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Power Quality Improvement utilizing DPFC in Eight Bus System Using Certain Controllers

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ABSTRACT

This article "Power Quality Improvement Utilizing DPFC In Eight Bus System Using Certain Controllers" aimed at obtaining the control is carried out by the Distributed Power Flow Controller (DPFC) recently presented is a powerful device within the family of FACTS devices, which provides much lower cost and higher reliability than conventional FACTS devices. It is derived from the UPFC and has the same capability of simultaneously adjusting all the parameters of the power system: line impedance, transmission angle, and bus voltage magnitude. Within the DPFC, the common dc link between the shunt and series converters is eliminated, which provides flexibility for independent placement of series and shunt converter. The DPFC uses the transmission line to exchange active power between converters at the 3rd harmonic frequency. Instead of one large three-phase converter, the DPFC employs multiple single-phase converters (D-FACTS concept) as the series compensator. This concept not only reduces the rating of the components but also provides a high reliability because of the redundancy.

KEYWORDS: Distributed Power Flow Controllers1, Unified Power Flow Controllers 2,Flexible AC Transmission System3

1. INTRODUCTION

The growing demand and aging of networks make it desirable to control the power flow in power transmission system fast and reliability. Flexible AC transmission system (FACTS) technology is the application of power electronics in transmission system. The main purpose of this technology is to control and regulate the electric variables in the power system and hence therefore increases the power transfer capability and can be utilized for power flow control.

Currently unified power flow controller (UPFC) is the most powerful device which can simultaneously control all the parameters of the system. Ex. line impedance, the transmission angle and bus voltage etc. the main reason behind the wide spread of the UPFC are its ability to pass the real power flow bidirectionally, maintaining well regulated DC voltage, work ability in the wide range of operating condition etc. Simplified representation of UPFC as shown in Fig.1a

UPFC is the combination of static compensator (STATCOM) and static synchronous series compensator (SSSC) coupled via a common DC link to allow bidirectional flow active power between the series output terminal of the SSSC and shunt output terminal of the STATCOM.

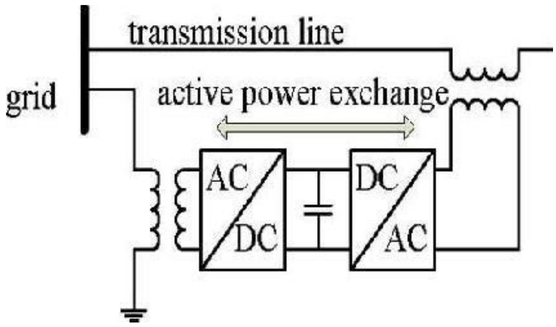

Fig.1a Simplified representation of a UPFC

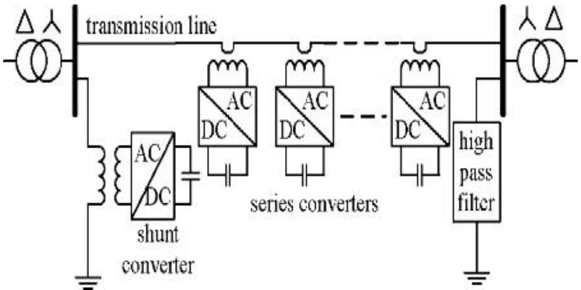

Fig.1c configuration of DPFC

The two converters operated from a DC link provided by a DC storage capacitor. The UPFC is not widely applied in practice due to their high cost and the redundancy to failure. Since the components of the UPFC handle the voltages and current with high rating, therefore the total cost of the system is high.

Due to the common DC link interconnection a failure that happens at one converter will influence the whole system. To achieve the required reliability for power systems, bypass circuit or redundant back ups are needed which leads to increase the cost.

The same as the UPFC, The Distributed Power Flow Controller (DPFC) recently presented in is a power flow device within the FACTS family, which provides much lower cost and higher reliability than the conventional FACTS devices. It is derived from the UPFC and has the same capability of simultaneously adjusting all the parameters of power system like line impedances, transmission angle and bus voltage magnitude. The DPFC Flow chart and configuration are shown in Fig.1b and Fig.1c respectively.

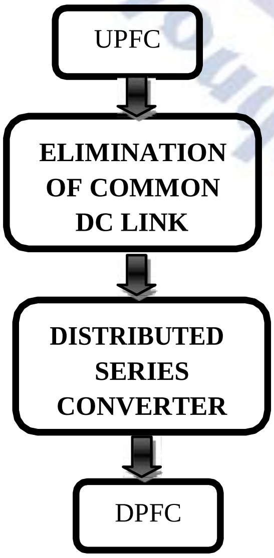

Fig.1b Flow chart from UPFC to DPFC

2. OBJECTIVES OF THE PROPOSED WORK

The objective of the paper is a Utilize Distributed Power Flow Controller (DPFC) to Compensate Unbalanced 3-phase Currents in Transmissions Systems. The implementation of Distributed Power Flow Controller is a new device within the family of FACTS. The DPFC has the same control capability as the UPFC, but with much lower cost and higher reliability. This project addresses one of the applications of the DPFC namely compensation of unbalanced currents in transmission systems. Since the series converters of the DPFC are single phase, the DPFC can compensate both active and reactive, zero and negative sequence unbalanced currents.

3. CONTROLLERS

Line diagram of 8-bus system without DPFC is shown in fig2 Voltage at bus-5 without DPFC is shown in fig 3 and its value is 2000V. Line diagram of 8-bus system is shown in fig4. Output voltage THD is shown in fig 5 and its value is 7.14%. Current at bus-5 without DPFC is shown in fig 6 and its value is 110A. Output current THD is shown in fig 7 and its value is 6.53%. Real Power & Reactive Power at bus-5is shown in fig 8 and its value are 3.9MW and 2.2 MVAR.

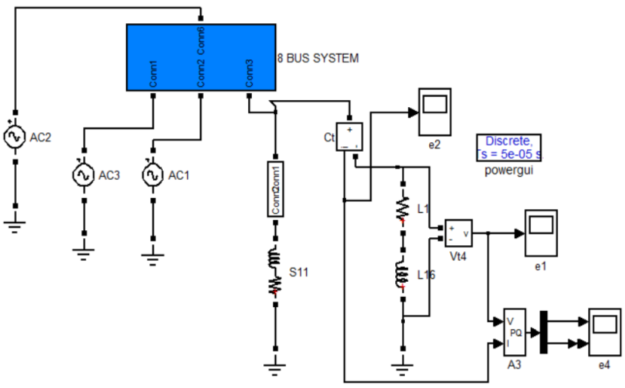

Fig 2 Line diagram of 8-bus system without DPFC

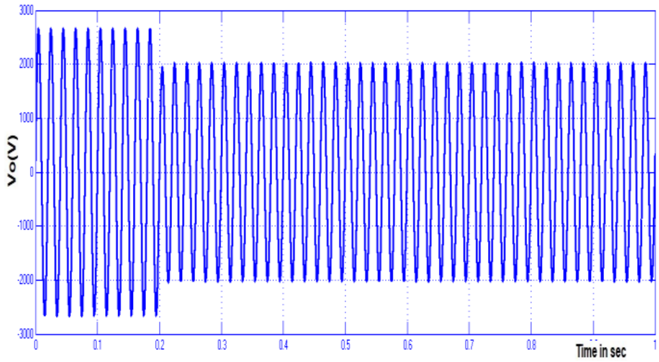

Fig 3 Voltage at bus-5 without DPFC

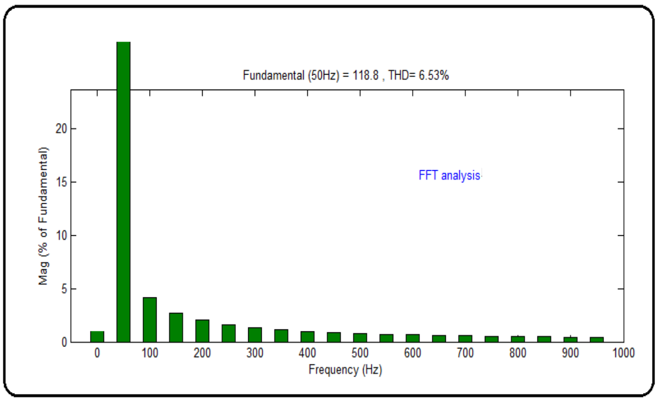

Fig 7 Output current THD

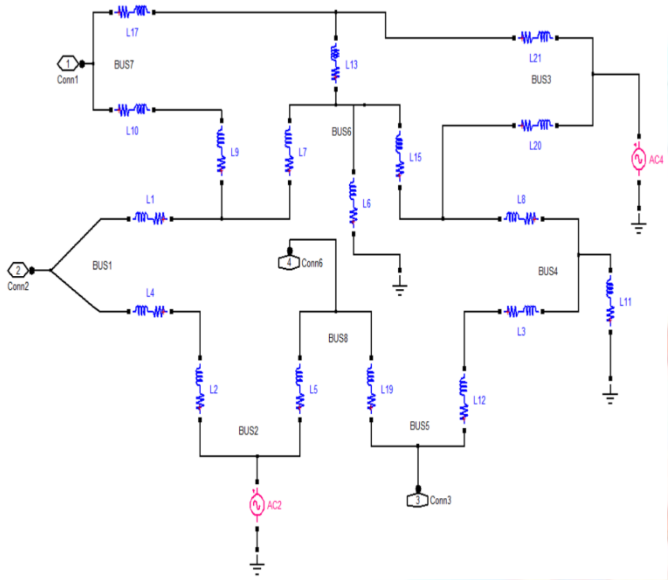

Fig 4 Line diagram of 8-bus system

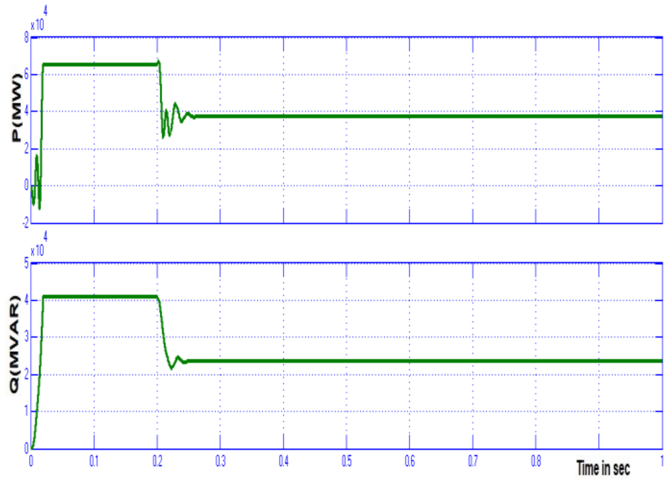

Fig 8 Real Power & Reactive Power at bus-5

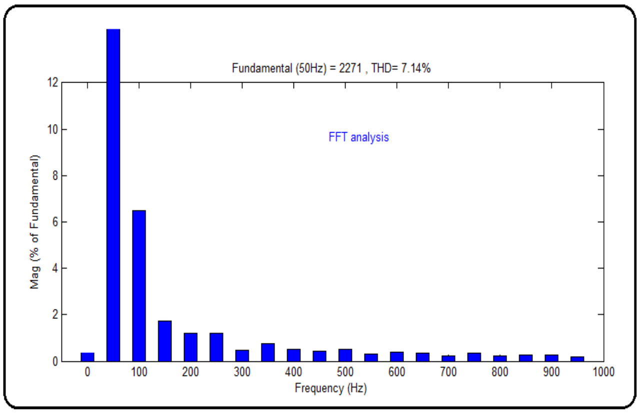

Fig 5 Output voltage THD

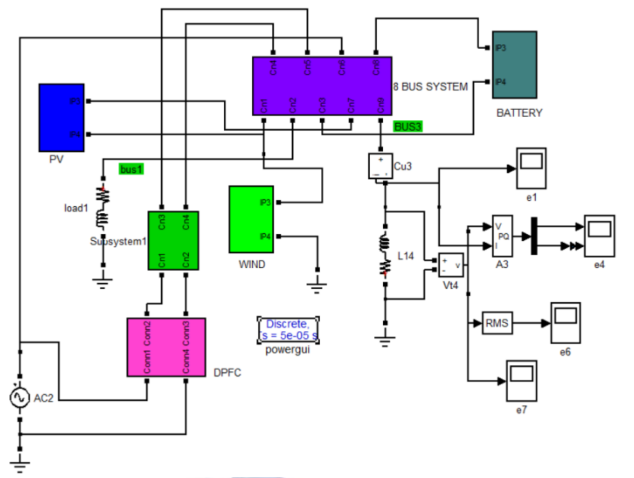

Fig 9 Line diagram of 8-bus system with DPFC

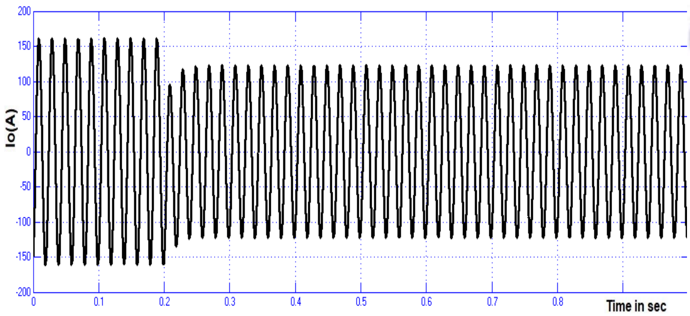

Fig 6 Current at bus-5 without DPFC

Line diagram of 8-bus system with DPFC is shown in fig 3.9. Voltage at bus-5 with DPFC is shown in fig 3.10 and its value is 2700V. Output voltage THD is shown in fig 3.11 and its value is 3.84%. Current at bus-5 with DPFC is shown in fig 3.12 and its value is 155A. Output current THD is shown in fig 3.13 and its value is 1.35%. Real Power & Reactive Power at bus-5 is shown in fig 3.14 and its value are 6.5 MW and 4.2 MVAR.

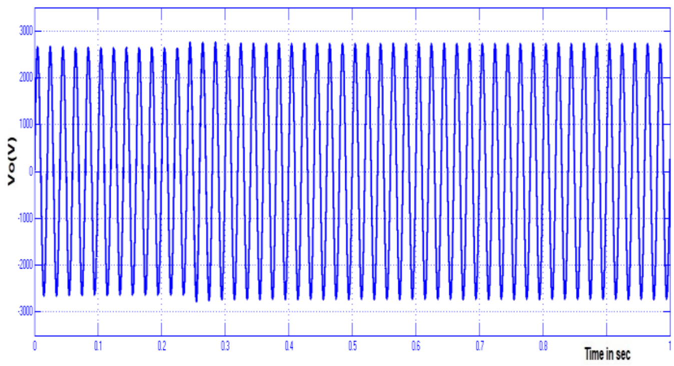

Fig 10 Voltage at bus-5 with DPFC

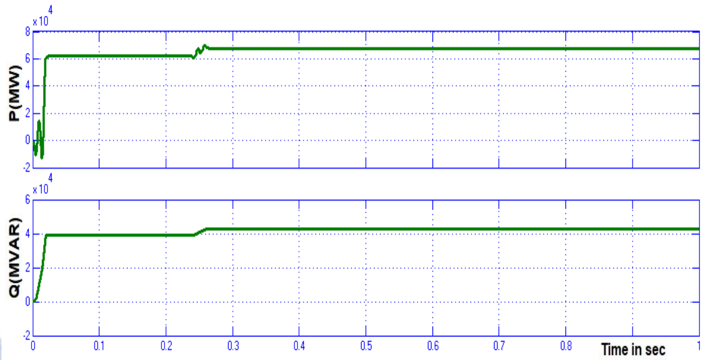

Fig 14 Real Power & Reactive Power at bus-5

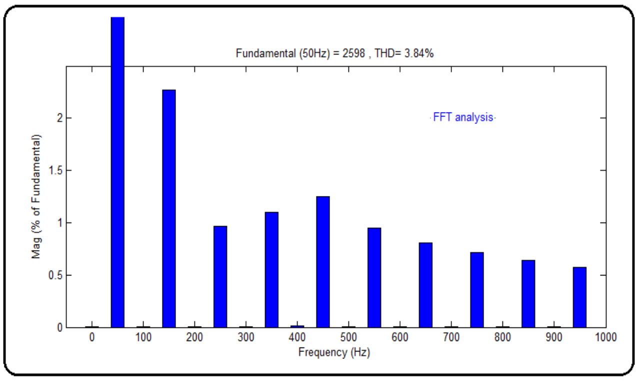

Fig 11 Output voltage THD

Table - 1 Comparison of voltage, P, Q & THD

FACTS	Voltage (Volts)	Real power (MW)	Reactive power(MVAR)	Voltage THD(%)	Current THD(%)
Without DPFC	2000	0.038	0.025	7.14	6.53
With DPFC	2700	0.065	0.042	3.84	1.35

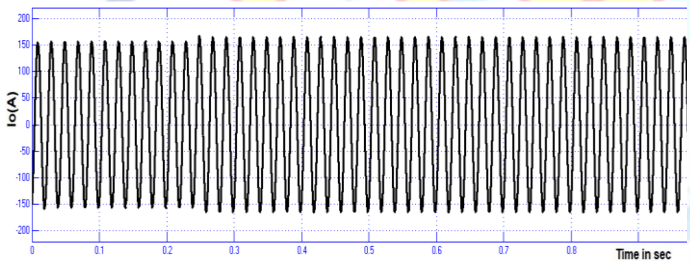

Fig 12 Current at bus-5 with DPFC

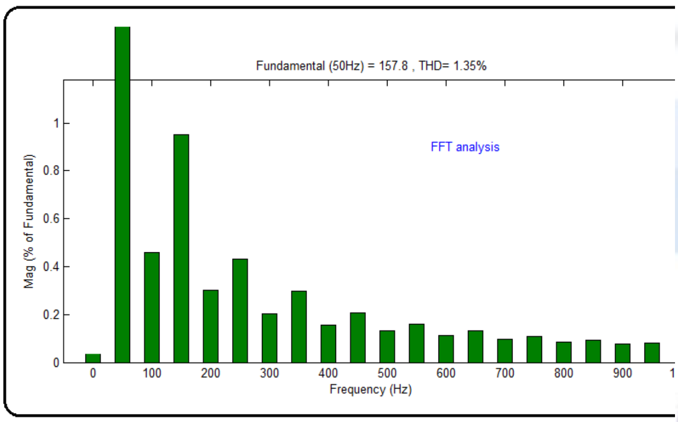

Fig 13 Output current THD

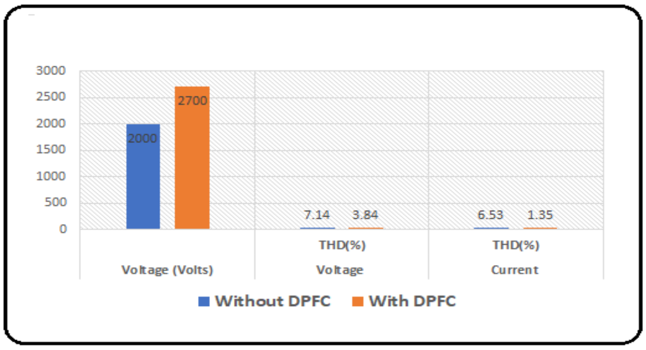

Fig 15 Bar chart comparison of voltage at bus-5, voltage THD and current THD for with and without DPFC system

The table 1 shows the Comparison of voltage, real power, reactive power, voltage & current THD for with and without DPFC system. The fig 3.15 shows the Bar chart comparison of voltage at bus-5, voltage THD and current THD for with and without DPFC system. The fig 3.16 shows the Bar chart comparison of real and reactive power for with and without DPFC system. By using DPFC, Output voltage is improved from 2000V to 2700V by using 8-bus with DPFC system; Real power is improved from 0.038MW to 0.065MW by using 8-bus with DPFC system; Reactive power is improved from 0.025MVAR to 0.042MVAR by using 8-bus with DPFC system; Voltage THD is reduced from 7.14% to 3.84% by using 8-bus with DPFC system; Current THD is reduced from 6.53% to 1.35% by using 8-bus with DPFC sstem.

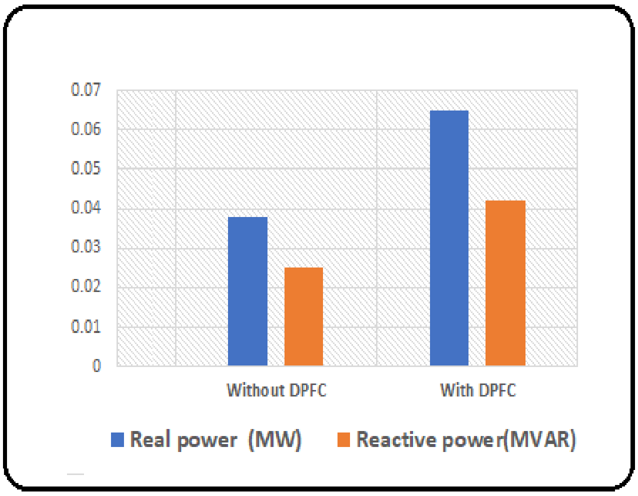

Fig 16 Bar chart comparison of real and reactive power for with and without DPFC system

4. CONCLUSION

Open loop Line diagram of 8-bus system without DPFC system is simulated. Open loop Line diagram of 8-bus system with DPFC system is simulated.Above systems are compared. By using DPFC system, Output voltage is improved from 2000V to 2700V by using 8-bus with DPFC system; Real power is improved from 0.038MW to 0.065MW by using 8-bus with DPFC system; Reactive power is improved from 0.025MVAR to 0.042MVAR by using 8-bus with DPFC system; Voltage THD is reduced from 7.14% to 3.84% by using 8-bus with DPFC system; Current THD is reduced from 6.53% to 1.35% by using 8-bus with DPFC system

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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