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Effect of Increasing Power Factor in Industries

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Abstract

Many inductive motors used in industrial settings draw inductive current, which causes the inductive current power factor to go below the permitted limit of 0.95–1%. Industries face penalties and higher losses or costs if the power factor falls below this threshold. Therefore, the goal of this project (paper) is to increase power factor while lowering costs, minimizing penalty charges, and reducing losses. Using a microprocessor, the Automatic Power Factor Correction Technique does this. The ratio of apparent power to real power is known as the power factor. Real power is often referred to as active power since it is helpful. Reactive power is the non-working power produced by an inductive load and a magnetic field.

Keywords: *Automatic of Power Factor Correction, Apparent Power, Microcontroller, ZCD, Capacitive Bank, Inductive Load.*

1. Introduction

Majority of the loads in the industries are highly inductive in nature such as induction motors, AC/DC drives, welding machines, arc furnaces, fluorescent Lightings, electronic controls and computers.

There may be a few resistive loads for heaters and incandescent bulbs. Very rarely industries may have capacitive loads such as synchronous motors [3]. This type of loads draws inductive current. Due to this inductive current power factor decreases. For a load with a low power factor more current required compared with a load with high power factor for the same amount of useful power transferred. If more current is drawn by the load, it affects different factors such as increasing losses, increases cost [1].

Low power factor is usually not that much of a problem in residential homes. It does however become a problem in industry where multiple large motors are used. So there is a requirement to correct the power factor in industries. Generally the power factor correction capacitors are used to correct this problem [4].

2. Disadvantage of Low Power Factors

1) Reduces the KVA capacity of the electrical equipment like transformer.
2) Increases losses.
3) Voltage level at load end is reduced (poor voltage regulation).
4) Deteriorates the performance of the motors, generator and transformer (reduce the efficiency of motor, transformer; reduce illumination of incandescent lamp etc.).
5) Increases the thermal stresses into the electrical equipment.
6) Reduces the useful life of equipment.
7) Increase the power factor penalty and maximum demand charges.
8) Increases the size of conductors, circuit breakers, alternators etc.

Power factor improvement is hence necessary to overcome the various power losses and enhance the performance of the electrical equipment [5].

3. Source / Cause of Low Power Factor

There are many causes of low power factor. Major are:

1) Induction motors

2) Transformer.
3) Arc furnace.
4) EM ballast.
5) Arc welders.
6) Alternator.
7) Magnetic levitation.
8) Rewound motors may reduce the pf due to increase in air-gap, change the materials and size of conductors etc.
9) Induction heating.
10) HPMV/HPSV Lamps.
11) Over rating of equipment: if the induction motor is oversized, than power factor is reduced because it runs at lower load than rated load.
12) Increase in system voltage: during off-peak period the load is decreased but system voltage is increased.

Hence due to this high voltage, magnetizing current in transformer, induction motor etc increase which leads to increase the KVAR and power factor is reduced [5].

4. Benefit of Power Factor Correction

Main benefits of correcting the power factor are:
1) Reduce Utility Power Bills.
2) Increase System Capacity.
3) Improve System Operating Characteristics (Gain Voltage).
4) Improve System Operating Characteristics (Reduce Line Losses) [5].

5. Type of Power Factor Correction

- Distributed PF correction.
- Group PF correction.
- Centralized PF correction.
- Combined PF correction.
- Automatic PF correction.

6. Proposed Method

6.1. Automatic Power Factor Correction

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 from the power supply with high accuracy by sing 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 industries to make them stable and due to that the system becomes stable and efficiency of the system increases. The use of microcontroller reduces the costs. [2].

7. Block Diagram of Complete System

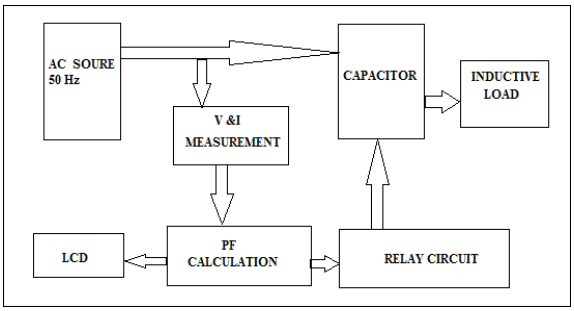

Figure 1: Block diagram for Monitoring PFC

8. Methodology

Block diagram of microcontroller based PFC is shown in fig1. Whole system may be divided into three stages. First stage is concern with the conversion of incoming voltage and current into the microcontroller level voltage (e.g. 5V). Here we have to use the step down arrangement like step down transformer. Second stage is concerned with zero crossing level detection for voltage and current, the incoming signals. Voltage signal can be acquired by the output of Potential Transformer for detection. Current signal can be acquired by using Current Transformer connected at main AC line. In third stage block diagram represents the Automatic power factor control with continuously load monitoring of the system. In this stage we calculate the phase angle between current and voltage that is continuously displayed on LCD.

The digital voltage and current signal so acquired are processed in the microcontroller with the help of appropriate algorithm realized in its software. The main part of the circuit is microcontroller (Atmega8) with crystal of 8MHz for power factor calculation, relay circuit, capacitor, voltage and current measurement unit, and inductive load. 50Hz Ac

supply is connected to the lamp and capacitor start induction motor. Current transformer and potential transformer are used to reduce current and voltage levels for zero crossing detectors. The zero crossing detects or is a device for detecting the point where the voltage crosses zero in either direction the measured voltage or current signal are given to RC0; RC1 pin of microcontroller . Microcontroller calculate the power factor of measured values, depends upon Error it will send signal to relay .LCD display is used to display power factor value of the line continuously. When relay energized by microcontroller it connect capacitor parallel with load, when relay de energized it disconnect the capacitor from the line.

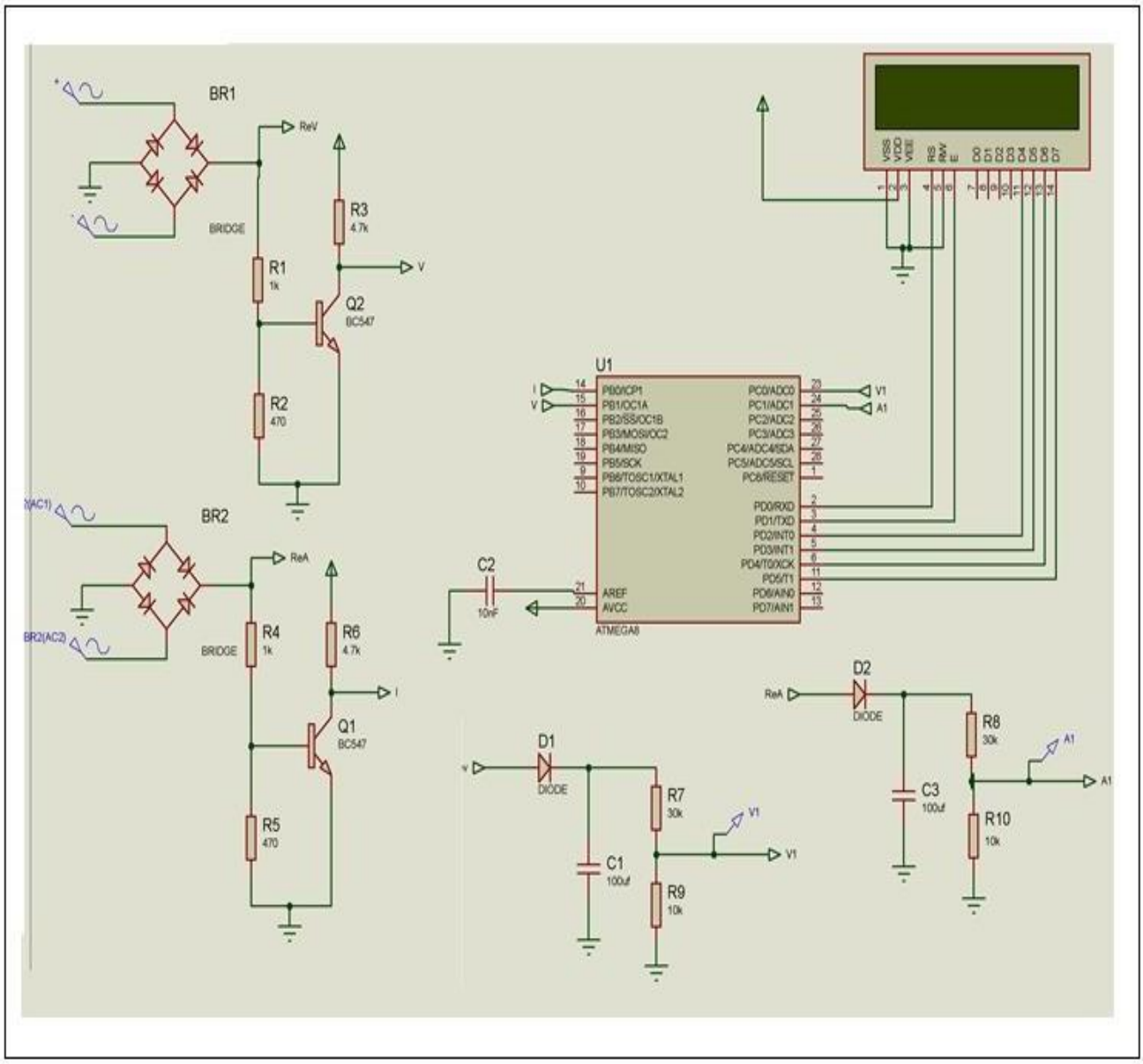

Figure 2: Circuit Diagram of Power Factor Correction

9. Results

The most important results obtained are summarized in table 1 below:

Table 1: Significant Results

Load	Old PF	Capacitor value (Kvr)	New PF
400 Watt	1	0	1
0.5 HP	0.78	0.309	0.9
1.0HP	0.57	0.687	0.9
1.5 HP	0.37	0.932	0.9

10. Conclusion

The most economical way of producing reactive power required by most electrical devices is by the use of capacitors. Installation of capacitor bank for power factor correction and monitoring by using Automatic power factor controller gives more accurate result than other methods. Thus we can conclude that from this system with increase in power factor we can save power and also efficiency can be increases and this system can be implemented in industries.

A reduction in the overall cost of electricity can be achieved by improving the power factor to a more economic level.

11. Future Work

The automatic power factor correction using microcontroller technique is very efficient as it reduces the cost by decreasing the power drawn from the supply. There is no anyone moving part, it operates automatically. So Automatic Power Factor Correction Technique can use in industries in future.

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