Isolated Zeta Converter for BLDC Motor Control with Hysterises Current Controller for Torque Ripple Minimization

[1]Gaddamidi Shiva Rama Rao, [2]Mohammed Shahzoor, [3]Syed Shahbaz Ahmed, [4]V.L.Surya Prabha, [5]R.Venkat Krishna
[123]B.Tech Student, [45]Asst.Professor
[12345]*Department Of Electrical & Electronics Engineering,*
Lords Institute Of Engineering And Technology
Hyderabad, Telangana, India.

ABSTRACT: *This paper presents a brushless dc (BLDC) motor drive with power factor correction (PFC) for low-power applications. In this the speed of the BLDC motor is controlled by adjusting the dc link voltage of the voltage source inverter (VSI) feeding a BLDC motor. Therefore, VSI is used for achieving only an electronic commutation of the BLDC motor and operates in a low frequency switching for reduced switching losses. A PFC based isolated zeta converter operating in discontinuous conduction mode (DCM) is used for controlling the dc link voltage of the VSI with inherent PFC at ac mains using single voltage sensor. The proposed drive is implemented to achieve a unity power factor at ac mains for a wide range of speed control and supply voltage fluctuations.*

Methods/analysis: *According to the reference values we give to the zeta converter, Operation of zeta converter has two modes of conduction mode. Continuous and discontinuous conduction modes. In order to minimize the torque ripples most methods are complicated and do not consider the stator flux linkage control, therefore, possible high-speed operations are not feasible. In this project a simple approach to achieve a low frequency torque ripple-free direct control with maximum efficiency is presented. Simulation results are presented using MATLAB software.*

Novelty: *With the use of hysteresis current controller we able to minimize the torque with ripple free*

Keywords: *Brushless dc (BLDC) motor, discontinuous conduction mode (DCM), isolated zeta converter, power factor correction (PFC), power quality, voltage source inverter (VSI).*

I. INTRODUCTION

Efficiency and cost are the major concerns in the development of low-power motor drives targeting household applications such as fans, water pumps, blowers, mixers, etc The use of the brushless direct current (BLDC) motor in these applications is becoming very common due to features of high efficiency, high flux density per unit volume, low maintenance requirements, and

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

low electromagnetic-interference problems . These BLDC motors are not limited to household applications, but these are suitable for other applications such as medical equipment, transportation, HVAC, motion control, and many industrial tools A BLDC motor has three phase windings on the stator and permanent magnets on the rotor The BLDC motor is also known as an electronically commutated motor because an electronic commutation based on rotor position is used rather than a mechanical commutation which has disadvantages like sparking and wear and tear of brushes and commutator assembly. Many topologies of the single-stage PFC converter are reported in the literature which has gained importance because of high efficiency as compared to two-stage PFC converters due to low component count and a single switch for dc link voltage control and PFC operation. The choice of mode of operation of a PFC converter is a critical issue because it directly affects the cost and rating of the components used in the PFC converter. The continuous conduction mode (CCM) and discontinuous conduction mode (DCM) are the two modes of operation in which a PFC converter is designed to operate In CCM, the current in the inductor or the voltage across the intermediate capacitor remains continuous, but it requires the sensing of two voltages (dc link voltage and supply voltage) and input side current for PFC operation, which is not cost-effective. On the other hand, DCM requires a single voltage sensor for dc link voltage control, and inherent PFC is achieved at the ac mains, but at the cost of higher stresses on the PFC converter switch; hence, DCM is preferred for low-power applications. The conventional PFC scheme of the BLDC motor drive utilizes a pulse width-modulated voltage source inverter (PWM-VSI) for speed control with a constant dc link voltage. This offers higher switching losses in VSI as the switching losses increase as a square function of switching frequency. As the speed of the BLDC motor is directly proportional to the applied dc link voltage, hence, the speed control is achieved by the variable dc link voltage of VSI. This allows the fundamental frequency switching of VSI (i.e., electronic commutation) and offers reduced switching losses.

II. Block Diagram and Description

Working of block diagram:

AC Input of 270V 50Hz supply is given to Diode Bridge Rectifier and DC output is connected to input of zeta converter where it is dc-dc converter and buck boost converter. The Dc-Dc voltage is connected to the voltage source inverter. From VSI to BLDC motor. from this BLDC motor we can know speed torque characteristics of BLDC Motor. The speed of the BLDC motor is sensed by the hall sensors from the rotor and those signals are converted into phase signals by electronic commutation. The reference voltage is compared to the voltage at zeta converter.

The Main blocks are:

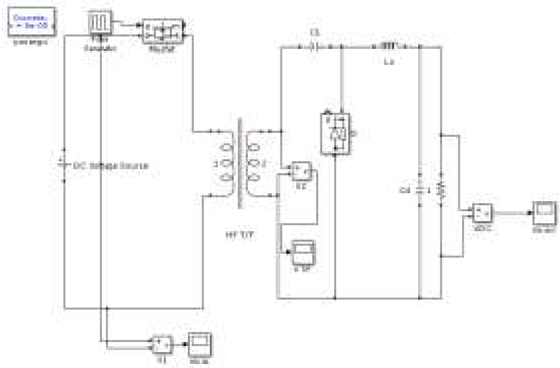
1. **Diode Bridge Rectifier**: A diode bridge rectifier (DBR) with a high value of smoothening capacitor is generally used for feeding the BLDC motor. It draws a distorted supply current from ac mains due to uncontrolled charging and discharging of the dc link capacitor [7]. Such type of supply current is highly distorted in nature and has a very high total harmonic distortion (THD) in the order of 65%–70% which further leads to a poor factor (PF) in the order of 0.7–0.72 at ac mains. Another major problem in such drive is the cost of current sensors required for achieving the pulse width modulation (PWM)-based current control of BLDC motor for speed control This suffers from high switching losses in three-phase VSI due to high frequency switching of PWM signals

2. **Voltage Source Inverter:** The above losses are reduced by Voltage Source Inverter(VSI) in fundamental frequency switching by electronically commutating the BLDC motor. Moreover, the speed is controlled by varying the dc link voltage of VSI. This reduces the switching losses of VSI and eliminates the requirement of current sensors for PWM based current control of BLDC motor for speed control.

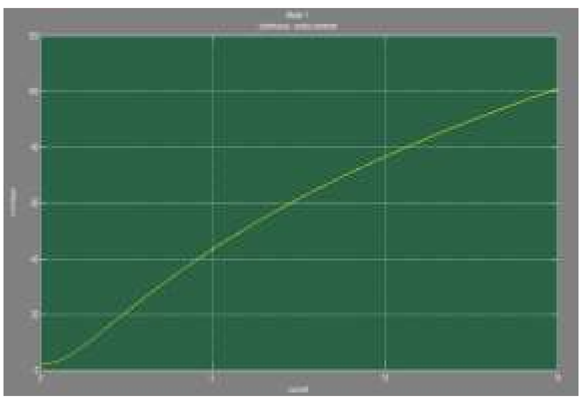
3. **Isolated Zeeta Converter:** The improved power factor and closed loop speed control of PMBLDCM using closed loop Zeta converter are proposed. In the proposed model, a closed loop zeta converter is used for active Power Factor Correction as well as for voltage regulation. It is having advantages of being naturally isolated structure, can operate as both step-up and step-down voltage converter and having a single stage processing for both voltage regulation and power factor correction. The wide range of speed control of PMBLDC motor is achieved by controlling the voltage of DC link capacitor of zeta converter. An active power factor correction is performed by using a zeta converter operating in Continuous Conduction Mode (CCM), where the inductor current must follow a sinusoidal voltage waveform. In addition to this, the sensorless scheme of feedback control is implemented in PMBLDC motor which reduces the usage of Hall position sensors. This method provides nearly unity power factor and also the implemented scheme improves the power factor and wide range of speed control of Permanent Magnet Brushless DC (PMBLDC) motor

Mode 1: Continuous conduction mode

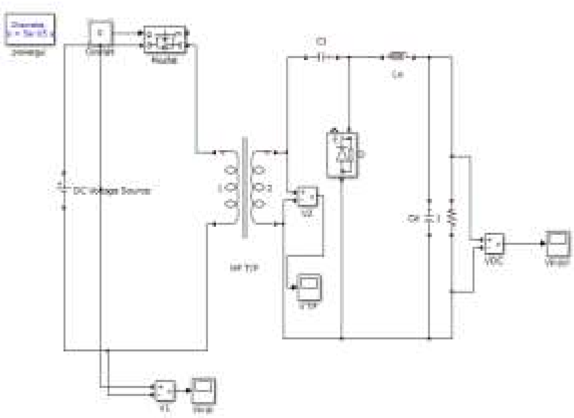
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

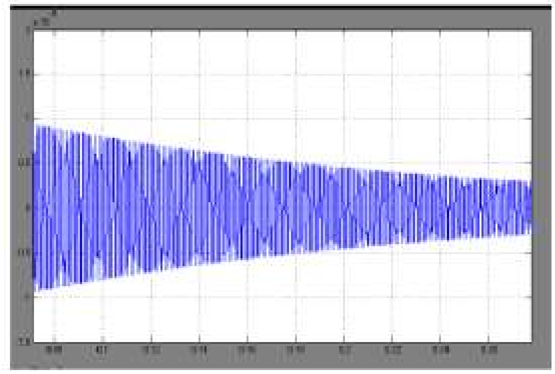


Output for Continuous conduction mode:



Mode. 2.Discontinuous conduction mode





BLDC Motor:A typical brushless motor has permanent magnets which rotate around a fixed armature, eliminating problems associated with connecting current to the moving armature. An electronic controller replaces the brush/commutator assembly of the brushed DC motor, which continually switches the phase to the windings to keep the motor turning. The controller performs similar timed power distribution by using a solid-state circuit rather than the brush/commutator system. Brushless motors offer several advantages over brushed DC motors, including more torque per weight, more torque per watt(increased efficiency), increased reliability, reduced noise, longer lifetime (no brush and commutator erosion), elimination of ionizing sparks from the commutator, and overall reduction of electromagnetic interference (EMI). With no windings on the rotor, they are not subjected to centrifugal forces, and because the windings are supported by the housing, they can be cooled by conduction, requiring no airflow inside the motor for cooling. Brushless motor commutation

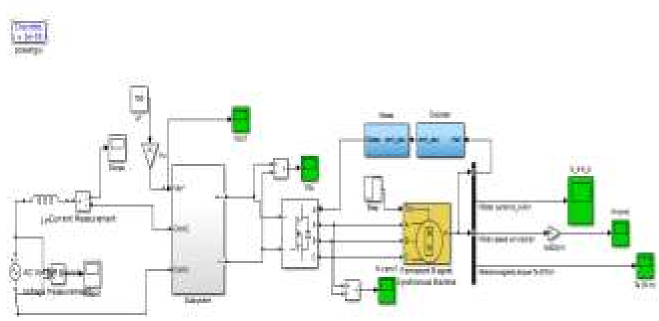
International Journal of Research
Available at
https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

can be implemented in software using a microcontroller or microprocessor computer, or may alternatively be implemented in analogue hardware, or in digital firmware using an FPGA. Commutation with electronics instead of brushes allows for greater flexibility and capabilities not available with brushed DC motors, including speed limiting, "micro stepped" operation for slow and/or fine motion control, and a holding torque when stationary. The maximum power that can be applied to a brushless motor is limited almost exclusively by heat] too much heat weakens the magnets and may damage the winding's insulation. When converting electricity into mechanical power, brushless motors are more efficient than brushed motors. This improvement is largely due to the brushless motor's velocity being determined by the frequency at which the electricity is switched, not the voltage. Additional gains are due to the absence of brushes, which reduces mechanical energy loss due to friction. The enhanced efficiency is greatest in the no-load and low-load region of the motor's performance curve under high mechanical loads, brushless motors and high-quality brushed motors are comparable in efficiency. Environments and requirements in which manufacturers use brushless-type DC motors include maintenance-free operation, high speeds, and operation where sparking is hazardous (i.e. explosive environments) or could affect electronically sensitive equipment

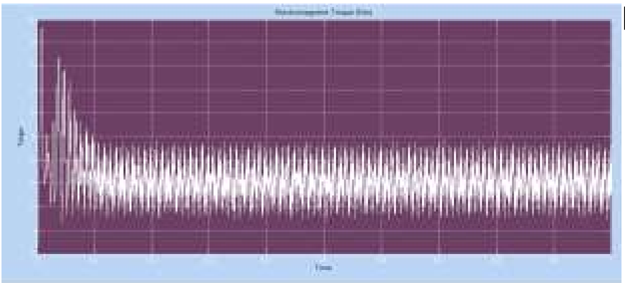
Hystersis current controller: A novel hysteresis current control for active power filter (APF) is suggested which is based on optimal voltage vector and in the meantime with constant switching frequency. In the method the location region of the reference voltage vector is detected quickly by a set of hysteresis comparators through one try-and-error process. Two appropriate switches are then selected to control the corresponding two line-to-line currents independently with constant switching frequency. The new method has the advantages of fast allocation of reference voltage space vector, good current tracking accuracy, and constant switching frequency. Therefore, it is efficient and safe in operation. Computer simulation results show that the new current control method can improve APF performance noticeably

III. SIMULATION AND ITS RESULTS

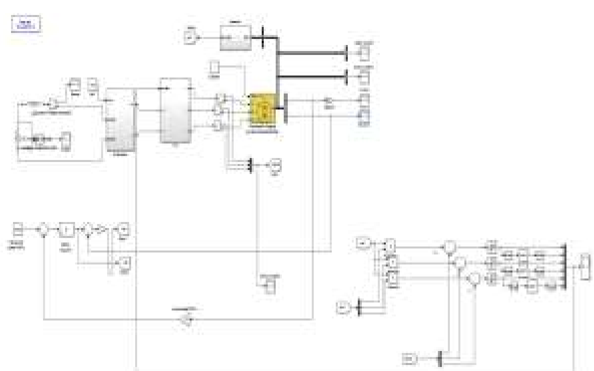
Torque for Isolated Zeta Converter for BLDC Motor Control:

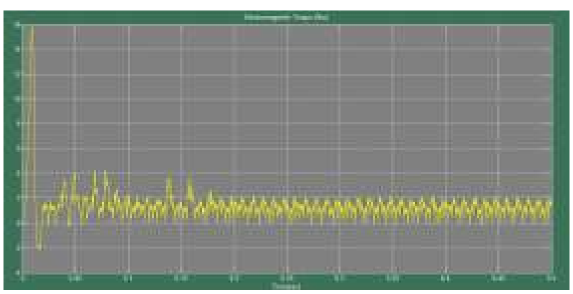


p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017



Torque for Isolated Zeta Converter for BLDC Motor Control using Hystersis Current Controller:





IV. CONCLUSION:

- Comparing both the simulation results ripple minimization is clearly shown in Isolated Zeta Converter for BLDC Motor Control using Hystersis Current Controller.
- As in Hystersis Current Controller Stating with high torque ripples are reduced and stabilizes within the range of 0 to 2Nm.
- Two appropriate switches are used to control the corresponding two line-to-line currents independently with constant switching frequency.

V. REFERENCES:

[1] VashistBist and Bhim Singh, "A Brushless DC Motor Drive with Power Factor Correction Using Isolated Zeta Converter," IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, Vol 10, no. 4, pp.2064-2072,Nov 2014.

[2] J.E.MURALIDHAR and Dr.P.VARANASI, "Torque Ripple Minimization & Closed Loop Speed Control of BLDC Motor with Hysteresis Current Controller, " 2014 2nd International Conference on Devices, Circuits and Systems (ICDCS),pp.1-10

[3] Y.Chen, C.Chiu, Y.Jhang, Z.Tang, and R. Liang, "A driver for the single-phase brushless DC fan motor with hybrid winding structure," IEEE TRANSACTION OF INDUSTRIAL ELECTRONICS, vol. 60, no. 10, pp. 4369–4375, Oct. 2013.

[4] T.F.Chan, L.T.Yan and S.Y.Fang, "In-wheel permanent-magnet brushless DC motor drive for an electric bicycle," IEEE

[5] X. Huang, A. Goodman, C. Gerada, Y. Fang, and Q. Lu, "A single sided matrix converter drive for a brushless DC motor in aerospace applications," IEEE TRANSACTION OF INDUSTRIAL ELECTRONICS, vol. 59, no. 9, pp. 3542–3552, Sep. 2012.

[6] JunyiShen and AlirezaKhaligh," A Supervisory Energy Management Control Strategy in a Battery/Ultracapacitor Hybrid Energy Storage System," IEEE TRANSACTION ON TRANSPORTATION ELECTRIFICATION, vol 1, no. 3, pp.223-231, Oct 2015.

[7] Ted K. A. Brekken, Hannes Max Hapke, Chad Stillinger, and Joe Prudell," Machines and Drives Comparison for Low-Power Renewable Energy and Oscillating Applications," IEEE TRANSACTIONS ON

ENERGY CONVERSION, vol. 25, no. 4, pp.1162-1170, Dec 2010.

[8] BoussadBoukais, HoucineZeroug, Tizi-Ouzou, Algeria Houari-Boumediene, "Magnet Segmentation for Commutation Torque Ripple Reductionin a Brushless DC Motor Drive," IEEE TRANSACTIONS ON MAGNETICS, vol. 46, no. 11, pp.3909-3919, Nov 2010.

[9] TilakGopalarathnamand Hamid A. Toliyat," A New Topology for Unipolar Brushless DC Motor Drive With High Power Factor," IEEE TRANSACTIONS ON POWER ELECTRONICS, vol. 18, no. 6, pp.1397-1404, Nov 2003.

[10] Bhim Singh, Brij N. Singh, Ambrish Chandra, Kamal Al-Haddad, AshishPandey and Dwarka P. Kothar," A Review of Three-Phase Improved Power Quality AC–DC Converters," IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, vol. 51, no. 3, pp.641-659, June 2004.

[11] Bhim Singh, Sanjeev Singh, Ambrish Chandra, and Kamal Al-Haddad," Comprehensive Study of Single-Phase AC-DC Power Factor Corrected Converters With High-Frequency Isolation," IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, vol. 7,no. 4, pp.541-555, Nov 2011.

[12] Sanjeev Singh and Bhim Singh," A Voltage-Controlled PFC Cuk Converter-Based PMBLDCM Drive for Air-Conditioners," IEEE TRANSACTIONS ON INDUSTRY APPLICATIONS, vol. 48, no. 2, pp.832-838, March/April 2012.

[13] J. Moreno, M. E. Ortuzar, and J.W. Dixon, "Energy-management system for a hybrid electric vehicle, using ultra capacitors and neural networks," IEEE TRANSACTION OF INDUSTRIAL ELECTRONICS, vol. 53, no. 2, pp. 614–623, Apr. 2006.