Automatic Power Factor Correction to reduce the power requirement

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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 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 efficiency of the system.

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 0.97(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.

A] Types of power

i] 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).

ii] 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).

iii] 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° 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° and 90°. The apparent power is vector sum of the true power and the reactive power.

C] Definition 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. 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:

\[
\text{Power factor (PF)} = \frac{\text{TruePower}}{\text{ApparentPower}}
\]

Equation 1

where

PF=power factor,

kW= the real power

KVA= apparent power

D) Reactive power
In an inductive load, such as a motor, active power performs the work and reactive power creates the electromagnetic field.

\[ \text{PF} \leq 1.0 \]

Usually P.F is always “Lag” (Inductive)
Sometime P.F can be “Lead” (Capacitive).

II. BLOCK DIAGRAM

In addition, harmonic problems can be introduced if the capacitors are not sized with the specific power system characteristics in mind. The utility company may also restrict or deny the introduction of KVARs into their power system. These are all considerations that need to be addressed prior to making any decisions about the size or type of power factor correction.

The method of power factor correction is the use of a variable capacitor bank. This bank would be connected just like the fixed bank. The advantage of the variable capacitor bank is that the bank monitors the system power factor and automatically regulates the amount of capacitive load connected to the system to offset the inductive load. Since the capacitive load is regulated, there would be no conflict with the utility. The variable capacitor banks normally come with internal protection, provide space for additional banks, and provide a centrally located easily maintained unit. The draw backs to the variable capacitor bank are an increased chance of harmonic problems due to the variations in capacitance, initial cost, and maintenance costs of internal parts used for capacitor switching.

IV. SOFTWARE SYSTEM DESIGN

A. Proposed Algorithm :-

i) Altering phase of two signals:

Step-1:- Timer0 set and run till Timer1 is set or vice-versa.

Step-2:- Two signals (current & voltage) are introduced.

Step-3:- Phase angle between the two signals altered by incrementing or decrementing delay between two.

Step-4:- Delay of 0.1 ms is given while incrementing or decrementing.

Step-5:- Accumulator stores the number of incrementing or decrementing operations.

Step-6:- Delay is called according to the number stored in the accumulator.

Step-7:- The signals, altered in phase are sent to the motherboard for power factor calculation.

ii) Phase angle Detection:

Step-1:- Microcontroller started on interrupt mode.

Step-2:- INTX0 & INTX1 are enabled.

Step-3:- INTX0 given VOLTAGE (V), INTX1 given CURRENT (I)

Step-4:- Timer measures time interval between two interrupts.

Step-5:- Time interval calibrated as 0-5ms = 0-90 degree.
V. EXPERIMENTAL WORK
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

Figure 2

The output at ZCD for current detector circuit is 5.4 V

Figure 3

The phase difference between current and voltage is 40 deg

Therefore power factor is 78%

Figure 4

After correction power factor was 94% approx

The result obtained gives the power factor approx.

VI. 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.

VII. REFERENCE

