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Performance Realization of Different Reactive Power

Controlling Techniques: A Review

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***Abstract*: This paper describes the reactive power control on 3 phase, 6.9 kVA, 10A, and 440V transformer. We know very well that, the reactive power is essential for support the active power but it should be at desire level if it is not then problems arises. In this project, author study different papers and compare with a newly innovative method. A more reliable, technically sound, fast acting and low cost idea is presented by arranging the thyristor switched capacitor units in binary sequential manner. This enables the reactive power difference with the smallest amount possible resolution. In addition a thyristor controlled reactor of the lowest possible step size is operated is combination with capacitor bank so as to achieve continuously variable reactive power. The shunt capacitor also improves development of transformer loading capability, the feeder performance, reduces voltage drop in the feeder & transformer, improved voltage at load end, improves power factor, improves system safety with enhanced utilization of transformer capacity, gives extent for additional loading, avoids low power factor penalty, reduces maximum breakdown charges, saves energy due to reduced system losses and increases over all efficiency.**

***Index Terms*—: reactive power, static VAr compensator, thyristor binary compensator, thyristor switched capacitor, thyristor controlled reactor, capacitor bank, binary sequential steps, power factor etc.**

I. Introduction

This paper is review paper gives information regarding SVC and how much work is previously done on TSC-TCR type Static VAr Compensaor. In this paper using the Static VAr Compensaor which is an advanced electrical device for provided that fast-acting i.e. automated matching reactive power on high-voltage electricity transmission networks. SVC is one of the part of Flexible AC transmission system, stabilizing the system and regulating voltage [1]. Unlike a rotating electrical machine which is a synchronous condenser, static Volt Ampere reactor (VAr) compensator consisting with no significant moving parts. Prior to the innovation of the SVC, the conservation of huge rotating machines such as synchronous condensers or switched capacitor banks done by the power factor compensation [13]. The SVC is used to regulate the grid voltage, System stability, in transmission applications. The SVC will use thyristor controlled reactors to consume VArs from the system when the power system's reactive load is capacitive (leading) and lowering the system voltage. As well as the capacitor banks are automatically switched in under inductive (lagging) conditions, thus providing a higher system voltage [7]. The net result is continuously changeable leading or lagging power by connecting the thyristor controlled reactor, which is continuously uneven, along with a capacitor bank steps. In industrial applications, Static Var Compensators are particularly placed near high and rapidly varying loads, such as arc furnaces [6].

In such problems we have to need of a solution. Thus, remedial in the performance investigation of static VAr compensator. Static VAr compensator (SVC) with a newly introduced technique thyristor binary compensator is carried out. The investigation work study with the performance valuation through implementation of simulation model of static VAr compensator (SVC) at 3Φ, 50Hz, 11kV/440V, DY-11, 500 kVA distribution transformer. The SVC used in this paper is connected with thyristor switched capacitor bank in binary sequential manner in conjunction with smallest size thyristor controlled reactor. Also, the work deals with the performance valuation through deeply studies and implementation of hardware circuit model of SVC at 3Φ, 50Hz, 6.9 kVA transformer. The Static VAr compensator (SVC) consisting of thyristor switched capacitor bank in binary sequential manner [7].

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Binary sequential 'n' steps, satisfying the equation:

$$Q = 2^n C + 2^{n-1} C + \ldots\ldots\ldots\ldots\ldots + 2^2 C + 2^1 C + 2^0 C$$

II. Problem Identification

In power system various type of loads are present like R-L, R-C or R-L-C. Therefore power factor varies with respect to load conditions. Power factor is depending upon the presenting reactive power and apparent power.

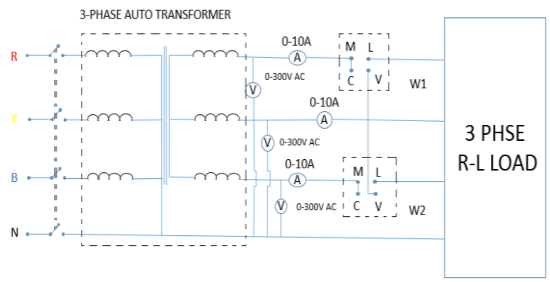

Fig.1:-Simplified circuitry of measurement of electrical parameters without SVC

A. Operation of R-L load without SVC

If reactive power in the system is large in quantity, there is directly impact on power factor. So, to improve the power factor it is essential that to reduce the reactive power in the system and maintain it at a desire level. To identify problem from system we took R-L and R-L-C load and their results are shown in below figure.

Vr-phase (volts)	Ir-phase (Amp)	Vy-phase (volts)	Iy-phase (Amp)	Vb-phase (volts)	Ib-phase (Amp)	Cos ¢	Active power (W)	Reactive power (VAR)
240	1	245	1	246	1	0.59(lead)	141.60	192.00
235	3.2	245	3.2	245	3.2	0.76(lead)	571.52	481.28
233	5	245	5	245	5	0.77(lead)	897.05	733.95
235	7	245	7	245	7	0.8(lead)	1316	970.55

B. Test Results

In practice, particularly the distribution system, have ample nonlinear loads, which significantly affect the stability and quality of power supplies. As a conclusion of the nonlinear loads, the purity of the waveform of supplies is lost. This ends up producing many power quality problems as voltage sag, flickers, phase unbalance, low power factor, and Harmonics [2].

Table no. 1 Performance of Transformer without Compensator with R-L Load

In radial system, during peak load conditions at consumer's end or end users low voltage problems arises. Due to those problems the equipment can be destructed. From Above completeness of test we, concluded that Reactive power is in large quantity as per as Ideal theoretical case. So, we have to need to regulate the voltage at the receiving end [12].

C. Observations under Load Condition

From above test results conclusion is that there is relation between reactive power and power factor. We observe that the reactive power is very large in this circuit test, therefore power factor is very low (lagging). While power disturbances occur on all electrical power systems, the compassion of today's complicated electronic devices makes them more liable to the quality and stability of power supply. For some sensitive devices, a quick disturbance can cause scrambled data, broken up communications, system crashes and equipment breakdown etc. A power voltage spike can damage valuable components. Power Quality problems include an extensive range of disturbances such as voltage sags/swells, flicker, impulse transient, harmonics distortion, and interruptions [15].

Reactive power compensation is essential for voltage regulation, saves energy, reduction in current, stability enhancement and for increasing power transmission ability, Thus by controlling reactive power, power factor can be improved. There are many inventions on the reactive power compensation by different techniques.

III. Literature Review

A. Different Reactive Power Controlling Techniques:

1] Performance Measurement of Static Var Compensators:- The main purpose of this paper is to study performance measurement of a SVC installation for the compensation of an electric arc furnace is demonstrated. The SVC system consists of a control system, TCR, and filters. Control signals are sent via optical fiber for reliability and fast transmission. It is found the SVC is capable of mitigating power quality problems, improving power factor, advance power transfer of the studied system and maintain efficiency system [4].

2] Harmonic Minimization In The Operation Of SVC:- Shunt Compensators are usually used to reduce or cancel the phase wise unbalanced reactive power (VAR) demand and to reduce the reactive power drawn from the AC supply lines. Static VAR Compensators are preferred over traditional VAR compensators for this reason. The operation of thyristor-controlled compensators at a variety of conduction angles can be used beneficially to get together the unbalanced reactive power demands in a system however such an operation introduces harmonic currents in to the Alternating Current system, in such cases it becomes essential both to minimize harmonic generation internally or provide enlarge harmonic filters. In this paper, an approach is presented for operation of VAR compensators for minimization of the consequence of the harmonics using the Total Harmonic distortion factor (THD) an Telephone Influence factor (TIF) the for a typical distribution system[5].

3] Reactive Power Control Using FC-TCR:- This paper will discuss and demonstrate how Static Var

Compensator (SVC) has successfully been applied to control transmission systems dynamic performance for system disturbance and efficiently regulate system voltage. Staic VAr Compensator is basically a parallaly connected static var generator whose output is adjusted to exchange inductive or capacitive current so as to preserve or control exact power variable. For this a Single Machine Infinite Bus (SMIB) system is modelled. In this paper, trouble-free circuit model of Thyristor Controlled Reactor is modeled and simulated using MATLAB. The simulation results are existing. The current drawn by the TCR varies with the variation in the firing angle. The simulation results are compared with the theoretical ideal results [6].

4] Hardware Circuit Implementation Of SVC Using Micro Controller:- In this paper, a single phase 1kvar capacitor-thyristor controlled reactor (FC-TCR) SVC type is fabricated and Tested experimentally by connected to a Single Machine Single Bus (SMSB) Test System. The hardware prototype model of this SVC control system is developed depend on Microcontroller LPC 2148 chip, the most recent industrial controller. Simulation analysis was done for the current with a variety of firing angles and the results are presented. The same trial system also has been tested with Static VAr Compensator automatic control circuit and investigational results have been presented in this paper for analytical study. The P-V Curves of the Single Machine Single Line (SMSL) Test system with and without SVC Control have been plotted and compared with theoretical concept which shows the effectiveness of Automatic control of SVC on Voltage Stability improvement and sustain [7].

5] Testing and Control of TSC-TCR Type SVC Using Microcontroller:- The automatic control circuit has been designed and implemented using microcontroller and tested with the Single Machine Two Bus Test system (SMTB) without and with SVC. Investigational results are presented and P-V Curves have been drawn for both the cases. Automatic control circuit have been designed and fabricate using LPC 2148 Microcontroller family. The same experiment was tested with Static VAr Compensator automatic control circuit and experimental results have been presented in this paper and plotted in well steps. The P-V Curves of the Single Machine Two Bus Test system with and without SVC have been plotted which shows the effectiveness of Automatic control of SVC i.e. efficiency of SVC on Voltage Stability improvement [8].

6] Transient Free Digital SVC Controller with Thyristor Binary Compensator:- A widespread static VAR compensator consisting of capacitor bank in five binary chronological steps in combination with a thyristor controlled reactor of smallest number of step size is employed in the investigative work. The work deals with the performance evaluation through practical implementation on an existing system and analytical investiogation and verifies it. It is successfully tested on a distribution transformer of three phase 50 Hz. Dy11, 11KV/440V, 125 KVA capacity. Theoretical and practical results are identical with each other [9].

7] Hardware Circuit Implementation of SVC with Thyristor Binary Compensator:-Electrical distribution systems having increasing large losses as the loads are wide spread, insufficient reactive power compensation conveniences and their intolerable control. In solution the experimental studies of static VAr compensator (SVC) with newly concept thyristor binary compensator is carried out. The work deals with the performance assessment through systematic studies and implementation of hardware circuit model of SVC at single phase, 50Hz, 2kVA transformer. The SVC consisting of thyristor switched capacitor bank in binary sequential manner. This compensation method facilitates control on the reactive power depending on load requirement so as sustain power factor near unity always, which results in efficient electrical power system [10].

8] Transient Free Adaptive SVC in Stepless Mode of Control:- The work deals with the performance assessment through investigative studies and practical implementation on an existing system an compared with ideal case if any. A fast acting error adaptive controller is developed suitable both for contactor and thyristor switched capacitors with resolution. The switching operations achieved are transient free, basically no need to provide inrush current restrictive reactors, TCR size minimum providing small percentages of nontriplen harmonics, facilitates step less variation of reactive power depending on load requirement so as keep up power factor near unity at all times. It is well-designed, closed loop microcontroller system having the features of self regulation in adaptive mode for automatic modification. It is successfully tested on a distribution transformer of three phase 50 Hz, Dy11, 11KV/440V, 125 KVA capacity and the functional possibility and technical accuracy are established [11].

IV. PROBLEM SOLUTION WITH NEW INVENTION

After deeply studying above papers & finding with different problems, we search out solutions with different techniques on TCS-TCR types SVC can be improve power quality. In this review, a more reliable, technically sound, fast acting and low cost scheme is as remedial as presented by arranging the thyristor switched capacitor units in three binary sequential manner. This makes the reactive power variation with the smallest amount probable resolution. In addition a thyristor switched capacitor (TSC) of the lowest step size reactor is operated is conjunction with capacitor bank in simulation model, so as to achieve continuously variable reactive power [16].

The work deals with the performance evaluation through analytical studies and implementation of hardware circuit model of SVC at three phase, 10A, 440V, 50Hz, 6.9 kVA transformer. In addition that enhancement of transformer loading capability the shunt capacitor also improves the feeder performance, reduces voltage drop in the feeder & transformer, better Voltage at load end, improves power factor, improves system security with enhanced utilization of transformer capacity, gives scope for supplementary loading, increases over all efficiency, saves energy due to reduced system losses, avoids low down power factor penalty, and reduces maximum demand charges as well as uninterrupted power supply [18].

A. Circuit Diagram of Three Phase Hardware proposed System:-

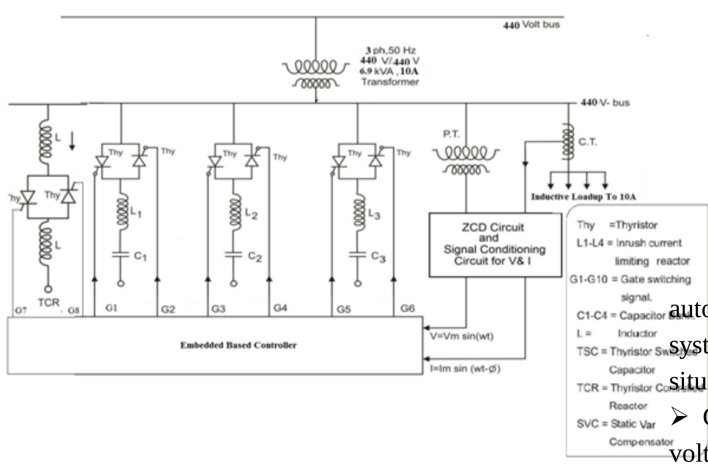

Fig.2:- Proposed Circuit Diagram of three Phase Hardware System

The Fig.3 shows the circuit diagram of TSC-TCR type SVC at 6.9 kVA distribution transformer of prototype proposed 3-phase model in which important elements as like Transformer, CT, PT, Thyristors, Capacitors, Resistive and Inductive Load Banks, TCR, Microcontrollers and Inductor with six coils are connected in proper manner [14].

B. Block Diagram of AVR 8-bit Microcontroller and 89C51 Microcontroller Operation

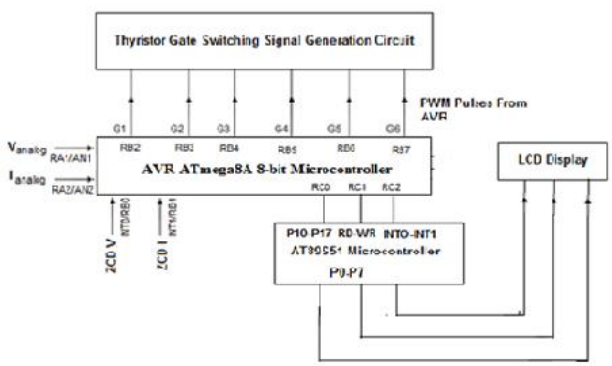

Fig.3:- Block Diagram of AVR 8-bit Microcontroller and 89C51 Microcontroller Operation

Fig.4 shows block diagram of AVR ATmega8A microcontroller operation; in which inputs to controller are V_{analog}, I_{analog}, $_{ZCD}$ V, $_{ZCD}$ I while outputs from controller are PWM pulses to thyristors and signals consists of each parameters values to LCD display card through AT89S51 microcontroller for showing on display. The block diagram also shows the details of pins which are to be used to perform the work [19].

V. APPLICATIONS

This project having number of applications but first aim of this project is to improve power quality.

a) Used in radial system for end user which facing voltage fluctuations.
b) Used in industries which have low power factor problems.
c) Used in research institute where superior power quality is required.
d) Used to eliminate harmonics from system.

VI. CONCLUSION

From this paper we concluded that, The SVC is an automated impedance matching device, designed to bring the system closer to unity power factor. SVCs are used in two main situations:

- Connected to the power system, to regulate the transmission voltage ("Transmission SVC").
- Connected near large industrial loads, to improve power quality ("Industrial SVC").

The static VAR compensator (SVC), and the thyristor controlled series capacitor (TCSC) are the example of these new technology. Basically, the SVC consists of a thyristor-controlled reactor (TCR) in parallel with a capacitor bank. The firing-angle control of thyristor enables the SVC to have very quick response. It provides fast reactive power compensation, improves the bus voltage profiles, increases system stability margin and damps power system oscillations. Active power consumed by the load tends to bring the power factor to unity.

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