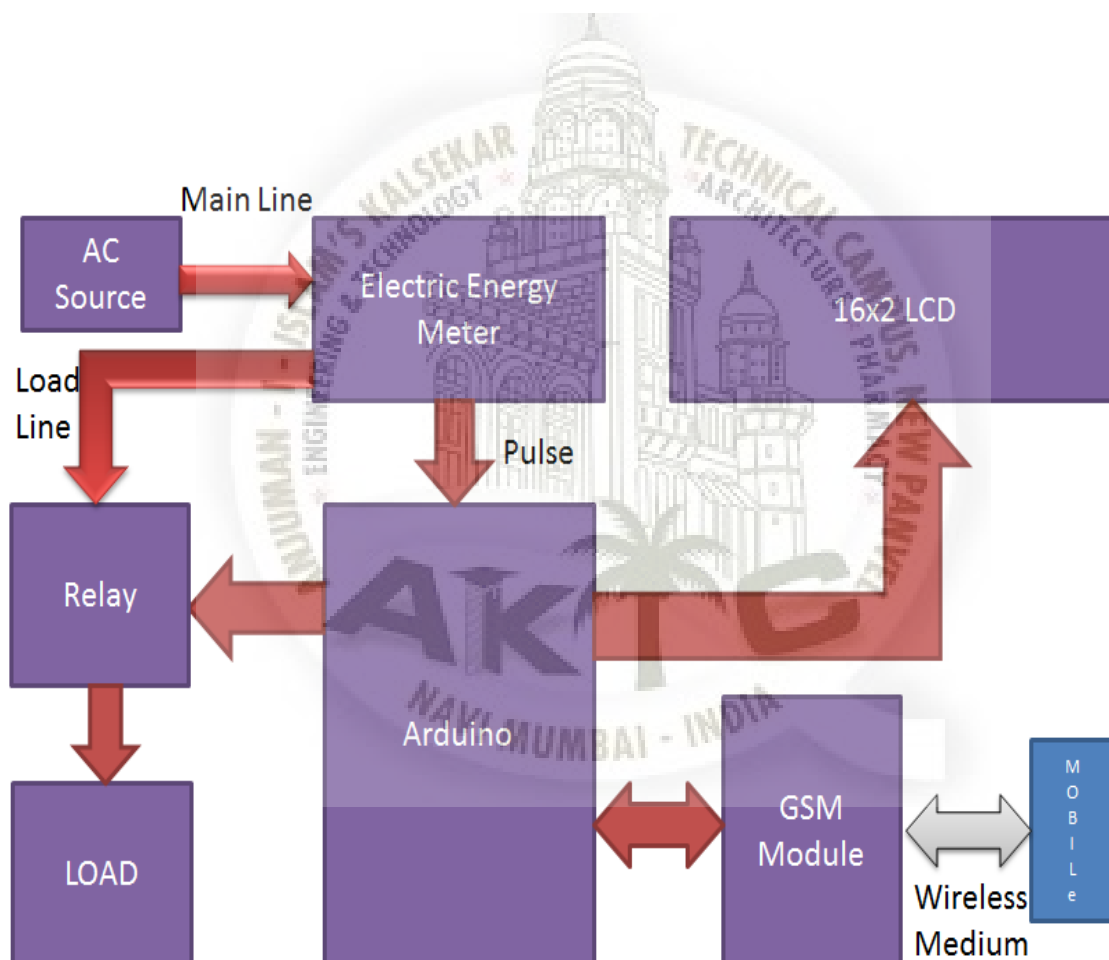
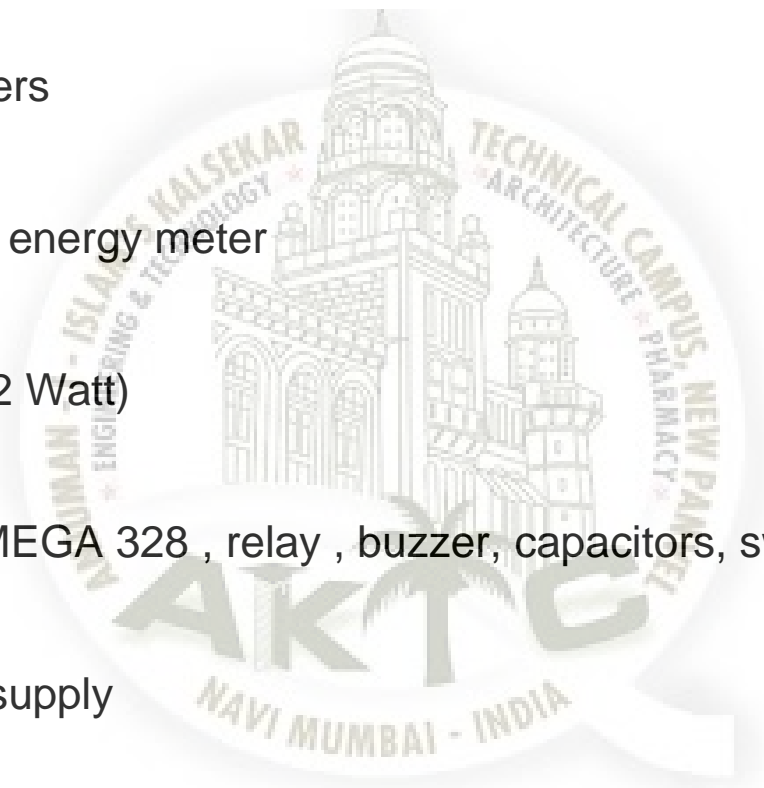


FIGURE 3.3

SMART ENERGY METER

Chapter 4 : Requirement Analysis

1. GSM module
 2. LED (16*2) display
 3. Adapters
 4. Digital energy meter
 5. Bulb(12 Watt)
 6. IC ATMEGA 328 , relay , buzzer, capacitors, switches.
 7. Power supply
- 



Chapter 5.

System Design

5.1 Hardware Implementation

The system requires a number of materials as mentioned above in the analysis. The materials need to be connected in a way because of which we achieve the required working of the system.

First of all we have a PCB upon which we connect all the required devices. These devices are connected on PCB and arranged according to the circuit diagram with the help of soldering. Soldering helps to do both the functions, to connect the devices and also provide the connectivity according to the circuit diagram.

GSM module is readily available in the market, hence it is connected to the circuit through the wire and the digital meter is also connected to the power supply side of the PCB and connected to the power supply through an adapter.

SMART ENERGY METER

5.1.1 Printed Circuit Board.

- P.C.B. is printed circuit board which is of insulating base with layer of thin copper-foil.
- The circuit diagram is then drawn on the P. C. B. with permanent marker and then it is dipped in the solution of ferric chloride so that unwanted copper is removed from the P.C.B., thus leaving components interconnection on the board.
- The specification of the base material is not important to know in most of the application, but it is important to know something about copper foil which is drawn through a thin slip.
- The resistance of copper foil will have an effect on the circuit operation.
- Base material is made of lamination layer of suitable insulating material such as treated paper, fabric; or glass fibers and binding them with resin. Most commonly used base materials are formed paper bonded with epoxy resin.
- It is possible to obtain a range of thickness between 0.5 mm to 3 mm.

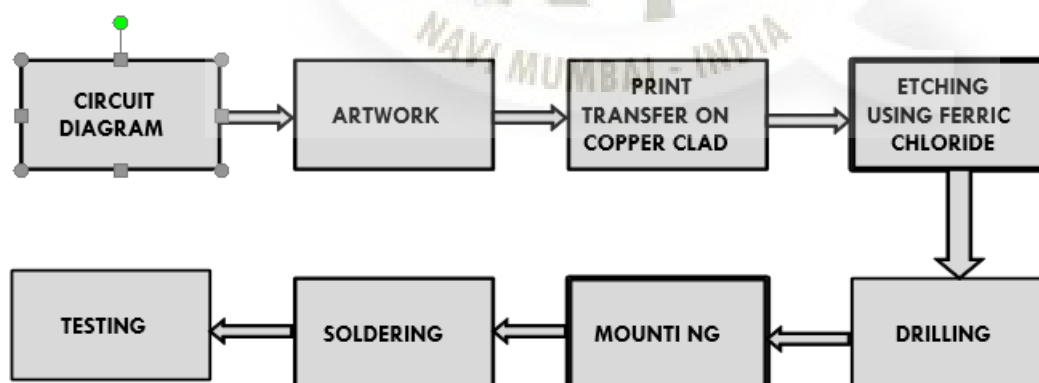


FIGURE 5.1.1

SMART ENERGY METER

5.1.1.1 Printed Circuit Board(PCB) Diagram

The circuit diagram required for pcb making is shown as follows. The circuit diagram is made in proteus software which helps in implementation of project stimulation.



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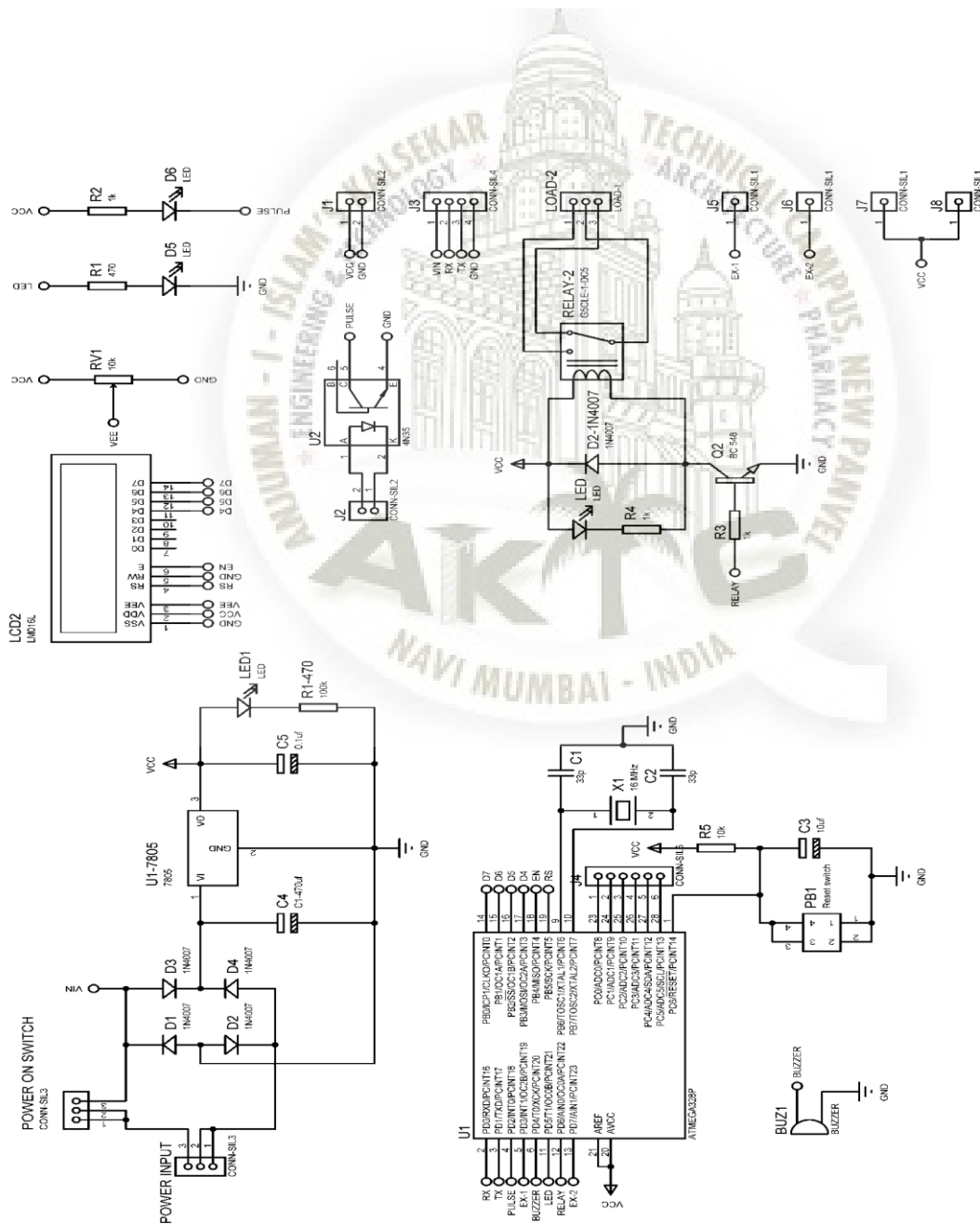


FIGURE 5.1.1.1

5.1.1.2 Fabrication of PCB

- While designing a layout, it must be noted that size of the board should be as small as possible.
- Before starting, all components should be placed properly so that an accurate measurement of space can be made.
- The component should not be mounted very close to each other or far away from one another and neither one should ignore the fact that some component need ventilation.
- The layout is first drawn on paper then traced on copper plate which is finalized with the pen or permanent marker which is efficient and clean with etching.
- The resistivity also depends on the purity of copper, which is highest for low purity of copper. The high resistance path is always undesired for soldered connections.
- The most difficult part of making an original printed circuit is the conversion from, theoretical circuit diagram into wiring layout. Without introducing cross over and undesirable effect.
- Although it is difficult operation, it provides greater amount of satisfaction because it is carried out with more care and skill.
- The board used for project has copper foil thickness in the range of 25 40 75 microns.
- The soldering quality requires 99.99% efficiency.
- It is necessary to design copper path extra large. There are two main reasons for this,
 - The copper may be required to carry an extra large overall current:-
 - It acts like a kind of screen or ground plane to minimize the effect of interaction.
- The first function is to connect the components together in their right sequence with minimum need for interlinking i.e. the jumpers with wire connections.
- It must be noted, that when layout is done, on the next day it should be dipped in the solution and board is move continuously right and left after etching perfectly the board is cleaned with water and is drilled.
- After that holes are drilled with 1 mm or 0.8 mm drill. Now the marker on the P. C. B. is removed.



SMART ENERGY METER

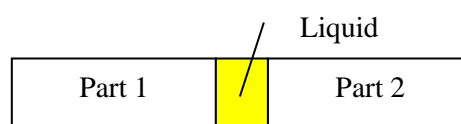




FIGURE 5.1.1.2

5.1.1.3 Implementation of PCB making

Permanent connection of mechanical parts may be done by using welding, soldering, and gluing. Their essence is introduction of liquid phase between the parts to be connected (molten base metal in welding, molten solder in soldering, glue in gluing). The liquid wets the parts, gets in intimate interfacial contact with them arising intermolecular attractive forces. Then the liquid solidifies keeping the parts connected.



Soldering is a process by which the parts are joined together using material (solder) with lower melting point than melting points of materials of joined parts. Welding is performed by melting of materials of joined parts. Glues are liquid materials that solidify as the result of chemical reaction or evaporation of solvent.

Thermal conductivity of PCB materials

| Material | Thermal conductivity, W/(m· K) |
|----------|---|
| FR4 | 0.25 |
| LTCC | 2.5...4 |
| HTCC | 16...30 (Al ₂ O ₃) |
| | 180 (AlN) |
| | 260 (BeO) |
| Copper | 401 |

Table 5.1.1.3

- For soldering of any joints first the terminal to be soldered are cleaned to remove oxide film or dirt on it. If required flux is applied on the points to be soldered.
- Now the joint to be soldered is heated with the help of soldering iron. Heat applied should be such that when solder wire is touched to joint, it must melt quickly.
- The joint and the soldering iron are held such that molten solder should flow smoothly over the joint.
- When joint is completely covered with molten solder, the soldering iron is removed.

PCB Layout:

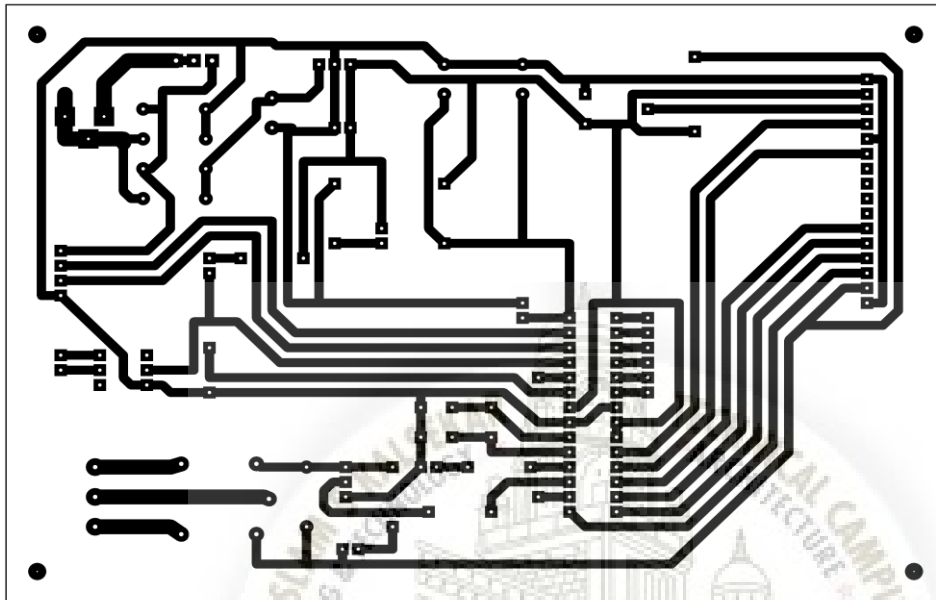


FIGURE 5.1.1.3.1

Components layout:

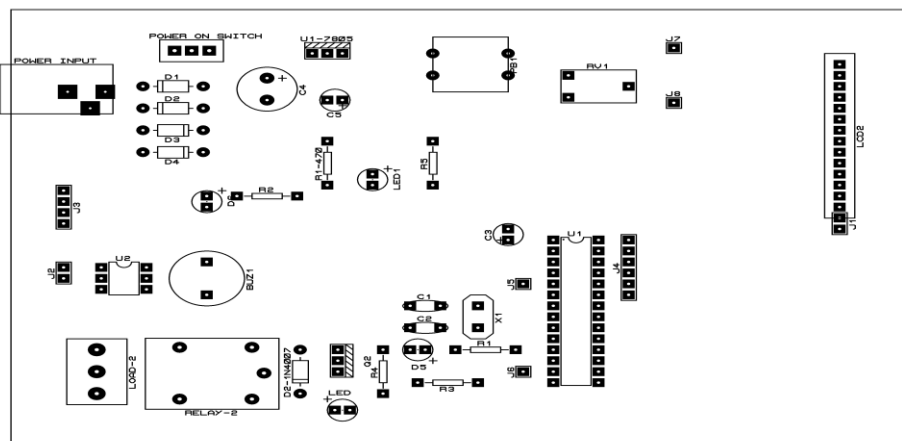


FIGURE 5.1.1.3.2

SMART ENERGY METER

5.1.2 LCD

LCD is used in the system to monitor the balance of the energy meter and the units consumed by the consumer . It is 16*2 type of LCD which displays the required data to the consumer. It is readily available in the market and also very cheap. Different types of lcd are available. LCD is connected in the pcb with help of a stand and fixed by a soldering ion .

FIGURE 5.1.2



5.1.2.1 LCD module

LCD module is as shown in the figure which is a 16*2 type module used to show the required data to the consumer.

Any type of data including alphabets or numbers etc can be displayed here

5.1.2.2 Features

- Operating Voltage is 4.7V to 5.3V
- Current consumption is 1mA without backlight
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters.
- Each character is build by a 5×8 pixel box
- Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters

SMART ENERGY METER

5.1.2.3 PINdiagram

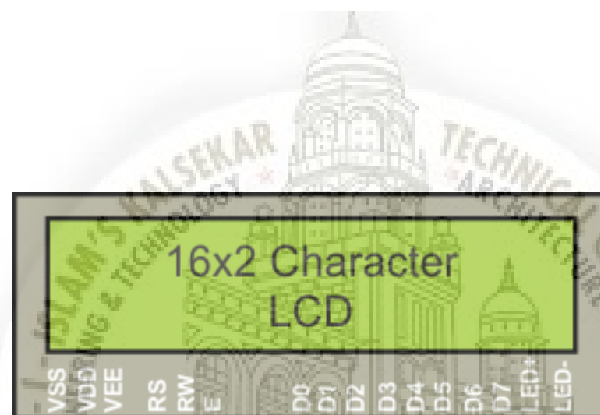


FIGURE 5.1.2.3

5.1.2.4 LCD pin diagram description

| Pin no. | Symbol | External connection | Function |
|---------|-----------------|----------------------|---|
| 1 | V _{SS} | Power supply | Signal ground for LCM |
| 2 | V _{DD} | | Power supply for logic for LCM |
| 3 | V ₀ | | Contrast adjust |
| 4 | RS | MPU | Register select signal |
| 5 | R/W | MPU | Read/write select signal |
| 6 | E | MPU | Operation (data read/write) enable signal |
| 7~10 | DB0~DB3 | MPU | Four low order bi-directional three-state data bus lines. Used for data transfer between the MPU and the LCM. These four are not used during 4-bit operation. |
| 11~14 | DB4~DB7 | MPU | Four high order bi-directional three-state data bus lines. Used for data transfer between the MPU |
| 15 | LED+ | LED BKL power supply | Power supply for BKL |
| 16 | LED- | | Power supply for BKL |

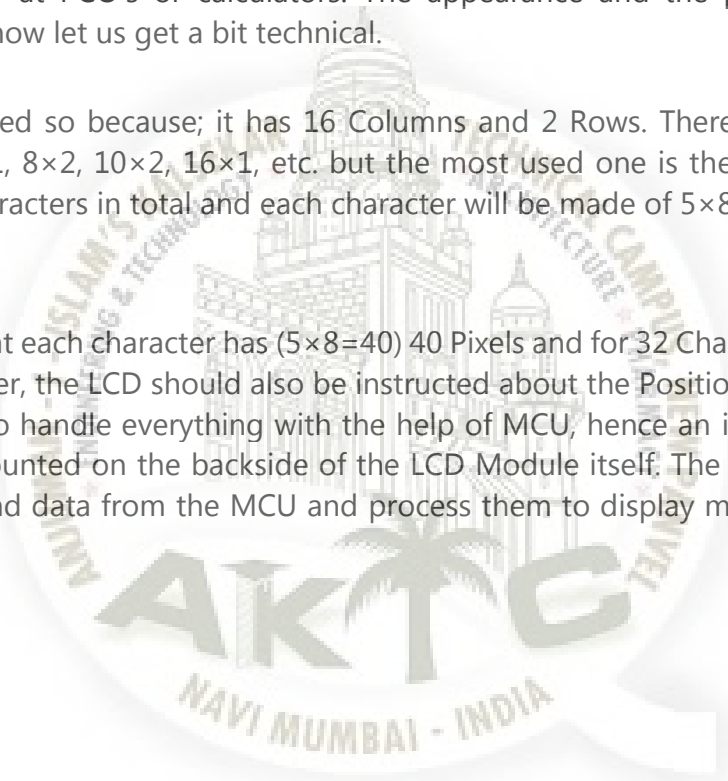
TABLE 5.1.2.4

5.1.2.5 Technical Data

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day to day life, either at PCO's or calculators. The appearance and the pinouts have already been visualized above now let us get a bit technical.

16*2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have $(16 \times 2 = 32)$ 32 characters in total and each character will be made of 5×8 Pixel Dot

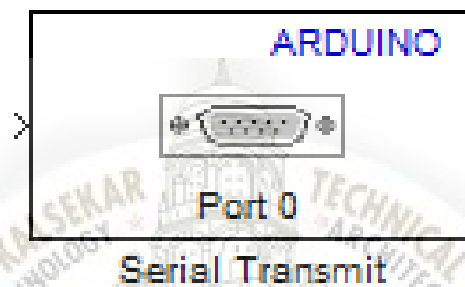
Now, we know that each character has $(5 \times 8 = 40)$ 40 Pixels and for 32 Characters we will have (32×40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels. Hence it will be a hectic task to handle everything with the help of MCU, hence an interface IC like HD44780 is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the commands and data from the MCU and process them to display meaningful information onto our LCD Screen



SMART ENERGY METER

5.1.3 PIC Microcontroller Atmega 328

5.1.3.1 Description



Serial Transmit
FIGURE 5.1.3.1

Send buffered data to the specified serial port. For more information, see Use Serial Communications with Atmega328 Hardware. The Atmega328 hardware has one serial port device, serial port 0, connected to the digital pins marked TX 1 and RX 0. If you set the **Port number** parameter to 0, this block transmits over the digital pin marked TX 1.

The block input accepts vector or scalar uint8 data. To convert a data source to uint8, use a Data Type Conversion block.

During simulations without the hardware, this block does nothing. If you use this block in models with the Standard Servo Read, Standard Servo Write, and Continuous Servo Write blocks, use longer sample times to avoid overruns.

5.1.3.2 PIN diagram Atmega 328

Pin-out

Figure 5-1. 28-pin PDIP

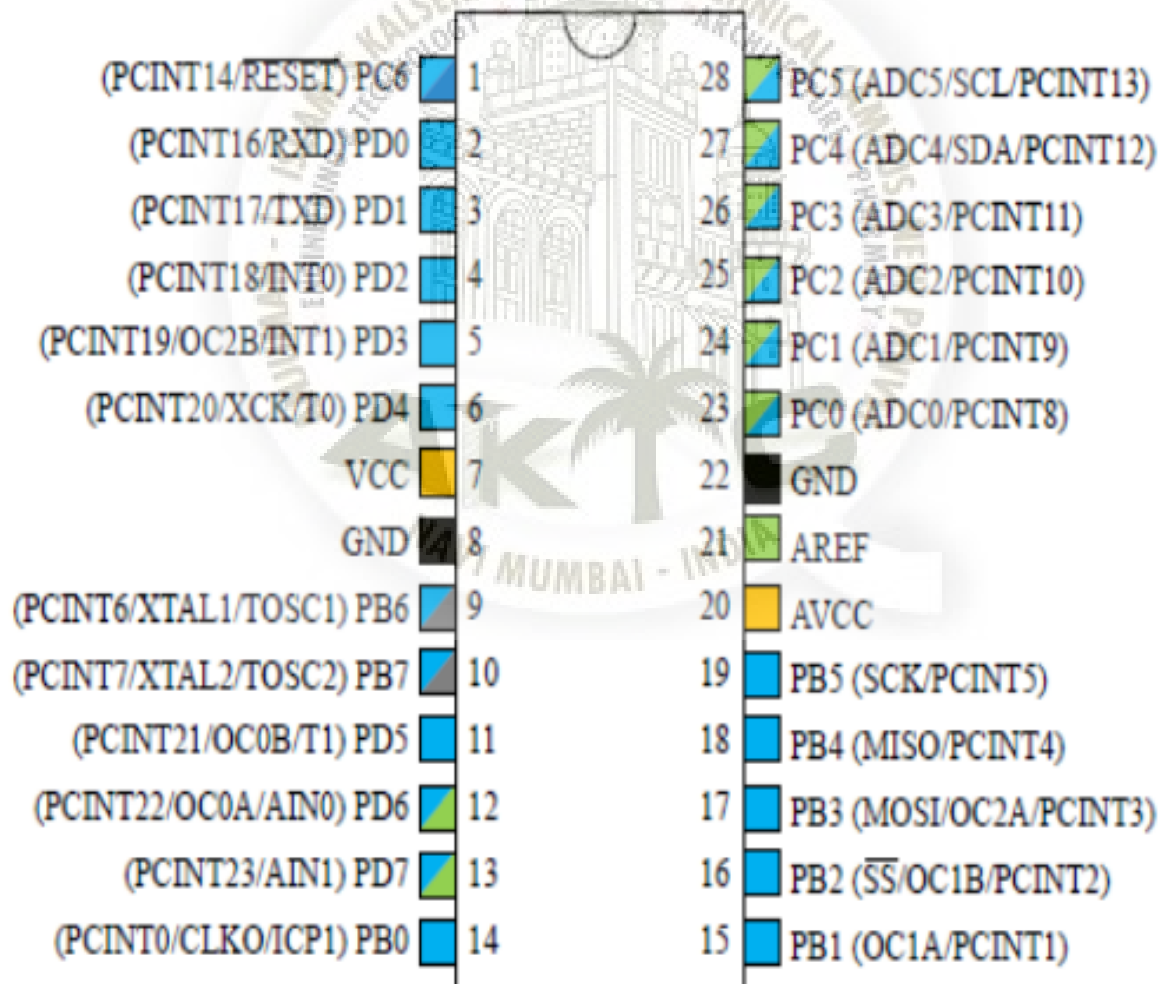


FIGURE 5.1.3.2

5.1.3.3 Ports of Atmega 328

You can use serial port 0 to communicate with other devices that have serial ports, or to communicate with a computer over the USB port. Each serial port supports one Serial Transmit and one Serial Receive block, one block per pin. To know pin mapping for the supported Atmega328 hardware.

➤ **Transmit Serial Data:**

To transmit data through a serial port or USB port on the Atmega328 hardware:

1. Add the Serial Transmit block to your model.
2. Connect a data source to the block input on the Serial Transmit block. If the data type is not uint8, use a Data Type Conversion block to convert it to uint8.
3. In the Atmega328 Serial Transmit block, select a **Port number**.
4. Click the Tools menu in the model, and select Run on Target **Hardware>Options**. In the Configuration Parameters dialog that opens, on the Run on Target Hardware pane, set the baud rate for the serial port you selected in the Atmega328 Serial Transmit block.
5. Connect the appropriate digital transmit pin to the hardware that receives the data.
6. Run the model, as described in Run Model on Atmega328 Hardware.
7. If your model uses the Atmega328 USB port (Serial port 0) to transmit data to a device.

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➤ Port Number

- Enter the number of the serial port.
- Click **View pin map** to open the Atmega328 Pin Mapping table.
- To know about the fixed ports and the allocated pins for the block, see Pin Mapping on Atmega328 Blocks.
- You can assign a Serial Transmit block and a Serial Receive block to the same serial port.
- Do not assign multiple Serial Transmit blocks to the same serial port.
- Do not assign the pin numbers used by the serial port to other blocks within the model.
- Serial port 0 is connected to the USB port through a converter. Do not use both serial port 0 and the USB port at the same time. For example, do not use serial port 0 if you intend to use External mode, because External mode requires the USB port.

➤ Receive Serial Data:

To receive data through a serial port or USB port on the Atmega328 hardware:

1. Add the Serial Receive block to your model.
2. On the Atmega328 Serial Receive block, connect the **Data** block output to a block that uses the data.
3. Open the Atmega328 Serial Receive block and specify the **Port number**.
4. Click the **Tools** menu in the model, and select **Run on Target Hardware>Options**. In the Configuration Parameters dialog that opens, on the Run on Target Hardware pane, set the baud rate for the serial port you selected in the Atmega328 Serial Receive block.
5. Connect the digital receive pin to the hardware that transmits the data.
6. Run the model, as described in.

7. If your model uses the Atmega328 USB port (Serial port 0) to receive data from a device that is not your host computer, reconnect the USB cable to that device and press the RESET button.

Get one byte of data per sample period from the receive buffer of the specified serial port. For more information, see Use Serial Communications with Atmega328 Hardware.

The Serial Receive block has two outputs, **Data** and **Status**.

When data is available:

- The **Data** block output emits data from the serial receive buffer.
- The **Status** block output emits 1.

When data is not available:

- The **Data** block output emits 255.
- The **Status** block output emits 0.

The **Data** block output emits uint8 values. The **Status** block output emits int values. You can use the Status block output to determine whether a value of 255 emitted by the **Data** port is data, or an indication that no data was received.

During simulations without the hardware, this block emits zeroes.

5.1.3.4 Programming Input and Output



The Atmega328 can be programmed using arduino software, which uses Java or C++. The programming used in the project is basically to measure the analog value of sensors, and to correspondingly provide the digital code. The Arduino integrated development environment (IDE) is a cross-platform application written in Java, and derives from the IDE for the Processing programming language and the Wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. A program or code written for Atmega328 is called a sketch. Atmega328 programs are written in C or C++. The Arduino IDE comes with a software library called "Wiring" from the original Wiring project, which makes many common input/output operations much easier. Users only need define two functions to make a runnable cyclic executive program:

- `setup()`: a function run once at the start of a program that can initialize settings
- `loop()`: a function called repeatedly until the board powers off

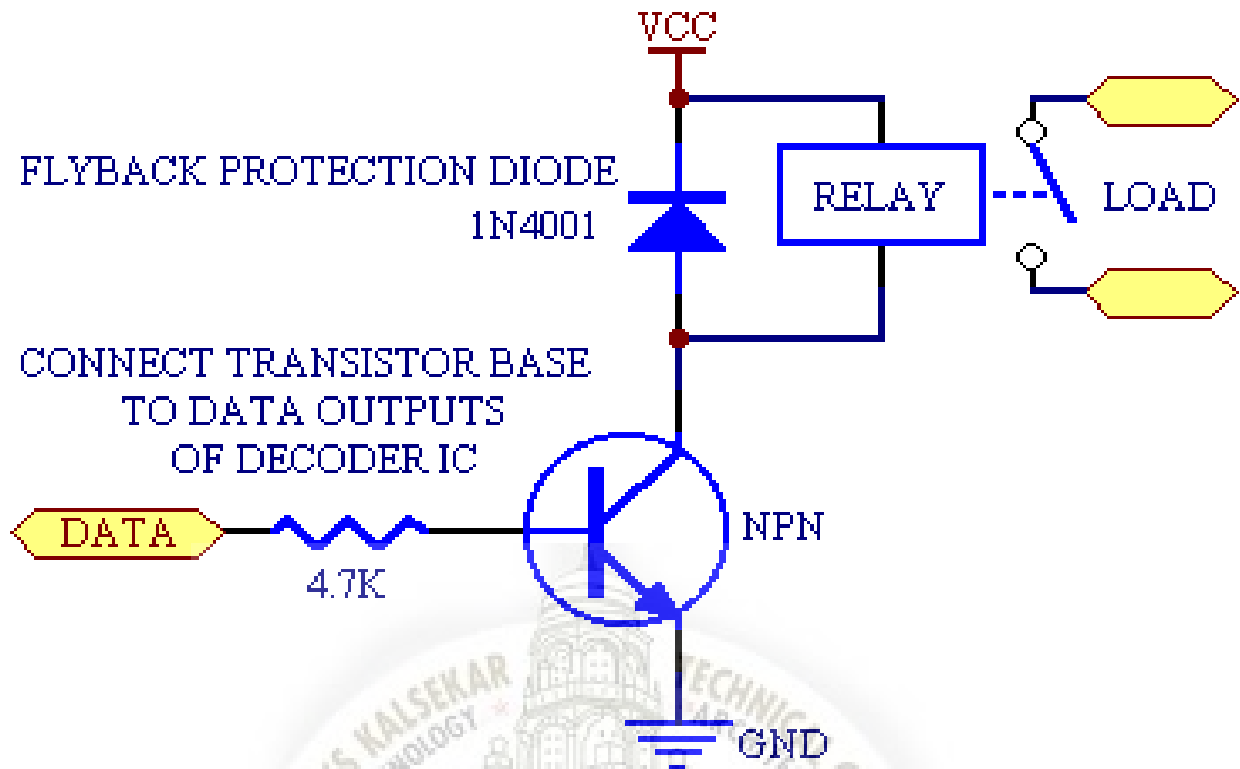
5.1.4 Power Supply

Power supply is given to the system with the help of adapter which is connected to the pcb which makes the digital meter and also the GSM module ON . After the circuit is on the system starts its functioning according to the programming done. The power supply specification is general (230V/50Hz). This power supply is AC but the circuit operates on DC thus there is a full wave bridge rectifier on the power supply output followed by the capacitor which converts the AC signal into a pure DC signal.

5.1.5 Relay Driver

Relay circuit is used to switch on or off (connect or disconnect) electric supply to the load according to the balance remained in the system. If the balance is enough it allows the electric supply to pass to the load. As soon as the balance reaches zero it cuts off the supply and the electric supply to the load is stopped

A basic diagram of relay driver circuit is as shown below.



5.1.6 Applications of relay

- 1. Relay Drive by Means of a Transistor
- 2. Relay Drive by Means of SCR
- 3. Relay Drive from External Contacts
- 4. LED Series and Parallel Connections
- 5. Electronic Circuit Drive by Means of a Relay
- 6. Power Source Circuit
- 7. PC Board Design Considerations

All the above mentioned applications are the main applications of Relay driver in electronic circuits.

SMART ENERGY METER

5.1.7 GSM module

5.1.7.1 Introduction:

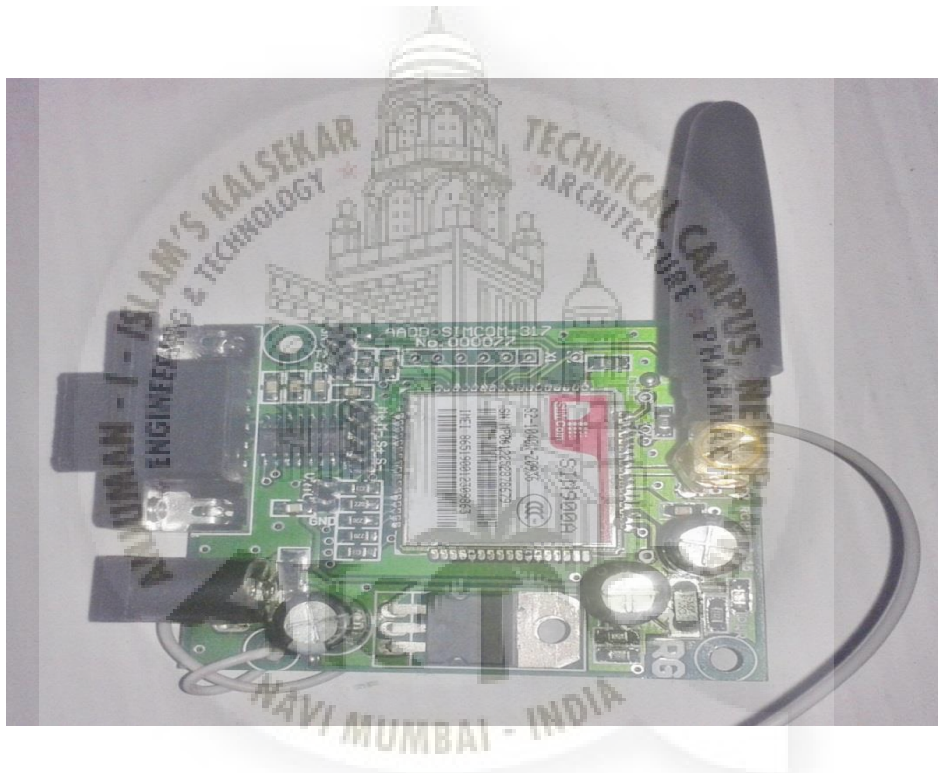


FIGURE 5.1.7

- SIM900 designed by using single-chip processor integrating AMR926EJ-S core
- Quad - band GSM/GPRS module in small size.
- GPRS Enabled

AT Command: AT means ATTENTION. This command is used to control GSM module. There are some commands for calling and messaging that we have used in this project for sending message

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For testing GSM Module we used AT command. After receiving AT Command GSM Module respond with OK. It means GSM module is working fine.

ATE0→ For echo off

AT+CMNI=2,2,0,0,0 <ENTER> → Auto opened message Receiving. (No need to open message)

ATD<Mobile Number>; <ENTER> → making a call (ATD+919610126059;\r\n)

AT+CMGF=1 <ENTER> → Selecting Text mode

AT+CMGS="Mobile Number" <ENTER> → Assigning recipient's mobile number

>>Now we can write our message

>>After writing message

Ctrl+Z → send message command (26 in decimal).

ENTER=0x0d in HEX

Working:

when we power up the system then it will read previous values of rupees stored in EEPROM and restores them to variables then check the available balance with the predefined value and take action according to them like if available balance is greater than 15 rupees then Atmega328 turned On the electricity of connection of home or office by using relay. And if balance is less than 15 rupees then Atmega328 send message to user phone of low balance alert and requesting to recharge soon. And if balance is less than 5 rupees then arduino turned off the electricity connection of home and send a sms to user phone for connection cut alert and requesting recharge soon.

Now when we need to recharge our system we have to send a sms using our cellphone to the system with some prefix like #45*.

System receives this message and extract recharge amount and update balance of system. And system again turned On the connection of house or office.

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Calculation: before proceeding calculation first we have to keep in mind the pulse rate of energy meter. There are two pulse rate of energy meter first is 1600 imp/kwh and second is 3200 imp/kwh. So here we are using 3200 imp/kwh pulse rate energy meter.

5.1.7.2 Applications

Access control devices:

Now access control devices can communicate with servers and security staff through SMS messaging. "Complete log of transaction is available at the headoffice Server instantly without any wiring involved and device can instantly alert security personnel on their mobile phone in case of any problem. -ionable is introducing this technology in all Fingerprint /Access control and time attendance products. You can achiEve high security any reliability.

Transaction terminals:

'1" machines, P2S terminals can use SMS messaging to confirm transactions from central servers. The main benefit is that central server can be anywhere in the world. Today you need local servers in every city with multiple telephone lines. 0ou save huge infrastructure costs as well as per transaction cost.

Supply Chain Management:

Today S"M re3uire huge infrastructure with leased lines, networking devices, data centre, work stations and still

you have large downtimes and high costs. You can do all this at a fraction of the cost with GSM M&M technology.

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5.1.7.3 Features

- Improved spectrum efficiency.
- International roaming.
- Compatibility with integrated services digital network (ISDN)
- Support for new services.
- phonebook management.
- Fixed dialing number (FDN)
- Real time clock with alarm management.
- High-quality speech.

SMART ENERGY METER

5.2 Software implementation

5.2.1 Proteus software:

Proteus is a Design Suite also known as Virtual System Modeling (VSM) offering the ability to simulate micro-controller code and also circuits.

So if you are willing to design hardware and software this is a great tool to start with. In this case Proteus ISIS is for simulation from the schematic form of the hardware and also the micro-controller code. It is possible to develop and test designs before a physical prototype is constructed.

I think that says it all about what Proteus is and it is for (can be used for more things).

Proteus ISIS combines ease of use with powerful editing tools as a very high degree of control over the drawing appearance, in terms of line widths, fill styles, fonts, etc.. It is capable of supporting schematic capture for simulation.

As for Proteus ARES is for PCB designs to make your own devices using the PCB layout tools and provides a powerful, integrated and easy to use suite of tools for professional PCB Design.

5.2.2 Source Code

The below mentioned code is the code used in the gsm module to run the programme

The code was designed in order to get the required out put in a sequence.

This code also helps in displaying message from the LCD monitor and beeps from the buzzer and etc all other parts to perform their functions on their time

```

#include<EEPROM.h>
#include <LiquidCrystal.h>

#define led      5
#define buzzer   4
#define pulsein  2
#define relay    6

unsigned int pusle_count = 0;
unsigned int rupees      = 0;
unsigned int temp        = 0;
unsigned int i           = 0;
unsigned int x           = 0;
unsigned int k           = 0;
float units              = 0;
float watt_factor        = 0.3125;
char flag1               = 0;
char flag2               = 0;
char rec                 = '0';
char str[200];
String bal                = "";
String number            = "+919967858690";

LiquidCrystal lcd(13, 12, 11, 10, 9, 8);

void setup()
{
  Serial.begin(9600);
  lcd.begin(16,2);

  pinMode(led      , OUTPUT);
  pinMode(buzzer   , OUTPUT);
  pinMode(pulsein  , INPUT );
  pinMode(relay    , OUTPUT);

  digitalWrite(pulsein, HIGH);

  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print(" Prepaid Energy ");
  lcd.setCursor(0,1);

```

```

    lcd.print("      Meter      ");
    beep();
    delay(2000);

    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("GSM Initilizing ");

    gsm_init();

    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("  System Ready  ");

    Serial.println("AT+CNMI=2,2,0,0,0");
    Serial.println("AT+CMGF=1");
    delay(200);
    Serial.print("AT+CMGS=\"");
    delay(200);
    Serial.print(number);
    delay(200);
    Serial.println("\");
    delay(200);
    Serial.print("System Ready");
    delay(200);
    Serial.write(26);
    delay(1000);

    digitalWrite(led, LOW);
    lcd.clear();
    beep();
    beep();
    beep();
    // EEPROM.write(1,0);
    // rupees = EEPROM.read(1);
}

void loop()
{
    while(Serial.available())
    {
        char ch = (char)Serial.read();
        str[i++] = ch;
        if(ch == '*')
        {
            temp = 1;
            lcd.clear();
            lcd.setCursor(0,0);
            lcd.print("Message Received");
            delay(500);
            beep();
            while(Serial.available())
            {
                char ch = (char)Serial.read();
            }
            break;
        }
    }
    rupees = EEPROM.read(1);
    units = rupees/5.0;
    lcd.setCursor(0,0);
    lcd.print("Units      :");
    lcd.print(units);
    lcd.print("      ");
    lcd.setCursor(0,1);
    if(rupees < 15)
    {

```

```

    lcd.print("LOW Balance:");
  }
  else
  {
    lcd.print("Balance      :");
  }
  lcd.print(rupees);
  lcd.print("      ");
  read_pulse();
  check_status();
  if(temp == 1)
  {
    decode_message();
    send_confirmation_sms();
  }
}

void gsm_init()
{
  boolean at_flag = 1;
  while(at_flag)
  {
    Serial.println("AT");
    delay(100);
    while(Serial.available()>0)
    {
      if(Serial.find("OK"))
      {
        at_flag = 0;
      }
    }
    delay(100);
  }

  boolean echo_flag = 1;
  while(echo_flag)
  {
    Serial.println("ATE0");
    delay(100);
    while(Serial.available()>0)
    {
      if(Serial.find("OK"))
        echo_flag = 0;
    }
    delay(100);
  }

  boolean net_flag = 1;
  while(net_flag)
  {
    Serial.println("AT+CPIN?");
    delay(100);
    while(Serial.available()>0)
    {
      if(Serial.find("+CPIN: READY"))
        net_flag = 0;
    }
    delay(100);
  }

  boolean text_mode_flag = 1;
  while(text_mode_flag)
  {
    Serial.println("AT+CSMP=17,167,0,0");
    delay(100);
    while(Serial.available()>0)
    {

```

```

    if (Serial.find("OK"))
        text_mode_flag = 0;
    }
    delay(100);
}

while (Serial.available() > 0)
{
    rec = Serial.read();
}
}

void read_pulse()
{
    if (!digitalRead(pulsein))
    {
        digitalWrite(led, HIGH);
        //count++;
        //units=watt_factor*count/1000;
        if (units < 1)
        {
            }
        else
        {
            units--;
        }
        rupees = units*5;
        EEPROM.write(1, rupees);
        while (!digitalRead(pulsein))
        {
            }
        digitalWrite(led, LOW);
        // delay(2000);
    }
}

void check_status()
{
    if (rupees > 15)
    {
        digitalWrite(relay, HIGH);
        flag1 = 0;
        flag2 = 0;
    }
    if (rupees < 15 && flag1 == 0)
    {
        beep();
        lcd.setCursor(0, 1);
        lcd.print("LOW Balance      ");
        Serial.println("AT+CMGF=1");
        delay(200);
        Serial.print("AT+CMGS=\"");
        delay(200);
        Serial.print(number);
        delay(200);
        Serial.println("\");
        delay(200);
        Serial.println("Energy Meter Balance Alert:");
        delay(200);
        Serial.print("Low Balance: ");
        delay(200);
        Serial.print(rupees);
        delay(200);
        Serial.println(" Rs remaining.");
        delay(200);
    }
}

```

```

Serial.println("Please recharge your energy meter soon.\n\nThank you");
delay(200);
Serial.write(26);
lcd.clear();
lcd.print(" Message Sent ");
delay(1000);
flag1=1;
}
if(rupees<5 && flag2==0)
{
digitalWrite(relay, LOW);
beep();
beep();
lcd.clear();
lcd.print("Light Cut Due to");
lcd.setCursor(0,1);
lcd.print(" Low Balance ");
delay(2000);
lcd.clear();
lcd.print("Please Recharge");
lcd.setCursor(0,1);
lcd.print("UR Energy Meter ");
Serial.println("AT+CMGF=1");
delay(200);
Serial.print("AT+CMGS=\"");
delay(200);
Serial.print(number);
delay(200);
Serial.println("\"");
delay(200);
Serial.println("Energy Meter Balance Alert:\nLight cut due to low
Balance\nPlease recharge your energy meter soon.\n\nThank you");
delay(200);
Serial.write(26);
lcd.clear();
lcd.print(" Message Sent ");
delay(1000);
flag2 = 1;
}
}

void decode_message()
{
x = 0, k = 0, temp = 0;
while(x < i)
{
if(str[x] == '#')
{
x++;
bal = "";
do
{
bal += str[x++];
}while(str[x] != '*');
goto here;
}
x++;
}
here: x = x;
//bal += '\0';
}

void send_confirmation_sms()
{
int recharge_amount = bal.toInt();
rupees += recharge_amount;
EEPROM.write(1, rupees);

```

```

    rupees = EEPROM.read(1);
    lcd.clear();
    lcd.print("  Energy Meter  ");
    lcd.setCursor(0,1);
    lcd.print("Recharged:");
    lcd.print(bal);
    Serial.println("AT+CMGF=1");
    delay(200);
    Serial.print("AT+CMGS=\"");
    delay(200);
    Serial.print(number);
    delay(200);
    Serial.println("\");
    delay(200);
    Serial.print("Energy Meter Balance Alert:\nYour energy meter has been
recharged with: ");
    delay(200);
    Serial.print(bal);
    delay(200);
    Serial.println(" Rs");
    delay(200);
    Serial.print("Total Balance is: ");
    delay(200);
    Serial.print(rupees);
    delay(200);
    Serial.println(" Rs");
    delay(200);
    Serial.println("Elctricity has been connected.\n\nThank you");
    delay(200);
    Serial.write(26);
    temp = 0;
    i = 0;
    x = 0;
    k = 0;
    memset(str,0, sizeof str);
    delay(1000);
    lcd.clear();
    lcd.print("  Message Sent  ");
    delay(1000);
}

void beep()
{
    digitalWrite(led, HIGH);
    digitalWrite(buzzer, HIGH);
    delay(150);
    digitalWrite(led, LOW);
    digitalWrite(buzzer, LOW);
    delay(150);
}

```

Chapter 6

System testing



SMART ENERGY METER

6.1 Test Cases and Test Results

| Test ID | Test Case Title | Test Condition | System Behavior | Expected Result |
|---------|----------------------------|-------------------|-------------------------------------|---|
| T01 | Power supply testing | Switch on or off | System is ON and OFF | System should working according to switch |
| T02 | Receiving and transmitting | GSM signal | System gets the message through GSM | Receiving and transmitting should be achieved |
| T03 | Notification to mobile | Balance remaining | Mobile receives a notification | GSM should send alert notification |

TABLE 6.1



Chapter 7

Project Planning

- The SMART ENERGY meter proves to be very helpful in keeping the consumer alert as nowadays there is a lot more usage of energy
- It helps in reducing the energy wastage
- We can use this type of energy meters in bungalows , residences , flats, or buildings or in big industrial areas
- This energy meter can be modified more and an app can be developed where the customer can keep an eye on the analysis of usage of energy day by day
- The apps may help to reduce the wastage of energy and hence reduce the energy bills which can then be termed as a SMART USAGE of energy

Chapter 8

Implementation

On the application level the SMART ENERGY METER can be implemented on the energy meter section of the consumer . This may be done by the electric suppliers side. And all we need is to provide a sim card at the meter end to recharge our ENERGY METER time to time



SMART ENERGY METER

Chapter 9

Screenshot of Project

9.1 Meter



IMAGE CAPTION 1

SMART ENERGY METER

9.2 PCB

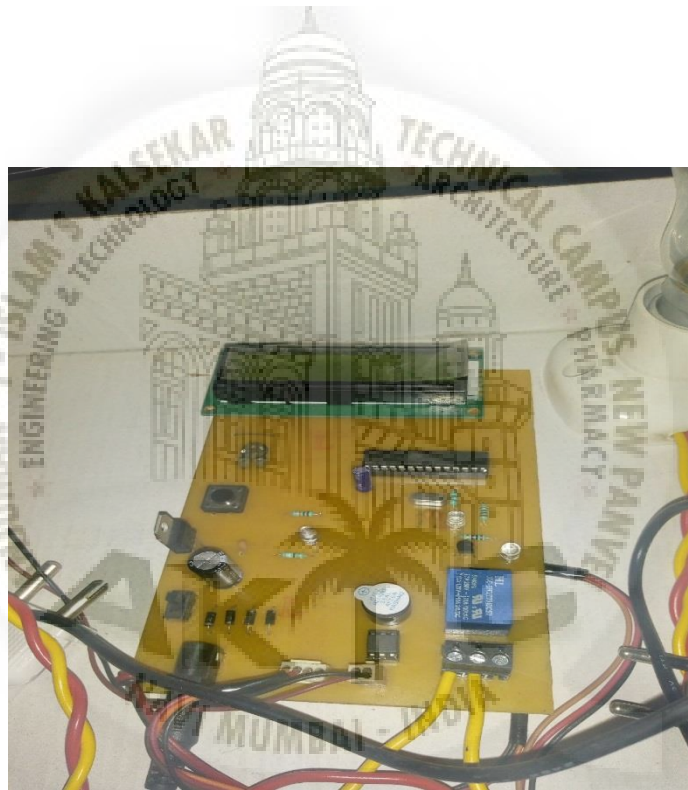


IMAGE CAPTION 2

SMART ENERGY METER

9.3 GSM module

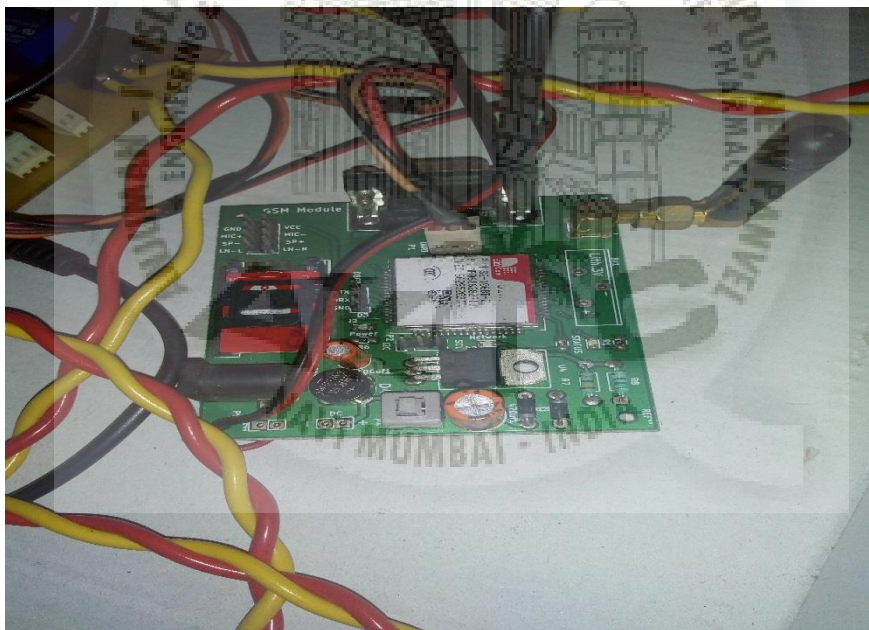


IMAGE CAPTION 3

SMART ENERGY METER

Chapter 10

Conclusion and Future Scope

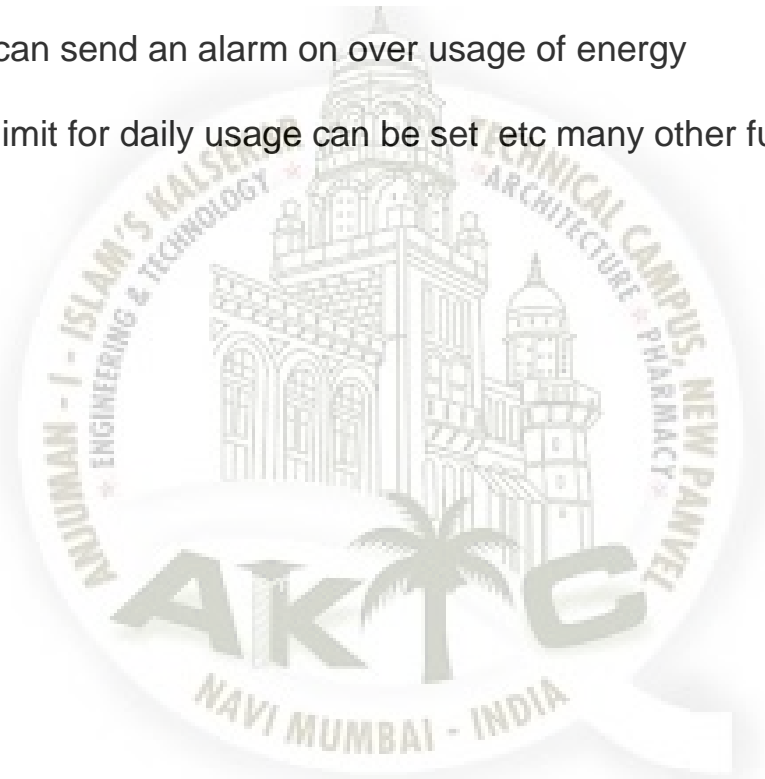
10.1 Conclusion

Hence we realize that the use of smart energy meter using GSM techniques is very essential tool in nowadays to save energy and prevention from wastage of energy

- (1) This all results in reduced energy bills which proves to be consumer friendly.
- (2) Also the consumer can recharge trough any part of the world.
- (3) Theft of energy is also prevented.
- (4) Overall it lets the customer consume the energy only according to his needs.

10.2 Future scope

- The smart energy meter can be used by developing an app which provides all the data related to the consumption of energy hour by hour or day by day
- Alert messages can be sent through voice notes to the customers mobile
- Buzzer can send an alarm on over usage of energy
- Energy limit for daily usage can be set etc many other future scopes



SMART ENERGY METER

CHAPTER 11

References

Department of Electrical E[1] Loss.P.A.V, Lamego. M.M and Vieira.J.L.F, “A single phase microcontroller based energy meter”, IEEE Instrumentation and Measurements Technology conference St. Paul, Minnessota, USA, May 18-21, 1998.

[2] Saptarshi De, Rahul Anand, A Naveen and SiratMoinuddin, “E-Metering Solution for checking energy thefts and streamlining revenue collection in India”, Student Member, IEEE, 2003.

[3] Chandler, T. 2005. “The technology development of automatic metering and monitoring systems”. Power Engineering Conference, 2005. IPEC 2005. The 7th International, Vol., No., pp.1-147.

[4] Ali Zaidi.S.K., “Design and implementation of low cost electronic prepaid energy meter”, Multitopic Conference, 2008. INMIC 2008. IEEE International 2008.

[5] Syed Khizar Ali Zaidi I, HuraMasroor I, Syed Rehan Ashraf I and Ahmed Hassan, “Design and Implementation of Low Cost Electronic Prepaid Energy Meter”, NED University of Engineering and Technology, Karachi, Pakistan, 2010.

[6] HuraMasroor I, Syed Rehan Ashraf I and Ahmed Hassan, “Design and Implementation of low cost Electronic Prepaid Energy Meter’,NED University of Engineering and technology, Karachi, Pakistan, 2010.

[7] Jain and Bagree , “A prepaid meter using mobile communication” , International Journal of Engineering, Science and 164 Technology, Vol. 3, No. 3, 2011, pp. 160-166.
ngineering, AIKTC, New Panvel Mumbai









