Automatic Power Factor Compensation (APFC) For Industrial Power Use to Minimize Penalty

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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.

Index Terms— ***Microcontroller 8051, Capacitor bank, Embedded Technology.***

I. INTRODUCTION

Power factor is the ratio between real power and the apparent power of the equipment. In the present trend, Automatic Power Factor Controller design can be achieved by using programmable device. As we think about programmable device embedded system comes forefront. Embedded system nowadays is very popular and microcontroller proves to be advantageous with the reduction of cost, extra hardware use such as timer, RAM, ADC are avoided. Only the relays used are disadvantageous as they are too bulky and need regular maintenance. Now the embedded technology has become cheaper with the help of technical revolution so as to apply it in all the fields. Automatic Power Factor Correction device is very useful to improve the transmission of active power efficiently. Power factor must be maintained within a limit. As inductive load is connected, Power factor lags and when Power factor goes below the lagging Power factor, then a penalty is charged by the supplying company. Therefore, it is necessary to maintain Power factor within limit. APFC techniques can be applicable to industries, power systems and also to households to make them stable and also help in improving the efficiency of the system. Poor Power factor can be improved by addition of Power factor correction, but a poor Power factor which is caused due to distortion in current waveform needs to have a change in the design of the equipment APFC is to be developed based on

Microcontroller (AT89S52\C51) Poor Power factor can be improved by addition of Power factor correction, but a poor Power factor which is caused due to distortion in current waveform needs to have a change in the design of the equipment APFC is to be developed based on microcontroller (AT89S52\C51). Lesser reactive power flows from the line. They decrease the phase difference in the voltage and current. When capacitors are used Losses are low and also requires very less maintenance. Installation of capacitors is easy because of lighter weight and do not require foundation.

II. LITERATURE SURVEY

[1] "Using capacitors", International Journal of Engineering Trends & Technology (IJETT), Volume 4, Issued 7-July 2013. The project's main goal was to develop corrective machinery that could measure the

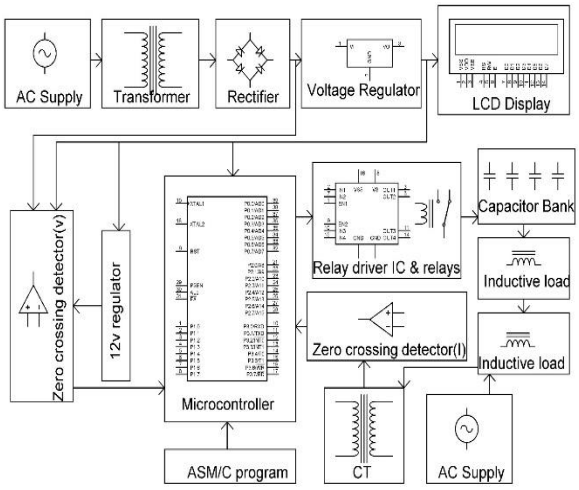
electrical system's power factor and raise it to a target level.

[2] Tagwira, M. P., Design of an Automatic Power Factor Correction System, (2014) The majority of industrial loads, including induction motors, function at comparatively low power factors. The power system's total power factor is low since motors make up about 60% of the utility load. These motors are innately low power factor devices, depending on the intensity of the load. These motors have a power factor that ranges from 0.30 to 0.95 depending on the size of the motor and other operational factors. As a result, utilities, users, and industrial power systems are always concerned with the power factor level.

III. OBJECTIVE

- To conduct an electrical survey of the existing system in an opencast mine to study the system configuration and load patterns, variation of power factor during the mine operation hours and analyze power factor correction facility, if any.
- Design a microcontroller-based correction equipment to improve the power factor of the system to desired value of greater than 0.95.
- Implement the system and monitor different electrical load models and diverse load patterns to verify the result Technological Feasibility
- To carry out economic analysis for power factor improvement.

IV. METHODOLOGY



Block Diagram

Power Supply: We are using step down transformer in power supply. Input supply 230-volt ac is given to primary of transformer without changing its frequency. The transformer transforms the power from one circuit to another. It is electromechanical static device. The flux induced in primary due to the magnetic effect of the coil is change to secondary coil.

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

Voltage Regulator: It is main function is to convert the variable output dc voltage into the constant dc voltage which is used for the supply to the microcontroller and zero crossing detector.

Zero Crossing detectors: The zero-crossing detector circuit is an essential application of the op- amp comparator circuit. It is required to detect sine wave zero crossing from positive half cycle to negative half cycle. It also known as sine to square wave convertor. The reference voltage with which the input voltage is to be balanced must be made zero.

Microcontroller: The main function of microcontroller is that execute programs for controlling other devices or machines. It is integrated circuit chip i.e., IC. They are used to control of another device and machine therefore is known as microcontroller. It includes RAM, ROM and I/O parts. In APFC panel 8051microcontroller is used. In the line it receives the load current and gives the signal to the relay driver and connect the capacitor as per the requirement.

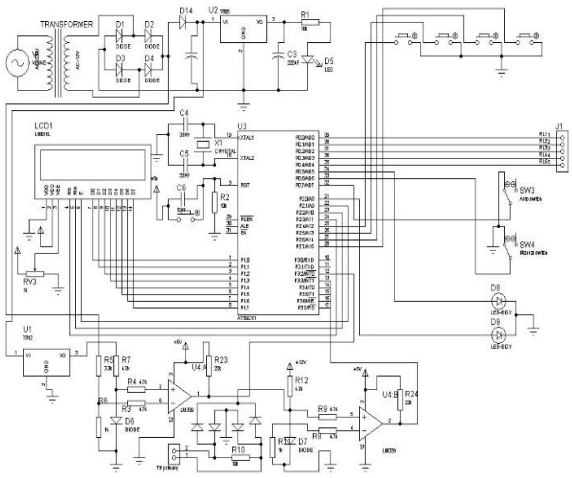
Relay: They are electrically operated switch several relays used an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. It is necessary to control a circuit by low power signal the relay is used. Current flowing through the coil of the relay produced a magnetic field which attract a level and changes the switch contacts. The relays have two switch position

therefore the coil current can be ON or OFF and most having double throw switch.

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.

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. CIRCUIT DIAGRAM



VI.RESULT AND MODEL

APFC (Automatic Power Factor Compensation) for Industrial Power Use to Minimize Penalty. The project is designed to minimize penalty for industrial units using automatic power factor correction unit. In this proposed system, two zero crossing detectors are used for detecting zero crossing of voltage and current.

By observing all aspects of the power factor it is clear that power factor is the most significant part for the utility company as well as for the consumer. Utility companies get rid from the power losses while the consumers are free from low power factor penalty charges. By installing suitably sized power capacitors into the circuit the Power Factor is improved and the value becomes nearer to 0.9 to 0.95 thus minimizing line losses and improving the efficiency of a plant. By using this APFC system the efficiency of the system is highly increased. The cost of consumer bill is reduced

VII.CONCLUSION

It can be concluded that power factor correction techniques can be applied to the industries, power systems and 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.

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