

Comparison the Performance of DPFC and UPFC for Power Quality Improvement in Power System

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Abstract— This paper, implements a novel concept in family of flexible ac-transmission system, called distributed power-flow controller. Generally, distributed power flow controller will be obtained derived from unified power-flow controller. Basically, the Distributed power flow controller can be modified from UPQC by eliminating the dc link capacitor between two converters, therefore, the power exchange between the two converters now doing through the transmission lines. The DPFC is from one of the distributed FACTS (D-FACTS) concept, like UPFC instead of large series converter the DPFC has a multiple small-scale converters. The control capability of DPFC is also same as the UPFC, is to control the transmission impedance, the load angle, and the magnitude of the bus-voltage. This paper concentrates on the working and operating principles of DPFC and results are checked in MATLAB/SIMULINK.

Index Terms— DPFC, Active Power, Park's Transformation, and Harmonics

1. INTRODUCTION

Transfer of energy from generating units to the utility customers, the term power quality criteria is most important. From consumer point, the power quality issue is concentrated about current, voltage or frequency deviation which causes the failure of power [1]. For solving the power quality problem a new method based on the power electronic based equipment's called custom power devices one of the flexible alternating current transmission system which is used in both transmission and distribution control. The majority of problems in transmission lines are such as voltage dip, over voltage and interruption. Because of grow thing in power demand and extension of transmission and distribution is restricted with the environmental constraints and availability of resource. Now a days the power quality improvement is main criteria from the customer side [2]. Generally, the power quality issues is more concentrated about transmission current, voltage or frequency deviation which also causes the failure of power station. For solving the power quality problem a new method based on the power electronic converter called custom power devices one of the flexible

alternating current transmission for controlling both transmission and distribution side controller should be developed. For reducing this power quality a new concept called unified power flow controller and static synchronous compensator (STATCOM) can be helpful [4]. This paper more concentrate on the new strategy for controlling power known as distributed power flow controller (DPFC) has been implemented.

Power flow is controlled by adjusting the parameters of a system, such as voltage magnitude, line impedance and transmission angle. The device that attempts to vary system parameters to control the power flow can be described as a Power Flow Controlling Device (PFCD) [6]. Depending on how devices are connected in systems, PFCDs can be divided into shunt devices, series devices, and combined devices (both in shunt and series with the system) as shown in figure 1.

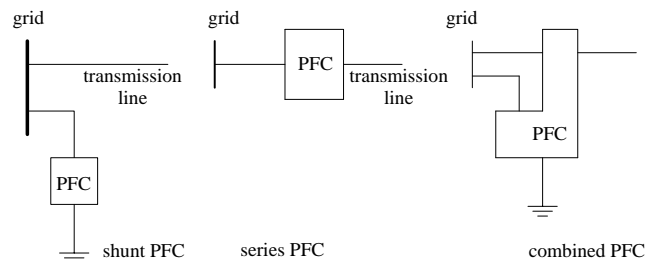


Fig 1: Simplified diagram of shunt, series and combined devices.

Generally, many problems in power system and transmission line can result from poor PQ, especially in today's complex power systems, such as the false operation of modern control systems. Voltage sag is an important PQ problem because of sensitive loads growth. Worldwide experience has shown that short-circuit faults are the main origin of voltage sags and, therefore, there is a loss of voltage quality [3], [14]. The voltage sag during the fault is proportional to the short circuit current value. An effective approach to prevent expected voltage sag and improve the voltage quality of point of common coupling (PCC) is fault current limitation by means of a device connected at the beginning of most exposed radial feeders [14]. And also in addition, the dynamic voltage regulator (DVR) is also a most common compensator. The general of the DVR is based on injection of a compensation voltage with required magnitude, phase angle, and frequency

in series with the sensitive electric distribution feeder [3]. Basically the Distributed Power Flow controller is combination of two converters like as UPFC, i.e one converter is used for controlling three phase series voltage called as series converter but in case of DPFC this series converter is spited into multi single phase converter. And second converter is used for compensating current in the line called as shunt converter. And the power exchange between these converters via a transmission line

In this paper, we introduce a new method like distributed power flow controller which is similar configuration to UPFC structure. The DPFC has a combination of single parallel converter and number of series converters which is used to balance the transmission line parameters, such as bus voltage, line impedance, and transmission angle.

II. DESCRIPTION OF PROPOSED CONTROL STRATEGY

DPFC is a combination of two converters. One is connected in parallel to line called shunt converter and STATCOM [10] is one of the most important classification. While the series converters is taken as dynamic voltage restorer on of the family of distributed flexible ac system. These two converters have their own dc link capacitors. The illustration 1 shows the structure of single machine system with Distributed Power Flow Controller [7]. To ensure that the Disturbed Power Flow Controller has the same control capability as the Unified Power Flow Controller device, a method that allows the exchange of active power between converters without DC link is the prerequisite [1].

By eliminating this DC link, the converters within the FACTS devices are operated independently, thereby increasing their reliability [4]. By elimination of dc link capacitor between the series and shunt converter now the active and reactive powers are exchanged with the help of transmission system.

The structure of DPFC system has following modification as compared with UPFC i.e. elimination of DC-link capacitor and active power exchange through the transmission line.

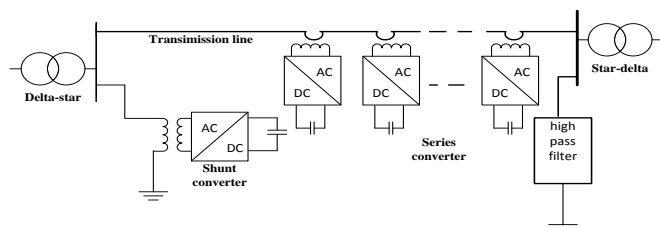


Fig 2: Basic Configuration of DPFC

The Distributed Power Flow Controller has the following merits as compared to UPFC, such as:

- 1) High capability to control the power.
- The DPFC can control all transmission parameters such as, impedance, load angle and voltage magnitude.
- 2) High efficient.
- 3) Economical.

2.1 CONTROL CIRCUIT FOR DPFC:

According to figure 2 the DPFC has three types of control strategies: i.e. Central controller, controller for series

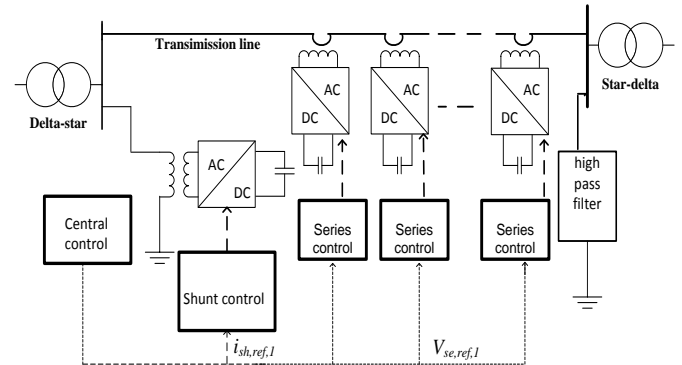


Fig 3: Control Diagram of DPFC

These three controllers are explained as follows:

2.1.1 CENTRAL CONTROLLER:

Generally, these central controllers have the capability of generating reference signals to the both series and shunt controllers.

2.1.2. CONTROLLING CIRCUIT FOR SERIES CONVERTER:

The main use of this series controller is to compensate the line voltages w.r.t changes due to load and maintain the series capacitor voltage within the limits. Generally, these series controllers have first order low pass and third order band pass filters for injecting natural and 3rd order harmonic currents into the line [13]. The closed loop control diagram for series controller is as shown in figure 4.

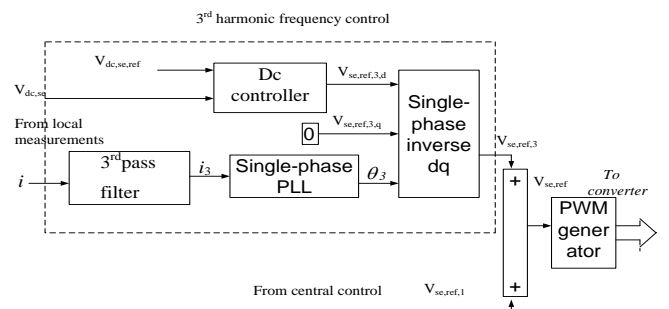


Fig 4: Block Diagram for Series Controller

2.1.3 SHUNT CONTROLLER:

The closed loop control diagram for the shunt converter is shown in 5th figure. The main purpose of this shunt converter is for providing active power into the line at frequency of 3rd order [8]. This static converter generally is a three phase converter which is connected with another single phase shunt converter [12].

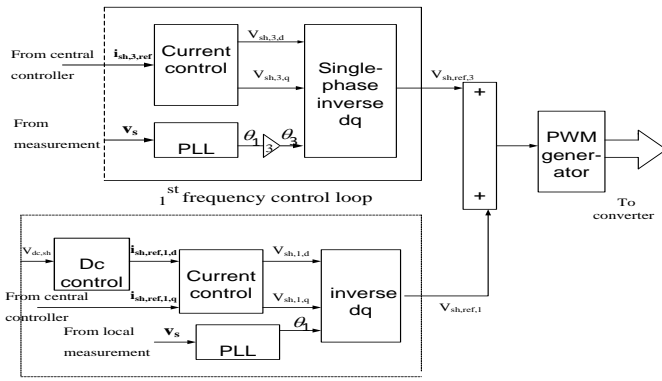


Fig 5: Control Diagram for Shunt Controller

III. . SIMULATION RESULT:

The principle and operation of Disturbed Power Flow Controller is demonstrated using MATLAB. The Simulation Diagram of DPFC is shown in figure 6. The simulation waveforms are presented and this results shows the performance of distributed power flow controller.

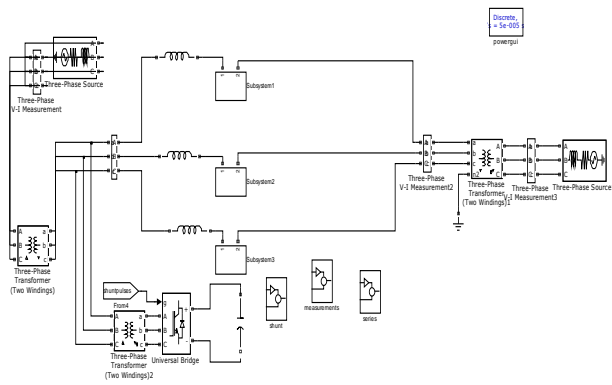


Fig 6: Simulink Diagram of DPFC controller

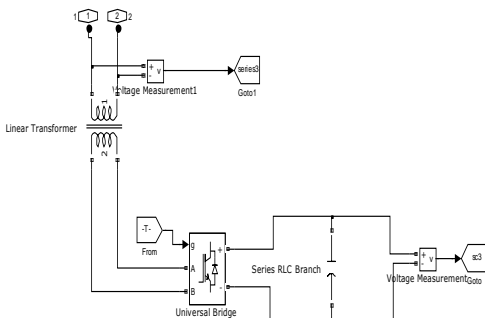


Fig7.Seires subsystem simulink block

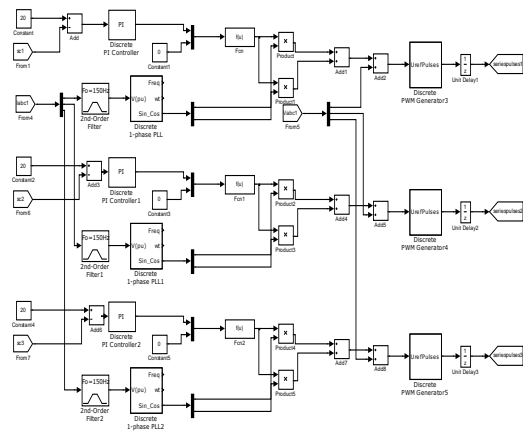


Fig8.Series measurement simu link block

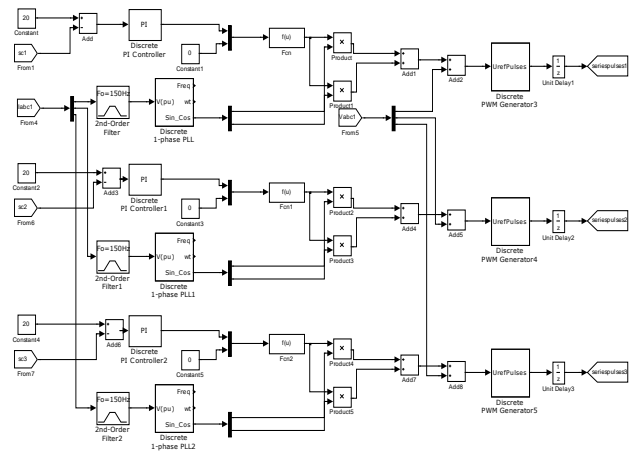


Fig9.Shunt subsystem simulink

CASE 1: By considering a step change in reference voltage of series converter: In this we are considering a step change of reference voltage after the time 0.28sec.

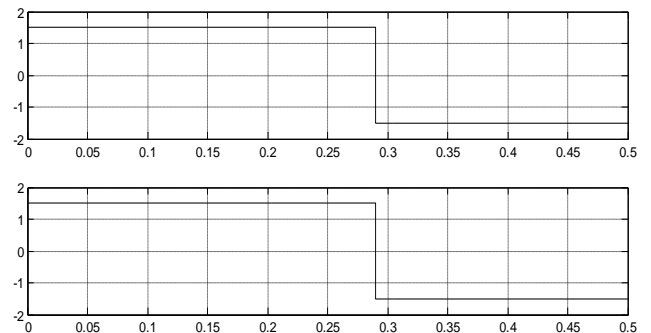


Fig 10: Reference Voltage for series converter

Fig 7 shows the simulation results for unit step change in series converter reference voltage, which causes the variations in both active and reactive powers. Fig 8: Unit Step response: Series Converter Voltage

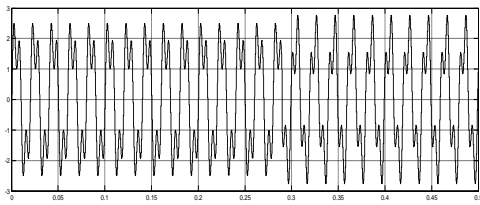


Fig 11: Unit Step response: Transmission Line Current

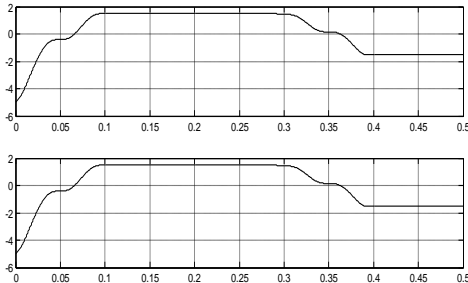


Fig 12: Unit Step response: series converter injected Active and Reactive power

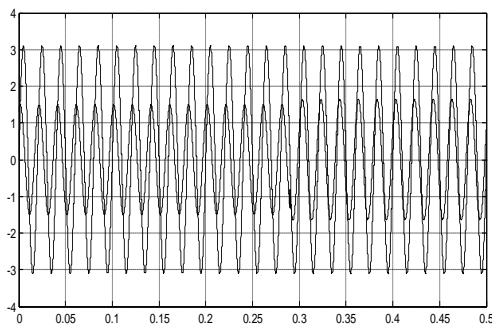


Fig. 13. Unit Step response: output transmission voltage and current

This paper concentrates on verification, whether if the series converter can inject powers at natural frequency. In this paper we considering a step change for series converter reference voltage, correspondingly these changes shows the effect on active and reactive powers as shown in Figure 10. Figure 11 shows the simulation results of transmission voltage and current during step change.

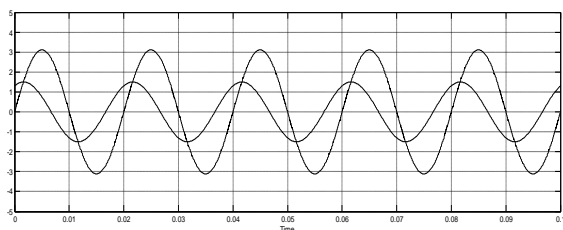


Fig. 14. Simulation Results for output transmission voltage and current at delta side of transformer

IV. CONCLUSION:

The concept of Distributed Power Flow Controller is generally obtained from the Unified power Flow Controller which has control of the transmission impedance, the load angle, and the magnitude of the bus-voltage. Like, in UPFC the common dc link between two converters is eliminated in case of DPFC and the active power is now exchanged

through the transmission line based on the third-harmonic frequency component. However, with the use of DPFC the reliability of the transmission system is extremely. And also in economical point of view the DPFC is much better than the UPFC, because no high-voltage isolation is requirement at the series-converter. Finally, the concept of DPFC is studied and verified in experimental setup MATLAB/SIMULINK. From the results we conclude that the Distributed Power Flow Controller can shows the better performance than other flexible ac transmission system and also as per economical and structure point of view it is better than UPFC.

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