Realisation of UPFC device using matlab simulation

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Abstract: **The possibility of controlling power flow in electric system without any rescheduling and topological changes can improve the power system performances. It has been proved that, instead of building new transmission lines, an efficient usage of the existing line to their thermal limit is possible. Flexible AC Transmission Systems (FACTS), which are power electronic based devices, can change parameters like impedance, voltage and phase angle. Therefore they have the ability to control power flow pattern and enhance the usable capacity of the existing lines. The important feature of FACTS Technology is that they can vary the parameters rapidly an continuously, which will allow a desirable control of the system operation. The Unified Power Flow Controller (UPFC) is a Flexible AC Transmission Systems device used for improving the power quality in power systems. The UPFC consists of a combination of series device and shunt device, the DC terminals of which are connected to a common DC link capacitor. The series device acts as a controllable voltage source VC, whereas the shunt device acts as a controllable current source IC. The main purpose of the shunt device is to regulate the DC link voltage by adjusting the amount of active power drawn from the transmission line. In addition, the shunt device has the capability of controlling reactive power.**

***Keywords*-**SSSC, Statcom, UPFC

I. INTRODUCTION

The flexible AC transmission systems (FACTS) concept based on applying leading edge Power Electronics Technology to existing AC transmission systems, improves stability to increase usable power transmission capacity to its thermal limit. A UPFC can simultaneously provide control of the transmission line impedance, phase angle and voltage. The UPFC is constructed from two power electronic inverters which are connected together by a common DC link. Two transformers are used to isolate the UPFC and to match the voltage levels between the power system and the power electronic inverters. One of the inverter is connected to the transmission line. The series connected inverter can generate a voltage which can have adjustable magnitude and phase angle. This inverter therefore can provide both real and reactive power to the transmission line. The second inverter primarily provides the real power required by the series inverter but it can also operate as an independent VAR compensator. Therefore the UPFC can control the flow of real and reactive power in the transmission line. The two VSI's can work independently by separating the DC side. So in that case, the shunt inverter is operating as a STATCOM that generates or absorbs reactive power to regulate the voltage magnitude at the connecting point. The series inverter is operating as SSSC that generates or absorbs reactive power to regulate the current flow, and hence the power flow on the transmission line is regulated. 2 The UPFC can be used to improve the power quality due to the separate controlling capability of real and reactive power. In this proposed work two bus system is modeled and simulated with UPFC. 14 bus system is also modeled and simulated with and without UPFC. The real and reactive power is investigated and observed that the real power increases with the increase in the angle of injection. The reactive power increases with the shunt voltage injection. Simulink models are developed for PWM inverter based UPFC, SVM inverter based UPFC and MLI based UPFC. The results of these three cases are compared. Multiple and Distributed Dynamic Voltage Restorer (DVR) concept is introduced to improve the voltage profile of the system. The IEEE 30 bus system is modeled and simulated with and without UPFC. The real and reactive powers are investigated. Voltage sag compensation is done by adding a additional load and it is observed that the UPFC mitigate the voltage sag.

II. UPFC

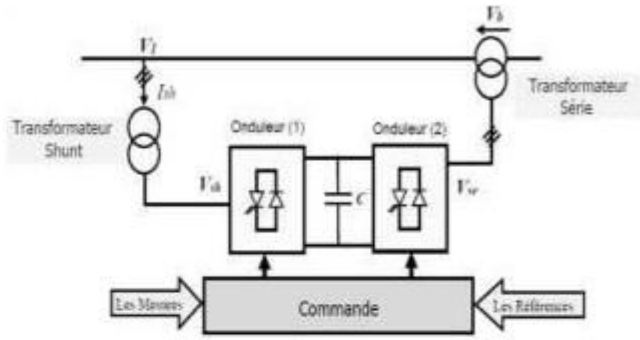

Fig.1 Schematic of three phases connecting between Power network and UPFC

UNIFIED POWER FLOW CONTROLLER (UPFC) According to IEEE definition and standard UPFC is combination of both static synchronous compensator (STATCOM) and static synchronous series compensator (SSSC).those device are coupled via common dc power link to allow bidirectional flow of real power between the series output terminal of SSSC and the shunt output terminal of STATCOM.

III. LITERATURE REVIEW

In this section we summarized the research papers in brief about allocation of unified power flow controller (UPFC) for a better power flow control. These are explained as: In 2015 Priyankakarwa, V.P.Rajderkar [1] presented a paper on "Optimal Placement of Unified Power Flow Controller (UPFC) To Maximize Power Transfer Capability" International Journal of Electrical, Electronics and Data Communication, ISSN: 2320-2084. In this paper, Real power flow performance index for the optimal placement of UPFC have been studied as FACTS devices are used to maximize power transfer capability of the system. This paper mainly deals with the optimal placement of UPFC to maximize power transfer capability. Real power sensitivity performance index have been used to find optimal location of UPFC on IEEE-5 and IEEE-14 bus system. Finally sensitivity performance index calculated so as to out optimal location for FACTS device placement i.e. UPFC to Maximize power transfer capability of the system. In 2017. Kyaw Myo Lin, published a paper on "Load Curtailment Sensitivity Indices through Optimal Placement of Unified Power Flow Controller." American Journal of Electrical and Computer Engineering. This paper proposes a set of load curtailment sensitivity indices for optimal placement of Unified Power Flow Controller (UPFC) in power system network. An OPF formulation considering the minimization of load curtailment requirement as an objective has been developed in this paper to study the impact of optimal placement of UPFC. The optimal placement of UPFC has been decided based on the load curtailment sensitivity factors. Optimal locations for UPFC placement in a line has been considered for the minimization of system load curtailment requirements. In 2010 Suppakarn Chansareewittaya and Peerapol Jirapong [3] presented a paper on "Power Transfer Capability Enhancement with Multi-type FACTS Controllers Using Particle Swarm Optimization" in IEEE Conference Publications. In this paper, particle swarm optimization (PSO) is proposed to determine the optimal allocation of multi-type FACTS controllers to enhance power transfer capability of power transactions between sources and sink areas in power systems. Test results from the test system indicate that optimally placing OPF with FACTS controllers by PSO can effectively and successfully enhance the power transfer capability compared to those from EP. Advantage of PSO is it gives higher benefit to cost ratio and faster convergence. www.ijcrt.org © 2018 IJCRT | Volume 6, Issue 2 April 2018 | ISSN: 2320-2882 IJCRT1892176 International Journal of Creative Research Thoughts (IJCRT) www.ijcrt.org 1188 In 2014 Sreerama Kumar R., Ibrahim M. Jomoah, and Abdullah Omar Bafail [5] made a study on “Optimal Placement of Unified Power Flow Controller for Minimization of Power Transmission Line” International Journal of Computer Theory and Engineering, Vol. 6, No. 5.This paper proposes the application of genetic algorithm for the determination of the optimal placement of unified power flow controller (UPFC) in a power system so as to minimize the system losses and enhance the voltage profile. The load flow analysis has been performed for each individual in every generation so as to determine the fitness function which is defined as the inverse of the total transmission line losses. The location of UPFC has been identified as the best individual from among the off-springs of the last generation. In 2005 Weerakorn Ongsakul and Peerapol Jirapong, [6] published a paper on “Optimal Allocation of FACTS Devices to Enhance Total Transfer Capability Using Evolutionary Programming” in IEEE In this paper, an evolutionary programming (EP) is proposed to determine the optimal allocation of FACTS devices for maximizing the total transfer capability (TTC) of power transactions between source and sink areas in deregulated power system. The EP approach is effectively and successfully implemented to determine optimal allocation of multi-type of FACTS devices to maximize TTC between different control areas. Test results from the test system indicate that optimally placed OPF with FACTS devices by EP could enhance the TTC value far more than OPF without FACTS devices. In 2013 R. Selvarasu and M. Surya Kalavathi [7] presented a paper “UPFC Placement: A New Self Adaptive Firefly Algorithm” in Chennai Fourth International Conference on Sustainable Energy and Intelligent Systems (seiscon 2013) 12-14 Dec 2013 In this paper a new strategy has been proposed for optimal placement of Unified Power Flow Controller (UPFC) in power systems with a view to minimize the transmission loss. The proposed strategy uses Self Adaptive Firefly Algorithm (SAFA) and identifies the optimal locations for UPFC placement and their parameter. Simulations results are presented for IEEE 14-bus system and IEEE 30-bus system. Results have shown that the identified location of UPFC minimize the transmission loss in the power system network In 2008 Sreekanth Reddy Donapati and M.K.Verma [8] publish a paper“An Approach for Optimal Placement of UPFC to Enhance Voltage Stability Margin under Contingencies” in Fifteenth National Power Systems Conference (NPSC), IIT Bombay. This paper proposes a sensitivity based technique for optimal placement of Unified Power Flow Controller (UPFC) to enhance voltage stability margin under contingencies. The sensitivity of system loading factor with respect to the reactive power flowing through lines computed for the system intact case and critical contingency cases have been used to decide optimal location for the placement of UPFC. The sensitivity of loading parameter (O) with respect to reactive power flowing through lines has been computed to decide optimal location for the placement of UPFC. From the case studies carried out on 75-bus Indian system, a considerable increase in loading margin have been observed after UPFC placement at the optimal location In 2015 M.R. Qader [9] presented a paper on “Design and simulation of a different innovation controller-based UPFC (unified power flow controller) for the enhancement of power quality” This paper provides a comprehensive presentation of UPFC model in practical circumstances; while the paper also discusses the control strategy and transient model of the UPFC. The control system presented in the paper is able to control the voltage flickers/sags; while eliminating the harmonics at the same time. Moreover, a MATLAB/Simulink model is also established in the paper for the UPFC in the environment of Simulink, once its principles are analysed. Test results using different power system models are presented throughout the thesis to illustrate the effectiveness of unified power flow controller. In 2014 Jayanti Sarker S.K. Goswami [10] published a paper on “Solution of multiple UPFC placement problems using Gravitational Search Algorithm”in international journal of electrical power and energy systems. This paper presents a heuristic method based on Gravitational Search Algorithm (GSA) to find optimal number and location of UPFC devices considering generation cost and power system losses. The performance of GSA is compared for accuracy and convergence characteristics with heuristic search techniques. The proposed UPFC placement algorithm has been tested on several test and real life power systems and some of the results are produced in this paper to establish the computational ability and robustness of the method

IV. CONCLUSION

The real and reactive power flow in the transmission line can be controlled by changing the magnitude and phase angle of the injected voltage produced by the series inverter. The basic function of the parallel inverter is to supply the real power demanded by series inverter through the common dc link. The parallel inverter can also generate or absorb controllable reactive power. The aims of this paper, to study and analyze most researches that topics cover the unified Power flow controller (UPFC) and made a comparison between them in order to improve its functions in addition to obtain a best controlling method for active and reactive power flow of the power system, where this paper offered most papers that used a UPFC to carrying out the following point after finding an optimal location of the FACTs device: 1- Improving the active and reactive control power flow of the power systems. 2- Increasing the transient stability, 3- Increasing the damping of sub synchronous resonance. 4- Controlling the steady state or dynamic performance. 5- Optimizing power flow. International Journal of Computer Applications (0975 – 8887) Volume 182– No.12, August 2018 26 6- Minimizing the operational costs of the electrical grid. Finally, when a comparison doing with the other FACTs devices it can concluded that UPFC is more dynamic stability, and it is a better way to control the active and reactive power flow with low cost and high reliability. FACTS are powerful strategies to improve the voltage waveform and power quality enhancement. It is founded also that the performance of the UPFC is more effective for the improving power system as compared with the other FACTS devices such as SVC, TCSC, and SSSC respectively

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