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BLDC Drive Speed Control with Quasi Z-Source Inverter Using Back EMF Estimation Control

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Abstract:
In this portion, the BLDC motor drive is proposed with quasi Z-source inverter (qZSI) interfaced with separate DC supply. The closed loop system is performed with the back EMF estimation control with PI controller. The proposed Z- source converter is controlled and the gate switching signals are provided by the Pulse Width Modulation (PWM). The DC- AC inverter is Z- source inverter which performs both conversion and inversion operation of proposed system. The bridges of the inverter power switches are controlled by proposed control methods. The PI controller with the current regulator provides the gate signals to the inverter part which act as the input supply for the BLDC motor drive. The performance of the BLDC with proposed system is verified using MATLAB/Simulink.

Keywords: *BLDC motor, quasi ZSI, PWM, and back EMF estimation method*

1. INTRODUCTION

Recently, in many applications brushless direct current motor is more interesting such as blower, and compressor in applications of high speed. Due to the high efficiency, low cost and less maintenance, this kind of motors are preferred. Normally, to run the blower and compressor, the speed of the drive is achieved the thousands of RPM. Generally, the brushless motor operation is important regarding its six signals of the discrete rotor position [1-2]. The DC-DC converter is normally used to power control and improve the supply voltage. The DC link voltage can be improved only by using the converters [3]. The converters are may be following as, buck converter, boost converter, ZETA converter etc. but to reduce the passive components in the supply side converter a z- source inverter is introduced. The certain inverter is done both the operation of DC-DC and the DC-AC performance. Many control methods are recently used for the purpose of system control [4-5]. The speed control and torque control are achieved using many control methods [6].The back EMF method is implemented to sensor less detection and the method consists of control the points of terminal voltage back EMF zero crossing. The method of sensor less back EMF is proposed by the k. lizuka [7-8]. The method is obtaining good results in the motor applications. While comparing with other conventional methods, the back estimation technique is dynamic performance and high accuracy [9-11].In this paper, the proposed quasi ZSI is analyzed and speed control of the BLDC drive is derived. The back EMF estimation control is briefly determined. The proposed system is implemented and verified using the Simulink software.

2. PROPOSED SYSTEM

In the proposed system, quasi-z source inverter is interfaced with BLDC motor drive and

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the speed of the system is controlled using back EMF estimation technique. This system consists of DC supply, Brushless Direct Current (BLDC) drive, quasi Z- source inverter, PI controller and back EMF estimation. The block diagram of the proposed system is shown in Fig.1.

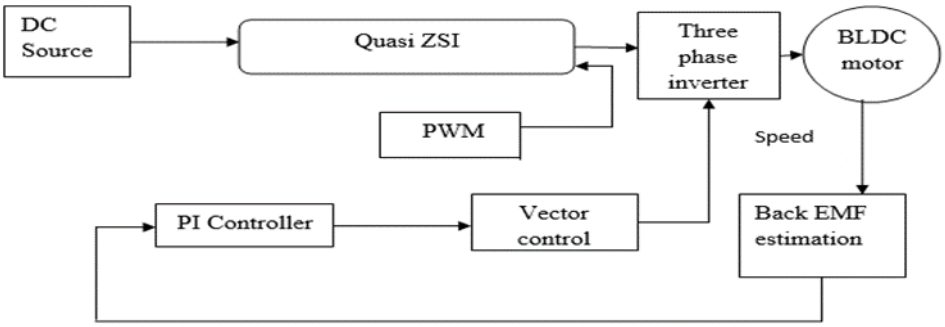

Fig. 1 Proposed system block diagram

2.1 Proposed quasi Z- source inverter:

The proposed quasi Z- source inverter is shown in Fig.2. this system is used to BLDC speed and torque expansion for the electric vehicle of traction motor. The inverter that proposed ensures the constant DC bus voltage. The inverter is interfaced between the DC power supply and required load. Since the proposed system operates in high voltage gain state, the motor can be operated in widened in terms of speed and torque range. According to this system, the weight and volume of the system will not be increased but at the same time, the power output and motor torque are enhanced while compared with conventional systems.

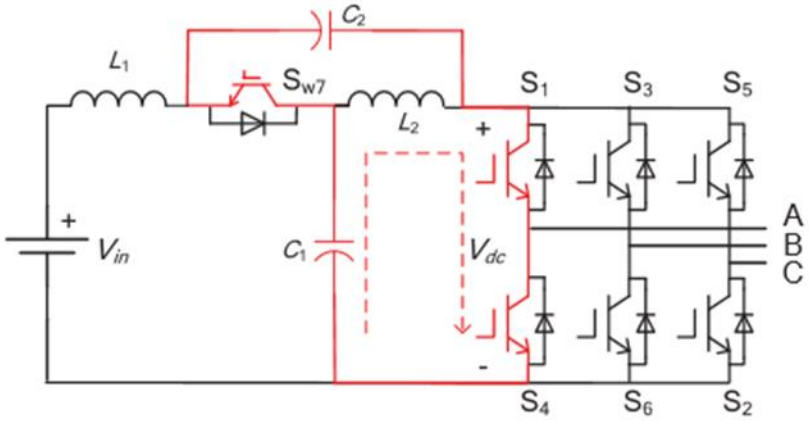

Fig.2 Proposed quasi Z- source inverter

In the proposed inverter, the shoot-through state of operation is allowed and the DC bus voltage is regulated at the same time the reliability is improved. The motor regenerative energy is given back to the DC power supply by using feedback system which is based on the motor speed regulation. This inverter is used to regulate the DC link capacitor voltage which is input to inverter. It uses low active components and permits shoot through state for more reliability. In terms of motor, the copper loss is much smaller in this proposed Z-source inverter.

2.2 Back EMF Estimation Control:

The sensor less estimation approach is based on the assumption that the rotor position a can be

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measured using an induction motor's back-EMF. Since an induction motor back-EMF cannot be determined explicitly, an unknown input observer can estimate that. This unknown input observer is constructed by a back-EMF which is called an unknown input and state of the motor drive mechanism for induction. The block diagram of sensor less control method using back EMF is shown below. Initially, three phase voltage and currents are obtained from the respective voltage and current transducers and transferred to d-q reference frame, and speed is determined by dividing the maximum EMF value back by the number of poles. The exact location of the rotor is needed for precise control of the BLDC motor and thus an encoder or position sensor must be mounted, but these sensors are highly costly and special arrangements must be made to mount these sensors. Therefore separate velocity and location estimation methods are used to measure the motor speed without any sensor.

3. SIMULATION AND RESULTS

The below Fig.3 shows that the proposed BLDC drive based on quazi Z- source inverter simulation for speed and torque range control. The DC supply is given as input source 12V. The given input source is fed to proposed quasi Z- source inverter which consists of reduced amount of active components that improve the source voltage as well as that ensures the constant DC link voltage. The Pulse Width Modulation control is used to proposed quasi Z- source inverter's power switch of conversion side that means DC-DC conversion.

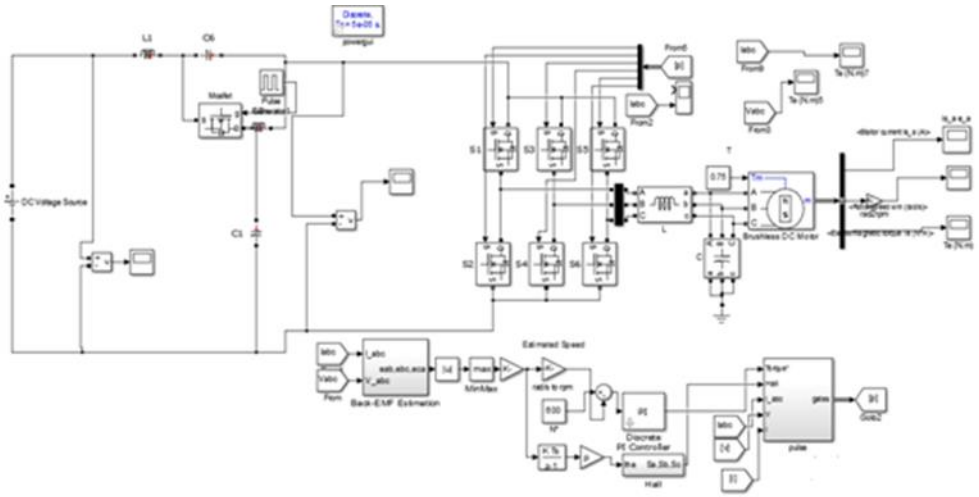

Fig. 3 Proposed System Simulation

The duty cycle of the MOSFET power switch is 0.5. The six power switches of the inverter side are controlled by using the proposed back EMF estimation method. According to this method, the speed of the drive and torque range can controlled widely. The waveforms for the input voltage, Dc bus voltage, inverter voltage, and drivespeed are shown in following Figures.

The input supply voltage for the given quasi ZSI is 12V as shown in belowFig. 4and the supply voltage is after improved by the DC- AC quasi Z- source inverter.

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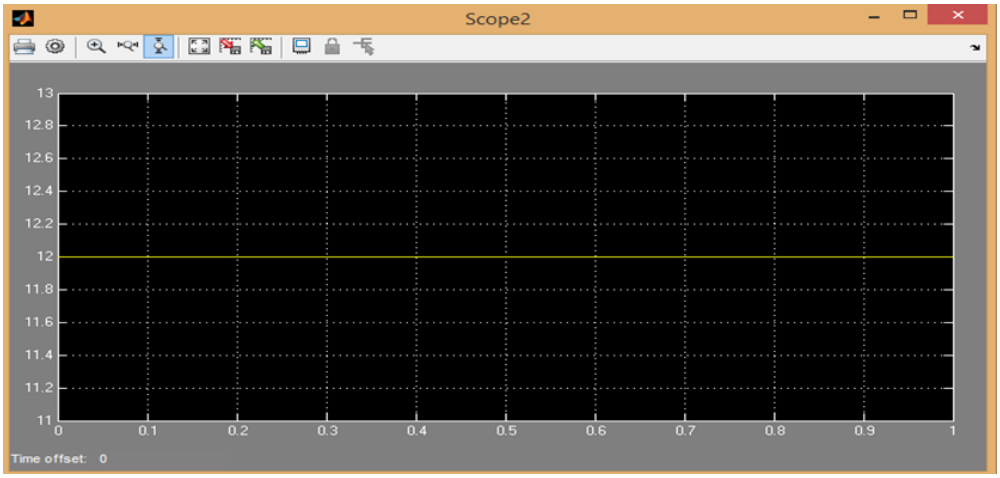

Fig. 4 Proposed System Input Voltage

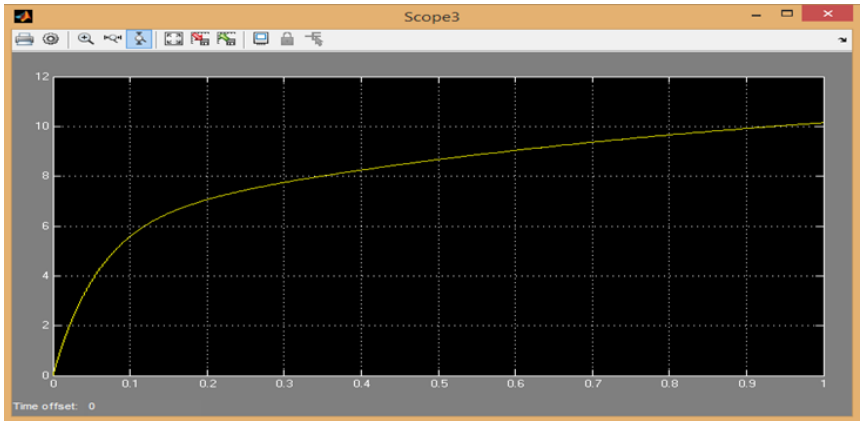

Fig. 5 DC link bus voltage

The DC bus voltage of proposed drive control system is shown in Fig. 5 and it can be done by the proposed inverter. The DC link voltage is fed to the three legs of six switches side. Here, the DC voltage is converted into AC voltage.

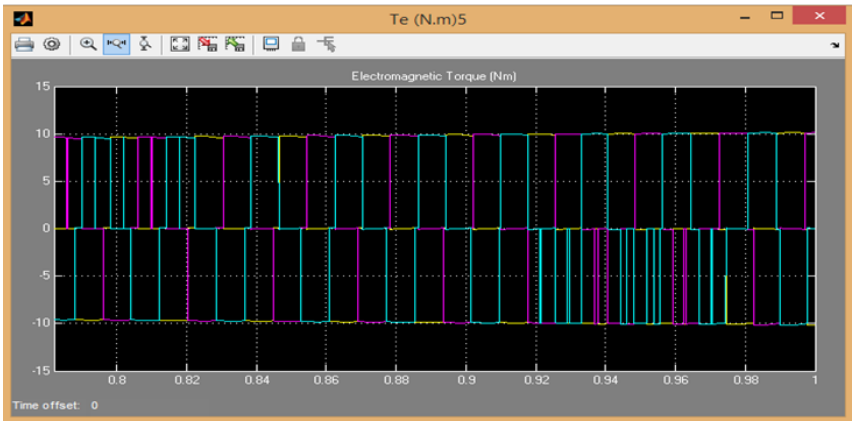

Fig. 6 Quasi Z- source inverter Output voltage

The quasi Z- source inverter output is shown in Fig. 6 the output of the proposed inverter is before using LC filter. The switching signals to the power switches are provided from the back EMF estimation control method. The stator current of the BLDC

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drive is shown in Fig. 7the motor drive stator current is 8.5 A.

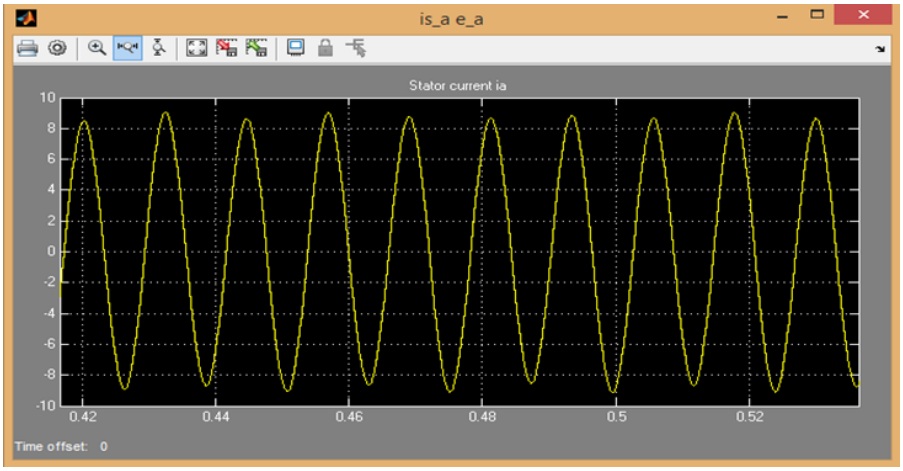

Fig. 7 Stator Current of BLDC motor

The speed of the proposed system is controlled and the speed of the BLDC motor is 610 revolution per minute (RPM). The motor speed is settled in quickly by means of back EMF estimation controller. The settling time of the proposed system is 0.2 sec. The ripples also reduced. The Fig. 8 is showing that the BLDC drive speed which is controlled and settled quickly.

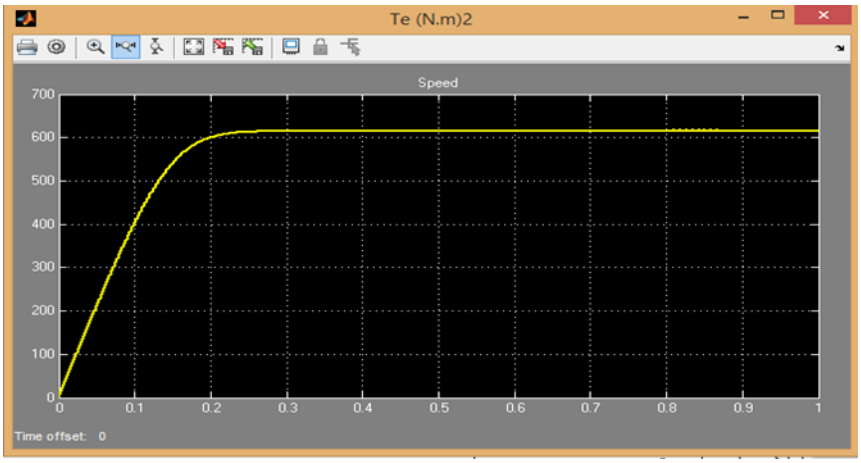

Fig. 8 Speed of the BLDC drive

4. CONCLUSION

In this paper, the BLDC drive based on quasi z-source inverter is designed with the back EMF estimation technique is proposed. The speed of the drive can be regulated using with proposed controllers. The drive speed and efficiency is improved and the dc supply voltage is improved by quasi z- source inverter. The results are verified and examined in MATLAB/Simulink and it shows that motor torque range and speed enlargement. The speed of the drive is achieved 610 rpm with the help of proposed control method. The settling time of the BLDC drive speed is 0.2 sec. The voltage boosting method and the efficiency of this proposed method is high while compared with traditional systems.

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