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AUTOMATIC POWER FACTOR CORRECTION AND MONITORING BY USING PIC MICROCONTROLLER

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ABSTRACT

In recent years, the power quality of the ac system has become great concern due to the rapidly increased numbers of electronic equipment, power electronics and high voltage power system. Most of the commercial and industrial installation in the country has large electrical loads which are severally inductive in nature causing lagging power factor which gives heavy penalties to consumer by electricity board. This situation is taken care by APFC. In this work the design and implementation of Automatic power factor correction and monitoring of Single Phase Power Factor using Capacitor Banks with Load Monitoring is performed in correspondence with the attached load to the system. The system will continuously monitors the load and how much lag occurred in power factor, its type and behavior of the load enduring at that time and what consequences it produces on power factor. An automatic power factor correction (APFC) Panel and measuring of power factor from load is done by using PIC microcontroller and trigger required capacitors in order to compensate reactive power and bring power factor near to unity.

Keywords - Power Factor Correction, Microcontroller, Capacitor Bank, Inductive Load.

I. INTRODUCTION

In the present technological revolution power is very precious. So we need to find out the causes of power loss and improve the power system. In some cases the amount of reactive power consumed might even exceed the amount of active power it generates. This undesirable characteristic places an undue burden on the power network [1]. Due to industrialization the use of inductive load increases and hence power system losses its efficiency. So we need to improve the power factor with a suitable method [2] .The Automatic Power factor Correction (APFC) device is a very useful device for improving efficient transmission of active power. If the consumer connect inductive load, then the power factor lags, when the power factor goes below 0.97(lag) then the Electric supply company charge penalty to the consumer. So it is essential to maintain the Power factor below with in a limit. Automatic power factor correction (APFC) device reads power factor from line voltage and line current by determining the delay in the arrival of the current signal with respect to voltage signal. This time values are then calibrated as phase angle and corresponding power factor. Then the values are displayed in the LCD module. Then the motherboard calculates the compensation requirement and accordingly switches on different capacitor banks. This is developed by using PIC microcontroller. These values of voltage, current, power factor send to PC by using serial interface cable (RS232). PC saves the record of the power factor values, voltage and current values. Automatic power factor correction techniques can be applied to the industries, power

systems and also households to make them stable and due to that the system becomes stable and efficiency of the system as well as the apparatus increases. The use of microcontroller reduces the costs.

II. SYSTEM DISCRIPTION

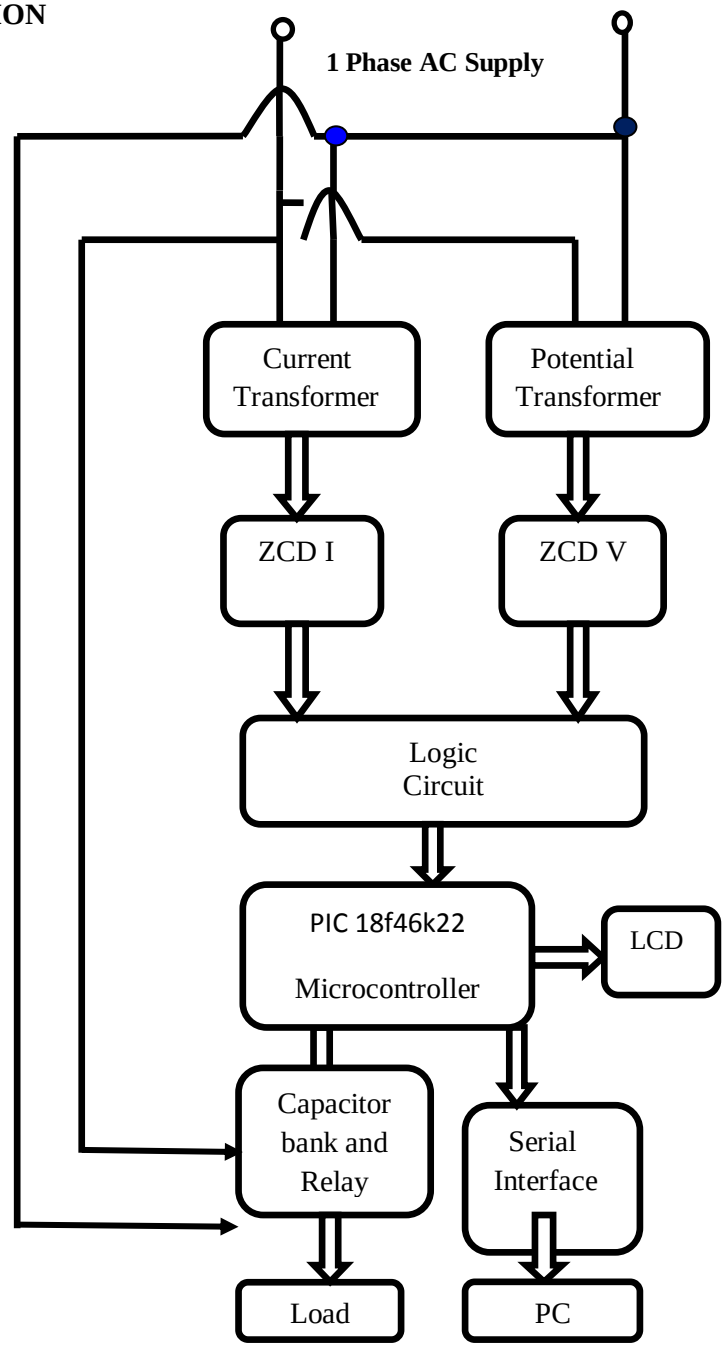

Fig.1 Automatic power factor correction and monitoring by using PIC Microcontroller

Automatic power factor correction (APFC) system is shown in Fig.1, the principal element in the circuit is PIC Microcontroller (18F46k22).The current and voltage signal are acquired from the main AC line (L) by using Current Transformer and Potential Transformer in analysis of the power factor. These acquired signals are then pass on to the zero crossing detector IC(ZCD I & ZCD V) individually that transposed both current and voltage waveforms to square-wave to make perceivable to the Microcontroller to observe the zero crossing of current

and voltage at the same time instant. Bridge Rectifier for both current and voltage signals transposes the analog signal to the digital signal. Microcontroller insure the RMS value for voltage and current used in its algorithm to select the capacitor of desired value for the load to mount the power factor and monitors the behavior of the enduring load on the basis of current depleted by the load. In case of lagging power factor Microcontroller send out the signal to switching unit (relay) that will switch on the in demand value of capacitor. The tasks executed by the PIC Microcontroller and their results i.e. lagging behavior of power factor, inset Values of necessitate capacitor and display the values of the voltage, current, power factor on Liquid Crystal Display (LCD). Same values are sending to PC to monitor the system.

III. FLOW CHART

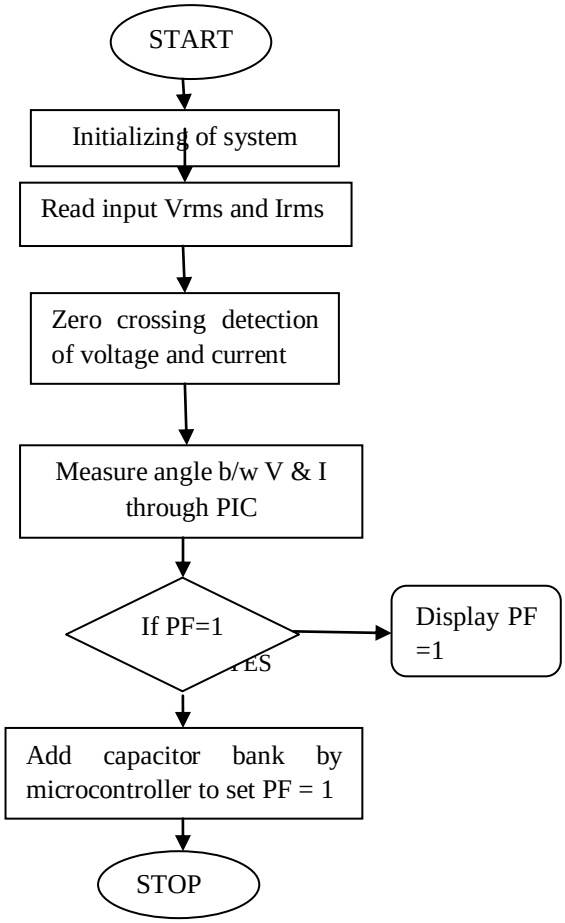

Fig. 2 Flow chart

IV. HARDWARE RESULTS

Fig 3 shows the complete hardware model of APFC. PIC microcontroller requires 5V DC supply. So, we are using step down transformer to get 230v AC to 12v DC. Then we use electrolytic capacitor to get ripple free output (pure DC). Voltage regulator is used to get required DC voltage (5v).

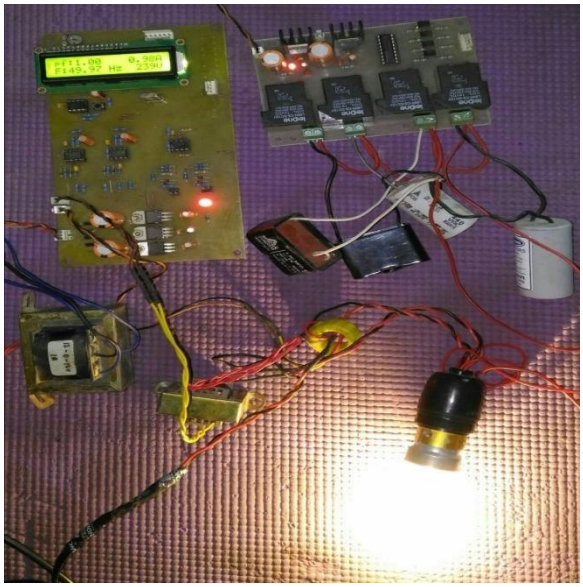

Fig. 3 Hardware model

Voltage and current signal are coming from main AC supply (230v, single phase) by using potential transformer (PT) and current transformer (CT), these are used as sensors. It senses voltage and current and then it is given to the comparator. In comparator ZCD (I) and ZCD (V) individually transposes both current and voltage waveform to square wave to make perceivable to microcontroller to observe the current and voltage at same time instant. And PIC microcontroller calculates the power factor of load. In case of low power factor microcontroller sends the signal to switching circuit which is nothing but the relay. After that, relay will operate and it adds the capacitor bank in the circuit to correct the power factor near to or equal to reference power factor value(1). The status of APFC system is displayed on the LCD such as lagging, calculated power factor as well as voltage and current.

Case1:

When resistive load is ON, as shown in Fig.4 there is no phase delay between current and voltage signals and they are in phase. In this case the power factor is 1, so there is no insertion of capacitors.

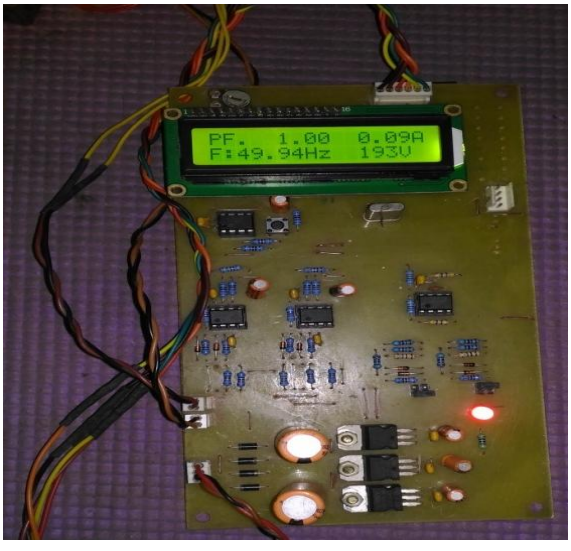

Fig. 4 Hardware model with resistive load

Case 2:

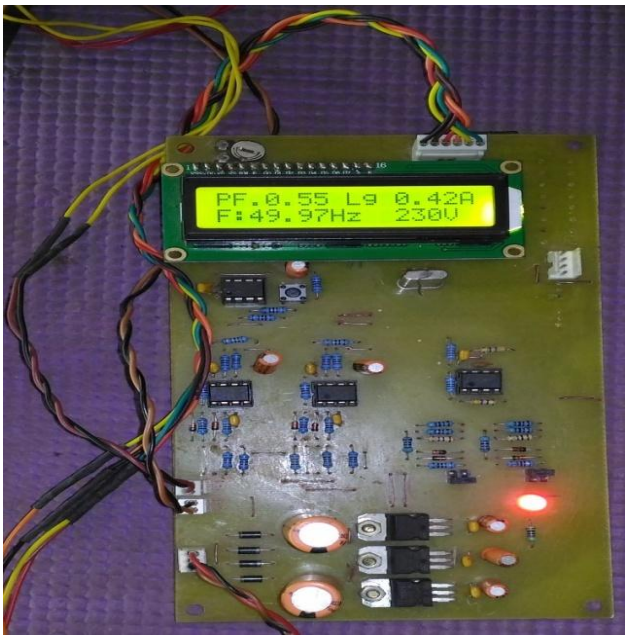

Fig.5 Hardware model with inductive load

Consider a case in which an inductive load (chock), is connected so, there is phase delay in between current and voltage signals. PIC Microcontroller senses the delay produced by the load, and calculates the power factor which is lagging in nature as shown in fig.5

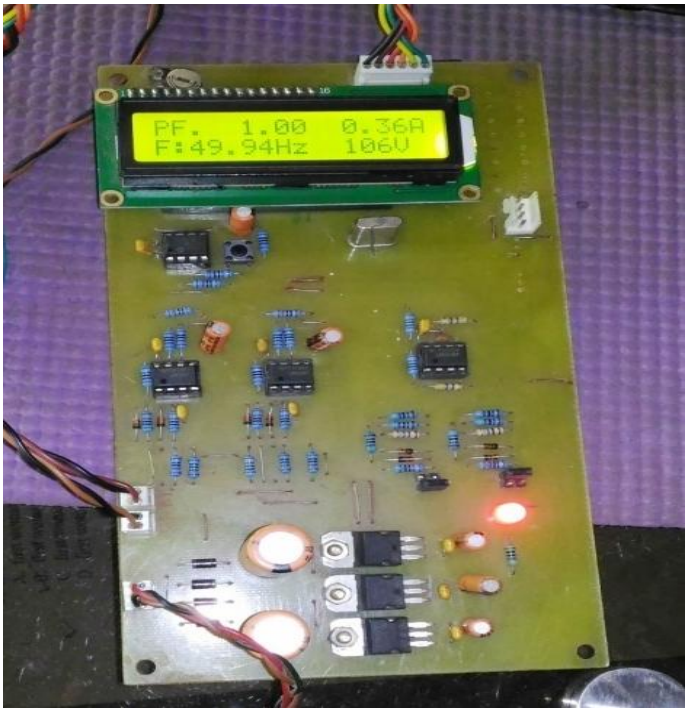

Fig.6 Hardware model with inductive load (corrected pf)

According to the phase delay in signals, microcontroller takes the intelligent decision and adds the desired value of capacitor and correct pf as shown in Fig 6.

V. RESULT

Before APFC circuit insertion,

Load	Watt	Voltage	Current	PF(Before APFC Circuit)
Resistive	25 w	230 v	0.09 A	1.00
Inductive	108 w	230 v	0.42A	0.55

After APFC circuit insertion,

Load	Watt	Voltage	Current	PF(After APFC Circuit)
Resistive	25 w	193 v	0.09 A	1.00
Inductive	108 w	106 v	0.36 A	1.00

Result,

Load	Power Factor	
	(Before APFC Circuit)	(After APFC Circuit)
Resistive	1.00	1.00
Inductive	0.55	1.00

VI. FUTURE WORK

The automatic 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 are not required and this Automated Power factor Correction using capacitive load banks can be used for the industries purpose in the future. In future 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.

VII. CONCLUSION

This project work is an attempt to design and implement the power factor controller using PIC microcontroller. PIC monitors voltage and current continuously and according to the lagging power factor it takes the control action. By observing all aspects of the power factor it is clear that power factor is the most significant part for the utility company as well as for the consumer. By installing suitably sized power capacitors into the circuit the Power Factor is improved and the value becomes nearer to 0.95 to 1. Benefits of increasing a low power factor include eliminated or reduced power factor charges on utility bills, more efficient operations with increased

capacity and reduced current draw, thus improving the efficiency of a plant. This thesis gives more reliable and user friendly power factor controller. This thesis makes possible to store the real time action taken by the PIC microcontroller. This thesis also facilitates to monitor the power factor changes on LCD in real time.

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