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Implementation of Static VAR Compensator for Performance Improvement in Electrical Distribution System

Sunil B. Sinare, Prasad D. Kulkarni

PG Student [EPS], Dept. of EE, KCE"s College of Engg., Jalgaon, Maharashtra, India

Assistant Professor, Dept. of EE, KCE"s College of Engg., Jalgaon, Maharashtra, India

ABSTRACT: Electrical energy is the key for developing the growth of nation. It also plays vital role in the phase of globalization currently there should some major issues while Transmission and Distribution (T & D) losses, power theft, poor power quality, fluctuations in power supply, etc. hence to solve this issue initiative and restructuring of power system is required. This paper present practical solution and various ideas for Electrical power system performance improvement at Distribution end. Static Var Compensator (SVC) is considered and design for regulation of power. The result shows active power improvement by minimizing reactive power. The overall effect of SVC is deliver maximum active or true power (Pmax) at consumer end with improve in power factor (p. f. or cos ϕ), system efficiency and reduction in breakdown due to various reasons viz. overvoltage, overcurrent, low power factor, etc. Also the SVC operates with variable operating conditions.

KEYWORDS:SVC, TCR, TBC, PFC, EAPFC, PIC Microcontroller.

I. INTRODUCTION

With the fast and rapid development of Electrical power system, it has become both practical and economical aspects to implement various types of power electronics equipments and technology viz., static var compensator (SVC), FACTS controller, voltage source controller (VSC-base shunt and series compensator, static compensator (STATCOM), Unified Power Flow Controller (UPFC), static synchronous series compensator (SSSC), thyristor controlled series compensator (TCSC), Thyristor controlled phase shifters (TCPS), etc. are the available for various practical applications viz., contingency analysis, generation rescheduling, linear programming, load shedding, power system damping improvement, increase system oscillation stability, mitigation of voltage sags and swells, regulating the load bus voltage, other PQ issues, viz., load voltage harmonics, source current harmonics, unbalancing, etc. The purpose of all aforesaid devices use under steady state to obtain more benefits during their continuous operation as there have been varieties of control strategies.

Now days the main measure to keep power system a running with high quality, minimization of reactive power is primitive. But complexity of network and diversity of electrical equipment, electrical power system becomes a complex nonlinear system and therefore it difficult to set precise mathematical models for power system. So satisfactory controlling results with justification cannot be archive by using any traditional controlled strategy.

A detailed study of electrical power system and its performance mainly depends upon PQ. Hence reactive power compensation is the main task because afterword transmission losses, line breakdown, leaking and loss of power, over loading of lines, etc. practically minimizes and hence improvement in PQ, power reliability, transmission efficiency with contingency reduction takes place.

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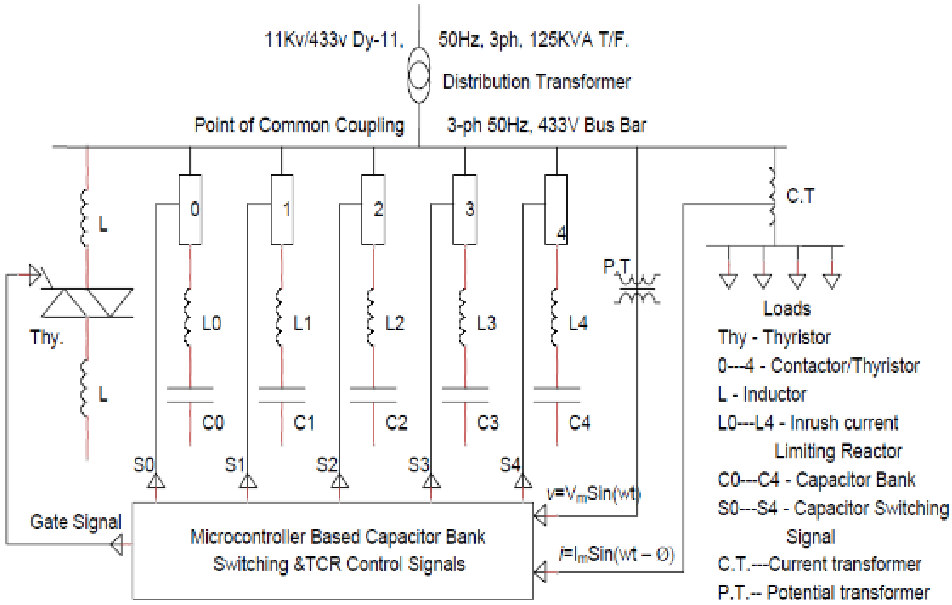
The proposed system work determinate that there are large losses in Electrical distribution systems as the loads are wide spread, because of improper control and inadequate reactive power compensation facilities. A comprehensive SVC consist of capacitor bank in five binary sequential steps in partnership with a TCR of smallest step size is apply in the investigation work. The work shows the performance calculation through practical implementation and analytical studies on an old system. For contactor and thyristor switched capacitors a fast acting error adaptive controller is developed. The operation of switching are transient free, no need to provide inrush current limiting reactors, Thyristor controlled reactor minimum size provide small percentages of non-third harmonics, provide step less variation of reactive power which depends on load requirement so as to maintain power factor near unity. It is losed loop microcontroller system having advantages of self-regulation in adaptive mode for automatic adjustment.

II. PROPOSED SYSTEM

1. Error Adaptive Power Factor Controller:

In power systems, the power factor amendment generally comprises of fanning capacitive loads to the electrical cable so as to reduce the reactive power produced from inductive loads. The assurance of the capacitance value depends upon various parameters, for example, the voltage, current, frequency and the phase angle between the voltage and current. In this way, lots of measurements and calculations are required to branch the best capacitor esteem and decrease the power loss. Most of modern correctors use experimentation methods or are constrained to few stages of power correction.

In the light of all the developments that have been reported in the recent past, the desirable features for the controller to be developed are listed below which forms the main theme of work under taken.



(Fig. 1: Proposed Scheme for TBC and TCR)

2. Digital KVAR Controller:

Digital kVAR controller task is intended to improve power factor naturally at whatever point power factor falls below a specific level. As you probably are aware interest of electrical vitality is expanding step by step. An ever increasing number of inductive loads are being utilized in industry and residential applications. Inductive loads are principle explanation behind low power factor in power system. Hence we have to build up a strategy to improve power factor

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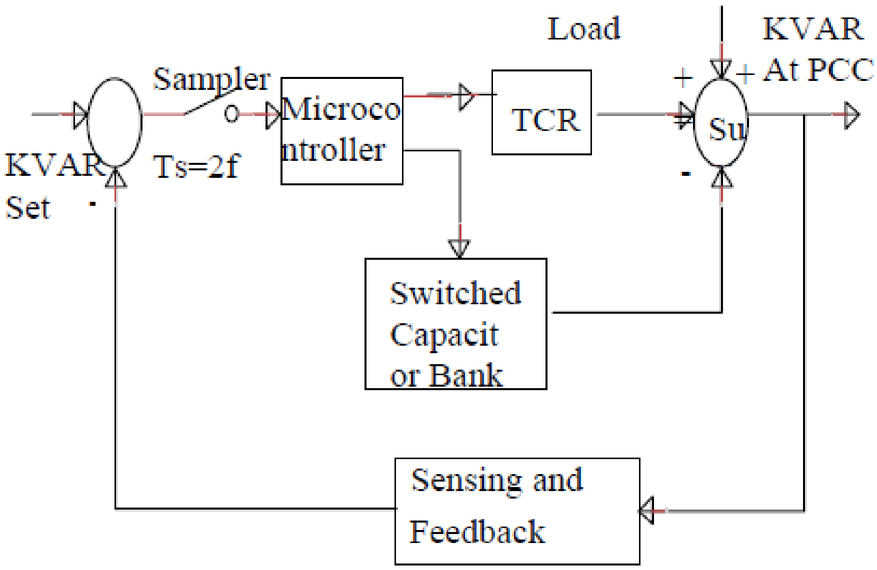
consequently. Digital kVAR controller venture gives solution for this problem. By improving power factor of power system consequently, power system efficiency can be improved.

KVArerror = KVArset - KVArsensed = e (t)



(Fig.2: Block Diagram of digital KVAr Controller)

III.IMPLEMENTATION OF WORK

1. Explanation:

The circuit consists of PIC16F877 microcontroller as a major component. In this circuit other components used are LCD display, amplifier, transistor, diode, rectifier, CT, PT, relays, resistors, capacitors, etc.

The PIC microcontroller is powered DC power supply of 5V. The power supply is built with bridge rectifier and capacitor filter. The loads which are used to check the power factor (p. f.) correction are bulb as a resistive load, exhaust fan as a inductive load, LED bulb, series R-L, R-C, L-C and R-L-C load etc. These loads are interfaced to the PIC microcontroller via relay control panel and capacitor bank. The controlling relay is interfaced the pins 17 to 20 of PIC microcontroller. The power factor of output is displayed on LCD display which is connected to pins 21 to 30 of PIC microcontroller. Once we switch on the circuit, the LCD display will show the power factor of load. PIC microcontroller detects the value of power factor and compare with the standard value. If the value of power factor is less than standard value PIC microcontroller send the signal to capacitor bank one by one through relay control panel. The capacitor bank will turn ON one by one to correct the load power factor. After successive process of capacitor banks the load power factor is found corrected to 0.99 approx. The same process is repeated for all types of loads.

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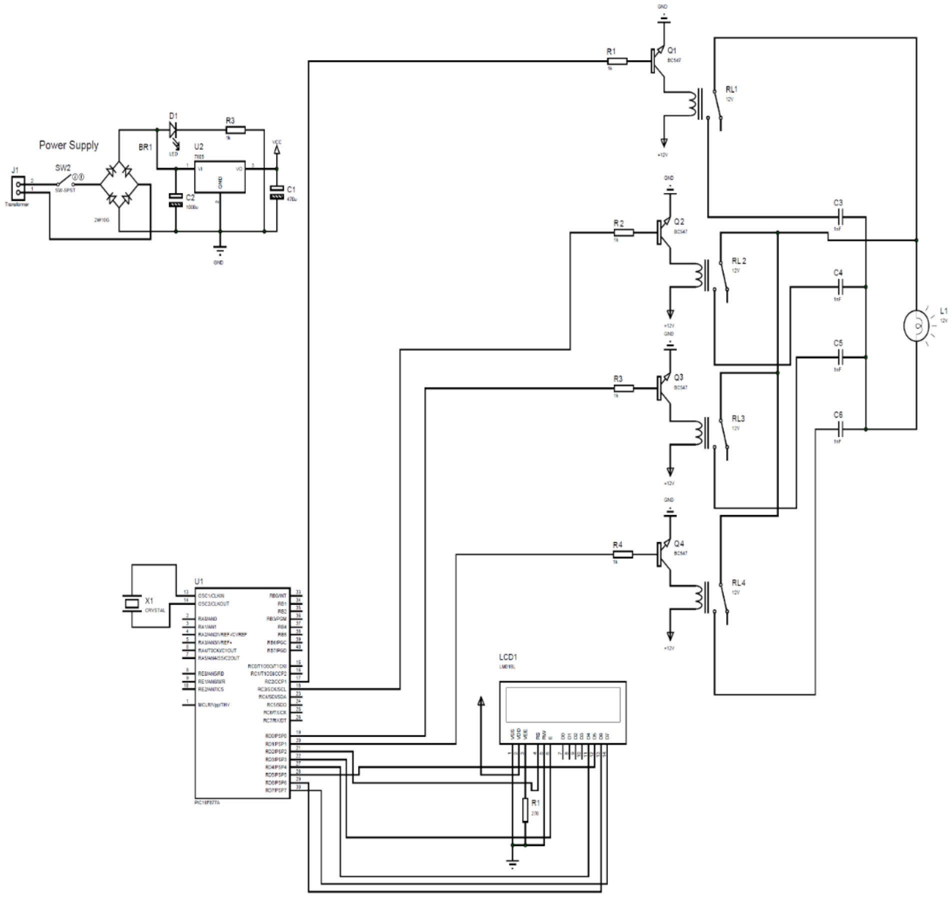
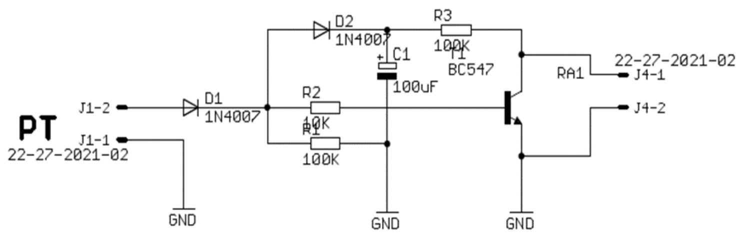


(Fig.3:Circuit Diagram-PFC)

2. Potential Transformer:

Potential transformer is for the most part utilized for step down or change high voltage into low voltage. In this framework there are measuring instruments and protective relays which are working at lower voltage, so these gadgets can't be associated straightforwardly to high voltage circuit. For this reason for estimation and assurance of framework potential transformer is utilized. The other utilization of potential transformer is to confine the measuring instruments and protective relays from high voltage. Electromagnetic or Wound Type Conventional Potential Transformer and Capacitive Voltage Transformers (CVTs) are the sorts of potential transformer.



(Fig. 4: Circuit Diagram- Potential Transformer)

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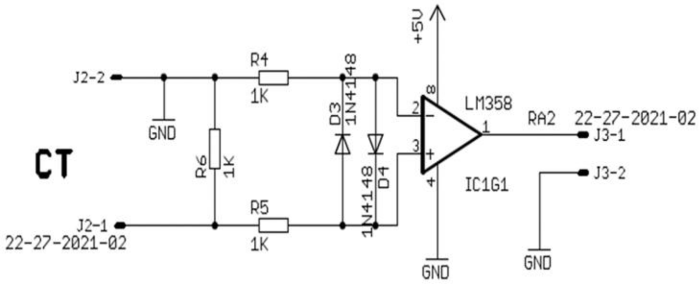
3. Current Transformer:

A current transformer is utilized for step down or change of current from a higher incentive into a proportionate current to a lower esteem. The current created in the secondary of current transformer is corresponding to the current in primary. Current transformer changes the high estimation of current to low esteem that are anything but difficult to deal with for measuring instruments and protective devices. The current transformer is valuable for detaching the measuring instruments and protective gadgets from high current. Its secondary current is actually relative to primary current. Wound Transformer, Bar-type Current Transformer, Toroidal Current Transformer are the kinds of current change.



(Fig. 5: Circuit Diagram- Current Transformer)

IV. HARDWARE IMPLEMENTATION

In hardware implementation we are used various hardware's. In this system we mainly used PIC microcontroller, 16×2 line LCD display, LM358 amplifier, BC547 transistor, IN4007 diode, AC/DC 4-channel relays, resistors and capacitors. PIC microcontroller (Programmable Interface Controller), are electronic circuits that can be customized to do a numerous tasks. They can be customized to control a generation line and some more. The PIC microcontroller are found in numerous electronic gadgets, for example, alert systems, PC control frameworks, telephones, in truth practically any electronic gadget. The PIC microcontrollers are modified and recreated by Circuit Wizard programming. A USB lead associates the PC to the programmable circuit, enabling the exchange of the program to the PIC microcontroller IC. At the point when the program has been recreated and works, it is downloaded to the PIC microcontroller circuit. The fundamental highlights of PIC microcontroller incorporate wide accessibility, minimal effort, reinventing with built in EEPROM. A LCD is an electronic display module which uses fluid precious stone to create a visible picture. The 16×2 LCD show is an essential module regularly utilized in circuits. The 16×2 deciphers a display 16 characters for each line in 2 such lines. In this LCD each character is shown in a 5×7 pixel framework. IC LM358-LM358 comprises of two free, high increase operational enhancers in a single bundle. Significant component of this IC is that we don't require free power supply for working of each comparator for wide scope of intensity supply. LM358 can be utilized as transducer speaker, DC addition square and so on. BC547 is a NPN bi-polar intersection transistor. A transistor, represents move of opposition, is normally used to enhance current. A little present at its base controls a bigger current at authority and producer terminals. BC547 is basically utilized for enhancement and exchanging purposes. 1N4007 is a PN intersection rectifier diode. These kinds of diodes permit just the progression of electrical flow one way as it were. Thus, it very well may be utilized for the transformation of AC capacity to DC. 1N 4007 is electrically perfect with other rectifier diodes and can be utilized rather than any of the diode having a place with 1N400X arrangement. Relays are only a switches and the capacity is open and close the circuit electronically. Relays control the one circuit by opening and shutting in another circuit. Relays are normally used to switch low flows in a control circuit. Relays can control high voltage and current by having an enhancing impact since little voltage connected to a relays loop can bring about a high voltage being exchanged by the contacts. Resistors and capacitors assumes a significant job in how an electronic circuit carries on.

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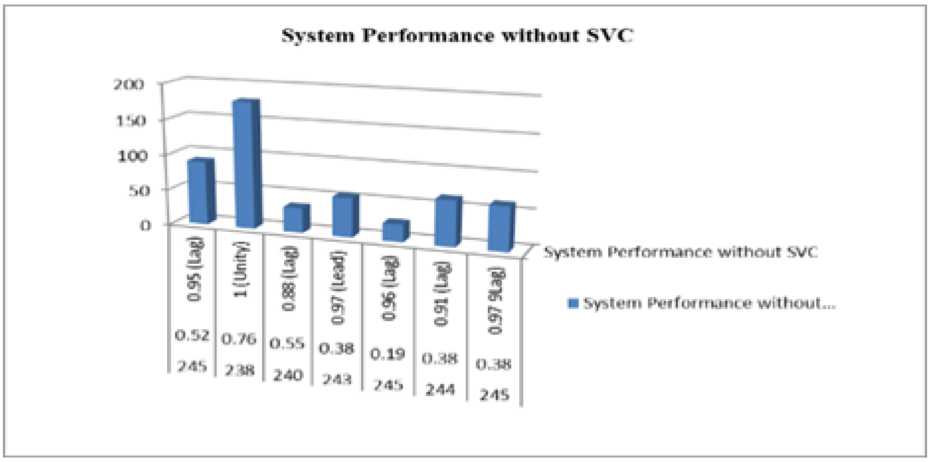
V. RESULT ANALYSIS

In the Table 1, it shows the system performance without static VAR compensator (SVC).

Table: 1 System Performance without SVC

Sr. No.	Load	Voltage in Volts	Current in Amp.	P.F.	Power in Watts
1	Fan	245	0.52	0.95 (Lag)	90
2	Tungsten Filament Lamp (200 W)	238	0.76	1 (Unity)	178
3	Choke Coil	240	0.55	0.88 (Lag)	35
4	Capacitor	243	0.38	0.97 (Lead)	55
5	LED lamp	245	0.19	0.96 (Lag)	25
6	Tungsten Filament Lamp (200 W) + Choke Coil	244	0.38	0.91 (Lag)	64
7	Lamp + Choke coil	245	0.38	0.97 9Lag)	62

In the fig 6, it shows the graph of system performance without static VAR compensator (SVC).



(Fig. 6: System Performance without SVC)

In the Table 2, it shows the table of system performance with static VAR compensator (SVC).

Table: 2 System Performance with SVC

Sr. No.	Load	Voltage in Volts	Current in Amp.	P.F.	Power in Watts
1	Tungsten Filament Lamp (200 W) + Choke Coil	250	0.39	0.988	60
2	R+L+C	250	0.26	0.91	30
3	Fan	250	0.55	0.988	80

In the fig 7, it shows the graph of system performance with static VAR compensator (SVC).

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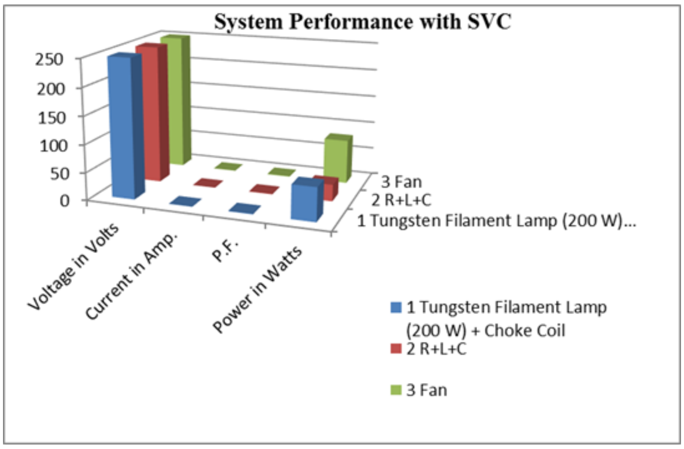


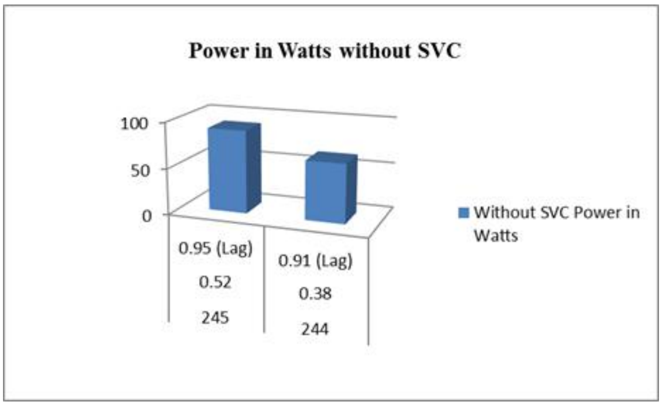
(Fig. 7: System Performance with SVC)

In the Table 3, it shows the power output without static VAR compensator (SVC).

Table: 3 Power output in Watts without SVC

Sr. No.	Load	Voltage in Volts	Current in Amp.	P.F.	Power in Watts
1	Fan	245	0.52	0.95 (Lag)	90
2	Tungsten Filament Lamp (200 W) + Choke Coil	244	0.38	0.91 (Lag)	64

In the fig 8, it shows the graph of power output without static VAR compensator (SVC).



(Fig. 8: Power output in Watts with SVC)

In the Table 4, it shows the power output with static VAR compensator (SVC).

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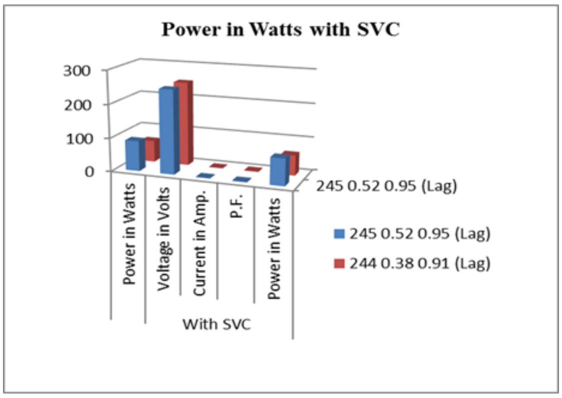
Table: 4 Power output in Watts with SVC

Sr. No.	Load	Voltage in Volts	Current in Amp.	P.F.	Power in Watts
1	Fan	250	0.55	0.988	80
2	Tungsten Filament Lamp (200 W) + Choke Coil	250	0.39	0.988	60

In the fig 9, it shows the graph of power output with static VAR compensator (SVC).



(Fig. 9: Power output in Watts with SVC)

VI. CONCLUSION

A static VAR compensator comprising of capacitor bank in five double consecutive strides related to a thyristor controlled reactor of littlest advance size will be utilized to investigative work. The work will deals with the performance valuation through analytical and practical implementation on system. It will give the following benefits: Maintaining the power factor at unity, Least feeder current and loss reduction, Improvement in distribution feeder productivity, Improvement in the voltage at distribution end, Relief in most extreme interest and compelling use of transformer limit, Saving in month to month bill because of decrease in punishment by virtue of poor power factor, and decrease in most extreme interest charges, Conservation of energy happens, It is conceivable to stepless control of Q firmly coordinating with load prerequisites, the mix offers more prominent adaptability in charge, there is generous decrease in harmonics created because of little size of reactor utilized in the static VAR compensator.

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