MATLAB/SIMULINK MODEL OF MULTI-MACHINE (3-Machine, 9-Bus) WSCC SYSTEM

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Abstract: - Power system stability is an important aspect which determines the stability of the system. This dissertation deals with the rotor angle stability of IEEE 9-bus system consists of three generators and nine buses. To demonstrate the performance of the system, a three phase fault is introduced on different locations. The nature of the rotor angle excitation voltage and speed for all three generators are discussed. As the fault is cleared the system takes its own time to settle down. Generation, transmission and distribution are generally the three stages in power system. The electrical power is generated mainly by using synchronous generators in the first stage of generation. Power system are designed to supply continuous power that maintains voltage stability due to unwanted events, like lightening, short circuit between the phase wires of the transmission lines, accidents or any other unpredictable events and the ground faults which may occur is called a fault. Due to these faults occurring in the system, one or many generators may be severely disturbed causing an imbalance between demand and generation.

Keywords – Multimachine, 9 bus, stability, Transient, Fault.

1. INTRODUCTION

The history of FACTS controllers can be traced back to 1970s when Hingorani presented the idea of high power electronic applications in power system control. Various researches from then onwards were carried out on the applications of high power semiconductors in transmission systems. The shunt-connected Static VAR Compensator (SVC) using solid-state switches and the series-connected controllers were proposed in ac transmission system application. Several examples of FACTS devices and controllers are in operation. The common definitions are given below:
Flexible AC Transmission System (FACTS): Alternating current transmission systems Implementing high power electronics-based and other static controllers to enhance controllability and increase power transfer capability .

FACTS Controller: A high power electronics-based system and other static equipment that provide control of one or more ac transmission system parameters.
Depending on the use of power electronic devices, FACTS Controllers can be classified as:
- Variable impedance type
- Voltage Source Converter (VSC) based type

The variable impedance type controllers include:
(i) Static Var Compensator (SVC), (shunt connected)
(ii) Thyristor Controlled Series Capacitor
(iii) (TCSC), (series connected)
(iv) Thyristor Controlled Phase Shifting Transformer (TCPST) (combined shunt and series)

These are based on thyristor switched and/or thyristor controlled capacitors or reactors. Such FACTS Controllers have limited performance, limited functionality and large footprint.
The VSC based FACTS controllers include:
(i) Static Synchronous Compensator (STATCOM) (shunt connected)
(ii) Static Synchronous Series Compensator (SSSC) (series connected)
(iii) Interline Power Flow Controller (IPFC) (combined series-series)
(iv) Unified Power Flow Controller (UPFC) (combined Shunt-series)

These controllers have superior performance due to versatile functionality and smaller footprint.

A. Introduction to MATLAB/SIMULINK
Simulink is a software package used for modeling, simulating, and analyzing dynamic systems. It supports linear and nonlinear systems, modeled in continuous time

2. RELEATED WORK

A. MATLAB/SIMULINK Based Model of HPFC1
This Hybrid Power Flow Controller simulated using a combination of Static Synchronous Series Compensator (SSSC) and Static Var Compensator, has been named as HPFC1 and the arrangement is shown in Figure. 1.

B. MULTI-MACHINE SYSTEM MODELING
The popular Western System Coordinated Council (WSCC) 3-machincs 9-bus practical power system with loads assumed to be represented by constant impedance model has been considered as a test case. WSCC system is widely used system. Fig. 2 shows the WSCC 3-machines 9-bus system.The base MVA of the system is 100, and system frequency is 60 Hz.. This model finds its utility for transient stability study. The complete system with all the required components has been modelled by using MATLAB /SIMULINK blocks

C. MATLAB/SIMULINK MODEL OF MULTI- MACHINE (3-Machine, 9-Bus) WSCC SYSTEM INCORPORATED WITH UPFC

Fig.-3 represents the MATLAB/SIMULINK model of Multi – Machine (3-Machine, 9-Bus) system incorporated with UPFC and fault occurring in it.

Fig. 4 represents the rotor-angle versus time curve for MATLAB/SIMULINK model of Multi-Machine system incorporated with UPFC and fault occurring in it as shown in

Fig.3. The total simulation time taken is 20 seconds. It has been analyzed at various instance of time by varying the Fault Clearing Time (FCT) of fault. As the fault takes place in the system, the system becomes unstable. To bring back the system to stability the UPFC controller has been placed in the line. As a result the system attains stability. The stable values, the time taken to attain stability, maximum overshoot of relative angular positions (delt1_2, del2_3 and delt3_1) with time for different value of Fault Clearing Time (FCT) are given in Table 1.1.

3. RESEARCH WORK

A. MATLAB/SIMULINK MODEL OF MULTI-MACHINE (3-Machine, 9-Bus) WSCC SYSTEM

Fig.-5 represents the MATLAB/SIMULINK model of Multi–Machine (3-Machine, 9-Bus) system

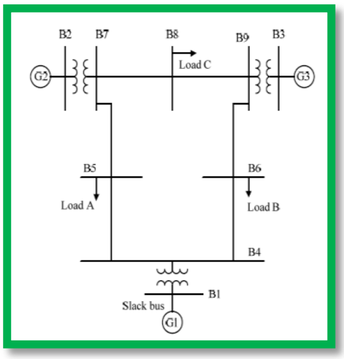

Fig. 2 WSCC 3-Machines 9-bus system

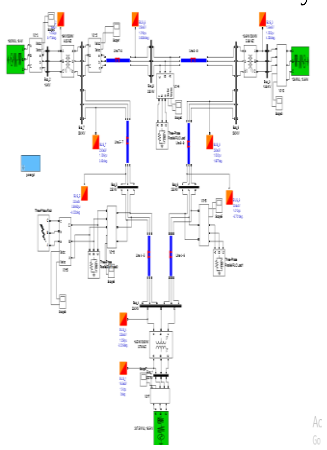

Fig.3 MATLAB/SIMULINK model of WSCC 3-Machines 9-Bus System incorporated with UPFC

The 3- phase fault in Y Phase (Single line to ground) is created at bus 5 at time 0.017 sec and is cleared after time 0.0705 sec. the electromechanical oscillations of electrical power is reduced and field voltage is also kept limited, due to this reason excitation is maintained. The various plots of electrical power, field current, and terminal current individually with ring main's method.

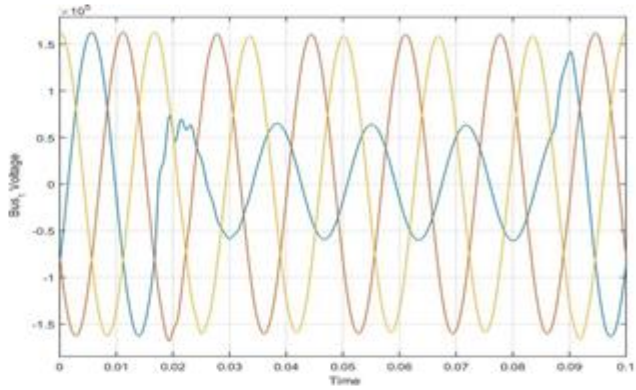

Fig. 5.3 : Waveform of bus-1 voltage

Figure 5.3 represents the voltage-time response of Bus-1. It is observed that approach takes 0.06 seconds for stabilization.

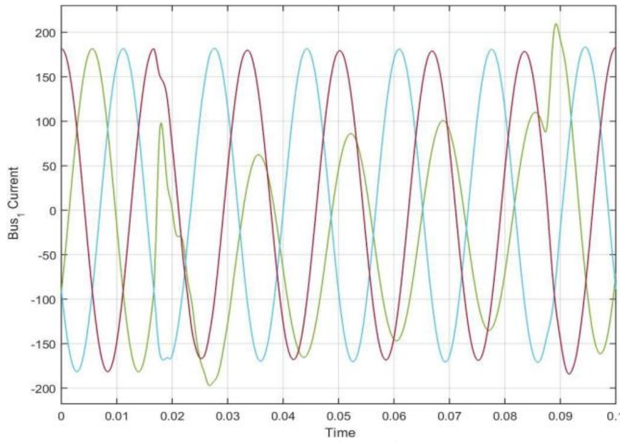

Fig.5.4: Shows the waveform of Bus-1 Current

Figure 5.4 represents the Current-time response of Bus-1. It is observed that approach takes 0.06 seconds for stabilization.

4. CONCLUSION

This dissertation presents the improved behaviour of transient and voltage stability of a 9-bus multi machine system using MATLAB software. The comparison of transient and voltage stability performances of the multi-machine system. Initially, results of without three phase fault and fault in power system network is compared and found that the voltage stability of the system is regained after 0.0705 sec by system during the three-phase fault condition by Ring Main method when fault occurs in Phase Y. Nowadays, power systems are being operated under increasingly stressed condition due to the prevailing trend to make the most of existing facilities. Increased competition, open transmission access, and construction and environmental constraints are shaping the operation of electric power systems which present greater challenges for secure system operation. This is clear from the increasing number of major power-grid blackouts that have been experienced in years such as, Northeast USA-Canada blackout of August 14, 2003. Planning and operation of today's power systems require a careful consideration of all forms of system instability. Significant advances have been made in recent years in providing better tools and techniques to analyse instability in power systems. The main requirement of system stability is to keep the synchronous operation of power system with adequate capacity and fast reaction to meet the fluctuations in electric demand and changes in system topology. Successful operation of a power system depends largely on the engineer's ability to provide reliable and uninterrupted service to all loads and supply the required amount of loads by the available facilities. Distance between the current state and a hypothetical state wherein units may lose synchronization evaluated after each state of estimation and after each new power flow. In the evaluation, the concern is the behaviour of the power system when it is subjected to transient disturbances. If the oscillatory response of a power system during the transient period following a disturbance is damped within acceptable time and the system can settle in a finite time to a new steady state, it is considered stable.

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