Automated Power Factor Correction and Surge Protection

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Abstract: Automatic Power factor correction is the capacity of absorbing the reactive power produced by a load. In case of fixed loads, this can be done manually by switching of capacitors, however in case of rapidly varying and scattered loads it becomes difficult to maintain a high power factor by manually switching on/off the capacitors in proportion to variation of load within an installation. This drawback is overcome by using an APFC panel. In recent years, the power quality of the ac system has become great concern due to the rapidly increased numbers of electronic equipment, power electronics and high voltage power system. most of the commercial and industrial installation in the country has large electrical loads which are severally inductive in nature causing lagging power factor which gives heavy penalties to consumer by electricity board. This situation is taken care by APFC . In this paper measuring of power factor from load is done by Arduino and trigger required capacitors in order to compensate reactive power and bring power factor near to unity.

Keywords: A-Ampere; ATP-Alternative Transient Program :APFC-Automatic Power factor Correction; CT-Current Transformer ; KVA-Kilo Volt Ampere; KVAR-Kilo Volt Ampere Reactive ; KW-Kilo Watt; kWh-kilo Watt Hour ;LCD- Liquid Crystal Display; PCB Printed Circuit Board; PFPower Factor; PFC-Power Factor Correction ; PTPotential Transformer; R-Resistive; R-L=ResistiveInductive; RMS-Root Mean Square; THD-Total Harmonic Distortion; V-Volt; ZCS- Zero Current Sensor ; ZVS-Zero Voltage Sensor.

I. INTRODUCTION

Power factor is defined as the ratio between the KW (actual load power) and the KVA (apparent load power) drawn by an electrical load. It is simply a measure of how efficiently the load current is being converted into useful work output Modern industries using mechanized methods suffers from low power factor due to the use of different electric equipment which requires more reactive power. Significant savings in utility power costs can be realized by keeping up an average monthly power factor close to unity. Utilizing shunt capacitor banks for Power Factor Correction (PFC) is an exceptionally established methodology. The recent trend is to automate the switching procedure of capacitors to get greatest advantage in real time basis. Embedded systems based on microcontrollers can be used to monitor and control the switching of correction devices because of its dependability and execution. All inductive loads require active power (KW) to perform the actual work, and reactive power (KVAR) to maintain the magnetic field. This reactive power is necessary for the equipment to operate, but imposes an undesirable burden on the supply, causing the current to be out of phase with the voltage (current lags the voltage). Low power factor can also result when inactive motors operate at less than full loadsuch as a surface grinder performing a light cut, a circular saw that is only spinning, an air compressor that is unloaded etc. Losses caused by poor power factor are due to the reactive current flowing in the system and can be eliminated using PFC.

In this paper we are using a method of the reactive power compensation by capacitor switching with automatic control using Arduino and protection of equipment from the surges.

II. EXISTING METHODS

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

A. Synchronous Condenser

The synchronous motor has long been used as a compensator with fixed ratings (known as a synchronous condenser). Compensation is achieved by setting the field excitation to arrive at a particular rating. A disadvantage of this device is that it is electromechanical and requires some maintenance. Since the degree of compensation is predetermined, as with a fixed capacitor bank, synchronous condensers have little appeal over capacitors. Accordingly, their application in the mining industry has been limited, except in cases where salvaged ones were available, at an attractive price.

B. Static Capacitor Bank

The application of shunt capacitor banks results in a decrease in the magnitude of the source-current, improves the power factor and consequently improves voltage regulation throughout the system. However, shunt capacitor banks do not affect current or power factor beyond their point of application. Capacitor banks can be fixed, switched, or a combination of both. The switching process can be manual or automatic. Capacitor banks are rugged and simple to configure and install .

C. Others Methods

There are also some other complicated methods invented for PF correction which are not much popular for economical

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

purpose and some methods are under research. 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.

III. PROPOSED SYSTEM

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. The functional block diagram of the complete project is shown in the following figure.

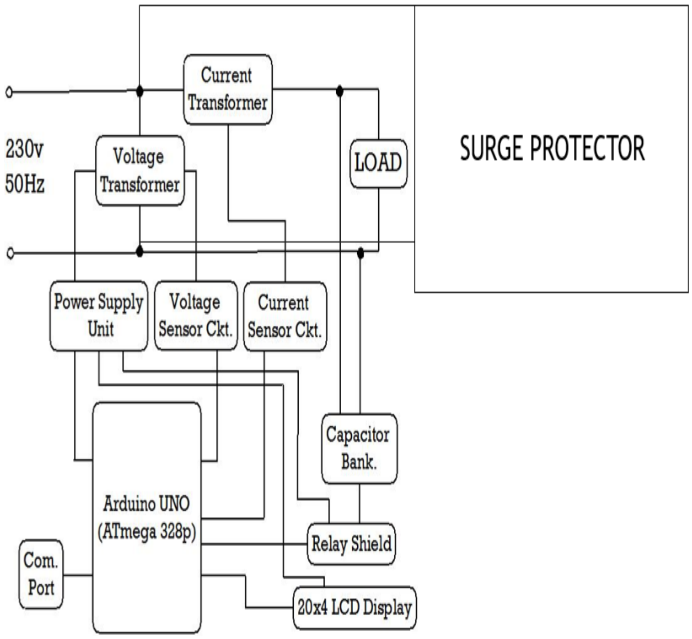

Fig. 1 Block diagram of the APFC

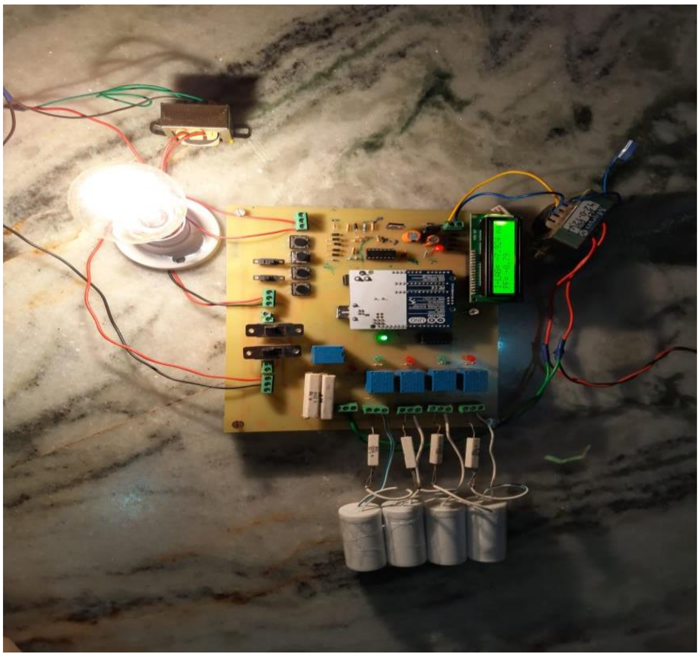

Fig. 2 Prototype of Proposed system

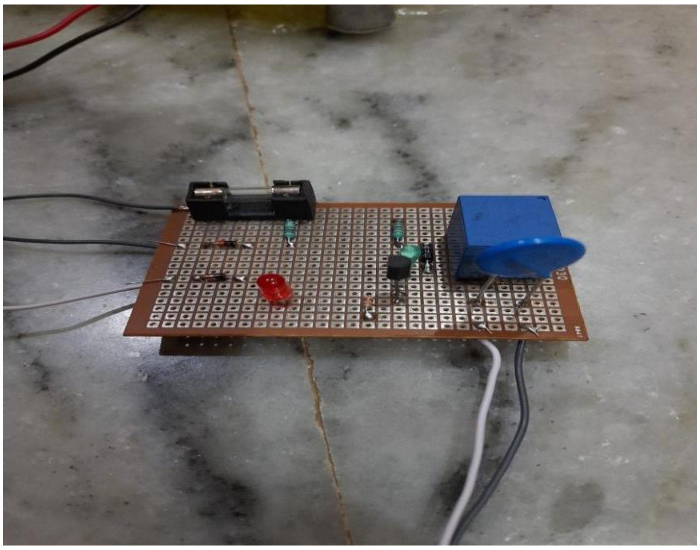

Fig. 3 Surge protector

IV. DESIGN METHODOLOGY

The Automatic Power Factor correction device is developed built on embedded system having 89S52 at its core. The voltage and current signal from the system is sampled and taken as input where the difference between the arrivals of wave forms indicates the phase angle difference. The difference is measured by the internal timer and calibrated as phase angle to calculate the corresponding power factor. The system power factor is compared with the desired level and the difference is measured for switching of required number of capacitors from the bank. The values of power factor and phase lag are shown on a display for convenience.

V. RESULTS ANALYSIS

By using this system **"Automated Power Factor Control and Surge Protector"** The system automatically corrects the power factor when it is below the unity power factor. The surge protector is used for protection of the equipment form voltage surges in the system.

VI. CONCLUSION

Automatic power factor correction techniques can be applied in industries, commercial lines and power distribution system to increase stability and efficiency of the system. Care should be taken so that the capacitors are not subject to rapid onoff-on conditions as well as overcorrection otherwise the lifespan of capacitor bank decreases significantly. 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.

ACKNOWLEDGMENT

We are thankful to our principal **Dr. G. DURGA SUKUMAR** for giving us permission to carry out this project.

We acknowledge **Dr. T RAMA SUBBA REDDY**, Head of Department of Electrical & Electronic Engineering for his guidance and moral support throughout the project.

We extend our sincere thanks to **Mr. K. VISHNU**, Assistant Professor Electrical & Electronics Engineering for her guidance and valuable suggestions, bondless co-operation, and encouragement throughout the project.

Lastly, we also extend our thanks to all the staff of the Department of Electrical & Electronics Engineering, VITS for their co-operation and support during our course work.

REFERENCES

[1] Alexander, C. K., & Sadiku, M. N. (2007). Fundamentals of electric circuits. Boston: McGraw-Hill Higher Education.

[2] Shwehdi, M. H. & Sultan, M.R., Power Factor Correction Capacitors; Essential and Cautions, IEEE Power Engineering Society Summer Meeting, 2000, pp. 1317-1322.

[3] Stephen, J. C. (1999). "Electric Machinery and Power System Fundamentals." 3rd.ed. United State of America: McGraw-Hill Companies, Inc.

[4] "POWER FACTOR CORRECTION." *www.nhp.com.au*. NHP Catalogue - PFC-SFC, Nov. 2007. Web. 14 July 2016. Available at *[https://portal.nhp.com.au/power-quality]*

[5] "Power Factor Correction: A Guide for the Plant Engineer." *www.eaton.com/*. Eaton Corporation, Aug. 2014. Web. 14 July 2016. Available at *[www.eaton.com/ecm/groups/public/@pub/.../sa02607001e.pdf]*

[6] Hudson, Glyn. "OpenEnergyMonitor". *[https://openenergymonitor.org/emon/modules/emon TxV3]* N.p., n.d. Web. 14 July 2016.

[7] "Microcontroller." Wikipedia *[https://en.wikipedia.org/wiki/Microcontroller]*. Wikipedia Foundation, n.d. Web. 14 July 2016.

[8] Evans, Brian. *Beginning Arduino Programming*. New York: Apress, 2011. Print.

[9] Monk, Simon. *Programming Arduino: Getting Started with Sketches*. New York: McGraw-Hill, 2012. Print.

[10] "Hobbyist.co.nz." Interfacing the Relay Modules to the Arduino [*http://www.hobbyist.co.nz/interfacing-relaymodules-to-arduino*]. N.p., n.d. Web. 14 July 2016.

[11] Choudhury, S. M., Design and Implementation of a Low Cost Power Factor Improvement Device, IEEE Region 10 Conference TENCON, 2008, pp.1-4.

[12] Using LCD Module with AVRs, Available at: http://extremeelectronics.co.in/, Accessed on: February 4, 2015.

[13] Ali, Murad. "Design and Implementation of Microcontroller-Based Controlling of Power Factor Using Capacitor Banks with Load Monitoring." *Global Journal of Researches in Engineering Electrical and Electronics Engineering* Version 1.0 13.2 (2013): n. page. Web. Online