

6. Simulation Results

The generator design functionality is confirmed using a wind power generator framework simulation model with an excitation synchronous generator and its corresponding sub-systems, using MATLAB/Simulink and MATLAB/Simpower software. Sub-systems include the wind power input, servo motor phase tracking control, maximum power tracking control, excitation synchronous generator, and grid connection. respectively. To output the three-phase voltage signals at 60 Hz, the excitation synchronous generator must operate at 1800 rpm with 4-pole windings.

The voltage phase tracking performance of the system at generator output 2 kW is investigated. Fig. 10(a) shows the phase voltage and current waveforms of the excitation synchronous generator. Fig. 10(b) shows the grid and generator voltage phase tracking waveforms. The simulation voltage and current waveforms in Fig. confirm that the proposed system has high-quality power and sufficient control stability during grid connection. The generator output phase voltage is in phase with the grid in Fig. Owing to the excitation synchronous generator rotation speed control and excitation control, the output power, voltage, and frequency are constant. The wind power generator system can thus connect directly to the grid

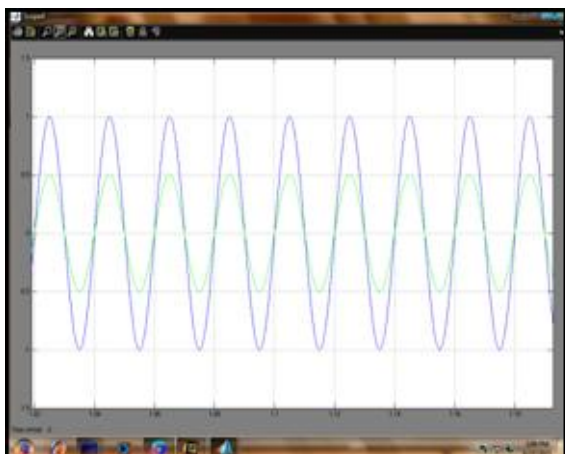


Figure : Vsg And Isg Of Phase A

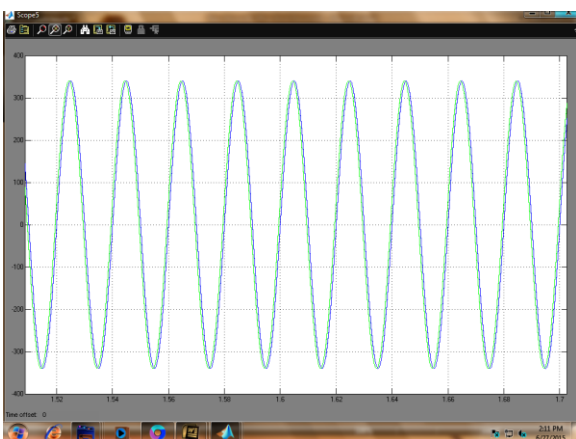


Figure : Grid Voltage And Inverter Voltage

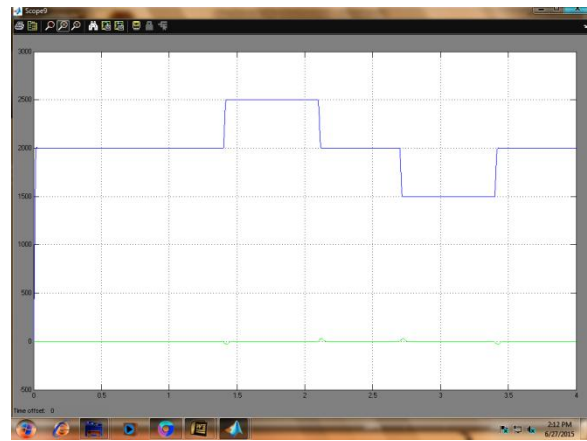


Figure : wind Power and torque of generator

7. Conclusion

This paper presented an excitation synchronous wind power generator with MPTC scheme. In the proposed framework, the servo motor provides controllable power to regulate the rotor speed and voltage phase under wind disturbance. Using a phase tracking control strategy, the proposed system can achieve smaller voltage phase deviations in the excitation synchronous generator. In addition, the maximum output power tracking scheme governs the input and output powers to achieve high performance. The excitation synchronous generator and control function models were designed from the physical perspective to examine the presented functions in the proposed framework. Experimental results demonstrate that the proposed wind power generator system achieves high performance power generation with salient power quality.

References

- [1] M. Liserre, R. Cárdenas, M. Molinas, and J. Rodriguez, "Overview of Multi-MW wind turbines and wind parks," *IEEE Trans. Ind. Electron.*, vol. 58, no. 4, pp. 1081–1095, Apr. 2011.
- [2] V. Delli Colli, F. Marignetti, and C. Attaianesi, "Analytical and multiphysics approach to the optimal design of a 10-MW DFIG for direct-drive wind turbines," *IEEE Trans. Ind. Electron.*, vol. 59, no. 7, pp. 2791–2799, Jul. 2012.
- [3] B. Singh and S. Sharma, "Design and implementation of four-leg voltage-source-converter-based VFC for autonomous wind energy conversion system," *IEEE Trans. Ind. Electron.*, vol. 59, no. 12, pp. 4694–4703, Dec. 2012.
- [4] A. Di Gerlando, G. Foglia, M. F. Iacchetti, and R. Perini, "Axial flux pm machines with concentrated armature windings: Design analysis and test validation of wind energy generators," *IEEE Trans. Ind. Electron.*, vol. 58, no. 9, pp. 3795–3805, Sep. 2011.
- [5] S. Zhang, K.-J. Tseng, D. M. Vilathgamuwa, T. D. Nguyen, and X.-Y. Wang, "Design of a robust grid interface system for PMSG-based wind turbine generators," *IEEE Trans. Ind. Electron.*, vol. 58, no. 1, pp. 316–328, Jan. 2011.
- [6] F. Bu, W. Huang, Y. Hu, and K. Shi, "An excitation-capacitor-optimized dual stator-winding induction generator with the static excitation controller for wind

- power application,” IEEE Trans. Energy Convers., vol. 26, no. 1, pp. 122–131, Mar. 2011.
- [7] S. Le-peng, T. De-dong, W. De-biao, and L. Hui “Simulation for strategy of maximal wind energy capture of doubly fed induction generators,” in Proc. IEEE Int. Conf. Cognit. Informat., Jul. 2010, pp. 869–873.
- [8] W. Qi, C. Xiao-hu, F. Wan-min, and J. Yan-chao, “Study of brushless doubly-fed control for VSCF wind power generation system connected to grid,” in Proc. Int. Conf. Electr. Utility Deregulation Restruct. Power Technol., Apr. 2008, pp. 2453–2458.
- [9] A. Mesemanolis, C. Mademlis, and I. Kioskeridis, “Maximum efficiency of a wind energy conversion system with a PM synchronous generator,” in Proc. IEEE Int. Conf. Exhib. Power Gener. Transm. Distrib. Energy Convers., Ayia Napa, Cyprus, Nov. 2010, pp. 1–9.
- [10] H. Geng, D. Xu, B. Wu, and G. Yang, “Active damping for PMSG-based WECS with DC-link current estimation,” IEEE Trans. Ind. Electron., vol. 58, no. 4, pp. 1110–1119, Apr. 2011.
- [11] W.-M. Lin and C.-M. Hong, “A new Elman neural network-based control algorithm for adjustable-pitch variable-speed wind-energy conversion systems,” IEEE Trans. Power Electron., vol. 26, no. 2, pp. 473–481, Feb. 2011.
- [12] C. Xia, Q. Geng, X. Gu, T. Shi, and Z. Song, “Input–output feedback linearization, and speed control of a surface permanent-magnet synchronous wind generator with the boost-chopper converter,” IEEE Trans. Ind. Electron., vol. 59, no. 9, pp. 3489–3500, Sep. 2012.
- [13] J. H. Zhao, F. Wen, Z. Y. Dong, Y. Xue, and K. P. Wong, “Optimal dispatch of electric vehicles, and wind power using enhanced particle swarm optimization,” IEEE Trans. Ind. Inf., vol. 8, no. 4, pp. 889–899, Nov. 2012.
- [14] S. Alepuz, A. Calle, S. Busquets-Monge, S. Kouro, and B. Wu, “Use of stored energy in PMSG rotor inertia for low-voltage ride-through in back-to-back npc converter-based wind power systems,” IEEE Trans. Ind. Electron., vol. 60, no. 5, pp. 1787–1796, Sep. 2013.
- [15] C. Xia, Q. Geng, X. Gu, T. Shi, and Z. Song, “Input–output feedback linearization, and speed control of a surface permanent-magnet synchronous wind generator with the Boost-Chopper converter,” IEEE Trans. Ind. Electron., vol. 59, no. 9, pp. 3489–3500, Sep. 2012.