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Automatic Power Factor Correction using Microcontroller

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Abstract: *Power quality is a key factor in all industrial and many more applications. An industry need to maintain certain power quality standard during day-to-day work for variety of applications. Power quality of electricity provided by utilities is also vital aspect. The best power quality helps to increase the overall production and gets rid of any sort of technical problems reducing cost of energy. The mains power factor is one of the important parameter which decides the quality of power. When the need of reactive power becomes more, power factor decreases, reducing the efficiency of power system. Therefore, there is need to add capacitance of required value when power factor goes below the specified value, preferably 0.92. Addition of required capacitors reduces the losses improving power factor. The paper proposes digitally controlled topology for performing Automatic Power Factor Correction to improve power quality. The design and simulation of Automatic Power Factor Correction system using microcontroller (AT89S52/C51) has been presented in the paper. The system power factor has been monitored using power factor transducer followed by Arduino microcontroller which control the switching of capacitor banks in order to compensate reactive power and bring power factor near to unity enhancing power quality. The simulation results are also presented in the paper.*

Keywords: Power Factor, Power Factor Transducer, Power Quality, microcontroller (AT89S52/C51), Capacitors

I. INTRODUCTION

Power factor plays a vital role in an electrical system. Low power factor in the electrical system leads to many problems. In case of constant load active power, the decrease of the load power factor will have two effects on voltage stability: the first is the rise of reactive power - voltage characteristics of load, while the second is the drop of reactive power – voltage char- acteristics of power grid. So the combined effect will cause a decline in voltage stability of the distribution substation [4].In the present scenario of technological revolution and all over Observations, it can be said that the power is very precious and becoming more and more complex with passing days. The increase in usage of inductive loads in industry will give impact to the power factor value of the system and thus due to this the efficiency of the power system decreases. Nonlinear loads will lead to a poor power factor, total harmonic distortion (In electrical power distribution, PF is denoted as the ratio of real power (kW) applied to the load to the apparent power (kVA) of the circuit [1]. It may also define as the cosine of the angle between the voltage and current in AC circuit which is known as PF [2]. Fig.1 shows the PF triangle where three powers i.e. active (kW), reactive (kVAR) and apparent (kVA) are employed. The real power is called active power which is actual amount of power being used and is measured in watts. The apparent power is the multiplication of voltage and current and is measured in Volt-Amp (VA). While power utilized in AC system is called reactive power and is measured in KVAR. 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. 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

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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.

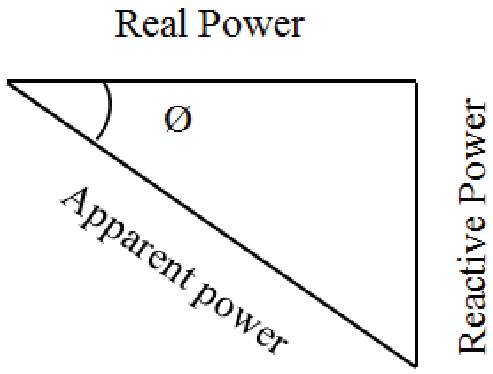

Fig. 1: Power factor trinagle

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. 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.

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 Research Article Volume 10 Issue No.7 IJESC, July 2020 26778 http:// ijesc.org/ 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.

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III. BLOCK DIAGRAM

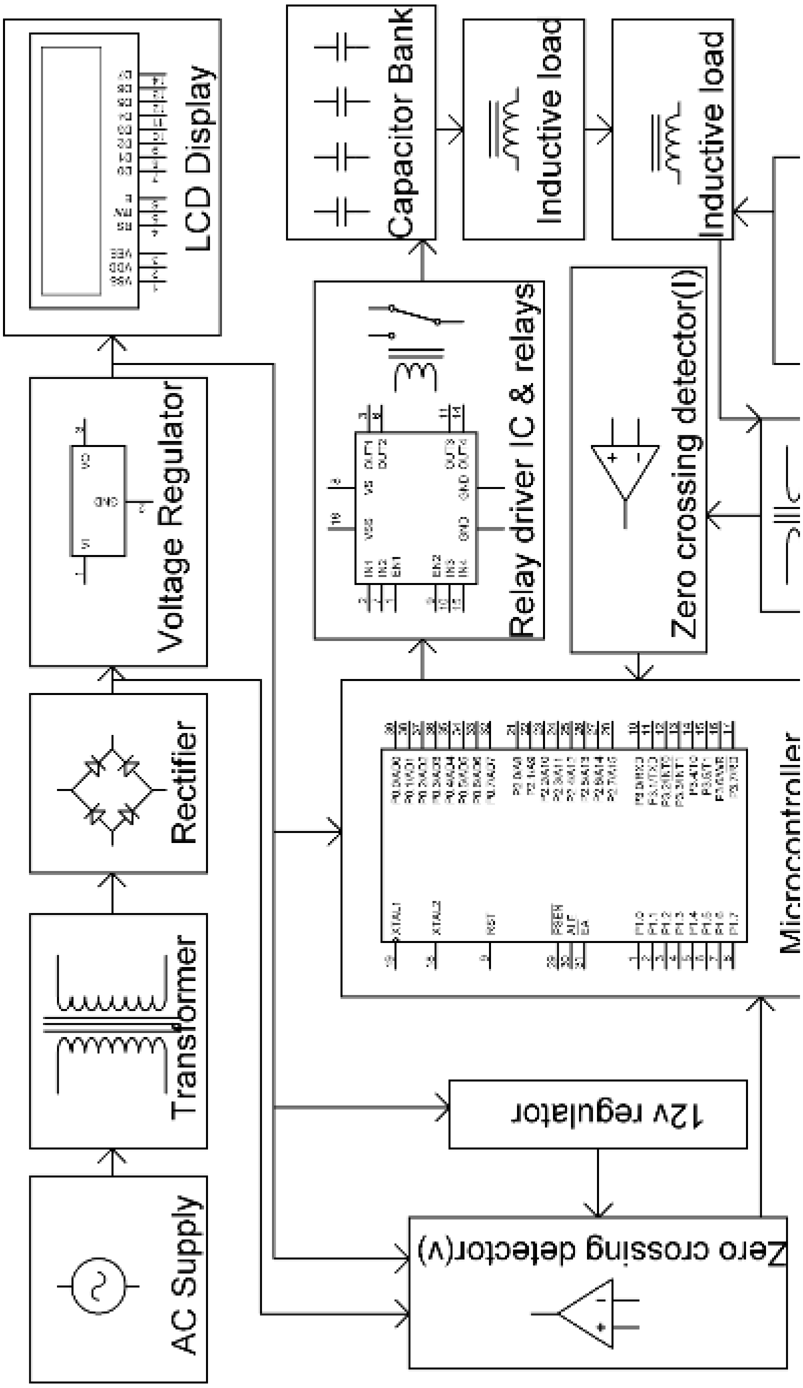

Fig. 2: Diagram

IV. DEFINATION AND CALCULATION

AC power flow has the three components: real power (also known as active power) (P), measured in watts (W); apparent power (S), measured in volt-amperes (VA); and reactive power (Q), measured in reactive volt-amperes The power factor is defined as: In the case of a perfectly sinusoidal waveform, P, Q and S can be expressed as vectors that form a vector triangle such that: If is the phase angle between the current and voltage, then the power factor is equal to the cosine of the angle, and: Since the units are consistent, the power factor is by definition a dimensionless

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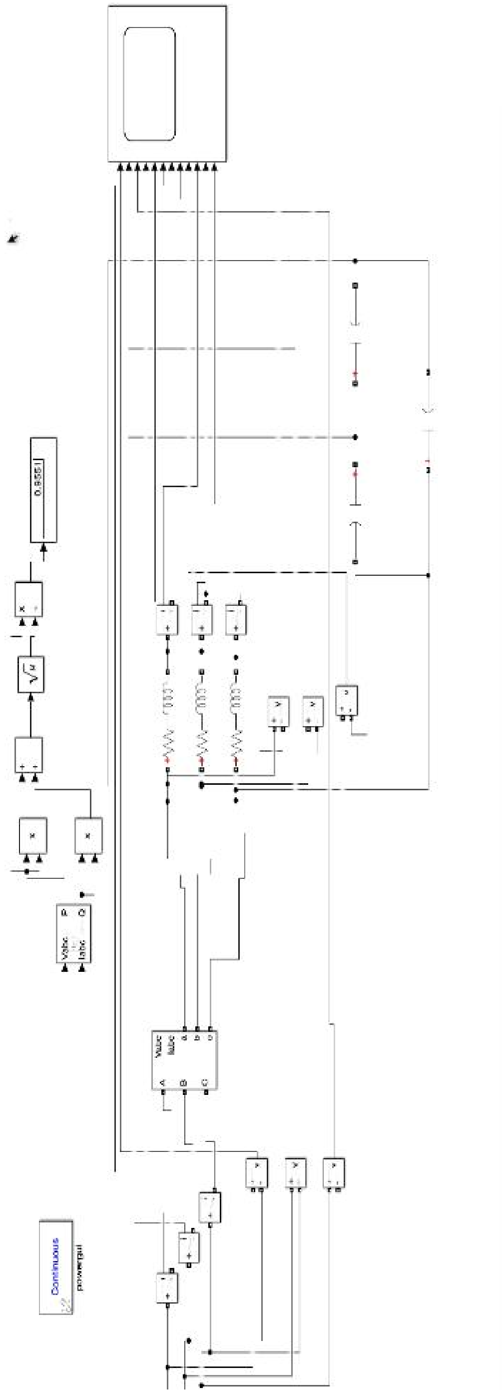
number between 0 and 1. When power factor is equal to 0, the energy flow is entirely reactive, and stored energy in the load returns to the source on each cycle. When the power factor is 1, all the energy supplied by the source is consumed by the load. Power factors are usually stated as ”leading” or ”lagging” to show the sign of the phase angle. If a purely resistive load is connected to a power supply, current and voltage will change polarity in step, the power factor will be unity (1), and the electrical energy flows in a single direction across the network in each cycle. Inductive loads such as transformers and motors (any type of wound coil) consume reactive power with current waveform lagging the voltage. Capacitive loads such as capacitor banks or buried cable generate reactive power with current phase leading the voltage. Both types of loads will absorb energy during part of the AC cycle, which is stored in the devices magnetic or electric field, only to return this energy back to the source during the rest of the cycle.



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For example, to get 1 kW of real power, if the power factor is unity, 1 kVA of apparent power needs to be transferred (1 kW Ã · 1 = 1 kVA). At low values of power factor, more apparent power needs to be transferred to get the same real power. To get 1 kW of real power at 0.2 power factor, 5 kVA of apparent power needs to be transferred (1 kW Ã · 0.2 = 5 kVA). This apparent power must be produced and transmitted to the load in the conventional fashion, and is subject to the usual distributed losses in the production and transmission processes. Electrical loads consuming alternating current power consume both real power and reactive power. The vector sum of real and reactive power is the apparent power. The presence of reactive power causes the real power to be less than the apparent power, and so, the electric load has a power factor of less than 1.

V. SIMULATION

Here, we have connected a 3 AC source as a supply for the load. The current measurement block is connected to all the three phases of the block. The current Measurement block measures the instantaneous current flowing in any electrical block or connection line. The voltage measurement block is also connected in parallel with the source. It measures the instantaneous voltage between two electric nodes. A 3 series RLC branch block is used to represent the load. The Three- Phase Series RLC Branch block impleme nts three balanced branches consisting each of a resistor, an inductor, or a capacitor or a series combination of these. Use the Branch type parameter to select elements you want to include in each branch. Negative values are allowed for resistance, inductance, and capacitance.

The Power Measurement block measures the real and reac- tive power of an element in a single-phase network. The block outputs the power quantities for each frequency component you specify. For three-phase measurements, consider using the Three-Phase Power Measurement block. Use this block to measure power for both sinusoidal and non-sinusoidal periodic signals. Set the Sample time parameter to 0 for continuous- time operation, or explicitly for discrete-time operation.

VI. SIMULATION RESULT

The ballast used affects the p.f. of the line and it drops to 0.5 lag. After the use of 5μF capacitors, the p.f. improved to 0.97

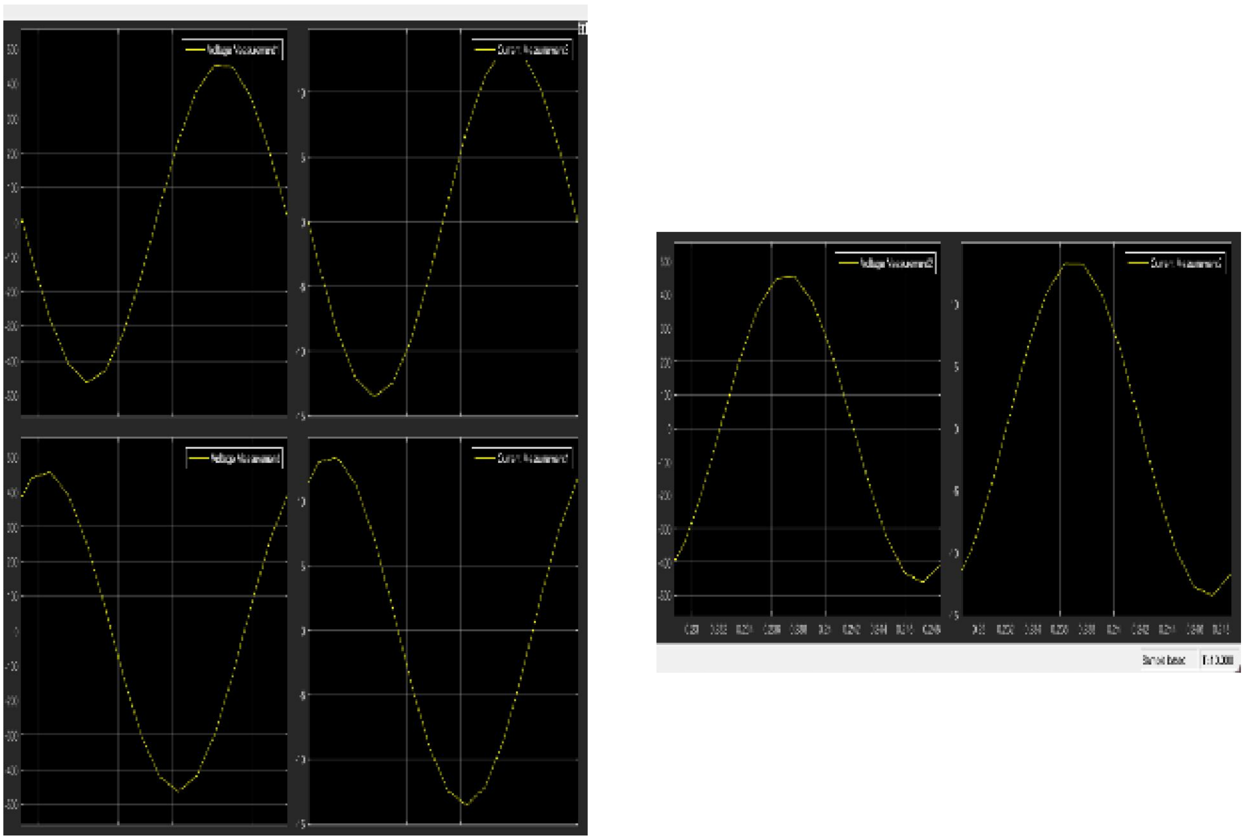

Fig. 4: result

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VII. FUTURE SCOPE

The automatic power factor correction using capacitive load banks is a very efficient as it reduces the cost by decreasing the power drawn from the supply. As it operates automatically, Man power is not required and this Automated Power Factor Correction using capacitive load banks can be used for the industries purpose in the future.

VIII. CONCLUSION

It can be concluded that the power factor correction approach can be applied to the industries, power systems and also households. Thus an improved power factor reduces reactive power, copper loss, transmission loss and avoids poor voltage regulation, overloading also improve voltage control and efficiency of the supply system. However, this method comes with some limitations such as the compensation lower ratings, they have a short service life range, easily damaged if the voltages exceed the rated value. In future, PWM techniques can be employed in this scheme along with power factor correction. As it operates automatically, human resources are not required and the use of automated power factor rectification capacitor banks can help attain more efficient way of running industries in the future.

REFERENCES

[1] Automatic power factor converter International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (A High Impact Factor, Monthly, Peer Reviewed Journal) Vol. 7, Issue 3, March 2018.

[2] Department of Electrical Engineering National Institute of Technology Rourkela Design of a Boost Converter By Abdul Fathah ,Under guidance of Prof. B.D. Subudhi June-2013.

[3] Microcontroler and power factor correction Conference: 2014 4th International Conference on Engineering Technology and Technopreneuship (ICE2T) Authors: F. Z. Hamidon I. H. Mohd Ali M. N. Khadari Dewi Abd Aziz University of Kuala Lumpur August 2014

[4] 13th IEEE International Conference on Industry Applications:- APFC System Year – 2018