Automatic Power Factor Correction Unit using Arduino

K.Mukundan[1], Pranav Bala[2], Karthikeyan.S[3], Ranjith Kumar.S[4], Nagaraj.R[5]

Assistant Professor, Department of EEE, Rajiv Gandhi College of Engineering & Technology, Puducherry, India[1]

UG Student, Department of EEE, Rajiv Gandhi College of Engineering & Technology, Puducherry, India[2,3,4,5]

Abstract: We are in the need of energy which we have to make major corrections in which the energy is wasted in form of reactive power. So, the required energy is can be utilised in which the energy can have the major correction to form a power factor. The power factor can be developed with the required energy the utilised power is used in a proper way.t\The reactive power can be compensated using capacitor banks and this can be termed as power factor correction. The power factor correction is major problem in a industry to compensate a reactive power factor. The reactive power can be compensated with a reactive and it make into real power. Hence the according to the load the power factor can be compensated using Arduino microcontroller and switching operation is done with the regular power factor and his can be controlled with microcontroller. The microcontroller is programmed with to operate with the necessary coding.

Keywords: Power factor, capacitor bank, solid state relay, precision rectifier, super diode, phase measurement, AC signal measurement, Arduino.

I. INTRODUCTION

In India power market is very critical and it is not enough to serve the people according to the generation. In order to reduce he energy losses we have to make up the losses which are wasted by means of reactive power generation. The huge industries may consume large amount of power in rating of kw sanctioned by the electricity department. We have a term called power factor in power system which can be defined as the ratio of losses to the total power generated to the power received in the consumer terminals. If the term power factor is maintained at a nominal value then the energy losses can be reduced. For this purpose, We were using capacitor banks to compensate the reactive power generated. The power factor may vary depending the rating of the load which are connected to supply mains. if we connect a less amount of inductive load, then the power factor will be less. If the load is resistive then the power factor is maintained at unity. If we switch on the capacitors according to the load variations at correct time then the power factor can be maintained at constant So, these are the introduction of our project.

II. THEORY

In this theory we will study about the installation of capacitor banks according to the load connected in power system. There are two methods available for the calculation capacitor banks to load connected. They are

   i.   Thumb rule
  ii.   Determining the power factor as we requied
 iii.   Thumb rule:

TOTAL LOAD	=250 kVA	
kVA TO kW	=250x0.8	=200 kw
kW to HP	=200/0.746=268.09HP	
capacitor rating (in kVAR)	= 268.09/3=89.365 kVAR	

So, according to thumb rule capacitor bank to be implemented to 250 kVA is 90 kVAR approximately.

i)   Determining the power factor as we required:
ACTUAL POWER FACTOR WITHOUT CAPACITOR BANK= COS Φ_1=0.7
REQUIRED POWER FACTOR TO BE MAINTAINED AS PER NORMS=COSΦ_2=0.9
Φ_1=COS^{-1}(0.7)=45.57
Φ_2=COS^{-1}(0.9)=25.84
IMPROVEMENT IN PHASE=Φ_1-Φ_2 = (45.57-25.84) =19.73
IMPROVEMENT FACTOR   =tan(Φ_1-Φ_2) =tan(19.73)   =0.358
REQUIRED CAPACITOR BANK RATING=LOAD X IMPROVEMENT FACTOR

=250   X 0.358
=89.6 kVAR = 90(APPROX)
So as we discussed in the theory part if the connected load is 250 kva then the capacitor banks to be installed is about 90 kvar approximately.

III.   MEASURING THE POWER FACTOR

As we discussed in the introduction part, before entering into the power actor correction we have to calculate the power factor in power system depends upon the load connected to the system. There are various methods involved in the power system to calculate the power factor. In this discussion we use potential transformer and current transformer and some electronic circuits to calculate the power factor.

 The electronic components are
i)   Op-amp(LM 358)
ii)   Ex-Or gate
iii)   Microcontroller (Arduino Uno Atmega 325)
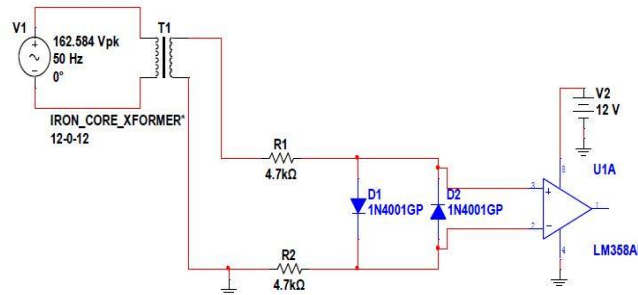
The above circuit is the zero-crossing detector circuit. Usually we will have a sine waveform in a supply. In order to measure a power factor, we need to find the time period in electric pulse present in the supply. We cannot able to find the time period using the sine waveform which is available in the supply. So, in order to calculate the time period, we need to convert the sinusoidal waveform into square waveform. This can be achieved using the zero-crossing detector circuit using the Op-amp   circuit. We have used potential transformer and its output is given to the rectifier circuit to convert the AC signal into pulsating dc signal and its given to the op amp terminals the output of the op amp is feed to Arduino microcontroller for the voltage signal. The same circuit is repeated for the current signal using the current transformer and its output is fed to the Arduino microcontroller. Both the current and voltage signals are feed to EX-OR gate in order o obtain a single square waveform to give o the Arduino microcontroller.

IV.   INTERFACING OF ARDUINO

The Arduino is an microcontroller with simplest form of programming language and easily available sets of programming and header files available on internet. I has a micro controller IC and several input and output terminals available which are easy to make connections to externel connection . it can be connected to a system with a USB cable and can be programmed easily through a common platform   given by the Arduino. The 5v power adapter is provided to connect to a main supply after he programming is done.
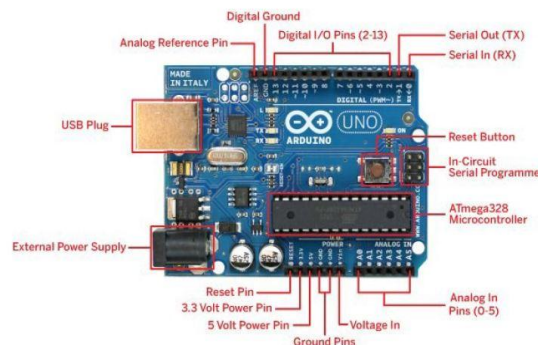
The above figure shows the clear explanation of the Arduino and its parts.

Now let us discuss the function used in the programming to determine the power factor.

```
void getpf()
{
duration = pulseIn(pin, HIGH);
duration1=(duration/1000);
si=(duration1/20);
phi=(si*360);
power_factor=cos(phi/57.2);
}
```

  Hence the power factor can be calculated by using this function in Arduino programming.

V.   SWITCHING OPERATION

Once the power factor is calculated then using the value of the power factor we can able to switch upon the various capacitors to compensate the reactive power generated. The function used for the switching operation of capacitor banks are

```
if(power factor < 0.98)
{
digitalWrite(cap1, HIGH);
getpf();
Serial.print("\tThe corrected Power factor is:\t\t\t");
Serial.println(power_factor);
if(power_factor <0.98)
{
digitalWrite(cap2, HIGH);
getpf();
Serial.print("\tThe corrected Power factor is:\t\t\t");
Serial.println(power_factor);
if(power_factor <0.98)
{
digitalWrite(cap3, HIGH);
getpf();
Serial.print("\tThe corrected Power factor is:\t\t\t");
Serial.println(power_factor);
}
```

Hence the power factor is set at 0.98 value and till it reaches he 0.98 the capacitor bank connected will keep on increasing according to the load and vice versa.
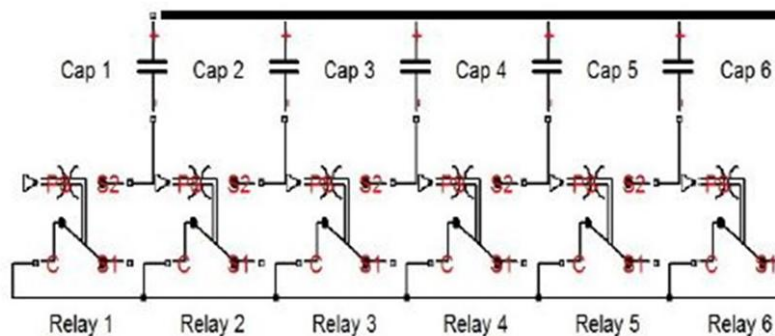
VI.   PROTEUS SIMULATION

The proteus is a software which helps to simulate a critical circuit which have the proper platform with which the blocks were used to obtain a proper simulation medium with electronic circuits and the required value can be viewed with the initial manner. the Arduino is also interfaced wih the proteus simulation to get a proper output and this can be viewed with the proper value.
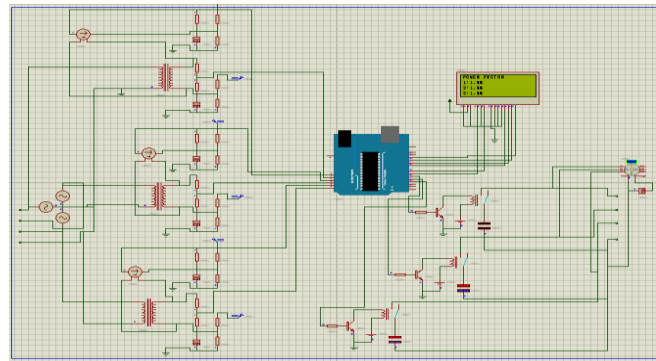
The above picture is a result of our concept and hence the output have been verified with our targeted outputs. in the simulation we have used a motor as a load and transistors as a switch for the switching operation.

VII.   RESULTS

All the algorithms and methods discussed above were tested on the experimental setup. Some of the results are discussed in this section.

VIII.   CONCLUSIONS

This project provided one of the techniques used to overcome power losses due to low power factor associated with common household and small industrial units. In this project AC load voltage and current was measured by sampling rectified sine wave. For rectification, a precision rectifier was designed and applied using op-amp. The sampling was started when the input wave crosses the horizontal axis in both cases of voltage and current. For measuring phase difference, EXOR gate was used for finding the phase difference between voltage and current, and thus measuring the on time of EXOR output gives the angle. All rest information (i.e. RMS voltage and & current, active power, reactive power, apparent power, power factor, capacitance) was worked out using different formulas. Moreover, based on this analysis, a corrective algorithm was established to achieve power factor close to unity. This algorithm incorporates switching capacitances inline automatically through solid state relays in order to compensate the lagging power factor.

IX.   ACKNOWLEDGMENT

REFERENCES

[1] G.PREMKUMAR, "Design, Fabrication and Implementation of Microcontroller Controlled Static Var Compensator," International Journal of Computer Applications, vol. 81, pp. 43-50, Nov 2013.
[2] S. B. Jamge, "Automatic Power Factor Controller using PSoC3," International Journal of Engineering Research & Technology, vol. 3, pp. 1056-1058, May. 2014.
[3] Anant Kumar Tiwari, "Automatic Power Factor Correction Using Capacitive Bank", International Journal of Engineering Research and Applications, vol-4, Page393-395, Feb- 2014
[4] Murad Ali, "Design and Implementation of Microcontroller-Based Controlling of Power Factor Using Capacitor Banks with Load Monitoring", Global Journal of Researches in Engineering Electrical and Electronics Engineering, Vol-13, pp. 21-31, 2013