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Minimizing Penalty in Industrial Power Factor by Engaging APFC Unit

Vikramsingh R. Parihar[#1], Rohan V. Thakur[*2],
Aparna R. Khairkar[#3], Kaustubh S. Kalkonde[#4], Roshani S. Nage[#5]

[#1,2,3,4] *Department of Electrical Engineering,*
Prof Ram Meghe College of Engineering & Management, Badnera- Amravati
Amravati, Maharashtra, India
[1] vikramparihar05@gmail.com, [2] rvt.prmceam@gmail.com, [3] khairkar.aparna@gmail.com,
[4] kskprmceam@gmail.com, [5] roshani.nage@gmail.com

Abstract - This project has proposed the advanced method of the power factor correction by using the microcontroller which has the many advantages over the various conventional methods of the power factor compensation. The switching of capacitors is done automatically by using the relay and thus the power factor correction is more accurate. 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. The automotive power factor correction using capacitive load banks is very efficient as it reduces the cost by decreasing the power drawn from the supply. As it operates automatically, manpower is not, required and this Automated Power factor Correction using capacitive load banks can be used for the industries purpose in the future.

Future Index Terms - Automatic Power Factor Correction (APFC), Capacitor Banks, Minimizing Penalty, Power Factor

I. INTRODUCTION

In the present scenario of technological revolution, it has been observed that the power is very precious. The industrialization is primarily increasing the inductive loading, the Inductive loads affect the power factor so the power system losses its efficiency. There are certain organizations developing products and caring R&D work on this field to improve or compensate the power factor. In the present trend the designs are also moving forwards the miniature architecture; this can be achieved in a product by using programmable device. Whenever we are thinking about any programmable devices then the embedded technology comes into forefront. The embedded is now a day very much popular and most the product are developed with Microcontroller based embedded technology. The advantages of using the microcontroller is the reduction of the cost and also the use of extra hardware such as the use of timer, RAM and ROM can be avoided. This technology is very fast so controlling of multiple parameters is possible; also, the parameters are field programmable by the user.

The electrical engineering and its applications are the oldest streams of Engineering. Though these systems are quite reliable and cheaper, it has certain disadvantages. The electro mechanical protection relays are too bulky and needs regular maintenance. The multifunctional is out of question. Recently, the technical revolution made embedded technology cheaper, so that it can be

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applied to all the fields. The pioneer manufactures of Power system and protection system such as SIMENS, LARSON & TUBRO, and CUTLER HAMPER etc. manufacturing power factor improvement devices on embedded technology.

The Automatic Power factor Correction device is a very useful device for improving efficient transmission of active power. If the consumer connect inductive load, then the power factor lags, when the power factor goes below 0.97(lag) then the Electric supply company charge penalty to the consumer. So, it is essential to maintain the Power factor below with in a limit. Automatic Power factor correction device reads the power factor from line voltage and line current, calculating the compensation requirement switch on different capacitor banks.

II. PROPOSED SYSTEM

In this proposed system, two zero crossing detectors are used for detecting zero crossing of voltage and current. The project is designed to minimize penalty for industrial units using automatic power factor correction unit. The microcontroller used in this project belongs to 8051 family. 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 microcontroller. 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 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.

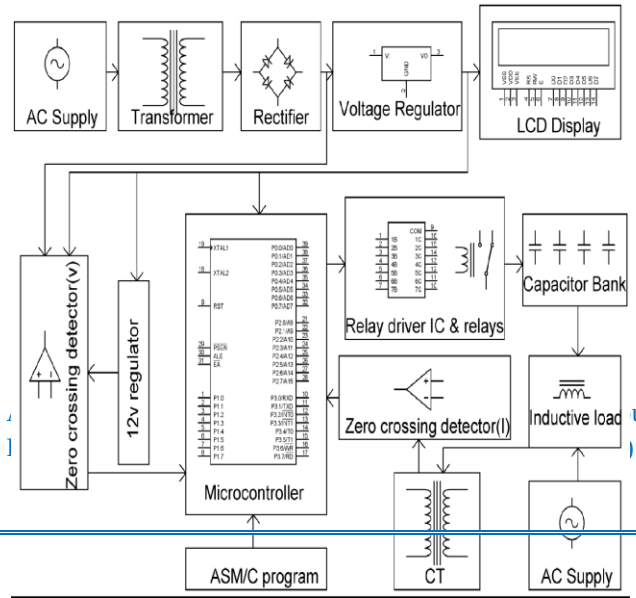

Fig. 1: Block Diagram

The output of the regulator 7805 is given to the Microcontroller 40th pin. The pulsating dc is fed to R11 and R24 Resistor's. The unregulated voltage is fed to 7812. 7805 output which is 5v is fed to 40th pin of Microcontroller. The output of the 7812 regulator is 12v and is fed to op-Amp. In this circuit we have another bridge rectifier it gives an output as pulsating dc corresponding to the current flowing across the load. The LCD display is connected to corresponding pins. Relay driver drive's relays and the contacts of relays switch ON the shunt capacitors. Description of ZVS and ZCS: In order to generate ZVS (Zero Voltage Sensing) pulses first we need to step down the supply voltage to 12 V and then it is converted into pulsating D.C. Then with the help of potential divider the voltage of 3 V is taken, which is given to a comparator LM339 part A. The comparator generates the zero crossing pulses by comparing this pulsating D.C with a constant D.C of 0.6 V forward voltage drop across a silicon diode.

Capacitors for Power-Factor Improvement:

Whatever the power factor is, however, the generating authority must install machines capable of delivering a particular voltage and current even

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though, in a particular case, not all the voltage and current products is being put to good use. The generators must be able to withstand the rated voltage and current regardless of the power delivered. For example, if an alternator is rated to deliver 1000A at 11000 volts, the machine coils must be capable of carrying rated current. The apparent power of such a machine is 11 M V A and if the load power factor is unit this 11 MVA will be delivered and used as 11 MW of active power i.e., the alternator is being used to the best of its ability. If, however, the load power factor is said, 0.8 lagging, then only 8.8 MW are taken and provide revenue, even though the generator still has to be rated at 1000A at 11 kV. The lower the power factor, the worse the situation becomes from the supply authorities' viewpoint.

Location of PF Improvement Capacitor Banks:

Any Installation including the following types of machinery or equipment is likely to have low power factor which can be corrected, with a consequent saving in charges, by way of reduced demand charges, lesser low power factor penalties:

1. Induction motors of all types (which from by far the greatest industrial load on a.
c. mains).
2. Power thyristor installation (for D.C. motor control and electro-chemical processes).
3. Power transformers and voltage regulators.

Apart from penalties like maximum demand charges, penalty for low power factor, which will enable additional machinery to be connected to the supply without enlarging these services. Additionally, the voltage drop in the system is reduced.

Factor Correction:

The power factor of an AC electric power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit, and is a dimensionless number between 0 and 1 (frequently expressed as a percentage, e.g. 0.5 pf = 50% pf). Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit. Due to energy stored in the load and returned to the source, or due to a non-linear load that distorts the wave shape of the current drawn from the source, the apparent power will be greater than the real power.

In an electric power system, a load with a low power factor draws more current than a load with a high-power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor

Linear loads with low power factor (such as induction motors) can be corrected with a passive network of capacitors or inductors. Non-linear loads, such as rectifiers, distort the current drawn from the system. In such cases, active or passive power factor correction may be used to counteract the distortion and raise the power factor. The devices for correction of the power factor may be at a central POWER substation, spread out over a distribution system, or built into power-consuming equipment.

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III. RESULT

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.

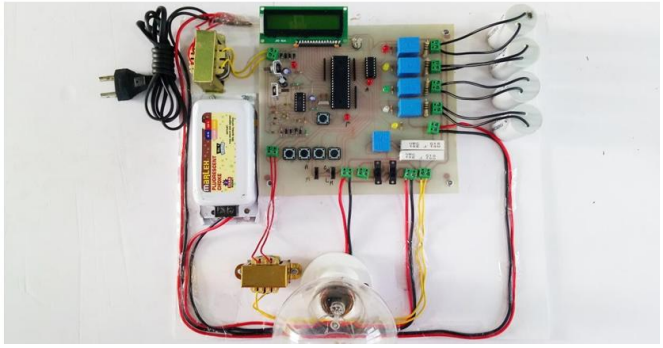

Fig. 2: Overall Project

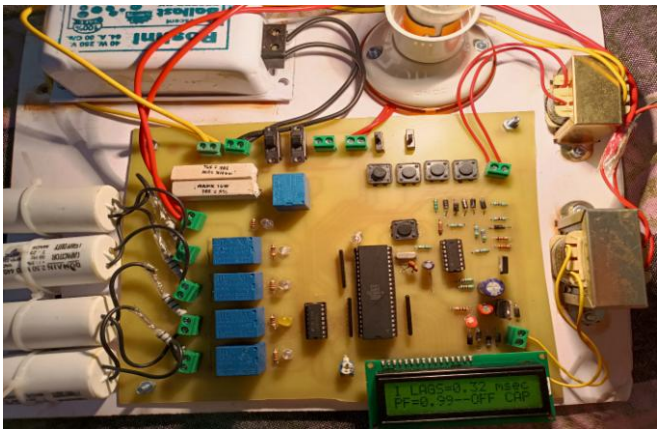

Fig. 3: When only Resistive Load is Present

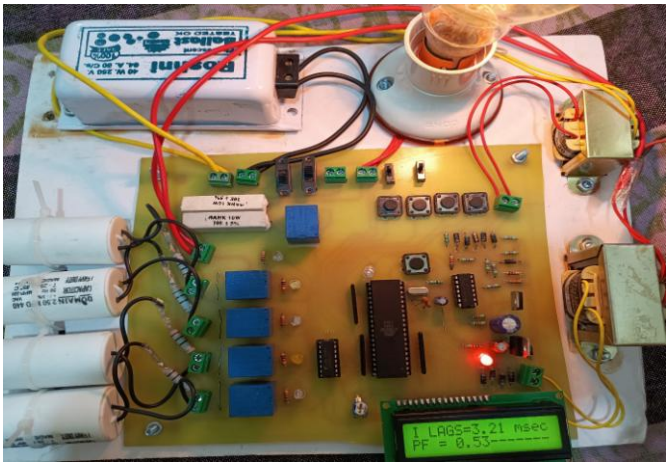

Fig. 4: When we add Inductive Load

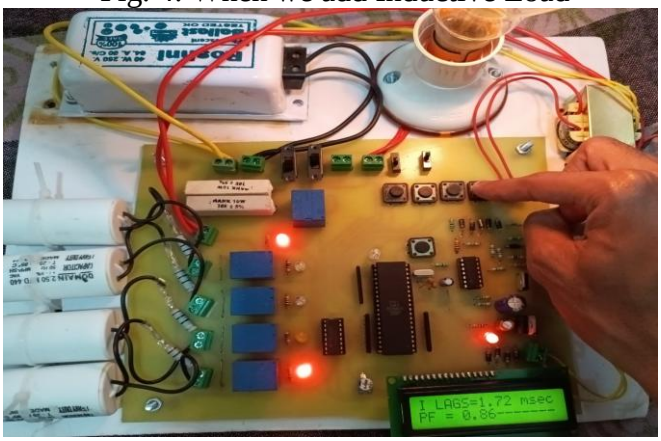

Fig. 5: When One Capacitor is ON

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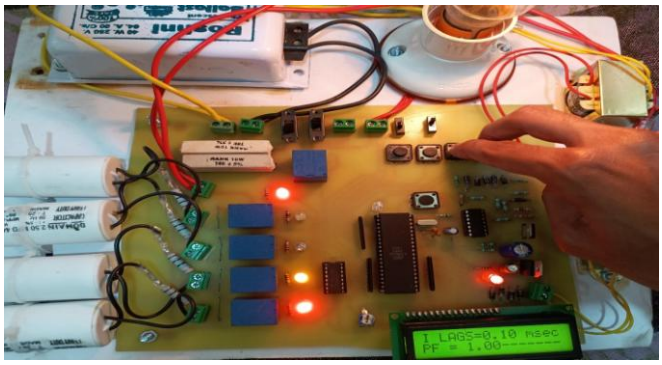

Fig. 6: When Two Capacitors are ON

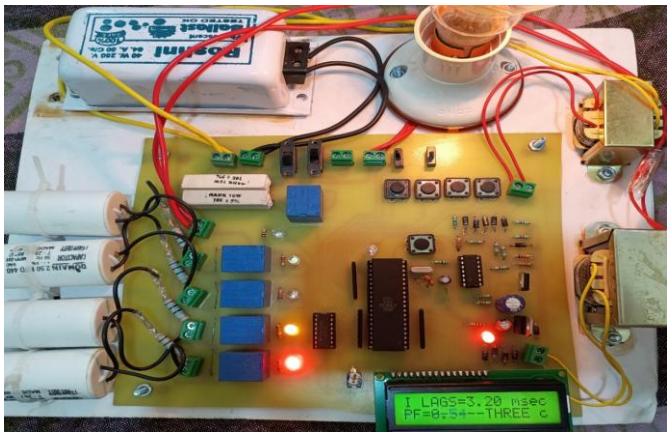

Fig. 7: When the Circuit is in Automatic Mode

IV. Advantages

- Reactive power decreases
- Avoid poor voltage regulation
- Overloading is avoided
- Copper loss decreases
- Transmission losses decreases
- Improve voltage control
- Efficiency of supply system and apparatus increases

V. Conclusions

This project has proposed the advanced method of the power factor correction by using the microcontroller which has the many advantages over the various conventional methods of the power factor compensation. The switching of capacitors is done automatically by using the relay and thus the power factor correction is more accurate. 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. The automotive power factor correction using capacitive load banks is very efficient as it reduces the cost by decreasing the power drawn from the supply. As it operates automatically, manpower is not, required and this Automated Power factor Correction using capacitive load banks can be used for the industries purpose in the future.

VI. Future Scope

- Reduces harmonic content in the network which further reduces disturbances in the telecommunication network, misbehavior in control equipment and relay protections, measuring errors in the measuring system
- Reduces network losses
- Reduces equipment overloading and stress on insulation Reduces cost, unplanned outages and increases power availability.
- The designed equipment was studied in the laboratory scale; it can be implemented in the mine substations with proper protection to verify the operation in a real time environment

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BIOGRAPHIES

Prof. Vikramsingh R. Parihar: He is an Assistant Professor in Electrical Department, PRMCEAM, Badnera-Amravati having 10 years of experience. He has received the B.E degree in Instrumentation from Sant Gadge Baba Amravati University, India, in 2011 and the M.E degree in Electrical and Electronics Engineering, Sant Gadge Baba Amravati University, India, in 2014. He is editorial board member of more than 30 prestigious and recognized journals and life member of ISTE, HKSME, ICSES, IJCSE, the IRED Engineering New Zealand and IAENG. His domain of research includes Electrical

Engineering, Instrumentation, Electrical Power Systems, Electrical and Electronics Engineering, Digital Image Processing, Neuro Fuzzy Systems and has contributed to research in a commendable way by publishing more than 50 research papers in National/International Journals including 4 papers in IEEE Conferences. He has written 8 book chapters and also authored 3 books.

Prof. Rohan Vijay Thakur received the B.E. in Electrical Engineering and M. Tech.in Electrical Power System from Government College of Engineering, Amravati, Maharashtra, India in 2009

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and 2012 respectively. He is currently working as an Assistant Professor in Electrical Engineering Department of Prof Ram Meghe College of Engineering & Management, Badnera-Amravti, Maharashtra, India. His area of research interest includes Power Quality, Power System Stability, Design and modelling of custom power devices, etc.

Prof. Aparna R. Khairkar has completed Bachelors Of Engineering in Electronics & Telecommunication and Masters in Management Studies with finance specialization. She has completed Masters in Engineering in Electrical and Electronics from SGBAU university. She has also completed Masters in Business Adminisration.

Prof. K. S. Kalkonde received ME Digital Electronics from SGBAU Amravati Since 2011. He is working with Prof Ram Meghe College of Engineering and Management Badnera Amravati in Department of Electrical Engineering. He has 11 years of teaching experience. His area of interest includes Signals and System, Digital Image Processing.

Prof. Roshani S. Nage is Assistant Professor in Electrical Engineering Department, PRMCEAM, Badnera-Amravati having 7 years of experience. She has received the B.E degree in Electronics and Telecommunication Engineering from Sant Gadge Baba Amravati University, India, in 2012 and the M.E degree in Electrical and Electronics Engineering, from Sant Gadge Baba Amravati University, India, in 2014. Her domain of research includes Digital Integrated Circuits, Control Systems, Digital Signal Processing, Digital Image Processing. She has published 5 research papers in National/International Journals and conferences.