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Automatic Power Factor Correction Using Pic Micro-Controller

#1Kulkarni Kaumudi, #2Kumbhar Pooja, #3Patil Priyanka, #4Prof.Madhuri Namjoshi.

[1]kaumudikulkarni28@gmail.com
[2]pooja.kumbhar2@gmail.com
[3]patilapriyanka222@gmail.com

#123Department of Electrical Engineering
#4Prof. Department of Electrical Engineering

Jayawant Shikshan Prasarak Mandal's
Bhivarabai Sawant Institute Of Technology &Research, Wagholi, Pune -412207

ABSTRACT

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. 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. Whenever we are thinking about any programmable devices then the embedded technology comes into force front. The embedded is now a day very much popular and most the product are developed with Microcontroller based embedded technology. Automatic power factor correction 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 modules. Then the motherboard calculates the compensation requirement and accordingly switches on different capacitor banks. This is developed by using microcontroller. 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.

Keywords : **power factor correction, zéro cross détection (ZCD), microcontroller, capacitor Bank, inductive load.**

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I. INTRODUCTION

In the present scenario of technological revolution it has been observed that the power is very precious. The industrialization is primarily increasing the inductive loading, the Inductive loads affect the power factor so the power system losses its efficiency. There are certain organizations developing products and caring R&D work on this field to improve or compensate the power factor. In the present trend the designs are also moving forwards the miniature architecture; this can be achieved in a product by using programmable device. Whenever we are thinking about any programmable devices then the embedded technology comes into force front. The embedded is now a day very much popular and most the product are developed with Microcontroller based embedded technology. The advantages of using the microcontroller is the reduction of the cost and also the use of extra hardware such as the use of timer RAM and ROM can be avoided. This technology is very fast so controlling of multiple parameters is possible; also the parameters are field programmable by the user. The electrical engineering and its applications are the oldest streams of Engineering. Though these systems are quite reliable and cheaper, it has certain disadvantages. The electro mechanical protection relays are too bulky and needs regular maintenance. The multifunctional is out of question. Recently, the technical revolution made embedded technology cheaper, so that it can be applied to all the fields. The pioneer manufactures of Power system and protection system such as simens, larson & tubro, and cutler hamper etc. manufacturing power factor improvement devices on embedded technology. The Automatic Power factor Correction 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 device reads the power factor from line voltage and line current, calculating the compensation requirement switch on different capacitor banks.

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II. PROPOSED SYSTEM

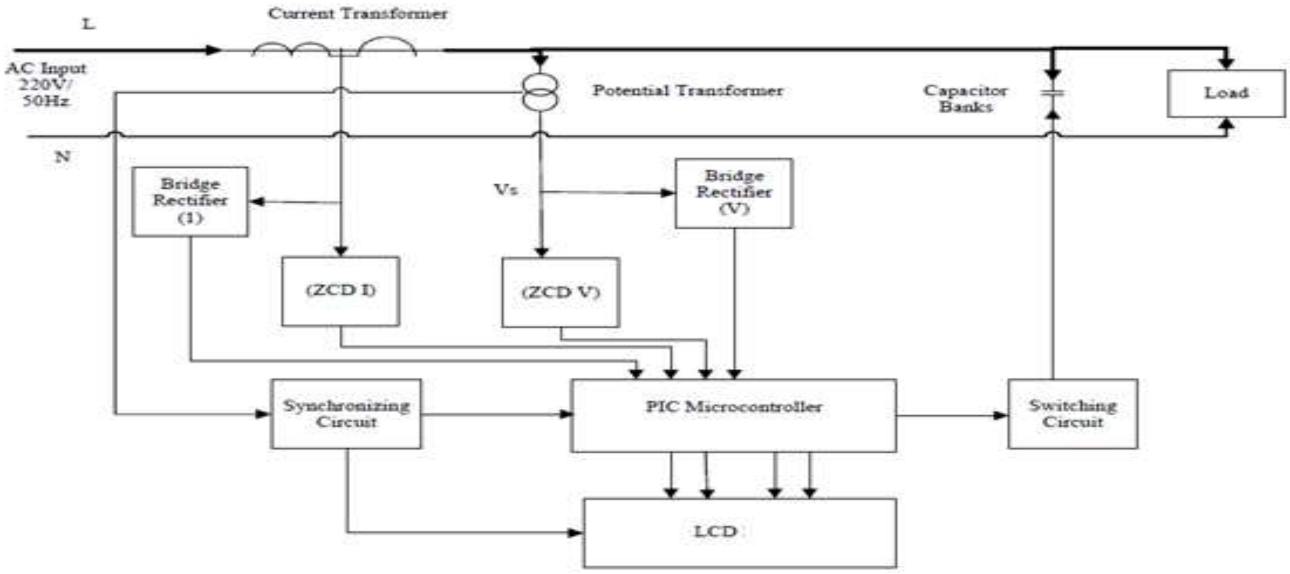

Fig 1. Block Diagram of APFC

Microcontroller base automatic controlling of power factor with load monitoring is shown in above figure. The principal element in the circuit is PIC Microcontroller that manipulates with 8 MHz crystal in this scheme. The current and voltage signal are coming from the main AC supply by using Current Transformer and Potential Transformer. 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. Microcontroller read the RMS value for voltage and current used in its algorithm to select the value of capacitor for the load to correct the power factor and monitors the behavior of the load on the basis of current depleted by the load. Synchronizing circuit is developed to synchronize the zero cross detection circuit, Microcontroller and LCD with incoming supply voltage. In case of low power factor Microcontroller send out the signal to switching unit (relay). Then relay will operate and it adds the capacitor bank in circuit. The tasks executed by the Microcontroller for correcting the low power factor by selecting the capacitor and load monitoring are shown in Liquid Crystal Display (LCD).

III. CALCULATION

- Vrms and Irms are read by the Microcontroller using ADC ports.
- After the zero crossing of voltage and current signals, which are converted to square-waves, are provided to Microcontroller.
- Power Factor is measured by the Microcontroller from manipulating of capture module for V and I signals.
- Real Power is measure as

$$P = I_{rms} V_{rms} \cos\varphi \qquad (1)$$

- For angle detection by taking the cos inverse of phi(φ) and getting the angle theta (θ).
  Set the Phi (φ2) as a reference value equal to1.00.and taking the cos inverse of 1.00 getting reference theta ($\theta 1$).
- From the power angle diagram, the reactive power (VAR) utilized in circuit is given as:

$$VAR_1 = P \times \tan\theta \qquad (2)$$

- For reference VAR

$$VAR_2 = P \times \tan\theta_1 \qquad (3)$$

- Required reactive power of the load is:

$$VAR = VAR_1 - VAR_2 \quad (4)$$

- Current required for new VAR by load is:

$$I_{required} = VAR / V_{rms} \quad (5)$$

- Required value of impedance X_c is:

$$XC = V_{rms} / I_{required} \quad (6)$$

- Required capacitor to improve the power factor for Inductive load is given as:

$$C = 1 / 2\pi f X_c \quad (7)$$

IV. FLOW CHART

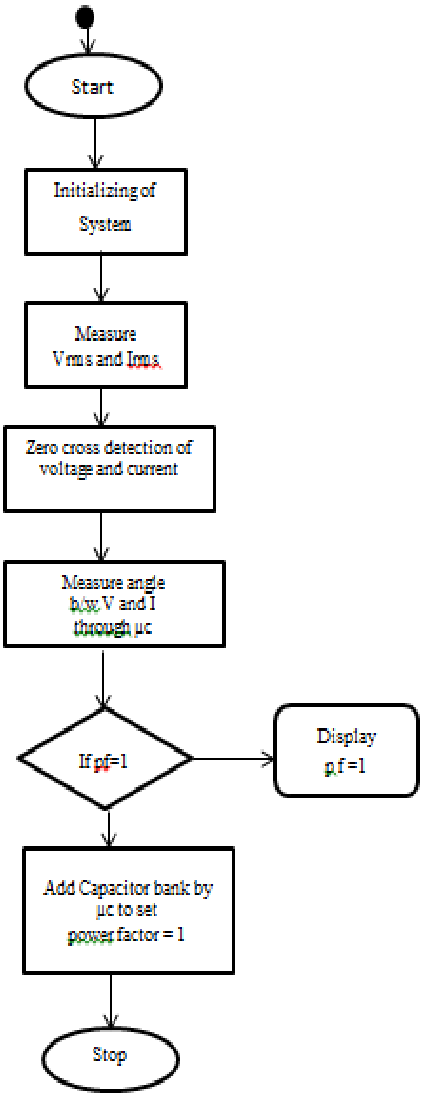

Fig 2. Flow chart

V. HARDWARE AND RESULT DISCUSSION

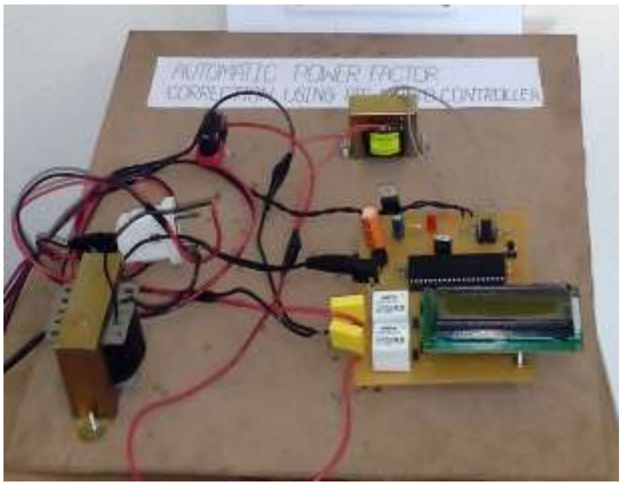

Fig 3 Hardware model with inductive load

Above fig 3 shows the complete hardware model with inductive load. 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. PIC microcontroller requires 5V DC supply. So, we are using adapter to convert 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). This 5v supply is required to microcontroller. In PIC microcontroller we already set the reference power factor value i.e. 1.00.Also PIC microcontroller calculates the power factor of load and it compares load power factor with reference power factor value. 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.

Fig 4. Final Result

So, we have calculated load power factor (i.e before pf) and corrected power factor (i.e after pf). These both power factor values are displayed on LCD screen as shown in fig 4.

VI. CONCLUSION

This project work is carried out to design and implement the automatic power factor controlling system using PIC Microcontroller (16F877A). PIC Microcontroller senses the power factor by continuously monitoring the load of the system, and then according to the lagging behaviour of power factor due to load it performs the control action through a proper algorithm by switching capacitor bank through different relays and improves the power factor of the load. This project gives more reliable and user friendly power factor controlling system by continuously monitoring the load of the system.

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