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Design of 9 Switch Converter for Wind Power Plant with PD and PID Controller

Mr. Mazharhussain N. Mestri
Department of Electrical Engineering
Fabtech Technical Campus,
Sangola, Solapur (MS), India.

Prof. B. Sampath Kumar
Department of Electrical Engineering
Fabtech Technical Campus,
Sangola, Solapur (MS), India.

Abstract- **In this paper, we are designing 9 pulses, 9 switches converter unit for Wind power plant with Double Feed Induction Generator (DFIG) Unit. 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 with PI or PD controller. In this paper we are going to show advancement in controller and converter control and stability by PD and PID.**

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) or by Proportional Derivative (PD) controller.

These controllers 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 both the controllers are used widely in past now a days for advanced controlling operations we must use Proportional Integral Derivative (PID) Controllers.

In this paper we will see the output differences in Active and Reactive Power of Generator side and Grid side by using PD and PID controllers. But the converter we are going to used is not 6 pulse, 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.

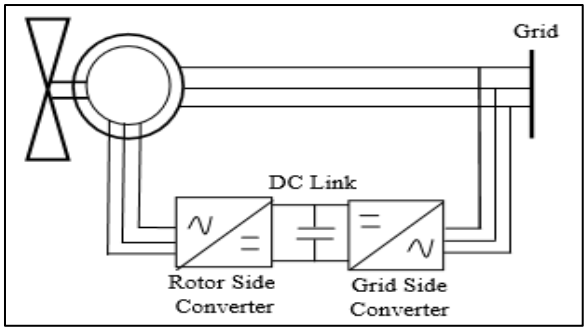

Fig.1: Conventional Converter with Wind Power Plant.

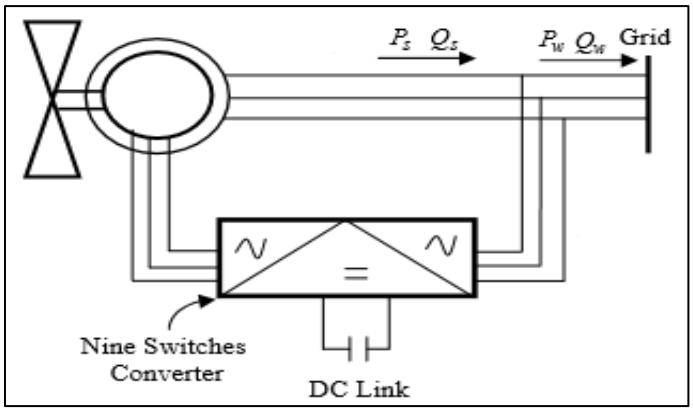

Fig.2: 9 Pulse, 9 Switch Converter with Wind Power Plant.

II. SIMULATION DIAGRAM

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

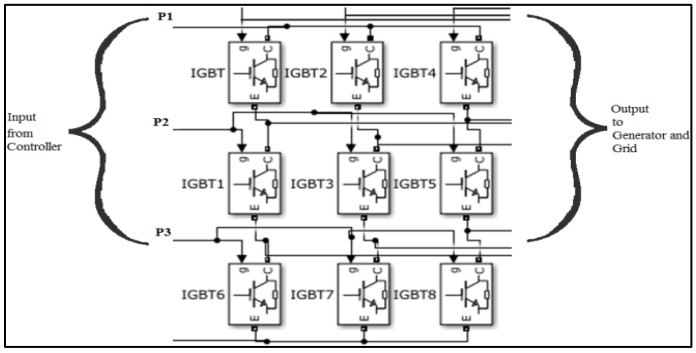

Fig.3: 9 Pulse, 9 Switch Converter.

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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 and PID 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 inn 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:

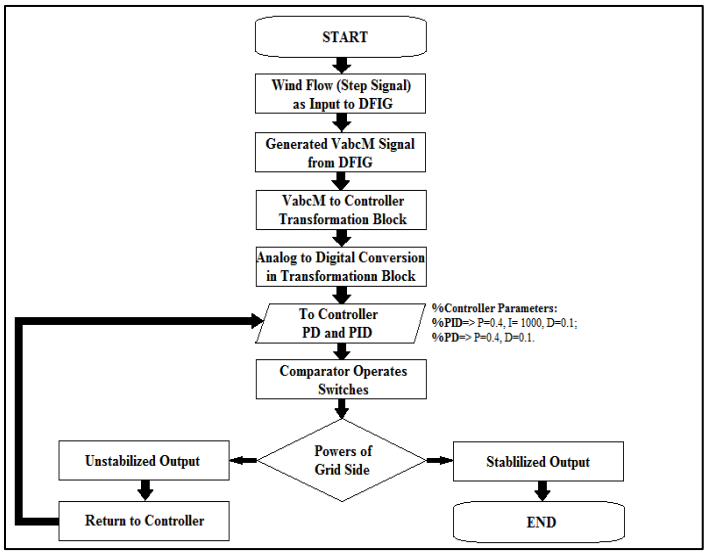

Fig.4: Flow Chart of PD and PID operation.

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 and PID controller to show the responses of output. The stable output with minimum settling time is most important and desirable output.

B. Mode of 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.

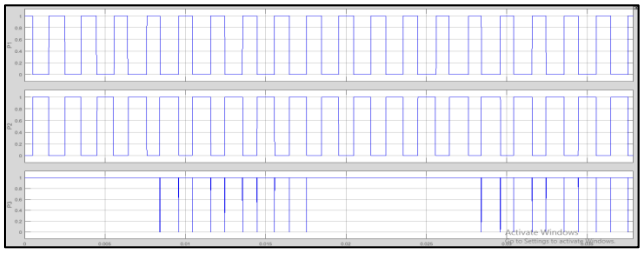

Fig.5: Output of 9 Pulse, 9 Switch Converter.

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	P1	IGBT3, IGBT5	P2
2	IGBT2, IGBT4		IGBT5, IGBT1	
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 and PID controller and going to compare there working. SIMULINK of controllers are.

C. With 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

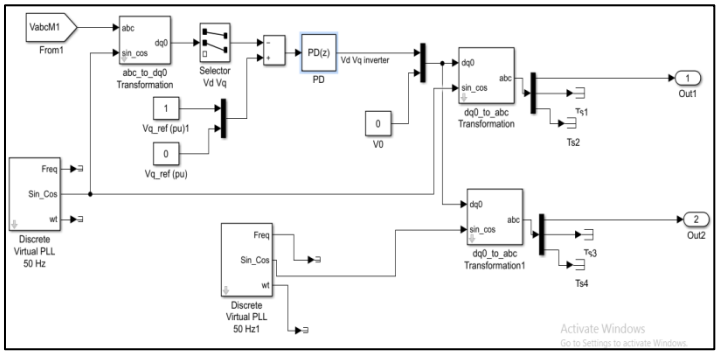

Fig.6: Proportional Derivative Controller SIMULINK.

D. With PID Controller:

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

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TABLE.3: Proportional Integral Derivative Parameters

Serial No.	Parameter	Values
1.	Proportional	0.4
2.	Integral	1000
3.	Derivative	0.1

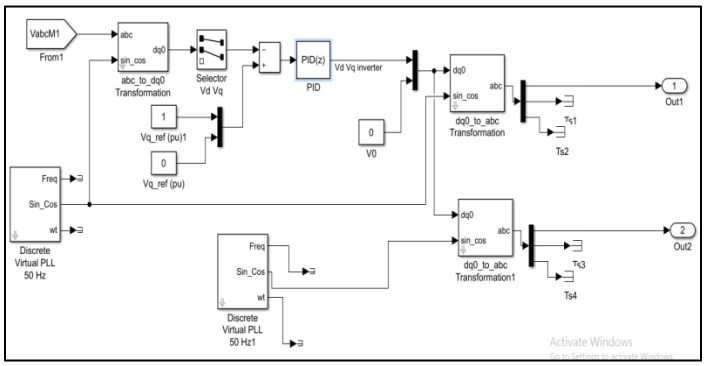

Fig.7: Proportional Integral Derivative Controller SIMULINK.

In both the SIMULINK the values of Proportional and Derivative is kept same to have proper comparative results which is 0.4 and 0.1 respectively.

The other all controlling units in PD and PID controller is also same.

III. OPERATION

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

Fig.6 and Fig.7 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 and PID controller the output characteristics we will achieve are.

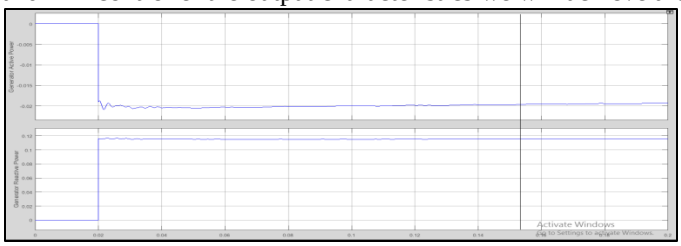

Fig.8: PD Controller output for Generaator side power

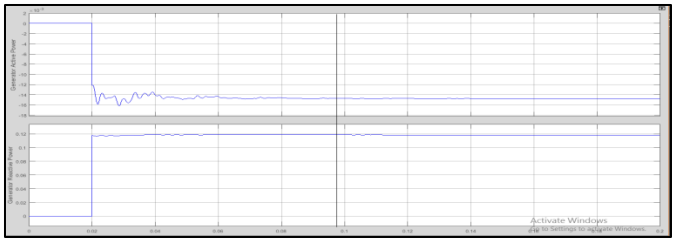

Fig.9: PID Controller output for Generator Side

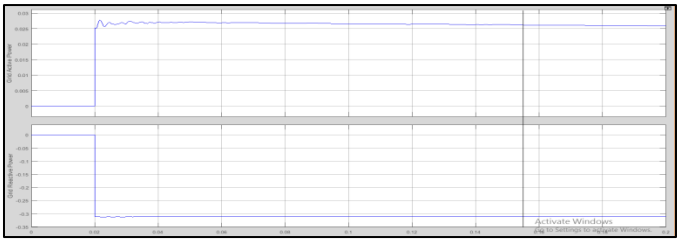

Fig.10: PD Controller output for Grid side power

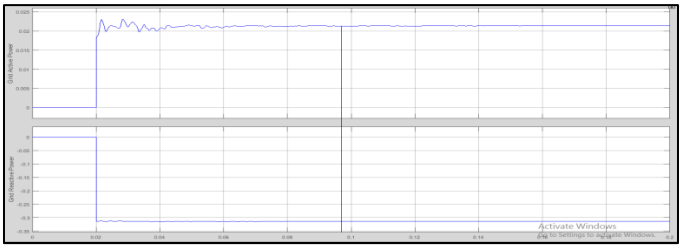

Fig.11: PID Controller output for Grid Side

By observing the vertical lines in above characteristics we can determine that the setting time of PID controller is much better than that of the PD controller.

IV. RESULT

Fig. 7, 8, 9 and 10 shows the outputs of PD and PID controller for 9 pulses, 9 switch converter for generator and grid side power control.

The following table shows the results of both controllers.

TABLE.4: Results

Serial No.	Controller	Section	Setting Time
1.	Proportional Derivative	Generator	0.155
		Grid	0.154
2.	Proportional Integral Derivative	Generator	0.094
		Grid	0.093

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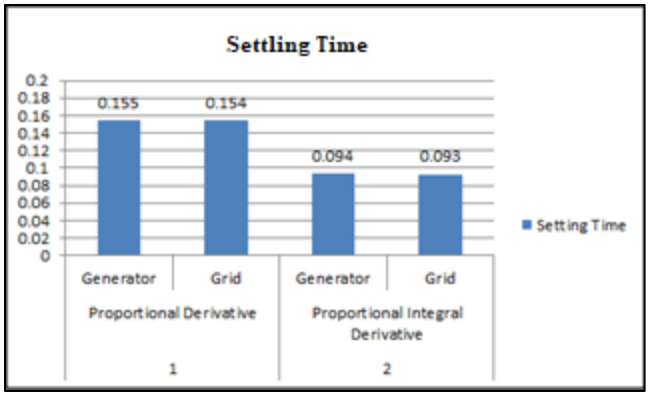

Fig.12: Graphical Representation

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

V. CONCLUSION

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

VI. ACKNOWLEDGEMENTS

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