Design of 9 Switch Converters for DFIG System for Active and Reactive Power Control by PD Controller

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ABSTRACT

In this paper, we are designing 9 pulses, 9 switches converter unit for DFIG based Wind power plant. In conventional systems the converters are of 6 pulses, 12 switches or 12 pulses, 24 switches. Which where bulky in size and uneconomical as well as the system is designed and built by basic controllers and operated on basic devices with high losses and low efficiency. The paper shows the operation with PD Controller which gives quick operation and more stability, as stability increases the losses reduced and efficiency increases.

Keywords- Double fed Induction generator (DFIG), 9 Switch Converter, Settling time, Proportional Derivative, Proportional Integral Derivative.

I. INTRODUCTION

In conventional systems the wind turbine system uses the two converters as shown in below figure.1 as one of it is Rotor Side Converter and another is Grid Side Converter and to stabilize them the DC Link is provided between them. In this system both the converters are controlled by Proportional Integral (PI) controller.

These controller are used to control switching of thyristor in converter and to control power in system and to bring the power to stability level or to achieve quick settling time. But the controllers are used widely in past, now a days for advanced controlling operations we must use Proportional Derivative (PD) Controllers.

In this paper we will see the output differences in Active and Reactive Power of Generator side and Grid side by using PD controllers. But the converter we are going to used is not 6pulse, 12 switch or 12 pulse, 24 switch we are going to design a new type of converter which is 9pulse, 9switch converter, which is much economical than other converters as the number of switches used in this converter is less as well as we require only one unit of switches for both generator and grid power control. The simplified figure of 9pulse, 9 switch converter is shown in Fig.2.

In 9 pulse, 9 switch converter unit we can control converter by any controller by dividing converter switches as per generator and grid side for obtaining the required operation to maintain stabilized active and reactive power flow with quick operation a minimum settling time.
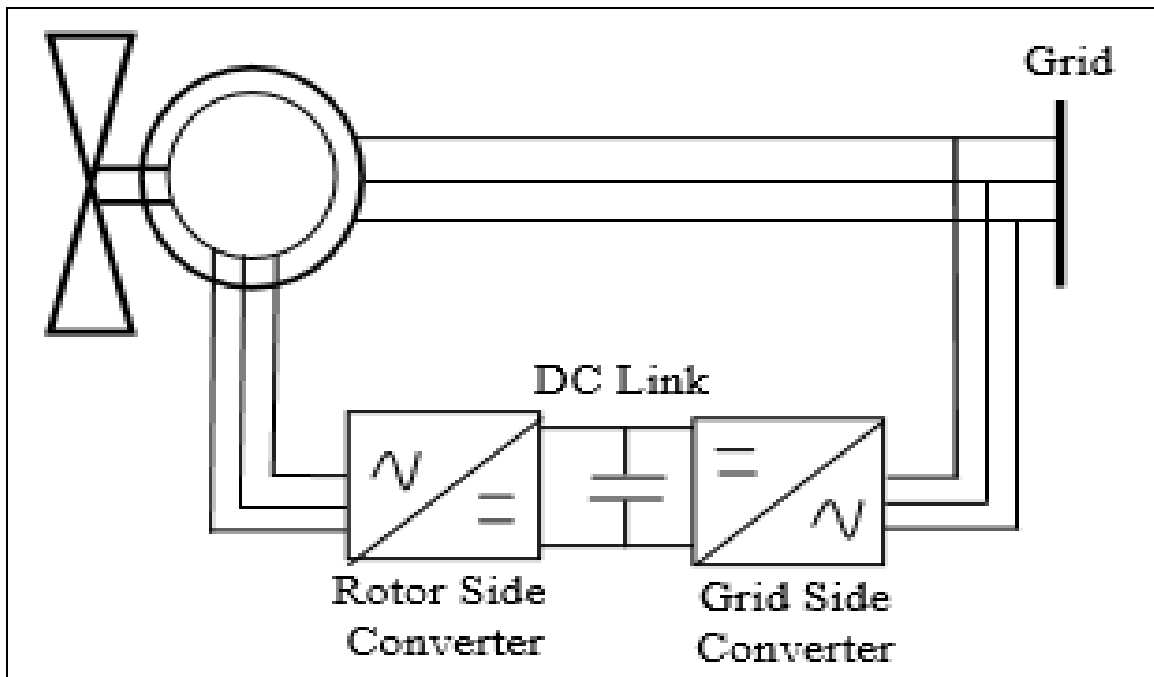
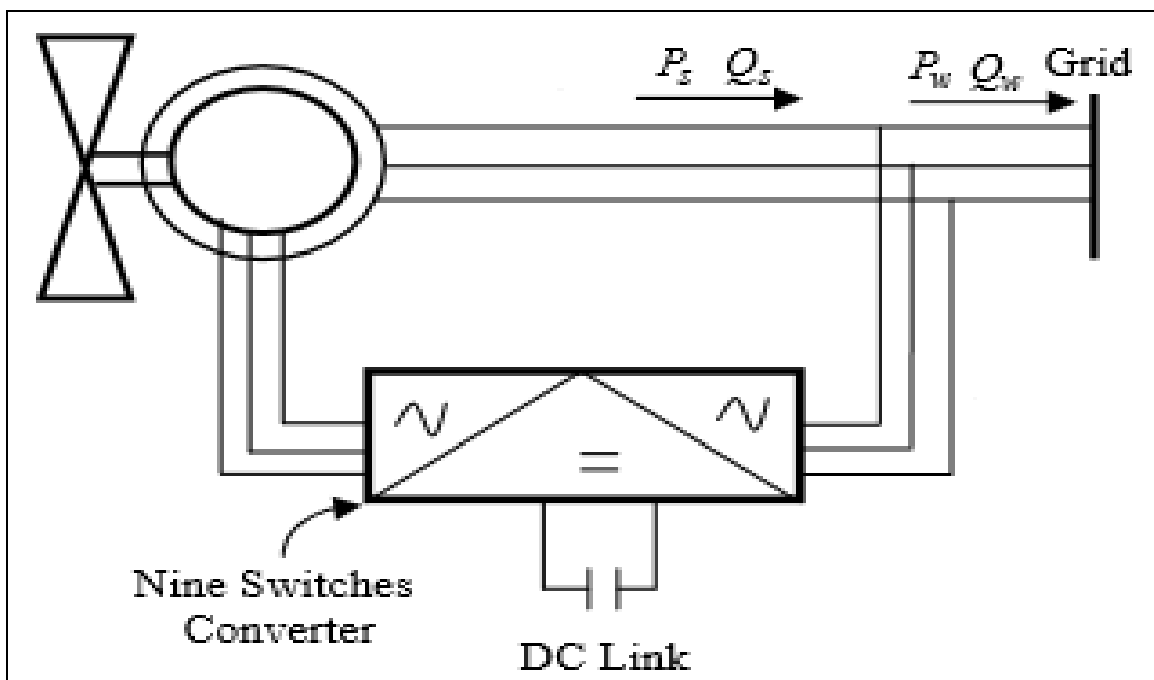Fig.1: Conventional Converter with Wind Power Plant.

Fig.2: 9 Pulse, 9 Switch Converter with Wind Power Plant.

II. SIMULATION DIAGRAM

In this section we will observe the SIMULIK Diagram of 9 Pulse, 9 Switch Converter with PD controller and PID controller.

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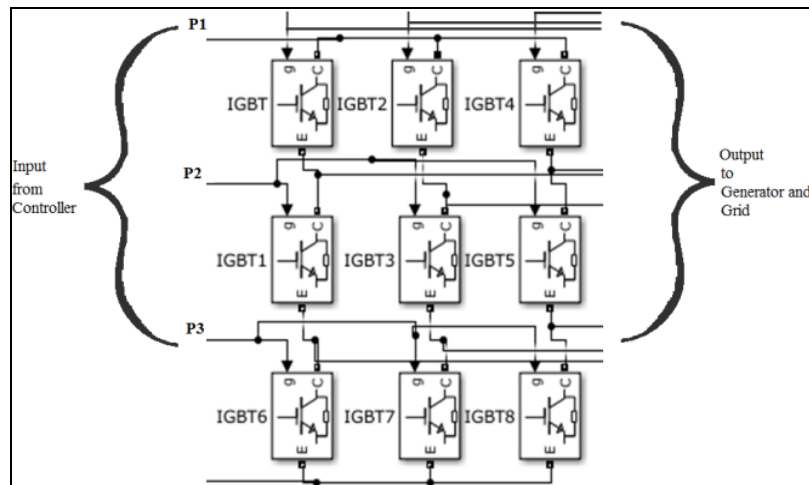www.ijarse.com

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Fig.3: 9 Pulse, 9 Switch Converter.

In above figure we can observe that the total number of IGBT's are 9 which will work as a 9 Pulse, 9 Switch Converter in which we will use PD controller for switching operation as per wind power plant operating condition to maintain stability.

In this SIMULINK we can observe that the 9 switches converter is divided in 3 section or in three groups as Inverter, Rectifier and as Voltage stabilizer to stabilize the voltage as a dc link is used in conventional method.

In this type of converter the numbers of components used and required are less
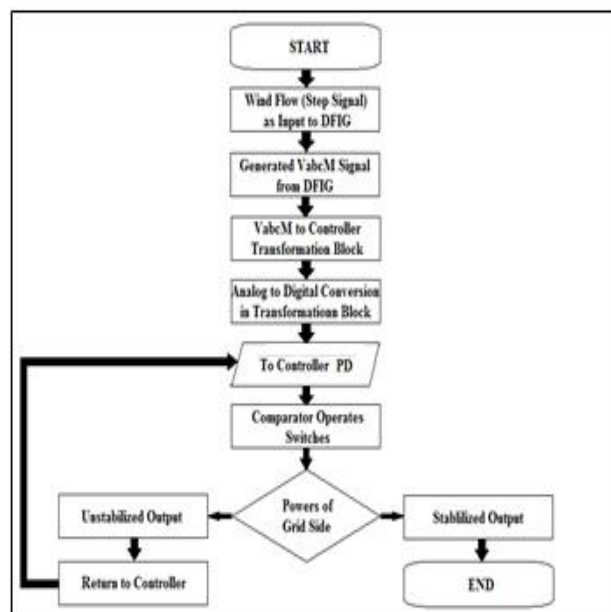
A. Flow Chart:

Fig.4: Flow Chart of PD operation.

In above Fig.4 the basic algorithm is shown in with we can analyze the operational details. The total operation is based on converter and controller used in system with DFIG unit. The wind input is simulated with

step signal which is input signal to DFIG unit and VabcM is output of DFIG unit. The further operation is dependent based on converter switching which is done by the controller used in system.

This paper is based on PD controller to show the responses of output. The stable output with minimum settling time is most important and desirable output.

B. *Operation:*

In this operating mode the group of IGBT's is created as mentioned before, the upper three IGBT's acts as a one group, middle three as second group and bottom three as third group. This can be said as P1, P2 and P3 set of IGBT. In this P1 and P2 set will act as a comparator set and P3 set will act as a NAND operating set, which means P1 and P2 will be inverter and rectifier and P3 will be voltage regulator.

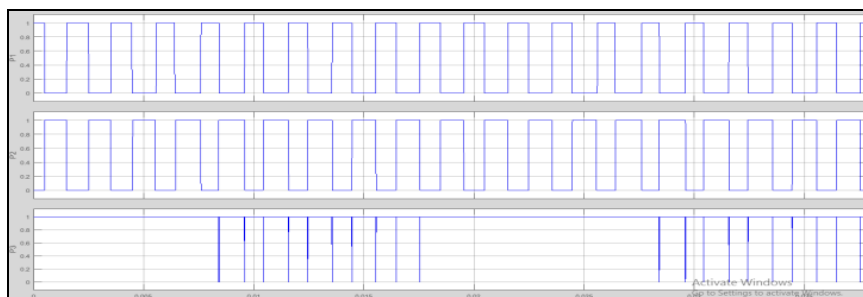The output of 9 pulse, 9 switch converter will be.

Fig.5: Output of 9 Pulse, 9 Switch Converter.

The switching of converter is shown in following table.

Table.1: Switching Operation of Converter

Serial No.	IGBT On Mode	Group	IGBT On Mode	Group
1	IGBT, IGBT2		IGBT3, IGBT5	
2	IGBT2, IGBT4	P1	IGBT5, IGBT1	P2
3	IGBT4, IGBT		IGBT1, IGBT3	

Mode P3 only operates as NAND gate to stabilize the voltage, it acts as a DC link.

The above operation is conducted with the help of controlling units, in this paper we are going to use PD controller and going to compare there working. SIMULINK of controllers are.

C. *PD Controller:*

Following SIMULINK shows the controlling unit for 9 pulse, 9 switch converter with PD controller which has following values,

Table.2: Proportional Derivative Parameters

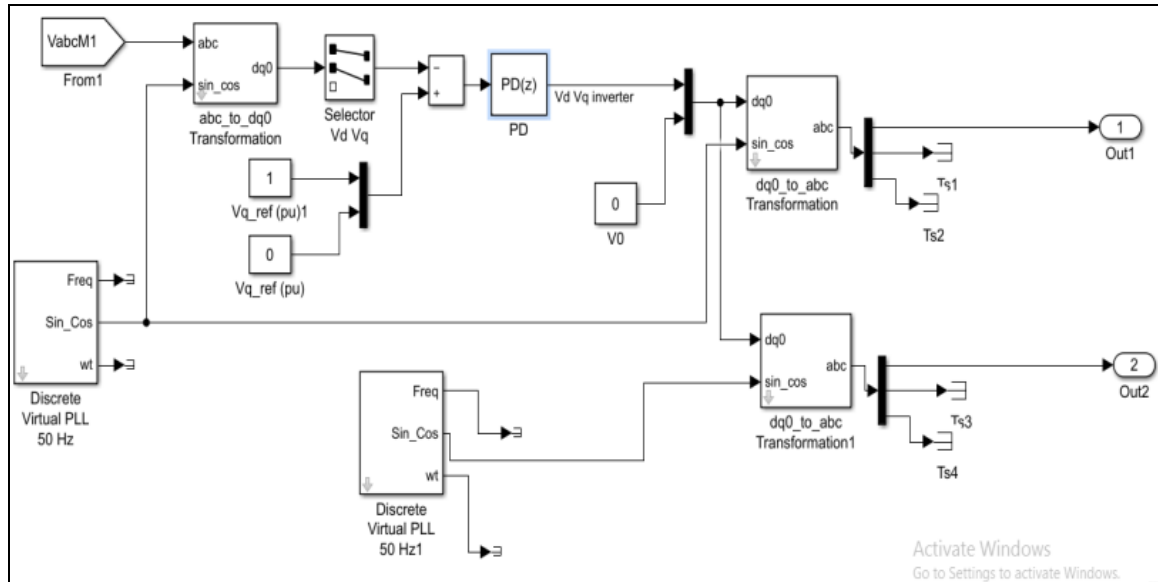| Serial No.	Parameter	Values
1.	Proportional	0.4
2.	Derivative	0.1

Fig.6: Proportional Derivative Controller SIMULINK.

III. OPERATION

In above section in this paper we have seen the designing of 9 pulse, 9 switch converter with PD controller output with wind plant. In this section we will observe the Active and Reactive Power output with Generator and with Grid side.

In Fig.6 we can see that VabcM1 port is taken from Wind Generator which is Double Feed Induction Generator (DFIG), this port provides the variation in speed of Generator to converter unit so as the converter unit can operate simultaneously as per requirement to achieve stable and proper output. After it transformation block change the three phase values of generator to single phase digital value to operate controller, as per the values controller start switching operation of converter due to which we get the following outputs.

The operation of 9 pulse, 9 switch converter with PD controller the output characteristics we will achieve are.
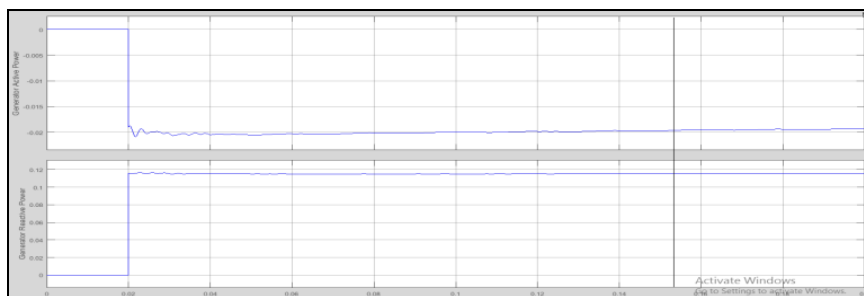

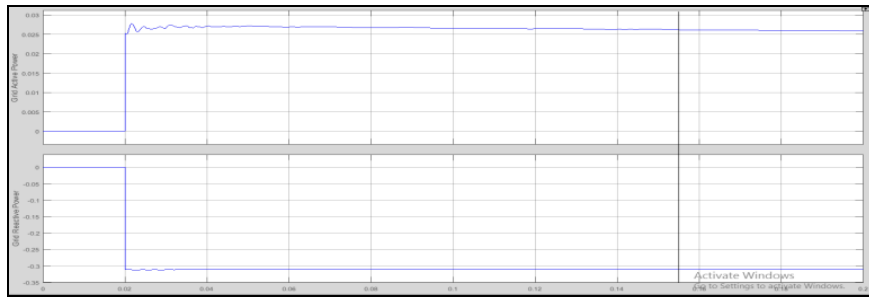Fig.7: PD Controller Output for Generaator Side Power

Fig.8: PD Controller Output for Grid Side Power

By observing the vertical lines in above characteristics we can determine that the setting time of the PD controller.

IV. RESULT

Fig. 7 and 8 shows the outputs of PD controller for 9 pulses, 9 switch converter for generator and grid side power control.

The following table shows the results of both controllers.

Table.3: Results

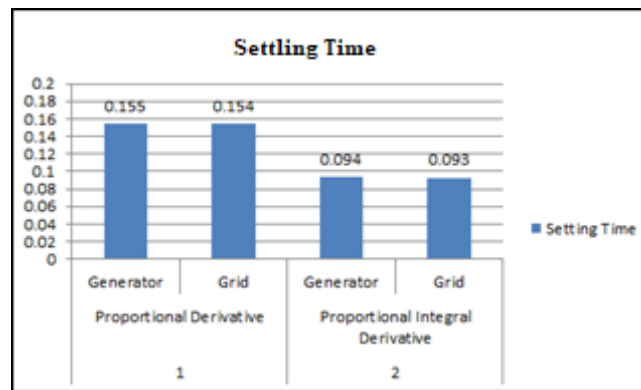| Serial No.	Controller	Section	Setting Time
1.	Proportional Derivative	Generator	0.155
		Grid	0.154

Fig.9: Graphical Representation

From above result we can say that the PD controller is quick operating with minimum settling time.

V. CONCLUSION

In this paper we have designedthe 9 pulse, 9 switch converter for Wind power plant with controllers such as PD controller the outputs and results. Thus we got to know that the PD controller has better.

VI. ACKNOWLEDGEMENTS

REFERENCES

Conferences

[1] "Variable universe fuzzy controller used in MPPT based on DFIG wind energy conversion system", Guolian Hou1, Zhuo Jiang, Yu Yang, Jianhua Zhang, IEEE- 2016.

[2] "TS-fuzzy controlled DFIG based Wind Energy Conversion Systems", S. Mishra, Senior Member, IEEE, Y. Mishra, Student Member, IEEE, Fangxing Li, Senior Member IEEE, Z. Y. Dong, Senior Member, IEEE, IEEE-2009.

[3] "Wind energy conversion system based on DFIG with Open Switch Fault Tolerant Six-legs AC-DC-AC converter", Mahmoud Shahbazi, Mohammad Reza Zolghadri, Philippe Poure, Shahrokh Saadate, IEEE.

[4] "Optimized Control of DFIG-Based Wind Generation Using Sensitivity Analysis and Particle Swarm Optimization", Yufei Tang, Ping Ju, Haibo He, Chuan Qin, Feng Wu, IEEE-2013.

[5] "Wind Farm Based Doubly Fed Induction Generator Using a Novel AC/AC Converter", Mohamad Reza Banaei, and AliReza Dehghanzadeh, IEEE- 2011.

[6] "Space Vectors Modulation for Nine-Switch Converter", Seyed Mohammad Dehghan Dehnavi, Student Member, IEEE, Mustafa Mohamadian, Member, IEEE, Ali Yazdian, Member, IEEE, and Farhad Ashrafzadeh, Senior Member, IEEE, IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 25, NO. 6, JUNE 2010.

[7] "A Novel Space Vector Modulation for Nine-Switch Converters", S. M. Dehghan, M. Mohamadian, A. Yazdian, F. Ashrafzaden, IEEE-2009.

[8] "Optimized Design of a Back-to-Back Rotor-side Converter for Doubly Fed Induction Generator equipped Wind Turbines", L. Piegari, Member, IEEE, R. Rizzo, Senior Member, IEEE, P. Tricoli **, Member, IEEE, IEEE-2009.

[9] "Coordinated Control of DFIG's Rotor and Grid Side Converters during Network Unbalance", Lie Xu, Senior Member, IEEE-2008.

[10] "A Novel Nine-Switch Inverter for Independent Control of Two Three-phase Loads", Tsutomu Kominami, IEEE- 2007.

[11] "Novel Pulse-Width-Modulated Current-Mode Analog Defuzzifier for the Fuzzy Control of Switching DC-DC Converters", E. Alarcdn, A. Poveda, I. Madrenas, E. Vidal, S. Gom5riz and F. Guinjoad, IEEE-1999.

Journals

[12] "Simulation of Closed Loop Fuzzy Logic Controller for a 3 Phase to 3 Phase Power Conversion Using Matrix Converters", B. Muthuvel, Dr. T. S. Anandhi, M. Jananiraj, IJSER-2016.