



## Programming Of PIC Microcontroller For Improvement Of Power Factor

*Sumit Raut*

*Student*

*Electrical Engineering Department*

*Government College of Engineering, Nagpur*

*Md Juned Siddiqui*

*Student*

*Electrical Engineering Department*

*Government College of Engineering,  
Nagpur,*

*Prashik Burbure*

*Student*

*Electrical Engineering Department*

*Government Collage of Engineering, Nagpur*

*Shivam barekar*

*Student*

*Electrical Engineering Department*

*Government Collage of Engineering,  
Nagpur*

### Abstract:

*Increasing thirst for novel new sources of energy is unquenchable, but we seldom realize that we are wasting a component of the power everyday because of the lagging power factor in the inductive loads we use. Hence necessity arises to provide energy to load at its full potential without the wastage of power so as to achieve such, we have to improve power factor which occurs because of phase shift between voltage and current. To minimize harmonic contamination in power system and reduce transmission loss, power factor correction became an essential topic. Many control methods for Power Factor Correction (PFC) were proposed. This paper describes the layout and development of a one-phase power factor corrector using PIC (Programmable Interface Circuit) micro-*

*controlling chip unit, after determining their zero crossing locations of load voltage and current waveforms.*

*Capacitive banks are used for the compensation of power factor according to the load connected which is determined based on microcontroller based algorithm. Then using desired algorithm in determining and triggering switching capacitors in order to compensate excessive reactive components, thus withdraw PF about unity; as a result, acquires higher efficiency and better-quality AC output.*

## 1. INTRODUCTION:

In the modern AC system the current and the power, is made up of a number of electrical components based on nature of the load consuming the electrical power. These are resistive, inductive and capacitive components. In the case of a purely resistive load, for example, electrical resistance heating, incandescent lighting, etc., the current and the voltage are in phase that is the current follows the voltage. Whereas in case of inductive loads, the current and voltage are out of phase with each other and current lags behind the voltage. Except for a few pure resistive loads and synchronous motors, most of the equipment in the present-day consumer installation are highly inductive in nature. For example, inductive motors of all types, welding machinery, electric arc and induction furnaces, choke coils and magnetic systems, transformers and regulators etc.

In case of capacitive compensation the current and voltage are out of phase but now the voltage lags the current. The most common capacitive loads are the capacitors installed at the correction system of power factor of the load. The inductive, capacitive loads are generally coined as the reactive loads. The significance of different types of loads is that true power can only be consumed in the resistive portion of the load, where the current and the voltage are in phase. Reactive power which is necessary for energizing the magnetic circuit of the equipment (and is thus not available for any useful work). Highly lagging loads require two types power, true power (KW) to perform the actual work of generating heat, light, motion, machine output, etc.,

and Reactive power (kVAR) to sustain the electromagnetic field. The current known as wattless current is required to produce the magnetic field around an electric motor. If there has been watt-less current then an electric motor will not turn on. The problems arise due to the fact that we can sometimes have too much watt-less current, in those cases we need to remove some of it. The phasor sum of these two power components true and reactive is termed as

Apparent Power (kVA), the value of which varies considerably for the same active power depending upon reactive power drawn by the equipment. The ratio of the active power (kW) of the load to the apparent power (kVA) of the load is known as the power factor of the load current is being converted into useful work. It is a measure of how efficiently the output more particularly is a good indicator of the effect of the load current on the efficiency of the supply system. Load power factor of 1 results in the most effective loading of the supply system and a Load with a power factor of 0.5 will result in much increased losses in the supply system. Low power factor leads to large copper losses, poor voltage regulation and reduce handling capacity of the system. The increment of load current, increase in power losses, and reduction in efficiency of the overall system. The industrial load is highly inductive in nature causing a poor lagging power factor. If this notoriously poor power factor is uncorrected, the industry will face high maximum demand from Electricity Company and also will suffer a fine for poor power factor regulation. Essential useful practice is to connect power capacitors in the power system at appropriate places to compensate the lagging nature of the load. Drawbacks of poor power factor can be easily understood by an example:

Supplied Voltage = 220 Volts Single phase.

Motor input = 15 KW

Power Factor = 0.71

Current (I<sub>1</sub>) = Power (kW)/Volts (V)\*P. F  
= 15000/220\*0.71 = 96.03 Amp.

If the power factor of the motor is increased to 0.95 the current Drawn by the motor shall be

Current (I<sub>2</sub>) = Power (kW)/Volts (V)\*P. F  
= 15000/220\*0.95 = 71.77 Amp.

Thus with the reduction of power factor the current requirement for the same value of true, or useful power increases effectively. The result is that the sizes of the equipment, like the switchgear, cables, transformers etc. will have to be increase to provide the higher current in the circuit. All this adds to the cost further the higher current causes increased power loss in the circuits. Also due to higher current, the conductor temperature increases steeply and hence the life

of the insulation is reduced. So, it is evident to improve the power factor by applying certain method and application doing so will lead to improve the system quality and will be cost effective. A poor power factor due to an inductive load can be improved by the addition of power factor correction device to cater the higher current in the circuit. All this adds to the cost.

The various conventional methods for the power factor correction are the using static switching capacitors, thyristorised control reactor, etc. doing so will increase the power factor.

## 2. PROPOSED TOPOLOGY:

Whole system may be divided into three stages. Beginning stage is concerned with step down setup of incoming voltage and current signals into the PIC voltage level. Here we will be using the step down centre tapped transformer. Second stage is concerned with signal level detection by using an IC (LM35G) for voltage and current, the incoming signals. Voltage signal can be acquired by using Optocoupler (TC # 4N25) at the output of Potential Transformer for detection. Current signals would be gained by Current Transformer connected at the main AC line. In third stage the block diagram representing the automatic power factor control with continuous load monitoring system is shown in Fig below

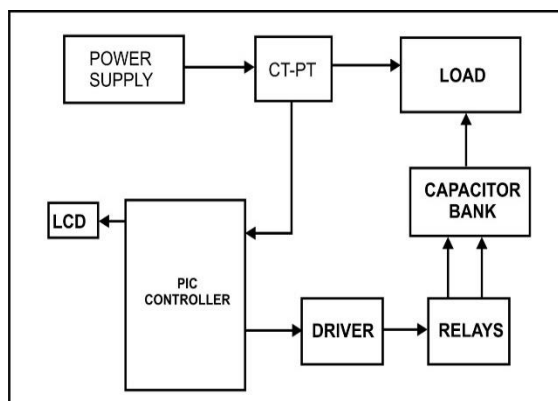
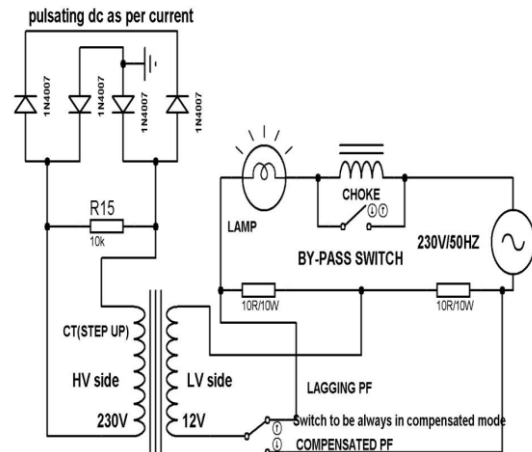


Fig Block Diagram

## 3. CIRCUIT DESIGN:

This design of microcontroller aims at monitoring phase angle continuously and the phase angle deviation a correction device is utilized to compensate the difference by continuous changing variable capacitors value via switching process.



### A. REGULATOR IC 7805

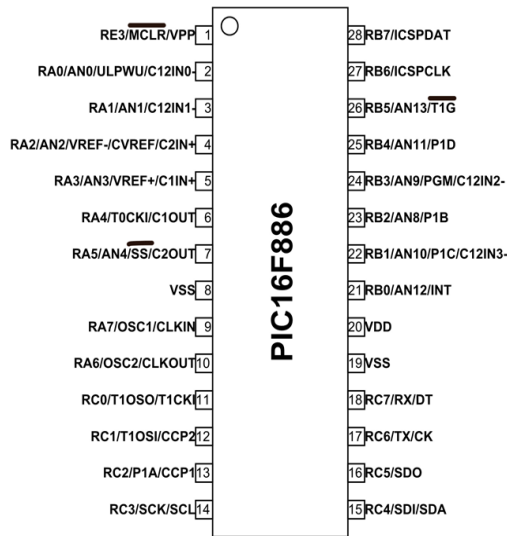
Voltage regulators are very common in electronic circuits. Generating fixed output voltage for variable input voltage of the system. In our case the 7805 IC is an iconic regulator IC that finds its application in most projects.

The output current of this IC can go up to 2.5A. But the IC suffers from high heat loss hence a Heat sink is recommended for projects that consume more current. For example if the input voltage is 15V and you are consuming 2A, then  $(15-5) * 2 = 20W$ . Thus 20 Watts will be dissipated as heat.

### B. PIC16F886 – 8 BIT MICRO CONTROLLER

PIC16F886 is a microcontroller good for experimenting and updating application since it has big flash memory rewrite cycle space. Because of availability of a lot of tutorials and support available online. The controller has 16 KBytes flash memory which is enough for many applications. With the 24 programmable Input and output pins which are designed to handle 22mA current (LED driving capability) the system can easily interface many peripheral smoothly. In

Addition of On timer to reset the errors automatically the controller may be used to develop applications for permanent availability.



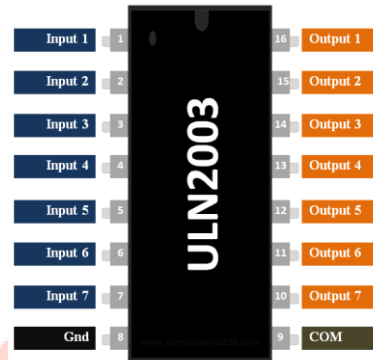
Like other microcontrollers PIC16F886 needs to be programmed before getting the chip working status. So for working of PIC16F886, first we need to save the desired program file in the controller FLASH memory. Once power is given, the controller executes this code available in FLASH memory to create the outcomes.

### C. CAPACITOR BANK

Parallel capacitor banks are utilized for improving voltage profile of electrical supply system and the efficient operation of the power system. Cases shows that a flat voltage profile on the system can steeply reduce line losses. Shunt capacitor banks are inexpensive and can be easily installed, modified anywhere on the electrical network. The capacitor bank consists of required number of shunt capacitors which are in switched state or not depending on the reactive power requirement of the system. The switching of capacitors can be done in both ways by manually or automatically by using relays. Parallel capacitors at customer location for power factor compensation or at the distribution system for voltage control, gradually alter the system impedance with frequency. Capacitors does not create harmonics in electrical circuit, but major harmonic distortion can sometimes be given to their presence. A shunt capacitor at the endline of a feeder network results in a gradual

change in voltage along the feeder line. Generally, the percent voltage increase at the capacitor would be zero at no load condition and give rise to maximum at full load. But with shunt capacitors, percent voltage rise of system is independent of load connected. Thus, automatic switching is often done in order to deliver the desired regulation at high loads, but prevent high level voltage at low loads.

### D. DRIVER IC ULN2003



The ULN2003 IC is generally used Motor driver IC. This Integrated circuit built in handy when we need to drive high load currents using logic circuits like Op-amps, Timers, Gates, DRIVERS, PIC, ARM etc. For example a RELAY that requires 12V and 300mA to run cannot be powered by an PIC I/O hence we use this IC to source enough current and voltage for the load. The Integrated Circuit is generally used to drive Relay modules structures, Motors, high current LEDs and even for the Stepper Motors. So for everything that anything more than 5V 85mA to work, this IC would be the right option for you.

## 4. WORKING

The power supply output which is 5V is connected to the 40th pin of microcontroller and ground to the 20th pin or pin 20 of microcontroller. From Port 0.1 to 0.4 of PIC microcontroller is connected to Pin 1 to 4 of relay driver IC ULN2003 arrangement and Port 0.5 to 0.7 of microcontroller is connected to Pin 4,5 and 6 of LCD display. Again similarly Port 2.0 to 2.7 of microcontroller is connected accordingly to Pin 7 to 14 of data pins of LCD display. Port 3 of

microcontroller is connected to output of the OPAMP LM339. Port 3.3 of microcontroller is connected to output of OPAMP LM339.

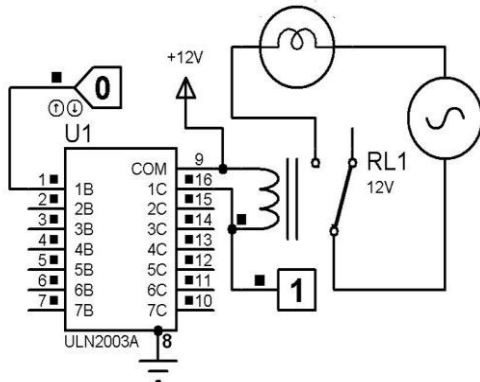


FIG4.1-LOAD OFF

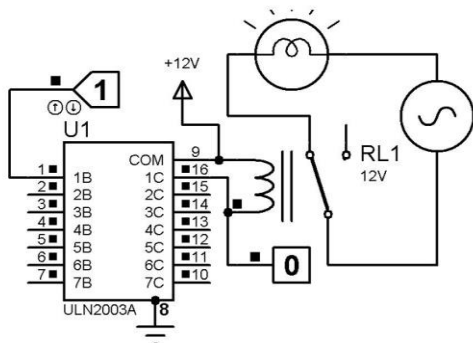


FIG4.2-LOAD ON

The regulator output of 7805 is given to the Microcontroller 40th pin. The pulses of dc is fed to R11 and R24 Resistors respectively. The unregulated voltage is fed to 7812. 7805 output which is 5V connected at pin 40 of Microcontroller. The output of the 7812 regulator is 12v and is fed to op-Amp. This circuit also have other bridge rectifier which an output as pulses of dc relating to the current flowing across the load. The LCD display is connected to corresponding pins. With the Relay driver drive's relay's and the contacts of relay switch turn ON the shunt capacitors.

## 5. CONCLUSION :

This project idea proposes the efficient method of the lagging power compensation by using the PIC microcontroller which has big advantage over the various conventional ways of the power factor correction. The switching capacitors action done

automatically with the relay action and thus this power factor correction method is more accurate and easy. We have this possible enhanced method for the correction of the power factor. Installation of capacitor bank for correction will obtain reasonable benefit for both consumer and electric flow system. Installation of capacitor bank can reduce lagging current further reduces losses. By mentioning various aspects of the power factor it is clear that power factor is the most important part not only for utility company as well as for the consumer. Utility companies get rid of power losses while the costumers are free from low power factor penalty charges for their residential purposes.. The automatic power factor correction using capacitive load banks is very efficient method as it minimizes the cost by reducing the power drawn from the supply system. As it automatically operates, manpower is not required and this Automated Power factor Correction system using capacitive load banks can be used for the industries purpose in the future.

## 6. REFERENCES:

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