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Review on Harmonic Reduction and Power Quality Improvement by using DPFC

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Abstract: *A new component within the flexible ac-transmission system (FACTS) family, called distributed power-flow controller (DPFC). The DPFC is derived from the unified power-flow controller (UPFC). The DPFC can be considered as a UPFC with an eliminated common dc link. The active power exchange between the shunt and series converters, which is through the common dc link in the UPFC, is now through the transmission lines at the third-harmonic frequency. The DPFC employs the distributed FACTS (D-FACTS) concept, which is to use multiple small-size single-phase converters instead of the one large-size three-phase series converter in the UPFC. The large number of series converters provides redundancy, thereby increasing the system reliability. As the D-FACTS converters are single-phase and floating with respect to the ground, there is no high-voltage isolation required between the phases. Accordingly, the cost of the DPFC system is lower than the UPFC. The DPFC has the same control capability as the UPFC, which comprises the adjustment of the line impedance, the transmission angle, and the bus voltage.*

Keywords: DPFC, UPFC, FACTS

I. INTRODUCTION

In modern power systems, there is a great demand to control the power flow actively .Power flow controlling devices (PFCDs) are required for such purpose, because the power flow over the lines is the nature result of the impedance of each line. Due to the control capabilities of different types of PFCDs, the trend is that mechanical PFCDs are gradually being replaced by Power Electronics (PE) PFCDs. Among all PE PFCDs, the Unified Power Flow Controller (UPFC) is the most versatile device. However, the UPFC is not widely applied in utility grids, because the cost of such device is much higher than the rest of PFCDs and the reliability is relatively low due to its complexity.The objective of this thesis is to develop a new PFCD that offers the same control capability as the UPFC, at a reduced cost and with an increased reliability. The new device, so-called Distributed Power Flow Controller (DPFC), is invented and presented in this thesis. The DPFC is a further development of the UPFC.

The DPFC eliminates the common DC link within the UPFC, to enable the independent operation of the shunt and the series converter. The D-FACTS concept is employed in the design of the series converter. Multiple low-rating single-phase converters replace the high-rating three-phase series converter, which greatly reduces the cost and increases the reliability. The active power that used to exchange through the common DC link in the UPFC, is now transferred through the transmission line at the 3rd harmonic frequency. The DPFC has been modeled in a rotating dq-frame. Based on this model, the basic control of the DPFC is developed. The basic control stabilizes the level of the of the capacitor DC voltage of each converter and ensures that the converters inject the voltages into the network according to the command from the central control. The shunt converter injects a constant current at the 3rd harmonic frequency, while its DC voltage is stabilized by the fundamental frequency component. For the series converter, the reference of the output voltage at the fundamental frequency is obtained from the central controller and the DC voltage level is maintained by the 3rd harmonic component

II. LITERATURE SURVEY

[1] The paper outlines The planning and operation of interconnected large power systems is becoming complex. The power transfer capability of long transmission lines is usually limited by large signals ability. Economic factors such as

the high cost of long lines and revenue from the delivery of additional power give strong intensive to explore all economically and technically feasible means of raising the stability limit. The development of effective ways is to use transmission systems at their maximum thermal capability. In this paper a Simulink Model is considered with UPFC model to evaluate the performance of a single and double transmission line systems (6.6/22) kV. The UPFC model is a member of the FACTS family with very attractive features and it is a solid state controller which can be used to control active and reactive power flow in a transmission line. In the simulation study, the UPFC model facilitates the real time control and dynamic compensation of AC transmission system. It provides the necessary functional flexibility required for solving the problems faced by the utility industry. It should be considered as real and reactive power compensation, capable of independently controlling voltage profile as well as the real and reactive powers in the line. The simulation model is tested for single and double transmission line systems with and without UPFC model in MATLAB / SIMULINK environment.

[2] The DPFC is derived from the unified power-flow controller (UPFC). The DPFC can be considered as a UPFC with an eliminated common dc link. The active power exchange between the shunt and series converters which is through the common dc link in the UPFC is now through the transmission lines at the third-harmonic frequency. The DPFC employs the distributed concept, in which the common dc-link between the shunt and series converters are eliminated and three-phase series converter is divided to several single-phase series distributed converters through the line.

According to the growth of electricity demand and the increased number of non-linear loads in power grids harmonics, voltage sag and swell are the major power quality problems. DPFC is used to mitigate the voltage deviation and improve power quality. Simulations are carried out in MATLAB/Simulink environment. The presented simulation results validate the DPFC ability to improve the power quality.

[3] In this paper we are discussing about a FACTS device named as UPFC (unified power flow controller). Its special features are to control active and reactive power course in a transmission line and to adjust the voltage at the bus at which it is situated. This device gives great quality flow on power system stability; these features even more considerable and perceptive that the unified power flow controller can be apply to the transmission line with in their limits and enhancing the power to flow through the preferred path. So this device gives unique control on the power flow and voltage stability. In this paper the working of UPFC is in the field of control flow of power in transmission-line. This research regarding the 6-bus power system to control the active and reactive power in the course of transmission line by keeping this controller at the sending end by simulation tools. When there is no FACTs device (UPFC) the active power, reactive power and voltage through the transmission line cannot be controlled. The circuit model for UPFC is developed using rectifier and inverter circuits. In this thesis, the power system simulation models are made on MATLAB version 7.13. By making the power system simulation model, we are getting result without and with using UPFC and after that these results are compared in form of real and reactive power in the transmission line. On the basis of simulation results and to analyze the performance of UPFC, we can conclude that UPFC is ideal controller for performing such parameters.

[4].This paper demonstrates The flexible ac-transmission system (FACTS) family called distributed power flow controller (DPFC). The DPFC is derived from the unified power flow controller (UPFC) with eliminated common dc link. The active power exchange between the shunt and series converters, which is through the common dc link in the UPFC, is now through the transmission lines at the third-harmonic frequency. The DPFC is to use multiple small size single phase converters instead of large size three phase series converter in the UPFC. The large number of series converters provides redundancy, thereby increasing the system reliability. As the D-FACTS converters are single phase and floating with respect to the ground, there is no high voltage isolation required between the phases. The cost of the DPFC system is lower than the UPFC. The DPFC has the same control capability as the UPFC, which comprises the adjustment of the line impedance, the transmission angle, and the bus voltage. Due to the high control capability DPFC can also be used to improve the power quality and system stability, such as low frequency power oscillation damping, voltage sag restoration or balancing asymmetry.

[5] This Paper explains In this paper a comparative analysis between Unified Power Flow Controller (UPFC) and Distributed Power Flow Controller (DPFC) in a grid integrated photovoltaic system is performed. A grid connected solar generation system with boost converter and voltage source inverter (VSI) is taken as the main model. Due to power quality issues like power oscillations, harmonic distortions, voltage sags and swells, the grid side system has to

be perfectly monitored and controlled. One way to mitigate these power quality problems is by using reactive elements like shunt/series reactor and shunt/series capacitor. The disadvantage on using these reactive elements is sub synchronous resonance phenomenon. Thanks to FACTS technology, which emerged out as power conditioning units and helps to feed power with required standards and free from power quality issues. Among them, the contemporary FACTS devices are Distributed Power Flow Controller (DPFC) and Unified Power Flow Controller (UPFC). Though the aims of both the devices are same but their working principles are different. In this paper the effect of adding a DPFC and UPFC to a solar PV generation system is analyzed. A detailed working principle and operation of both the devices were presented. At last, MATLAB/SIMULINK environment is used to compare the performances of above mentioned devices.

[6] This paper presents a new component within the flexible ac-transmission system (FACTS) family, called distributed power-flow controller (DPFC). The DPFC is derived from the unified power-flow controller (UPFC). The DPFC can be considered as a UPFC with an eliminated common dc link. The active power exchange between the shunt and series converters, which is through the common dc link in the UPFC, is now through the transmission lines at the third-harmonic frequency. The DPFC employs the distributed FACTS (D-FACTS) concept, which is to use multiple small-size single-phase converters instead of the one large-size three-phase series converter in the UPFC. The large number of series converters provides redundancy, thereby increasing the system reliability. As the D-FACTS converters are single-phase and floating with respect to the ground, there is no high-voltage isolation required between the phases. Accordingly, the cost of the DPFC system is lower than the UPFC. The DPFC has the same control capability as the UPFC, which comprises the adjustment of the line impedance, the transmission angle, and the bus voltage. The principle and analysis of the DPFC are presented in this paper and the corresponding experimental results that are carried out on a scaled prototype are also shown.

[7] For power transmission in grid, a new concept of direct power flow controller (DPFC) was proposed based on single-stage ac–ac converter with controllable phase and amplitude. By connecting its regulated output compensation voltage with grid in series, DPFC is able to regulate the amplitude and phase angle of grid node voltage, and thus can effectively control active and reactive power flow in grid, respectively and simultaneously. Compared with unified power flow controller (UPFC), DPFC also has a parallel transformer and a series transformer but has no dc energy storage element that easily leads to high equipment failure rate. Furthermore, UPFC is similar to two-stage conversion circuit, while DPFC has only one-stage conversion circuit, which consists of three single-phase buck-type ac units and a three-phase output filter. With respect to the input voltage of DPFC basic circuit, the phase regulation range of its output compensation voltage is 60°, which is easy to extend to 360° with two selection switches changing the connection groups of the input and output transformer. The topology structure and operational principle of DPFC were presented, and the experimental results of a prototype showed its feasibility and verified the theoretical analysis of DPFC

III. RESEARCH OBJECTIVES

Main objective of project to eliminate the power quality problem

- To minimize the sag using DPFC
- To minimize swell using DPFC
- To Reduce harmonics using DPFC
- To design PVA based Shunt converter of DPFC
- To design series converter of DPFC

IV. PROPOSED METHODOLOGY

The proposed work is planned to be carried out in the following manner:

1. Study of basic concepts of Distributed Power flow Controller.
2. Finding the problems from conventional system by surveying literature.
3. Design the distribution System.
4. Design and study of DPFC.
5. Analysis of the proposed topology.

6. Study of the control strategies of system.
7. Design PV system for DPFC

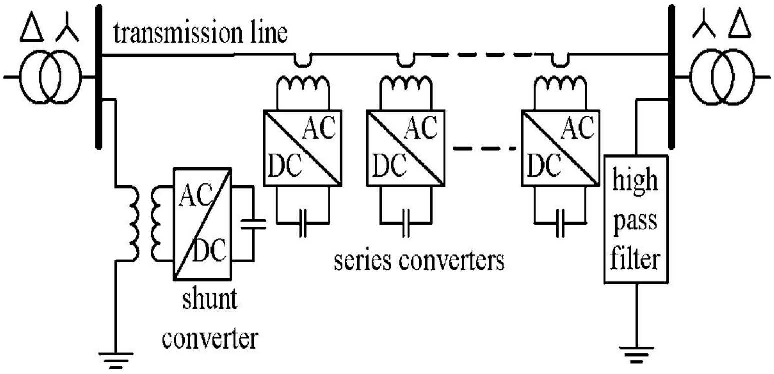

Fig 1 DPFC Configuration

As Fig. 1 Similar as the UPFC, the DPFC consists of shunt and series connected converters. The shunt converter is similar as a STATCOM, while the series converter employs the SSSC concept, which is to use multiple single-phase converters instead of one three-phase converter[19]. Each converter within the DPFC is independent and has its own DC capacitor to provide the required DC voltage.

V. EXPECTED CONCLUSION

The power quality improvement using DPFC will be simulated in the MATLAB Simulink and related waveform will be observed

Without DPFC (Waveform observe)

a) sag

b) swell

c) Harmonic

With DPFC (Waveform observe)

a) sag

b) swell

c) Harmonics

With and without DPFC result Compare

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