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Automatic Power Factor Correction Using Microcontroller

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ABSTRACT

The power factor correction of electrical loads is aproblem common to all industrial companies. Earlier the power factor correction was done by adjusting the capacitive bank manually. The automated power factor corrector (APFC) using capacitive load bank is helpful in providing the power factor correction. Proposed automated project involves measuring the power factor value from the load using microcontroller. The design of this auto-adjustable power factor correction is to ensure the entire power system always preserving unity power factor. The software and hardware required to implement the suggested automatic power factor correction scheme are explained and its operation is described. APFC thus helps us to decrease the time taken to correct the power factor which helps to increase the efficiency.

Keywords—
A.C–Alternating current, D.C–Direct Current, P.F–power factor , P.F.C-power factor correction, ZCD-Zero Cross Detectors, , P.T-Potential Transformer, Capacitor Bank

I. INTRODUCTION

POWER factor is the ratio between real power and the apparent power of the equipment. In the present trend, Automatic Power Factor Controller design can be achieved by using programmable device. As we think about programmable device embedded system comes forefront. Embedded system nowadays is very popular and microcontroller proves to be advantageous with the reduction of cost, extra hardware use such as timer, RAM, ADC are avoided. Only the relays used are disadvantageous as they are too bulky and need regular maintenance. Now the embedded technology has become cheaper with the help of technical revolution so as to apply it in all the fields.

Automatic Power Factor Correction device is very useful to improve the transmission of active power efficiently. Power factor must be maintained within a limit. As inductive load is connected, Power factor lags and when Power factor goes below the lagging Power factor, then a penalty is charged by the supplying company. Therefore, it is necessary to maintain Power factor within limit. APFC techniques can be applicable to industries, power systems and also to households to make them stable and also help in improving the efficiency of the system.

Poor Power factor can be improved by addition of Power factor correction, but a poor Power factor which is caused due to distortion in current waveform needs to have a change in the design of the equipment APFC is to be developed based on microcontroller PIC16F877A. The voltage and current sampled are connected into square wave using a Zero crossing detector and this voltage and current signals are fed to the microcontroller. APFC is designed to improve Power factor automatically whenever the Power factor falls below a certain predefined limit. As demand of electricity is increasing day by day, more and more inductive loads are being used in industries as well as household applications which are the main reason for low Power factor in Power system. Hence this creates a need to develop a technique to improve Power factor automatically. APFC provides a solution to this problem.

A. Advantages of power factor improvement

Advantages which can be achieved by employing proper power factor correction scheme are:

- Efficiency increases due to Reduction of power consumption.
- Due to reduced power consumption there will be less greenhouse gases.
- Reduction of electricity bills.
- Extra KVA available from the same existing supply.
- Reduction of I^2R losses in transformers and distribution equipment.

B. Idea to improve power factor

The basic idea For Power factor correction of a motor or circuits we have to connect an capacitor in parallel with the device which having low power factor.One of traditional method for power factor

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correction is static type compensation in which static type capacitors are used for power factor correction. However in this case care should be taken when applying power factor correction star/delta type control so that the capacitors should not subjected to rapid on-off conditions.

C. Working of Capacitors

By representing active power & reactive power at sides of right angle we can determine the apparent power from the right triangle rule:

$(KVA)^2 = (KW)^2 + (KVAR)^2$

To reduce the KVA, total current requirement for any given load, one must have to shorten the line that represents the KVAR. This is precisely what capacitors do. The ratio of actual power to apparent power is usually expressed in percentage and is called power factor.

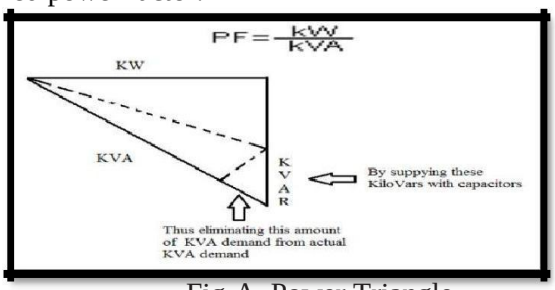

Fig-A Power Triangle

II. METHODS OF POWER FACTOR CORRECTION (P.F.C)

A. Static compensation

In this method for power factor improvement static capacitors are connected in parallel with the device which works on low power factor. These static capacitors provide leading current which eliminates lagging component of load current and improves power factor.

B. Synchronous condenser

When a synchronous motor operates at no load and at over excited condition then it is called synchronous condenser. When a synchronous condenser is over excited then it provides leading current and works like capacitor. When a synchronous condenser connected across supply then it provides leading current and partially eliminates reactive component and thus improves power factor.

C. APFC scheme

In our project, we are going to use technique which is called automatic power factor correction. This system is

based on technique of continuous monitoring of the systems parameters such as voltage and current with the use of potential transformer and current transformer respectively. Through continuous monitoring phase difference between the two quantities will be calculated continuously and depending upon phase difference correspondingly suitable amount of capacitors will be switched on or off in the system in order to improve power factor as close as unity.

As there is no moving part in capacitors hence switching losses are less as compare to that of static compensation also no extra motor is required for power factor correction and hence cost is much less as compare to that of power factor correction by synchronous condenser technique.

III. COMPONENTS, FUNCTIONAL BLOCK DIAGRAM AND SCHEMATIC DIAGRAM

A. Main components

Main components used in this scheme for automatic power factor correction using microcontroller includes following components [11].

1. Auxiliary power Supply: Transformer, Bridgerectifier, Voltage regulator IC 7805
2. Microcontroller(AT89S52)
3. LCD Display
4. Capacitor Bank
5. Potential transformer & current transformer
6. Relay & relay driver IC
7. Zero Cross Detector

B. Functional Block Diagram

Zero crossing of voltage and current waveform from line is detected by ZCD from P.T and C.T respectively. Depending upon phase difference between voltage and current microcontroller sends out the signal to switch on capacitor through relay driver IC and improves power facto

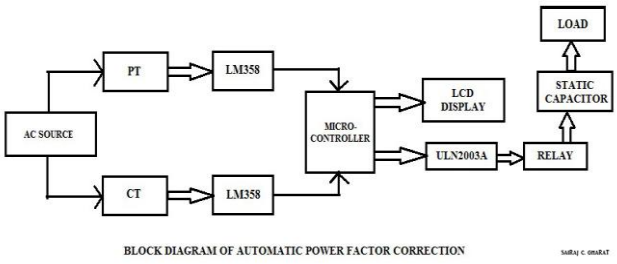

Fig B Block Diagram of System

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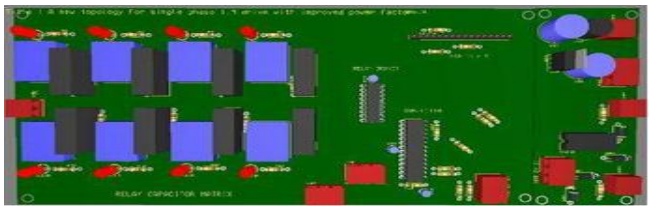

Fig-C Proposed 3-D View of System

V. FUTURE ENHANCEMENT

The automotive power factor correction using capacitive load banks is very efficient as it reduces the cost by decreasing the power drawn from the supply. As it operates automatically, manpower is not required and this Automated Power Factor Correction using capacitive load banks can be used for the industries purpose in the future. In future the project can be enhanced by using thyristor control switches instead of relay control to avoid contact pitting often encountered by switching of capacitors due to high in rush current & also, PWM techniques can be employed in this scheme. Along with power factor correction also speed control can be done in future. In future, Work can be done for harmonics reduction.

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V.CONCLUSION

This paper shows an efficient technique to improve the Power factor of a Power system by an economical way. As this method of APFC gives rise to correction of Power factor of inductive load. PFC makes system stable and due to improvement in Power factor efficiency also increases. PFC scheme can be made applicable to industries, domestic purposes. Use of microcontroller makes the APFC method more convenient and efficient.

As it operates automatically, manpower is not required and hence cost reduction takes place. In future PWM techniques can also be employed in this schemes. Along with PFC, speed control can be done in future. Work can be done for reduction of harmonics.

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