Power Quality Improvement using Three Phase Six Switch Converter Topology

Jitendra Kumar Rajak[1] Arvind Jain[2]
[1]PG Scholar [2]Professor
[1,2]Department of Electrical & Electronics Engineering
[1,2]SRIT, Jabalpur, India

Abstract— The increasing use in the industry of nonlinear loads based on the power electronic elements introduced serious perturbation problems in the electrical power grids. Also, increase in the harmonic emissions and current unbalance in addition to high consumption of active and reactive power can be noticed. To overcome these issues, in this paper six switch topology is designed and control by PWM technique. The Six Switch Converter topology model with the proposed control schemes are developed in MATLAB/Simulink software and its performance is examined under various conditions like load voltage and supply current harmonics, supply unbalanced currents, voltage sag/swell. %THDs of voltage and current are also analyzed in this work.

Key words: Six-Switch Converter; PWM; %Total Harmonic Distortion

I. Introduction

The increasing use in the industry of nonlinear loads based on the power electronic elements introduced serious perturbation problems in the electrical power grids. Also, increase in the harmonic emissions and current unbalance in addition to high consumption of active and reactive power can be noticed. Interconnection between grids and transmission lines and power system expansion in transmission and generation for satisfy the increasing power demand, dynamic and transient stability of power systems are an important object in stability of the healthy power systems. In the past Power System Stabilizer (PSS) have been used as an effective, and optimal method to improve power system stability. While Power System Stabilizer may not be able to eliminate oscillations resulting from severe disturbances, such as three phase faults at generator terminals. Flexible AC Transmission System (FACTS) controllers, such as Static VAR Compensators, Unified Power Flow Controller and Static Synchronous Compensators, can be applied for damping oscillations and improve the system constancy of power systems by adding a supplementary signal for main control loops. The Three Phase Bridge Converter is a new concept of the FACTS controller. The TPSS Topology employs voltage source converters with a common dc voltage source; With VSC can provide series compensation for the selected line of the transmission system and is capable of exchanging reactive power with its own transmission system. The consumption of reactive power in industrial and domestic loads presents also an important issue in the discussion of power quality problems. The reactive power consumed by non-resistive loads causes higher RMS current values in addition to extra heating of power transmission and distribution systems. The use of batteries of capacitors or synchronous machines for local reactive power production has been proposed for a long time.

II. Power Systems Distortion & Problems

Electric systems and grids are complex dynamic systems. These systems suffer usually from unexpected or sudden changes of the voltages and currents. These changes are due mainly to the different types of loads and abnormal conditions to which they are connected. Since the development of interconnection of large electric power systems, it has been the spontaneous system variations at very low frequencies in the range of 0.2–3.0 Hz. After starts, it would continue for a long period of time. In certain cases, it continues to develop causing system separation due to the lack of damping of the mechanical modes. In power systems, different voltage and current problems can be faced. The main voltage problems can be summarized in short duration variations, voltage interruption, frequency variation, voltage dips, and harmonics. Harmonics represent the main problem of currents of power systems.

III. Results & Discussion

This chapter represents the simulation results of different power system conditions. The simulation results are shown and Different grid conditions discussed and results will be analyzed. The entire system is simulated using power system toolbox of MATLAB/Simulink. A three phase loads are introduced. Figure 1shows the simulation diagram of proposed system.

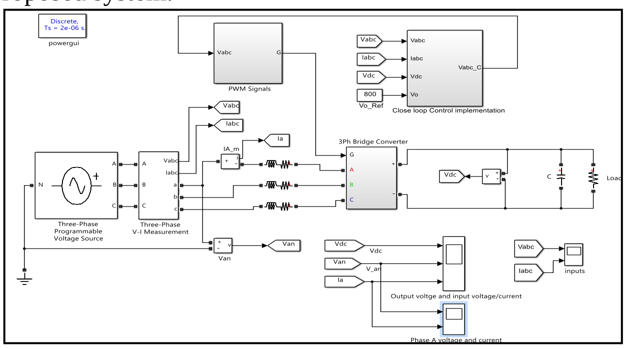

Fig. 1: Proposed Simulation Model

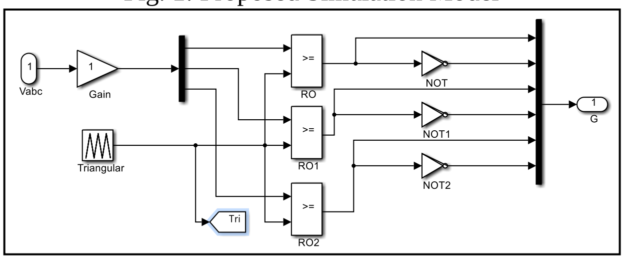

Fig. 2: Pulse Width Modulation

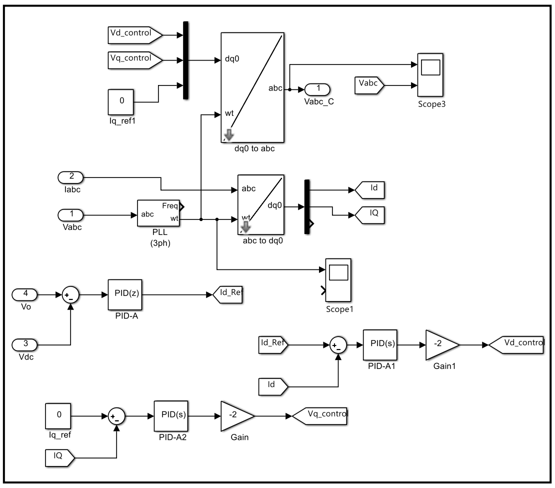

Fig. 3: Controller Design

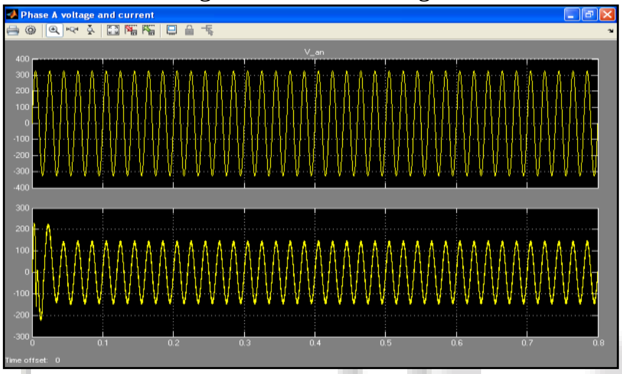

Fig. 4: Output Waveform of Phase A Current & Voltage

Figure 2 and 3 shows the control scheme and PWM technique for proposed system. In this paper feedback voltage is used to generation of control signal.

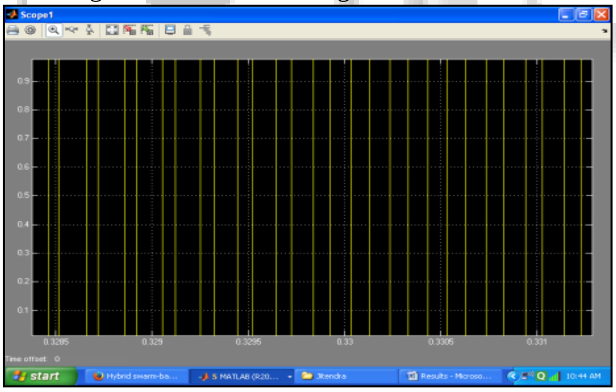

Fig. 5: Gate Pulse

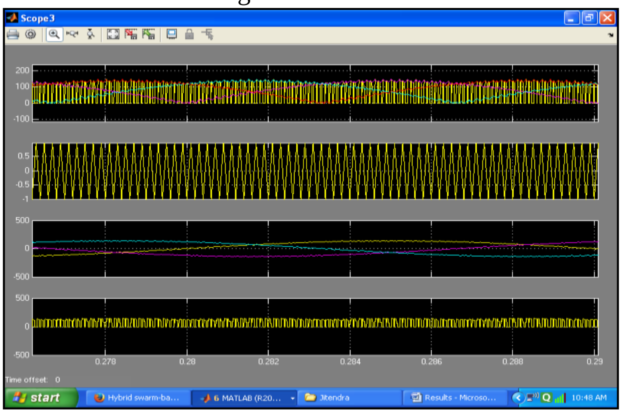

Fig. 6: Control Signals

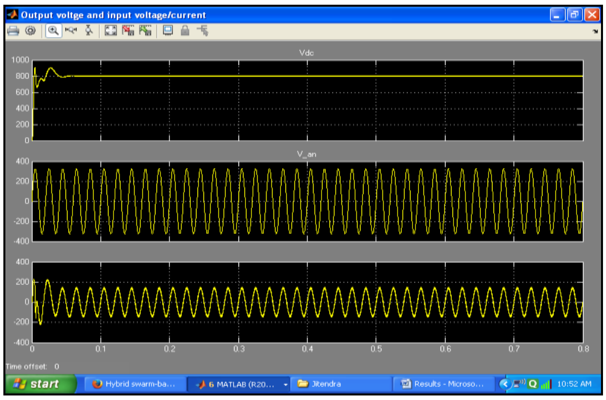

Fig 7Output Voltage and Current DC Input

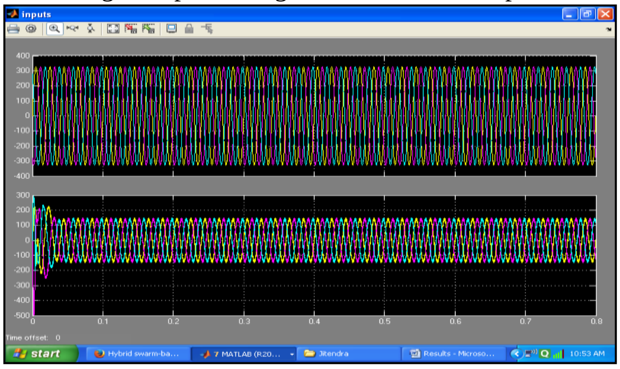

Fig 8/ Three Phase Voltage and Current

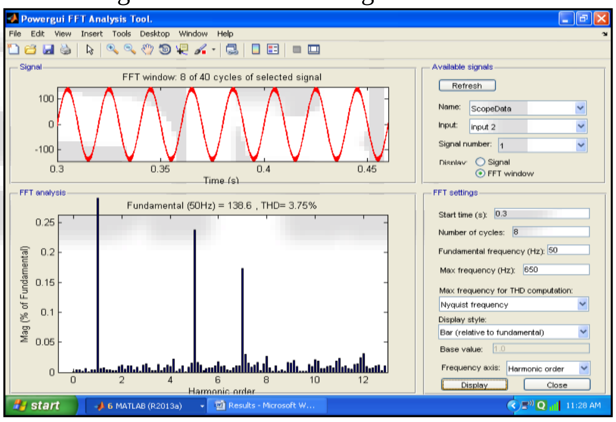

Fig. 9: Current Harmonics

The figure 8 and 9 shows the output voltage waveform of the system and current. And the current harmonics received at permissible limit the %THD is around 2 % of the nonlinear system.

IV. CONCLUSION

The Six Switch Converter Controller is simulated for the compensation and power flow management. In the paper PWM Scheme is used to control the output waveform. Inverter can provide a series reactive compensation, as an SSSC, for its own line. However, the converters can transfer real power between them through their common DC terminal. This capability allows the Controller to provide both real and reactive Compensation for some of the lines and thereby optimize the utilization of the overall transmission system. The dispatch results show that the Controller can improve the power transfer in the system. The power circulation between the VSCs can be used to adjust bus voltages to improve the voltage stability limit transfer. The simulation results are in line with the predictions. Controller system is developed using MATLAB. These models are used for simulating a two bus system. The simulation results using MATLAB are presented. The Bridge Converter increases the real power transfer and improves the voltage profile and maintains TDH at permissible limit

REFERENCES

[1] Srinivas Bhaskar Karanki, Nagesh Geddada, Mahesh K. Mishra, B. Kalyan Kumar, "A Modified Three-phase Four Wire UPQC Topology with Reduced DC-link Voltage Rating," IEEE Trans. Ind. Electronics,vol. 60, no. 9, pp. 3555-3566, Jan 2013.
[2] Bharath Babu Ambati and Vinod Khadkikar, "Optimal Sizing of UPQC Considering VA Loading and Maximum Utilization of Power-Electronic Converters," IEEE Trans. Power. Del., vol.29, no. 3, pp. 1490-1498, June 2014.
[3] Rodrigo Augusto Modesto et. al., "Versatile Unified Power Quality Conditioner Applied to Three-Phase Four-Wire Distribution Systems Using a Dual Control Strategy," vol. 31, no. 8, pp. 5503-5514, 2016.
[4] Venkata Reddy Kota and Sudheer Vinnakoti, "SRF-Based Control of Unified Power Quality Conditioner for Power Quality Enhancement," IEEE Conf., Electrical, Electronics, Signals, Communication and Optimization (EESCO), pp. 1-6, June 2015.
[5] Shanhu Li, Changliang Xia, Yan Yan and Tingna Shi, "Space Vector Over-Modulation Strategy for Ultra Sparse Matrix Converter Based on the Maximum Output Voltage Vector," IEEE Trans on Power Electronics, Vol. PP, No. 99, pp.1-10, Aug 2016.
[6] J.W. Kolar, F. Schafmeister, S. D. Round, and H. Ertl, "Novel threephase AC–AC sparse matrix converters," IEEE Trans. Power Electron., vol. 22, no. 5, pp. 1649–1661, Sep. 2007.
[7] René Vargas, Ulrich Ammann, and José Rodríguez, "Predictive Approach to Increase Efficiency and Reduce Switching Losses on Matrix Converters,"IEEE Trans. Power Electron., vol. 24, no. 4, pp. 894–902, Apr. 2009.
[8] J.W. Zhang, D. G. Dorrell and L. Li, "Applications of the direct space vector modulation controlled matrix converter as the unified power flow controller,"8th IET International Conference on Power Electronics, Machines and Drives (PEMD 2016), 10 Nov 2016.
[9] Hui Wang, Mei Su, et. al., "Active third-harmonic injection indirect matrix converter with dual three-phase outputs," IET Power Electronics, Vol. 9, No. 4, pp.657-668, March 2016.
[10] M. Jones, S. N. Vukosavic, D. Dujic, E. Levi, and P. Wright, "Five-leg inverter PWM technique for reduced switch count two-motor constant power applications," IET Electr. Power Appl., vol. 2, no. 5, pp. 275–287, Sep. 2008.
[11] F. Blaabjerg, S. Freysson, H. H. Hansen, and S. Hansen, "A new optimized space-vector modulation strategy for a component-minimized voltage source inverter," IEEE Trans. Power Electron., vol. 12, no. 4, pp. 704–714, Jul. 1997.
[12] E. Ledezma, B. McGrath, A. Munoz, and T. A. Lipo, "Dual ac-drive system with a reduced switch count," IEEE Trans. Ind. Appl., vol. 37, no. 5, pp. 1325–1333, Sep./Oct. 2001.
[13] Feng Gao, Lei Zhang, Ding Li, Poh Chiang Loh, Yi Tang, and Houlei Gao, "Optimal Pulse width Modulation of Nine-Switch Converter," IEEE Trans. Power Electron., vol. 25, no. 9, pp. 2331-2343, Sep. 2008.
[14] Lei Zhang, Poh Chiang Loh and Feng Gao,"An Integrated Nine-Switch Power Conditioner for Power Quality Enhancement and Voltage Sag Mitigation," IEEE Trans. Power Electron.,, vol. 27, no. 3, pp. 1177-1190, March 2012.