International Journal of Engineering Sciences & Emerging Technologies, Mar. 2018.
ISSN: 22316604 Volume 10, Issue 3, pp: 69-73 ©IJESET

REACTIVE POWER COMPENSATION IN DISTRIBUTION SYSTEM

Piyush Upadhyay, Praveen Nagar, Priya Chhaperwal, Rajat Agarwal, Sarfaraz Nawaz
Department of Electrical Engineering, SKIT M& G, Jaipur

ABSTRACT

In this paper, a reactive power compensation system is presented where inductor plays a major role for developing the lagging condition. Reactive power variations have an effect on the generating systems, lines, circuit-breakers, transformers, relays and isolators. Due to this there is an effective voltage sags and increased losses. In the proposed system, voltage and current pulse lead time are given to the interrupt pins of the microcontroller in which the fed program helps to bring the shunt capacitors in circuit for the reactive power compensation. Based on the delay the program fed in the microcontroller brings the result which gives the number of relays using relay driver IC from its output to connect shunt capacitors into the load circuit till the power factor reaches nearest to unity.

KEYWORDS: *VAR compensator, power factor, Reactive Power Compensator.*

I. Introduction

Since it has become mandate to increase the availability of electrical power because of its increasing demand, the energy efficiency is a topic that has been turned out to be more and more protruding. The available voltage at the consumer ends gets reduced with the introduction of inductive loads in the power system by the customers. With increase in reactive power, the load current also gets increased and hence the utility has to supply to the inductive load. This in turn cuts down the efficiency and increases the system losses of the power system. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers by applying penalties where there is a low power factor at the load side because of the significant reactive power. This problem can be alleviated by an extensively used approach that is through the use of corrective capacitors. Reactive power can be supplied by use of capacitors, and hence gives the required reactive power to the inductive loads.

Linear loads with low power factor (such as induction motors) can be corrected with a passive network of capacitors or inductors.

II. Literature Review

In practical operation of transmission systems, the voltage needs to be continuously monitored and controlled to compensate for the daily changes in load, generation and network structure. In fact, the control of voltage is a major issue in power system operation. Kundur (1994). It identifies the main objectives of voltage control as: Voltage at the terminals of all equipment in the system should be kept within acceptable limits, to avoid malfunction of and damage to the equipment. Keeping voltages close to the values for which stabilizing controls are designed, to enhance system stability and allow maximal utilization of the transmission system. Minimize reactive power flows, to reduce active as well as reactive power losses whereas distribution systems as a rule are operated in radial configuration. Consequently, more sophisticated control schemes than those used in distribution systems are necessary.

To get the minimum operating cost with the increased efficiency for the electrical power received by the consumers at the load ends, development of optimum solution was initiated (Kichmayer 1958).

Narita et al (1971) using the method of base optimization technique for the minimization of voltage deviation and reduce the system losses developed the sensitivity analysis. They used voltage and reactive power regulating devices to obtain successful operation by installing them at various points.

Table 1: Component List with specification

Component	**Rating**
Micro- controller	Atmel AT89S52
LCD	16 x 2 Character
Quad Comparators IC	LM339
LED	Red
Choke	250V/40W
Relay	12 V
Electrolyte Capacitors	10uF/50V
	2200 uF/25V
	1000 uF/25V
Ceramic Capacitor	33pF
Crystal Oscillator	11.0592 MHz
Diodes	1N4007
Resistors	100 K Ω
	47 K Ω
	10 K Ω
	1 K Ω
	4.7 K Ω
	100 Ω
Variable Resistor	10 K Ω
Network Resistor	10 K Ω
Voltage Regulator	7805
IC Base	16 Pin
Transformer	12-0-12 V/ 500 mA

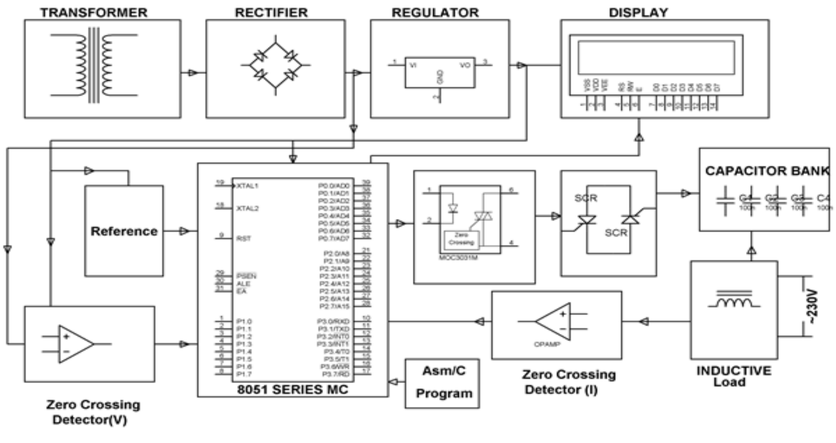

Fig 1: Block diagram of reactive power compensation technique

III. Component Details

3.1 MICROCONTROLLER AT89C52 (8051 Family)

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density non-volatile memory technology and is compatible with the industry- standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry.

3.2 Liquid Crystal Display (LCD) Controller

The HD44780U dot-matrix liquid crystal display controller and driver Logical System Integration (LSI) displays alphanumeric, Japanese kana characters, and symbols. It can be configured to drive a dot-matrix liquid crystal display under the control of a 4- or 8-bit microprocessor. Since all the functions such as display RAM, character generator, and liquid crystal driver, required for driving a dot-matrix liquid crystal display are internally provided on one chip.

3.3 RELAY

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

3.4 Low Power Low Offset Voltage Quad Comparator LM 339

The LM339 is consists of four independent voltage comparators that are designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies also is possible, as long as the difference between the two supplies is 2V to 36V, and V_{CC} is at least 1.5V more positive than the input common-mode voltage. Current drain is independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationships.

3.5 Regulator

Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

Many of the fixed voltage regulator ICs has 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a heat sink if necessary.

IV. Project Implementation

The LCDs and microcontroller ports are initialised first along with the output voltage rating to determine the improved power factor. Change in phase angle is determined by comparing the values of CT and PT. If the calculated power factor is less than 0.9 lag or greater than 0.1 lead the current through the capacitor is varied by the application of relays which sense the current variation. Thus, the capacitor is added in the circuit and the reactive power is compensated. This process goes on whenever the supply is given.

Power to the circuit is fed from a step-down transformer where a rectifier is used for converting AC-DC and regulated. The time lag between the zero-voltage pulse and zero current pulse duly generated by suitable operational amplifier circuits in comparator mode are fed to two interrupt pins of the 8051 microcontroller. The time lag between the current and voltage are displayed on LCD which is interfaced with microcontroller. Depending upon the delay the program which has been dumped in the microcontroller brings appropriate number of relays through relay driver IC from its output to bring shunt capacitors into the load circuit to get the power factor, till it reaches nearest to unity.

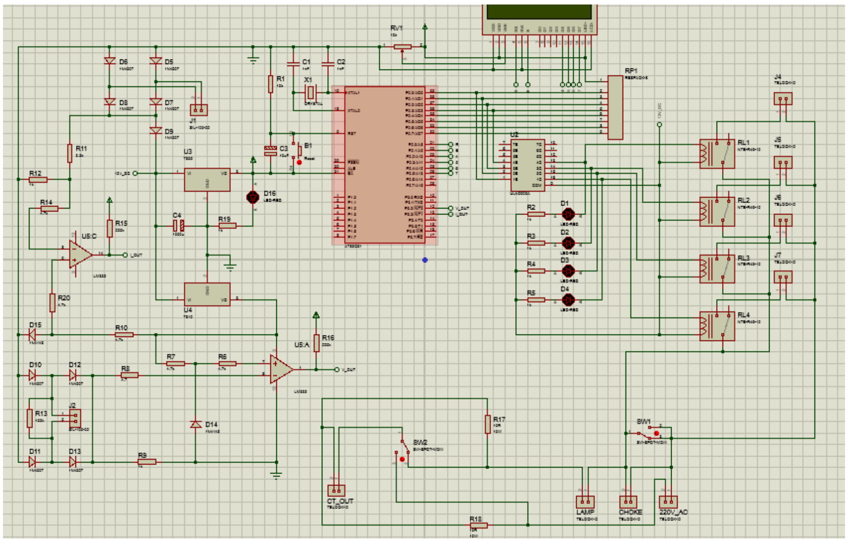

Fig. 2: Circuit diagram

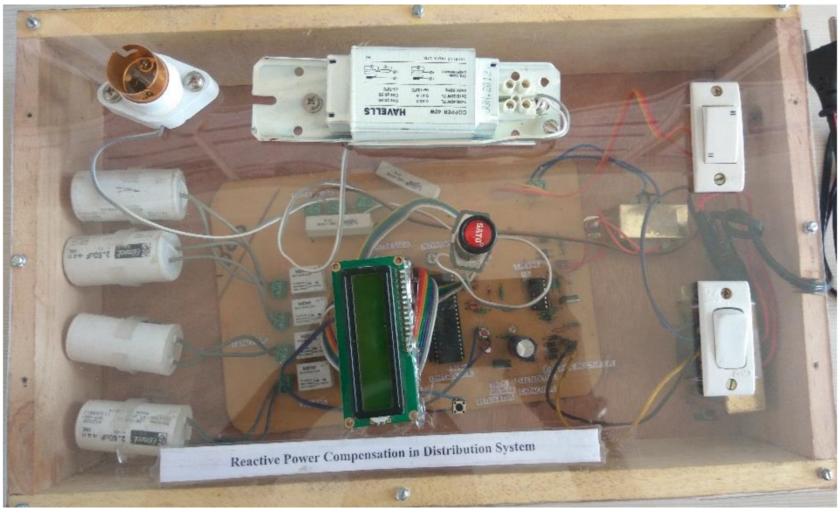

Fig. 3: Project Overview

V. Conclusion

Research and experimental work has been conducted successfully and such a setup is designed which is helpful in reactive power compensation at the distribution ends. It is capable to bring shunt capacitors into the load circuit to get the power factor, till it reaches nearest to unity. It is known that transmission losses are reduced to over 2-3% but the distribution losses are still there up to 27%, so by compensating the reactive power a lot can be done in getting the losses down. The time lag between the current and voltage are displayed on LCD along with the power factor compensated which is interfaced with microcontroller. Depending upon the delay the program which has been dumped in the microcontroller brings appropriate number of relays through relay driver IC from its output and hence capacitor get connected according to the requirement for the compensation purpose.

VI. Future Scope

This being the initial stage for reactive power compensation many improvements can be done further by using the FACT devices. Further the paper 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 rush current. We can also add the novel technique to find the allocation of capacitor in the distribution line.

References

[1] M.D.Ruhul Amin, Design of Microcontroller Based Thyristor Controlled Three-Phase Static Volt-Ampere Reactive Compensator, 3rd International Conference on Informatics , Electronics & Vision, 2014.
[2] A. Gelen and T. Yalcinoz,, Three-Phase System with Static and Dynamic Loads, IEEE
[3] Taufik and Bryan Paet, a Small Scale Static VAR Compensator for Laboratory Experiment,2nd IEEE International Conference on Power and Energy (PECon 08), December 1-3, 2008.
[4] J. Glover, M. Sarma, and T. Overbye, Power System Analysis and Design, 4th ed., Toronto: Thomson 2008.
[5] C. L. Wadhwa, Electrical Power Systems, New Age International Publishers, 2009
[6] Hadi Saadat, Power System Analysis,WCB McGraw Hill, 1999.

Authors Biography

Dr. Sarfaraz Nawaz, associate professor in SKIT, Jaipur in electrical engineering.

Priya Chhaperwal, pursuing B. Tech from SKIT, Jaipur in electrical engineering.

Piyush Upadhyay, pursuing B. Tech from SKIT, Jaipur in electrical engineering.

Rajat Agarwal, pursuing B. Tech from SKIT, Jaipur in electrical Engineering.

Praveen Nagar, pursuing B. Tech from SKIT, Jaipur in electrical engineering.