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A Power Frequency Phase and Transient Condition Control through STATCOM in Power System

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***Abstract*: - The article presents a hybrid scheme to improve the stability of the multi machine power system. The voltage regulation and the angular stability of the power system are improved with the help of STATCOM. A new standard controller for the STATCOM with a Supplemental Bandwidth Multiple Band Controller is used to improve the power supply voltage profile and to cushion the low frequency oscillation between zones. The selection of the wide area control signals is performed using the sensitivity of the eigenvalues expressed in terms of participation factor. The efficiency of the proposed scheme is tested in the IEEE 12 bus reference system to cover a wider range of operating conditions. The results of the simulation show that the proposed scheme stabilizes the system at multiple points of operation.**

Key words: - STATCOM , Robust Control, Voltage Regulation, Low Frequency Oscillation.

1 INTRODUCTION

Due to economic, geographic and environmental reasons, transmission and power system generation networks are being operated close to their safety limits. This, in turn, weakens the system against transient and dynamic disturbances. The steady-state Static Synchronous Compensator (STATCOM) can control the voltage and exchange of reactive energy with the network at the common coupling point (PCC) and is also capable of improving the damping of the power system during dynamic and transient disturbances. Many control schemes have been reported in the literature to improve the regulatory property of STATCOM in terms of voltage and power under different applications with the use of the PI regulator as a regulator for AC system voltage, DC voltage and current regulators under dynamic conditions of failure and load. To regulate the voltage in the PCC, a typical double loop PI control strategy was employed using fixed gain. Due to failure or switching, there is a change in the system matrix and in the eigenvalue; also the controller can give uncertain or indefinite results, if the controller integrator saturates in the presence of control error that becomes too large under the condition of sudden changes of load, configuration of the power system To have the dynamic response satisfactory, some techniques nonlinear using ANN and fuzzy logic have been sent to adapt the gain of the STATCOM PI controller during dynamic perturbations [8-11]. The main contribution of the work described is to highlight a new PI regulator scheme that has the advantage of being cheap, robust and provides better reactive power support compared to the conventional STATCOM PI controller while performing its main task of voltage regulation and not involves the use of intelligent or non-linear control technique that requires rule base or training which is a tedious and costly method of implementation.

2. STATIC SYNCHRONOU COMPENSATOR (STATCOM)

The STATCOM is based on a solid-state synchronous voltage source that generates a balanced set of three sinusoidal voltages at the fundamental frequency with rapidly controllable amplitude and phase angle. The configuration of a STATCOM is shown in Figure 2. It basically consists of a voltage source converter (VSC), a coupling transformer and a DC capacitor. The control of the reactive current and, therefore, the susceptance presented to the power system is possible by varying the magnitude of the output voltage (VVSC) with respect to the bus voltage (VB) and thus operating the STATCOM in inductive region or capacitive region. Fig. 2: Static synchronous compensator (STATCOM).

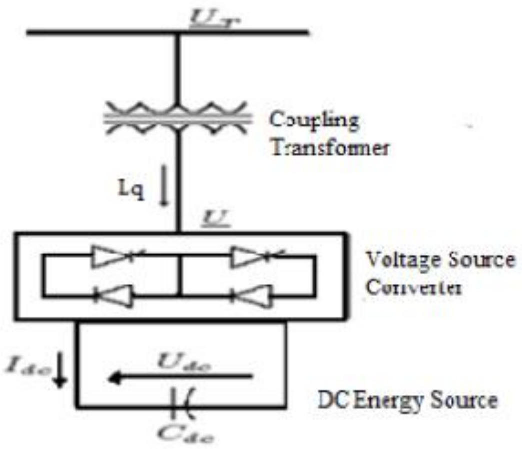


Fig.2.1: Static synchronous compensator (STATCOM).

2.2 Static Var Compensator (SVC): -

Static VAR systems are applied by utilities in transmission applications for various purposes. The main objective is usually the rapid control of the voltage at the weak points of a network. The installations may be at the midpoint of the transmission connections or at the line ends. Static VAR Compensators are deriving connected static / absorber generators whose outputs are varied to control the voltage of the electrical power systems. In its simple form, the SVC is connected as a Fixed Capacitor Thyristor Controlled Reactor (FC-TCR) as shown in Fig.2.2

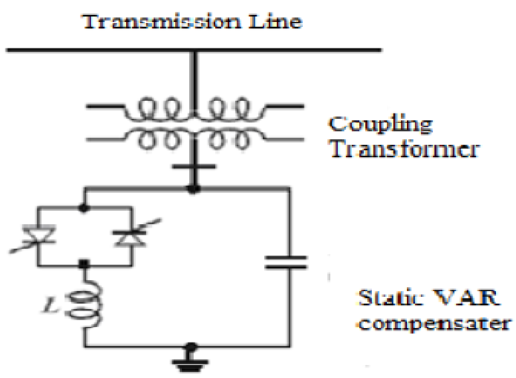


Fig. 2.2: SVC static VAR compensator.

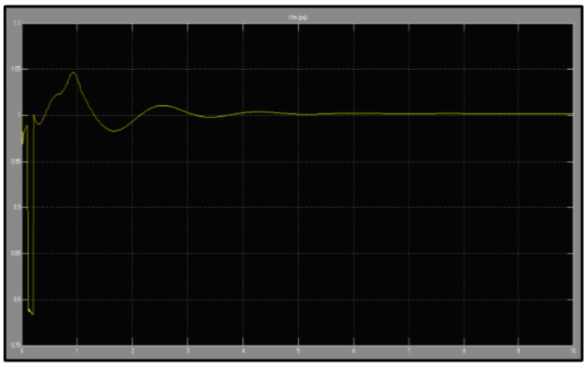
The SVC is connected to a coupling transformer which is connected directly to the AC bus whose voltage must be regulated. The effective reactance of the FC-TCR is varied by control of firing angle of the antiparallel thyristors. The trip angle can be controlled via a PI controller (Proportional + Integral) in such a way that the bus voltage, where the SVC is connected, is maintained at the reference value.

The bus system 6 shown above describes a transmission line network. The load data, voltage magnitude, generating program and reactive power limits for the buses are tabulated in the appendix. Bus 1, with a voltage specified as, is taken as the loose bus, and represents all losses associated with the transmission line, as well as generators.

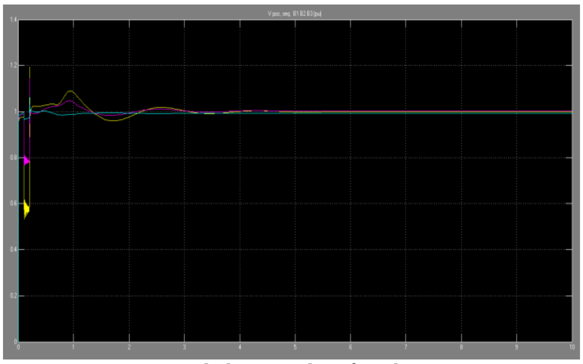
The base MVA is taken as 100 MVA. All resistors, reactances, susceptances and other parameters are calculated on the basis of this MVA. First we analyze the system without the implementation of a STATCOM and we see the results of the failure in different buses and eliminating different lines. Next, we compare the graphs of the different buses with their respective faults, and find out the point at which it would be more appropriate to implement a STATCOM. Later we analyze the system with a STATCOM and check the improvement, if there is one. The transient stability due to the sudden failure at any point is analyzed.

3 RESULT AND ANALYSIS: -

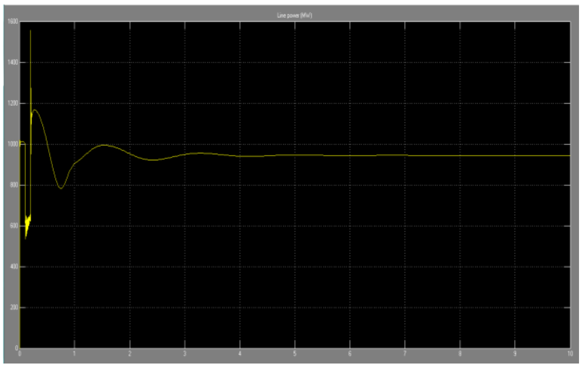
Case 1: We analyze the system of 3bus and the fault in bus being the lines eliminated, we obtain to the voltage magnitude. The fault is cleared in 0.1 seconds for a simulation time of 10seconds.



Case 2: Similarly, we analyse for fault at a voltage sequence for the same simulation time and fault clearance time.



Case 3: similarly we analyze for a line power



Case 4: similarly we analyze for a line power

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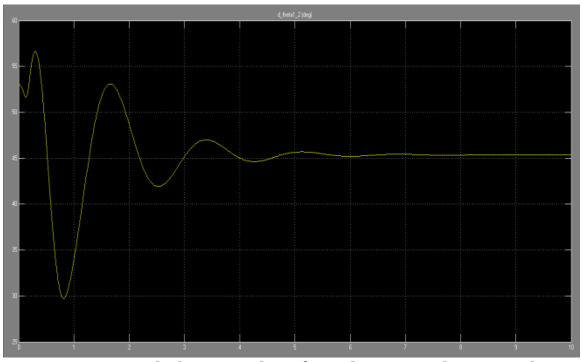
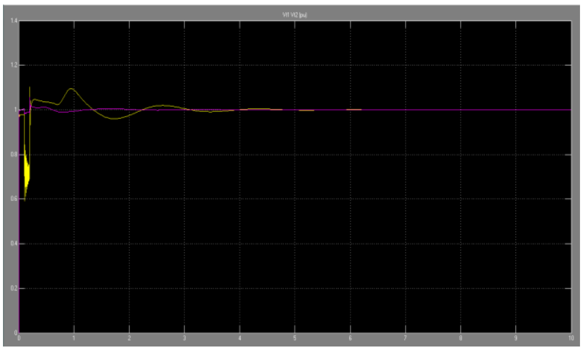
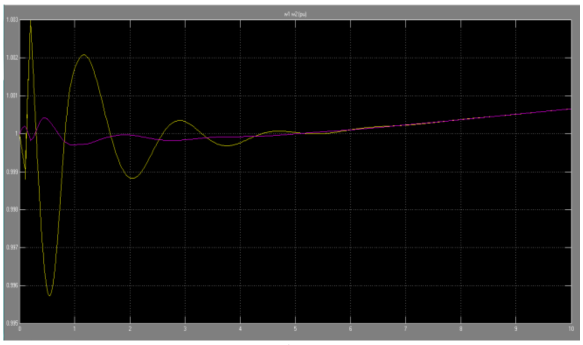

Case 5: Similarly we analyze for a theta 1 machine signal


Case 4: Similarly we analyze the machine signal


Case 5: similarly we analyze for a Machine signal w1 power

Therefore, we discovered that the bus fault 5 causes maximum displacement of the rotor angle of the generator 2 and 3 with respect to the generator 1. The angle misalignment varies greatly in this case and deviates greatly compared with the above cases . Therefore, it would be an appropriate point for the implementation of STATCOM. Therefore, we put the STATCOM in shunt with bus 5, and the value of STATCOM reactive power is assumed to be 30 MVAr. Thus, bus 5 and STATCOM together have a total reactive power of 60 MVAr.

STATCOM Implementation:

Below is the graphics that the bus system without and with STATCOM and see the difference in rotor angle characteristics. Improved rotor angles can be seen from both graphs and the STATCOM application has made the transient features much better.

The graph above shows the difference between faulty system behavior on all connected buses without and with STATCOM. We can see that the waveform of the rotor angle of the generator 3 with respect to generator 1 shows much better characteristics with the STATCOM and the the harmonics are eliminated because of their action.

5. CONCLUSION

The study of the basic principles of SVC and STATCOM is carried out as well as the fundamentals of reactive power compensation using a STATCOM. The bus system shows improved plots and we can conclude that the addition of an SVC or STATCOM controls the output of a bus in a robust way and improves stability.

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