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Implementation of Static Synchronous Series Compensator for Power Flow Improvement in Electrical Power Transmission System

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ABSTRACT

During this study, a static synchronous series compensator (SSSC) is employed to dominant active and reactive powers still as damping grid oscillations in transient mode. For quick power flow management within the cable system this reducing the effective electrical phenomenon of lines by series compensation may be a direct approach to extend transmission power capability. But power transfer capability of long transmission lines is proscribed by stability thought. The SSSC with a supply of energy within the DC link will provide or absorb the reactive and active power from the road. Complete Simulations are worn out MATLAB/SIMULINK atmosphere. Simulation result shows the accuracy of planned compensator and achieving the required price for active and reactive powers, and damping of oscillations.

Keywords:*— Cable, Power oscillation damping, Static Synchronous Series compensator (SSSC), Active and Reactive power.*

I. INTRODUCTION

An inherent characteristic of electric energy transmission and distribution by alternating current (AC) is that real power is generally associated with reactive power. Distribution lines and AC transmission are reactive power networks that are characterized by their per-Kilometer series inductance and shunt capacitance [2]. As load power factor changes the transmission lines voltage profile change that can cause large change amplitude variations in the receiving end voltage. Voltage degradation is affect in the performance of loads. The Over voltage is causes harmonic generation and magnetic saturation in system equipment is cause insulation breakdown [4]. After any disturbance of the system Power system has ability to regain its original operating condition. Power system transient stability analysis is generation or transmission system due to fault or switching [1]. Reactive power compensation has identified as a very key measure to improve the transient stability of the system. For increasing system stability margin gain Flexible AC Transmission Systems (FACTS) devices provides suitable control strategy. Static Synchronous Series compensator (SSSC) is a member of FACTS family which is connected in series with a power system [1]. It is consists solid state Voltage Source Converter (VSC) which generates a controllable alternating current voltage at fundamental frequency. While the primary purpose of a SSSC is to control power flow in steady state also improves transient stability of a power system.

Static Synchronous Series Compensator

The Static Synchronous Series Compensator (SSSC) is a series type FACTS controller based on Voltage Source Compensate [3]. A SSSC has several advantages over a TCSC such as elimination of passive components; improve technical system characteristics, symmetric capability in both inductive and capacitive operating modes, and possibility of connecting an energy source on the DC side to exchange real power with the AC network.

Operation of SSSC and the Control of Power Flow

The Static Synchronous Series Compensator (SSSC) is one of series FACTS devices. SSSC is a solid-state voltage source inverter, injects a nearly sinusoidal voltage, with variable magnitude in series with the transmission line. The injected voltage is in quadrature with the line current that provides the losses in the inverter. The injected voltage, which is in quadrature with the line current, follows an inductive or a capacitive reactance in series with the transmission line [6]. This variable reactance, inserted by the injected voltage source and the electric power flow through the transmission line. Schematic of a SSSC is shown in Figure 1.1(a). The equivalent circuit of the SSSC is shown in Figure. 1.1(b). Regulation of power flow can control with control the magnitude of Vc. The winding resistance and leakage reactance of the connecting transformer appear is series with the voltage source V_C. If there is no energy source on The DC side, neglecting losses in DC capacitor and the converter, the power balance in steady state. Equation (1.1) Vc is in quadrature with current I. If Vc lags I by 90, the operating mode is capacitive and the current (magnitude) in the line is increased with resultant increase in power flow [8]. On the other hand, if Vc leads I by 90, the operating mode is inductive, and the line current is decreased. Note that we are assuming the injected voltage is sinusoidal (neglecting harmonics).

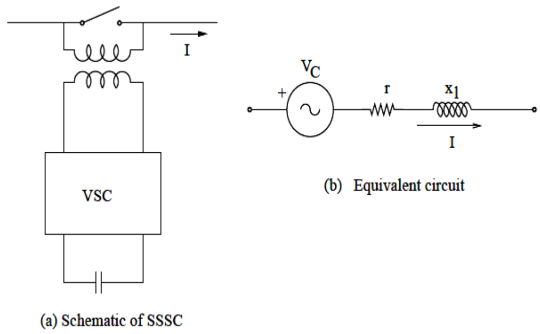

Figure 1. Schematic of SSSC. [2]

Since the losses are always present, the phase shift between current and Vc is less than 90 (in steady state). In general, it can be written as

$$Re[V_c I^*] = 0 \ldots\ldots\ldots\ldots\ldots\ldots (1.1)$$

$$V_c = V_c(\cos\gamma - j\sin\gamma)e^{j\Phi} \quad (1.2)$$

Equation (1.2) where Φ is the phase angle of the line current, γ is the angle by which lags the current. V_{Cp} and V_{Cr} are the in-phase and quadrature components of the injected voltage (with reference to the line current) [10]. We can also term them as active (or real) and reactive components. The real component is required to meet the losses in the converter and the DC capacitor.

2. METHODOLOGY

A Static Synchronous Series compensator (SSSC) is a member of FACTS family which is connected in series with a power system. It consists of a solid state Voltage Source Converter (VSC) which generates a controllable alternating current and voltage at fundamental frequency. When the voltage injected is kept in quadrature with the line current, it can follow as inductive or capacitive reactance so as to influence the power flow through the transmission line[11]. While the primary purpose of a SSSC is to control power flow in steady state and also improve transient stability of a power system. A Static Synchronous Series compensator (SSSC) is used to investigate the effect of this device in controlling active and reactive powers as well as damping power system oscillations in transient mode. The SSSC set with a source of energy in the DC link can supply or absorb the reactive and active power from or to the line. Simulations have been done in MATLAB/ SIMULINK environment. Simulation results shows for selected bus-2 in three phase 500 KV transmission line system shows the accuracy of this compensator [17]. FACTS devices member in controlling power flows, achieving the desired value for reactive and active powers, and damping oscillations appropriately. The methodology of this paper is shown in the figure (4.1) with the help of simulink diagram representation. The description of each block in the above figure is as follows:

1. ***Three Phase Source*** – The three phases block supplies 500KV three phase voltage to the transmission line.

2. ***Three phase fault generator-*** this block generator fault on the transmission line according to user specification.

3. ***B1 Bus-*** this bus indicates interfacing connection between 500 KV 2100 MVA source and SSSC block and also provides Voltage(V) & Current (I) measurement.

4. ***Static Synchronous Series Compensator (SSSC) block*** - This block represents the SSSC simulation model for the project work.

5. ***B2 Bus-*** this bus indicates interfacing connection between SSSC block and 280 KM line and also provides Voltage(V), Current(I) measurement.280 Km Line – this block represents 280 KM transmission line.

6. ***Three Phase Dynamic Load*** – represents load at the end of transmission side.

7. ***150 Km Line*** – this block represents 150 KM transmission line.

8. ***B4 Bus-*** this bus indicates interfacing connection between 150 KM line to next 150 KM line.

9. ***B3 Bus-*** this bus indicates interfacing connection between 50 KM line and dynamic load.

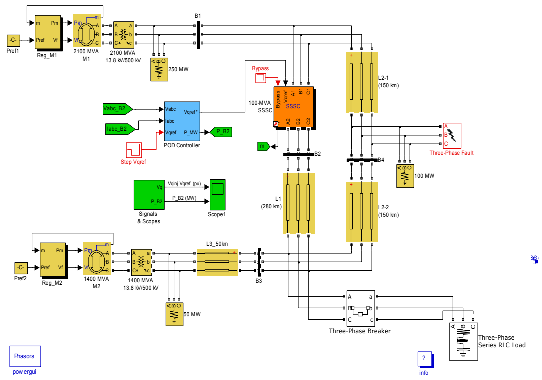

Figure 2 Simulink Diagram Representation of Proposed Work.

III. Results and Discussions

SSSC with POD Controller the facility grid consists of 2 power generation substations and one major load center at bus B3. the primary power generation station (M1) encompasses a rating of 2100 MVA; representing half dozen machines of 350 MVA and also the alternative one (M2) encompasses a rating of 1400 MVA, representing four machines of 350 MVA.

1. SSSC Dynamic Response

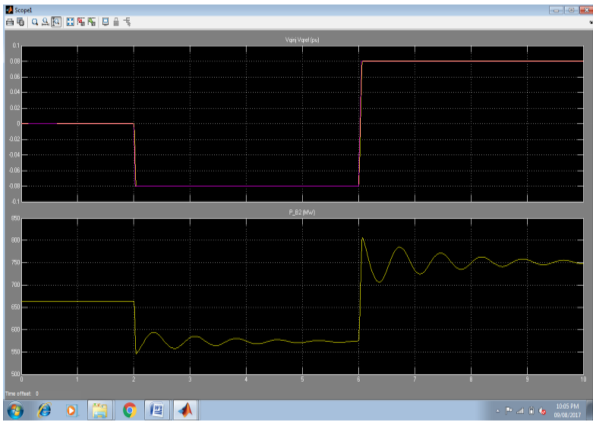

Figure 3. illustrates, the facility obtained at bus B2 while not SSSC.

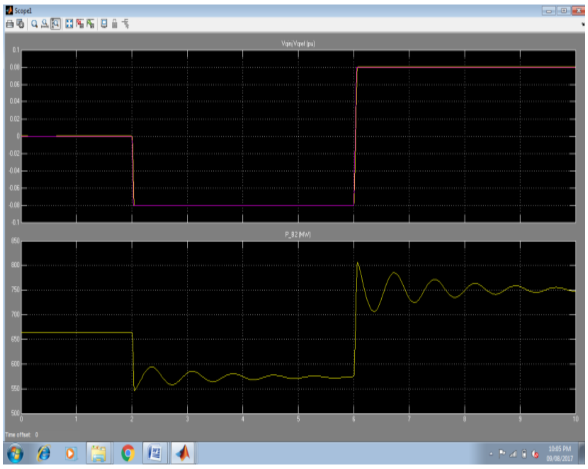

Figure 4. Shows the facility obtained in the least the buses B1, B2, B3 and B4 while not SSSC.

When parameter is amendment from three to zero.05. Rerun the simulation. the facility oscillation on the active power ought to currently be terribly little.

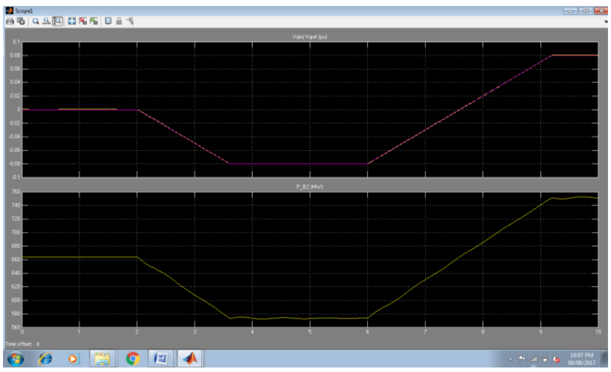

Figure 5 Illustrates, the facility obtained at bus B2 while not SSSC.

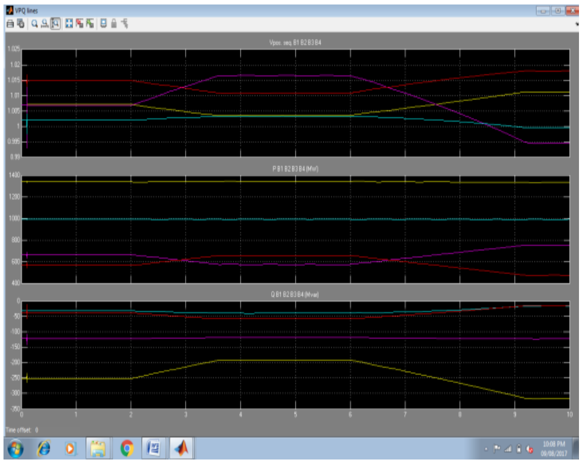

Figure 6. The Facility Obtained in the Least the Buses B1, B2, B3 and B4 while not SSSC.

The advancement in the technology like home equipments and plant equipments, demands for precession and highly regulation in the received power from energy generator through the lines, because in current scenario the equipments are very much sensitive to supply power regulation. Any kind of fluctuation either damage the costly equipment or may harm full for further used equipments. In this paper used algorithm shows an efficient solution of this problem.

3. CONCLUSION

The advancement in the technology like home equipments and plant equipments, demands for precession and highly regulation in the received power from energy generator through the lines, because in current scenario the equipments are very much sensitive to supply power regulation. Any kind of fluctuation either damage the costly equipment or may harm full for further used equipments. In this paper used algorithm shows an efficient solution of this problem. In this paper, a Static Synchronous Series compensator (SSSC) is has been investigated to analyze the effect of this device in controlling active and reactive powers as well as damping power system oscillations in transient mode. The SSSC setup with a source of energy in the DC link can supply or absorb the reactive and active power to or from the line.

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