Power Flow Control of UPFC in Power Systems

Bhupesh Deshmukh
Dept. of Electronics & Telecommunication
Parthivi College of Engineering &Management
Bhilai-3, India

Roshni Gupta
Dept. of Electronics & Telecommunication
CSIT
Durg, India

***Abstract*—The maintenance of power system has become a serious facet of study. The encouragement to the development of HV lines, the capability of power transmission on HV line and therefore the quantity of power dealings as seen from economic aspect is much liable for concern towards congestion in grid. The answer is that the use of FACTS devices particularly the utilization of UPFC. This paper consists of the study of UPFC with its various modes of operation. Second, the operation of system employed in its converters is additionally studied. Finally by facilitate of modeling of an influence system in MATLAB, and by installing UPFC in transmission line, its use as power flow controller and voltage injection is seen. Conclusion is created on completely different results to see the good thing about UPFC in grid.**

Keywords- FACTS, UPFC, Voltage Source Converter, Power Flow Controller

I. INTRODUCTION

In AC power systems, for several years to beat the reactive power issues mechanical switched teams of capacitors and reactors square measure used. In power systems, it absolutely was ascertained that compensation with the case of the semiconductor switches, the voltage crashes may well be prevented and therefore the transient and dynamic stability may well be improved FACTS controllers square measure quick against ancient instrumentality due to their power electronic based mostly structure that they increase the steadiness in operation limits of the transmission systems once their controllers square measure properly tuned [3]. It provides the management of gear mechanism parameters like voltage, point and line electric resistance in power systems [3]. In [5] CSI (current source inverter) topology is employed and applied to STATCOM in an exceedingly grid. In [6], a STATCOM system is applied for compensation of displacement power issue beneath distorted mains voltage conditions.

According to simulation results STATCOM is making certain the displacement power issue compensation with smart transient and steady state performance. Impacts of UPFC, STATCOM and SSSC on voltage stability are investigated in [6].

It has been shown that these devices square measure regulate the voltage profile and multiplied the load ability margin of power systems. This study presents a simulation program which may be used for investigation of effects of UPFC and alternative convertor based mostly FACTS devices on grid.

UPFC system during this program consists of equations obtained in dq frame of reference. In simulation studies, management of bus voltage and active power management with UPFC is performed by adding inductive and electrical phenomenon masses to the system.

II. UNIFIED POWER FLOW CONTROLLER

A. Characteristics of UPFC

Line outage, congestion, cascading line tripping, power system stability loss are the major issues where capability and utilization of FACTS are noticed. Representative of the last generation of FACTS devices is the Unified Power Flow Controller (UPFC).The UPFC is a device which can control simultaneously all three parameters of line power flow (line impedance, voltage and phase angle). Such "new" FACTS device combines together the features of two "old" FACTS devices: the Static Synchronous Compensator (STATCOM) and the Static Synchronous Series Compensator (SSSC). In practice, these two devices are two Voltage Source Inverters (VSI's) connected respectively in shunt with the transmission line through a shunt transformer and in series with the transmission line through a series transformer, connected to each other by a common dc link including a storage capacitor. The shunt inverter is used for voltage regulation at the point of connection injecting an opportune reactive power flow into the line and to balance the real power flow exchanged between the series inverter and the transmission line. The series inverter can be used to control the real and reactive line power flow inserting an opportune voltage with controllable magnitude and phase in series with the transmission line. Thereby, the UPFC can fulfill functions of reactive shunt compensation, active and reactive series compensation and phase shifting.

Besides, the UPFC allows a secondary but important function such as stability control to suppress power system oscillations improving the transient stability of power system. As the need for Operation of UPFC the basic components of the UPFC are two voltage source inverters (VSIs) sharing a common dc storage capacitor [6], and connected to the power system through coupling transformers. One VSI is connected to in shunt to the transmission system via a shunt transformer, while the other one is connected in series through a series transformer.

A basic UPFC functional scheme is shown in fig.1. Flexible and fast power flow controllers, such as the UPFC, is expected to grow in the future due to the changes in the electricity markets, there is a corresponding need for reliable and realistic models of these controllers to investigate the impact of them on the performance of the power system. In this article emphasis is laid to project the use of Unified Power Flow Controller (UPFC) in transmission link to increase the power flow and to improve the voltage profile of the power system using MATLAB SIMULINK.

B. Operation of UPFC

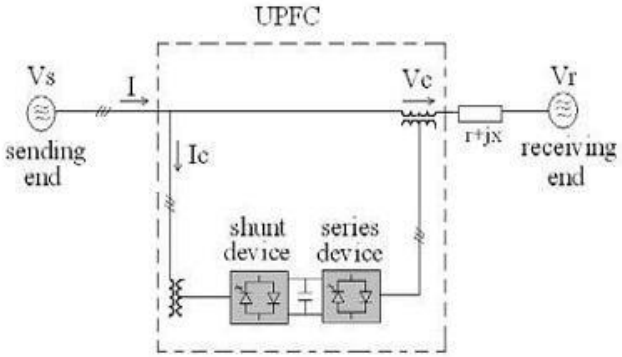

Figure 1: UPFC Link in Transmission Line

The series inverter is controlled to inject a symmetrical three phase voltage system (V_c), of controllable magnitude and phase angle in series with the line to control active and reactive power flows on the transmission line. So, this inverter will exchange active and reactive power with the line. The reactive power is electronically provided by the series inverter, and the active power is transmitted to the dc terminals. The shunt inverter is operated in such a way as to demand this dc terminal power (positive or negative) from the line keeping the voltage across the storage capacitor V_{dc} constant. So, the net real power absorbed from the line by the UPFC is equal only to the losses of the inverters and their transformers. The remaining capacity of the shunt inverter can be used to exchange reactive power with the line so to provide a voltage regulation at the connection point. The two VSI's can work independently of each other by separating the dc side. So in that case, the shunt inverter is operating as a STATCOM (Static Synchronous Compensators) that generates or absorbs reactive power to regulate the voltage magnitude at the connection point. Instead, the series inverter is operating as SSSC (Static Synchronous series compensators) that generates or absorbs reactive power to regulate the current flow, and hence the power flows on the transmission line.

III. MODELING OF UPFC ON A TRANSMISSION SYSTEM

Using the concept of the UPFC an influence system is taken to implement the utilization of UPFC. The 2 modes i.e. the ability flow management and also the voltage injection mode are simulated in SIMULINK to ascertain the impact of UPFC on an influence system. Study is allotted to verify the utility of FACTS device. Figure 2 illustrates application study the steady-state and dynamic performance of a unified power flow controller (UPFC) accustomed relieve power congestion in an exceedingly transmission system.

The load flow analysis and also the single line diagram simulation are done on power flow machine. This software helps to calculate the ability flow, the voltage at every bus and also the price effectiveness of the system.

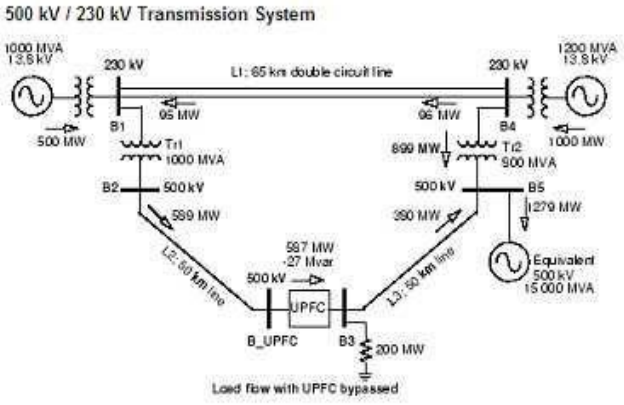

Figure 2: Description of 500kV/230kV Transmission system [2]

A UPFC is employed to manage the ability flow in an exceedingly five hundred kilovolt /230 kilovolt transmission systems. The system, connected in an exceedingly loop configuration, consists basically of 5 buses (B1 to B5) interconnected through 3 transmission lines (L1, L2, L3) and 2 five hundred kilovolt/230 kV electrical device banks Tr1 and Tr2. 2 power plants settled on the 230 kilovolt system generate a complete of 1500 MW (illustrated in figure 2) that is transmitted to a 500 kilovolt, 15000 MVA equivalent and to a two hundred MW load connected at bus B3. Every plant model includes a speed regulator, associate degree excitation system further as an influence system stabilizer (PSS). In traditional operation, most of the 1200 MW generation capability of power plant #2 is exported to the five hundred kilovolt equivalents through 2 400 MVA transformers connected between buses B4 and B5.

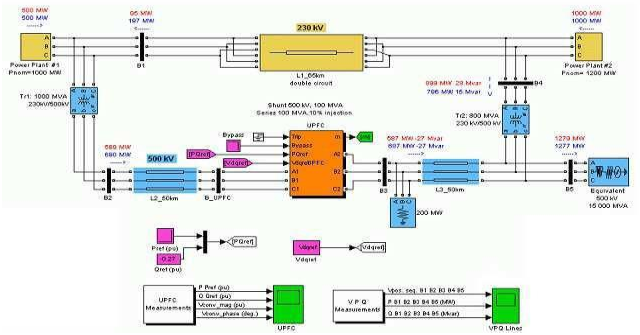

Figure 3: Model of UPFC

For this illustration we tend to consider a contingency case wherever solely 2 transformers out of 3 are available (Tr2= 2*400 MVA = 800 MVA). The load flow shows that the majority of the ability generated by plant #2 is transmitted through the 800 MVA electrical device bank (899 MW out of 1000 MW) which 96 MW is circulating within the loop. Electrical device Tr2 is therefore overloaded by 99 MVA. This {can} currently illustrate however a UPFC can relieve this power congestion. The UPFC settled at the proper finish of line L2 is employed to manage the active and reactive powers at the 500 kilovolt bus B3, further because the voltage at bus. The UPFC consists of 2 100 MVA, IGBT-based, converters (one shunt converter and one series converter interconnected through a DC bus). The series converter will inject a most of 100 percent of nominal line-to-ground voltage (28.87 kV) in series with line L2.

IV. CONCLUSION

In power system transmission, it's fascinating to take care of the voltage magnitude, phase angle and line impedance. Therefore, to manage the power from one end to a different end, this idea of power flow management and voltage injection is applied. Modeling the system and finding out the results have given a sign that UPFC are very helpful once it involves organize and maintain power system.

REFERENCES

[1] Oliveira M. Power Electronics for Mitigation of Voltage Sags and Improved Control of AC Power Systems. – Doctoral Dissertation. Royal Institute of Technology, Stockholm, 2000.

[2] Gyugyi L. Dynamic compansation of AC transmission lines by solid–voltage souces// IEEE/PES. – Vancouver Canada, 1993. No. 92. PP. 18–22.

[3] Maram S. Hierarchical Fuzzy Control of the UPFC and SVC located in AEP's Inez Area. Master Thesis. – Virginia Polytechnic Institute and State University, 2003.

[4] Nabavi–Niaki A., Iravani M. R.Steady State and Dynamic Models of Unified Power Flow Controller (UPFC) For Power system studies // IEEE Transactions on Power Systems, 1996. Vol.11, No. 4. –PP. 1937–1943.

[5] Gang Y., LiXue T., LiDan Z., Chen C. State feedback Control of a Current Source Inverter STATCOM// Electronics And Electrical Engineering, Kaunas, 2010. No.3 (99)–17–22 .

[6] R. Cimbals, O. Krievs, L. Ribickis, A Static Synchronous Compensator for Displacement Power Factor Correction under Distorted Mains Voltage Conditions // Electronics and Electrical Engineering.– Kaunas: Technological, 2011.