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ENHANCEMENT OF VOLTAGE STABILITY IN TRANSMISSION LINE USING UPFC AND IPFC

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Abstract-The Paper discusses the dynamic behaviour of two different flexible ac transmission system devices; interline power flow controller (IPFC) and unified power flow controller (UPFC). UPFC is the most versatile and complex equipment that has emerged for control and optimization of power flow in electrical power transmission system. IPFC is a voltage source converter based FACTS Controller for series compensation with the unique capability of power flow management among the multiline transmission system. When no UPFC and IPFC is installed, real and reactive power through the transmission line cannot be controlled .simulations were carried out using MATLAB software to validate the performance of the UPFC and IPFC.

Keywords-FACTS controllers, IPFC, UPFC voltage source converter, power quality, Matlab software.

I. INTRODUCTION

Today's power systems are highly complex and require careful design of new devices taking into consideration the already existing equipments, especially for Transmission system in new deregulated electricity markets. The main objectives of FACTS are to increase the transmission capacity and control power flow over designated transmission routes .UPFC is the most versatile and complex of the FACTS devices, combining the features of the STATCOM and the SSSC.IPFC is an extension of static synchronous series compensation (SSSC).The performance of the UPFC and IPFC in real and reactive Power flow through the transmission line has been evaluated.

II. FACTS CONTROLLER

The basic principles of the following FACTS controllers, which are used in transmission line system under study, are discussed briefly.

Unified Power Flow Controller (UPFC):

The control system of the UPFC can be divided into two parts: the control of STATCOM and the control of SSSC. The control of STATCOM is used to operate the voltage source inverter to inject or absorb reactive power to regulate the connecting point voltage to the setting value vref. The control strategy for the SSSC is based on automatic power flow control.

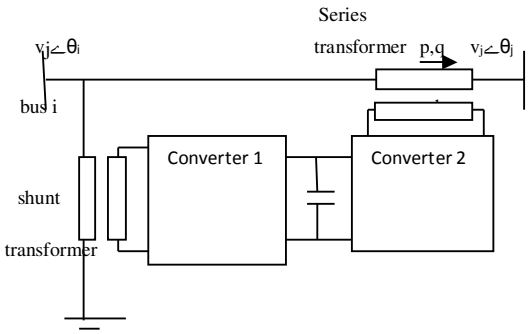
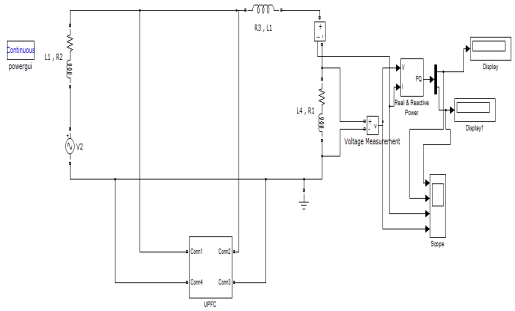


Figure 1 :Basic UPFC circuit arrangement

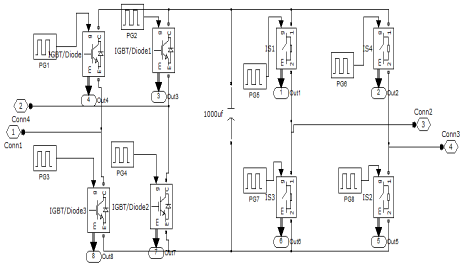
Where the STATCOM and SSSC are usually employed as reactive compensator, the UPFC could be considered as a comprehensive real and reactive power compensator capable of independently controlling both real and reactive power flow in the line. UPFC is an advanced power system device capable of providing simultaneous control of voltage magnitude, active and reactive power flows in an adaptive fashion.

SIMULATION MODEL OF UPFC



The UPFC is the most versatile FACTS controller developed so far,with all encompassing capabilities of voltage regulation,series compensation and phase shifting.

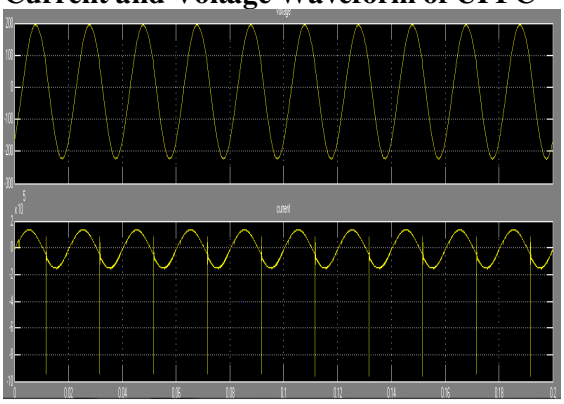
UPFC SUBSYSTEM MODEL



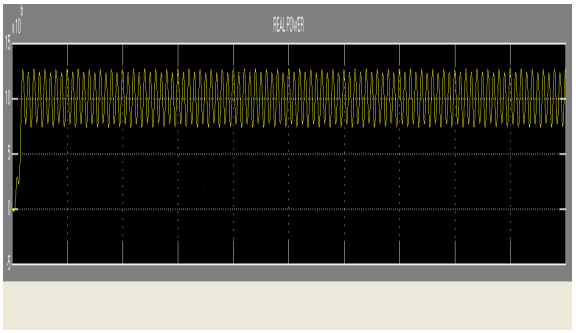
The UPFC concept provides a powerful tool for the cost effective control of both real and reactive power flow and thus the maximization of real power transfer at minimum losses in the line.

The UPFC is able to control, simultaneously or selectively, all the parameters affecting power flow in the transmission line.

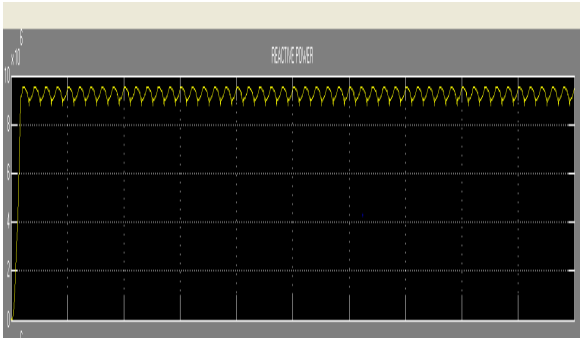
Current and Voltage Waveform of UPFC



Real Power Waveform OF UPFC



Reactive Power Waveform OF UPFC



Interline Power Flow Controller (IPFC):

The primary function of the IPFC is power flow control with injection of a voltage in series with its host line. The IPFC controls the magnitude and phases angle of the injected voltages in each line.

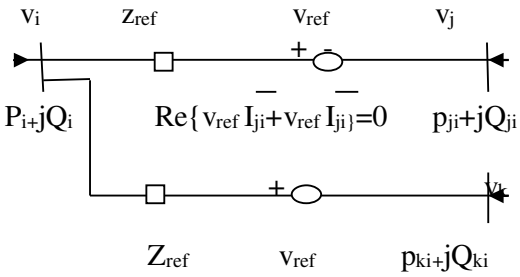


Figure 2:Equivalent circuit of IPFC

The power flow equations are as follows:

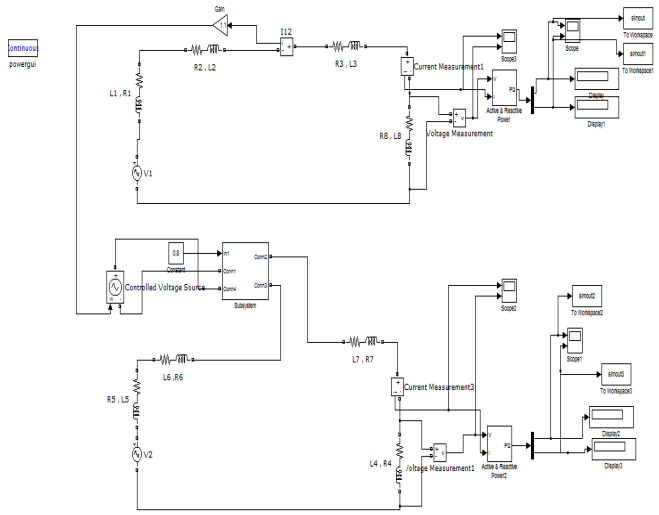
$$P_i=v_i^2 g_{ii}-\Sigma v_i v_j\ (g_{ij}\cos(\theta_i-\theta_j)+b_{ij}\sin(\theta_j-\theta_j))\ -\Sigma v_i vse_{ij}(g_{ij}\cos(\theta_i-\theta se_{ij})+b_{ij}\sin(\theta_j-\theta se_{ij}))$$

$$Q_i=v_i^2 b_{ij}-\Sigma v_i v_j(g_{ij}\sin(\theta_j-\theta_i)+b_{ij}\sin(\theta_j-\theta_i))-\Sigma v_i vse_{ij}(g_{ij}\sin(\theta_i-\theta se_{ij})+b_{ij}\sin(\theta_i-\theta se_{ij}))$$

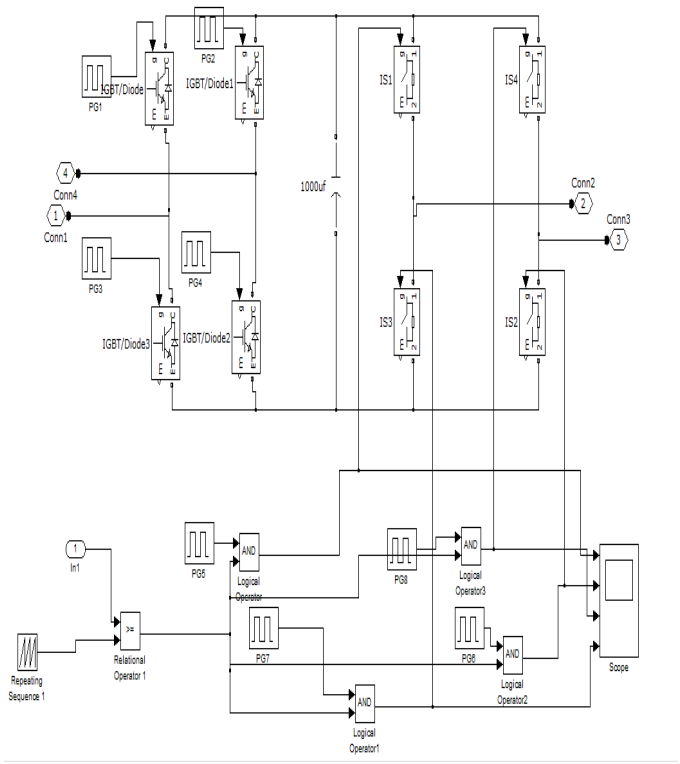
Where v ; bus voltage magnitude
θ ; bus angle
v_{se} ;magnitude of injected voltage
θ_{se} ; angle of injected voltage

Interline power flow controller is to provided a comprehensive power flow control scheme for a multiline transmission system, in which two or more lines employ a SSSC for series compensation. A multiline IPFC comprises of number of 'n' SSSC'S, one for each line of the transmission system to be controlled. SSSC is employed to increases the transferable power on a given line and to balance the loading of a transmission network.

Simulation Model of IPFC



IPFC Subsystem Model



Mathematical expression of UPFC and IPFC
For transmission line

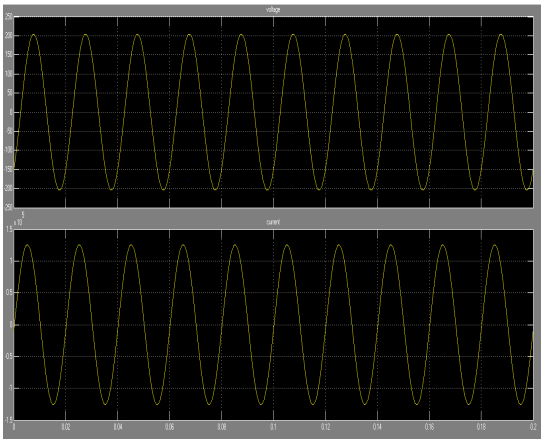
$V_R=V_S-V_X$

$I=V_S/(X+X_L+R_L)$

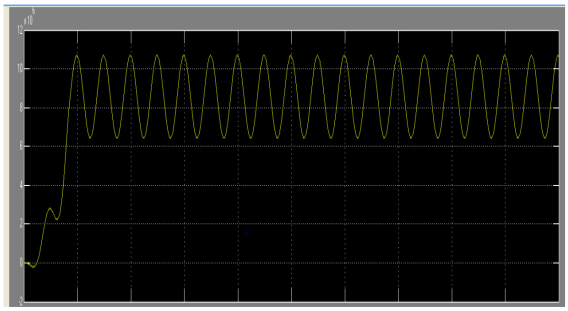
V_R=Receiving end voltage
V_S=Sending end voltage
V_X=Voltage across the line reactance
X=Line current
X_L=Load reactance
R_L=Load resistance

The transmission line, the power factor is controlled by means of injected a voltage across it .The transmission line consists of lumped R and L parameters. Without an injected of voltage, the power factor is lagging in RL circuit. By injected additional voltage across it, the angle between V and I is reduced and the power factor is improved.
The power flow through the line can be regulated by controlling the magnitude and the angles of the converters. By providing converters between two transmission lines, the reactive power can be transferred from under loaded line to the overloaded line.

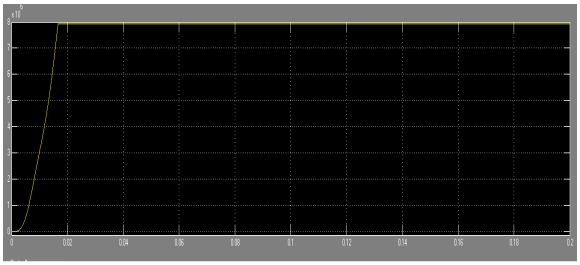
Current and Voltage Waveform of IPFC



Real Power Waveform OF IPFC



Reactive Power Waveform OF IPFC



III. CONCLUSION

UPFC and IPFC has been modeled and their effect on power quality is studied. The control and performance of UPFC and IPFC intended for installation on a transmission line is presented.By placing various FACTS devices with multiple compensation techniques is used in the specified lines for increased power flows, and is implemented for an IEEE bus system.The referred analysis was based upon the shunt and series real power balance,when the converter losses are neglected.

The model developed can also be adapted ,by doing some minor changes ,to the case of an UPFC anf IPFC device. A matlab /simulink based model has been simulated.This paper presents an

improvement in the real end reactive power flow through the transmission line with UPFC and IPFC.

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BIOGRAPHY

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