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Automatic Power Factor Compensation for Industrial Power Use to Minimize Penalty

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ABSTRACT

This project is designed to minimize penalty for industrial units using automatic power factor correction unit. The micro controller used in this project belongs to 8051 family. In this proposed system, two zero crossing detectors are used for detecting zero crossing of voltage and current. The time lag between the zero-voltage pulse and zero-current pulse is duly generated by suitable operational amplifier circuits in comparator mode is fed to two interrupt pins of a micro-controller. The program takes over to actuate appropriate number of relays from its output to bring shunt capacitors into load circuit to get the power factor till it reaches near unity. The capacitor bank and relays are interfaced to the micro-controller using a relay driver. It displays time lag between the current and voltageon LCD.

Keywords :- PF controller, Inductive, Microcontroller, Load, Relay, PFCorrection.

INTRODUCTION

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) . 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. The capacitor bank and relays are Research Article Volume 10 Issue No.7 IJESC, July 2020 26778 interfaced to the microcontroller using a relay driver. It displays time lag between the current and voltage on an LCD. Furthermore, 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.

LITERATURE REVIEW

Automatic Power Factor compensation for industrial power use to minimize penalty.

"Microcontroller Based Automatic Power Factor Correction" by Smruti Suman Routray. This paper discusses The power factor correction device designed was able to improve the power factor from 0.76 to
0.97 under the test load conditions. The average savings in energy consumption was about 1.7% for the designed load anddifferent load patterns.

Design & Implementation of a Microcontroller Based Automatic Power Factor Rectification System for Different Loads.Md. Mayen Uddin; Abdullah Al Mahmud; Naeemul Islam.2019 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT)Year: 2019

W. Ali, H. Farooq, M. Jamil, A. U. Rehman, R. Taimoor and M. Ahmad, "Automatic Power Factor Correction for Single Phase Domestic Loads by Means of Arduino Based TRIAC Control of Capacitor Banks," 2018 2nd International Conference on Energy Conservation and Efficiency (ICECE), Lahore, 2018

Y. Kabir, Y. M. Mohsin and M. M. Khan, "Automated power factor correction and energy monitoring system," 2017 Second International Conference on Electrical, Computer and Communication Technologies (ICECCT), Coimbatore, 2017

M. B. Khan and M. Owais, "Automatic power factor correction unit," 2016 International Conference on Computing, Electronic and Electrical Engineering (ICE Cube), Quetta, 2016

METHODOLOGY

There are several existing procedures for power factor correction in modern days.

A. Synchronous Condenser

It is a synchronous motor that rotates under no load condition. Asynchronous motor shows capacitive behaviour while operating in over-excited mode. By controlling the field excitation power factor can be adjusted

continuously. It provides on . step-less PF correction and not affected by system harmonics. But its installation and maintenance is costly.

B. Static Capacitor Bank

Power factor as it shifts current ahead of the voltage. So to correct lagging power factor, it is a convenient method for which this method is practiced worldwide vastly. Though it has some limitations like the inability to absorb harmonics and doesn't provide step-less correction, it is a popular choice for PFC for its low cost of installation and maintenance.

C. Others Methods

There are also some other complicated methods invented for PF correction which are not much popular for economical purpose and some methods are under research. Phase Advancer, Three-phase buck-boost PFC circuit and controlling method etc. are some other under research methods. Our developed system is based on power factor correction using capacitors as it is convenient for economic design. PF will be determined by the microcontroller and capacitors will be introduced in the system. Automatic switching of capacitor combination ensures the desired amount of PF correction and eliminates over- correction.

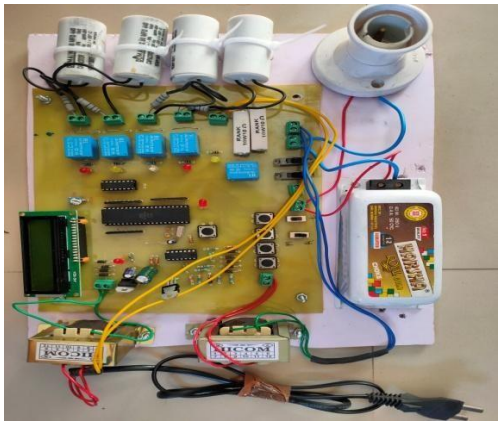
The whole APFC unit consists of eight modules. They collectively work together to gain a power factor correction.

These modules are given as follows:o

Power supply.
- o Voltage sensor circuit.
- o Current sensor circuit.
- o Microcontroller.
- o Inductive load network.
- o Relay driver.
- o Display.
- oCapacitor Bank

HARDWARE SETUP

The proposed system takes 230v 50Hz mains supply as a power source and steps down the voltage level to 12v through a PT. The power supply unit, then converts this 12v AC into two different DC power consisting of +9v and +5v. The sample voltage signal is obtained from this 12v AC signal and processed through the voltage sensor circuit for microcontroller input. A current signal sample is also obtained from the mains supply by a current transformer

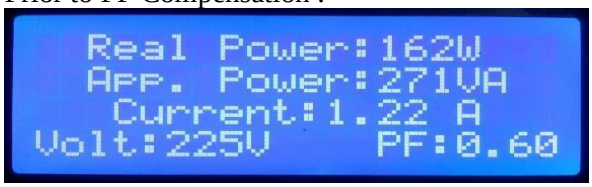


and processed by a current sensor circuit for another microcontroller input. The microcontroller performs power factor calculations and switches capacitors from the bank. The results are displayed on a 20x4 LCD display.

OPERATION PROCEDURE

To demonstrate the working process of the APFC and Energy Monitoring system some highly inductive loads were installed to create a load network. The loads were connected in a manner of combination such that different power factors could be introduced to the system. The load network consisted of some inductors having high inductance value in series with some combination of resistors. As the resistance level is decreased keeping the inductance constant, the proportion of inductance compared to resistive component increased, and the power factor falls down. A decreasing power factor was thus created in the system. The system can detect and measure the exact power factor of a load network. The pre-programmed microcontroller can determine the required VAR demand for raising the power factor up to 0.97. It then switches on capacitors from the capacitor bank based on the VAR demand.

Prior to PF Compensation :-



After PF Compensation :-

FUTURE SCOPE

In case of automatic PF correction, if the load is changing frequently, the numerous switching of capacitor bank may cause harmonic problem. Suitable filter design as well as an optimum algorithm design can be done based on the frequent load change pattern to avoid regular switching of capacitor bank. A comparative study on the location of correction equipment may be employed in the field to find out the optimum location referring to maximum utilization and savings. This project can be extended using Zigbee technology, which increases operating wireless distance. The system can also be extended using GSM technology which sends the alerting SMS messages about the power factor correction to the authorities.

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. 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. The APFC device helps to pull in high current drawn from the system and reduce charges on utility bills. A reduced power consumption results in lower greenhouse gas emissions and fossil fuel depletion by power stations and would benefit the environment.

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