Automatic Power Factor Controller With GSM

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Abstract- *In an electrical power systems, a load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred. In this 21st century, power quality has become one of the greatest concerns due to the rapidly increased number of industries and consumers who primarily depend on inductive loads and distortion inducing electronic equipment etc. Ultimatum of all these industries and consumers are lesser transmission efficiency and increase in line losses in transmission lines. In order to reduce line losses and improve the transmission efficiency, power factor correction has been suggested as one of the effective measures. This marked the development of many control methods for the Power Factor Correction (PFC). In this thesis we describe the design and development of microcontroller based automatic single-phase power factor correction along with a protective circuit to activate the relays when the power factor cannot be compensated. Also a message is sent to the user via GSM in case the required power factor is not attained. This thesis revolves around measurement of power factor using PIC (Peripheral Interface Controller) microcontroller and then using proper algorithm to switch on and off the capacitor bank in order to attain nominal power factor specified by the utilities.*

Keywords- Capacitor Bank,Microcontroller, Relays.

I. INTRODUCTION

Power factor for the sake of simple definition is the ratio between the real power and the apparent power drawn by an electrical load and this ratio can vary between 0 and 1. The ratio which we have defined above is not a mere theoretical quantity which can be confined to books. It is a quantity that has got wide range of significance in real world day to day phenomena. It is a measure of how effectively the current is being converted into useful work output and more particularly is a good indicator of the effect of the load current on the efficiency of the supply system. Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit.Due to energy stored in the load and returned to the source, or due to a non-linear load that distorts the wave shape of the current drawn from the source, the apparent power will be greater than the real power. In an electric power system, a load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred.The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor. Linear loads with low power factor (such as induction motors) can be corrected with a passive network of capacitors or inductors. Non-linear loads, such as rectifiers, distort the current drawn from the system. In such cases, active or passive power factor correction may be used to counteract the distortion and raise the power factor. The devices for correction of the power factor may be at a central substation, spread out over a distribution system, or built into power- consuming equipment. When an electric load has a PF lower than 1, the apparent power delivered to the load is greater than the real power that the load consumes voltage Basically, this control scheme is a static power factor correction method by continuous voltage or current control of a capacitor. In this work the voltage across the capacitor is being changed by a bi-directional switch to control the magnitude compensating capacitor current and thereby attaining unity power factor.

II. OBJECTIVES AND PROBLEM STATEMENT OF PROJECT

There are four objectives of this project, which is stated in the following texts:

- To learn the way of power factor correction in power systems.
- To learn and identify methods to control capacitor banks.
- To provide an automatically controlled PFC unit that will bring the power Factor to as near to unity as practical (typically0.9) and have sufficient capacity for future PFC requirements or expansion.

A. Problem Statement

This project is developed to improve the weakness of static capacitor bank. Static capacitor bank is a traditional method was used to improve the power factor by using capacitor bank. In the configuration of static capacitor bank, the value of capacitor was fixed and cannot to control.

B. Operation

Capacitive compensation does not change according to increase or reduction in loads.Could not detect load rating that change in efficiency. Operation and power factor correction not optimized.

III. BLOCK DIAGRAM

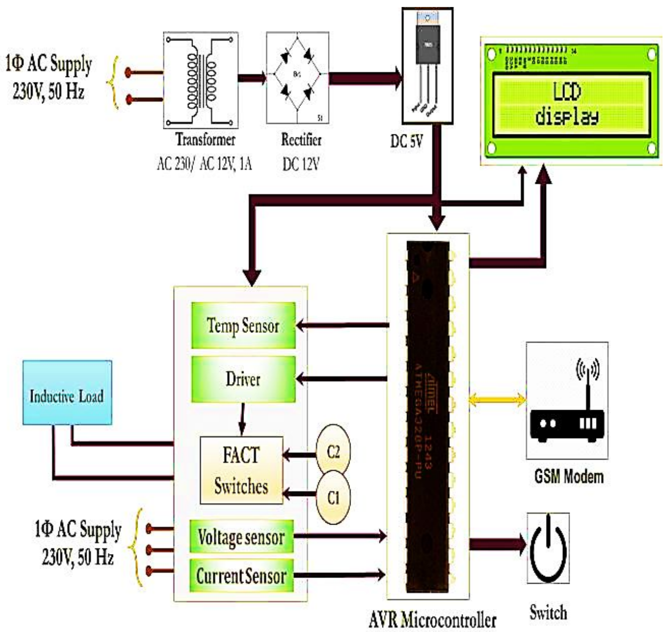

Fig1: Block Diagram of APFC System

The input to the circuit is given from the regulated power supply.The AC input i.e. 230V from the mains is step down by transformer to12V and is fed to the rectifier. The output obtained from the rectifier is a pulsating DC voltage. So in order to get a pure dc voltage, the output voltage from the rectifier is fed to a filter to remove any AC components present even after rectification. The supplied voltage and current signals taken through potential transformer and current transformer. The two sinusoidal waveforms are given to ADC pins of microcontroller and active and apparent power is calculated and thus power factor is calculated. It controls the capacitor bank as required to compensate for leading or lagging power factor.If required compensation is not obtained after adding the capacitors, an alert is sent to the user's mobile via GSM.

Case Study of Inductive Load

Given:- 400V,50Hz,3ph,100HP(74.6KW)
0.75p.f lag, efficiency 93%

Original p.f: $\cos\phi 1=0.75$ lag,
Desired pf : $\cos\phi 2 =0.95$ lag
Input P= =80KW
Leading kVAR taken by capacitor bank = P(tan ϕ1-tan ϕ2)
=44.25 kVAR
Phase current of capacitor,
$I_{cp}=2\pi fC\, V_{ph}$
= 125600 C Amp
KVAR/phase =50240
C =293.4μf

A. Power factor

Power factor is the ration between the KW and the KVA drawn by an electrical load where the KW is the actual load power and the KVA is the apparent load power. It is a measure of how effectively the current is being converted into useful work output and more particularly is a good indicator of the effect of the load current on the efficiency of the supply system.

All current will cause losses in the supply and distribution system. A load with a power factor of 1.0 result in the most efficient loading of the supply and a load with a power factor of 0.5 will result in much higher losses in the supply system. A poor power factor can be the result of either a significant has difference between the voltage and current at the loadTerminals, or it can be due to a high harmonic content or distorted/discontinuous current waveform. Poor load current phase angle is generally the result of an inductive load such as an induction motor, power transformer, lighting ballasts, welder or induction furnace.

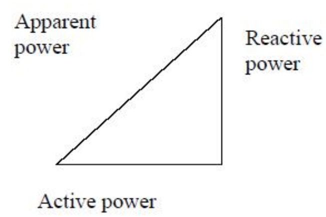

Fig.6: Power factor

B. Power factor correction:

Capacitive Power Factor correction is applied to circuits which include induction motors as a means of reducing the inductive component of the current and thereby reduce the losses in the supply.

There should be no effect on the operation of the motor itself. An induction motor draws current from the supply that is made up of resistive components and inductive components.

The resistive components are:

1. Load current
2. Loss current

The inductive components are:

1. Leakage reactance.
2. Magnetizing current.

III. SIMULATIONAND OBSERVATIONS

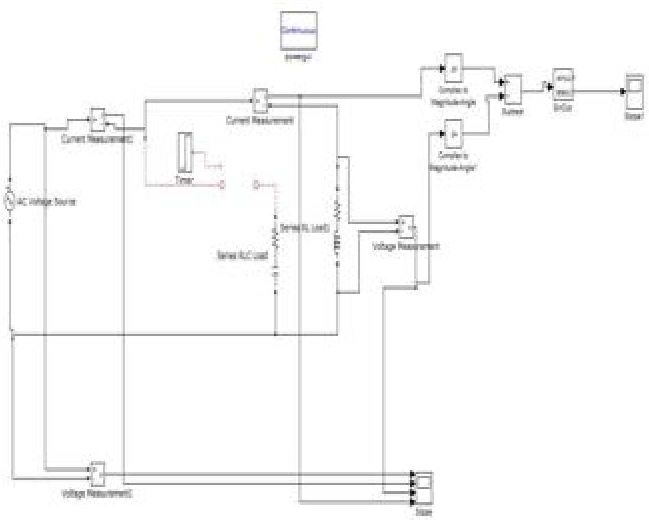

Fig.2: Simulation of Inductive Load Without Capacitor Bank

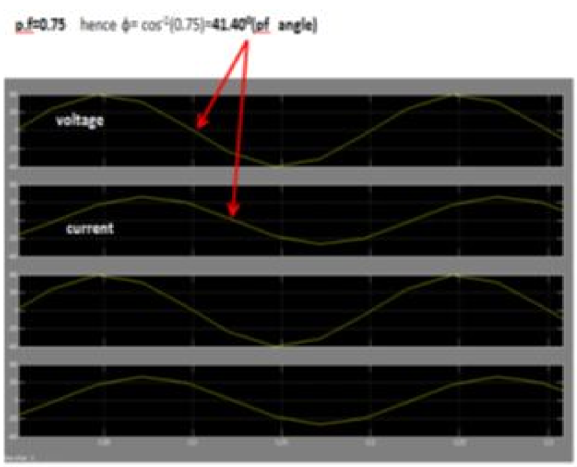

Fig.3: Simulation Result of System (WITHOUT CAPACITOR BANK)

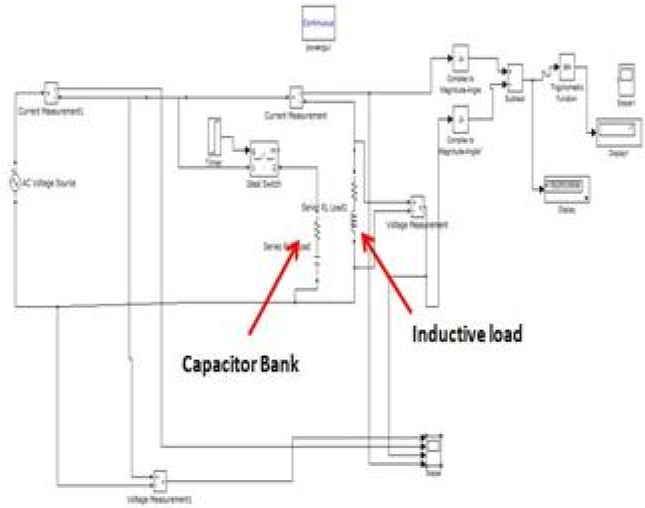

Fig.4: Circuit diagram of system (with capacitor bank)

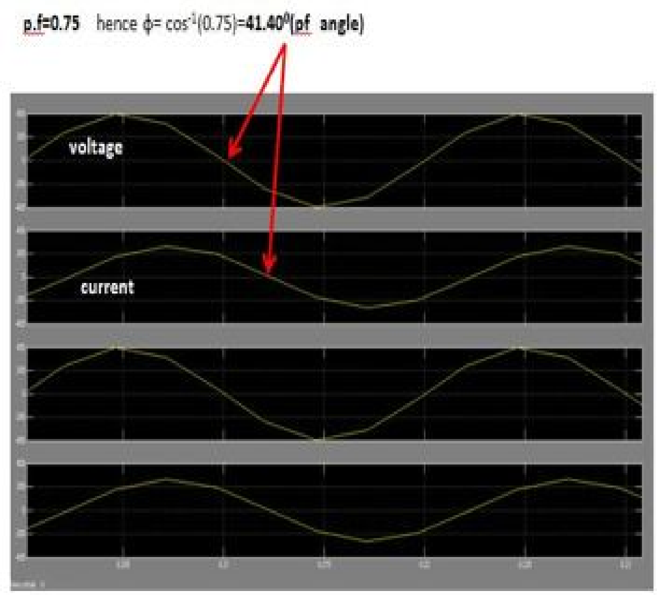

Fig.5: Simulation Result of System (WITHCAPACITOR)

IV. CONCLUSION

This is work is an attempt to design and implement the APFC system using PIC microcontroller. PIC continuously monitors the power factor and then according to the lagging and leading power factor it takes the control action. This thesis also gives the further modification of GSM system. When required compensation is not achieved, message is sent to the user via GSM and corrective action is taken accordingly.

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