Dynamic Performance of UPFC Integrated with a DC Source for Power System Controlling

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Abstract— UPFC is a new version of FACTS devices for different application in power system. The DC source along with UPFC can improve the power transfer to the transmission line. This paper proposes a model of UPFC integrated with a DC source to improve the controllability and performance of power system. It can control both real power and reactive power independently. This system can control the real power and reactive power flow through the transmission line according to power variations. MATLAB/SIMULINK is used to show the effectiveness of result.

Key words: FACTS Devices, UPFC

I. INTRODUCTION

The Unified power flow Controller is one of the most powerful device among the FACTS devices. It can regulate the magnitude of voltage, real power and reactive power flow in steady state but also can damp power oscillation. The Real power flow in UPFC is controlled by the DC capacitor, the energy stored in the capacitor is limited for a range. The power regulation and power oscillation damping ability of UPFC cannot be bring together.

Unified Power Flow Controller can control voltage, current and phase angle to control real power and reactive power flow in the transmission line .The control of real power flow in the transmission line can be done by injecting a suitable voltage in series with a phase angle to the transmission line. The results show that UPFC can track the power changes and inject a suitable voltage into the transmission line so that power flow can be maintained according to the changes in the transmission line.[4].

UPFC has a unique capability .It can control real power and reactive power flows on a transmission line as well as to maintain voltage at the point in which it is connected, this device creates a high quality impact on stability of power system. These features become significant because of UPFC can allow loading of the transmission lines close to a particular range and should be with in its thermal limits, forcing the power to flow through the transmission line. This will increase the power system flexibility in order to satisfy the demands imposed by the system. The PI controller used in the control of power flow has an important effect on the performance of UPFC and it different modes of operations.[5].

Current control of unified power flow controller (UPFC) that is used for stability and controllability of power system. The series compensator can maintain the voltage and the two components of voltage which are in phase and quadrature with the line current flows through the transmission line.[2].

II. THE SYSTEM TOPOLOGY

The UPFC is a device which can control power flow as well as all the parameters of line. i. e. system voltage, reactance of line and phase angle of voltage. Such UPFC combines together with the features and effects of two FACTS devices are the Static Synchronous Compensator and the Static Synchronous Series Compensator.

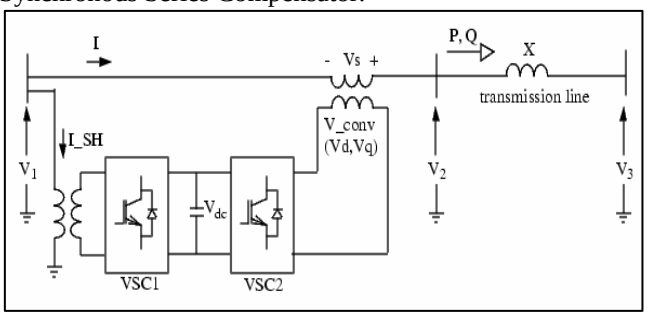

Fig. 1: UPFC Configuration.

The Unified Power Flow Controller consists of two converters.VSC1 are VSC2 are voltage sourced inverters which is connected back to back via a DC link. Converters are operated from a common dc link provided between converters as a dc storage capacitor. This arrangement can allow the real power can freely flow in either direction between the terminals of the two VSC's and each converter can independently generate/absorb reactive power to the transmission line. Since UPFC can inject a voltage in series to the line with variable magnitude and phase angle .Hence it can exchange real power by injecting voltage with the transmission line.

The shunt voltage source converter is controlled by the shunt controller of UPFC which can act as a variable reactive power source .This source can charge the DC link capacitor. This converter is connected parallel to the transmission line through a transformer. Series converter is connected series with the transformer which can provide series injection of voltage or can compensate the phase angle. Thus real power flow can be maintained. The DC link capacitor voltage should be constant for the performance of UPFC. Series converter alone can function in UPFC because it can absorbs or generate the reactive power demand of line.[3].

UPFC itself cannot supply or absorb active power in steady state. UPFC need a source instead of DC link. Thus the shunt converter functions to compensate the converter losses and reactive power. If there occurs a disturbance in line, the capacitor voltage varies. VSC 2 can independently exchange reactive power to the transmission line .The main advantage of FACTS is their high speed and its compact size.

III. OPERATING PRINCIPLE OF UPFC

It can control both active and reactive power flows through transmission line. Series device will exchange active and reactive power with the line independently. The reactive power is provided by the series device and it permits the active power flow to the dc terminals. The shunt device (STATCOM) provides demand of dc terminal power by keeping the voltage across the storage capacitor remains constant. So the net real power absorbed from the transmission line by the UPFC is equal to the converter losses and losses of their transformers. The shunt device, with its remaining capacity exchange reactive power with the line to maintain voltage at the connection point.

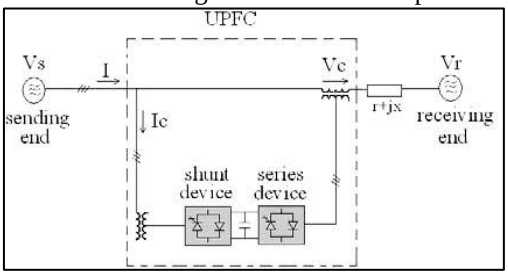

Fig. 2: Functional Diagram Of UPFC.

The two VSC's can work independently connected back to back using a DC link. The shunt device which can generates or consumes reactive power to maintain the the voltage at the point where it is connected.

The UPFC works on Automatic voltage control mode, the shunt device (STATCOM) reactive current is regulated to maintain the voltage of transmission line at the point which it is connected to a reference value. The series device is used to inject a voltage series in the transmission line.

IV. MATLAB SIMULINK MODELING

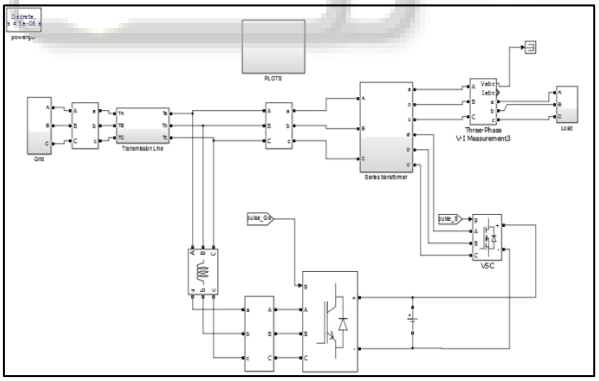

Fig. 3: Simulation model of UPFC with DC source.

A. Series Controller

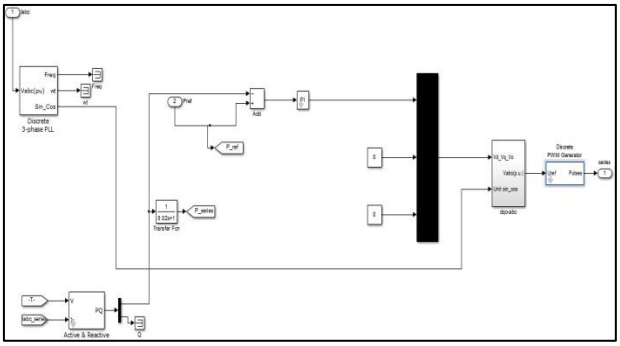

Fig. 4: Series controller

The power control method is used. The pulse signal is generated by comparing the actual signal with the reference. The generated pulse signal which is used as an input to the series converter. In the series controller the voltage at sending end and voltage at receiving end were compared. Hence generate the error signal which will create a new pulse signal for control the power flow by injecting series voltage.

B. Shunt Controller

The currents are compared in the shunt controller.ie the current at the sending end of transmission line and current at receiving end were compared. Controller generates a pulse signal to control the real and reactive power flow through the transmission line.

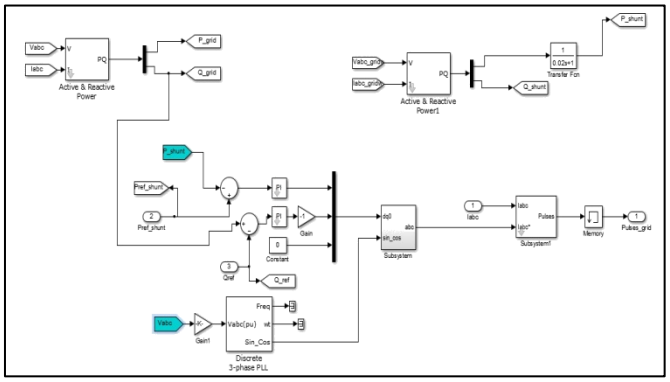

Fig. 5: Shunt controller

V. SIMULATION RESULTS

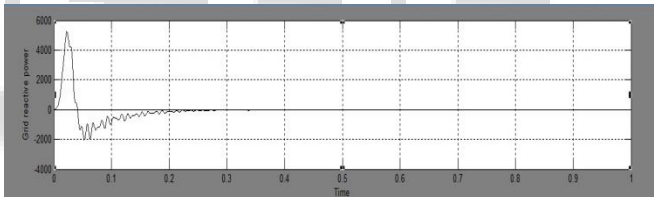

Fig. 6: Grid reactive power of conventional UPFC.

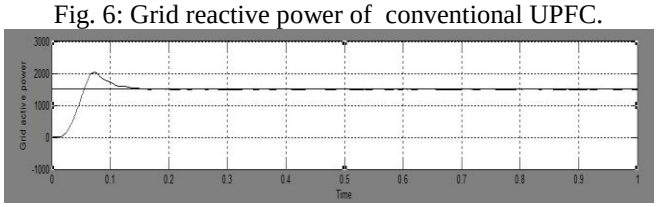

Fig. 7: Grid active power of conventional UPFC.

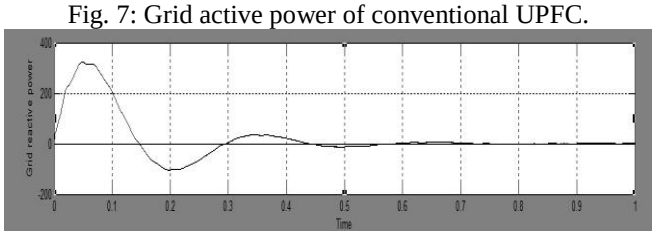

Fig. 8: Grid reactive power of proposed system.

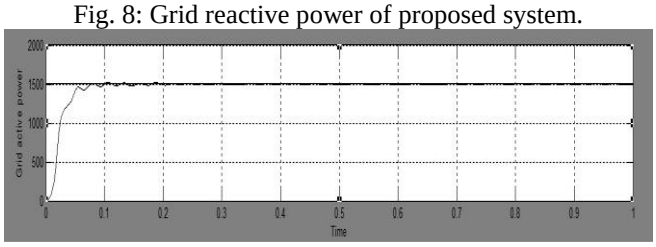

Fig. 9: Grid active power of proposed system

UPFC with DC source absorbs/supplies a real power flow through the transmission line.

UPFC functions mainly for maintaining voltage, regulating the power flow and improve power system stability. The proposed model of UPFC with DC source is then simulated in MATLAB platform on a power system. The simulation results show power flow controllability of the UPFC with DC source. The UPFC responds simultaneously according to the controlled real and reactive power changes in the system. This proposed system is capable of controlling the real and reactive power flow in a very fast manner and It can improve the stability of a power system. The unified power flow controller has compact size, simpler design and improve the system performance by controlling the power.

VI. CONCLUSION

UPFC with DC source devices independently generate and consumes reactive power. The DC source provides real power to UPFC when it is necessary of real power. In all mode of operation existing UPFC voltage and phase angle will be controlled. The real power can be supplied by a DC source by connecting with UPFC to a particular range. Hence the integrated system of UPFC with DC source can improve power transferability and it can also control the real and reactive power through the transmission line.

REFERENCE

[1] A. B. Arsoy, Y. Liu, and P. F. Ribeiro, "Static synchronous compensators and superconducting magnetic energy storage systems in controlling power system dynamics," IEEE Industry Applications Magazine.2003.
[2] M. Zarghami, M. L. Crow, J. Sarangapani, Y. Liu, and S. Atcitty, ". Modelling and Controlling of UPFC for Power System Transient Studies," IEEE Trans. on Power Systems, vol. 25, no. 1, pp. 404-412, Feb. 2010.
[3] Gyugyi L, Schauder CD, Torgerson SL, Edris A. "The unified power flow controller: a new approach to power transmission control. "IEEE Trans Power Delivery 1995; 10(2):1085–97.
[4] Kang Mingcai Bo Zhiqian," Reducing of power system low frequency oscillations by UPFC ", International Conference on IEEE, pp.1-6, 21 August 2009.
[5] Sen, K.K. (1998). "SSSC-static synchronous series compensator: Vtheory, modeling and publications." IEEE Trans. Power Delivery Vol.13, No.1, January, PP. 241-246.

