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Zeta DC-DC Converter Based on MPPT Technique for BLDC Application

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Abstract

Zeta converter based BLDC motor for industrial applications is proposed in this paper. Speed of the motor is controlled by using the back EMF with hysteresis controller. The proposed method is designed and implemented to attain speed and reduce the input voltage fluctuations. It gives high voltage gain ratio with improved capability. It is a combination of zeta and quadratic boost converter. An improved design is implemented inverter output voltage, and speed of the motor is verified using MATLAB/Simulink.

Keywords: Wind, Zeta converter, Wind, BLDC, Wind MPPT.

1. Introduction

In Due to the advantages of high energy density, less maintenance, more efficient, and smaller in size, BLDC motor is generally predictable as being greater for a number of reasons. 3-phase 3- phase winding on stator and magnet on the rotor is called as BLDC motor drive. It has no mechanical parts and no electronically commutated parts, Hall Effect sensor is used to sense the position of the rotor [1-2]. There is necessity to improve the quality of power at mains. Hence converters are implemented in front of BLDC motor [3-4]. There are different converter are available to improve the voltage from source like boost, SEPIC, buck-boost, fly back, and zeta. Zeta converter is a 4th order non-linear system made-up of 2 inductor, 2 capacitor and proficient of operating in either voltage boost or buck mode or inverse of SEPIC [5-8]. Generally Zeta converter is classified into isolated and non isolated type converter. The performance of this converter is similar as buck boost converter and high output voltage gain. Advantages of the zeta converter over the SEPIC converter are mentioned below easier compensation, and lower output-

voltage ripple. Among all renewable energy resource wind is also has growing attention in recent days. However, output from the wind generator is depends on the air [9]. It is low conversion efficiency for production. Due to the load variation, wind, this factor reduces the efficiency of the system. MPPT is performs to improve the efficiency of the renewable system which tracks the maximum power point of the wind. In many applications MPPT based control technique is used for DC-DC converter. It is obtained by using the P&O method. Because of it easy to install, maintenance, simplicity and efficiency it is most commonly used [10-11]. In this paper, speed control of BLDC motor using Zeta converter based Hysteresis controller for reducing the settling time of the drive.

2. Proposed Methodology

Improves performance of BLDC motor control using ZETA converter sensor less vector control technique where DC supply is preferred for powering the motor. The sensor less control technique does not use position and speed sensors instead make use of voltage and current measurements. Sensor less vector control technique with back EMF estimation methods corresponds to reference speed commands quickly. A single hysteresis band controller is used to generate reference voltage for sine PWM generation which removes the phase delay in back-EMF which limits ripple in output voltage to a lesser value. The improved performances of sensor less BLDC motor with various control techniques are verified. The dc link voltage, Speed and torque characteristics is achieved using indirect field oriented control method.

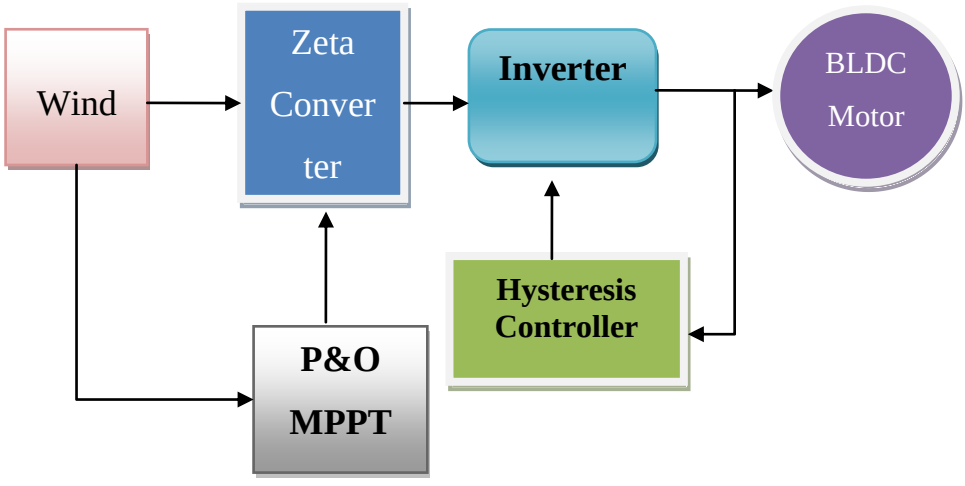

Figure. 1 Proposed Block Diagram

3. Wind Energy

PV Wind energy is structure sun based energy. It is origin by the irregular warming of the climate by the sun, variety in the earth surface, and pivot of the earth. Mountains, waterway and impact all vegetation wind stream designs. The change of AC-DC control production utilizing wind turbine strengthen PMSG is appeared in fig. 2. Fig. 3 shows the wind energy generation design in MATLAB. Wind energy expresses that the procedure is utilized to create power. Wind turbine which is utilized to produce power. Wind turbine machine is utilized for changing over the dynamic energy in the breeze into mechanical energy. Mechanical energy is changed over to power the changing over machine is known as a wind generator. There are three key variables influence the measure of energy in turbine can be tackle from the breeze. It comprises of wind speed, air thickness, and cleared area.

$$P = \frac{1}{2}\,\rho \text{Area} V^3 \qquad (1)$$

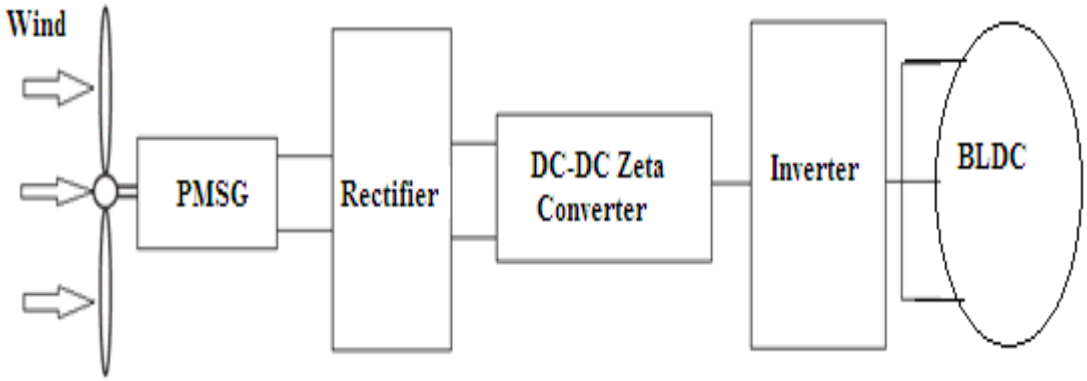

Figure. 2 Block Diagram of Wind Energy Generation

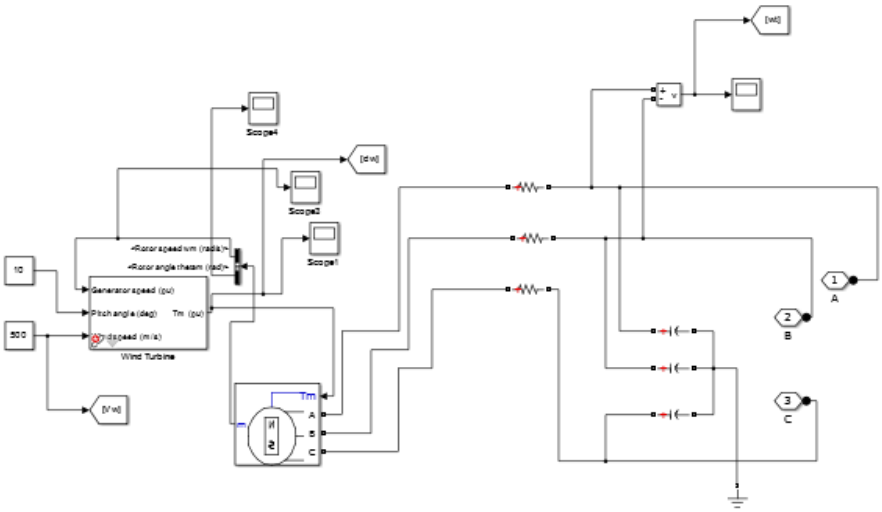

Figure. 3 Simulink Model of Wind Energy Generation

4. Zeta Converter

A zeta converter is a 4th order non direct system. Circuit diagram of the proposed Zeta converter is shown in fig.4. It consists of 2-inductor (L1, L2), 2-capacitor (C1, C2), 1-switch (S) and 1-diode. In charging mode, switch (S) is turn ON, then the diode (D) is turn OFF. In this period, the current flows through an inductor and drawn voltage from the source. In discharging mode, switch (S) is turn OFF and the diode (D) is ON, energy from the source is discharging through the load. Reduce DC link capacitor voltage stress that appeared by the torque ripples at the BLDC motor drive.

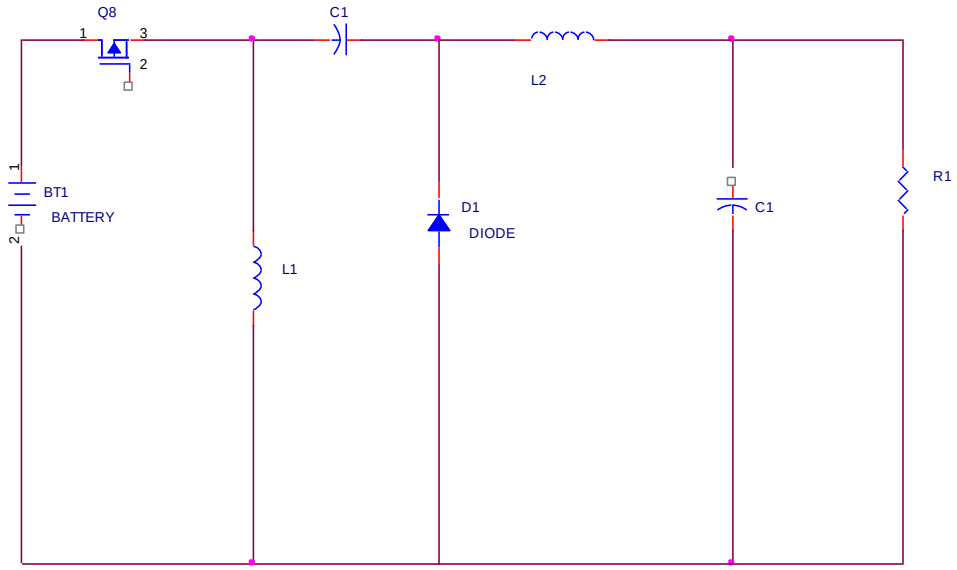

Figure. 4 Circuit Diagram of Zeta Converter

The zeta converter output voltage is

$$\frac{V_{output}}{V_{input}} = \frac{D_0}{1-D_0} \tag{1}$$

5. MPPT

There are different control techniques and algorithms used for the MPPT process. The algorithms are based on the iterative method such as Perturb and Observe (P&O) and Incremental Conductance approach. Figure 4 shows the MATLAB diagram of incremental conductance approach. This paper employs the incremental conductance method because it has advantage of producing the accurate results than the P&O approach. The incremental conductance method summons the process of measuring and calibrating the voltage and current incremental changes of the wind array. The conditions are given by,

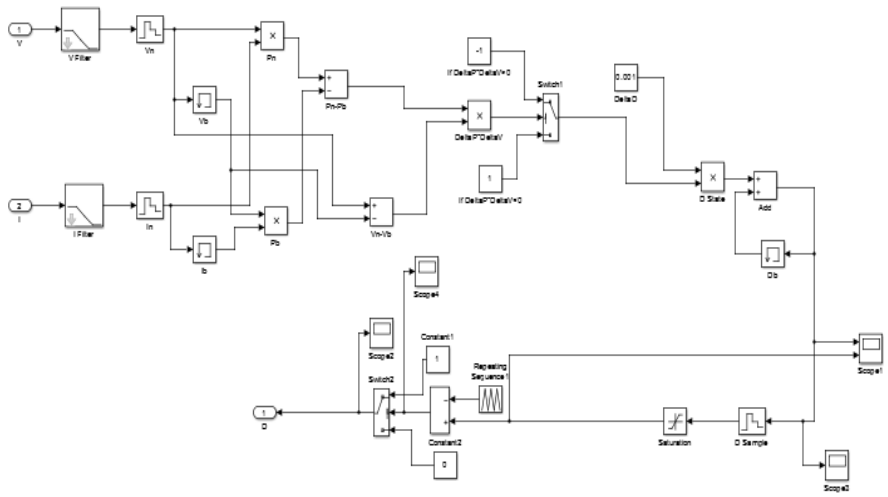

Figure. 5 MPPT Model in Simulink

6. Back EMF Observer

To validate the speed and position of motor for applying sensor less control procedure back EMF observer technique is utilized. This technique depends on BLDC engine scientific model with straightforward estimations and no tuning procedure included. The capacity of spectator is to appraise back EMF of BLDC engine drive from detected estimation of terminal voltage and flows at BLDC engine windings. Back EMF is determined from line voltage and line current flow utilizing connection given in condition (1).

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} R & 0 & 0 \\ 0 & R & 0 \\ 0 & 0 & R \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} + \begin{bmatrix} L-M & 0 & 0 \\ 0 & L-M & 0 \\ 0 & 0 & L-M \end{bmatrix} \frac{d}{dt} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} + \begin{bmatrix} e_a \\ e_b \\ e_c \end{bmatrix} \quad (2)$$

7. Hysteresis controller

The sensor less control scheme including reference voltage signal generation for hysteresis sinusoidal PWM generation and closed loop control involved is shown in figure 3.6. The current process of sensor less control technique in any motor control applications is sensing three phase voltage, current and back-EMF of motor and then deriving required speed or position signal from machine mathematical model. Performance enhancement of the sensor less controller

is done by adding a low pass filter to remove noise and higher frequency components from sensed three phase voltage.

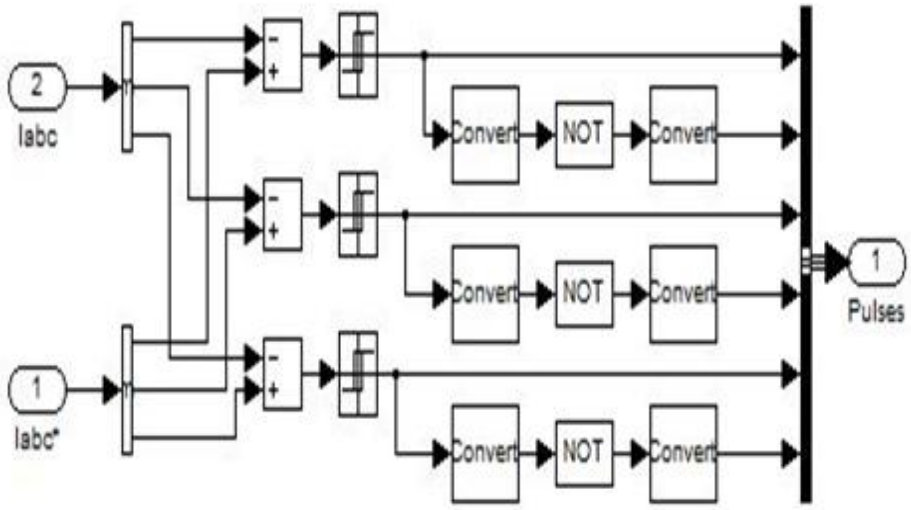

Figure. 6 Hysteresis Controller

7. Simulation Results

Closed loop overall simulink diagram of Zeta converter based BLDC motor control is delineated in Fig.7. Power from Source is fed to the zeta converter which boosts the input voltage with the 3.75 voltage gain ratio. Then it transfers to the load BLDC drive through three phase inverter. The generated voltage and current feedback to the back EMF observer and it produces the speed as input of Hysteresis controller which control and generates pulses to the inverter with the help of current regulator.

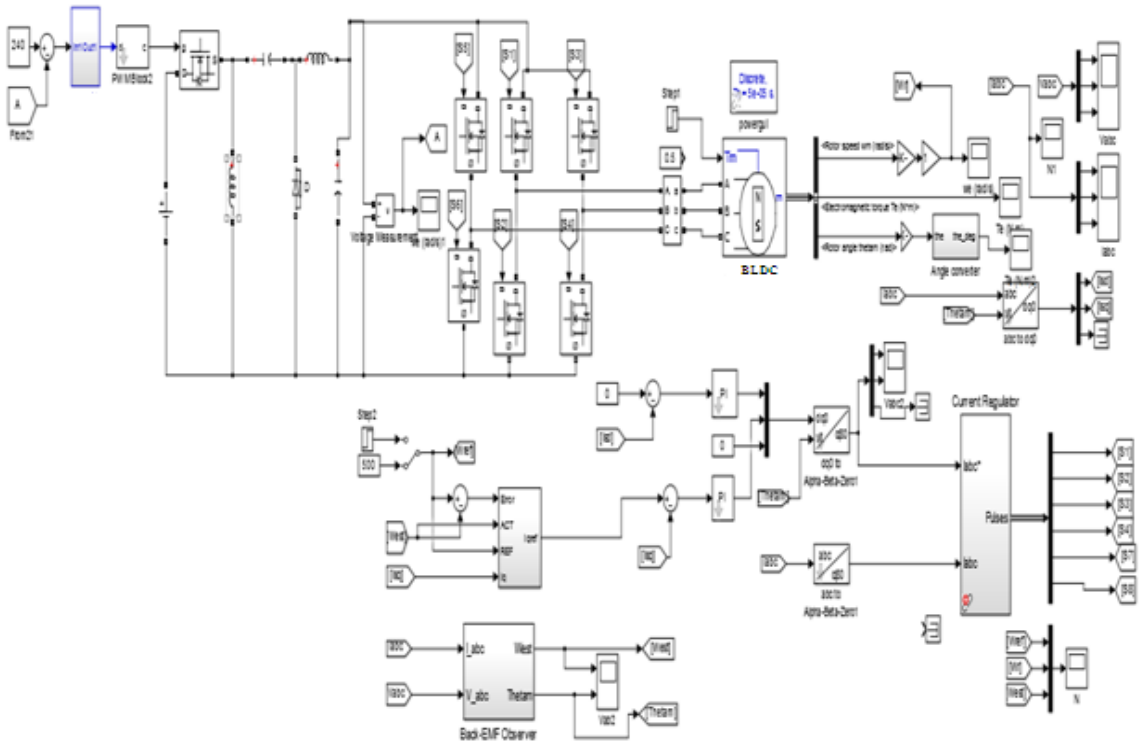

Figure. 7 Simulink Model of the Proposed Zeta Converter Fed BLDC Motor

Fig. 8 represents the waveform of wind voltage and current and its value is 80V, and 8amps. Fig.9 shows the DC link capacitor voltage of the Zeta converter and its value is 300V.

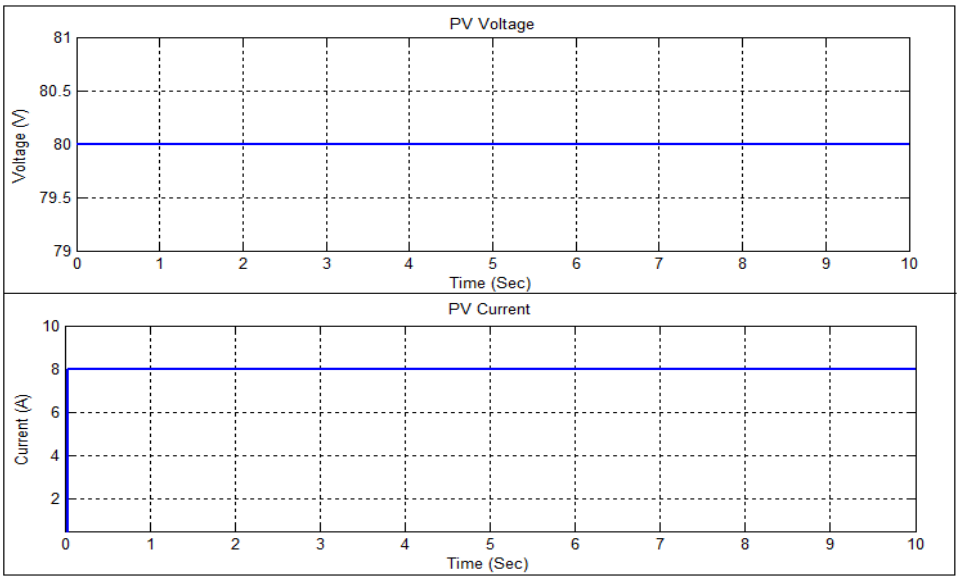

Figure. 8 Wind Voltage and Current

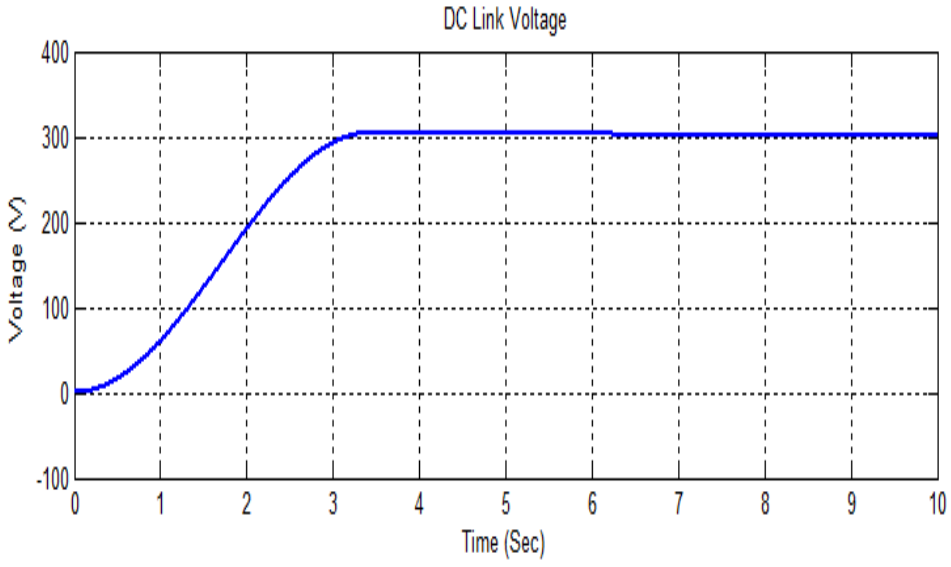

Figure. 9 DC Link Capacitor across Voltage Waveform

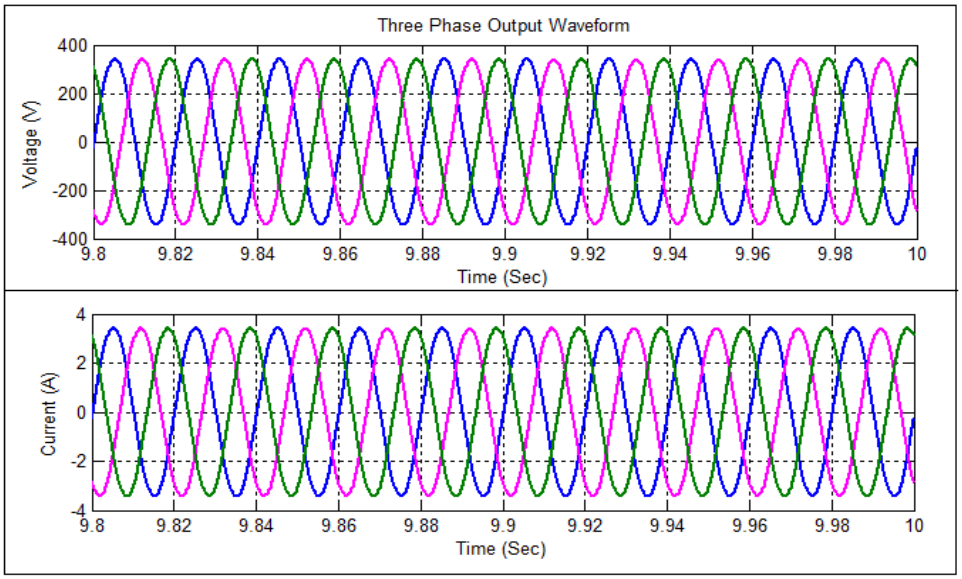

Figure. 10 Three Phase Voltage and Current Waveform

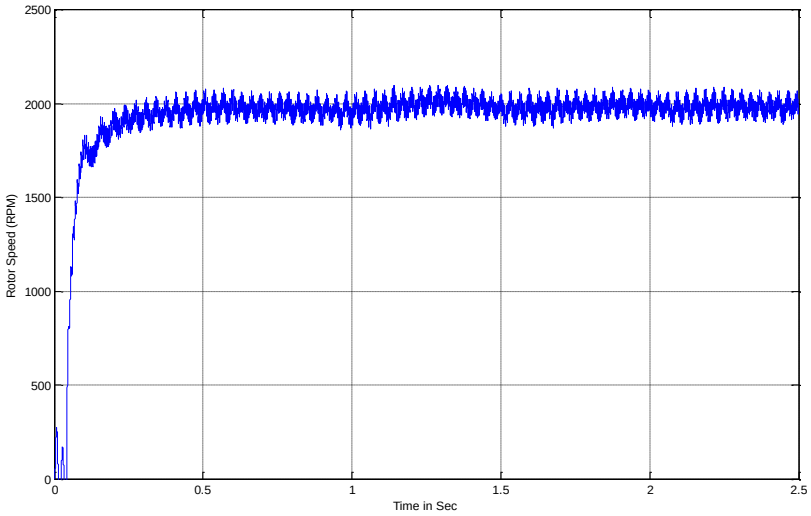

Figure. 11 Speed of a BLDC

7. Conclusion

This paper presented a speed controller using a PI controller for hysteresis of BLDC drives fed by a ZETA converter from wind source. Low voltage gain is achieved through ZETA converter using fuzzy logic controller. The project describes the ZETA converter fed BLDC drive. The topology can effectively reduce the capacitor voltage stress and improve the DC link capacitor voltage gain and its value 300V. The settling time of the BLDC motor drive is 0.2sec. The output results are obtained, and the obtained results are verified through Matlab/Simulink.

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