iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 2 Issue: XII Month of publication: December 2014

DOI:

ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Performance Enhancement of a fixed speed Wind Turbine Induction Generator under Asymmetric Faults Using Dynamic Voltage Restorer

P karthigeyan#1, M Senthil Raja#2, N Senthamilarasi#3, T.M.VishnuKumar#4
[1]*PG scholar, Pondicherry Engineering College, Pondicherry*
[2]*Assistant professor, VI institute of Technology, Chennai*
[3]*Assistant professor, Roever College of Engineering and Technology, Tiruchy*
[4]*Calibration Engineer, Industrial Meterology Centre, Chennai*

Abstract— This paper presents the mitigation of faults in wind turbine connected fixed speed induction generator using dynamic voltage restorer because of its excellent performance of fault mitigation. The DVR consists of shunt and series converters connected back-to-back through a dc-to-dc step up converter. The presence of the dc-to-dc step converter permits the DVR to compensate faults for long duration. The series converter is connected to the supply side whereas the shunt converter is connected to the load side. The control theory is based on vector control- dq(direct quadrature axis) reference frame fed hysteresis controller using DSOGI-PLL(Dual second order generalized integrator- Phase locked loop). The proposed wind turbine fed fixed speed induction generator is evaluated and simulated using MATLAB/SIMULINK environment with and without dynamic voltage restorer under asymmetric faults..
Keywords— Fixed Speed Induction Generator, Wind Turbine, Hysteresis Controller, Dynamic Voltage Restorer, DSOGI-PLL

I. INTRODUCTION

Wind power penetration has increased dramatically in the past few years, hence it has become necessary to address problems associated with maintaining a stable electric power system that contains different sources of energy including hydro, thermal, coal, nuclear, wind, and solar. In the past, the total installed wind power capacity was a small fraction of the power system and continuous connection of the wind farm to the grid was not a major concern. With an increasing share derived from wind power sources, continuous connection of wind farms to the system has played an increasing role in enabling uninterrupted power supply to the load, even in the case of minor disturbances. The wind farm capacity is being continuously increased through the installation of more and larger wind turbines. Voltage stability and an efficient fault ride through capability are the basic requirements for higher penetration. Wind turbines have to be able to continue uninterrupted operation under transient voltage conditions to be in accordance with the grid codes. Grid codes are certain standards set by regulating agencies. Wind power systems should meet these requirements for interconnection to the grid. Different grid code standards are established by different regulating bodies, but Nordic grid codes are becoming increasingly popular.One of the major issues concerning a wind farm interconnection to a power grid concerns its dynamic stability on the power system. Voltage instability problems occur in a power system that is not able to meet the reactive power demand during faults and heavy loading conditions. Stand alone systems are easier to model, analyze, and control than large power systems in simulation studies. A wind farm is usually spread over a wide area and has many wind generators, which produce different amounts of power as they are exposed to different wind patterns. The proposed DVR is a DVR with no storage and load-side-connected shunt converter

II. WIND TURBINE FIXED SPEED INDUCTION GENERATOR

A. Grid connected Induction Generator

Grid connected induction generators develop their excitation from the Utility grid. The generated power is fed to the supply system when the IG is run above synchronous speed. Machines with cage type rotor feed only through the stator and generally operate at low negative slip. But wound rotor machines can feed power through the stator as well as rotor to the bus over a wide range known as Doubly Fed Induction Machines.

B.Fixed Speed Grid Connected Wind Turbine Generator

The structure and performance of fixed-speed wind turbines as shown in Fig. 2.1 depends on the features of mechanical sub-circuits, e.g., pitch control time constants etc.

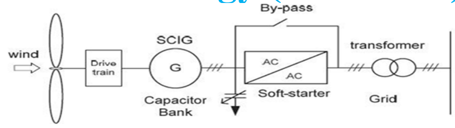


Figure 1 Fixed Speed Wind Turbine With Directly Grid Connected Squirrel - Cage Induction Generator

The reaction time of these mechanical circuits may lie in the range of tens of milliseconds. As a result, each time a burst of wind hits the turbine, a rapid variation of electrical output power can be observed. These variations in electric power generated not only require a firm power grid to enable stable operation, but also require a well-built mechanical design to absorb high mechanical stress, which leads to expensive mechanical structure, especially at high-rated power.

III. DYNAMIC VOLTAGE RESTORER

A. *Principles of DVR Operation*

DVR is a solid state power electronics switching device which comprises of either gto or igbt, a capacitor bank as energy storage device and injection transformers. From the figure it can be seen that DVR is connected in between the distribution system and the load. The basic idea of DVR is that by means of an injecting transformer a control voltage is generated by a forced commuted convertor which is in series to the bus voltage. A regulated dc voltage source is provided by a dc capacitor bank which acts an energy storage device. Under normal operating conditions when there is no voltage sags, DVR provides very less magnitude of voltage to compensate for the voltage drop of transformer and device losses. But when there is a voltage sag in distribution system, DVR will generate a required controlled voltage of high magnitude and desired phase angle which ensures that load voltage is uninterrupted and is maintained. In this case the capacitor will be discharged to keep the load supply constant.

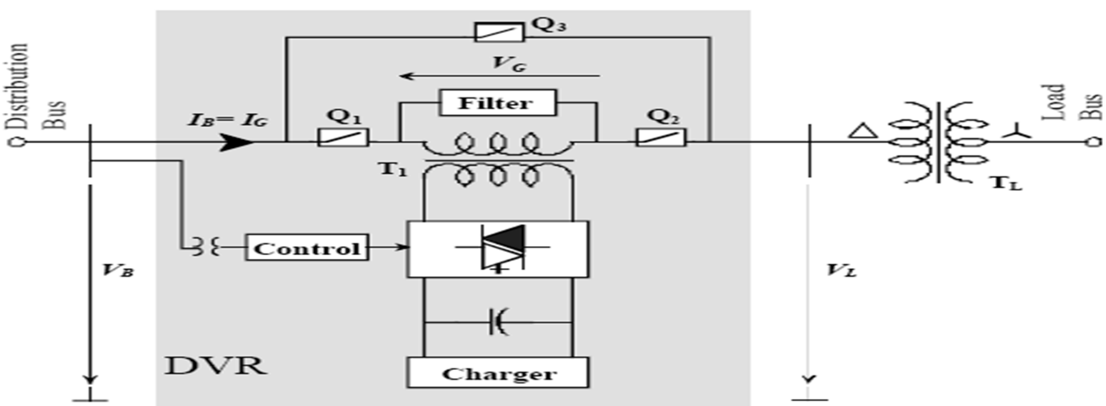


Figure 2. Principle of DVR With a Response Time of Less Then One Millisecond

Note that the DVR capable of generating or absorbing reactive power but the reactive power injection of the device must be provided by an external energy source or energy storage system. The response time of DVR is very short and is limited by the power electronics devices and the voltage sag detection time. The expected response time is about 25 milliseconds, and which is much less than some of the traditional methods of voltage correction such as tap-changing transformers.

B. *CONTROLLER*

The aim of the control scheme is to maintain constant voltage magnitude at the point where a sensitive load is connected, under system disturbances. The control system only measures the r.m.s voltage at the load point, i.e., no reactive power measurements are required. The vsc switching strategy is based on a sinusoidal pwm technique which offers simplicity and good response. Since custom power is a relatively low-power application, pwm methods offer a more flexible option than the fundamental frequency switching (ffs) methods favored in facts applications. Besides, high switching frequencies can be used to improve on the efficiency of the converter, without incurring significant switching losses.The controller input is an error signal obtained from the reference voltage and the value rms of the terminal voltage measured. Such error is processed by a hysteresis controller the output is the angle δ,which is provided to the pwm signal generator. It is important to note that in this case, indirectly controlled converter, there is active and reactive power exchange with the network simultaneously: an error signal is obtained by comparing the reference voltage with the rms voltage measured at the load point. The hysteresis controller process the error

ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

signal generates the required angle to drive the error to zero, i.e., the load rms voltage is brought back to the reference voltage. The dc capacitor cfdc of the uncontrolled rectifier, the dc capacitor cdc and the inductor ldc of the dc-to-dc step up converter are designed based on single-phase voltage sag which induces a voltage fluctuation with twice the line frequency of the dc capacitor. The parameters of the series and shunt transformers are the default parameters of the transformer model in matlab/simulink. Hysteresis band voltage control is used to control load voltage and determine switching signals for inverter switches. There are bands above and under the reference voltage. If the difference between the reference and inverter voltage reaches to the upper (lower) limit, the voltage is forced to decrease (increase).

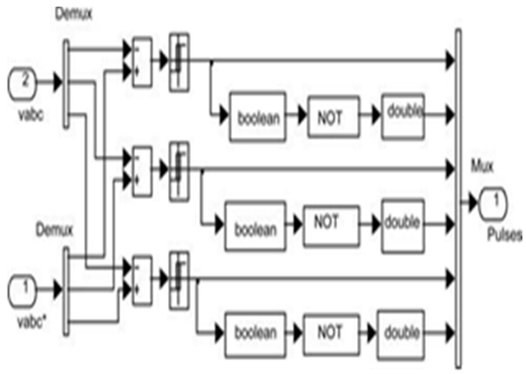
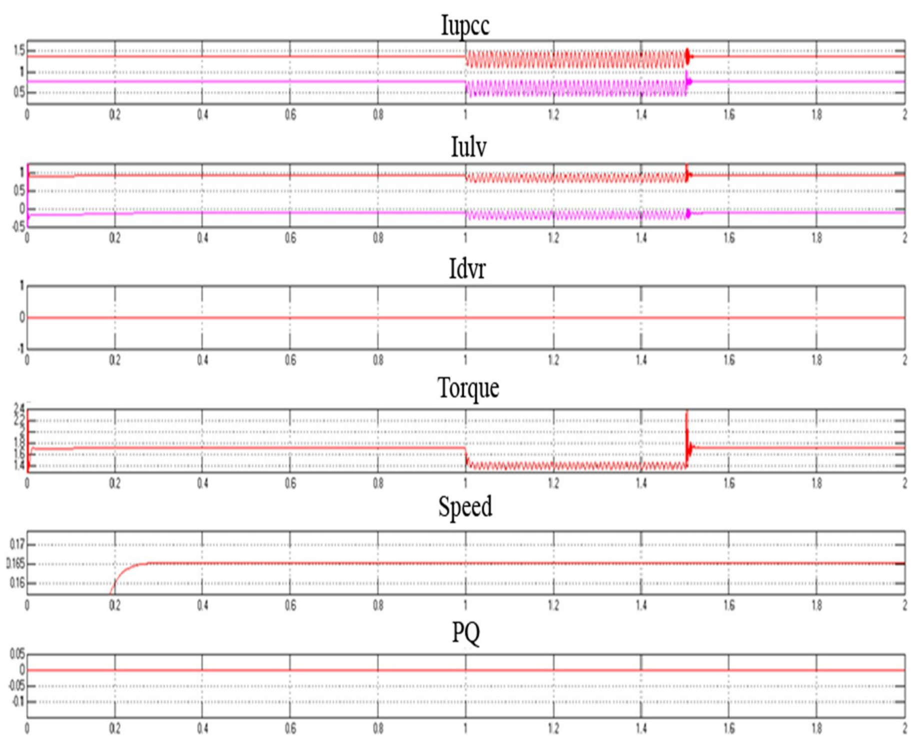


Figure 3. SIMULINK Diagram Showing The Hysteresis Voltage Controller

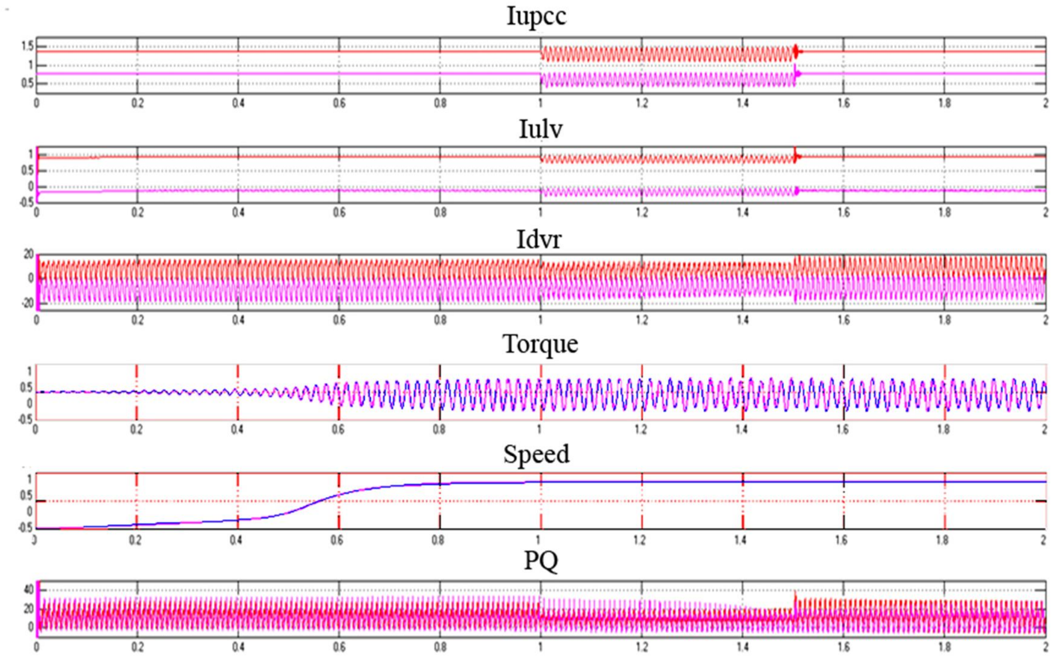
IV. SIMULATION RESULTS

A. Wind Turbine Fed Fsig Without DVR- 1ph50% fault



International Journal for Research in Applied Science & Engineering Technology (IJRASET)

B. Wind Turbine Fed Fsig With DVR-1ph50% fault



V. CONCLUSION

In this project a windturbine fed fixed speed induction generator is modeled under asymmetric grid fault 1ph-50%. To mitigate these faults DVR is injected into the windturbine fed fixed speed induction generator. It also compensates the positive and negative sequence voltage and current. The respective waveforms are verified for without and with dynamic voltage restorer

A. Appendix

TABLE I. SIMULATION PARAMETERS

Wind Farm Induction Generator	Simulation Parameters
Base Apparent Power	575 MW
Rated Active Power	50 MW
Rated Voltage (Line To Line)	690 V
Stator Resistance	0.0108 p.u
Stator Stray Impedance	0.107 p.u
Mutual Impedance	4.4 p.u
Rotor Impedance	0.01214 p.u
Rotor Stray Impedance	0.1407 p.u
Compensation Capacitors	0.17 F
Mechanical Time Constant	3s

B. Grid And Transformer Parameters

	Grid	High Voltage Transformer	Medium Voltage Transformer
Base Apparent Power and Rated Voltage	1000 MW 110 KV	100 MW 30 KV	100 MW 690 V
Stray Impedance	0.98 p.u	0.05 p.u	0.1 p.u
Resistance	0.02 p.u	0.01 p.u	0.02 p.u

ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

VI. ACKNOWLEDGEMENT

I like to dedicate this paper to my mother Mrs. P. Jayalakshmi, my father Mr. N. Periyasamy, and my sister Miss. P. Senthil Kumari.. Special thanks to my close friend Mr. C. Prakash

REFERENCES

[1] M. Liserre, R. Cardenas, 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] M. Tsili and S. Papathanassiou, "A review of grid code technical requirements for wind farms," *IET Renewable Power Gener.*, vol. 3, no. 3,pp. 308–332, Sep. 2009.

[3] M. Ali and B. Wu, "Comparison of stabilization methods for fixed speed wind generator systems," *IEEE Trans. Power Del.*, vol. 25, no. 1,pp. 323–331, Jan. 2010.

[4] D. Soto and T. Green, "A comparison of high-power converter topologies for the implementation of FACTS controllers," *IEEE Trans. Ind. Electron.*, vol. 49, no. 5, pp. 1072–1080, Oct. 2002.

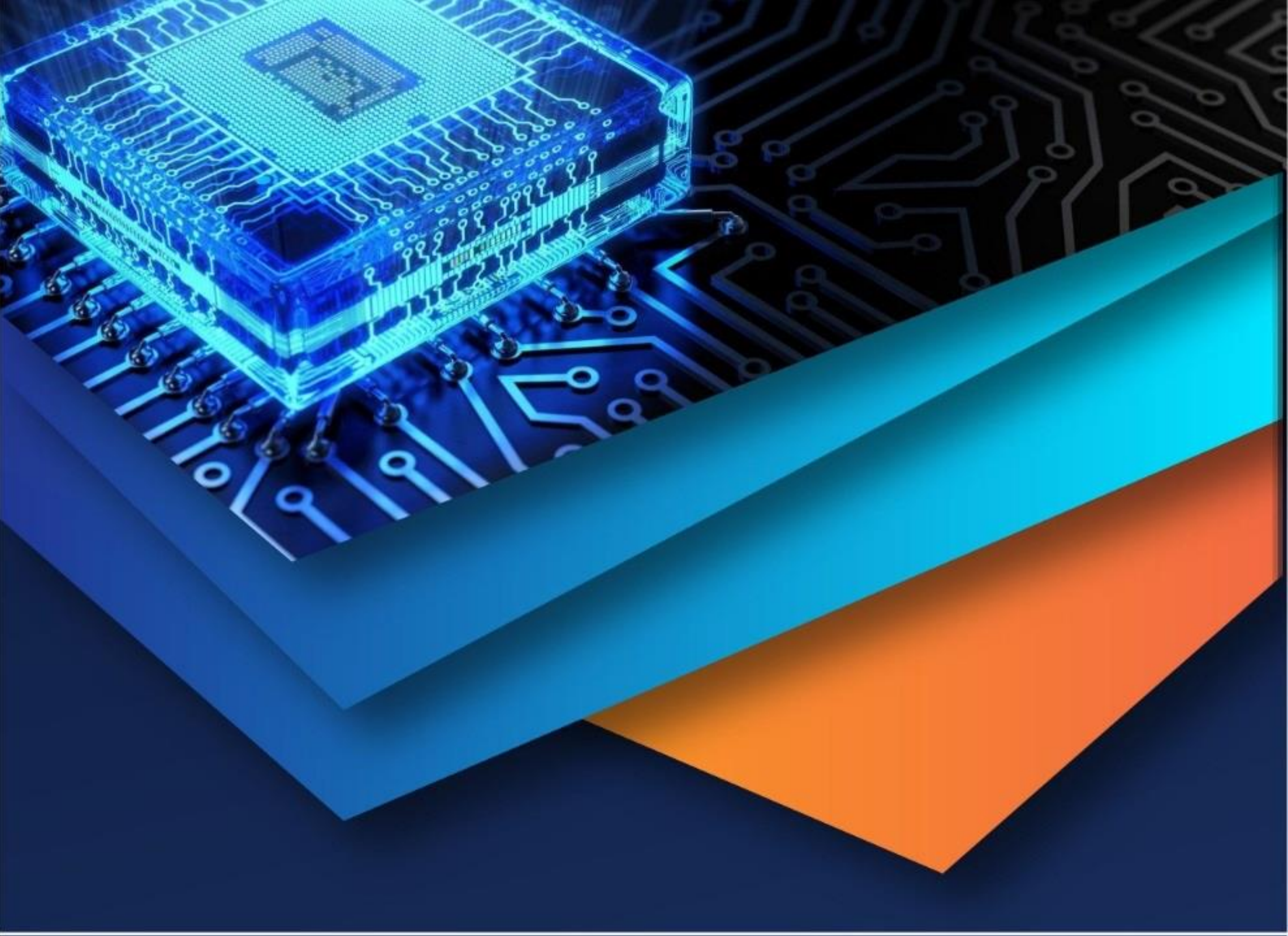
[5] M.H. Haque "Compensation of distribution system voltage sag by DVR and DSTATCOM" Power Tech Proceedings, 2001 IEEE Porto , Volume: 1 , 10-13 Sept. 2001 Pages:5 pp. vol.1.

[6] N. Hoffmann, L. Asiminoaei, and F. W. Fuchs, "Online grid-adaptive control and active-filter functionality of PWM-converters to mitigate voltage unbalances and voltage-harmonics a control concept based on grid impedance measurement," in *Proc. IEEE ECCE*, Sep. 2011, pp. 3067–3074.

[7] J. Dannehl, C. Wessels, and F. W. Fuchs, "Limitations of voltage oriented PI current control of grid-connected PWM rectifiers with LCL filters," IEEE Trans. Ind. Electron., vol. 56, no. 2, pp. 380–388, Feb. 2009..

[8] P. Rodriguez, R. Teodorescu, I. Candela, A. Timbus, M. Liserre, and F. Blaabjerg, "New positive-sequence voltage detector for grid synchro-nization of power converters under faulty grid conditions," in *Proc. 37th IEEE PESC*, Jun. 2006, pp. 1–7.

.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY