Simulation of Unified Power Flow Control using Matlab/Simulink

Mr. Suyog S Dhakne, Mr. Yashwant G Zambare, Mr. Datta A Shinde, Mr. Ganesh B Murade

Abstract **—The Power electronic based flexible alternating current transmission system is integrated with static equipment utilized for AC transmission system. Use of FACT system enables improvement at reliability of AC grids as well as reduces power transmission cost. At flexible alternating current transmission system, the Unified power flow control system (UPFC) is used. Unified Power Flow Controller (UPFC), as a representative of the third generation of FACTS devices, is by far the most comprehensive FACTS device , in power system steady-state it can implement power flow regulation, reasonably controlling line active power and reactive power, improving the transmission capacity of power system, and in power system transient state it can realize fast-acting reactive power compensation, dynamically supporting the voltage at the access point and improving system voltage stability, moreover, it can improve the damping of the system and power angle stability.**

Index Terms**—Flexible alternating current transmission system (FACTS), Unified Power Flow Control (UPFC), Matlab, Simulink. Power flow stability.**

I. INTRODUCTION

In early years, Demand has been increased extensively at transmission Network. This demand in future will grow like a ramp due to increased nonutility generators and major competition between utilities themselves. Changed and fast demand on transmission network, Lack of of long –term planning & management and necessity to give open access to power generation companies and subscribers all in bunch have produced tendencies of minimized security and minimized supply quality. To overcome this situation it's necessary to use FACTS technology. It is important to overcome some of but not all of them difficulties by initiating utilities to have the most of service from AC transmission facilities and improve grid functioning. With other aspect, as AC power transmission increases, the AC power system becomes proportionally more complicated to perform and the Power system could be less secure for performing through the major outages. It may cause to large power flows with minimized control, excess reactive power in multiple functional blocks of the system, heavy dynamic swings in between numerous parts of the system. The important advantage of the Unified power flow control is to regulate the active and reactive power flows in the AC transmission line System. If there is existence of disturbances or faults at the source side, the UPFC will face difficulty to operate. The UPFC works at balanced sinusoidal wave from source side. The controllable parameters using UPFC are Voltage, Phase angle, reactance in the line. The UPFC concept was introduced in 1995 by L. Gyugyi, Westinghouse. The UPFC enables a secondary but major function such as stability control for suppression of AC power system oscillations. It helps to improve the transient stability of AC power system.

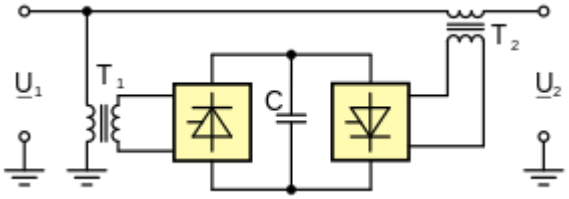

Figure. 1

The proposed system has been implemented using Matlab/ Simulink. The simulation in Matlab / Simulink enables researcher to avoid real time implementation cost. It helps to analyze problems in simulated model and sort out them before actual implementation.

II. LITERATURE REVIEW

The paper named as "A Simple control technique for unified power flow controller (UPFC)" authored by Mr. S. Natarajan published *in* International Journal of Pure and Applied Mathematics. States that "The paper suggested the better application of UPFC over STATCOM and SSSC in terms of reactive power compensation, voltage stability and control in a power system. The main advantage of the UPFC in three phase line compensation is integrated in to a Unified or Generalized power flow controller. This paper describes the simple technique of controlling real and reactive power flow & a comparative study between the conventional power flow controllers like STATCOM & SSSC with UPFC. This paper suggests a simulation study of all the controllers individually through MATLAB simulation tool." [1]

The paper named as "Study and Effects of UPFC and its Control System for Power Flow Control and Voltage Injection in a Power System" authored by Vibhor Gupta published in International Journal of Engineering Science and Technology Vol. 2(7), 2010, 2558-2566, states that "The maintenance and reliability of the power system has become a major aspect of study. The encouragement to the construction of HV lines, the amount of power transmission/km on HV line and the amount of power transaction as seen from economic side is much responsible for concern towards congestion in power

system. The solution is the use of FACTS devices especially the use of UPFC. In this paper the study of UPFC with its various modes of operation is understood. Second, the operation of control system used in its converters is also studied. Finally by help of modelling of a power system in MATLAB, and by installing UPFC in transmission link, its use as power flow controller and voltage injection is seen. Conclusion is made on different results to see the benefit of UPFC in power system."[2]
The Paper named as "Review of the UPFC Different Models in Recent Years" authored by Mahmoud Zadehbagheri, Rahim Ildarabadi, Majid Baghaei Nejad. Published in International Journal of Power Electronics and Drive System (IJPEDS) Vol. 4, No. 3, September 2014, pp. 343~355,says that "Unified Power Flow Controller (UPFC) is one of the most intriguing and, potentially, the most versatile classes of Flexible AC Transmission Systems (FACTS) devices. The UPFC is a device which can control simultaneously tree parameters line impedance, voltage, phase angle and dynamic compensation of AC power system. In order to analyze its true effects on power systems, it is important to model its constraints, due to various ratings and operating limits. This paper reviews on the different models of UPFC used in recent years and gives sets of information for each model of the UPFC in AC transmission. Then the different models are compared and features of each model are examined."[3]
The paper named as "A New Hybrid UPFC Controller for Power Flow Control and Voltage Regulation Based on RBF Neuro sliding Mode Technique" authored by Godpromesse Kenne, published in Hindawi, Advances in Electrical Engineering Volume 2017, states that "This paper presents a new technique to design a Unified Power Flow Controller (UPFC) for power flow control and DC voltage regulation of an electric power transmission system which is based on a hybrid technique which combines a Radial Basis Function (RBF) neural network (online training) with the sliding mode technique to take advantage of their common features. The proposed controller does not need the knowledge of the perturbation bounds nor the full state of the nonlinear system. Hence, it is robust and produces an optimal response in the presence of system parameter uncertainty and disturbances. The performance of the proposed controller is evaluated through numerical simulations on a Kundur power system and compared with a classical PI controller. Simulation results confirm the effectiveness, robustness, and superiority of the proposed controller."[4]

III. System Development

A. Block Diagram

In proposed system Unified power flow control system used to control power flow in a transmission line of a 500 kV /230 kV transmission systems. As shown in system model system has five buses (B1 to B5). These buses are connected through transmission lines (L1, L2, L3). At plant A side and Plant B side two transformers of rating 500 kV/230 kV are used. Power plant A is of 1000 MW and power plant B is of 1200 MW capacity. 230-kV system generates a total of 1500 MW which is transmitted to a 500-kV 15000-MVA equivalent source and to a 200-MW load connected at bus B3. Normally, most of the 1200-MW generation capacity of power plant B is exported to the 500-kV equivalent through three 400-MVA transformers connected between buses B4 and B5. We are considering a contingency case where only two transformers out of three are available (Tr2= 2*400 MVA = 800 MVA).

Using the load flow option of the powergui block, the model has been initialized with plants A and B generating respectively 500 MW and 1000 MW and the UPFC out of service (Bypass breaker closed). The example illustrates how the UPFC can relieve this power congestion.

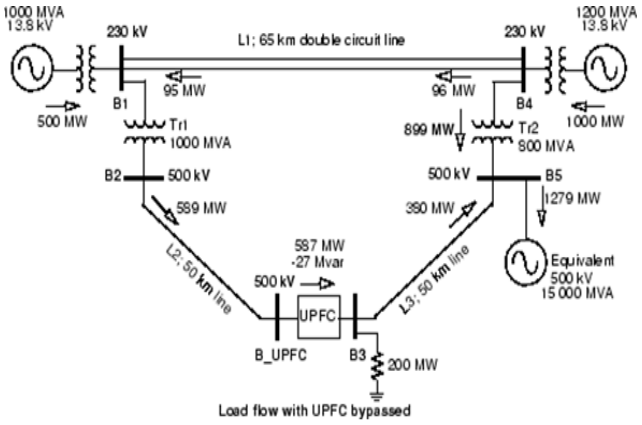

Figure. 2

The UPFC located at the right end of line L2 is used to control the active and reactive powers at the 500-kV bus B3, as well as the voltage at bus B_UPFC, IGBT-based, converters (one connected in shunt and one connected in series and both interconnected through a DC bus on the DC side and to the AC power system.

B. Algorithm

1. Start
2. Set reference reactive power
3. Read Input measurements
4. Feed input measurements to Control Unit
5. Generate Vsh And Vse
6. Send feedback to control unit to vary Ish and Ise
7. Generate Vdc to control reactive power
8. End.

IV. CONCLUSION

The proposed system has been implemented using MATLAB/ Simulink. In proposed Flexible alternating current transmission system model model, Unified power flow control device has been implemented over AC transmission line. This is found to be so efficient and effective. The implemented system model is able to match set reference reactive power. With this feature the implemented model enables stable voltage, control over reactive power, and impedance for better AC power transmission system.

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