# ✚IJESRT

## INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

## AUTOMATIC POWER FACTOR CORRECTION IN AN ECONOMIC WAY

**Palak Sharma\*, Kashmira Sinha**

Electronics and Commmunication, Medicaps Institue of Science and Technology, Indore (M.P.), India.

## ABSTRACT

Today everybody is fighting for power efficiency. In industry power factor is the measure for the same which could be kept near unity by manual and costly atomization methods. Most of the industries are armed with inductive loads which results in lagging the power factor and to correct the same usually capacitive loads are added. The economical and easier way is using (APFC) automated power factor corrector using capacitive load bank. The proposed economical automated project involves the power factor measurement using micro-controller 8051.
Just to add capacitive load to reduce the power factor is the most economical way but to do it manually is not the efficient way to reduce the cost and the penalty raised by the power supplier.

As the manual corrections are done by estimation method and not by the measurement method hence no accurate and exact addition of capacitive load may leads lagging or leading of power factor.

To pour the beer in a glass (actual power) in a sophisticated way not to create a foam (reactive power) so the glass is full of maximum beer and minimum foam ( apparent power) and this can be achieved by only APFC method.

The goal of design of this automatic power factor correction is to achieve unity power factor in an economical and efficient way. The software and hardware required to implement the suggested APFC in economical and efficient way are explained and its operation is elaborated. APFC removes manual methods and ultimately reduce man power and improves economy and efficiency. Ultimately, it decreases the time taken to correct the power factor to save the energy of nation.

**KEYWORDS**: APFC, Apparent power, Actual power, Reactive power, Capacitive load bank, Power factor.

## INTRODUCTION

Power Factor is the ratio of Real Power to Apparent Power drawn by electrical load. Ideally it is unity and our aim is to keep it near unity e.g. to pour the beer in a glass (Actual Power KW ) in a sophisticated way not to create foam (Reactive Power KVAR) so the glass is full of maximum beer and minimum foam (Apparent Power KVA) and this can be achieved by APFC method.

Due to inductive load the current lags and creates a phase difference between voltage and current at the load terminal and results in a poor power factor. We have to minimize this phase difference by adding capacitive load which leads current and minimize the phase difference and results in improvement in poor power factor.

To achieve our goal for unity power factor we have designed and implemented system using 8051 micro controller. It determines the Power Factor and corrects it by adding capacitors in shunt to the loaded power system. To implement the project we have designed and programmed in C ,using Kiel μvision4 compiler and simulated the same using Proteus VSM(Virtual System Modeling).

## MATERIALS AND METHODS
**Figure 1**:
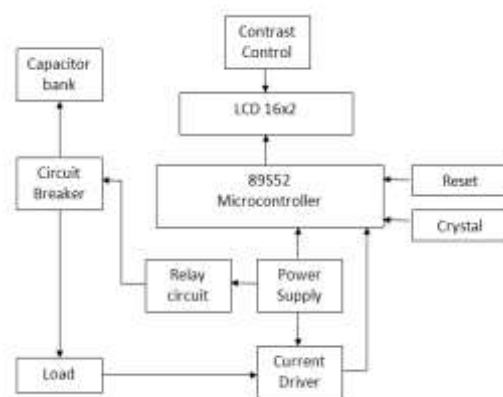


**Block Diagram of APFC System.**

Input to the system is applied from regulated power supply AC 230V mains supply. It is step down by a

transformer to 12V and is fed to rectifier, the output from the rectifier is pulsating DC which is then filtered to get pure DC by removing AC component present after rectification.

The current Driver circuit consists of the CT (Current Transformer) and PT (Potential Transformer), these are used to get voltage and current signals from the supply and load. These signals must be changed to square wave through two zero crossing detectors.

The square wave signals from zero crossing detectors are for the use of micro controller to calculate phase difference and Power Factor.

Capacitor Bank contains capacitors installed within an isolated non-conducting metal box. These capacitors are switched (in shunt) on line and taken off as required by APFC system. The value of capacitor in Farads can be calculated using the formula[2]:
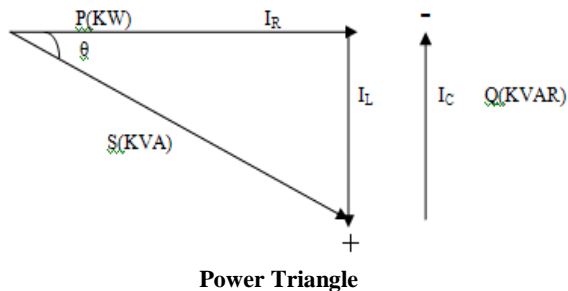
$$C = \frac{VAR}{2\pi f V^2} \qquad (1)$$

Where , VAR = Capacitor unit VAR rating
        C = Capacitor (Farads)
        f = Frequency (Hertz)
        V = Capacitor unit rated voltage

**Figure 2**:



**Power Triangle**

As majority of industries have motors, computers, all these belong to inductive load which leads lag of current thus lag of power factor, to have improvement in power factor we have to add capacitors to the system in shunt to lead the current and power factor. Addition of capacitors from capacitor bank to the system shrink the angle between real power and apparent power and by that way reduce reactive power which is shown in Fig2 power triangle [2].

The LCD is used to display status of the system power factor lagging, leading or calculated. For any error buzzer is used to indicate the same and information displayed on LCD for the error.

## CAPACITOR ADDITION TO THE SYSTEM

The Single phase and three-phase installation for Capacitor Bank is same. In single phase we choose one phase among three phases. Generally standard values for capacitor are 1, 2, 3, 5, 7, 10, 15, 20, 25, 50, 100, 150, 200, 300 and 400 KVAR. Typical power factor for some industries without any compensation are listed in table1 [3].

*Table1. Typical Power Factor for some Industries.*

| Industry | Power Factor (%) |
|---|---|
| Automobile | 75-80 |
| Chemical | 65-75 |
| Steel Works | 65-80 |
| Plastic | 75-80 |
| Oil Field Pumping | 40-60 |
| Office Building | 80-90 |
| Hospitals | 75-80 |

In order to make addition of capacitors from the capacitor bank to system .The micro controller operates the relays which are on the other hand connected to the circuit breaker which finally adds the required capacitor values in order to correct the power factor. The value of capacitance is calculated by the micro controller and accordingly the selection of different values of capacitor is done, which are connected in parallel to the load.
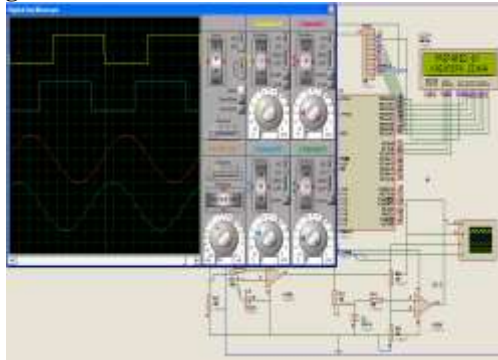
**Figure 3**:
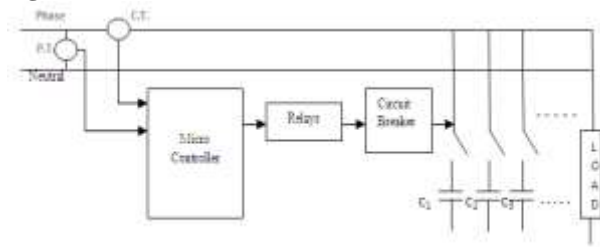


**Capacitor Switching**

## SIMULATION

Protues VSM is the simulation tool used for the analysis of the APFC system. In the design environment an interactive circuit simulation tool is Protues VSM. Any circuit with microcontroller can be drawn and simulated with the same software. For professional engineers or student ISIS produces best attractive schematics. Program written in c using Keil compiler can be linked for simulation and by changing parameters of inputs we can test possible output results before going to built up actual hardware. Figures shown are of simulation.
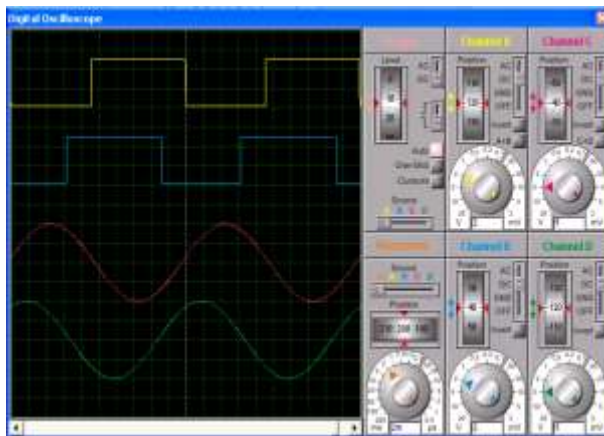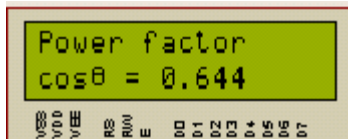
**Figure 4**:



**Simulation for APFC System.**

The values of power factor can be seen in digital form on the LCD and the corresponding waveforms are shown by the virtual oscilloscope.

## RESULTS AND DISCUSSION

The results of the simulation are shown in Figure5 and Figure6. Figure5 shows the input waveform of voltage and current with phase difference which indicates the power factor of 0.644 calculated by the micro controller. This is a very low value of power factor which is not accepted as per the standards, because it affects efficiency and cost for both supplier and consumer. Reactive power can require use of higher current capacity wiring, switches, circuit breaker, transformer, transmission lines, etc.

**Figure 5**:



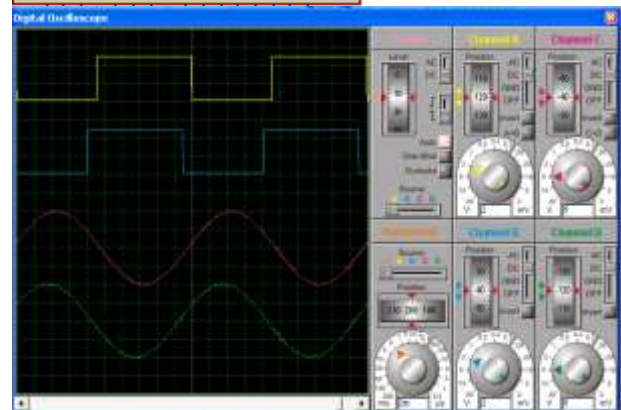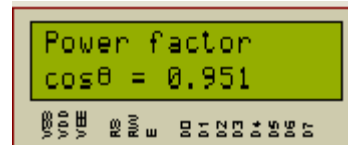**Uncorrected Power Fator Waveform.**

Figure6 shows corrected waveforms after addition of capacitive load to the system. Now, the phase

difference is minimum and the power factor value is 0.94 which is in improved form. Addition of capacitors is done one after another till we get the desired power factor level of 0.95.

First we study the industrial load for its minimum, maximum and average situations. Accordingly we decide size and values of capacitor bank to compensate the inductive load to achieve the desired power factor (which in this case is 0.95).

By installing suitable size power capacitors into the circuit the power factor is improved and the value becomes nearer to 0.9 to 0.95 thus, minimizing the losses and improving the efficiency of the plant.[4]

**Figure 6**:



**Corrected  Power Fator Waveform.**

## CONCLUSION

Power factor correction is used to adjust the power factor of an A.C. load or A.C. power transmission system to unity (1.00) through various methods. Simple methods include switching in or out banks of capacitors or inductors which add to cancel inductive or capacitive effects of load respectively.[2][5]

By observing all aspects of APFC System it is clear that to avoid power losses in power transmission line and penalty raised by the power supplier it is recommended that economical power factor correction system can be installed to get the benefit and save the energy of nation.

## REFERENCES
[1] en.wikipedia.org/wiki/power_factor_correction
[2] Barsoum, Nader (2007) "Programming of PIC Micro-Controller for Power Factor Correction" IEEE Conference on Modeling & Simulation, Pages:19-25.

[3] Tinggren, R.; Yi Hu; Le Tang; Mathews, H.; Tyner, R. (1999) "*Power Factor Controller- an Integrated Power*

[4] *Quality Device*", IEEE Conference on Transmission and Distribution, Volume: 2, Pages: 572-578.

[5] Ramasamy Natarajan (2005). "Power System Capacitors." Boca Raton, FL: Taylor & Francis.

[6] Rakendu Mandal; Sanjoy Kumar Basu; Asim Kar; Shyama Pada Chowdhury (1994) "A Microcomputer – Based Power Factor Controller", IEEE Transactions on Industrial Electronics, Volume: 41, Issue: 3, Pages: 361–371.