ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

Automatic Power Factor Correction Using Microcontroller

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ABSTRACT: In the present technological revolution power is very precious. So we need to find out the causes of power loss and improve the power system. Due to industrialization the use of inductive load increases and hence power system losses its efficiency. So we need to improve the power factor with a suitable method. Whenever we are thinking about any programmable devices then the embedded technology comes into forefront. The embedded is now a day very much popular and most the product are developed with Microcontroller based embedded technology. In this paper, it propose an algorithm which give advancement to improve power factor fastly on the basis of calculating the power factor by judging the time difference between voltage and current signals.

KEYWORDS: Zero crossing detector, Time difference between two signals, Microcontroller, Power factor, Relay driver, & Capacitor bank.

I.INTRODUCTION

In the present scenario there is huge number of loads are Inductive in nature. This Inductive loads drawn inductive current and this inductive current result into large phase angle between voltage and current of source and this deflection between them cause lagging power factor. This lagging power factor result in flowing of reactive current which causes power loss, unstability of power supply, increase in cost, etc. Due to these losses, power factor should be unity or near about unity which reduce electricity bills, improve stability etc.
Power factor can be improve by using the three methods-

- By using the synchronous motor as synchronous condenser,
- By using the phase advancers, and
- By using the capacitors bank.

Capacitors bank is usually employed in our substation, industries, domestic uses etc. because this doesn't require any additional supply as like in synchronous motor.
Our project work on improvement alongwith correction of power factor using the Capacitor bank controlled by Microcontroller. In this project two Zero crossing detector are used which work as comparator compares the output voltage signal and current signal with the reference one which is set at ground or at any specified value. This output of zero crossing detectors is converted sine wave into square wave which is fed into Microcontroller pin RA0 and RA1. These signal act as interrupt for Microcontroller. When first interrupt high microcontroller starts counting with the help of internal timer and when other interrupt high it stops the counting. With the help of these counting, microcontroller will determine the power factor between the voltage and current signal. Determined power factor is again compare with predefined value of power factor. When power factor is below the predefined value then microcontroller actuate the relays to connect the different capacitors in the sequence of series or parallel for the desired power factor. This series or parallel combination of capacitors is according to their rating.

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The time period is Δt,

$$\text{PHASE ANGLE}\varphi° = 360° * f * \Delta t$$

Where,

Δt - time delay between voltage and current waveform.

f - supply frequency

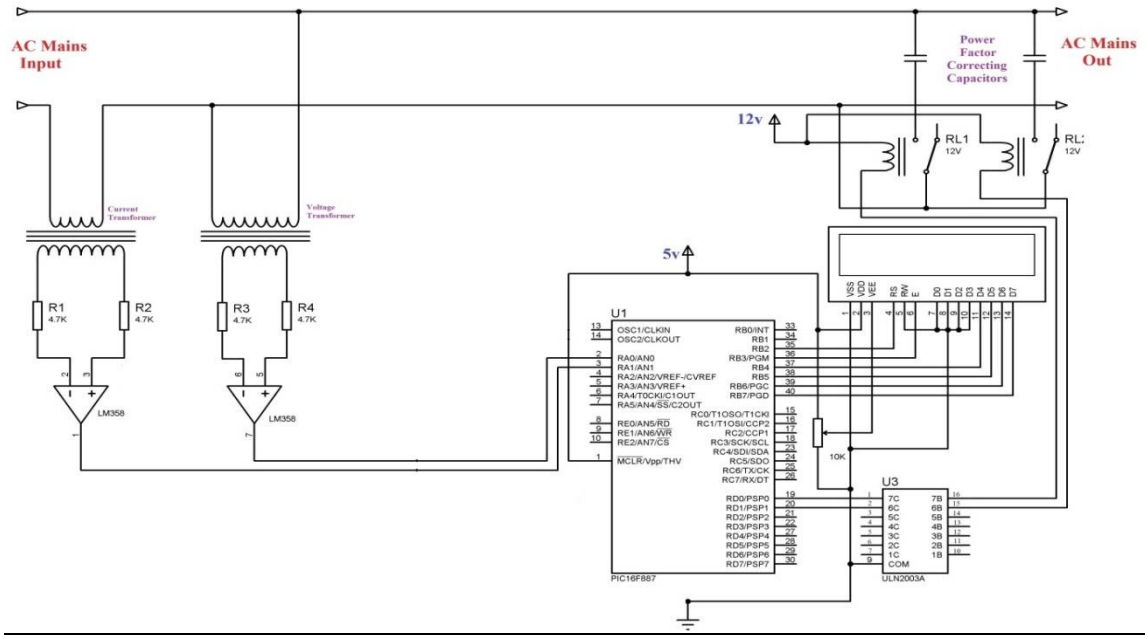
$POWERFACTOR = COS\varphi°$

II.SYSTEM MODEL AND ASSUMPTIONS

This project of correction of power factor using Microcontroller which consists of determining the time difference between the two signals they are voltage and current one. This system of determining the time difference uses the defined program and algorithm which judging the entering of signals into the predefined pins of Microcontroller. These signals are in square wave which is converted by Zero crossing detector to determining the zero crossing of signal with the predefined reference signal.

Here is one assumption that is there will be some lagging in the voltage and current signals due to large inductive loads used industry, institution, homes etc. which can be inspected by Microcontroller and which help in the determination of time difference. If there is no lagging in the signals then model is designed to create some lagging by adding inductive loads at load end.

III. BLOCK DIAGRAM WITH DESCRIPTION



Microcontroller based Automatic Power Factor Correction

In the above block diagram there is the supply signal Voltage and current is given by CT and PT to the rectifier unit which converts these ac signals to dc signal. Then this dc supply is given to regulator. There is regulator 7805 is used. +ve 12V supply is given to ZCD(V) and ZCD(C) for their operation and also give to the LCD display unit. +ve 5V

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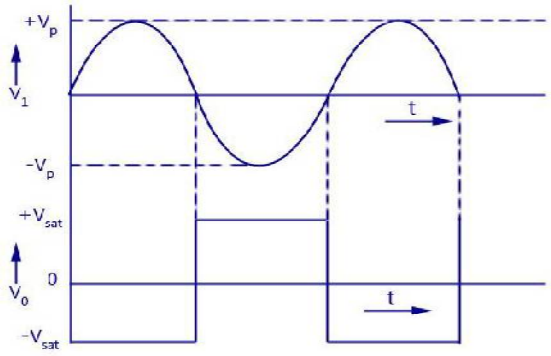
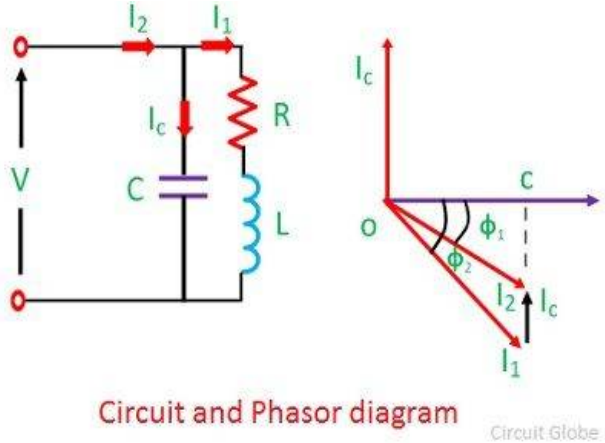
supply is given to microcontroller. Operational amplifier act as comparator and generate dual pulses. These pulses are given to two interrupt pin that is INT0 and INT1 of microcontroller PIC 16F887. Microcontroller have internal timer circuit which calculate time in millisecond which then convert into phase angle and power factor will display on LCD. If Power factor will be low then microcontroller give signal to relay driver ICULN2003A which actuates relay which help in connection of capacitor with the power supply.Thus Power factor will be improve and show on LCD.



IV. ADVANTAGES OVER CONVENTIONAL METHODS

Conventional methods for power factor improvement are Static capacitors, Synchronous motor and Phase advancers.
Static Capacitors: Static capacitors are generally simple capacitors which are always connected to supply lines with load without caring of this that these are able to correct this or not or whether this is suitable to correct fluctuation in power factor within seconds. These capacitors provide reactive current to compensate the lagging power factor.



Synchronous motor: This motor is employed with the load and run at full excitation without load, this help in to lead the current. Due to this this is known as Synchronous condenser. But this requires additional supply for that due to this, this method is also a cause for power loss.

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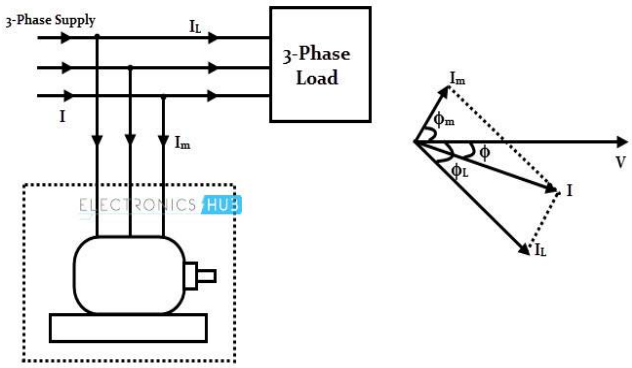

Phase Advancers: It is a source of reactive power, connected either to certain junction points in an electrical network or directly to the load terminals. It is used to compensate the phase shift between voltage and current. Phase advancers make it possible to adjust or maintain .the voltage in the network, lower the power loss, and increase the carrying capacity of electrical systems.
Limitation: There are considerable losses in the motor, Maintenance cost is high and it produces noise.

V. MODERN TECHNIQUE

Due to the Drawback of above methods we are using the following modern method, with the use of Microcontroller. This project of include connection of capacitor bank in series or parallel on the account of present power factor value of supply. This project gives high accuracy, no power loss, no noise, no maintenance problem etc. due to our one conventional method i.e. capacitor bank but in innovative manner. This method also helps to retain the maximum efficiency of equipment and reduces the bill.

On the future demand of our power system we require low or negligible power loss, for that we have to reduce the flowing of leakage current in conductor which is due to the lagging between voltage and current.

VI. OBSERVATION TABLE

Table shows a result of before and after APFCas a follows.

LOAD	Power(Watt)	Power factor before correction	Power factor after correction
No Load	0	0.86	0.96
Full Load	200	0.67	0.94

VII. RESULT, CONCLUSION& SIMULATION

This method deals with modify method of automatic powers factor correction. This method 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.

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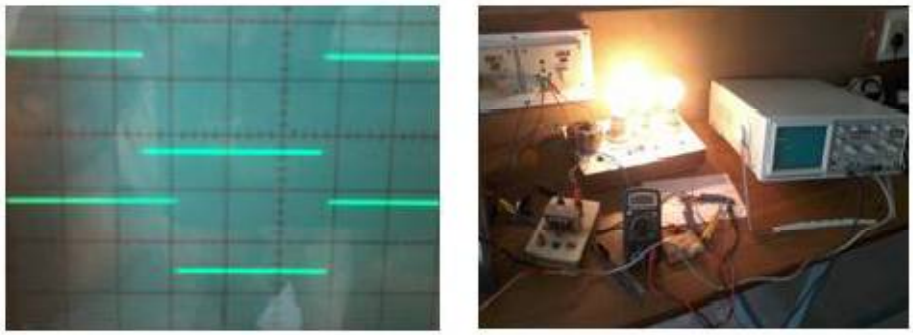
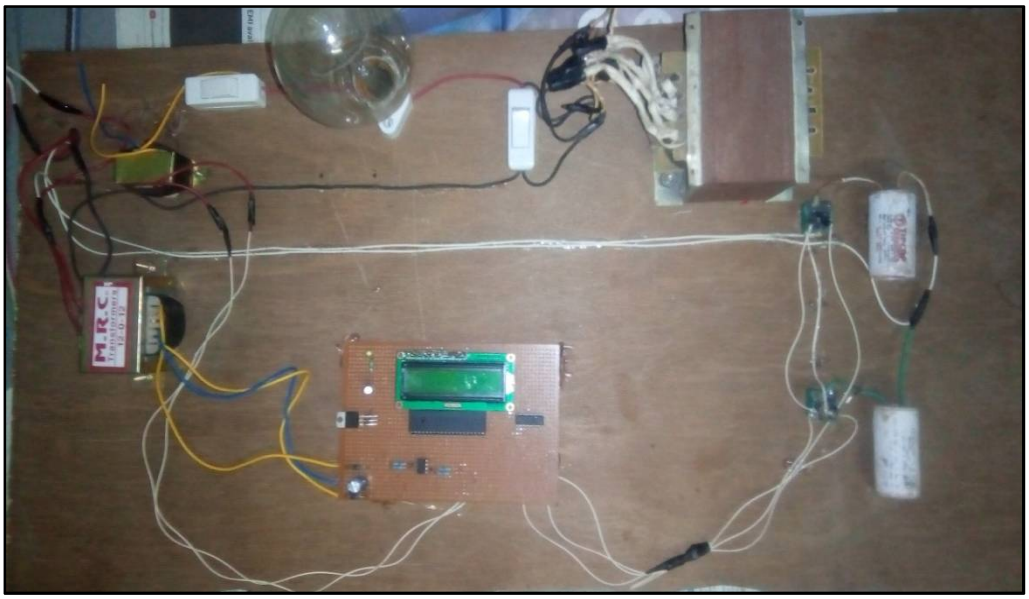


Oscilloscope graphs

VIII. HARDWARE ANALYSIS



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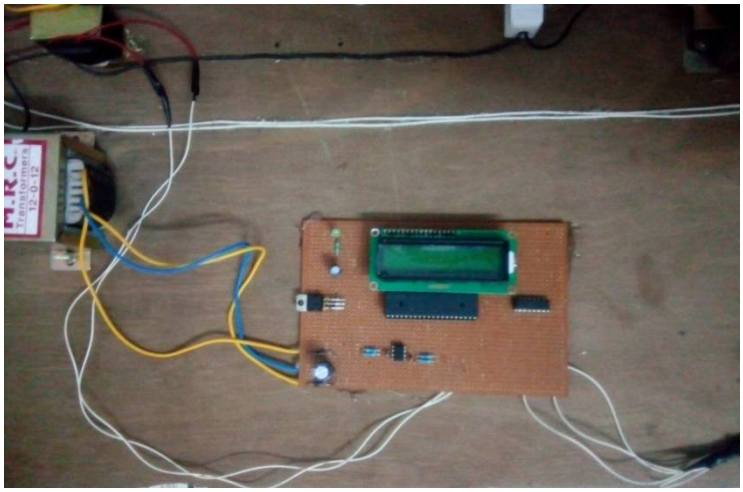

(ii)

Hardware analysis of a project is done on the compeletion of circuitry of the project designed according to requirement. In the hardware of this project there is a rectifier circuit, a voltage regulator circuit, a load box (inductive load), a capacitor bank of two or more capacitors and a microcontroller circuit which has program which create interlink between hardware and software.

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