FUZZY LOGIC BASED WIND TURBINE DRIVEN DFIG INTERFACED TO UTILITY GRID

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Abstract – *In this paper an impact method of wind energy conversion systems with doubly-fed induction generator to interfaced using fuzzy logic is designed. A doubly fed induction generator (DFIG) whose stator is directly connected to the grid and the rotor is connected to the grid through a back-to-back AC-DC-AC PWM converter by mean of proposed control method. To ensure a smooth DC voltage and sinusoidal current within the grid side is achieved by means of the grid side converter (GSC). The system is modeled and simulations are carried out in MATLAB using Sim Power Systems tool box.*

Key Words: *Doubly fed induction generator (DFIG), power quality,* Fuzzy Logic Controller*, Utility grid, wind energy conversion system (WECS).*

1. INTRODUCTION

Wind industry is becoming one among the world's fastest growing energy sectors nowadays, offering the simplest opportunity to unlock a replacement era of environmental protection, helping to satisfy global energy demand and starting the transition of sustainable energy to a worldwide economy. Variable speed constant frequency operation, reduced flicker and independent control capabilities for active and reactive powers are often achieved by Wind turbines supported doubly fed induction generators have attracted particular attention due to their advantages. Active power from the generator is decided by the turbine control and must in fact be within the potential of the turbine generator system. The development caused by doubly fed induction generator features a good performance without losing any equilibrium when the voltage reduction occurs in these conditions; it will remain connected to the power system. DFIGs are variable speed generators with controlled power electronic converters are used for improving the efficiency and power quality. The main components of a wind turbine system that including the turbine rotor, gearbox, generator, transformer and possible power electronics. Wind turbines capture the power from the wind and convert it to rotating mechanical power, which successively converted into electric power by alternator/ generator.

2. PROPOSED WIND DRIVEN DFIG UTILITY GRID

Figure 1 shows the block diagram for the overall control strategies including two parts of DFIG-WECS. The primary part is that the electrical control system of DFIG, which incorporates control of the RSC and the GSC. The target of the RSC is to permit the DFIG wind turbine for decoupled control of active and reactive power or speed. The most objective for the grid-side converter is to stay the dc-link voltage constant it's possible to regulate the torque or the speed of the DFIG and therefore the power factor at the stator terminals by the machine-side converter. The second part is that mechanical control system of the wind turbine having the important objective to be the capture of wind generation maximization and minimization of transient low speed shaft loads. The RSC control scheme including the inner and outer control loops. The outer control loops have two PI controllers, which are used to regulate the stator reactive and active power independently, whereas the inner ones have two PI controllers, which are used to regulate the *d*-axis and *q*-axis rotor currents independently. The GSC is connected between the DC-link and therefore grid via the filter. The main objective is to take care of the DC-link voltage at a given value and to manage the reactive power flow between the GSC and therefore the grid. The GSC is typically operated at unity power factor, but it is often used for voltage support during the grid fault by injecting reactive power into the grid. Most doubly-fed electric machines in industry today are three-phase wound-rotor induction machines that contain the stator and the rotor windings. Doubly-fed electric machines are basically electric machines with a back-to-back converter are often seen in Figure 1. The back-to-back converter consists of two converters i.e machine-side converter and grid-side converter. DFIG are that they permit the amplitude and frequency of their output voltages to be maintained at a permissible value.

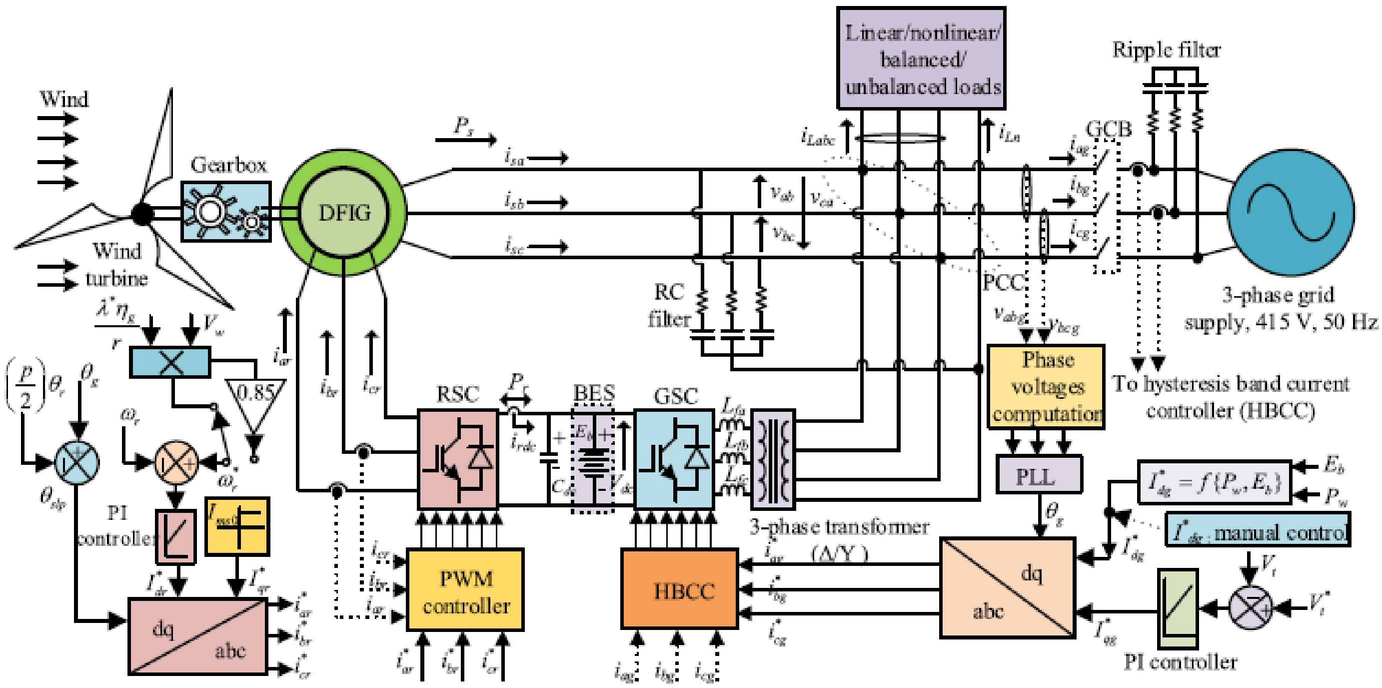


Figure 1 Utility grid-interfaced wind driven DFIG

3. DESIGN OF FUZZY CONTROLLER

The basic block diagram of fuzzy logic controller is shown in figure 2, which mainly contains three blocks which are Defuzzifier, Decision rules, Fuzzifier. Fuzzifier is one which measures inputs and are converted into fuzzy inputs. The decision rule block which enables the FLC to require intelligent decisions is predicated on upon a group of if-then rules. The defuzzifier block converts the control output generated by the decision rule out to the numerical value. Fuzzy logic has been applied to several fields from control theory to artificial intelligence.

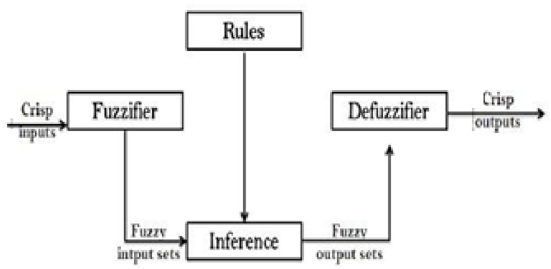


Figure 2 Fuzzy logic controller

Using fuzzy logic controller, the automated tuning of MPPT controller has been done. A linguistic control transforms into an automatic control strategy by means of fuzzy logic system. Figure 6 shows the block diagram of a fuzzy logic controller. The inputs to the fuzzy controller are the error (e) and therefore the rate of change of error (Δe) while the outputs are controller gains *KP & Ki.*

The fuzzy sets have been determined as: Negative Large (NL), Negative Medium (NM), Negative Small (NS), zero (ZE), Positive Small (PS), Positive Medium (PM), Positive Large (PL) respectively as shown in table 1 by fuzzy linguistic variables.

Δe \ e	NB	NS	EZ	PS	PB
NB	NB	NB	NS	NS	EZ
NS	NB	NS	NS	EZ	PS
EZ	NB	NS	EZ	PS	PS
PS	NS	EZ	PS	PS	PB
PB	EZ	PS	PS	PB	PB

Table 1 Fuzzy Rule Bases

The following advantages of fuzzy logic controller are

a) It is cheap compared to other conventional controllers and it does not require a previous mathematical model.

b) It reduces the entire harmonic distortion compared to others controller.

4. SIMULATION AND DISCUSSION

Figure 3 show the wind power generation system (WECS) based on doubly fed induction generator (DFIG) connected to grid system with fuzzy control system is simulated using MATLAB/SIMULINK software.

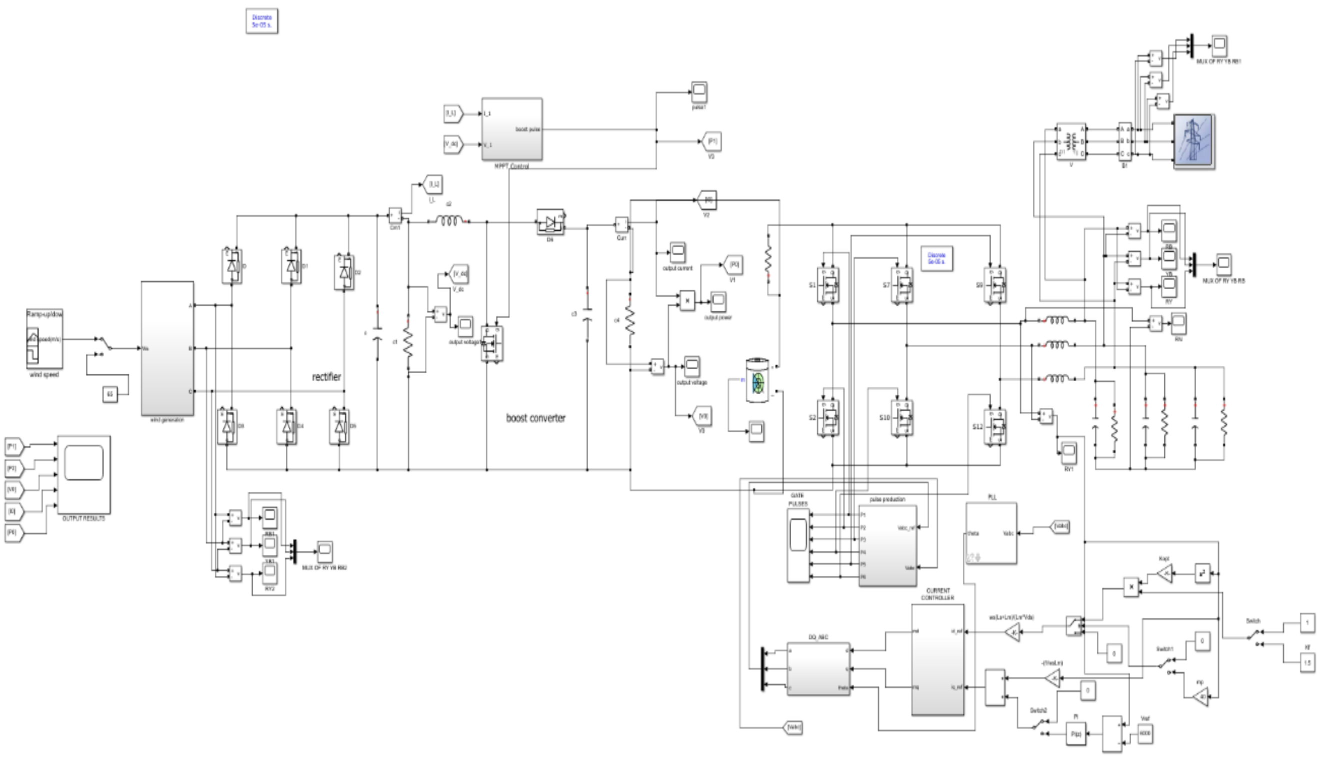


Figure 3 Simulation Diagram of Doubly Fed Induction Generator with Fuzzy Logic Controller

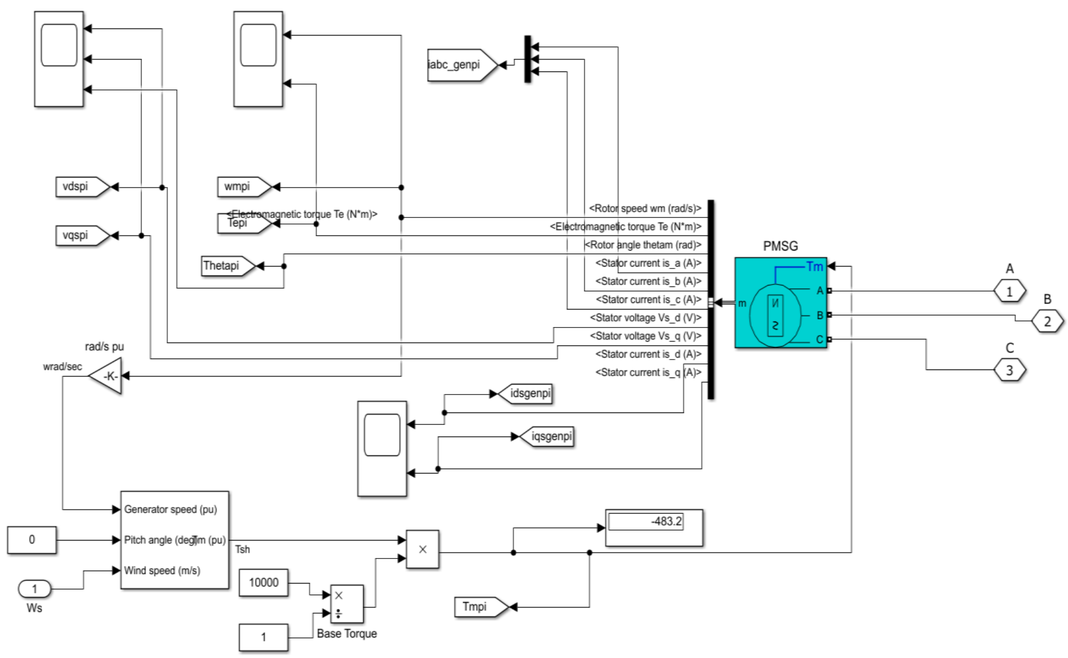


Figure 4 Wind generation

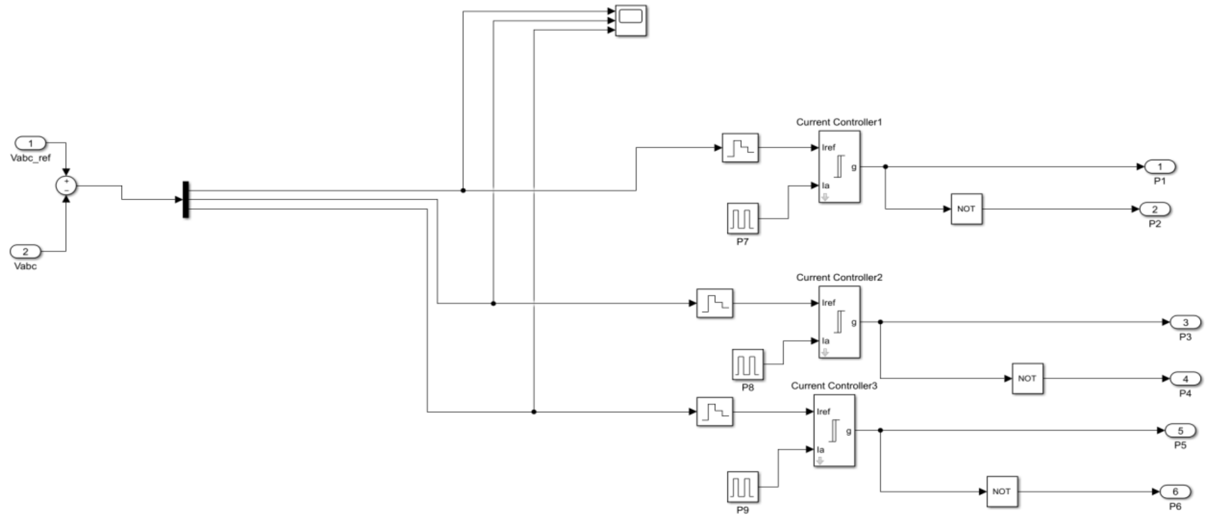
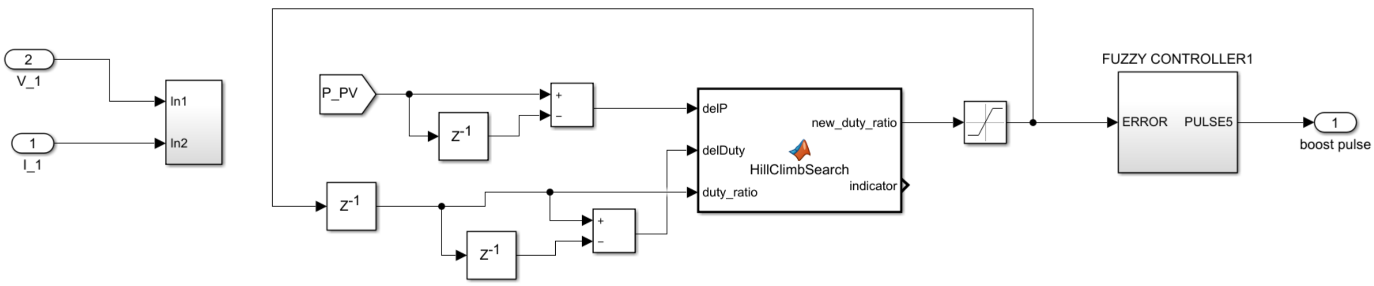


Figure 5 Pulse production



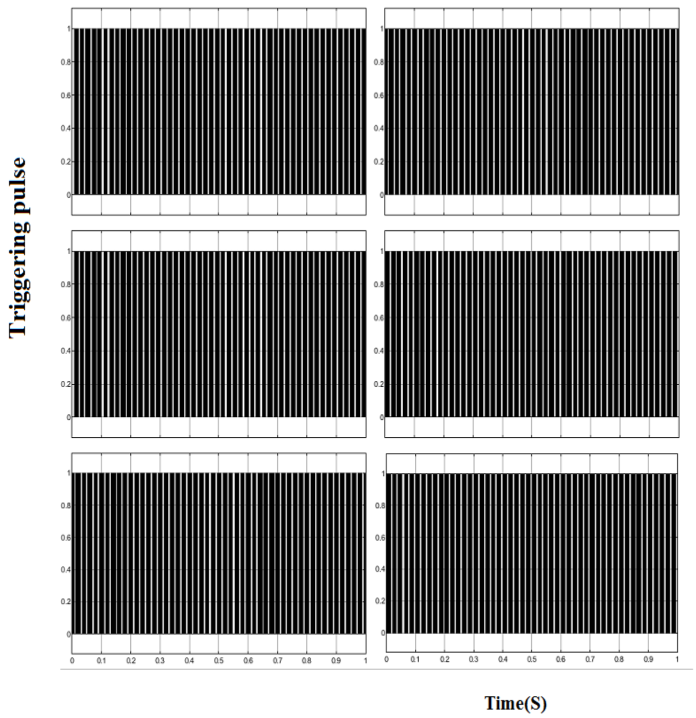


Figure 7 Gate Pulse

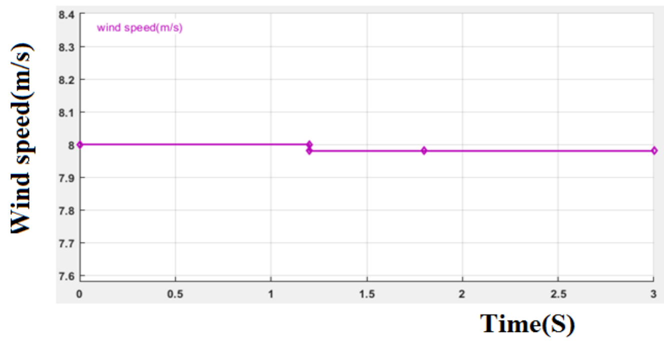


Figure 8 Wind Speed

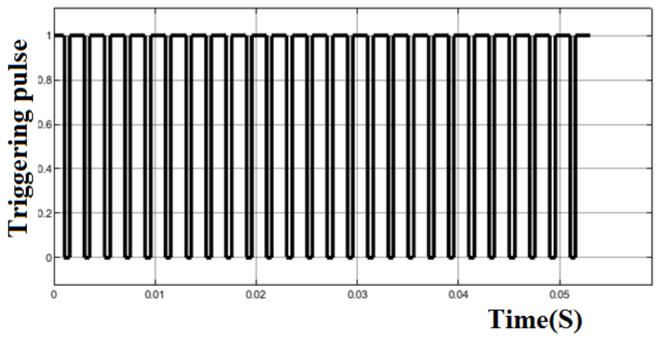


Figure 9 Pulse at Boost converter

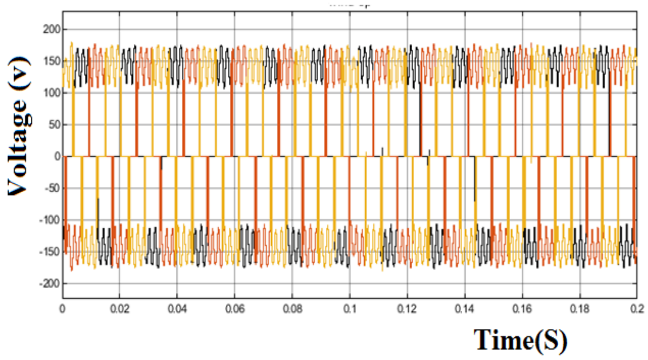


Figure 10 Input voltage at RY,YB,BR

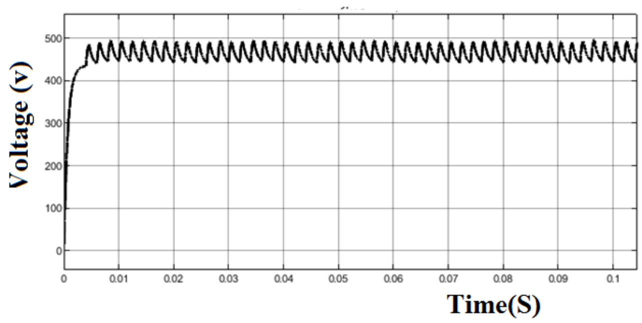


Figure 11 Boost converter output voltage

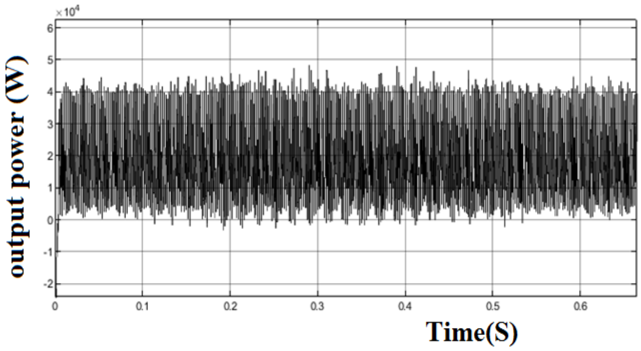


Figure 12 Boost converter output power

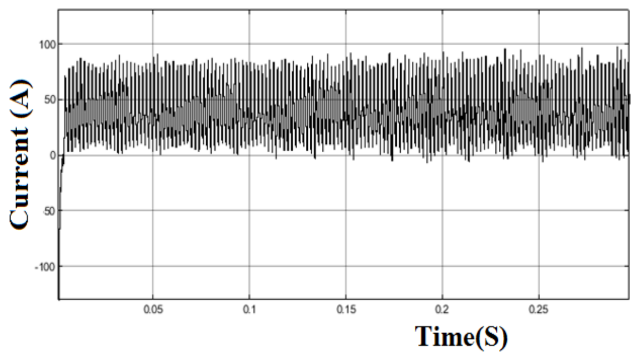


Figure 13 Boost convertor output current

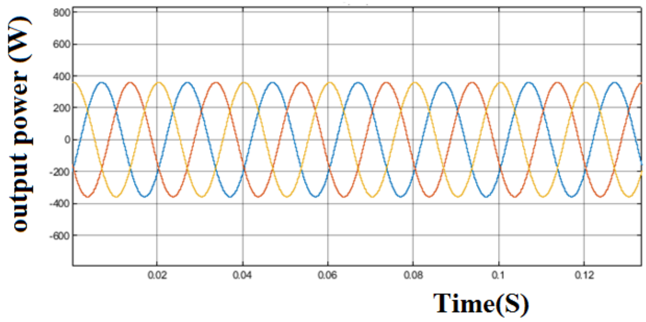


Figure 14 Three phase output Power

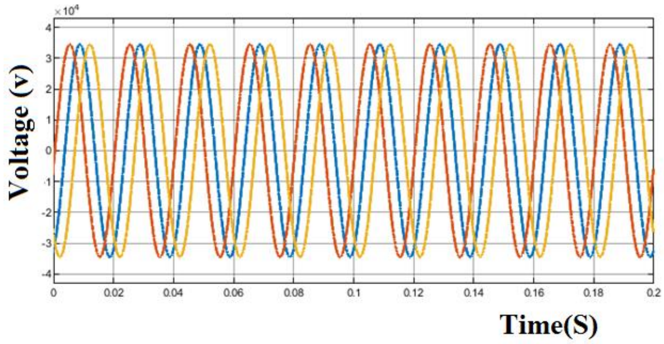


Figure 15 Output Grid Voltage

6. CONCLUSION

In this paper a control method for a doubly-fed induction generator used in wind energy conversion systems using fuzzy logic was designed. The design parameters of fuzzy controller have strong robustness to control system whose varied parameters. The results show that fuzzy controller has better performance and results obtained from a system shows more accurate control performance and faster dynamic response with almost no steady state error.

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BIOGRAPHIES

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