

Figure 3: MATLAB/SIMULINK diagram of proposed concept.

The waveforms are almost close to a sine wave. It can be seen that the load voltage remains constant irrespective of the load changes as shown in figure4 (A) & (B), but the load current changes with respect to the load. The rms voltage remains constant at 250V for the entire simulation time as seen from the Fig. 5. The DC link bus voltage, $V_{dc}=VC1+VC2$ is around 340 V. The FFT analysis of the load voltage for THD as shown in Figure 7. The total harmonic distortion is around 2.37% in steady state which is less than 5% as per the IEEE standards.

A single phase induction motor (capacitor run) type connected with variation of load torque, which gives transient and study state condition. with a step size of 0.2 sec and the system performance is tested for both R and RL Loads. A resistive load of 2.5 kW is connected in the time range of 0 to 0.2 sec. A RL load of 4.5 kVA is connected in the time range of 0.2 to 0.4 sec and a RL Load of 3.6 kVA is connected in the time range of 0.4 to 0.6 sec. The response of the system is analyzed in both steady state and transient conditions. It is observed that the developed PI controller gives better response and takes 3 to 5 cycles to reach a new steady state value during load changes from 50% to 90%.

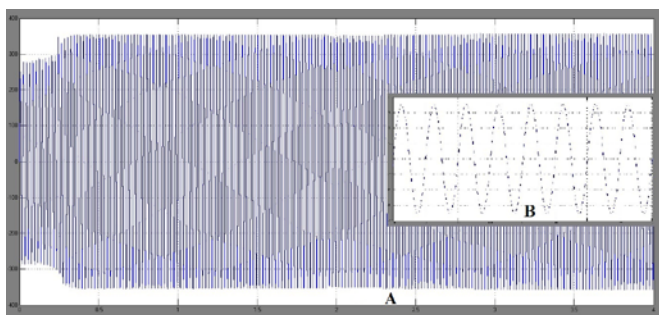


Figure 4: Load voltage A) During variation of motor torque B) X-axis zoom view of load voltage.

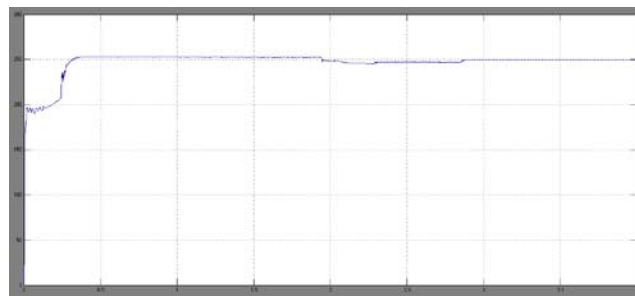


Figure 5: Inverter output voltage waveform during the load variation.

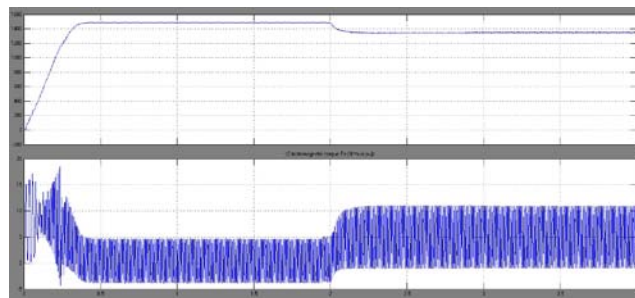


Figure 6: Speed and Electromagnetic Torque waveforms for variation of load motor.

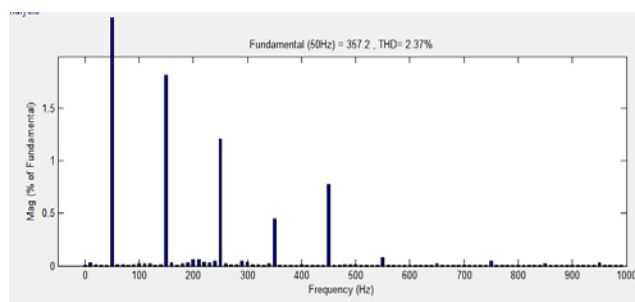


Figure 7: THD (%) of Load voltage.

6. Conclusion

A comprehensive state of the art of STATCOM for power quality improvement in the three-phase power system has been presented to explore the multilevel inverter topologies and control technique. The detailed classification, state of the art and comparison have been given for easy selection of a STATCOM for high power quality applications. The performances of topologies of STATCOMs selected from each category have been demonstrated to validate the designed STATCOM system. The compensation of reactive power for voltage regulation, harmonics elimination, load balancing, and THD (%) has been demonstrated for three-phase STATCOM. Finally, from the results Incremental - reduction cascade H-bridge topology best for STATCOM applications for low 3rd harmonic and low THD not only those, it also perform better as remaining topologies.

References

- [1] L. Gyugyi, E. C. Strycula, "Active AC Power Filters"- in Proc. IEEE/IAS Annu. Meeting, Vol.19-c, pp 529-535, 1976
- [2] Hirofumi Akagi, Yoshihira Kanazawa, Akira Nabae "Instantaneous Reactive Power Compensators

- Comprising Switching Device s without Energy Storage Components"- IEEE Trans on Industry Appl, Vol.II-20, No.3, pp.625-630, 1984
- [3] E. H. Watanabe, R. M. Stephan, M. Aredes, "New Concepts of Instantaneous Active and Reactive Powers in Electrical Systems with Generic Loads"- IEEE Trans. Power Delivery, Vol.8, No.2, pp.697-703, 1993.
- [4] Bhim Singh, Kamal Al-Haddad & Ambrish Chandra, "A New Control Approach to 3-phase Active Filter for Harmonics and Reactive Power Compensation"-IEEE Trans. on Power Systems, Vol. 46, NO. 5, pp.133 – 138, Oct-1999
- [5] W. K. Chang, W. M. Grady, Austin, M. J. Samotyj "Meeting IEEE- 519 Harmonic Voltage and Voltage Distortion Constraints with an Active Power Line Conditioner"- IEEE Trans on Power Delivery, Vol.9, No.3, pp.1531-1537, 1994
- [6] Hirofumi Akagi, "Trends in Active Power Line Conditioners"- IEEE Trans on Power Electronics, Vol.9, No.3, May-1994
- [7] W.M.Grady, M.J.Samotyj, A.H.Noyola "Survey of Active Power Line Conditioning Methodologies" IEEE.Trans on Power Delivery, Vol.5, No.3, pp.1536-1542, July-1990
- [8] Leszek S. Czarnecki "Instantaneous Reactive Power p-q Theory and Power Properties of Three-Phase Systems"- IEEE Trans on Power, VOL. 21, NO. 1, pp 362-367, 2006
- [9] Karuppanan P and Kamala Kanta Mahapatra "Shunt Active Power Line Conditioners for Compensating Harmonics and Reactive Power"-Proceedings of the International Conference on Environment and Electrical Engineering (EEEIC), pp.277 – 280, May 2010
- [10] Fang Zheng Peng & Jih-Sheng Lai, "Generalized Instantaneous Reactive Power Theory for Three-Phase Power Systems", IEEE Trans. on Inst. and Meast, Vol.45, No.1, pp.293-297, 1996
- [11] Joao Afonso, Carlos Couto, Julio Martins "Active Filters with Control Based on the p-q Theory"- IEEE Industrial Elects Society Nletter-2000
- [12] E. H. Watanabe, H. Akagi, M. Aredes "Instantaneous p-q Power Theory for Compensating Non sinusoidal Systems"- International School on Non sinlusoideal Currents and Compensation Lagow, Poland-2008.