

Enhancement of Power Quality and Stability in Power system using FACTS device with Controller

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Abstract - In last some year the demand of electricity has been increased day by day. So due to limitation of generated electricity and transmitted power we cannot fulfill the requirement of the consumers. To overcome such limitations, to reduce transmission line losses and to achieve desired real and reactive power, modeling, simulation of the system using the FACTS device such as a Static Synchronous Series Compensator (SSSC) controller in a three-machine system is proposed. SSSC gives power system stability enhancement and also reduce the transient oscillation. So we used SSSC a FACTS device model Simulink system model in MATLAB. By modeling a three machine system and install FACTS device at the midsection of the transmission line. The FACTS devices give controlling power flows, achieving the desired value for active and reactive powers, and damping oscillations appropriately. The results obtained from simulations validate the effectiveness of proposed modeling and tuning approach for power system stability improvement. The simulation results also shows that the proposed SSSC controller is effective in damping a range of small disturbance conditions in the power system.

Key Words: SSSC-Static Synchronous Series Compensator, PID – Proportional Integral Derivative controller

1. Introduction

As the consumption of electricity is increasing day by day the power transmission lines are becoming crowded and this leads to instability in the power system due to overcrowded bus. So it is necessary to grow our technical aspect to deal with the scenario. But we know that the power systems are complex non-linear systems, which are often subjected to low frequency oscillations. The application of power system stabilizers for improving dynamic stability of power systems and damping out the low frequency oscillations due to disturbances has received much attention. So we introduce the FACTS device to damp out the oscillation and compensate the required Reactive power to the system. So in this system SSSC second generation FACT device is used in three machine system. For the better performance PID controller is used. We introduce a small disturbance or fault

for 4 cycle in system. The results obtained from simulations validate the effectiveness of proposed modelling and tuning approach for power system stability improvement. While giving a small disturbance fault in power system, the simulation result will show the effective performance of the SSSC controller in simulation result.

1.1 Power system under study

The Multi machine Power system with SSSC FACT devices at mid-section is considered in this system. This system consist of three generator which is divided in to 2 subsystem through which it is connected with a inter tie line transmission system. All of three generator are Hydraulic turbine and Governor System with Excitation (HTG). A system which have PID controller governor system model and also have a servo-motor with it. All the data of the system is given at the last Appendix. Now a small disturbance is produce at the double circuit tie line of 4 second small fault.

1.2 Modeling of SSSC

As the basic line diagram of SSSC consist of Capacitor (Energy storage device), Invertor, and Transformer. SSSC is installed at Midsection of the system to get better performance. In double circuit line two parallel transmission lines are used of 175km in which a small disturbance is introduce in double circuit line 2. Required voltage is given in system by SSSC system. A capacitor ($365e-4$ f), Voltage source convertor (Invertor) is a readymade model of Universal Bridge, and three coupling transformer and controlling circuit is used.

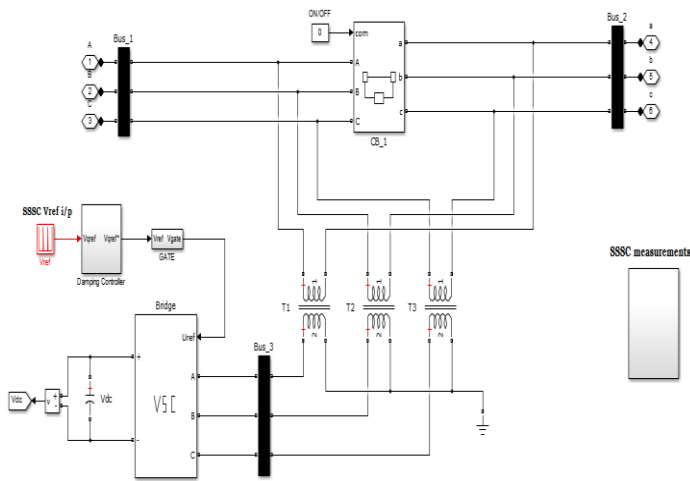


Fig 1. SSSC model circuit

2. Reference voltage generator circuit

Three circuit are placed in the subsystem 1) Measurement and Conversion, 2) Controller circuit & 3) Conversion circuit

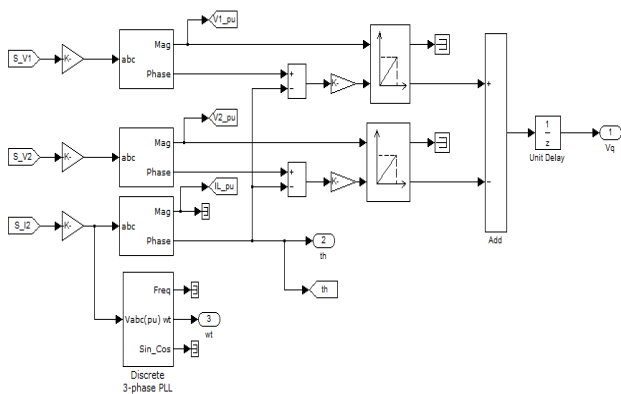


Fig 2. Measurement and conversion circuit.

The voltage and current are taken from the Bus 1 and 2. From this we can identify the required voltage and current in the system. From the abc phasor to Vq and Vd. Vd is terminated because it is not required in the system.

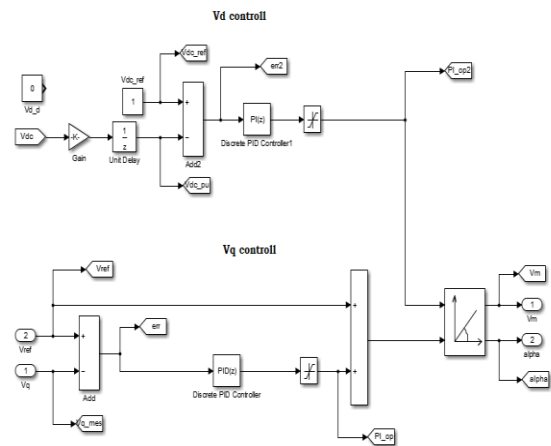


Fig 3. Controller circuit (PID controller)

From the measurement circuit Vq voltage is further given to the controller circuit. PID controller it will minimized the error. Vd control is for the charging and discharging of Capacitor. Vq is for the required voltage given to the system from the SSSC.

3. Damping control circuit of SSSC

There are main 3 parameter which create oscillation in system. 1) Power, 2) Rotor angle, and 3) Speed of generator. From these three oscillations, I had used to damped out the power (voltage and current) power oscillation. So first take the V2 I2 from the bus2 of system. Using gain block we had convert.

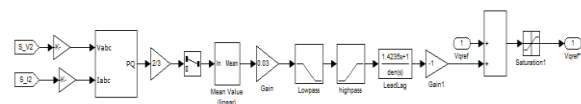


Fig 4. Oscillation Damping Circuit.

In this Lead-Lag transfer function block is used. From this we can get the Vq references at the output.

4. Waveform

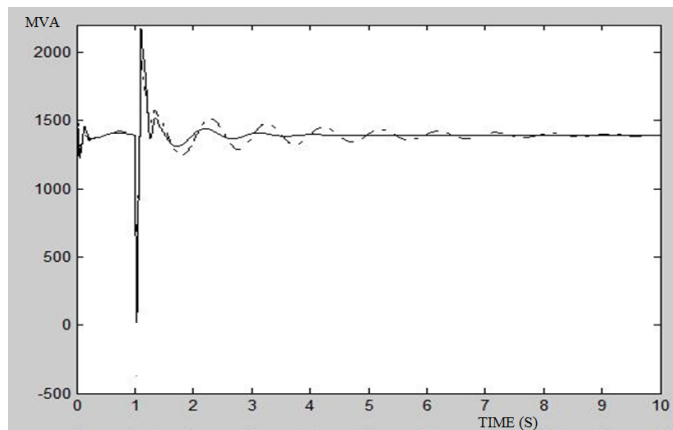


Fig 5. Power P1,P2 (with and without controller)

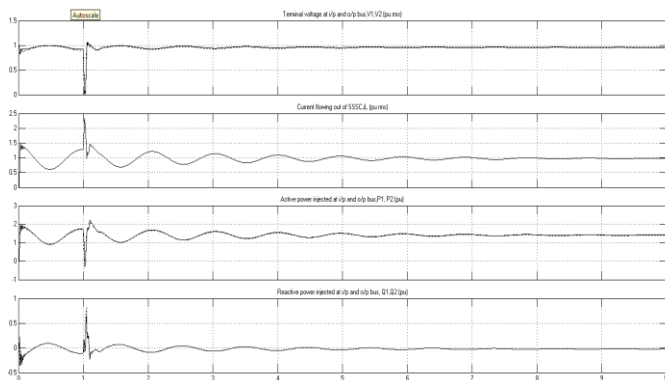


Fig 6. SSSC input output bus data without controller

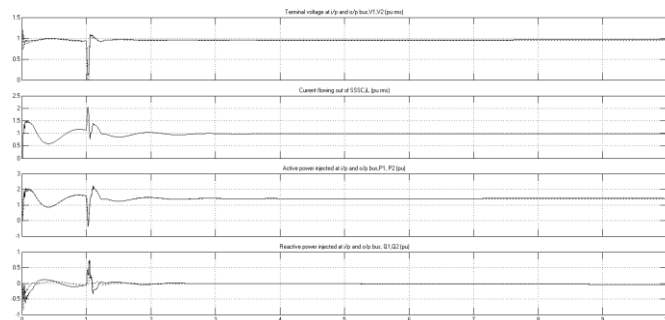


Fig 7. SSSC input output bus data with controller

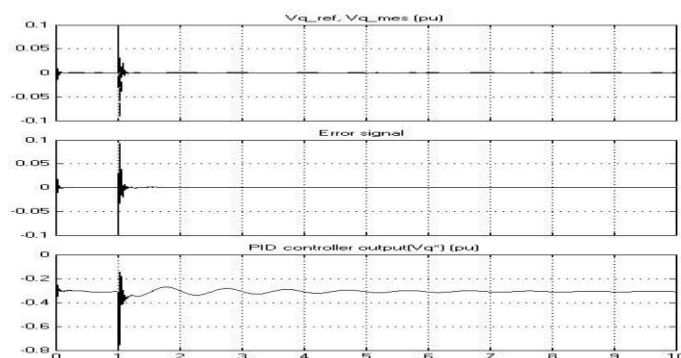


Fig 8. PID Without damping circuit

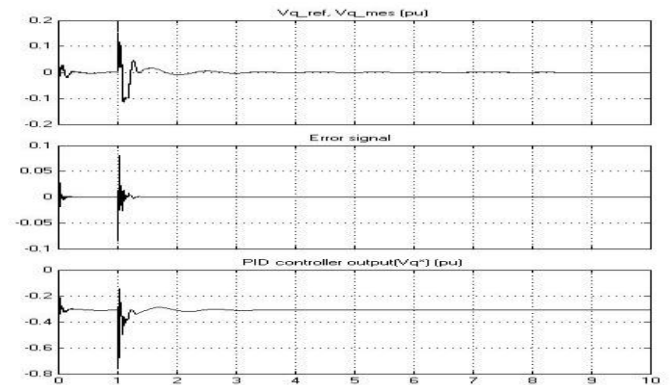


Fig 9. PID With damping circuit

5. CONCLUSIONS

This article present an SSSC based controllers to improve the transient stability when we introduce a sudden three phase fault in system. PID controller with damping circuit take minimum time to minimize the error and damp out the oscillation. Proposed FACTS device provide damping to the oscillation and improve the voltage profile of the model system. We can observe from waveform that the oscillations wave produced due to sudden introduce of fault in SSSC data input and output, PID controller circuit, and power P1 P2 waveform that are clearly damp out by SSSC and Damping circuit.

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