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

Utkarshkumar B Solanki[1], Brijesh D Parmar[2], Divyang D Patel[3], Hardik V Patel[4]
[1,2,3,4]*Pacific School of Engineering*

***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. So to achieve its requirement of the consumer, the transmission line losses are reduced and achieve its real and reactive power by modeling, simulating the system using the FACTS device such as a Static Synchronous Series Compensator (SSSC) controller in a three-machine system. 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.**

I.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 second in system. The results obtained from simulations validate the effectiveness of proposed modeling 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.

II. POWER SYSTEM UNDER STUDY

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

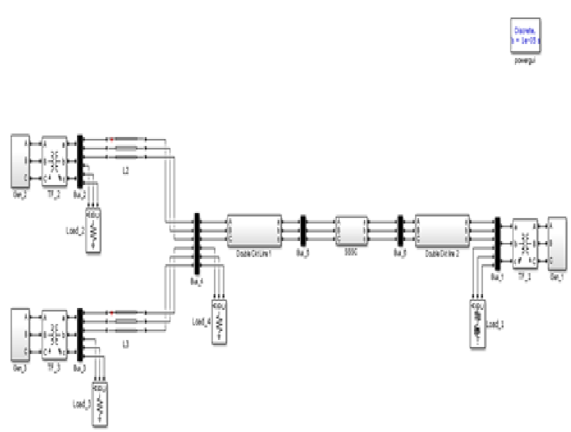

Fig 1. System model circuit with SSSC

A. Modelling 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 line 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.

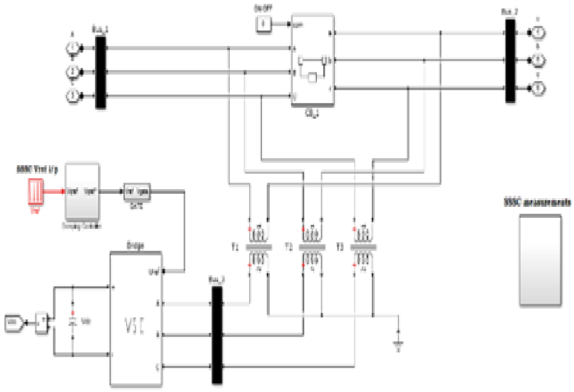

Fig 2. SSSC model circuit

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.

III. REFERANCE VOLTAGE GENERATOR CIRCUIT

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

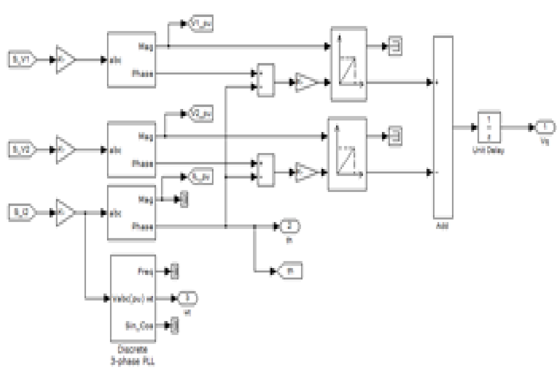

Fig 3. Measurement and conversion circuit

The voltage and current are taken from the Bus 1 and Bus 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.

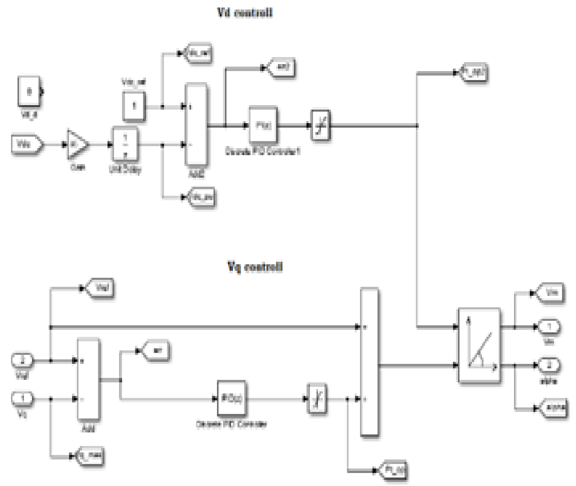

Fig 4. Controller circuit (PID controller)

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.

IV. DAMPING CONTROL CIRCUIT OF SSSC

There is 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.

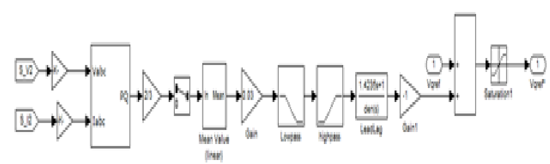

Fig 5. Oscillation Damping Circuit

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

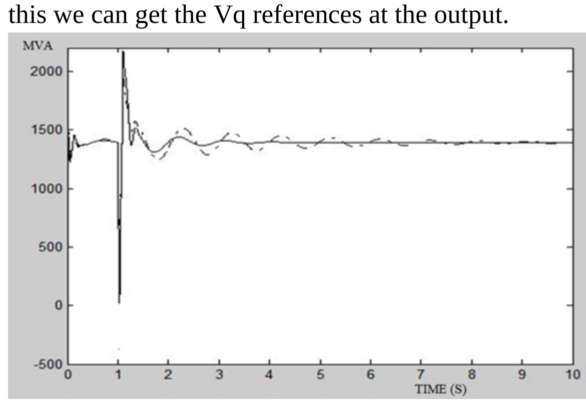

Fig 6. Power P1, P2 (with and without controller)

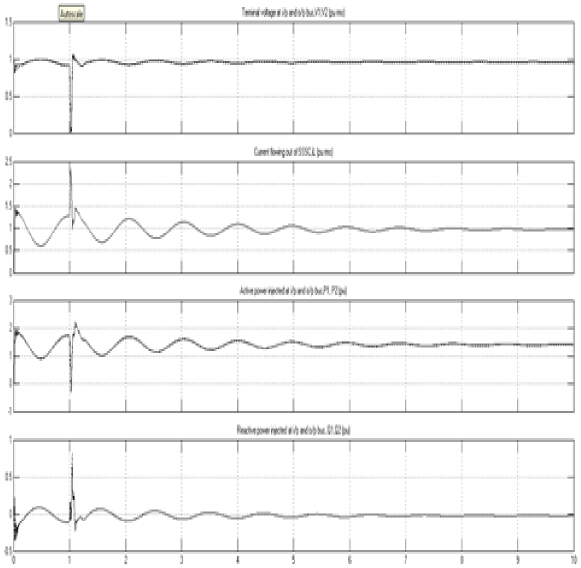

Fig 7. SSSC input output bus data without controller

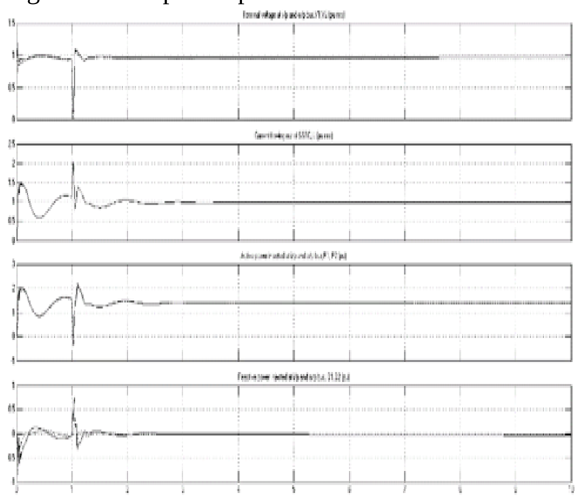

Fig 8. SSSC input output bus data with controller

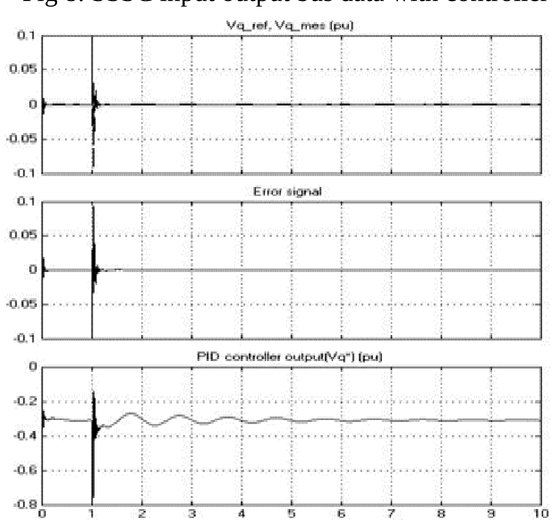

Fig 9. PID Without damping circuit

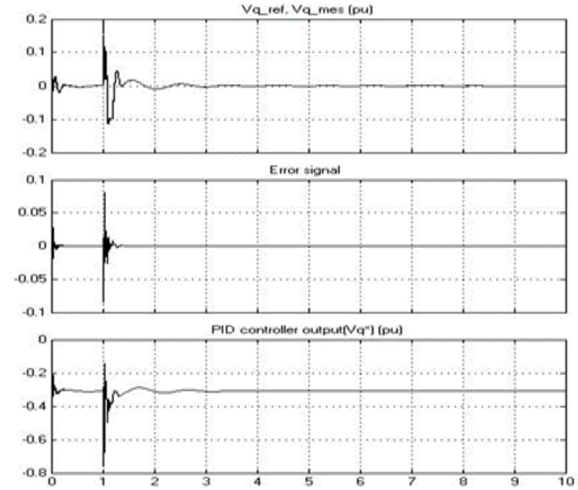

Fig 10. PID With damping circuit

V. CONCLUSION

This article present an SSSC based controllers which 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.so from this SSSC FACT 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.

V1. APPENDIX

Generator: G1=3450 MVA, G2=1280 MVA, G3=880 MVA. Xd=1.305, X ' d = 0.296 , X " d = 0.252, Xq = 0.474 , X 'q = 0.243 , X " q = 0.18 , f= 60 HF.
Transformer: Winding V1=13.8 KV, V2=500KV, f= 50 hz.
Transmission line: Double Circuit 1 & 2= 175 km, L2= 50 km, L3= 100 km
SSSC: C= 375e6 farad, coupling transformer= V1= 5e5, V2= 40e3,
Converter rating: nom S = 100 MVA, System nominal voltage: nom V = 500kV,
Frequency: f = 60 Hz.

B.REFERENCES

[1] NPTEL webcourse of DIGITAL CONTROL SYSTEM from IIT Guwahati by DR.Indrani Kar and Somnath Majhi.
[2] "Simulation Study of a SSSC-based Neuro-Fuzzy Controller for Improvement of Transient Stability in a Three-Machine Power System" Swasti R. Khuntia, Student Member, IEEE Graduate Student Dept. of Electrical Engineering Illinois Institute of Technology Chicago, USA 2012.
[3] "Design and Analysis of STATCOM for Reactive Power Compensation and Transient Stability Improvement Using Intelligent Controller" P.K.Dhal Assistant Professor, C.Christober Asir Rajan, Department of IEEE VelTech DR.RR&DR.SR Technical University Chennai,2010 India
[4] "Modelling, simulation and optimal tuning of SSSC-based controller in a multi-machine power system" Sidhartha Panda Department of Electrical and Electronics Engineering, National Institute of Science and Technology, Brahmapur 761008, India 2011 ISSN 1 746-7233, England, UK World Journal of Modelling and Simulation
[5] "Power System Stability Enhancement Using Static Synchronous Series Compensator (SSSC)" M. Faridi & H. Maeiiat, M. Karimi & P. Farhadi, H. Mosleh Electrical Eng, Department 2009. Islamic Azad University-Ahar- Branch, Ahar, Iran.
[6] "Application of SSSC Based Power Oscillation Damping Controller for Transient Stability Enhancement of Multimachine system for Unsymmetrical Faults". Maninder rohal, Mr.Ravi. Research Scholar Dept. of Electrical Engg D.C.R.U.S.T University Sonepat (Haryana), 2012 India.
[7] V. K Chandrakar and A. G kothari "fuzzy logic based static synchronous series compensator for transient stability improvement" IEEE international conference of power system 2009
[8] I. Ngamroo and W. Kongprawechnon, "A Robust Controller Design of SSSC for Stabilization of Frequency Oscillations in Interconnected Power Systems", Electric Power Systems Research,67(2) (2003), pp. 113–119.
[9] Proceedings of India International Conference on Power Electronics 2006 140 "Comparing and evaluating the performance of SSSC with Fuzzy Logic controller and PI controller for Transient Stability Enhancement", B. Geethalakshmi A. Saraswathi P. Dananjayan
[10] 2004 Intemational Conference on Power System Technology – POWERCON 2006 Singapore, 21-24 November 2004 "An Intelligent Fuzzy Controlled SSSC to Enhance Power System Stability "K.M. Sze, L.A. Snider, T.S. Chung, K.W. Chan
[11] M. H. Haque, "Use of Energy Function to Evaluate the Additional damping Provided by STATCOM Electric Power Systems Research,72(2)(2004),pp. 195– 202.
[12] 2011 2nd International Conference on Control, Instrumentation and Automation (ICCIA) Intelligent PID Controller Design of SSSC for Power System Stability Enhancement Mojtaba Alizadeh, Soheil Ganjefar, Member, IEEE, and Mohsen Farahani