Mitigation of Subsynchronous Resonance Using UPFC with Fuzzy Logic Control for Power System Stability

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ABSTRACT— This paper presents the study of a very severe problem occurring in power systems, i.e. Subsynchronous Resonance (SSR). In today's time when the electricity is the life on earth and the quality of power provided has been the key point of focus, this study gives a way of improving this power quality. When the transfer of power is done from one place to another through long transmission line, there is a need for series compensators. These series compensators under certain conditions give rise a resonant currents causing a phenomenon called SSR. In this study this problem is mitigated using UPFC in the transmission line. This UPFC is further equipped with Fuzzy Logic Controller (FLC) giving the better results. The comparative results are shown in the study to prove the effectiveness of designed control scheme.

Keywords: - Subsynchronous Resonance (SSR), Unified Power Flow Controller (UPFC), FACTS, Torsional Interaction, Fuzzy logic control.

I. INTRODUCTION

The power system is working at its limits because of the increasing demand especially in the developing countries such as India were the demand for electricity is increasing extremely. In today's world we see that there is need for a reliable, efficient, stable, adequate system for good power quality because of the increase in sensitive industries such as information technology, telecommunication, electronics industries, etc. thus in these times it is the duty of power engineers to not only fulfill the demand but also to provide the power of good quality and reliability. These problems help us understand the need of power system stability [1] [2].

Flexible AC Transmission Systems, commonly known as FACTS, which make the use of power electronic devices have been trending in recent time for the whole purpose of stability and control of electrical power system [3].

An IEEE Committee Report (1985) defines SSR as follows: "Sub-Synchronous Resonance is a condition in electric power system in which the energy in electrical system with a turbine of a generator at one or more of the frequencies (natural) of the combined system is below the synchronous frequency of the system"[4].

The UPFC is versatile and one of the powerful FACTS-equipment and it can be used to improve the stability, power quality of power system as well as it can be used to control the reactive and real power flow in the dynamic system. UPFC can act as a dynamic device as well as the static device [5].

An IEEE second benchmark Simulink model is used to analyze the SSR problem in this paper. The UPFC is connected to the system along with FL based controller in order to mitigate the SSR problem from the system. The execution of the proposed scheme is verified with MATLAB/SIMULINK.

II. UNIFIED POWER FLOW CONTROLLER (UPFC)

The various parameters which can be simultaneously controlled by UPFC are Line impedance, voltage and phase angle, thus making it most effective FACTS device. It is that family of FACTS devices which is used for optimal power flow in the system. The UPFC when sectionalized consists of two devices. Static synchronous compensator (STATCOM) is one and the other one is static series synchronous compensator (SSSC) as shown in schematic Fig 3.1. There is dc common link and dc storage capacitor that connects the two devices together. Between the two-ac branches, the direction of real power flow can be from either converter. Each converter has the property of absorbing or delivering the reactive power individually from the ac coupling point of the line. The gating signals to the converter valves are provided by the controller to give the required series voltages. Shunt currents are drawn simultaneously by it, which are necessary to provide the series injected voltages required. The inverter requires the dc voltage with the regenerative capability [6], [7].

UPFC provides the dynamic compensation response and real time turn-off control of transmission systems. The Unified Power Flow Control contains two switching converters which are known to be voltage sourced inverters (VSCs) and they use thyristor gating valves, as demonstrated in Fig.1. Both the inverters marked as "VSC1" and "VSC2" shown in the Fig. 1, can work on a dc link provided with a capacitor which acts as

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