ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

A New PQ Coordination Control with Improved UPFC Performance

Rathod Rama Krishna
M.Tech Student
Department of EPS
Anasuyadevi Engineering College.

P.Vidyasagar
Associate Professor
Department of EEE
Anasuyadevi Engineering College.

Abstract:

This paper proposes a new real and reactive power coordination controller for a unified power flow controller(UPFC). The basic control for the UPFC is such that the series converter of the UPFC controls the transmission line real/reactive power flow and the shunt converter of the UPFC controls the UPFC bus voltage/shunt reactive power and the DC link capacitor voltage. In steady state, the real power demand of the series converter is supplied by the shunt converter of the UPFC.

To avoid instability/loss of DC link capacitor voltage during transient conditions, a new real power coordination controller has been designed. The need for reactive power coordination controller for UPFC arises from the fact that excessive bus voltage (the bus to which the shunt converter is connected) excursions occur during reactive power transfers. A new reactive power coordination controller has been designed to limit excessive voltage excursions during reactive power transfers. Simulation results have been presented to show the improvement in the performance of the UPFC control with the proposed real power and reactive power coordination controller.

*Index Terms—**FACTS, unified power flowcontroller (UPFC), coordinationcontroller.***

I. INTRODUCTION

UPFC is the most comprehensive multivariable flexible ac transmission system (FACTS) controller. Simultaneous control of multiple power system variables with UPFC possesenormous difficulties. In addition, the complexity of the UPFCcontrol increases due to the fact that the controlled and thecontrol variables interact with each other.

UPFC which consists of a series and a shunt converter connected by a common dc link capacitor can simultaneouslyperform the function of transmission line real/reactive powerflow control in addition to UPFC bus voltage/shunt reactivepower control [1]. The shunt converter of the UPFC controlsthe UPFC bus voltage/shunt reactive power and the dc linkcapacitor voltage. The series converter of the UPFC controlsthe transmission line real/reactive power flows by injectinga series voltage of adjustable magnitude and phase angle.The interaction transient conditions, the series converter real power demand issupplied by the dc link capacitor. If the information regardingthe series converter real demand is not conveyed to the shuntconverter control system, it could lead to collapse of the dclink capacitor voltage and subsequent removal of UPFC fromoperation. Very little or no attention has been given to theimportant aspect of coordination control between the seriesand the shunt converter control systems [2]–[15]. The realpower coordination discussed in [15] is based on

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

the knownfact that the shunt converter should provide the real powerdemand of the series converter. In this case, the series converterprovides the shunt converter control system an equivalent shuntconverter real power reference that includes the error due tochange in dc link capacitor voltage and the series converterreal power demand. The control system designed for theshunt converter in [15] causes excessive delay in relaying theseries converter real power demand information to the shuntconverter. This could lead to improper coordination of theoverall UPFC control system and subsequent collapse of dclink capacitor voltage under transient conditions.

In this paper,a new real power coordination controller has been developedto avoid instability/excessive loss of dc link capacitor voltageduring transient conditions.

In contrast to real power coordination between the series andshunt converter control system, the control of transmission linereactive power flow leads to excessive voltage excursions of theUPFC bus voltage during reactive power transfers. This is dueto the fact that any change in transmission line reactive powerflow achieved by adjusting the magnitude/phase angle of theseries injected voltage of the UPFC is actually supplied by theshunt converter. The excessive voltage excursions of the UPFCbus voltage is due to absence of reactive power coordination betweenthe series and the shunt converter control system. Thisaspect of UPFC control has also not been investigated [2]–[15].A new reactive power coordination controller between the seriesand the shunt converter control system has been designedto reduce UPFC bus voltage excursions during reactive power transfers.

In this paper, a UPFC control system that includes the realand reactive power coordination controller has been designedand its performance evaluated

II.PROPOSED SYSTEM

Basic Concepts

Submit your The UPFC consists of two series and shunt converters with AC transmission systems. It is a combination of STATCOM and SSSC. These parts are coupled together with common DC link (capacitor) to allow the real power flow between the series and shunt converter output terminals bi-directionally, and to provide real and reactive line compensation without an external energy source. UPFC is able to control the series voltage injection by the means of unconstrained angle. The transmission line with UPFC, which is extended in AC transmission network.

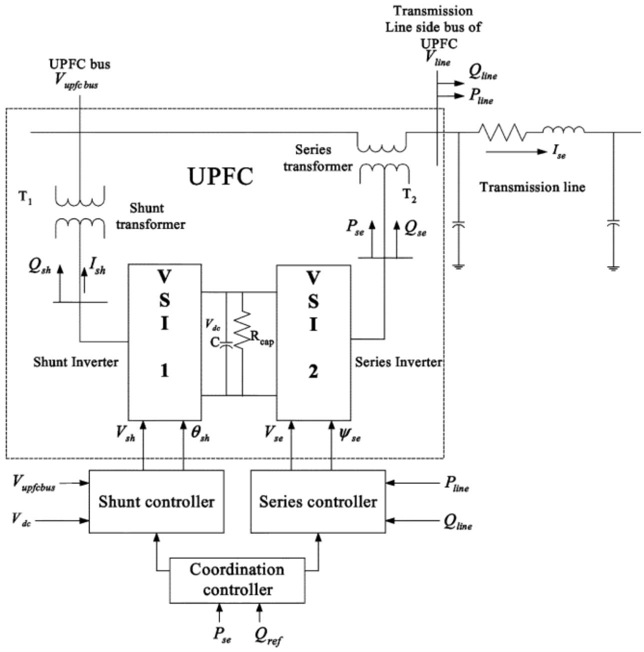

Fig.1. UPFC connected to a transmission line.

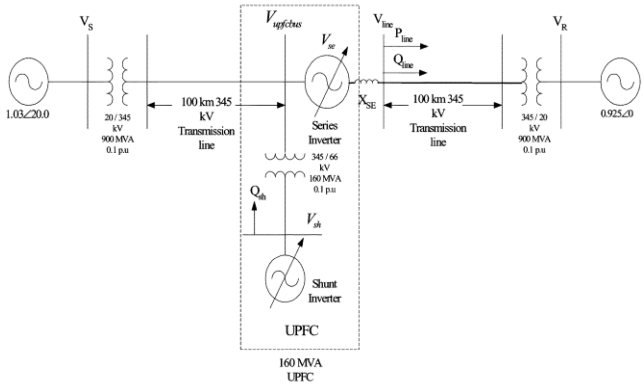

Fig. 2 Power system with UPFC.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

The washout circuit represents the reactive power coordination controller. The gain of the washout circuit has been chosen to be 1.0. This is because, any increase/decrease in the transmission line reactive power flow due to change in its reference is supplied by the shunt converter. The washout time constant is designed based on the response of the power system to step changes in transmission line reactive power flow without the reactive power coordination controller.

III CONTROL STRATEGY

A. Shunt Converter Control Strategy

The shunt converter of the UPFC controls the UPFC bus voltage/shunt reactive power and the dc link capacitor voltage.In this case, the shunt converter voltage is decomposed intotwo components. One component is in-phase and the other inquadrature with the UPFC bus voltage. De-coupled controlsystem has been employed to achieve simultaneous control ofthe UPFC bus voltage and the dc link capacitor voltage.

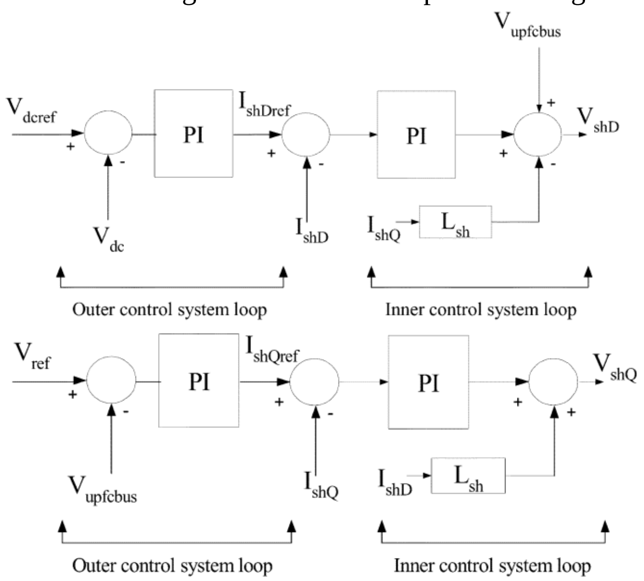

Fig. 3 . De-coupled D-Q axis shunt converter control system.

B. Series Converter Control Strategy

The series converter of the UPFC provides simultaneouscontrol of real and reactive power flow in the transmission line.To do so, the series converter injected voltage is decomposedinto two components. One component of the series injectedvoltage is in quadrature and the other in-phase with the UPFCbus voltage. The quadrature injected component controls thetransmission line real power flow. This strategy is similar tothat of a phase shifter. The in-phase component controls thetransmission line reactive power flow. This strategy is similarto that of a tap changer.

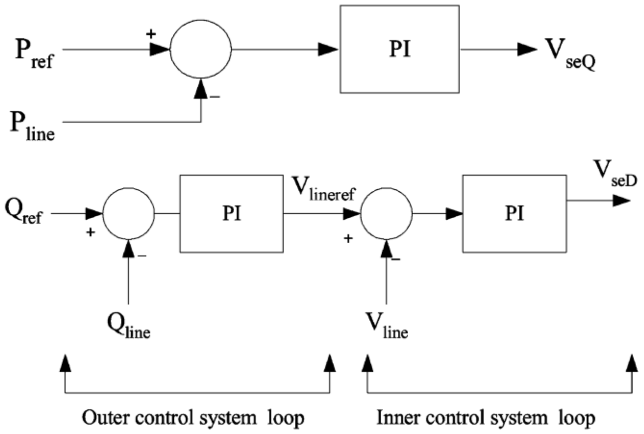

Fig. 4. Series converter real and reactive power flow control system.

IV.SIMULATION RESULTS

RESPONSE OF THE POWER SYSTEM TO STEP CHANGES IN REACTIVE AND REAL POWER FLOW REFERENCE

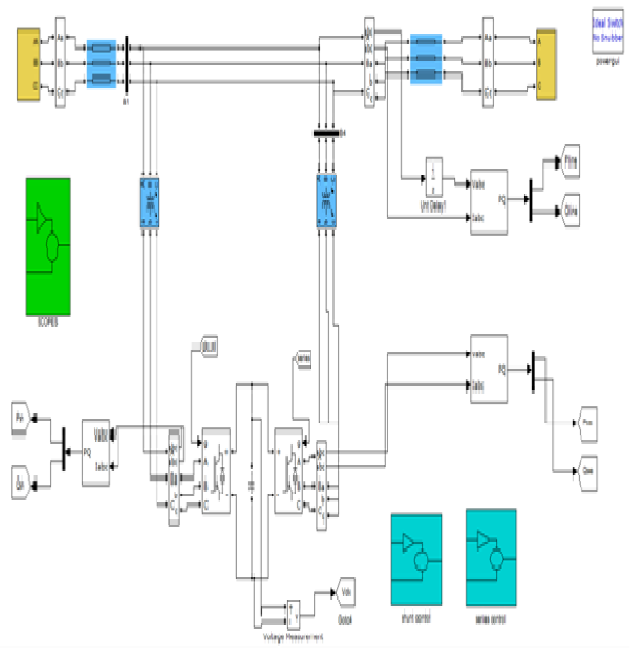

Fig.5 Single line diagram in MATLAB

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

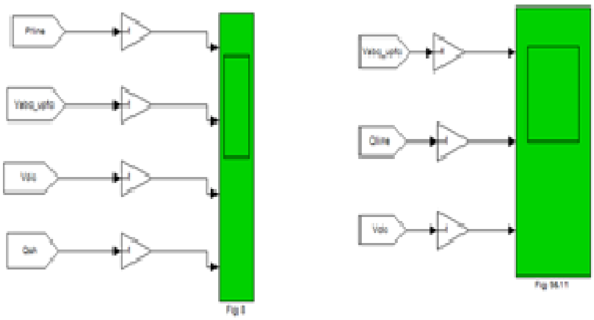

Fig6UPFC scope in MATLAB

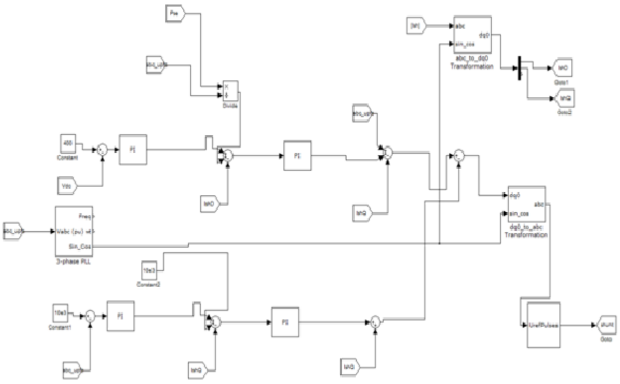

Fig.7 shunt controller in MATLAB

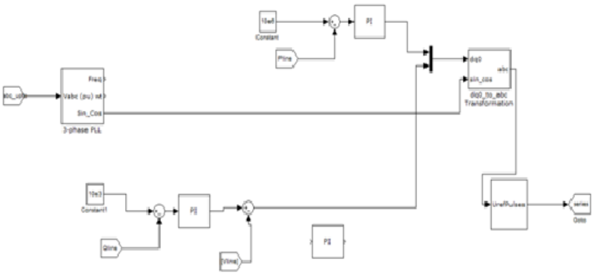

Fig.8 series controller in MATLAB

POWER OSCILLATION DAMPING

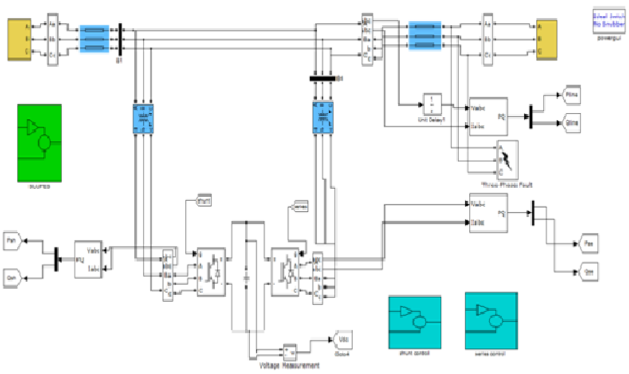

Fig.9single line diagram for fault UPFC in MATLAB

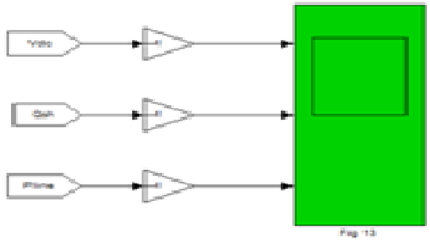

Fig.10 Fault UPFC scope

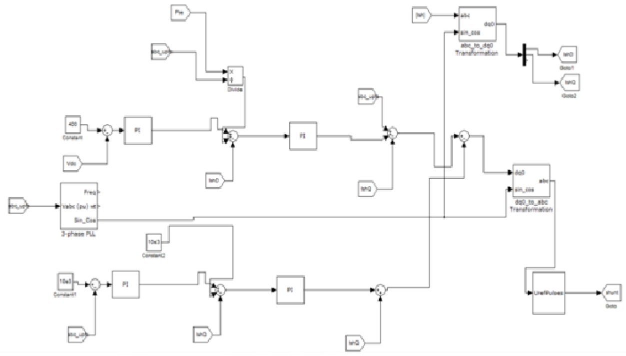

Fig.11 Fault shunt control in MATLAB

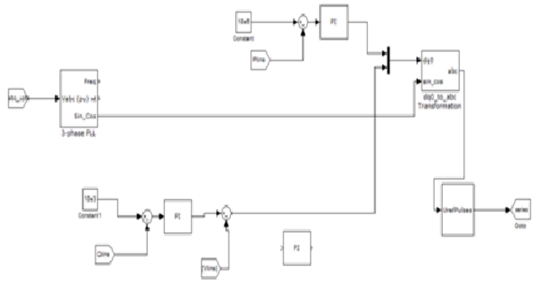

Fig.12 Fault series control in MATLAB

Response Of The Power System To Step Changes In Reactive And Real Power Flow Reference

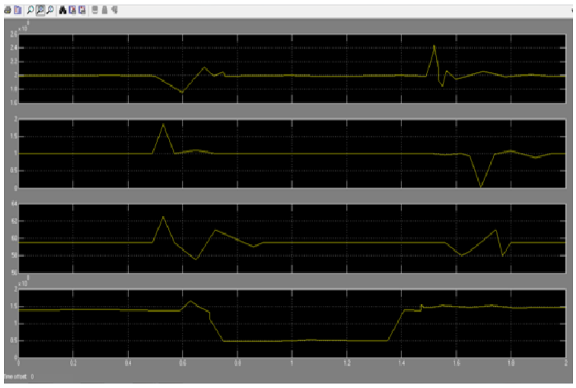

Fig.13 Response to step change in reactive power reference P line (MW), V upfc bus (p.u), V dc(KV),Q line(MVAR)

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

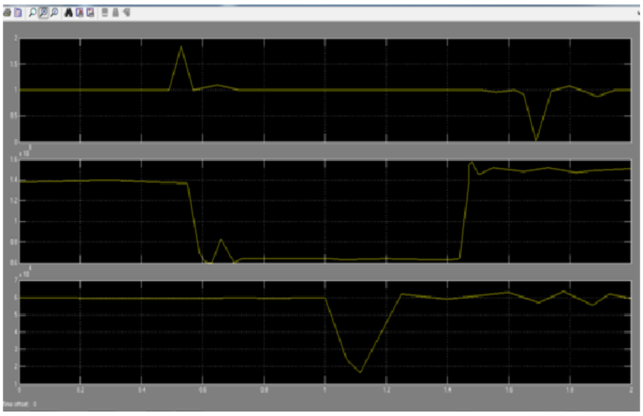

Fig14 Impact of reactive and real power coordination control V upfcbus(p.u), Q line (MVAR),V dc (KV)

POWER OSCILLATION DAMPING

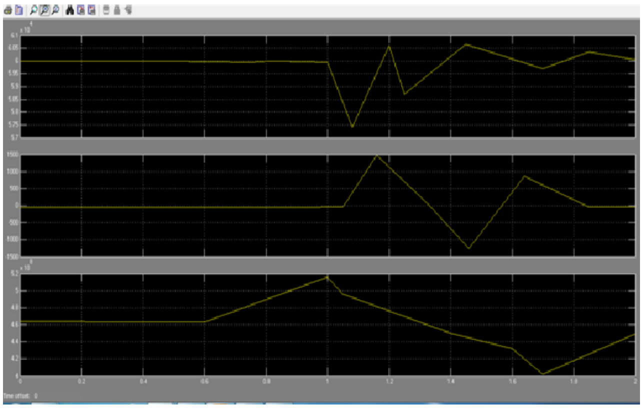

Fig.15 Response of the power system to three phase fault with UPFC V dc (KV), Q sh (MVAR),P line (MW)

V CONCLUSION

In this study, the MATLAB environment using phasor model of UPFC connected to a three phase-three wire transmission system. This paper presents control and performance of UPFC intended for installation on a transmission line. Simulation results show the effectiveness of UPFC in controlling real and reactive power through the line.

REFERENCES

[1] N.G. Hingorani and L. Gyugyi, “Understanding FACTS: concepts and technology of flexible ac transmission systems”, IEEE Press, NY, 1999.

[2] Y.H. Song and A.T. Johns, “Flexible ac transmission systems (FACTS)”, The Institute of Electrical Engineers, London, 1999.

[3] M. Noroozian, L. Angquist, M. Ghandhari, and G. Andersson, “Use of UPFC for optimal power flow control”, IEEE Trans. on Power Delivery, Vol. 12, No. 4, pp. 1629-1634, 1997.

[4] L. Gyugyi, “Dynamic compensation of ac transmission line by solid-state synchronous voltage sources”, IEEE Trans. Power Delivery, Vol. 9, pp. 904-911, Apr.1994.

[5] R. MihaliEet.al, “Improvement of Transient Stability Using Unified Power Flow Controller”, IEEE Transactions on Power Delivery. Vol.11,No1. January 1996.

[6] A. Edris, A.S. Mehraban, L. Gyugyi, S. Arabi, T. Reitman, "Controlling the Flow of Real and Reactive Power ", IEEE Computer Applications in Power, pp. 20-25, January 1998.

[7] L.Gyugyi, C.D. Schauder, S.L. Williams, T.R. Reitman, D. R. Torgerson, A. Edris, "The Unified Power Flow Controller: A New Approach to Power Transmission Control," IEEE Trans. on Power Delivery, Volume 10, No. 2, pp. 1085-1097, April 1995

[8] Ying Xiao; Song, Y.H.; Chen-Ching Liu; Sun, Y.Z.; “Available transfer capability enhancement using FACTS devices”, Power Systems, IEEE Transactions on Volume: 18, Issue: 1, 2003 , Page(s): 305 – 312.

[9] Farhangfar, A.; Sajjadi, S.J.; Afsharnia, S.; “Power flow control and loss minimization with Unified Power Flow Controller (UPFC)”, IEEE Conference on Electrical and Computer Engineering, 2004, Page(s): 385 - 388 Vol.1.

AUTHOR DETAILS

Rathod Rama Krishna
Received B.Tech from ACE Engineering College, Ankushapur(V), Ghatkersar(M), Ranga Reddy(DT), Telangana in 2012. And currently pursuing M.Tech in Electrical Power Systems at Anasuyadevi Institute of Technology & Science, Gudur, Bibinagar(M), Nalgonda(DT), Telangana.

P.Vidya Sagar
Obtained his B.Tech(EEE) degree from Vidya Bharathi Institute of Technology, Jangaon, Warangal(DT),Telangana. M.tech (POWER ELECTRONICS) from Aurora's Engineering College, Bhongir in 2014. He worked as Asst. Prof. in Vidhya Bharathi Institute of Technology, Jangaon and Asst Professor at Sri Indu College of Engineering & Technology, Ibrahimpatnam.He has been working as a Associate Professor in dept. of EEE at Anasuyadevi Institute of Technology & Sciences since 2014.He is having 5 years teaching experience.