

A Novel d-q control of DDPMSG in WECS for enhanced performance characteristics.

¹R.SATHYAPRIYA, ²K.SAKTHIVEL

^{1,2}Assistant professor, Dept. of EEE,
BIST, BIHER, Bharath university, Chennai-73
r.sathyapriya2013@bharathuniv.ac.in

Abstract- PMSG driven by wind turbine to be one of the best alternatives for electric power generation which speaks for the best future energy generation. Various control strategies have been developed for obtaining the best performance characteristics. But simultaneous obtaining of there is impossible. In this paper, a novel d-q control technique is proposed on PMSG along with grid side converter, by which the performance characteristics namely the real power and reactive power are made to be enhanced. Control is implemented on the d-q voltages of the stator voltage of the PMSG. Measure will be taken to have enhanced performance characteristic .Mat Lab / simulink is used for the simulation of the so specified PMSG control techniques. A simple wind turbine system driving a PMSG without any control and with the proposed d-q control is simulated and the simulated results are shown. It has been proved that the proposed d-q control enhances the performance of the DDPMSG.

Keywords— DDPMSG, WECS, d-q control, PWM power converter, abc-dq transformations

I. INTRODUCTION

Nowadays wind power is most rapidly growing renewable Energy source. Wind turbines can either operate at fixed speed or variable speed. For a fixed-speed wind turbine, the generator, normally a conventional fixed-speed induction machine is directly connected to the grid. For a variable speed Wind turbine[1-6], the generator is controlled by power electronic equipment.

Moreover, due to the permanent magnet excitation of the generator, the DC excitation system can be eliminated, reducing again weight, losses, costs and maintenance requirements [7-9]. The efficiency of a PMSG wind turbine was thus assessed to be higher than other variable-speed wind turbine concepts[10-16].

But, the performance of a PMSG depends not only on the synchronous generator but also on how it is controlled. In order to understand PMSG power generation characteristics, various techniques have been developed to investigate the behavior of a PMSG under different d-q control conditions. This can be divided into two categories: 1) transient approaches [4-10,] and 2) steady-state techniques. Transient simulation approaches are essential to study PMSG dynamic performance in a short time period[17-25].

For wind power generation[26-34], the speed of a PMSG changes as wind turbine drive power varies, and the PMSG stator terminal voltage depends on the d-q control applied to the machine side converter, making it improper to investigate PMSG characteristics using traditional approaches. On another

aspect, although the d-q control regulates PMSG speed, it also changes all other parametric data of a PMSG system simultaneously, such as torque, stator real/reactive power, and the depth of PWM converter modulation, requiring an investigation for all the relevant aspects.

II. d-q control of DDPMSG

In modern PMSG wind turbine designs, the frequency converter is built by two self commutated PWM converters, machine- and grid-side converters, with an intermediate DC voltage link. The DC-link created by the capacitor in the middle decouples the operation of the two converters, thus allowing their design and operation to be optimized. The two back-to-back converters are controlled independently through the decoupled d-q vector control approach for modern PMSG wind turbine designs. For both converters, the direct axis current component is normally used for one control goal and the quadrature axis current component utilized for another control goal [5]. Consider fig.1 shows control of PMSG wind turbine.

The power electronic converter controller in a PMSG is divided into two parts: the machine side converter controller and the grid-side converter controller.

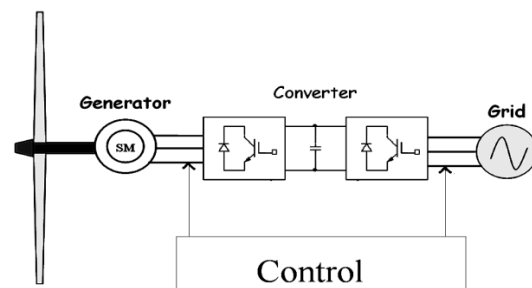


Fig: 1 Control of PMSG wind turbine

The fixed-speed wind-turbine direct driven with permanent magnet synchronous generator converts with rectifier. Here getting output waveform for the machine side controller and the input waveform for the grid side controller. To measure the voltage from the DC link capacitor to maintain the desired value. The d-q control of the power electronic converter is applied depends upon for this enhanced performance characteristics[35-41].

When aligning the direct axis along the grid voltage position, the d-axis current represents the active component and the q-axis current the reactive component[42-45]. The d and q

i_c , for control of the machine-side PWM converter. The injected current is linearly proportional to the three-phase

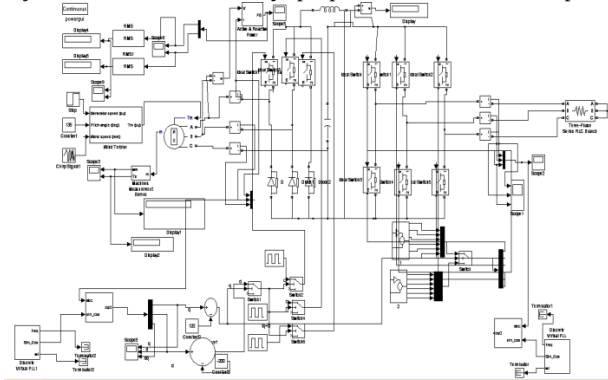


Fig: 4 I_{ds} control of wind turbines DDPMSG

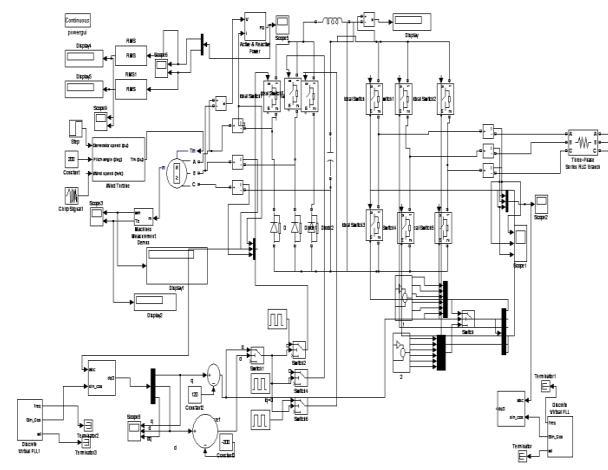


Fig: 5 I_{qs} control of wind turbines DDPMSG

sinusoidal control current signals in normal converter linear modulation mode. Therefore, in d-q reference frame, the direct axis component of the injected rotor current is proportional to the d reference current I_{ds} , and the quadrature axis component is proportional to the q reference current I_{qs} . Fig. 4 represents the simulink circuit for I_{ds} control proposed to wind turbine DDPMSG. Fig. 5 represents the simulink circuit for I_{qs} control proposed to wind turbine DDPMSG.

The proposed I_{ds} and I_{qs} control method is used to enhance the power of the system.

V WAVEFORMS AND OBSERVATION

Simulation is an effective way to investigate the operations and controls of a PMSG for wind power generation.

Figs 6 represent the waveform of torque and speed characteristics of DDPMSG without control and with control, respectively.

In this the value of torque is negative because it is generator side. In spite of d-q control given to the wind turbine system, the torque –speed characteristics remain unaltered.

Fig 7 and 8 represents variable speed characteristics with I_{ds} and I_{qs} proposed control. Different speed is given to wind turbine, in this value torque is negative because it is PMSG.

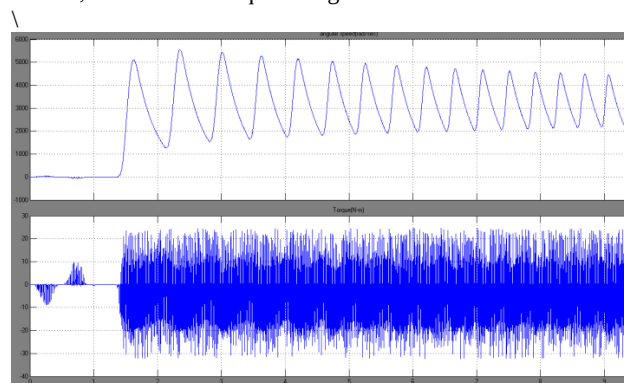


Fig: 6 Torque and Speed Characteristics of DDPMSG without Control

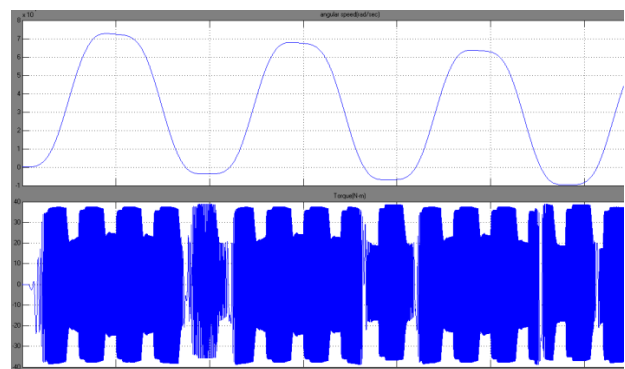
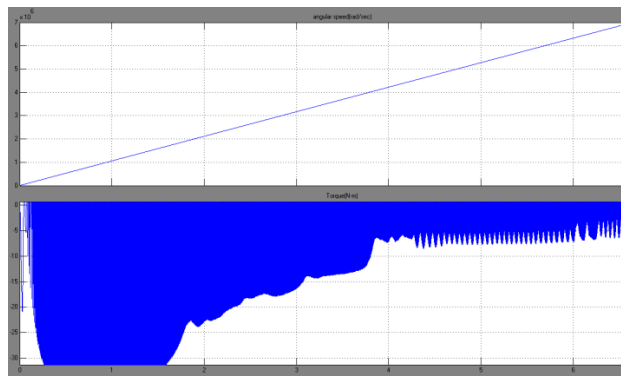


Fig: 7 Torque and Speed Characteristics for I_{ds} Control

Fig: 8 Torque and Speed Characteristics for I_{qs} Control

After proposed I_{ds} and I_{qs} control the value of the torque and speed characteristics are enhanced very well.

The power generation of a PMSG includes real and reactive powers delivered to the machine-side converter through the generator stator path. However, for a PMSG, the operating speed is affected by the wind speed, and the generator terminal current depends on the d-q control applied to the machine-side converter, making PMSG real or reactive power characteristics different from a traditional Variable-speed synchronous generator.

Similarly fig 9 represents real and reactive power characteristics without proposed control.

Fig 10 and 11 represents real and reactive power characteristics of the proposed I_{ds} and I_{qs} control. From the wave form it can be observed that the reactive and real power is enhanced by using d-q control

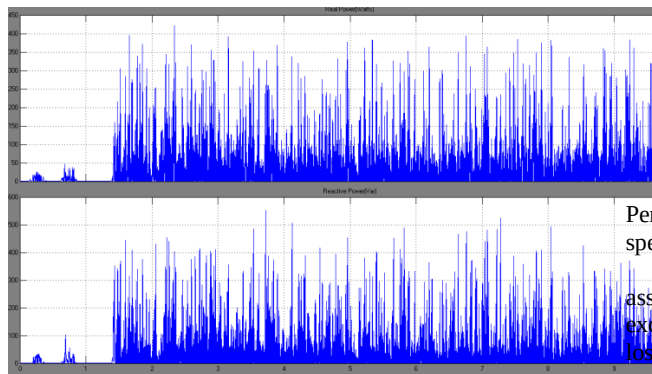
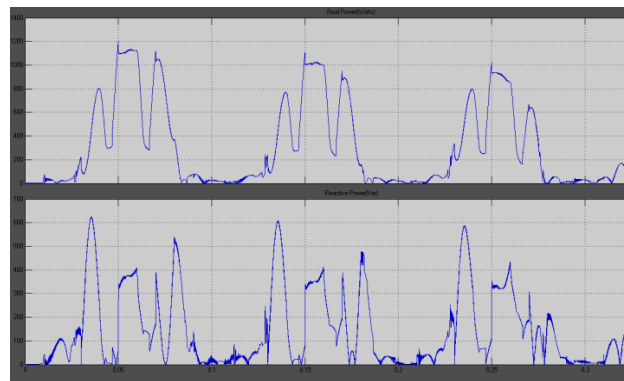
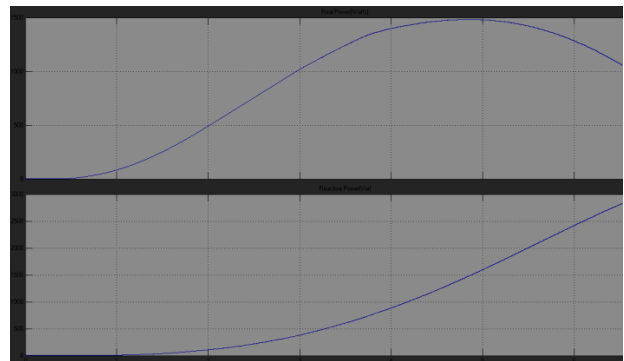


Fig: 9 Real Power and Reactive Power Characteristics without Control

Fig: 10 Real Power and Reactive Power Characteristics for I_{ds} ControlFig: 11 Real Power and Reactive Power Characteristics for I_{qs} Control

VI CONCLUSIONS

This paper shows the performance of a direct-driven Permanent-magnet synchronous generator used in variable speed wind-energy conversion systems with I_{ds} - I_{qs} control.

The efficiency of a PMSG wind turbine was thus assessed to be higher than variable-speed wind turbine. The DC excitation system can be eliminated, reducing again weight, losses, costs and maintenance requirements less. The various control strategies have been developed for obtaining these best performance characteristics. Enhanced performance characteristics of the variable speed in the wind turbine were measured successfully. It has been observed that d-q control provides a great enhancement of power and the torque speed characteristics remain unaltered. The model was simulated using Matlab/Simulink and the results are shown and compared. The simulation model built up in the paper provides

corresponding technique support and analysis method for further research on direct-drive permanent magnet synchronous wind generation system.

REFERENCES

1. Nimal, R.J.G.R., Hussain, J.H., Effect of deep cryogenic treatment on EN24 steel, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-113-116, 2017
2. Parameswari, D., Khanaa, V., Deploying lamport clocks and linked lists, International Journal of Pharmacy and Technology, V-8, I-3, PP-17039-17044, 2016
3. Parameswari, D., Khanaa, V., Case for massive multiplayer online role-playing games, International Journal of Pharmacy and Technology, V-8, I-3, PP-17404-17409, 2016
4. Parameswari, D., Khanaa, V., Deconstructing model checking with hueddot, International Journal of Pharmacy and Technology, V-8, I-3, PP-17370-17375, 2016
5. Parameswari, D., Khanaa, V., The effect of self-learning epistemologies on theory, International Journal of Pharmacy and Technology, V-8, I-3, PP-17314-17320, 2016
6. Pavithra, J., Peter, M., Gowtham Aashirwad, K., A study on business process in IT and systems through extranet, International Journal of Pure and Applied Mathematics, V-116, I-19 Special Issue, PP-571-576, 2017
7. Pavithra, J., Ramamoorthy, R., Satyapira Das, S., A report on evaluating the effectiveness of working capital management in googolsoft technologies, Chennai, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-129-132, 2017
8. Pavithra, J., Thooyamani, K.P., A cram on consumer behaviour on Mahindra two wheelers in Chennai, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-55-57, 2017
9. Pavithra, J., Thooyamani, K.P., Dkhar, K., A study on the air freight customer satisfaction, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-179-184, 2017
10. Pavithra, J., Thooyamani, K.P., Dkhar, K., A study on the working capital management of TVS credit services limited, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-185-187, 2017
11. Pavithra, J., Thooyamani, K.P., Dkhar, K., A study on the analysis of financial performance with reference to Jeppiaar Cements Pvt Ltd, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-189-194, 2017
12. Peter, M., Dayakar, P., Gupta, C., A study on employee motivation at Banalari World Cars Pvt Ltd Shillong, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-291-294, 2017
13. Peter, M., Kausalya, R., A study on capital budgeting with reference to signware technologies, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-71-74, 2017
14. Peter, M., Kausalya, R., Akash, R., A study on career development with reference to prem heera surgicals, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-415-420, 2017
15. Peter, M., Kausalya, R., Mohanta, S., A study on awareness about the cost reduction and elimination of waste among employees in life line multispeciality hospital, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-287-293, 2017
16. Peter, M., Srinivasan, V., Vigneshsa, A., A study on working capital management at deccan Finance Pvt Limited Chennai, International Journal of Pure and Applied

- Mathematics, V-116, I-14 Special Issue, PP-255-260, 2017
17. Peter, M., Thooyamani, K.P., Srinivasan, V., A study on performance of the commodity market based on technical analysis, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-99-103, 2017
 18. Philomina, S., Karthik, B., Wi-Fi energy meter implementation using embedded linux in ARM 9, Middle - East Journal of Scientific Research, V-20, I-12, PP-2434-2438, 2014
 19. Philomina, S., Subbulakshmi, K., Efficient wireless message transfer system, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-289-293, 2017
 20. Philomina, S., Subbulakshmi, K., Ignition system for vehicles on the basis of GSM, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-283-286, 2017
 21. Philomina, S., Subbulakshmi, K., Avoidance of fire accident by wireless sensor network, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-295-299, 2017
 22. Pothumani, S., Anuradha, C., Monitoring android mobiles in an industry, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-537-540, 2017
 23. Pothumani, S., Anuradha, C., Decoy method on various environments - A survey, International Journal of Pure and Applied Mathematics, V-116, I-10 Special Issue, PP-197-199, 2017
 24. Pothumani, S., Anuradha, C., Priya, N., Study on apple iCloud, International Journal of Pure and Applied Mathematics, V-116, I-8 Special Issue, PP-389-391, 2017
 25. Pothumani, S., Hameed Hussain, J., A novel economic framework for cloud and grid computing, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-5-8, 2017
 26. Pothumani, S., Hameed Hussain, J., A novel method to manage network requirements, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-9-15, 2017
 27. Pradeep, R., Vikram, C.J., Naveenchandra, P., Experimental evaluation and finite element analysis of composite leaf spring for automotive vehicle, Middle - East Journal of Scientific Research, V-12, I-12, PP-1750-1753, 2012.
 28. Pradeep, R., Vikram, C.J., Naveenchandran, P., Experimental evaluation and finite element analysis of composite leaf spring for automotive vehicle, Middle - East Journal of Scientific Research, V-17, I-12, PP-1760-1763, 2013.
 29. Prakash, S., Jayalakshmi, V., Power quality improvement using matrix converter, International Journal of Pure and Applied Mathematics, V-116, I-19 Special Issue, PP-95-98, 2017
 30. Prakash, S., Jayalakshmi, V., Power quality analysis & power system study in high voltage systems, International Journal of Pure and Applied Mathematics, V-116, I-19 Special Issue, PP-47-52, 2017
 31. Prakash, S., Sherine, S., Control of BLDC motor powered electric vehicle using indirect vector control and sliding mode observer, International Journal of Pure and Applied Mathematics, V-116, I-19 Special Issue, PP-295-299, 2017
 32. Prakesh, S., Sherine, S., Forecasting methodologies of solar resource and PV power for smart grid energy management, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-313-317, 2017
 33. Prasanna, D., Arulselvi, S., Decoupling smalltalk from rpcs in access points, International Journal of Pure and Applied

- Mathematics, V-116, I-16 Special Issue, PP-1-4, 2017
34. Prasanna, D., Arulselvi, S., Exploring gigabit switches and journaling file systems, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-13-17, 2017
 35. Prasanna, D., Arulselvi, S., Collaborative configurations for wireless sensor networks systems, International Journal of Pure and Applied Mathematics, V-116, I-15 Special Issue, PP-577-581, 2017
 36. Priya, N., Anuradha, C., Kavitha, R., Li-Fi science transmission of knowledge by way of light, International Journal of Pure and Applied Mathematics, V-116, I-9 Special Issue, PP-285-290, 2017
 37. Priya, N., Pothumani, S., Kavitha, R., Merging of e-commerce and e-market-a novel approach, International Journal of Pure and Applied Mathematics, V-116, I-9 Special Issue, PP-313-316, 2017
 38. Raj, R.M., Karthik, B., Effective demining based on statistical modeling for detecting thermal infrared, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-273-276, 2017
 39. Raj, R.M., Karthik, B., Energy sag mitigation for chopper, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-267-270, 2017
 40. Raj, R.M., Karthik, B., Efficient survey in CDMA system on the basis of error revealing, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-279-281, 2017
 41. Rajasulochana, P., Krishnamoorthy, P., Ramesh Babu, P., Datta, R., Innovative business modeling towards sustainable E-Health applications, International Journal of Pharmacy and Technology, V-4, I-4, PP-4898-4904, 2012
 42. Rama, A., Nalini, C., Shanthi, E., An iris based authentication system by eye localization, International Journal of Pharmacy and Technology, V-8, I-4, PP-23973-23980, 2016
 43. Rama, A., Nalini, C., Shanthi, E., Effective collaborative target tracking in wireless sensor networks, International Journal of Pharmacy and Technology, V-8, I-4, PP-23981-23986, 2016
 44. Ramamoorthy, R., Kanagasabai, V., Irshad Khan, S., Budget and budgetary control, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-189-191, 2017
 45. Ramamoorthy, R., Kanagasabai, V., Jivandan, S., A study on training and development process at Vantec Logistics India Pvt Ltd, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-201-207, 2017

1.

