

# Automatic Power Factor correction using Microcontroller 8051

<sup>1</sup>Akash Mishra, <sup>2</sup>Kuldeep Swarnkar <sup>3</sup>G.K.Naveen

<sup>1</sup>Student of Electrical & Electronics Engineering, Madhav Institute of technology Gwalior, MP, India,

<sup>2</sup>Assistant Proffesor, Madhav Institute of technology Gwalior, MP, India,

<sup>3</sup>Assistant Proffesor(Co-Guide), Madhav Institute of technology Gwalior, MP, India.

## ABSTRACT:-

To minimize penalty for industrial units by using automatic power factor correction unit. Power factor is defined as the ratio of real power to apparent power. This definition is often mathematically represented as KW/KVA, where the numerator is the active (real) power and the denominator is the (active + reactive) or apparent power. Reactive power is the non-working power generated by the magnetic and inductive loads, to generate magnetic flux. The increase in reactive power increases the apparent power, so the power factor also decreases. Having low power factor, the industry needs more energy to meet its demand, so the efficiency decreases. In this proposed system the time lag between the zero voltage pulse and zero current pulse duly generated by suitable operational amplifier circuits in comparator mode are fed to two interrupt pins of the microcontroller. It displays the time lag between the current and voltage on an LCD. The program takes over to actuate appropriate number of relays from its output to bring shunt capacitors into the load circuit to get the power factor till it reaches near unity. The microcontroller used in the project belongs to 8051 family. Further the project can be enhanced by using thyristor control switches instead of relay control to avoid contact pitting often encountered by switching of capacitors due to high in rush current.

**Keywords :** Reactive power, Power factor, Power factor correction, Shunt capacitor, Microcontroller 8051, Power Supply, Transformer, Crystal Oscillator, LCD, Capacitor Bank, Relay and Relay Driver.

**1 INTRODUCTION** — In electrical engineering, the power factor of an AC electrical power system is defined as the ratio of real power flowing to the load to the apparent power in the circuit, and is a dimensionless number in the closed interval of -1 to 1. A power factor of less than one means that the voltage and current waveforms are not in phase, reducing the instantaneous product of the two waveforms ( $V \times I$ ). Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of current and voltage of the circuit. Due to energy stored in the load and returned to the source, or due to a non-linear load that distorts the wave shape of the current drawn from the source, the apparent power will be greater than

the real power. A negative power factor occur when the device (which is normally the load) generates power, which then flows back towards the source, which is normally considered the generator.

In an electric power system, a load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor.

## 2.METHODS OF POWER FACTOR CORRECTON

**2.1 Static Capacitor-** We know that most of the industries and power system loads are inductive that take lagging current which decrease the system power factor. For Power factor improvement purpose, Static capacitors are connected in parallel with those devices which work on low power factor. These static capacitors provides leading current which neutralize (totally or approximately) the lagging inductive component of load current (i.e. leading component neutralize or eliminate the lagging component of load current) thus power factor of the load circuit is improved. These capacitors are installed in Vicinity of large inductive load e.g. Induction motors and transformers etc, and improve the load circuit power factor to improve the system or devises efficiency.

**2.2 Synchronous Condenser-** When a Synchronous motor operates at No-Load and over excited then it's called a synchronous Condenser. Whenever a Synchronous motor is over-excited then it provides leading current and works like a capacitor When a synchronous condenser is connected across supply voltage (in parallel) then it draws leading current and partially eliminates the re-active component and this way, power factor is improved. Generally, synchronous condenser is used to improve the power factor in large industries.

**2.4 TRANSFORMER**

**2.4.1. Main Transformer :** The main transformer of 230V to 12V step down is used. At the starting of the setup it is installed for step down the single phase supply voltage 230 volts to 12 volts. The output of this transformer is given to the diodes, which are connected in bridge style for the rectification purpose. Also from the transformer primary side the supply is given to the choke which is used as inductive load and an incandescent lamp which is act as a resistive load in the system.



**Fig.2.4.1 Main Transformer**

**2.4.2 Current Transformer:** Current transformer reduce the magnitude of the current The current transformer is connected between the load (inductive) which draws the lagging current and the zero crossing detector which output is given to the microcontroller.



**Fig. 2.4.2 Current Transformer**

**2.4.3 Capacitor Bank** The capacitors are used in the project for the improvement of the power factor which is decreases due to lagging current drawn by the circuit. In this system four capacitors are used each of 4.70μF.



**Fig. 2.4.3 Capacitor Bank**

**2.4.4 LCD** 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. The values are

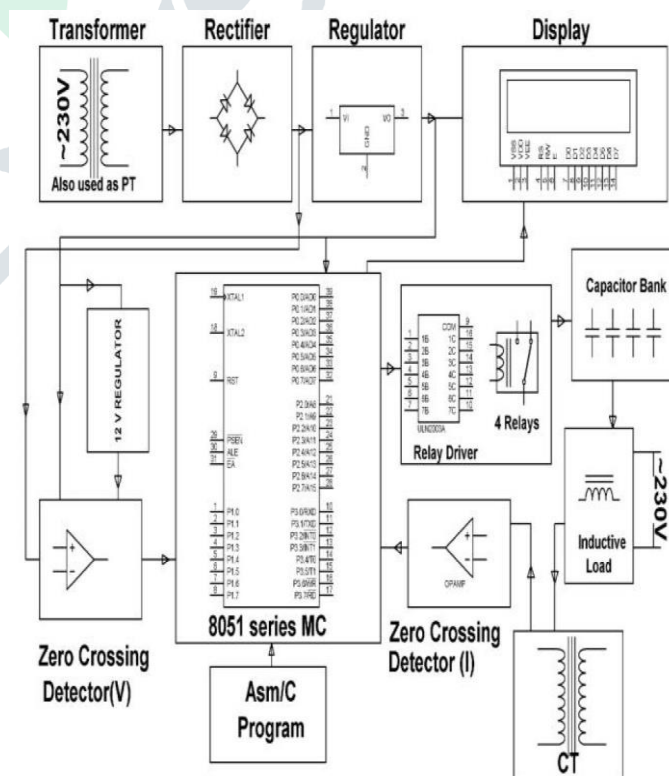
displayed in the 2x16 LCD modules after converting suitably. The liquid crystal display (LCD), as the name suggests is a technology based on the use of liquid crystal. It is a transparent material but after applying voltage it becomes opaque. This property is the fundamental operating principle of LCDs.



**Fig. 2.4.4: Liquid Crystal Display**

**2.4.5 Phase Advancer-** Phase advancer is a simple AC exciter which is connected on the main shaft of the motor and operates with the motor’s rotor circuit for power factor improvement. Phase advancer is used to improve the power factor of induction motor in industries. As the stator windings of induction motor takes lagging current 90° out of phase with Voltage, therefore the power factor of induction motor is low. If the exciting ampere-turns are excited by external AC source, then there would be no effect of exciting current on stator windings. Therefore the power factor of induction motor will be improved. This process is done by Phase advancer.

**2.4 BLOCK DIAGRAM**



**Fig 2.4 Block Diagram of Power Factor Improvement**

### 3. Literature Review:-

**1.Md. Shohel Rana, Md. Naim Miah & Habibur Rahman, "Automatic Power Factor Improvement by using Microcontroller" Volume 13 Issue 6 Version 1.0 Year 2013 from University of Engineering & Technology Rajshahi- 6204, Bangladesh.** In modern times the use of electricity is increasing day by day and most of the electrical energy utilized in industrial sector other than residential and farming sector. The conservation of electrical energy is of great importance because of the resources are decreasing as the time passes. In industrial sector most of the loads are of inductive in nature that is lagging type load. These lagging type of loads require reactive power which is to be provided by the power generating utility. But the loads are continuously varying so the need of reactive power varies. The poor power factor cause more losses in our power system. Also, poor power factor led to wastage of energy. The industrial and commercial installation in the country has large inductive loads installed which causes lagging power factor and gives penalties to consumers by utilities.

**2. V.K Mehta and Rohit Mehta, "Principles of power system", S. Chand & Company Ltd, Ramnagar, Newdelhi-110055, 4th Edition, Chapter,6.** The Automatic power factor correction unit is the cheapest way to implement the power factor compensation for the lagging loads which are continually varying. It brings the power factor near to unity. Also we can define the power factor range which should be maintained for a particular system using this unit. It also monitors the lagging and leading power factor and takes the necessary control action. The real time data for the power factor can also be stored using this unit. The consumers using power near unity power factor is also provided incentives to encourage the efficient use of electricity.

**3. Dr. Kurt Schipman and Dr. Francois Delince, "The importance of good power quality", ABB power quality Belgium.** 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.

### 4.1 Major finding Outcomes

#### Microcontroller 8051 and Features Of 8051



Fig.2.1 MICROCONTROLLER 8051

#### FEATURES OF MC 8051

- 8bit accumulator, 8bit Register and 8bit ALU
- On chip RAM 128 bytes (data memory).
- On chip ROM 4 Kbytes (program memory).
- Two 16bit counter/ timer.
- A 16 bit DPTR (data pointer)
- Two levels of interrupt priority
- 4 byte bi-directional input/ output port.
- Power saving mode (on some derivatives).
- 16bit address bus:-it can access  $2^{16}$  memory locations:- 64kb (65536) each of RAM and ROM.

**4.2 APPLICATIONS OF POWER FACTOR** This project is a model of static power factor correction method. By increasing the capacity and the ratings of the components it can be used for the following purpose – 1. In industries

2. At substations
3. On the transmission line
4. For commercial purpose

#### PERFORMANCE ANALYSIS

#### 4.3 Advantages OF Improved Power Factor

- Reactive power decreases
- Avoid poor voltage regulation
- Overloading is avoided
- Copper loss decreases
- Transmission loss decreases



- Improved voltage control
- Efficiency of supply system and apparatus

inspected by Microcontroller and which help in the determination of time difference.

#### 4.4 Adverse Effect of Over Correction

- Power system becomes unstable
- Resonant frequency is below the line frequency
- Current and voltage

**6. REFERENCES** 1) D. Beeman, Industrial Power Systems Handbook, Mc Graw-Hill Inc, 1955

### 5. IMPLEMENTATION AND RESULT

**5.1 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 wares 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.

2) Gopal Reddy.K, Mohmed Sufiyan Khan, Asifulla khan, Mohamed Manan, "Intelligent Automatic Power Factor Correction", ISSN: 2394-3696, Volume 2, Issue 5, May 2015

3) I. Lazar, Electric System Analysis and Design for Industrial plan, McGraw-Hill Book Inc, 1980

4) Mazidi Muhammad Ali, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson Education, September 2007, Second edition

5) R. H. S. Soeprapto, A, A. F. A. Abd. Rahman,A, M. N. M. Nasir,A, Z. H. Bohari, "Analysing of a Shunt Compensator Installation" , IJES, Volume 3, Issue 12, December 2014

**5.2 Future Improvement** • In this project, we used the assembly language program to operating the microcontroller 8051 and all other related components. We can also use the Aurdino for this project to make the advanced. In future days in many applications Aurdino is used. • Currently we use microcontroller 8051, the use of another MC can make the system advanced. • By changing the program we can obtain the other advanced features or the LCD will be showing other parameters present in the system for different applications.

6) Satyasuranjeet Behera, Sibasis Mohapatra, Monalisa Bisoi, "Automatic Power Factor Correction By Microcontroller 8051", Thesis, National Institute of Technology Rourkela, 2007

**5.3 Recommendation** It is highly recommended that this system of high capacity should be installed at every industry, commercial buildings an also in a transmission system where the power factor is continuously poor.

**5.4 Acknowledgement:-** 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