Automatic Power Factor Compensation for Industrial Power Used To Minimize Penalty

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Abstract-- We know the importance of electricity as its most important thing in current time. As it’s the major source for the any country and its development as they both are interconnected. Also, the thirst for new sources of energy is never ending, but we seldom realize that due to inductive load we use are wasting lot of energy due to lagging power factor. Hence this waste of energy is needed to be avoided as soon as possible. Before getting into the details of Power factor correction, let’s just revised basic knowledge related to “power factor”. In simple words power factor basically states how far the energy provided has been utilized. The maximum value of power factor is unity (but its mere an ideal condition). So closer the value of P.F to unity, better is the utility of energy and lesser is the wastage. In electrical terms Power factor is basically defined as the ratio of the active power to reactive power or voltage and current phase difference. Active power performs useful work while reactive power does non useful work by compensating the loss but is used for developing the magnetic field required by the device. The power factors of the most of the device used by us in our daily routine are having power factor less then unity. Hence, there is a necessity to bring this power factor close to unity. Hence to solve this problem we are presenting the paper as well as model using PIC microcontroller.

Keywords:-8051 Microcontroller, Relay, Capacitor Bank

I. INTRODUCTION

As we know that electrical power is produce as the high cost in terms of nature destruction in our country as the most of the plant are thermal based as well as transmission and distribution at some cost so it’s our foremost duty to save the power by switching off the device and source when it’s not in use. Apart from there is loss of power due to lagging power factor due to inductive load. So our project will work under the shade of save electricity camping by creating the system to correct the lagging power factor with the help of microcontroller, relay, capacitor bank, etc.

II. PROBLEM SPECIFICATION

In power factor correction capacitors reduce energy costs by avoiding the premium rates that utilities charge when power factor falls below specified values.

Industries typically install these capacitor banks at their premises to avoid the problem when inductive loads cause power factor problems. Usually much year service is provided capacitor bank, to ensure there proper working they need to be inspected at regular interval. Problems such as loose connections, blown fuses or failing capacitance value of capacitor can reduce the amount of power correction available; even cause a total system failure or a fire in the extreme case. This article describes how to inspect power factor correction capacitors and avoid these problems.

III. LITERATURE REVIEW

In [1] 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 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 industries, power systems and also households 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.

In [2], in the industrial sector various types of loads are inductive in nature. This type of loads draws inductive current. Due to this inductive current power factor decreases. If load with low power factor then more current required than load with high power factor for the same amount of useful power transferred. If more current is required by load then it affects on Different factors such as increase losses, increases cost. In this project operational amplifier is used which act as comparator mode to generate dual pulses to detect voltage and Current passing through their respective zero position. The voltage source is given by potential transformer to the zero crossing detectors and also current source is given by current transformer to the zero crossing detector .These pulses are given to two interrupt pins of the microcontroller.
Then microcontroller display power factor on LCD. If the Power factor will be low then microcontroller actuates relays using relay driver and connect capacitor bank in circuit Which draws leading current thus improve power factor .The ideal power factor is unity. If power factor will be improve then losses and cost will be reduced. Power factor improvement saves power. The 8 bit microcontroller is used in the project belongs to 8051 family of microcontroller.

In [3], Any motor that operates on alternating current requires apparent power, but apparent power is addition of active power and reactive power. Active power is the power which is actually consumed by the load. Reactive power is the power demanded by the load and returned to the power source. The simplest way to specify power factor is POWER FACTOR is the ratio between the useful (true) powers whose unit is KW to the total (apparent) power whose unit is KVA consumed by an A.C electrical equipment or motor.

Power factor is a measure of how effectively electrical power is used to perform an useful work. The ideal power factor is unity or one. If power factor is less than one it means that excess power is required to perform or achieve the actual work.

In [4], 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. Net industrial load is highly inductive causing a very. poor lagging power factor. If this poor power factor is left uncorrected, the industry will require a high maximum demand from Electricity Board and also will suffer a penalty for poor power factor. Standard practice is to connect power capacitors in the power system at appropriate places to compensate the inductive nature of the load.

Block Diagram

**BLOCK DIAGRAM OF PF improvement**

- Transformer
- Rectifier
- Regulator
- Display
- Reference
- Micro Controller
- Asm/C Program
- Zero Crossing Detector (V)
- Zero Crossing Detector (I)
- Capacitor Bank
- Inductive Load
- Capacitor Bank
- ~230V
- ~230V
Four. Methodology

Microcontroller

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Here we will use the PIC16F877A. It is one of the most advanced microcontroller from Microchip. This controller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality, and ease of availability. It is ideal for applications such as machine control applications, measurement devices, study purpose, and so on. The PIC 16F877 features all the components which modern microcontrollers normally have.

IC -7805

7805 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

Capacitor

Just like the Resistor, the Capacitor, sometimes referred to as a Condenser, is a simple passive device that is used to “store electricity”. The capacitor is a component which has the ability or “capacity” to store energy in the form of an electrical charge producing a potential difference (Static Voltage) across its plates, much like a small rechargeable battery.

Resistor:

A resistor is a two-terminal passive electronic component which implements electrical resistance as a circuit element. When a voltage V is applied across the terminals of a resistor, a current I will flow through the resistor in direct proportion to that voltage. This constant of proportionality is called conductance, G. The reciprocal of the conductance is known as the resistance R, since, with a given voltage V, a larger value of R further "resists" the flow of current I as given by Ohm's law.

Diode

In electronics, a diode is a two-terminal electronic component that conducts electric current in only one direction. The term usually refers to a semiconductor diode, the most common type today.

This is a crystalline piece of semiconductor material connected to two electrical terminals. The diode is a device formed from a junction of n-type and p-type semiconductor material. The lead connected to the p-type material is called the anode and the lead connected to the n-type material is the cathode. In general, the cathode of a diode is marked by a solid line on the diode. The primary function of the diode is rectification.

Relay

A relay is switch worked by electromagnet. It is useful if we want a small current in one circuit to control another circuit containing a device such as lamp or electric motor which requires a large current or if we wish several differential switch contacts to be operated simultaneously.

Current Transformer

CT is a one type of transformer which is used to measure current. It mostly used in measuring instruments in substation. In this current carrying conductor pass through a circular core which work as a secondary winding and conductor work as primary winding. The Current Transformer (C.T.), is a type of “instrument transformer” that is designed to produce an alternating current in its secondary winding which is proportional to the current being measured in its primary. Current transformers reduce high voltage currents to a much lower value and provide a convenient way of safely monitoring the actual electrical current flowing in an AC transmission line using a standard ammeter. The principal of operation of a current transformer is no different from that of an ordinary transformer.

Potential Transformer

Potential Transformer is designed for monitoring single-phase and three-phase power line voltages in power metering applications. The working principle of transformer is very simple. It depends upon Faraday's law of electromagnetic induction. Actually mutual induction between two or more winding is responsible for transformation action in an electrical transformer. Faraday's laws of Electromagnet According to these Faraday's law, "Rate of change of flux linkage with respect to time is directly proportional to the induced EMF in a conductor or coil".

LCD (Liquid Crystal Display)

The values are displayed in the 2x16 LCD modules after converting suitably. The liquid crystal display (LCD), as the name suggests is a technology based on the use of liquid crystal.
It is a transparent material but after applying voltage it becomes opaque. This property is the fundamental operating principle of LCDs.

**Transistor:**

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor’s terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal.

V. CONCLUSION

In this project we represented our work on developing an affordable efficient method of detection of power factor by use of automatic power factor corrector.

We can implement automatic system which using capacitor bank that can be controlling using the relay. Our system decreases the cost.

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