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Minimizing Penalty in Industrial Power Consumption by Engaging APFC Unit

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Abstract: *In the industrial division, the numerous motoring loads are continuously running and generating the inductive load. Power consumption is increasing day by day at a very high rate. So the power factor in this operation gets lessened due to the inductive reactive power. The electricity company charges the penalty to the industrial consumers if the power factor goes below the specified limit;. By using power capacitors the required compensation can be achieved to overcome inductive reactance with the help of APFC panel. The current transformer sends a current signal which is received by the microcontroller 8051 and simultaneously the signals are fed to the various contactors to connect the capacitors in the line. Thus due to addition of the capacitor to the line, it will help in compensating the reactive power and thus maintain the power factor near to unity. This will avoid the penalty to the industrial consumers. In the conventional methods, we were using the fixed capacitor for compensation. But these led to excessive charging of the capacitors, which in turn caused the voltage surges. Thus it becomes complicated to maintain power factor near unity by on and off operation of the fixed capacitor. The contactor switched capacitors are connected and disconnected automatically eliminating the previous predicament.*

Keywords : *microcontroller 8051, capacitor bank, embedded technology.*

I. Introduction

In any AC system the current, and thus the power, is formed of variety of components based on the nature of the load consuming the power. These are resistive, inductive and capacitive elements. In case of a purely resistive load, for instance, electrical resistance heating, incandescent lighting, etc., the current and also the voltage are in phase i.e the current follows the voltage. While, in case of inductive loads, current lags behind the voltage i.e the current is out of phase with the voltage. Almost all of the equipment and appliances in the present day are inductive in nature (Except few purely resistive loads and synchronous motors), for instance, inductive motors of every type, electric arc, welding machines, and induction furnaces, choke coils and magnetic systems , transformers and regulators, etc. In the case of a capacitive load the current and voltage are once more out of phase however now the current leads the voltage. The foremost common capacitive loads are the capacitors put in for the correction of power factor of the load.

II. Problem Statement

An electrical load that operates on alternating current requires apparent power, which consists of real power plus reactive power. Real power is the power actually consumed by the load. Reactive power is repeatedly required by the load and given back to the power source, and it is the cyclical effect that occurs when alternating current passes through a load that contains a reactive component.

The real power is less than apparent power whenever reactive power is present which results in a power factor less than 1 of electrical loads . The reactive power increases the current flowing between the power source and the load, which also increases the power losses through transmission and distribution lines. This results in operational and financial losses for power companies. Therefore, power companies require their customers, especially those with large loads, to maintain their power factors above a specified amount (usually 0.90 or higher) or be subject to additional charges.

Electrical engineers involved with the generation, transmission, distribution and consumption of electrical power have an importance in the power factor of loads because power factors affect efficiencies and costs for both the electrical power industry and the consumers. If the operating costs are increased, reactive power may require the use of switches, C.B, Transformers, transmission lines with higher current capacities. In order to correct the power factor of ac loads or transmission system, there are various methods available. One of

the methods is by switching the capacitors or inductor banks on or off which results in canceling of inductive or capacitive effects of the connected loads. Whenever a non-linear load is connected to a system it creates harmonic currents in addition to the original Ac current. The above simple method described does not nullify the reactive power at harmonic frequencies, for this, there are other techniques which must be used while dealing with the non-linear loads.

III. Block Diagram

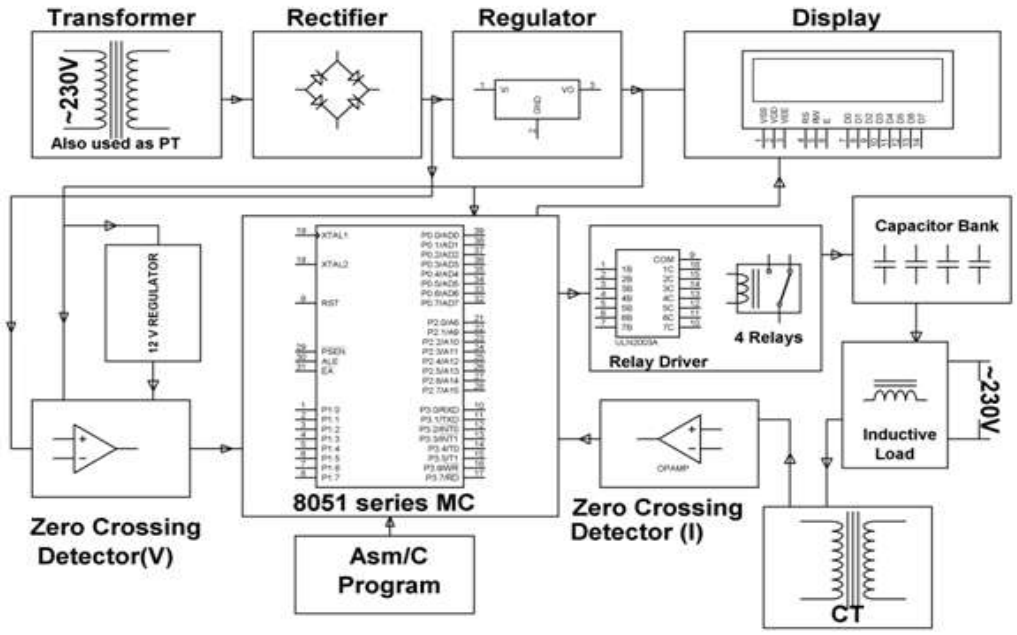

Fig 3.1 Block diagram of APFC unit

IV. Methodology

4.1 Power supply: In power supply we are using step-down transformer. The 230 V ac input supply is given to the primary of the transformer. Transformer is an electromechanical static device which transforms power from one circuit to another without changing its frequency. Due to the magnetic effect of the coil the flux induced in the primary is transferred to the secondary coil.

4.2 Rectifier: The main function of the rectifier is to convert the ac voltage to the dc output. The diode is a primary component in most of the rectifier circuits since it conducts in one direction. This property of diode convert the
sinusoidal voltages with zero average value into waveforms that contains both ac and dc components (pulsating dc). It is a full wave bridge rectifier.

4.3 Voltage Regulator: The main function of the voltage regulator is to convert the variable output DC voltage into the constant DC voltage which is required for the supply for the microcontroller and zero crossing detector. Zero Crossing Detectors: The zero crossing detector circuit is an important application of the op-amp comparator circuit. It can also be called as sine to square wave convertor. It is used to spot the sinusoidal wave zero crossing from positive half cycle to negative half cycle. The reference voltage with which the input voltage is to be compared, must be made zero (Vref=0). The input sine wave is given as an Vin. To measure the time difference between two waves we need to detect zero crossing of two waves. Zero crossing detector produces an output state change whenever the input crosses the reference input.

4.4 Microcontroller: Microcontroller is a IC chip that executes programs for controlling other devices or machines. Its a micro sized IC chip device which is used for control of other devices and machines, that is why it is called microcontroller. It is a microprocessor having RAM, ROM and I/O ports. 8051 microcontroller is used in automatic power factor correction panel. The microcontroller receives the load current in the line and gives the signal to the relay driver and simultaneously connects the capacitors as per the need.
Relay: A relay is an electrically commanded switch. Many relays employ an electromagnet to perform a switching mechanism automatically, however, different operating principles are also utilized. Relays are used

wherever it is essential to control a circuit by a weak-power signal or where numerous circuits must be controlled by unit signal. Current running through the coil of the relay generates a magnetic field which attracts a lever and switches the switch connections. The coil current can be on or off so relays have two switch locations and utmost have double throw switch.

4.5 Relay Driver: Relay Driver is interfaced with the microcontroller output. It is used to drives the multiple relays as per the compensation required.

4.6 LCD: LCD stands for liquid crystal display. It is a flat panel display or alternative electronic visual display that uses the light modulating properties of liquid crystals. liquid crystal display is employed to indicate the present power factor. 16x2 digital display is connected with 8051 microcontrollers. it's obtainable in an exceedingly 16 pin package with backlight, adjustment of contrast function and each dot matrix have 5×8 dot resolution.

4.7 Capacitor Bank: Capacitors can be included for compensation of power factor through a relay. A capacitor bank is a combination of different capacitors of the similar rating that are connected in series or parallel with each other to stock electrical energy. The resulting bank is then used to correct a power factor lag or phase shift in an ac power capacitor does. They are intended to store electrical energy. The most basic use of a capacitor bank for Alternating Current power supply (AC) error improvement is in industrial conditions. Where a huge number of transformers and electric motors are used. As this machine makes use of an inductive load, they are responsive to phase shifts and power factor lags in the power supply which may reduce system efficiency if left uncorrected. By including a capacitor bank in the system, the power lag can be corrected at the lowest cost possible for the company when compared to making notable changes to the company power grid or system that is supplying the equipment.

V. Requirements

Hardware requirements:

1.Capacitor Banks

2.Transformers

3.Diodes

4.PCB

5.8051 Micro Controller

6.LED

7.Voltage Regulator

8.Relays

9.LCD

10.Relay Driver IC

11.Switches

12.Resistors

Software Requirements:

1.Embedded C language: Embedded C language is an add-on to programming c language with some addition of header files, from a controller to controller these header files may vary.Embedded C programming depends on hardware architecture. It possesses cross development in nature.Embedded C programming is used for limited resources like RAM, ROM and I/O peripherals on an embedded controller.Embedded C programming

needs some non-standard extensions for the C language which is required to support some features like fixed-point arithmetic, multiple well-defined memory banks, and basic I/O operations.Programming of 8051 microcontrollers is first done in embedded C and then converted into Hex code and this code is dumped into microcontroller IC.

2.Compiler: A compiler is basically a translator, a compiler is also a program which is built to transform the source code which is written by a developer in a binary code which is also known as machine language. The process of converting programs into machine language is known as compilation. An important part of the translation process is that compiler sends warnings or reports to its user about the errors present in the source program. compilers are sometimes classified as single pass, multi-pass,load and go, debugging, optimizing. There are two parts of compilation analysis and synthesis. In the first part which is analysis it breaks up the program into its integral pieces and on the other hand in the second part which is synthesis, it builds the desired target program from the intermediate representation. compilers translate source code into object code and this is unique for each type of computer platforms hence there are many compilers available for the same language.

VI. Conclusion

After studying in depth and observing the aspects of the power factor it's clear that power factor is that the most important part for the utility company also as for the consumer. Utility companies get rid of from the power losses whereas the consumers are free from low power factor penalty charges. The automotive power factor correction by the use of capacitive load banks is extremely economical because it reduces the cost by decreasing the power drawn from the supply. Other advantage is that it is automated process, hence no man power is required.

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