Minimising Penalty In Industrial Power Consumption By Using Apfc Unit

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Abstract- *The project is designed 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- Transformer, Bridage Rectifier, LCD Display, Voltage Regulator, Microcontroller AT89C51, Relay, Capacitor Bank, Zero Crossing Detector.

I. INTRODUCTION

Power Factor Theory

In any AC system the current, and therefore the power, is made up of a number of components based on the nature of the load consuming the 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 the case of inductive loads, the current is out of phase with the voltage and it lags behind the voltage.

Except for a few purely resistive loads and synchronous motors ,most of the equipment and appliances in the present day consumer installation are inductive in nature, for example, inductive motors of all types, welding machines, electric arc and induction furnaces, choke coils and magnetic systems , transformers and regulators, etc. In the case of a capacitive load the current and voltage are again out of phase but now the current leads the voltage. The most common capacitive loads are the capacitors installed for the correction of power factor of the load. The inductive or the capacitive loads are generally termed as the reactive loads.

The significance of these different types of loads is that the active (or true or useful) power can only be consumed in the resistive portion of the load, where the current and the voltage are in phase. (Watt less or) reactive power which is necessary for energizing the magnetic circuit of the equipment (and is thus not available for any useful work). Inductive loads require two forms of power - Working/Active power (measured in kW) to perform the actual work of creating heat, light, motion, machine output, etc., and Reactive power (measured in kVAr) to sustain the electromagnetic field. The current known as watt- less current is required to produce the magnetic field around an electric motor. If there was no watt-less current then an electric motor would not turn.

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 vector combination of these two power components (active and reactive) is termed as Apparent Power (measured in kVA), the value of which varies considerably for the same active power depending upon the 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.

It is a measure of how effectively the current is being converted into useful work output and more particularly is a good indicator of the effect of the load current on the efficiency of the supply system. A load with a power factor of 1.0 result in the most efficient loading of the supply and a Load with a power factor of 0.5 will result in much higher losses in the supply system.

Low power factor leads to large copper losses, poor voltage regulation and reduce handling capacity of the system. The increase in the load current, increase in power loss, and decrease in efficiency of the overall system 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.

Power Triangle

Power factor is the ration between the KW and the KVA drawn by an electrical load where the KW is the actual load power and the KVA is the apparent load power. It is a measure of how effectively the current is being converted into useful work output and more particularly is a good indicator of the effect of the load current on the efficiency of the supply system.

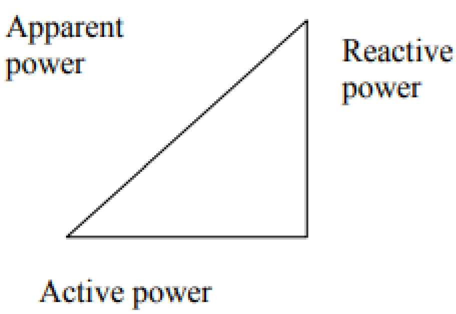

Figure 1 :Power Triangle

All current will cause losses in the supply and distribution system. A load with a power factor of 1.0 result in the most efficient loading of the supply and a load with a power factor of 0.5 will result in much higher losses in the supply system. A poor power factor can be the result of either a significant phase difference between the voltage and current at the load terminals, or it can be due to a high harmonic content or distorted/discontinuous current waveform. Poor load current phase angle is generally the result of an inductive load such as an induction motor, power transformer, lighting ballasts, welder or induction furnace. A distorted current waveform can be the result of a rectifier, variable speed drive, switched mode power supply, discharge lighting or other electronic load.

A poor power factor due to an inductive load can be improved by the addition of power factor correction unit(capacitor bank) but, a poor power factor due to a distorted current waveform requires a change in equipment design or expensive harmonic filters to gain an appreciable improvement. Many inverters are quoted as having a power factor of better than 0.95 when in reality, the true power factor is between 0.5 and 0.75. The figure of 0.95 is based on the Cosine of the angle between the voltage and current but does not take into account that the current waveform is discontinuous and therefore contributes to increased losses on the supply

II. CIRCUIT DESCRIPTION

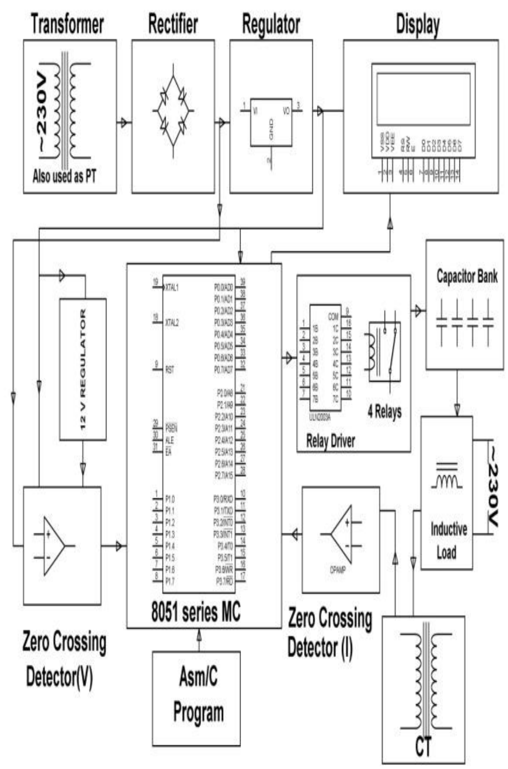

Figure 2: Circuit Diagram of Power Factor Correction

As Shown in above Fig The supply signal voltage and current is given by CT and PT to the rectifier unit which converts these ac signal to dc signal. Then this dc supply is given to regulator. There are two regulators are used 7805 & 7812. +ve 12V supply is given to ZCD(V) and ZCD(C) for their operation and also give to the LCD display unit. +ve 5V supply is given to microcontroller. Operational amplifier act as comparator and generate dual pulses. These pulses are given to two

Power Supply

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as “Regulated D.C Power Supply”.

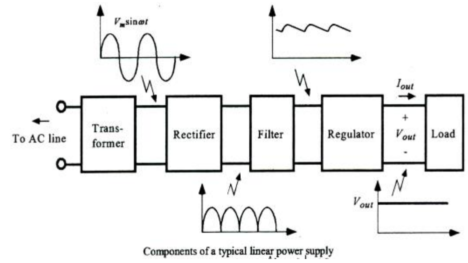

Figure 3 Block Diagram of Power Supply

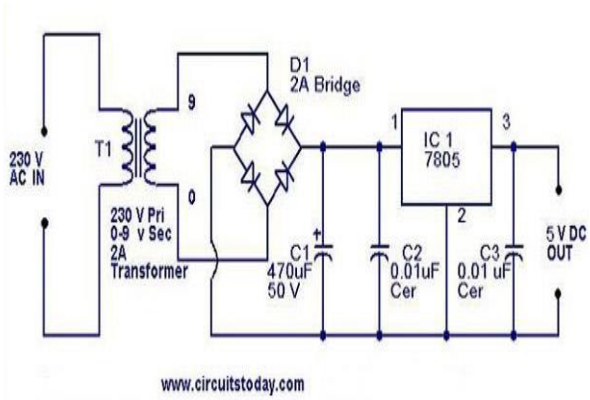

Figure 4 circuit diagram of power supply

Explanation: - The input supply i.e., 230V AC is given to the primary of the transformer (Transformer is an electromechanical static device which transform one coil to the another without changing its frequency) 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 out put of the bridge circuit is not pure dc, some what rippled ac is also present. For that capacitor is connected at the output of the diodes to remove the unwanted ac, capacitor are also used for filtering purpose. The both (-ve) terminal of the diode (D2 & D3) is connected to the (+ve) 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 +ve voltage is obtained.

Similarly , for –ve voltage ,here the both +ve terminals of the diodes(D1 & D4) is connected to the –ve terminals of the capacitors and thus to the I/p of the IC regulator with respect to ground. The o/p of the IC regulator(7912) which is a –ve 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 –ve voltage is obtained. The mathematical relation for ac input and dc output is

$Vdc=Vm/3.141$ (before capacitor)

$Vd=Vm$(after capacitor)

III. RESULTS

This method of improving the power factor gives rise to the correction of power factor of inductive load.

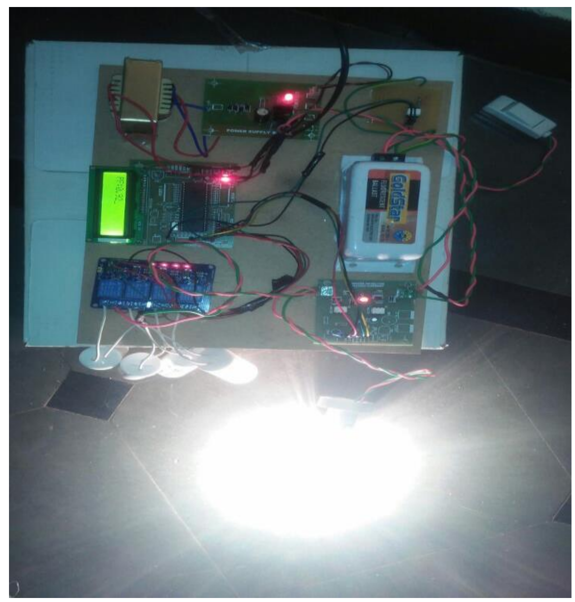

Figure 5 Project Kit

IV. 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 hardwares 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.

FUTURE SCOPE

In this technique there is no anyone moving part and also no extra motor is required for power factor correction thus it has low cost as compared to synchronous compensation technique. As compare to static compensation technique it has long life. So Automatic Power Factor Correction Technique can use in industries in future.

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