Review on Automatic Power Factor Improvement of Induction Motor

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Abstract – *The Purpose of this paper is designing a new technique for power factor improvement of 3 phase induction motor and single phase induction motor. Improvement of power factor necessary to make as close as unity without facing penalty from electrical distributers. So that is requirement to improve power factor of induction motor, because it operate in lagging power factor. Automatic power factor improvement techniques can be applied to the industries, power factor mostly operate nearest to unity for systems to make them stable and efficiency of the system as well as the apparatus capacity increases. This is done by use of microcontroller to reduce the costs.*

KeyWords: *Induction Motor (IM), Programmable Logic Controller (PLC), microcontroller, Zero Crossing Detector (ZCD),*

1. INTRODUCTION

In the present generation, power factor has one of the most important and major issued. Any motor that operates on ac system t requires apparent power, but apparent power is addition of active power and reactive power. the load is consumed active power. Reactive power also importance for load, because reactive power is the power demanded by the load and returned to the power source. To specify power factor is the ratio between the useful powers whose unit is KW to the total power whose unit is KVA consumed by an electrical equipment or motor. Power factor is a measure of how effectively electrical power is used to perform a useful work. The ideal power factor is unity. If power factor is less than one it means that excess power is required to perform or achieve the actual work. The basic idea for Power factor correction of a motor, we have to connect a capacitor in parallel with the device which having low power factor. One of traditional method for power factor correction is static type compensation, in which static type capacitors are used for power factor correction. However in this case Care should be taken when applying power factor correction star/delta type control. Therefore capacitors should not subject to rapid on-off conditions.

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. Advantages of power factor improvement

Advantages which can be achieved by employing proper power factor correction scheme are:

a) Efficiency of induction motor increases due to Reduction of power consumption.
b) Due to reduced power consumption there will be Less greenhouse gases
c) Reduction of electricity bills
d) Extra KVA available from the same existing supply
e) Reduction of I^2R losses in transformers and distribution

B. The Causes of Low Power Factor

The usual cause of low power factor is due to inductive loads. The current in an inductive load lags behind the voltage. Therefore power factor is lagging. The important inductive load is responsible for low power factor are as follows:

i) Low power factor is caused by inductive loads such as transformers, induction motors, generators and certain lighting ballasts. Three phase induction motor operate at a power factor of about 0.8 lagging at full load. At light loads this motor work at a very small power factor in order of 0.2 to 0.3 lagging. Single phase induction motor at power factor of about 0.6 (lag)
ii) A transformer draws magnetizing current from the supply. At light loads, this current does not affect the power factor much but at light load the primary current power factor is low.

iii) Arc lamps, electric discharge lamp, industrial heating furnaces, welding equipment operate at low lagging power factor.

2. BLOCK DIAGRAM

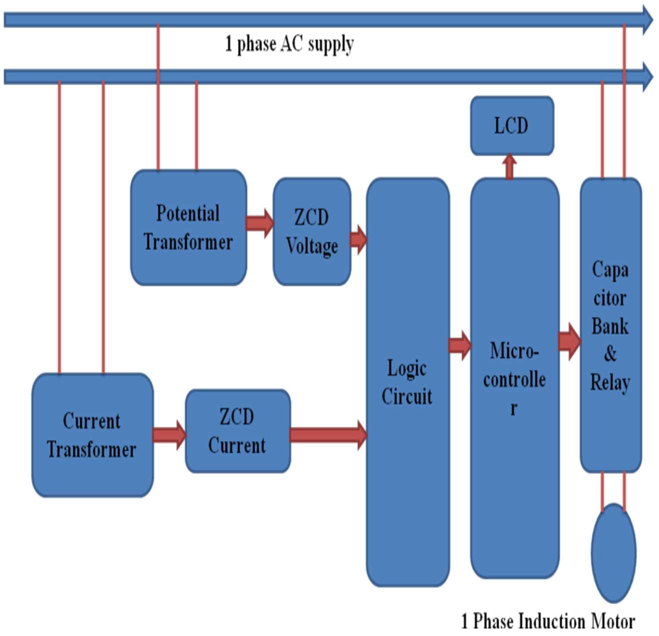

Fig.1- Block Diagram of Automatic Power Factor Improvement by Microcontroller

A. Power Supply

In this power supply we are using step-down transformer, IC regulators, Diodes, Capacitors and resistors. The input supply i.e., 230V AC is given to the primary of the transformer. Due to the magnetic effect of the coil the flux is induced in the primary is transfer to the secondary coil. The output of the secondary coil is given to the diodes. Here the diodes are connected in bridge type. Diodes are used for rectification purposes. The output of the bridge circuit is not pure dc, somewhat rippled ac is also present. For that capacitor is connected at the output of the diodes to remove the ac, capacitor are also used for filtering purpose. The both negative terminal of the diode (D2 & D3) is connected to the positive terminal of the capacitor and thus the input of the IC Regulator (7805 & 7812). Here we are using voltage regulators to get the fixed voltage to our requirements." Voltage regulator is a CKT that supplies a constant voltage regardless of changes in load currents. These IC's are designed as fixed voltage regulators and with adequate heat sinking can deliver o/p currents in excess of 1A. The o/p of the IC regulator is given to the LED through resistors, When the o/p of the IC i.e. The voltage is given to the LED, it makes its forward bias and thus LED gloves on state and thus the positive voltage is obtained. Fig. 2 Power supply shown bellow:

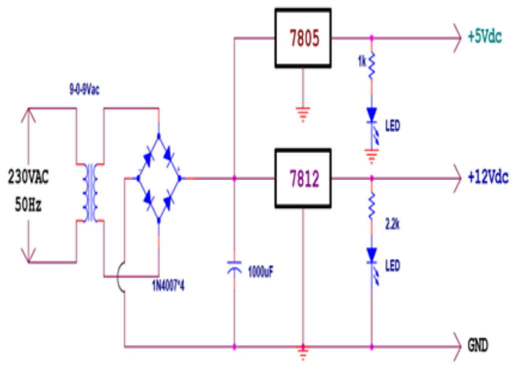

Fig.2- Power Supply

Similarly, for negative voltage, here the both positive terminals of the diodes (D1 & D4) are connected to the negative terminals of the capacitor. The o/p of the IC regulator (7912) which is a negative voltage is given to the terminal of LED, through resistor, which makes it forward bias, LED conducts and thus LED gloves in ON state and thus the negative voltage is obtained. The mathematical relation for ac input and dc output is

Vdc = Vm /3.141 (before capacitor)

Vd = Vm (after capacitor)

B. Zero Crossing Detectors

The zero crossing detectors are a sine-wave to square-wave converter. The reference voltage in this case is set to zero. The output voltage waveform shows when and in what direction an input signals crosses zero volts. If input voltage is a low frequency signal, then output voltage will be less quick to switch from one saturation point to another. And if there is noise in between the two input nodes, the output may fluctuate between positive and negative saturation voltage is Vsat.

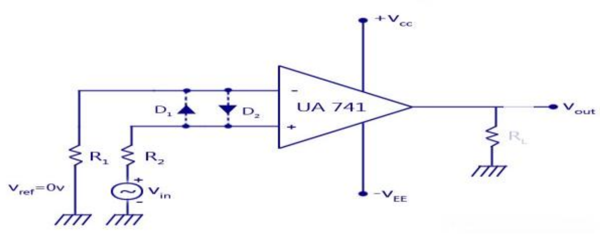

Fig.3- Zero Crossing Detectors

C. MICROCONTROLLER (ARDUINO)

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2programmed as a USB-to-serial converter."Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version1.0 will be the reference versions of Arduno, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions. We are using the compile software Adriano Uno to execute the programs and it downloads to the controller board through USB cable.LCD display is used to shown the current, voltage and power factor values.

D. Electro Magnetic Relay

These are varying much reliable devices and widely used on field. The operating frequency of these devices are minimum 10-20ms.That is 50Hz –100Hz.The relay which is used here can care 25mA currents continuously. The electromagnetic relay operates on the principle magnetism. When the base voltage appears at the relay driver section, the driver transistor will be driver transistor will be driven into saturation and allow to flow current in the coil of the relay, Which in turn create a magnetic field and the magnetic force produced due to that will act against the spring tension and close the contact coil.

Those contact points are isolated from the low voltage supply, so a high voltage switching is possible by the help of electromagnetic relays.

The electromagnetic relays normally having 2 contact points. Named as normally closes (NC) , normally open (NO). Normally closed points will so a short CKT path when the relay is off. Normally open points will so a short CKT path, when the relay is energized.

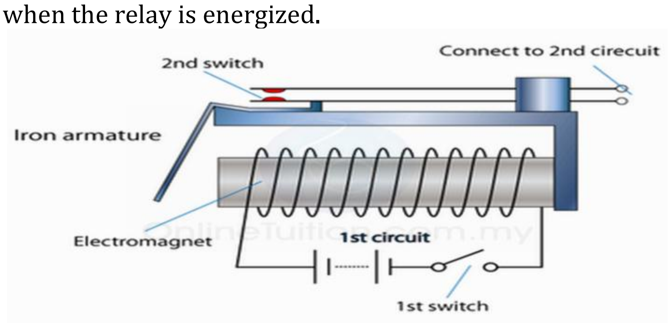

Fig.3- Electromagnetic relay

E. LCD (Liquid Crystal Display)

LCD panel consists of two patterned glass panels in which crystal is filled under vacuum. The thickness of glass varies according to end use. Most of the LCD modules have glass thickness in the range of 0.70 to 1.1mm. Normally these liquid crystal molecules are placed between glass plates to form a spiral stair case to twist the twist the light. Light entering the top plate twist 900 before entering the bottom plate. Hence the LCDs are also called as optical switches. These LCD cannot display any information directly. These act as an interface between electronics and electronics circuit to give a visual output. The values are displayed in the 2x16 LCD modules after converting suitably.

Fig. 4- Liquid crystal display

F. Capacitor Bank

As a large proportion of the inductive or lagging current on the supply is due to the magnetizing current of induction motors, it is easy to correct each individual motor by connecting the correction capacitors to the motor starters. With static correction, it is important that the capacitive current is less than the inductive magnetizing current of the induction motor. In many installations employing static power factor correction, the correction capacitors are connected directly in parallel with the motor windings. When the motor is Off Line, the capacitors are also Off Line. When the motor is connected to the supply, the capacitors are also connected providing correction at all times that the motor is connected to the supply. This removes the requirement for any expensive power factor monitoring and control equipment.

In this situation, the capacitors remain connected to the motor terminals as the motor slows down. An induction motor, while connected to the supply, is driven by a rotating magnetic field in the stator which induces current into the rotor. When the motor is disconnected from the supply, there is for a period of time, a magnetic field associated with the rotor. As the motor decelerates, it generates voltage out its terminals at a frequency which is related to its speed. The capacitors connected across the motor terminals, form a resonant circuit with the motor inductance. If the motor is critically corrected. It is imperative that motors are never over corrected or critically corrected when static correction is employed.

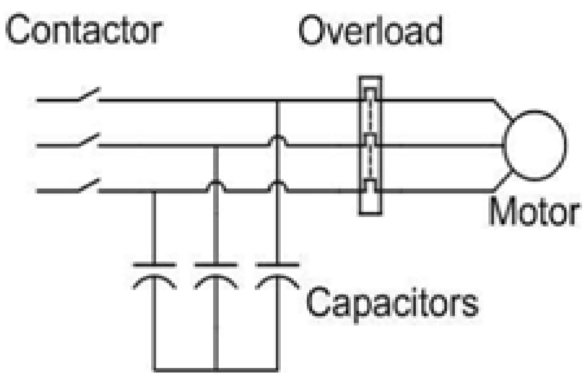

Fig. 5- Capacitor Bank

3. Software detail

i) Atmel Studio 6.0 Compiler

Atmel Studio 6 delivers a lot of the value that AVR Studio 5 promised but never quite gave. Released in 2011 and based on Microsoft Visual Studio, Studio 5 was a large change from AVR Studio 4, which was based on the tried and true Eclipse IDE. Studio 4 is seriously showing its age these days, so a refresh was welcome. However, version 5 came with a long list of bugs and didn't deliver on a lot of the feature list, which left a lot of people wondering whether they should upgrade. The new version appears to have addressed a lot of those bugs, and gets higher marks from us in our initial testing

Atmel Studio 6 is free of charge and is integrated with the Atmel Software Framework (ASF)—a large library of free source code with 1,600 ARM and AVR project examples. ASF strengthens the IDP by providing, in the same environment, access to ready-to-use code that minimizes much of the low-level design required for projects. Use the IDP for our wide variety of AVR and ARM Cortex-M processor-based MCUs, including our broadened portfolio of Atmel SAM3 ARM Cortex-M3 and M4 Flash devices.

ii) Embedded C Language

Most common programming languages for embedded systems are C, BASIC and assembly languages C used for embedded systems is slightly different compared to C used for general purpose (under a PC platform) - programs for embedded systems are usually expected to monitor and control external devices and directly manipulate and use the internal architecture of the processor such as interrupt handling, timers, serial communications and other available features. There are many factors to consider when selecting languages for embedded systems.

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. Due to use of microcontroller multiple parameters can be controlled and the use of extra hard work such as timer, RAM, ROM and input output ports reduces. 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.

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