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Automatic Power factor Compensation Using Microcontroller

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Abstract: In the present technological and industrial revolution, electrical power is more essential and very precious. So we need to find out the causes of power loss and improve the efficiency of the power system by reducing it. Due to industrialization the use of inductive load has increased and hence power systems had loosed its efficiency. So we need to improve the power factor with a suitable method.

Automatic power factor correction device reads the power factor from line voltage and line current by determining the delay in the arrival of the current signal with respect to voltage signal from the AC mains with high accuracy by using an internal timer. This time values are then calibrated as phase angle and corresponding power factor. Then the microcontroller calculates the compensation requirement and accordingly switches on different capacitor banks. Automatic power factor correction techniques can be applied to the IT industries, power systems and also house-holds to make them stable and due to that the system becomes stable and increases the efficiency of the system.

Keywords: Power factor correction, PIC Microcontroller, ZCD

I. INTRODUCTION

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 0.9(lag) then the Electric supply utility charge penalty to the consumer. In some cases the amount of reactive power consumed might even exceed the amount of active power. This undesirable characteristic places an undue burden on the power network [1].So it is essential to maintain the Power factor with in a limit. Automatic Power factor correction device reads the power factor from line voltage and line current [2], calculating the compensation requirement; switch on different capacitor banks automatically by use of the microcontroller [3] [4].

A poor power factor can be the result of a significant phase difference between the voltage and current at the load terminals. Poor load current, phase angle is generally the result of an inductive load such as an induction motor, power transformer, lighting ballasts, and welder or induction furnace. [5]

A. Types of power

1) *True Power:* The actual amount of power being used, or dissipated, in a circuit is called true power. It is measured in watts and is symbolized mathematically by the capital letter P. True power is a function of the circuit's dissipative elements, such as resistances (R).
2) *Reactive Power:-* Reactive loads such as inductors and capacitors dissipate zero power, but the fact that they drop voltage and draw current gives the perception that they do dissipate power. This "dissipated power" is called the reactive power and is measured in Volt-Amps-Reactive (VAR).Reactive power is represented by the capital letter Q, and is a function of a circuit's reactance (X).
3) *Apparent Power:-* The combination of true power and reactive power is called apparent power. It is the product of a circuit's voltage and current, without reference to phase angle. Apparent power is measured in the unit of Volt-Amps (VA) and is symbolized by the capital letter S. Apparent power is a function of a circuit's total impedance (Z).

B. Power factor satisfaction Based on Above Types

Power system loads consist of resistive, inductive, and capacitive loads. Inductive and capacitive loads are opposite in nature. Equal amounts of inductive and capacitive loads within the same system will offset each other leaving only real power. This is defined as a power factor of 1 or unity. When a unity power factor is achieved the real power (KW) or demand is equal to the apparent power (KVA). Achieving a unity power factor will provide the most efficient power system. In a purely resistive circuit, all circuit power

is dissipated by the resistor, voltage and current are in phase with each other, and the true power is equal to the apparent power. In a purely reactive circuit, no circuit power is dissipated by the load. Rather, power is alternately absorbed from and returned to the AC source. Voltage and current are 90^o out of phase with each other, and the reactive power is equal to the apparent power.
In a circuit consisting of both resistance and reactance, there will be more power dissipated by the load than returned, but some power will definitely be dissipated and some will merely be absorbed and returned. Voltage and current in such a circuit will be out of phase by a value somewhere between 0^o and 90^o. The apparent power is vector sum of the true power and the reactive power.

C. Definition

1) *Power Factor:* In power systems, wasted energy capacity, also known as poor power factor, is often overlooked. It can result in poor reliability, safety problems and higher energy costs [2]. The lower your power factor, the less economically your system operates. Power factor is the ratio between the real power and the apparent power drawn by an electrical load. Like all ratio measurements it is a unit-less quantity and can be represented mathematically as:

$$PF = \frac{KW}{KVA}$$

Where PF=power factor,
KW= the real power
KVA= apparent power

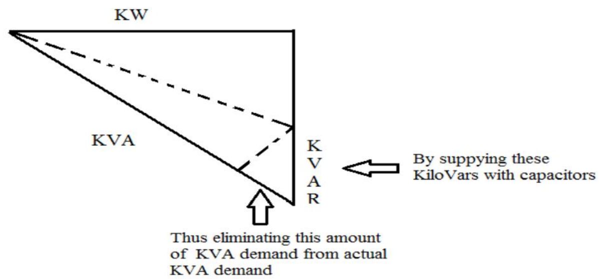


Fig-1 Power Triangle

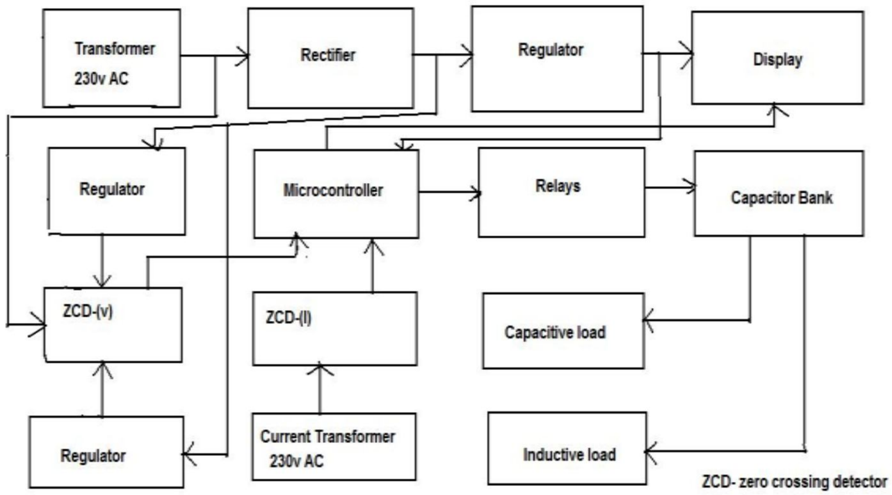
D. Reactive Power

In an inductive load, such as a motor, active power performs the work and reactive power creates the electromagnetic field. PF ≤ 1.0 Usually P.F is always “Lag” (Inductive) Sometime P.F can be “Lead” (Capacitive).

II. SYSTEM WORKING PRINCIPLE

A. Micro Controller

Here we are using PIC microcontroller like a small computer. In this paper it is actually behave as a converter to convert analog signal from zero crossing detector in to digital signal. PLC does not accept analog signal so that we convert to digital signal by using micro controller. It is very fast in action.



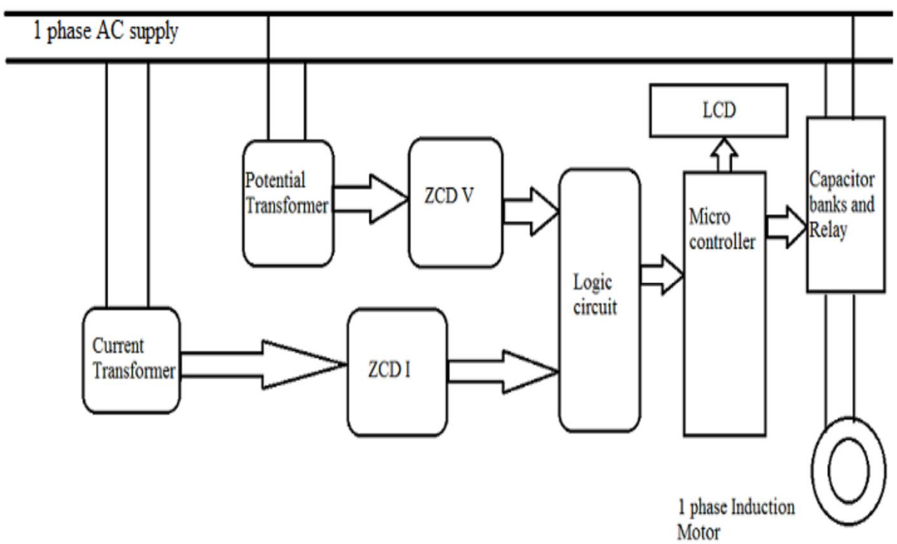


Fig.2 system Block Diagram

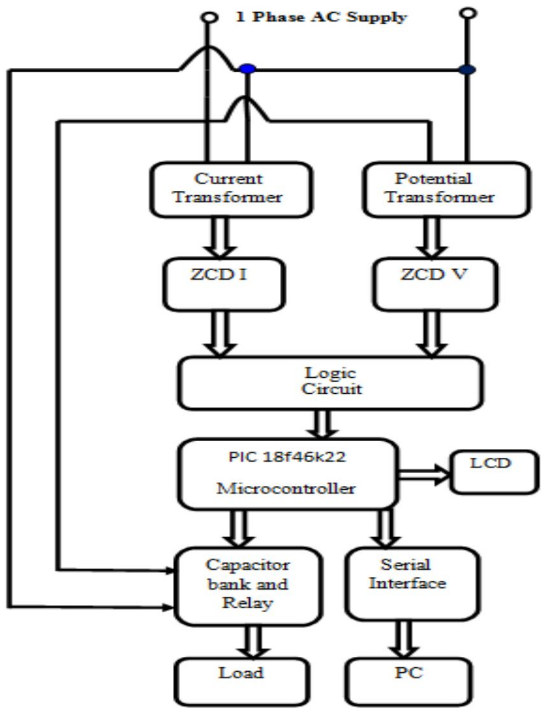


Fig.3. Automatic power factor correction by using PIC Microcontroller

B. Zero Crossing Detectors

The zero crossing detector is actually a detector, it detects the signals which crosses the zero first and it also known as a sine-wave to square wave converter, If input signal is a low frequency signal .then output voltage will be less quick to switch from one saturation point to another and there is no in between the two input nodes, the output may fluctuate between negative and positive saturation voltage.

In this paper power factor control, the power factor mainly depends on the current and voltage signals position if the current signal first crosses the zero it's a leading power factor otherwise it's a lagging power factor the role of the detector is to detect whether the current or voltage signal, which crosses the zero first is detected by the zero crossing detector.

The proposed power-factor correction scheme was implemented and tested in the laboratories. The supply voltage used was a 220-V, 50-Hz, single-phase. The output at ZCD for voltage detector circuit is 5.4 v

III. CONCLUSION

It can be concluded that 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. Care should be taken for overcorrection otherwise the voltage and current becomes more due to which the power system or machine becomes unstable and the life of capacitor banks reduces.

IV. FUTURE ENHANCEMENTS

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 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. In future, Work can be done for harmonics reduction.

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