Voltage Stability Improvement using Static VAR Compensator (SVC) in Power System

Dhruv Patel[1] Mr. M.C.Pandya[2]
[1]ME Student [2]Assistant Professor
[1,2]Department of Electrical Engineering
[1,2]L.D.R.P. I.T.R, Gandhinagar, Gujarat, India

Abstract— Now a days the power system are operated nearer to their stability limits due to economics and environmental reason and due to of this, the secure operation of power system is very important and challenging issue. A system enters a state of voltage instability when a disturbance occurs, increase in load demand & change in system conditions because of voltage collapse. Based on review, to compensate this problem the SVC is used in transmission system. These papers investigate the effect of Static Var Compensator (SVC) on voltage stability and improvement of that stability in power system. In this paper shunt FACTS devices SVC is used in a transmission line for improving a voltage profile and stability. MATLAB Simulink platform has been used in this study. The voltage at various buses is calculated and weak buses are identified to place the FACTS devices to improve the voltage stability limits are analyzed before and after the placement of svc.

Key words: Shunt FACTS Devices, Voltage Stability Improvement, SVC

I. INTRODUCTION

The load variation on the power system is not stable in other word its variable in nature and these Static Var Compensator are very effective for controlling of voltage fluctuations. Now a times the demand of electrical energy has very much intense but at time of real operations some limitations occur due to maintaining a balance between supplying a demand with allowed level of voltage stability limits in the power system. Whenever there is change in load or fault occurrence, the system voltage level changes, with the drop in voltage level the reactive power demand increase, if the reactive power demand is not met then its lead to decline in bus voltage and these will also effect in neighboring region [3]. The disturbance are arises in the system due any abnormal condition of fault, it goes to transient oscillations. This Unwanted oscillation can change the performance of application of transmission network. This is required to control and is done by the use of shunt FACTS devices such like Static Var Compensator (SVC) designed with required Controller (7). SVC will damp out the oscillation and improves the overall system stability (8).The PID (Proportional integral Derivative controller are used in SVC. This is applicable when system faces the large and widely disturbance at time of faults.

There is requirement of devices which can control the random fluctuations and transient disturbance comes in the transmission line. It is necessary that system has very less overshoot and very less settling time for retain for voltage in Steady state level. From last several years, the Static Var Compensator plays an important role in voltage regulation in Ac transmission system. Flexible AC Transmission systems (FACTS) controllers are mainly used for solving various power system problems. FACTS controller are widely used to control the voltage, phase angle and impedance of Ac transmission system .SVC is the most promising FACTS controller used to enhance the power system stability. In this paper the maximum load ability limit of the power system has been improved by placing the SVC.

II. STATIC VAR COMPENSATOR

A shunt connected Static Var Compensator classified into two parts one is Static Var generator & second one is Static Var absorber whose output is adjusted to exchange capacitive and inductive current so s to maintain or control specific parameter of the electrical power system typically a bus voltage. This is general term for Thyristor Controlled Reactor (TCR) or Thyristor Switched Capacitor (TSC) and which are shown in fig.(1).The term SVC has been used for shunt connected equipment for leading and lagging Var ; the thyristor controlled reactor for absorbing reactive power and thyristor switched capacitor for supplying the reactive power.

The SVC has no any rotating or moving parts such like synchronous condenser. The main purpose of using the SVC in transmission line is to rapid control of voltage profile at weak points.

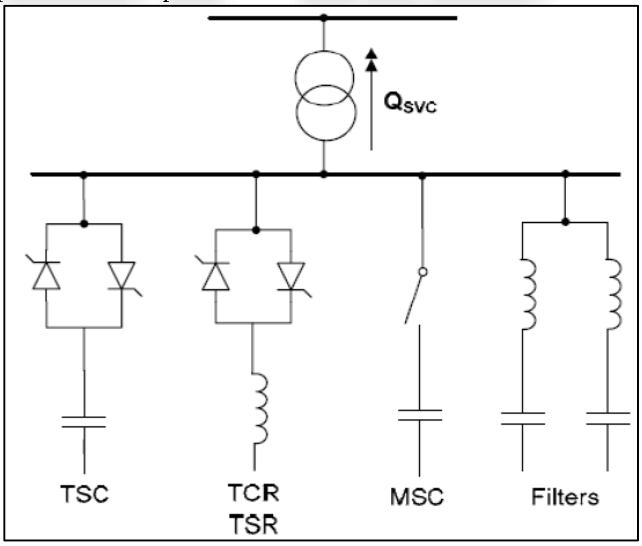

Fig. 1: Static VAR Compensator

III. V-I CHARACTERISTICS OF SVC

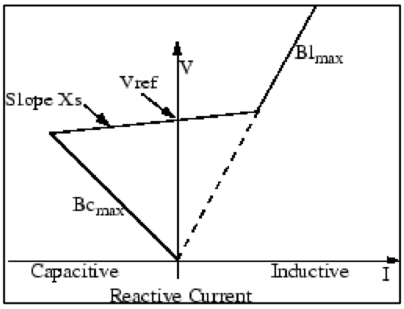

Fig. 2: V-I Characteristics

The V-I characteristics represent the steady state relationship, which are shown in fig. (2). A typical V-I characteristics determines the range of inductive and capacitive current supplied by the SVC. The V-I characteristics of the SVC indicates that regulations with the given slope around the nominal voltage can be achieved in the normal operating range defined by the maximum capacitive and inductive currents of the SVC.

IV. SVC CONTROL SYSTEM

The Controlling of shunt susceptance (B) is the basic concept of SVC control system and which can be controlled by changing the firing angle of thyristor. The control objective of the SVC is to maintain a desired voltage at the High- Voltage bus. The SVC regulates Voltage at its terminal by controlling the amount of Reactive power injected into or absorbed from the power system.

- When system voltage is low, the SVC generate reactive power (SVC capacitive)
- When system voltage is High, it absorbs reactive power (SVC inductive)

At the secondary side of the coupling transformer there are three phase capacitor bank and inductor banks which are based on switching operation.

- If each capacitor switched on and off by three thyristor switches is called Thyristor Switched Capacitor
- In same way each reactors are switched on and off by three thyristor switches is called Thyristor Controlled Reactor.

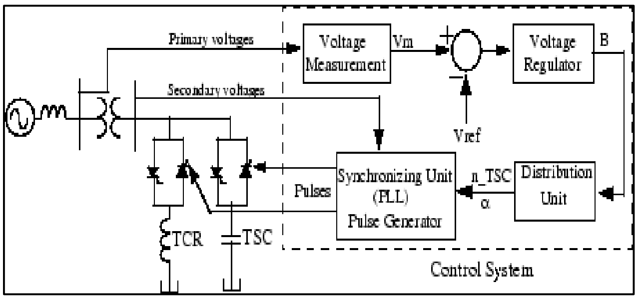

Fig. 3: SVC control system

The Measurement of Positive Sequence voltage is done by measuring element. A Voltage regulator that uses the voltage errors (difference between the measured voltage Vm and the reference voltage Vref to determine the SVC susceptance B needed to keep the system voltage constant. The next units compute the firing angle of Thyristor controlled reactor. A synchronizing system using a phase locked loop (PLL) synchronized on the secondary voltage and a pulse generator that send appropriate pulses to the thyristor.

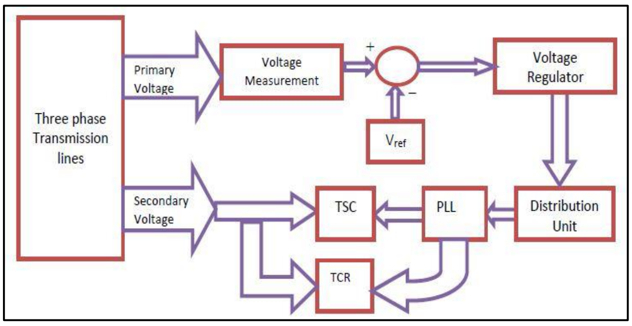

Fig. 4: SVC control system

V. CASE STUDY OF SVC SIMULATION MODEL

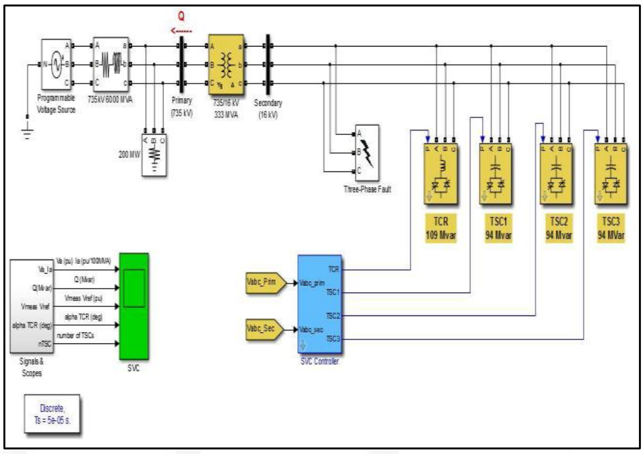

Fig. 5: SVC Simulation Model

The efficient regulation of voltage with the help of static VAR compensator based voltage regulator has been successfully studied and implement in a Simulink. The reference voltage is taken as 1.0 pu. The following figure shows the waveforms of voltage Va and current Ia verses time across the three phase transmission line subjected to line to ground fault. The fault is introduced at time of 0.4 m sec to o.6 m sec so voltage goes down and current increase suddenly and these are represented by fig.

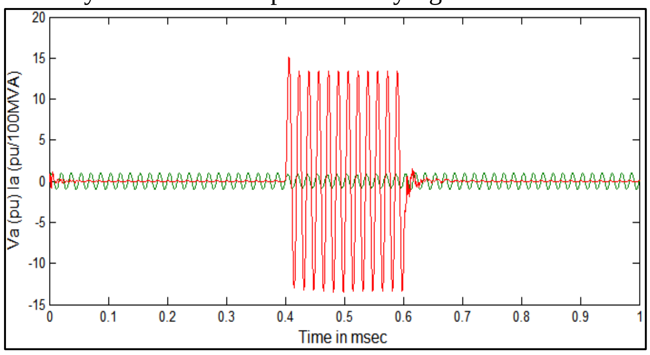

Fig. 6: voltage goes down and current increase suddenly

Figure shows the waveform of reactive power verses time. We can see clearly in waveform the system demanded reactive power from input supply. We can see these changes in waveform between 0.4 m secs to 0.65 m sec time intervals.

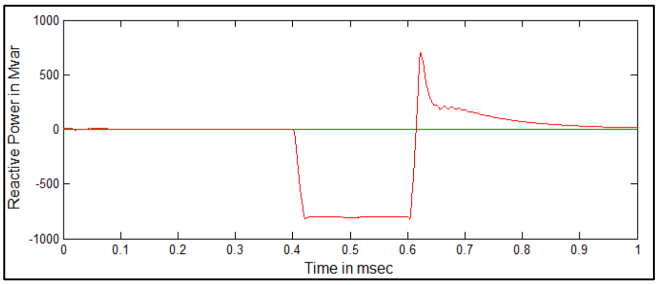

Fig. 7: waveform of reactive power verses time

Fig. shows the waveform of measured voltage Vmea, reference voltage Vref and time. The reference voltage sets to 1.0 pu. In normal operating condition the measured voltage follows the reference voltage 1.05pu. At the time of fault between t=0.4 m sec to 0.6 m sec, the voltage goes down after 1.2 m sec the SVC control system activated and return back to the voltage control from 1.12 pu to 1.0 pu at the time of 1.8 sec.

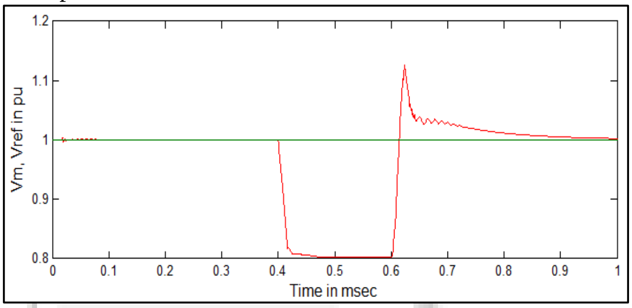

Fig. 7: waveform of measured voltage Vmea, reference voltage Vref and time

Fig shows the variation in firing angle of TCR with respect to time. At the time of fault the TCR start to trigger at 170* and finally reaches with 180* at no conduction region. As the fault occur at t=0.4 m sec the TCR start to trigger and generate firing pulses for TSC. Alpha angle changes suddenly from 90*to 180* that mean full conduction to no conduction state. Finally t=0.65 m sec the measured voltage value reached to nominal reference voltage 1.0 pu and that is a result of SVC for reduction of reactive power at zero level.

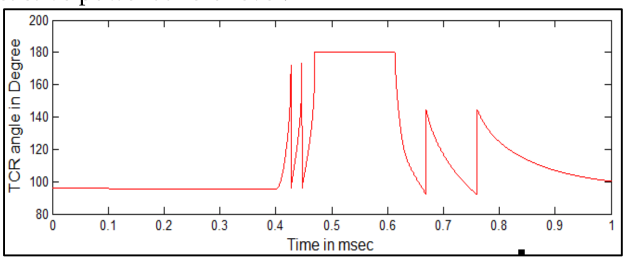

Fig. 8: Variation in firing angle of TCR with respect to time

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