Design and Construction of Home Energy Meter

This report submitted in partial fulfillment of the requirement for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering

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Certification

This is to certify that this project entitled **"Design and Construction of Home Energy Meter "** is done by the following student under my direction supervision and this work has been carried by the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering .The presentation of the work of the work was held on 15 January, 2019..

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Dedicated To

Our Parents

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List of Abbreviations

DC	Direct current
AC	Alternating Current
LED	Light emitting Diode
LCD	Liquid Crystal Display
KWH	Killo watt houre
nF	Nano Farad
pF	Pico Farad
mF	Micro Farad

ACKNOWLEDGEMENT

First of all, we give thanks to allah. It is a great intention for authors to express their unfettered gratification, sincere appreciation and a great honor to our respective supervisor Mr. Md. Mahmudur Rahman**,**Department of Electrical & Electronic Engineering, Daffodil International University, for his constructive suggestion, scholastic guidance, constant inspiration, valuable advices and kind cooperation for the successful completion of work on **" Home Energy Meter"**. This could not be possible without his help. Space does not allow us to mention each person by name, but we are deeply grateful to everyone associated with this project and thesis. We also wish to complement all our respective concern teachers & staffs of our department of their direct and indirect assistance at different times.

ABSTRACT

This paper produces the design and building a system that gives a solution to the measurement of energy and helps the local customers to save the power in an efficient manner. Also, in this paper have been introduced the design, realization, and testing a wire monitoring system for measuring the energy consumption of electrical devices in the consumer's homes. The system consists of power consumption monitoring systems (smart energy meter) at customer homes and a control system for remotely reporting and handling the smart meter readings at the power distribution station.

The server shows the readings from these meters system by means of a client visual interface continuously. An arduino kit with voltage , current ,watt ,power factor ,unites and unites cost are used in the meter for measuring the power .The client does not need to exert oneself to note their power use so as to control their behavior to decrease their energy usage and costs.

Chapter-1
Introduction

1.1 Introduction.

The amount of electrical energy Meter is a device that measures residence by a business an electrical devices and electrical power.the electricity is very important role of our country. The electrical energy is billing system express the kilo watt our .

1.2 Objectives

Objective of these project is providing indication of to how traffic structure .

- The factors that help identify households that may be vulnerable to changes in electricity costs
- What the current pattern of electricity usage by each group might be through the year
- How each group is likely to be subject to different degrees of advantage and disadvantage as tariff structures change
-

1.3 Problem Statement.

The single phase motor working mechanism are two type of the working system.

The basic working of single phase induction type energy meter is on two mechanism

i. mechanism of rotation of an aluminum disc witch is made to rotate at a speed proportional to the power.

ii. mechanism of counting and display the amount of energy has been transferred

Chapter-2
Literature Reviews

2.1 Introduction.

Energy meter is most important present life .First meter are recording the amount of the energy and calculating the per units coast and to the customer electricity bill . To record the units ,show the power factor, and total units and coast of the electricity Digital home energy meter are not missing the electricity and appropriate the reading the amount of electricity ..

2.2 Electromechanical meters.

Electromechanical meters are extremely unreliable. Anything that expands the delay that the episode roller can bring about a meter to run heavily, resulting in reduced bills. Worn gears, consumption, humidity, dust, or affected by an accidental drop to floor It can cause obstruction of work and result in an electromechanical meter that does not catch the full advantage of the reason for its manufacture.

Chapter-3
Theoretical Model

3.1 Introduction

The usages of the digital energy meter. This meter are show the electricity amount and total units and total taka of the per units .The home energy meter is reduce the electricity bills.and clearly the meter unite and voltage ,current shows.

3.2 Evolution of Electricity Meters from the Past.

The history of electrical meter Is well connected involving reacherse from past .The general usages of electricity meter in early 1870 ‘s in to only confined telegraph and arc lam.electricity is available in our society to specification of affluent society. With the invention of the electric bulb by Thomas Elva Edison, the power energy market became widely opened to the public in the year 1879 .

3.3 Smart Grid.

Modern development in electricity meter is known is smart grid.Recent electrical grids are becoming weak with respect to the electrical load variation of appliances inside the home. The higher the population, the more load on the grid. Improving the efficiency of grid by remotely controlling and increasing reliability, measuring the consumptions in a communication that is supported by delivering data (real time) to consumers, supplier and vice versa is termed as Smart Grid .

3.4 Traditional Electricity Meters.

Traditional meters are used since the late 19th century .The electrical devices that can detect and display energy in the form of readings are termed as electricity meter.. They exchange data between electronic devices in a computerized environment for both electricity production and distribution. In most of the traditional electricity meter aluminum discs are used to find the usage of power . Today's electricity meter is digitally operated but still has some limitations. A single phase two wire are shown figure below.

Figure 3.4: Traditional Electricity meter

3.5 Traditional meter are some limitation faced below.

- Monthly electrical bills unreliable in nature as consumer .
- The electrical meter process of measurement is supported by a specific mechanical structure and hence they are called as electromechanical meters.
- a great number of inspectors have to be employed. In order to perform meter readings,
- Time consuming and payment is expensive .

3.6 Various electricity meters.

Table-1

Different Types	Outline
Electrolytic Meter	The whole current passes through the electrolyte. The major drawback is mechanical considerations and adoption by limited localities.
Commutator Meter	Brush-shifting device is used to vary the current load and commutator's of small diameter facilitates in insulation attention. The major drawbacks are inadequate load characteristics, maintenance cost and lack of proper insulation.
Mercury Motor Meter	There is a satisfactory performance with the introduction of this meter. The adoption of rotor made a prominent role in supplying the calibration. The momentary short circuit is reduced or even prevented.
D.C Watt Hour Meter	This meter model is developed for heavy current circuits where the temperature coefficient is high. For indication of demand purposes a separate time switch is used. Also, it is a clock-type meter in which voltage variations is less with the reduced shunt loss.
Single Phase Induction Meter	Magnetic conditions are better improved to control the energy consumption and a considerable improvement in performance is also done. Meter inspection is easily assessed as the construction of this model has accessibility of simplifying assembly.
Poly-Phase Watt Hour Meter	Lagging power factors in the meter reflects the characteristics of the current transformer. Attempts for improving high degree of accuracy have been built to avoid troublesome corrections. Interaction effects, calibration and increase in the effects of shunt loss are the greatest drawback of this model.

3.7 Smart Meter.

The smart energy meter are commonly name is digital energy meter,show the digital letter , are the latest in energy metering technology. Similar to interval meters, they record electricity usage in 30 minute intervals allowing different rates to be charged at different times of day.

Figure 3.7: Smart Energy Meter

3.8Energy consumption.

The amount of total power consume in individual household is referred as electrical power .the consumption of electricity power important supply

Chapter -4

Hardware Development

4.1 Hardware Component.

- LCD DISPLAY
- CAPACITORS
- SOME RESISTOR
- DIODE
- STEP DOWN TRANSFORMER
- CURRENT TRANSFORMER
- POTINTIAL TRANSFORMER
- OPM
- ARDUIONO
- INDUCTOR 220UH
- CONNECTOR
- AC POWER SUPPLY
- HOLDER
- LIGHT
- SOME WIRES
- PCB BOARD
- SWITCH

4.2 Power Supply.

Power supply is the reference to a source of electrical energy. A device or a system that Supply electrical or other types of energy to an output load is called is power.High voltage power are reduce the inverter convert to the low power of the device such as 220v convert of the device 12 v.using. inverter..

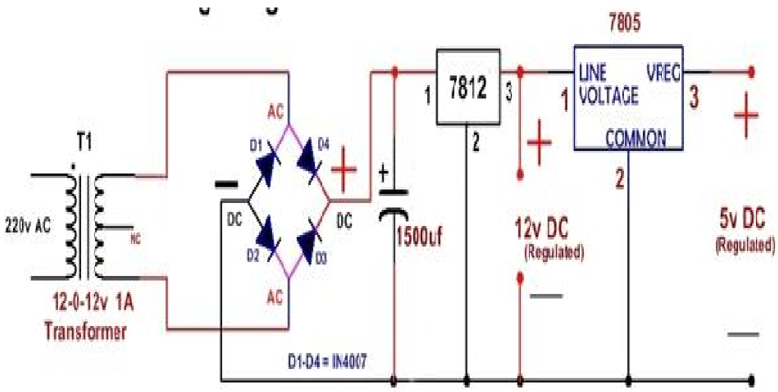

Fig.4.2:AC to DC Converter Power Supply

4.3 Voltage Regulator.

Usually, we start with an unregulated power supply ranging from 9volt to 12volt DC.To make a 5volt power supply, IC 7805 voltage regulator as shown in figure has been used

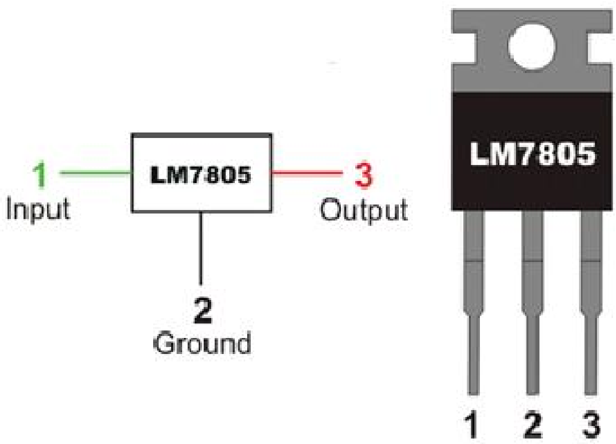

Fig. 4.3: Pin Diagram of IC 7805

4.4 Resistor.

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

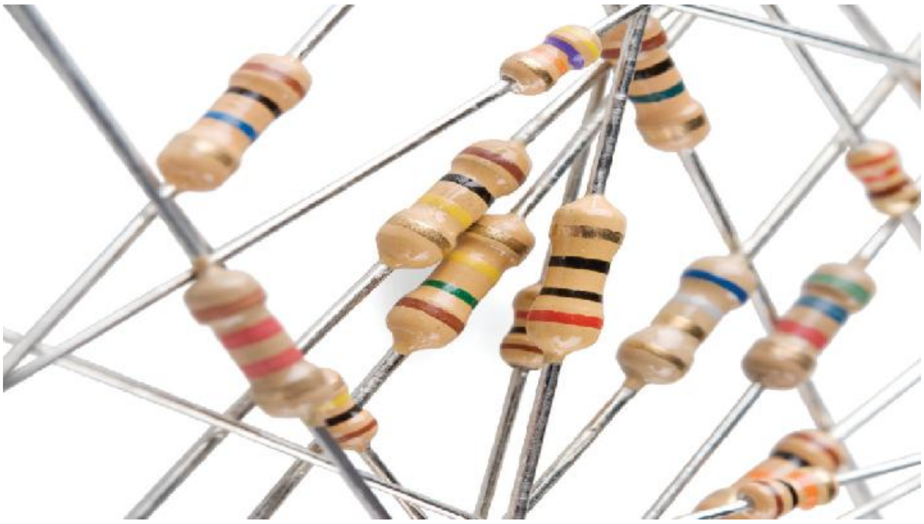

Fig. 4.4:Resistors

4.4.1 Variable Resistor.

Fig. 3.4.1:variable resistorr

By changing resistor.. When resistance increases in a variable resistor, the amount of current that is allowed to flow in a circuit decreases. Two basic components make up variable resistors. The resistive material is the first component and is called the element.

The second component, called the wiper or brush, is used to set the resistance, and is often controlled with a knob or sliding switch.

Variable Resistors can be found in:

- Audio control
- Television
- Motion control
- Transducers
- Computation
- Home Electrical Appliances
- Oscillators

4.4.2 Tips for Reading Resistor Code.

In the sections below examples are given for different numbers of bands, but first some tips are given to read the color code:

4.4.3 Resistor Color Code Chart.

Below the resistance color code chard to determine and tolerance .table shown are below.

Color	Signficant figures			Multiply	Tolerance (%)	Temp. Coeff. (ppm/K)	Fail Rate (%)
black	0	0	0	x 1		250 (U)	
brown	1	1	1	x 10	1 (F)	100 (S)	1
red	2	2	2	x 100	2 (G)	50 (R)	0.1
orange	3	3	3	x 1K		15 (P)	0.01
yellow	4	4	4	x 10K		25 (Q)	0.001
green	5	5	5	x 100K	0.5 (D)	20 (Z)	
blue	6	6	6	x 1M	0.25 (C)	10 (Z)	
violet	7	7	7	x 10M	0.1 (B)	5 (M)	
grey	8	8	8	x 100M	0.05 (A)	1(K)	
white	9	9	9	x 1G			
gold			3th digit only for 5 and 6 bands	x 0.1	5 (J)		
silver				x 0.01	10 (K)		
none					20 (M)		

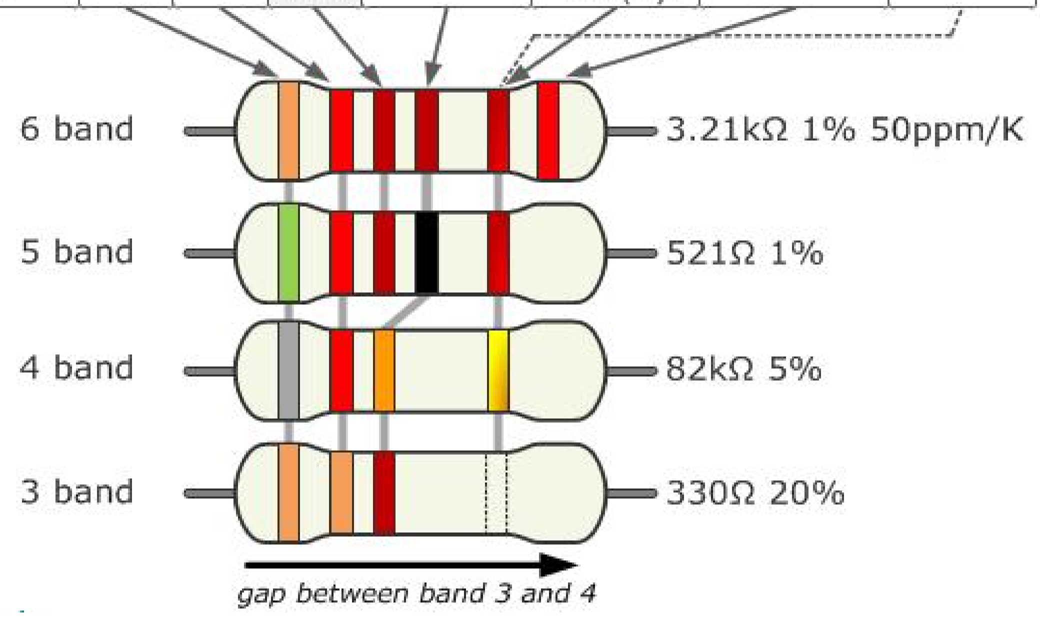

Fig.4.4.3:Color Code Chart of Resistor

4.4.4 4-Band Resistor.

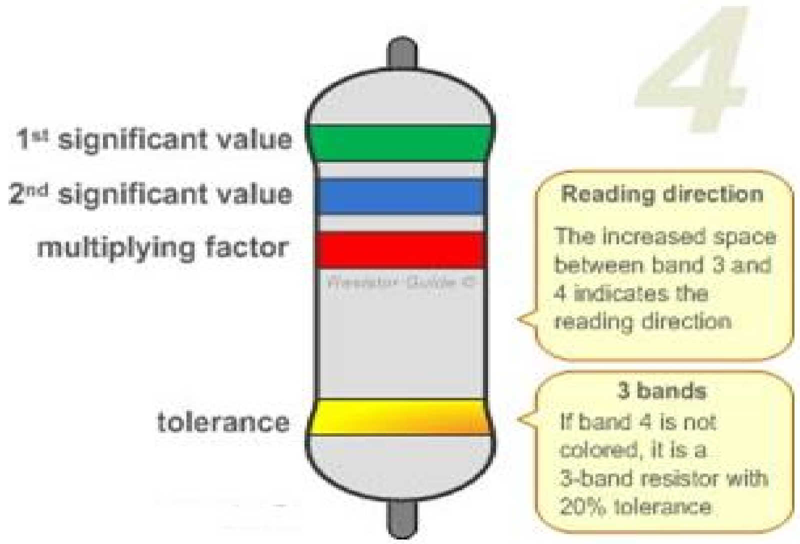

Fig. 4.4.4: four band Resistor Color Code

4.4.5 5-Band Resistor.

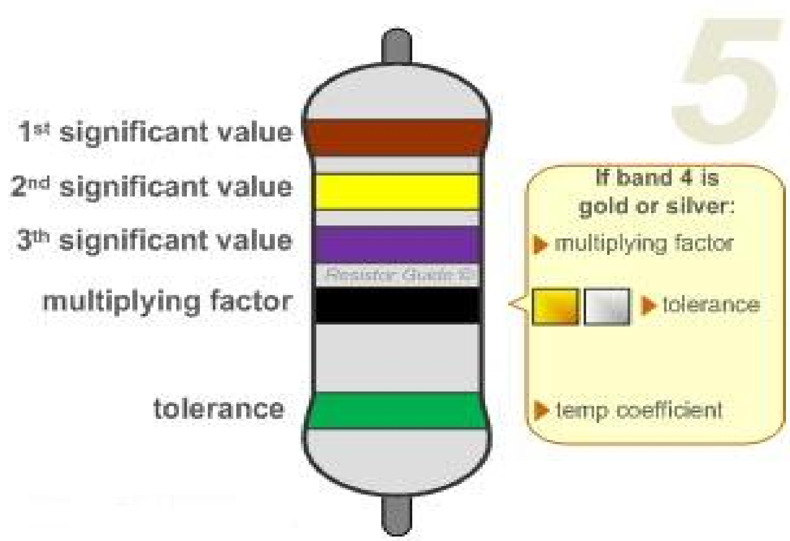

Fig. 4.4.6: 5-Band Resistor Color Code

4.5 Capacitor.

A capacitor is a passive electronic component that stores energy in the form of an electrostatic field. In its simplest form, a capacitor consists of two conducting plates separated by an insulating material called the dielectric. The capacitance is directly proportional to the surface areas of the plates, and is inversely proportional to the separation between the plates. Capacitance also depends on the dielectric constant of the substance separating the plates.

Fig. 4.5(a): Electrolytic Capacitor

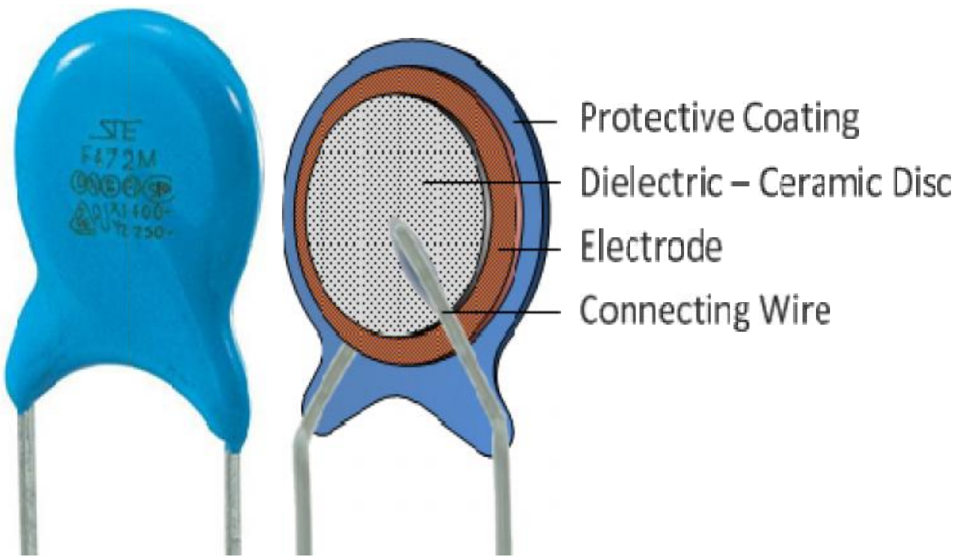

Fig. 4.5(b): Ceramic Capacitor

4.6 Diode.

The diode are variety current only convert in on way current .this diode are two part anode and cathode.low pressure element gas .we are use diode can be rectifires,voltage regulator,signal limiters,swichese ,signal modulation and demodulation,oscillator.

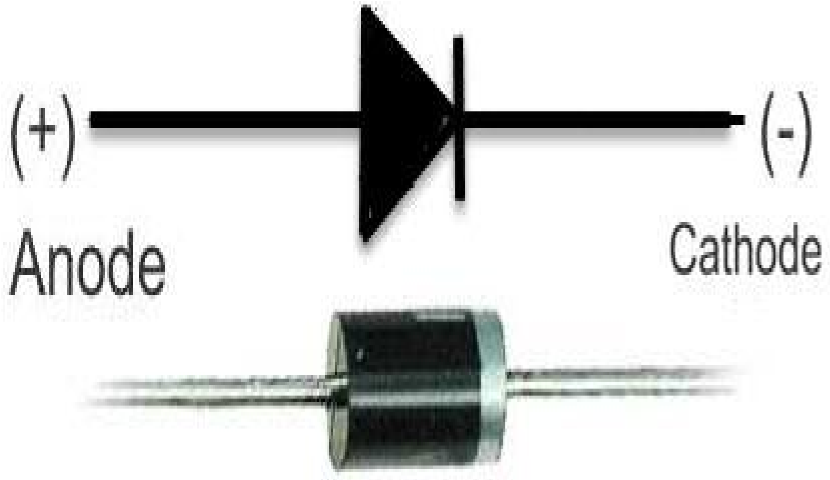

Fig. 4.6:Diode

4.7 Light Emitting Diode(LED).

The LED means light emitting diode device that emits visible light when an electric current passes through it.

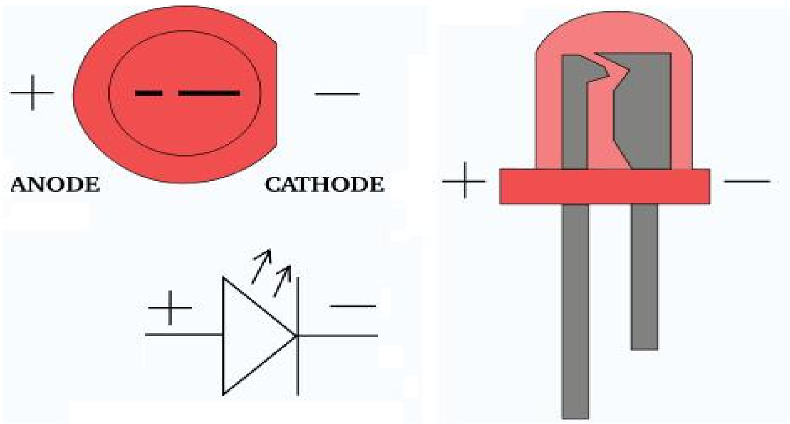

Fig.4.7(a):LED Function

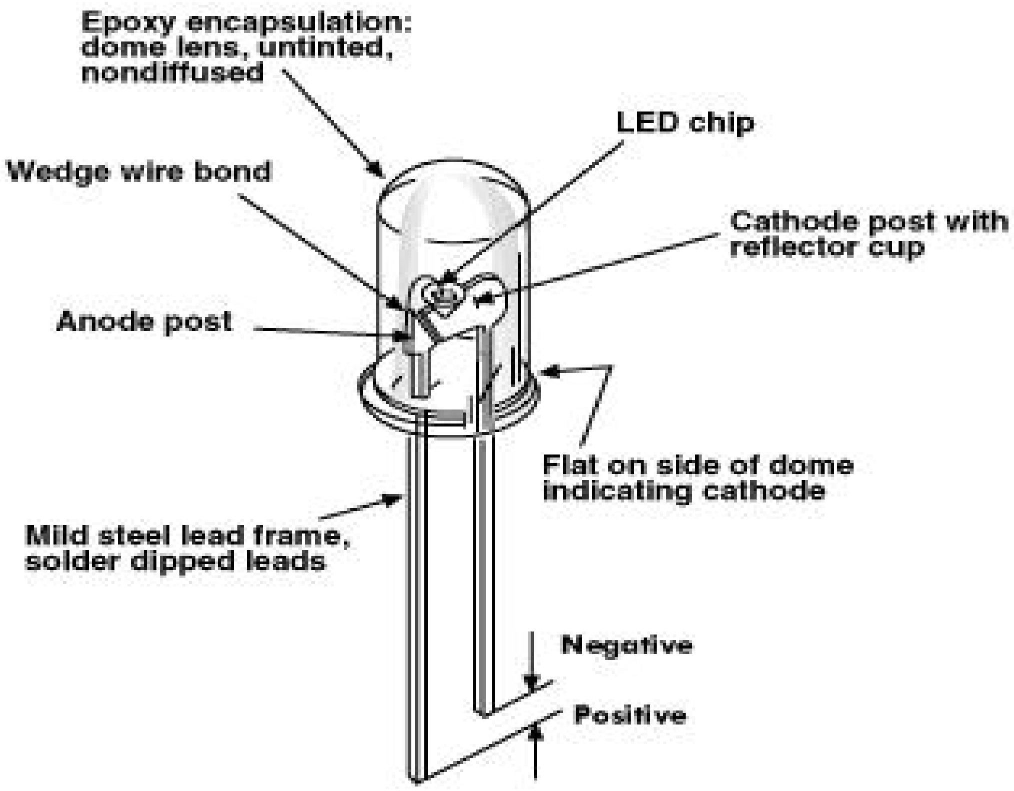

Fig. 4.7.(b):Light Emitting Diode

4.7.1 kinds of LED

Some type are define are under

- Gallium Arsenide (GaAs)
- Phospide gallium
- Gallium allomonium phosphide
- Zenk solinoide
-

4.8 Step down Transformer.

Transformers are electrical devices consisting of two or more coils of wire used to transfer electrical energy by means of a changing magnetic field

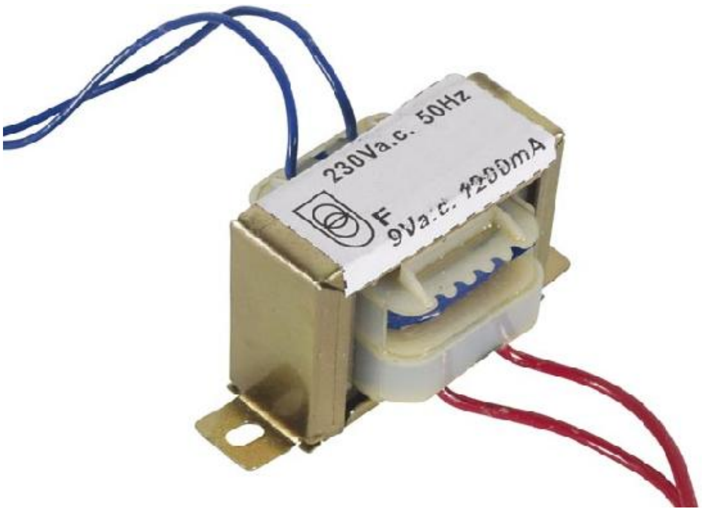

Fig.4.8:Step Down Transformer

4.8.1 Construction of Transformer (Single Phase)

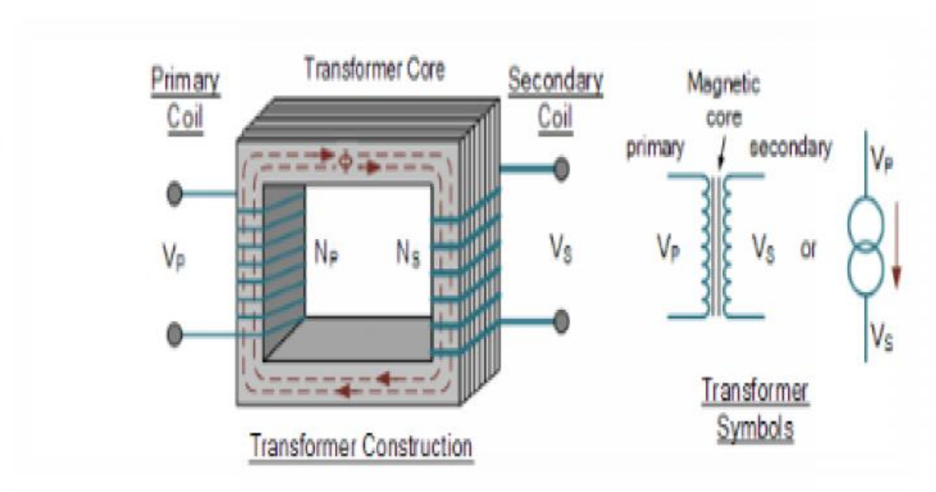

Fig. 4.8.1: Construction and Symbol of Single Phase Transformer

In the above figure, we see a single phase Transformer's construction and symbol

Where:

V_P - the Primary Voltage

V_S - the Secondary Voltage

N_P - the Number of Primary Windings

N_S - the Number of Secondary Windings

Φ (phi) - the Flux Linkage

Notice that the two coil windings are not electrically connected but are only linked magnetically. A single-phase transformer can operate to either increase or decrease the

voltage applied to the primary winding. When a transformer is used to “increase” the voltage on its secondary winding with respect to the primary, it is called a Step-up transformer. When it is used to “decrease” the voltage on the secondary winding with respect to the primary it is called a Step-down transformer.

However, a third condition exists in which a transformer produces the same voltage on its secondary as is applied to its primary winding. In other words, its output is identical with respect to voltage, current and power transferred. This type of transformer is called and

“Impedance Transformer” and is mainly used for impedance matching or the isolation of adjoining electrical circuits.

The difference in voltage between the primary and the secondary windings is achieved by changing the number of coil turns in the primary winding (Np) compared to the number of coil turns on the secondary winding (Ns).

As the transformer is basically a linear device, a ratio now exists between the numbers of turns of the primary coil divided by the number of turns of the secondary coil. This ratio, called the ratio of transformation, more commonly known as a transformers “turns ratio”, (TR). This turn’s ratio value dictates the operation of the transformer and the corresponding voltage available on the secondary winding.

4.8.2 Efficiency of Transformer.

$$\text{efficiency}, \eta = \frac{\text{Output Power}}{\text{Input Power}} \times 100\%$$

$$= \frac{\text{Input Power - Losses}}{\text{Input Power}} \times 100\%$$

$$= 1 - \frac{\text{Losses}}{\text{Input Power}} \times 100\%$$

.

Generally when dealing with transformers, the primary watts are called “volt-amps”, VA to differentiate them from the secondary watts. Then the efficiency equation above can be modified to:

$$\text{Efficiency}, \eta = \frac{\text{Secondary Watts (Output)}}{\text{Primary VA (Input)}}$$

4.8.3 current transformer.

Fig.4.8.3(a):Typical Current Transformer

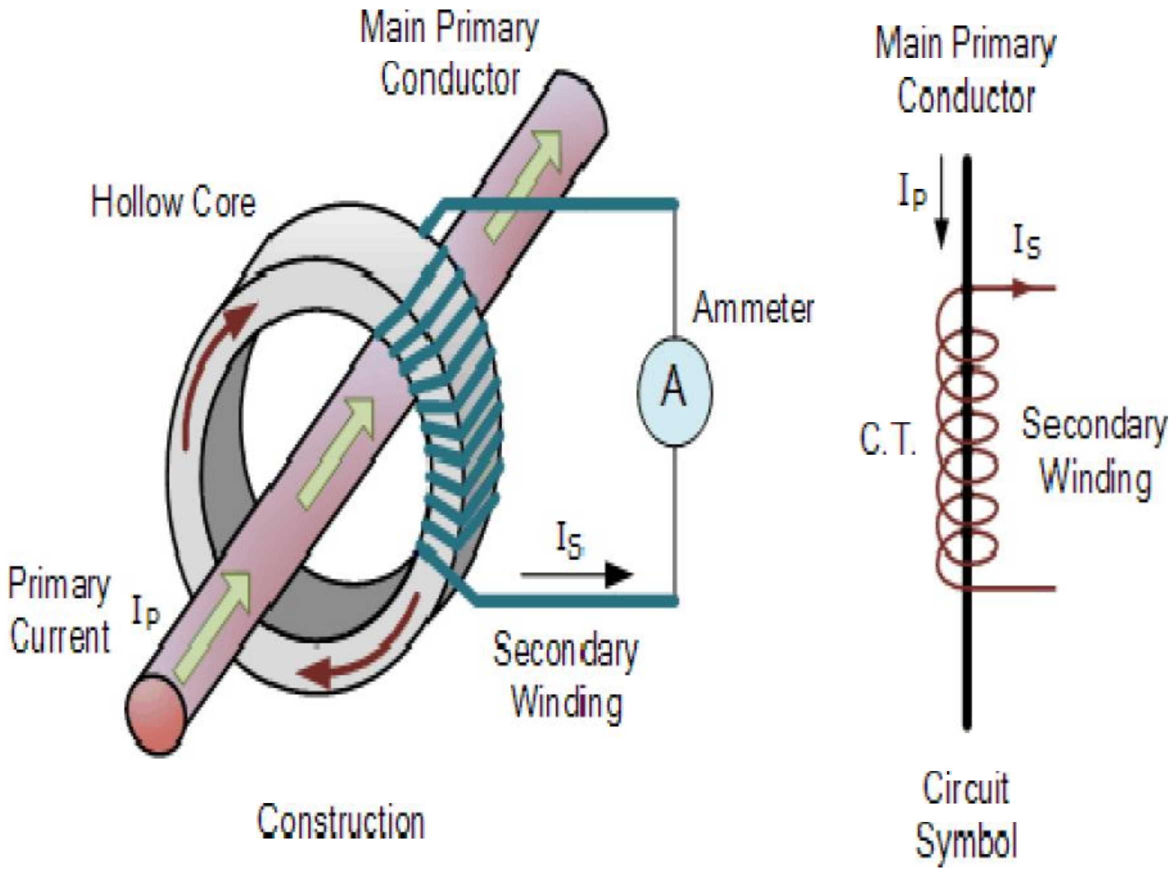

Fig.4.8.3(b):symbol of current transformer

secondary current, $I_S = I_P\left(\frac{N_P}{N_S}\right)$

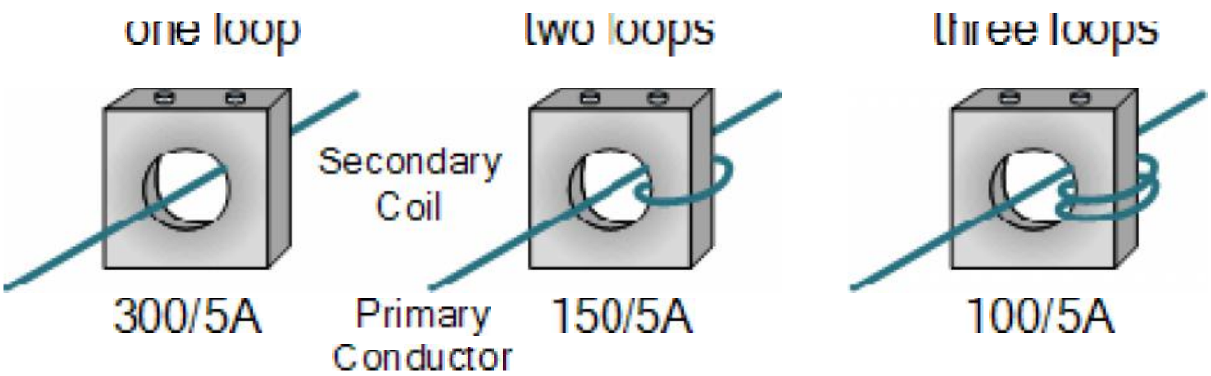

Fig.4.8.3(c):Current Transformer Primary Turns Ratio

4.8.4 Potential Transformer (PT).

The potential transformer may be defined as an instrument transformer used for the transformation of voltage from a higher value to the lower value.

4.8.4 (a) Construction of Potential Transformer.

The potential transformer is made with high-quality core operating at low flux density so that the magnetising current is small.

4.8.4 (b) Connection of Potential Transformer.

The potential transformer is connected in parallel with the circuit. The primary windings of the potential transformer are directly connected to the power circuit whose voltage is to be measured.

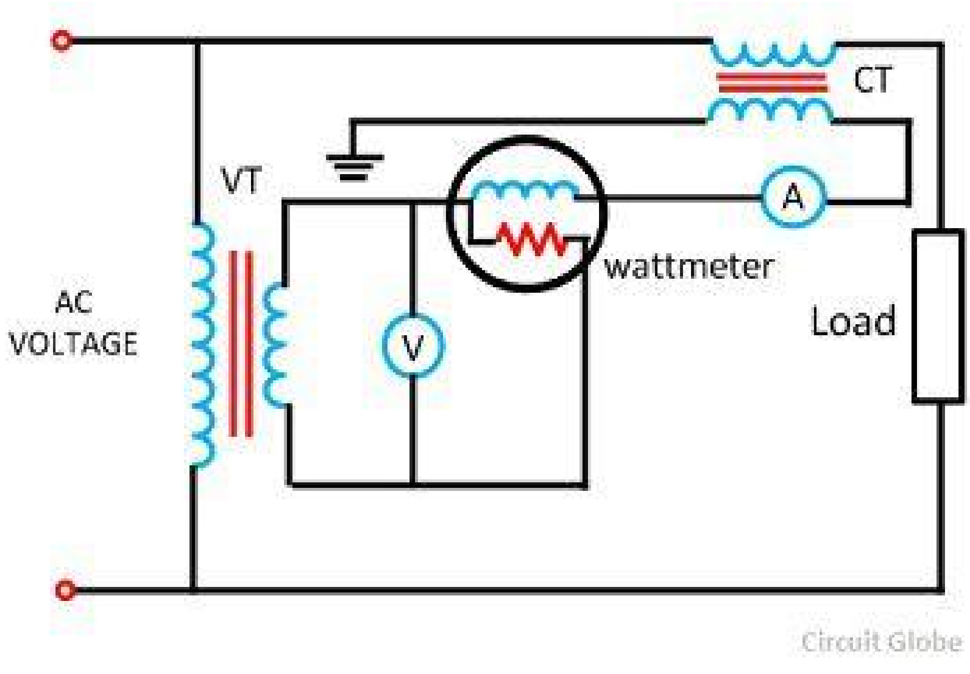

Fig.4.8.4(b) :Potential Transformer

4.8.4 (c) Kinds of potential transformer

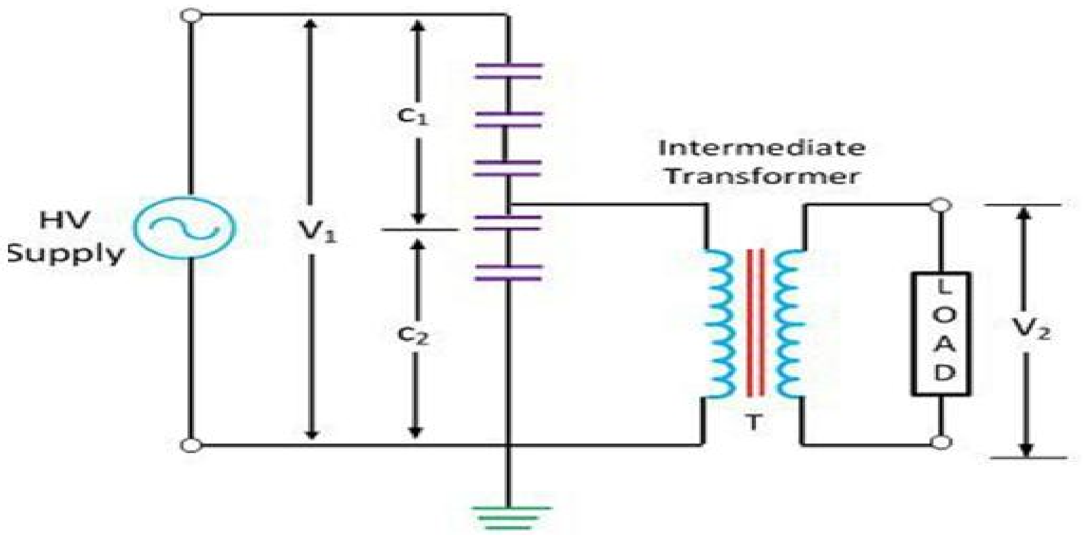

Fig 4.8.4(c):Capacitor Potential Transformer Circuit Diagram

4.8.4 (d) use sector of Potential Transformer.

i.It is used for a metering purpose.

ii For the protection of the feeders.

iii For protecting the impedance of the generators.

iv For synchronising the generators and feeders.

The potential transformers are used in the protecting relaying scheme because the potential coils of the protective device are not directly connected to the system in case of the high voltage. Therefore, it is necessary to step down the voltage and also to insulate the protective equipment from the primary circuit.

4.5 LVAP Amplifier(Dual OPM).

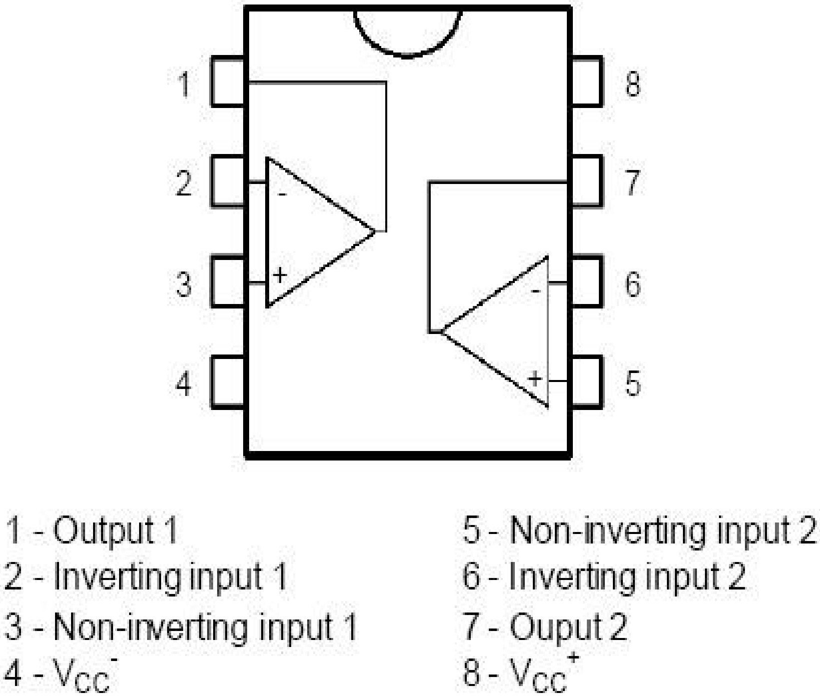

Fig.4.5:Dual OPM Pin Diagram

4.5.1 Dual OPM Application.

- AM-FM Radio Amplifiers
- Portable Tape Player Amplifiers
- Intercoms
- TV Sound Systems Line Drivers
- Ultrasonic Drivers
- Small Servo Drivers
- Power Converters

4.6 Arduino (NANO)

The Arduino NANO R3 is the best version after the desimiliune of the electronic device .this device is the best of microcontroller and it varias type of the device.

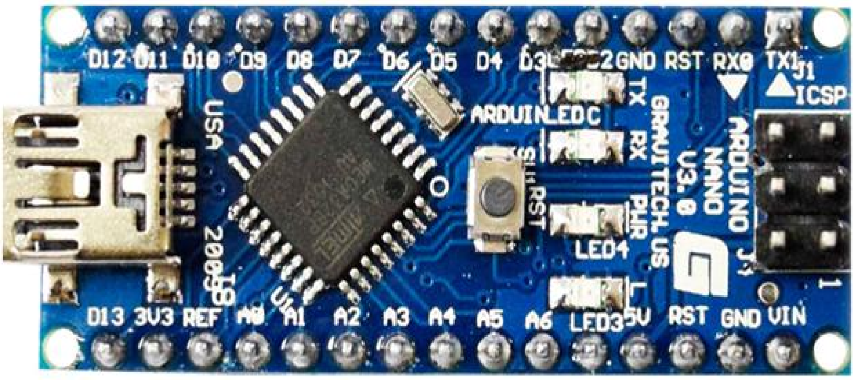

Fig: 4.6:Arduino (NANO)

4.6.1 Arduino (NANO) ATMEGA328 Operation.

Microcontroller	Atmega 8
Controlling voltage	Five volt
I/V	7V to 12 V
I/P L	6V to 12v
Digital I/O Pins	14 (of which 6 provide PWM output
Analog Input Pins	6
DC I/O Pin	40mA
DC .3V Pin	50mA
Flash memory	32 KB (ATmega328) of which 0.5 KB used by boot
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)

4.6.2 Pin Diagram of Arduino (NANO) ATMEGA328

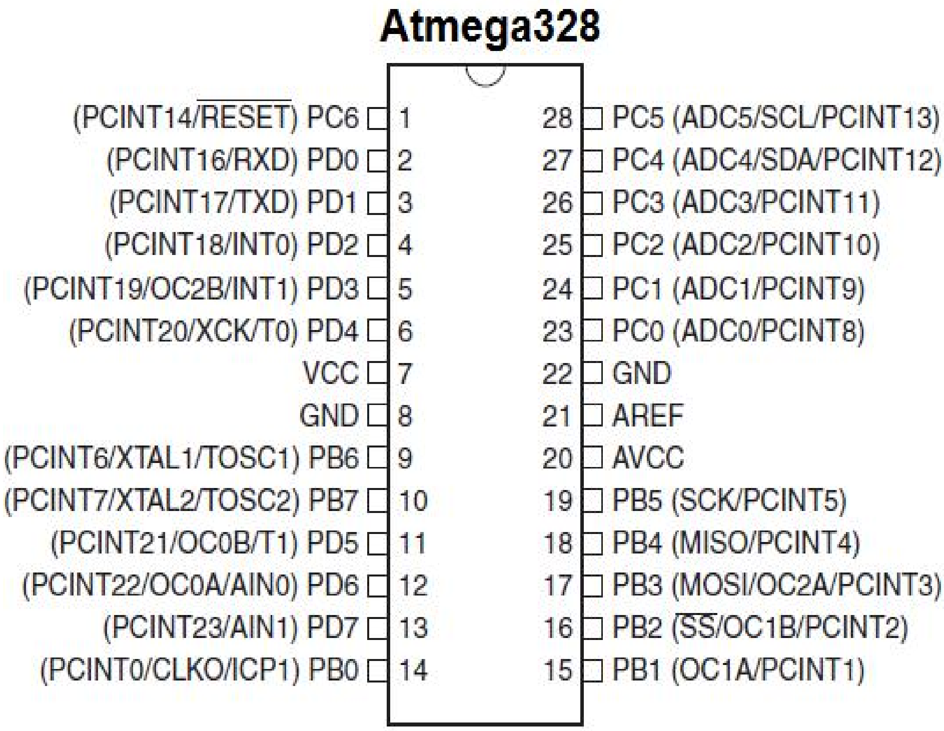

Fig.4.6.2:Pin Diagram of ATMAGA328

4.7Liquied crystal Display.

We use 16*2 line display .one line total 16 character show the display.

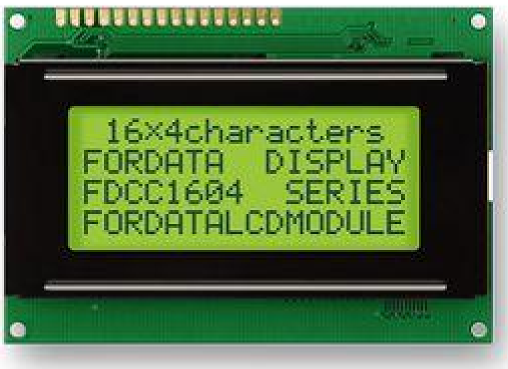

Fig.3.12:LCD Display

4.8 Circuit Diagram.

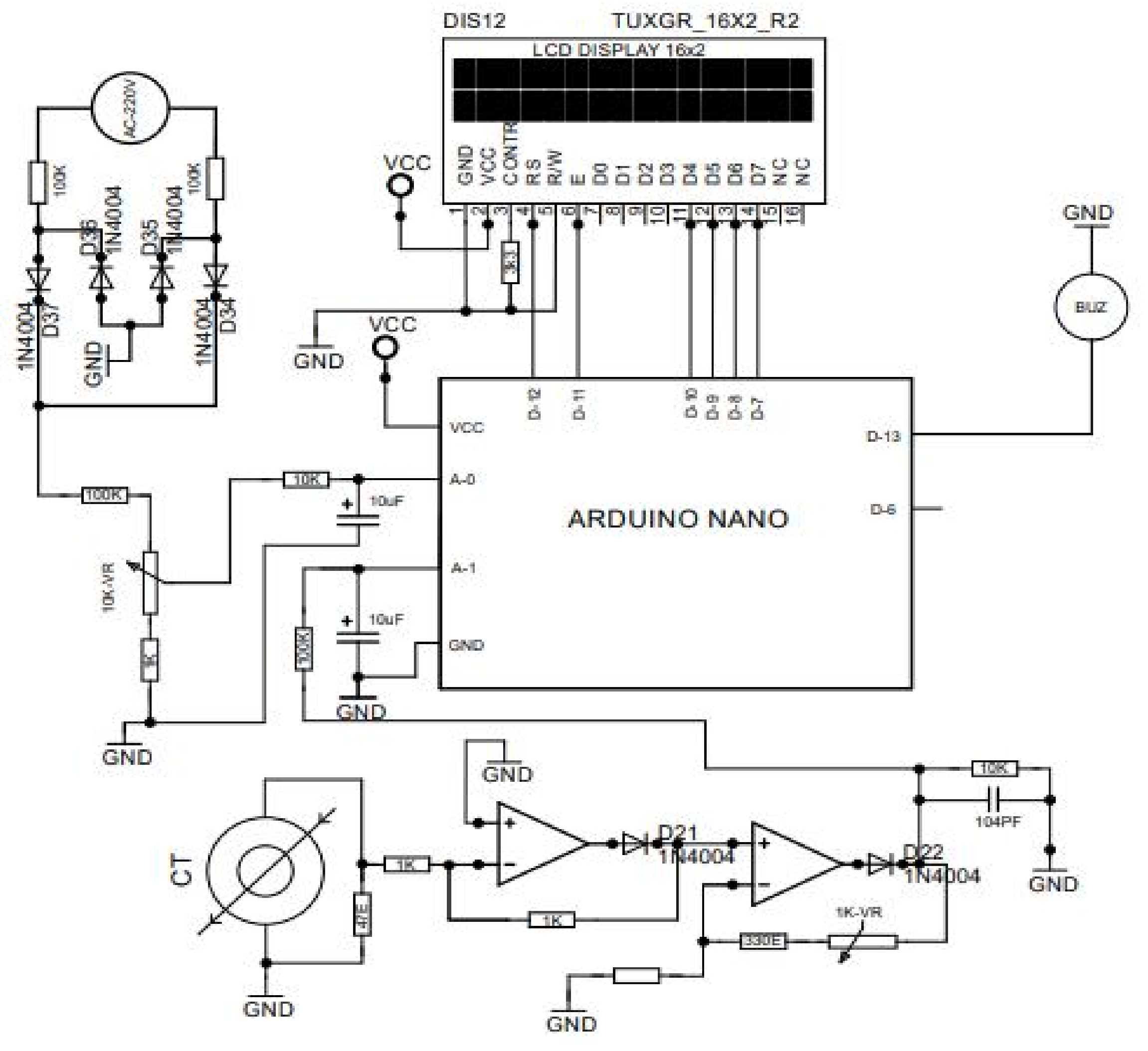

Fig 4.8 : Circuit Diagram of Home Energy Meter

4.9 Block Diagram.

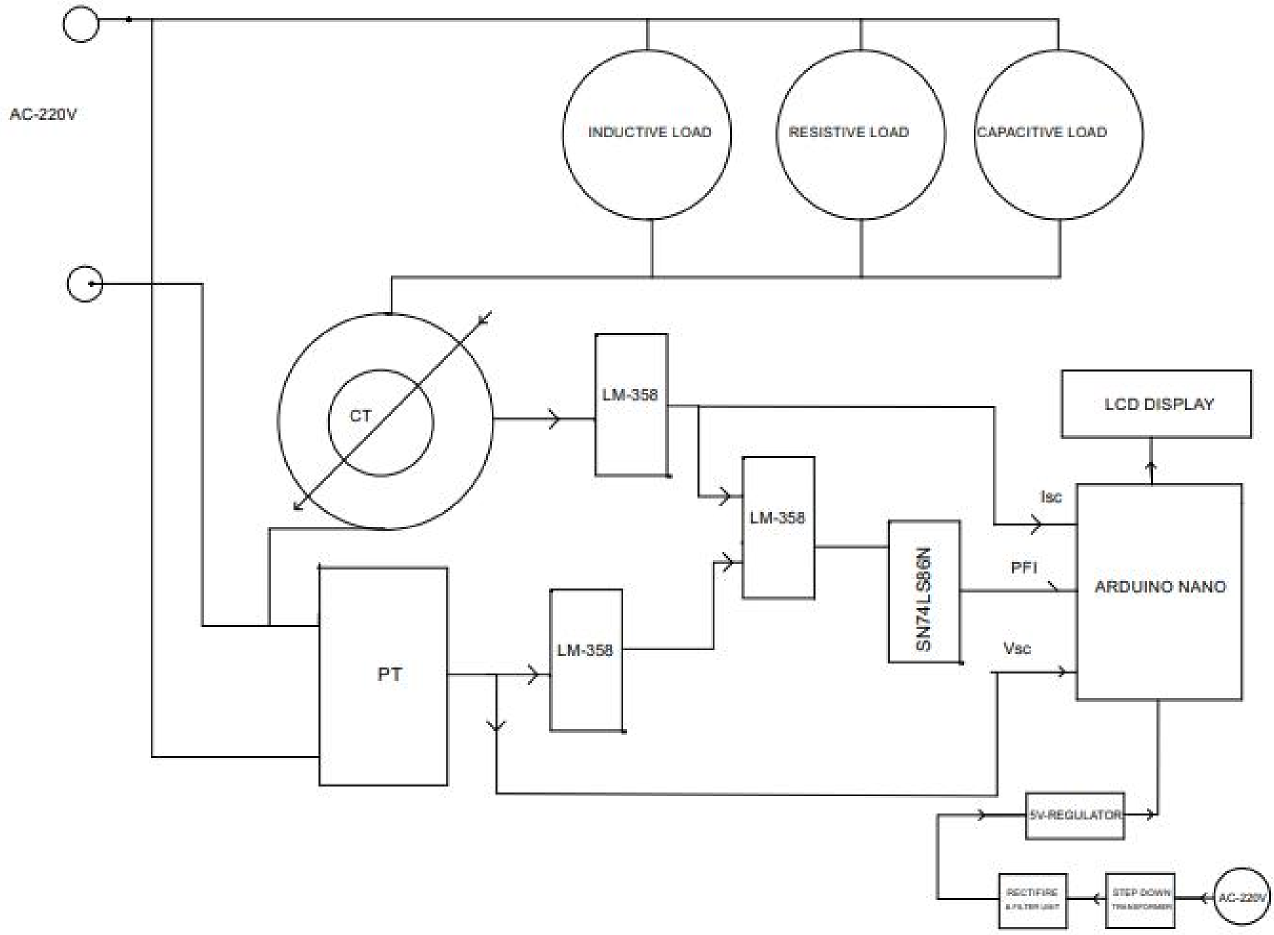

Fig. 4.9:Home Energy Meter

4.10 Cost Estimate.

Component Name	Quantity	Cost
Buzzer	1	50 Taka
LCD	1	50 Taka
Capacitor	4	36 Taka
Resistor	8	30 Taka
Diode	5	30 Taka
CT	1	50 Taka
PT	1	150 Taka
Step dowen Transformer	1	150 Taka
Dual OPM	1	80 Taka
Arduino	1	250 Taka
Light	2	56Taka
Push Switch	3	45 Taka
Holder	2	40 Taka
Fan	1	30 Taka
PCB Board	1	80 Taka
Some wire	-----	25 Taka
LED	2	5 Taka
	Total	**1157 Taka**

Chapter-5

Power factor & Improvement

5.1 Definition of Power Factor: The ratio of between real power to total power is known as power factor .

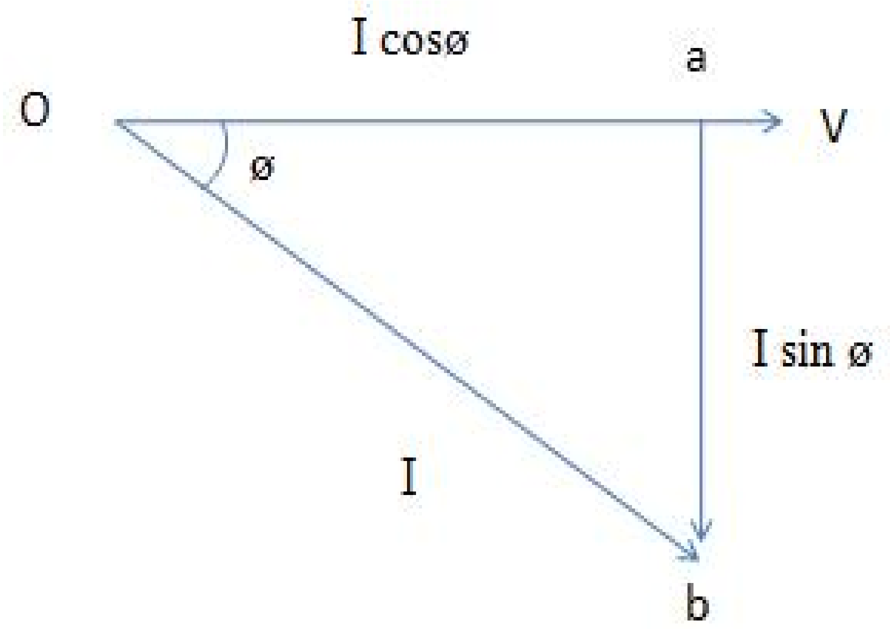

Fig.5.1(a) power factor

So

Power Factor=Real Power/Total Power

5.2 Power Triangle.

The analysis of power factor can also be made in term of power drown by the ac circuit. If each side of the current triangle is multiply by voltage V. Then we get the power triangle OAB shown in figure

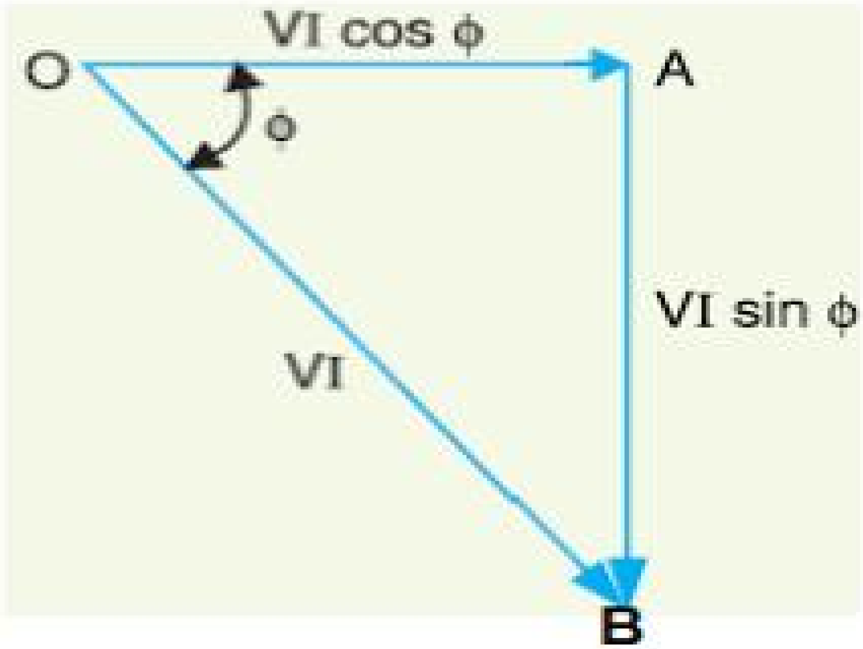

Fig.5.2(a) power triangle

OA= VI cosø represent active power in watts

AB= VI sinø represent active power in KVAR

OB= VI represent total power in VA Or KVA

5.3.Advantage

(1) less power consumption and improve efficiency.

(2) less power consumption

(3) Decrease electricity bills

(4) Reduction of voltage drops in long cables.

(5) Environmental benefit

(6) Equipment of extendent.

(7) decrees electrical bills.

5.4 Disadvantages of Low Power Factor.

1. Large cupper losses
2. Poor voltage regulation
3. Large KVA rating of the equipment.
4. Large size of conductor.
5. Reduce plant life.
6. Decrease energy efficiency.

7.. Large power losses

5.5 Causes of Low Power Factor.

Induction load make the current lagged behind the voltage. Thus a lagging power factor .

1.Motors:3-phase induction motor operates at 0.8 lagging at full load and 0.2 to 0.3 at light load .1-phase operate at o.6 lagging.

2.Due to magnetizing current ,power factor is low at light.

3. ,Electrical discharge lamps ,industrial heating furnaces ,arc lamp ,Welding

5.6 Power factor improvement equipment.

There are three equipment of improvement of power factor

1.phase advancer

2.synchronous condenser

3.staic capacitor

5.6.1 Static Capacitor.

When the pf improve than the capacitor connected in parallel the equipment operating at lagging power factor.   shown in figure below 4.6.1(a).

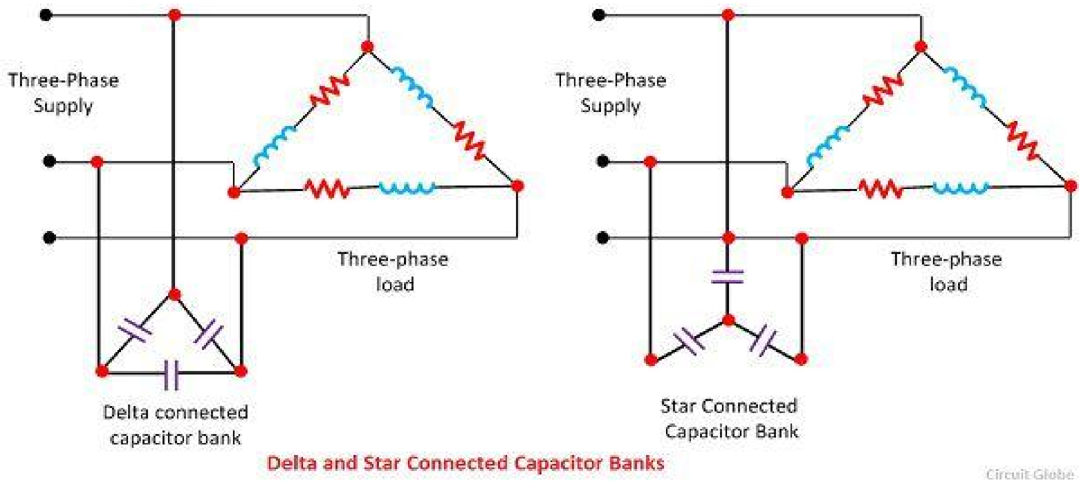

Fig.5.6.1(a) Static Capacitor (Star and Delta Connection)

5.6.2 Synchronous condenser.

A synchronous motor takes a leading current when over-exited and, therefore behave as a capacitor.

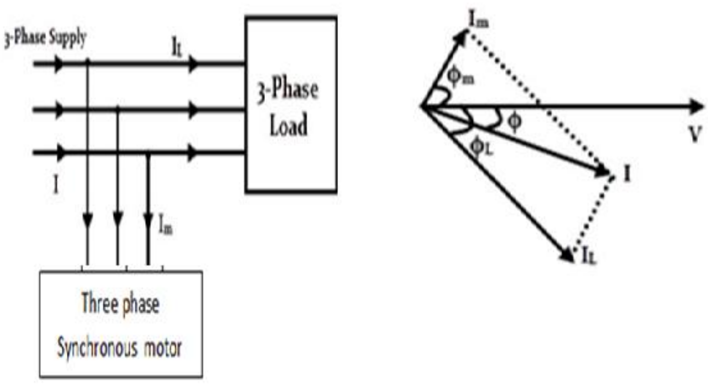

Fig.5.6.2(a) :Synchronous Condenser

5.6.3. Phase advanser.

This system are usedto improvement thepower factor of induction motor.

The low pf of an induction motor is due to fact that its stator winding draw exciting current .which lags behinds the supply voltage by 90 degree.

Chapter-6

Summery

6.3 Summery.

This Home energy meter is exceptional because shown the Voltage,Unite,Per Unite cost ,Power Factor and Current of the AC supply.

CHAPTER-7

Conclusions and Recommendations

7.1 Conclusion.

In this project, we develop a general purpose of electronic circuit design that can Show the LCD display Voltage,Unite,Per Unite cost ,Power Factor and Current of the AC supply . The project is successfully developed and met the stated objectives.

7.2 Limitations of the Work.

The working procedure of this project is very easy but we are facing some limitation for doing this project. Such as coding problem, program writing, connecting to PCB board, commend following etc

.

7.3 Future Scopes.

i. Analog Energy Meter Convert to Digital Energy Meter

ii.Prepaid System Energy Meter

iii.Energy meter Monitoring by GSM System

References

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APPENDIX A

```
#include <LiquidCrystal.h>
#include <math.h>
#include <EEPROM.h>
LiquidCrystal lcd(12, 11, 10, 9, 8, 7);
#define ACV_PIN A0
#define I_PIN A2
int pin = 8;
float rads = 57.29577951;
float degree = 360;
float frequency = 50;
float nano = 1 * pow (11,-9);
float angle;
float pf = 0;
float angle_max = 0;
int ctr;
float I = 00.0,PW=00.0,UNIT = 00.0,BALANCE = 0.0;
int ACV=0;
int cnt,cnt1,MSGF;
char str[20];
void setup()
{
pinMode(pin, INPUT);
  pinMode(ACV_PIN,INPUT);
  pinMode(I_PIN,INPUT);
  lcd.begin(20, 4);

}
void loop()
{
```

```
  ///////////////////////////////////////
  cnt++;
  if(cnt > 200)
  {
   calculate();
   DISPLAY1();
   ACV = analogRead(A0);
   delay(2);
   I = analogRead(A1);
   delay(2);
   UNIT += ((PW/1000)/60);
   if(UNIT < 100)
   {
     BALANCE = UNIT * 5.5;
   }
   if( (UNIT > 99) && (UNIT < 200) )
   {
     BALANCE =  UNIT * 6.0;
   }
   if(UNIT > 199)
   {
     BALANCE =  UNIT * 8.0;
   }
   I = (I * 5.0) / 255;
   PW = ACV * I;
   cnt=0;
  }
  ///////////////////////////////////////
}
```

```
////////////////////////////////////////////////////////////////////////////////
////////////////////////////////////////////////////////////////////////////////
void DISPLAY1()
{
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("AC:");
  lcd.print(ACV);
  lcd.print(" V        ");
  lcd.setCursor(10, 0);
  lcd.print("BL:");
  lcd.print(BALANCE);
  lcd.print(" TK ");
  lcd.setCursor(0, 1);
  lcd.print("I:");
  lcd.print(I);
  lcd.print(" A        ");
  lcd.setCursor(10, 1);
  lcd.print("P:");
  lcd.print(PW);
  lcd.print("W  ");
  lcd.setCursor(0, 2);
  lcd.print("U:");
  lcd.print(UNIT);
  lcd.print(" KW/h");
  lcd.setCursor(0,3);
  lcd.print("PF=");
  lcd.print(pf);
  //lcd.setCursor(10,3);
  //lcd.print("Ph:");
```

```
    //lcd.print(angle_max);
    //lcd.print(" ");
    delay(200);
}

void calculate()
{
  for (ctr = 0; ctr <= 4; ctr++)
   {
    angle = ((((pulseIn(pin, HIGH)) * nano)* COS *degree)* frequency);

     if (angle > angle_max)
     {
      angle_max = angle * COS;
      pf = cos(angle_max / rads);
     }
   }
   if (angle_max > 360)
   {
    angle_max = 0;
    pf = 1;
   }
   if (angle_max == 0)
   {
    angle_max = 0;
    pf = 1;
   }
   if(pf >= 1.0)
   pf=0.99;
```

```
  if(pf < 0.5)
  pf=0.52;

  angle = 0;
  angle_max = 0;

}//////////////////////
```