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A novel component minimized converters for unified power flow controller

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ABSTRACT

In this paper a novel configuration employing multistage two-leg three phase converters for UPFC is proposed. The switching level modeling of UPFC is carried out using IGBT based shunt and series converters. The proposed converter has the capability of delivering sinusoidal input current with unity power factor and bidirectional power flow. The operating performance of UPFC is demonstrated on Single Machine Infinite Bus (SMIB) system and IEEE 14 Bus system for different load conditions. The real and reactive power tracings through the transmission lines in the system are obtained. The simulation study is carried out in a MATLAB/SIMULINK environment. The proposed topology effectively controls the real and reactive power flow in the transmission lines. This model considerably improves the system stability by damping the oscillation during the vulnerable conditions.

1. Introduction

Nowadays the growth of power system relies more on increasing capability of already existing transmission system, rather than on building new transmission lines and power stations for economical and environmental reasons. The need for new power flow controllers capable of increasing transmission capability and controlling power flow through predefined converters will certainly increase.

The promising concept of flexible AC Transmission system (FACTS) markets is possible to achieve fast and reliable power system control by means of high power electronic devices. The detailed descriptions of FACTS devices have been described [1,2]. In FACTS devices, Unified Power Flow Controller (UPFC) is the device, which can realize the FACTS concept more efficiently. The concepts of Unified Power Flow Controller (UPFC) its performance and steady state characteristics have been widely reported in the literature [3,4]. The UPFC has been researched broadly and many research articles dealing with UPFC modeling, analysis, control and application have been published in the recent years. Mathematical models were developed for UPFC to determine steady state operational characteristics using state space equations without considering the effects of converters and the dynamics of generator [6,7]. The performance of UPFC was analyzed by designing a series converter using conventional and advanced controllers [8,9]. Many power converter topologies have been proposed for the implementation of FACTS devices such as voltage source converter [10], current source converter [11], Mulitpulse converter like 24 pulses and 48 pulses [12–14] and multilevel converter [15].

This paper presented the identification of input control parameters of UPFC in order to provide effective damping of power system with different load conditions. The linearized state space system model of single machine infinite bus power system installed with UPFC was modeled and participation factor method is used for identification [16]. A new controller was designed based on the Lyapunov theory for UPFC and its stability is evaluated. The performance of the proposed controller is demonstrated on a two bus test system using MATLAB/SIMULINK software [17]. The damping of multimode oscillations by using single FACTS devices is presented. The multiple stabilizers are arranged in a single FACTS device for effective damping of oscillations. The multiple stabilizers are designed by the optimization method using artificial fish swarm algorithm. Both the UPFC and power system was simulated using nonlinear model for validation [18].

The UPFC was modeled as voltage source model and PWM switching level model. The voltage source model of UPFC was constructed with equivalent voltage source and impedances using MATLAB. The switching level model of UPFC was designed and simulated in EMTP. The equivalent impedance of voltage source model was found from the dynamic responses of UPFC switching level model. The results show that switching level model was more accurate than voltage source model [19].

The advantages and drawbacks of high power converters are discussed in [10,20]. In these converters unbalanced current

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