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Automatic Power Factor Corrector Using Capacitive Load Bank

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Abstract-This project provides continuous power factor correction without manual capacitive bank loading. A PFC controller provides power factor correction and peak current limiting for a switch-mode power converter of any topology (buck, boost or buck-boost), without having to directly sense inductor current. The PFC control technique involves using a piecewise-polynomial analog computer (AC) to compute power transistor on-times in accordance with separate polynomial transfer functions for power-factor control and peak-current-linking using as inputs current representations of line input voltage (VLN), load output voltage (VLD), and long-term current demand (VCD). A conduction cycle is initiated by sensing when the rate of change in the inductor current reaches zero using an auxiliary winding on the current storage inductor, and terminated after the computed on-time to implement either power-factor control or peak-current-limiting.

Index Terms-Power Factor; Power Factor Improvement; Microcontroller; Capacitor Bank;

1. INTRODUCTION

Since most loads in modern electrical distribution systems are inductive, there is an ongoing interest in improving power factor. The low power factor of inductive loads robs system's capacity and can adversely affect voltage level. As such, power factor correction through the application of capacitors is widely practiced at all system voltages. As utilities increase penalties they charge customers for low power factor, system performance will not be the only consideration. The installation of power factor correction capacitors improves system performance and saves money. A number of manufacturers have catalogs and design manuals to assist in the application of their products. These publications provide guidance in the selection and placement of capacitors and discuss general provisions that will affect the overall performance of the installation. The Reactive Power charge on your electricity bill is directly targeted against those companies who do not demonstrate clear energy efficiency use. You will find this charge itemized on electricity bill. Reactive power charges can be made significantly smaller by the introduction of Power Factor Correction Capacitors which is a widely recognized method of reducing an electrical load and minimizing wasted energy, improving the efficiency of a plant and reducing the electricity bill. It is not always necessary to reach a power factor of 1. A cost effective solution can be achieved by increasing your power factor to greater than 0.95

This project uses regulated 5V, 750mA power supply. 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12V step down transformer.

2. POWER FACTOR

In general power is the capacity to do work. In electrical domain, electrical power is the amount of electrical energy that can be transferred to some other form (heat, light etc) per unit time. Mathematically it is the product of voltage drop across the element and current flowing through it. Considering first the DC circuits, having only DC voltage sources, the inductors and capacitors behave as short circuit and open circuit respectively in steady state. Hence the entire circuit behaves as resistive circuit and the entire electrical power is dissipated in the form of heat. Here the voltage and current are in same phase and the total electrical power is given by Electrical power = Voltage across the element X Current through the element. Its unit is Watt = Joule/sec.

2.1. *Power factor improvement*

Power factor improvement apparatus should always be located near the equipment/machinery which is responsible for low power factor. If synchronous condensers are to be used for improving the power factor of the transmission line, then the best location for these will be at the receiving end. Synchronous condensers thus installed will relieve both the transmission line and generators form the excessive current. However, if synchronous condensers are installed near the generators then only generators will be relieved from the excessive lagging current component and the transmission line will have to carry more than normal current.

2.2. *Capacitor Circuit*

Sections, Once it's charged, the capacitor has the same voltage as the battery (1.5 volts on the battery means 1.5 volts on the capacitor). For a small capacitor, the capacity is small. But large capacitors can hold quite a bit of charge. You can find capacitors as big as soda cans that hold enough charge to light a flashlight bulb for a minute or more. Once it's charged, the capacitor has the same voltage as the battery (1.5 volts on the battery means 1.5 volts on the capacitor). For a small capacitor, the capacity is small. But large capacitors can hold quite a bit of charge. You can find capacitors as big as soda cans that hold enough charge to light a flashlight bulb for a minute or more.

2.3. *Lists of items*

1. Microcontroller
2. Transformer
3. Bridge rectifier
4. Light Emitting Diode
5. Voltage Regulator Unit
6. LCD Display
9. Relay
10. Crystal Oscillator
11. Inductive load Choke Coil
12. Switches
13. Bulb

3. Equations

The inductance of single-layer air-cored coils can be calculated to a reasonable degree of accuracy with the simplified formula $\mu H = \frac{(R^2N^2)}{(9R+10L)}$. (1)

Where µH (micro henries) are units of inductance, R is the coil radius (measured in inches to the center of the conductor), N is the number of turns, and L is the length of the coil in inches. The online Coil Inductance Calculator calculates the inductance of any coil using this formula. Higher accuracy estimates of coil inductance require calculations of considerably greater complexity. A layperson's translation is.

$$\text{inductance}(\mu H) = \frac{redius^2 \times number\ of\ turns^2}{9 \times redius + 10 \times length}$$

4. Proposed System Block Diagram APFC

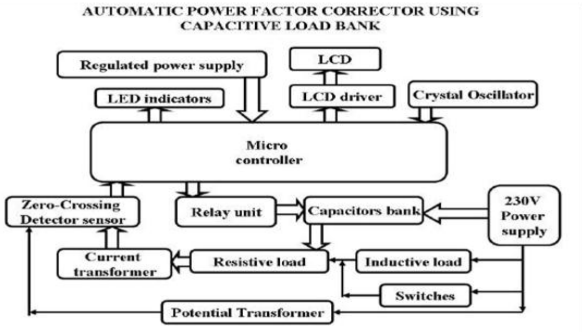

Fig. 1.

4.1. *Crystal oscillator*

The crystal oscillator speed that can be connected to the PIC microcontroller range from DC to 20Mhz. Using the CCS C compiler normally 20Mhz oscillator will be used and the price is very cheap. The 20 MHz crystal oscillator should be connected with about 22pF capacitor. Please refer to my circuit schematic.

4.2. *Rectifiers*

A rectifier is an electrical device that converts alternating current (AC) to direct current (DC), a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid-state diodes, vacuum tube diodes, mercury arc valves, and other components**.**

When only one diode is used to rectify AC (by blocking the negative or positive portion of the waveform), the difference between the term diode and the term rectifier is merely one of usage, i.e., the term rectifier describes a diode that is being used to convert AC to DC. Almost all rectifiers comprise a number of diodes in a specific arrangement for more efficiently converting AC to DC than is possible with only one diode. Before the development of silicon semiconductor rectifiers, vacuum tube diodes and copper (I) oxide or selenium rectifier stacks were used**.**

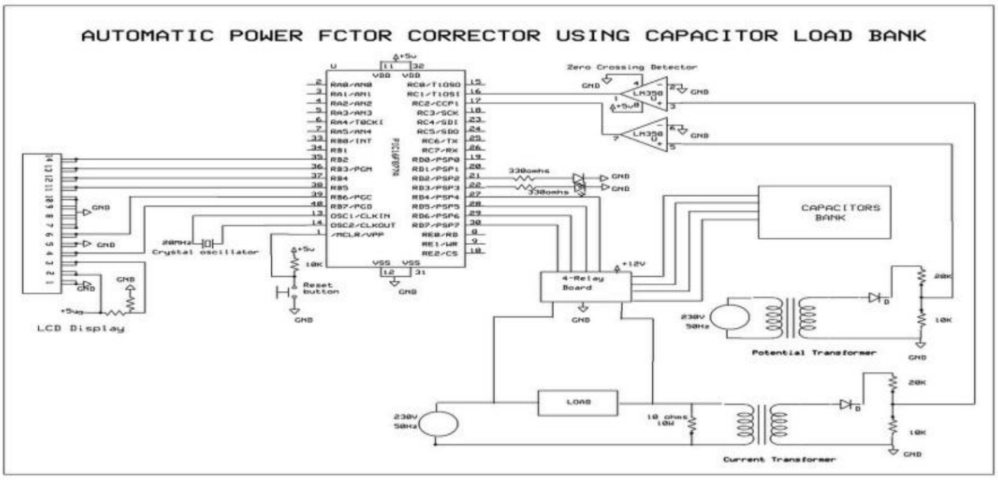

Fig. 1. Automatic Power Factor Corrector Using Capacitor Load Bank.

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