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Article

Modeling of Multi-Machine System by means of Facts Device for Aggregate Transient Stability

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ABSTRACT

In this paper, transient stability of IEEE 9- bus system collective with Unified Power Flow Controller (UPFC), has been complete UPFC based on Voltage Source Controller (VSC) has a higher switching frequency, an obvious voltage harmonic and a lower voltage level. Further down a symmetrical three-phase short circuit with a diverse fault locations were used and the load angle variation also studied to test the control performance. The multi machine system combined with UPFC controller, perform outstanding to reduce damping oscillation in power system observed in results of simulation.

Keywords: FACTS, UPFC, Transient Stability, Reactive Power Compensation

Introduction

Nowadays, the upsurge in loading of existing power transmission system consequences in the problems of voltage instability. Maintaining constant voltage level at all buses is a major challenge due to heavy loading on transmission network it make the stabilizing problem more thought-provoking. With the application of FACTS devices, the stability of FACTS devices not only increase the power transmission capability, but also enhance the stability, transfer capability, as well as reduce the transmission losses.[2]

These capabilities make the UPFC greatest power full device in current scenario control and transmission system. To find the best location for UPFC and the angle and quantity voltage to be injected is a major issue. In the current refurbishment energy market, novel modelling styles for UPFC and controller design are being reputable to elevate the power system enactments.[3-4] UPFC is covered of shunt and series converter which are linked via a common dc link. The series transformer is used to attach the series converter to the transmission line and inject series voltage Vb. Operating function of shunt convertor is to amount active power, which is mandatory by series converter, dc bus voltage regulator to overcome losses in the line and also rewards reactive power independently. It control and meet the varied objects in diversity of conducts. This has made UPFC generalize to control for numerous usages.[5] The numerous researchers have industrialized few tactic to classify the optimal location in transmission line.[6] An optimization algorithms have used to get the size and optimal location.[7] In section II dissertation about UPFC controller and its topology, Section III present modeling and simulation of multi machine system using with and without UPFC and Consequences and deliberations are talked in Section IV.

Unified Power Flow Controller

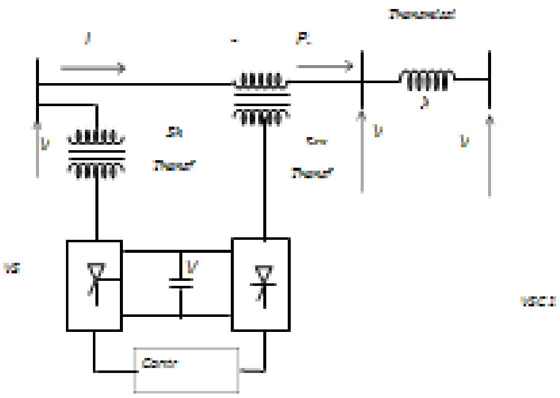

Figure 1.Single-Line Diagram of a UPFC

The UPFC concept was planned by gyugyi in 1991. It is a powerful FACTS device it use two voltage source converters together (SVC). Since voltage sourced converters are used along with passive devices to control flow. UPFC provide fast-acting reactive power compensation on high-voltage electricity transmission network. UPFC work in both directions to maintains real and reactive power in transmissions systems.

The UPFC combine with the two FACTS device Static Synchronous Series Compensator (SSSC) and Static Synchronous Compensator (STATCOM). In the presence of two converters UPFC supply active and reactive power. [8] In steady-state operation UPFC neither injects reactive power or nor absorb active power.

The voltage sourced converters VSC1 and VSC2, are connected to the transmission line by coupling transformers shown in Figure 1,

The dc terminals of the converters are coupled to form a system performances [3],[4]. UPFC is comprised of shunt and series converter which are connected via a common dc link. The series transformer is used to connect the series converter to the transmission line and inject series voltage Vb. Operating function of shunt convertor is to supply active power, which is required by series converter, dc bus voltage regulator to overcome losses in the line and also compensates reactive power independently. It Control and meet the diverse objectives in variety of ways.

About UPFC controller and its Topology

Section III present modeling and simulation of multi machine system using with and without UPFC and Results and discussions are discoursed in Section IV.

UPFC provide fast-acting reactive power compensation on high-voltage electricity transmission network. UPFC work in both directions to maintains real and reactive power in transmissions systems.

The active power is exchange with the help of dc circuit in UPFC. The reactive power supply in transmission line and the flow of active power in transmission line controlled by controlling magnitude and supplied angles of voltage by the converters. It is an ability to control line impedance, voltage and phase angle concurrently or selectively this capability is due to both shunt and series compensation. UPFC can be used to independently and simultaneously control the flow of active power through the line.

Modelling & Simulation of MMIB Using UPFC

In this section, Controlling and Simulation of UPFC has been discussed using MATLAB environment. For Multi Machine (3 machines 9 bus) system simulation work takes remained approved out. By seeing the incidence of three phase fault and varying diverse system constraint has been examined for varies answers in this case. With the damping constant, Fault clearing time and the location of fault and its effect on the system stability leads to learning about variation of load angle has been carried out during investigation.

WSCC-Multi-Machine Infinite Bus (MMIB) System

The WSCC (Western System Coordinated Council) System having 3-machines 9-bus with standard value of parameters has been considered as a test case. Figure 2. shows the WSCC 3-machines 9-bus system.

UPFC controller

UPFC is limited of shunt and series converter which are connected via a common dc link. The adaptable phase angle voltage and magnitude can be producing by a series convertor.

The primary requirement of the real power on condition that by shunt converter but VAr compensator, it can also act as an self-governing operator. The exchange of active power in UPFC controller is done by dc link with the loss in the controller component and the flow through link, disturb the dc voltage level.

Hence dc voltage regulator required for proper operation of the controller, which can attain by separate control loop. Finally, a control procedure is required to start up the UPFC.

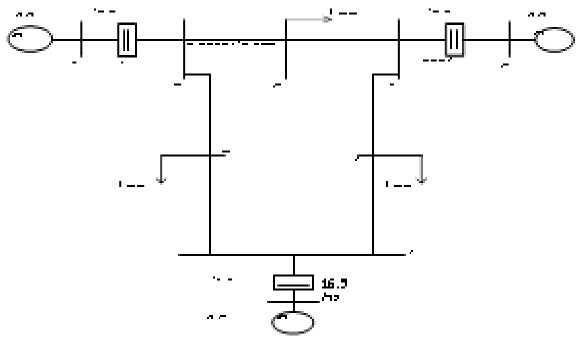

Figure 2.WSCC 3-Machines, 9-Bus System

MATLAB/Simulink based model of WSCC without UPFC

The MATLAB/Simulink grounded model of WSCC 3-Machine 9-Bus system deprived of UPFC shown in Figure 3. In this classical three phase fault and compensating device is not associated. It offers transient response of system in the condition of without fault

MATLAB/Simulink based model of WSCC with UPFC

In MATLAB/Simulink based model of WSCC 3-Machine 9-Bus system with UPFC and three phase fault at three diverse location are shown in Figure 4.

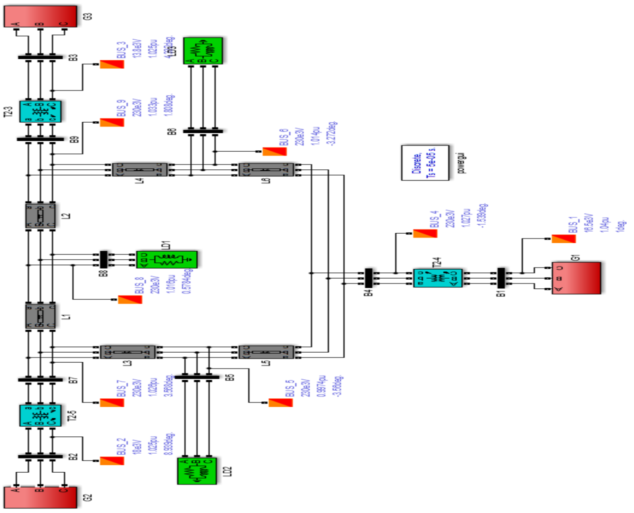

Figure 3.MATLAB/Simulink Based Model of WSCC without UPFC

Converter Controller

In converter controller diverse type of blocks are used like Phase Locked Loop (PLL), measurement, current regulator and reference computation block. To match the frequency of an input signal voltage driven oscillator that repeatedly adjusted by the PLL block. The value of P, Q, Vd, Vq, Id, and Iq are measure by measurement system with the help of bus terminal frequency and voltage. Measurement of Id and Iq reference values done by reference computation block with the help of reference values of P, Q and Vd, Vq. The Vd, Vq value and the current value are generated by current regulator block between both converters and generate sigma signal voltage is compared with DC voltage transferred in Sigma Computation block. To control the operation of converters Firing pulse generator produces firing pulse on basis of reference values. MATLAB/Simulink mode of UPFC is shown in Figure 5.

Result and Discussions

A fault was considered at three diverse locations and their effect was studied with and without UPFC. The three phase fault is occurring just after 5 second and fault clearing time is 1 second. The variation of relative angular position load angle 1-2, load angle 2-3 and load angle 3-1 with respect to time is observed.

Veriatio of Relative load Angles at Location I

The results of variation in maximum value of overshoot (degree), steady state stable value of relative angular position(degree) and value of time taken to attain stability (second) at location 1 are shown in Figure 6-8 for with and without UPFC.

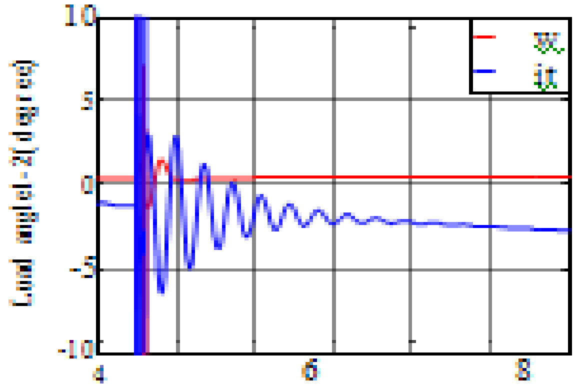

Figure 6.Relative Load Angle 1-2 w.r.t Time

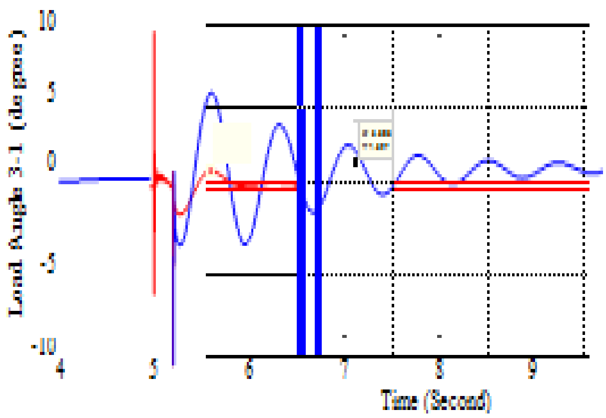

Figure 7.Relative Load Angle 2-3 w.r.t Time

Variation of relative load angles at location 2

The consequences of variation in maximum value of overshoot (degree), steady state stable value of virtual angular position (degree) and value of time occupied to achieve stability (second) at location 1 are shown in Figure 12-14 for with and without UPFC.

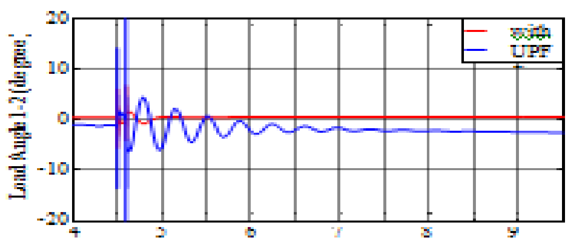

Figure 12.Relative Load Angle 1-2 w.r.t Time

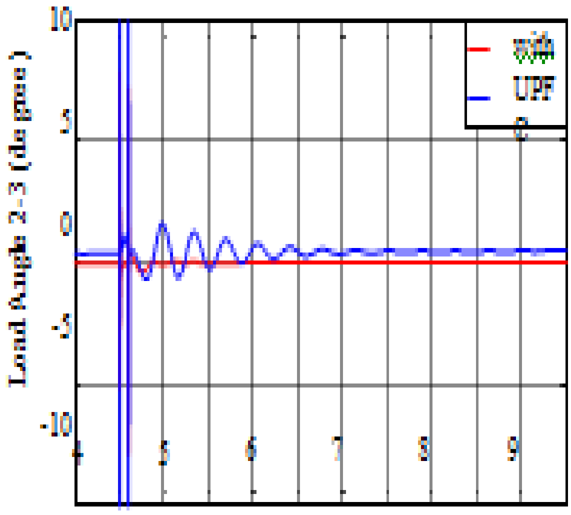

Figure 13.Relative Load Angle 2-3 w.r.t Time

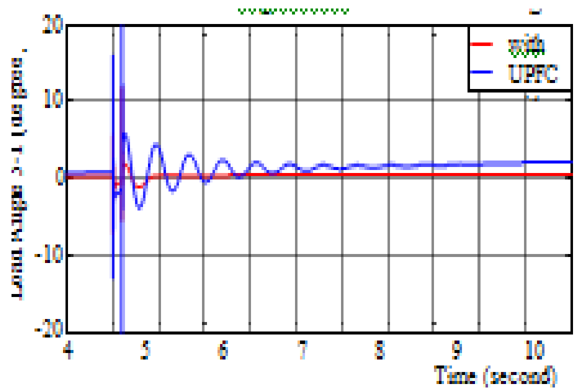

Figure 14.Relative Load Angle 3-1 w.r.t Time

It can be experiential from above figures that regardless of location of fault, UPFC decreases the time taken to attain stability value approximate1/4rd of uncompensated network. UPFC inclines to the steady state stable value of relative angular position near to zero. Maximum value of overshoot value is abridged by around 1/3rd of uncompensated network by UPFC, regardless of fault location. The response of the generator adjoining to the fault location having more transient.

Conclusions

The current work shows that regardless of the location of fault, 3- Machine 9- Bus WSCC system has been positively modelled and examined by applying voltage source converter type FACTS – UPFC in MATLAB/Simulink environment and the controller presentation in attractive power system transient stability was studied. Imitation result is quite encouraging and shows the effectiveness of UPFC. It has been found to be versatile FACTS controller as it has unique capability of controlling instantaneously/ selectively all the parameters moving power flow in transmission line i.e voltage, impedance and phase angle. It is also seen UPFC can self-sufficiently control both real and reactive power flow in transmission line. Presentation assessment in terms of transient stability improvement has been deliberate and the load angle variations with time have been plotted in both the cases by varying the location of fault UPFC improves the transient response of system. The extent of change in the value of strictures such as steady state stable value, time taken to accomplish steadiness and maximum value of overshoot, depends on reserve amid fault location and both, generator and Controller.

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