

A REVIEW PAPER ON ZETA CONVERTER FED BLDC MOTOR DRIVE

¹Akash Ghodake , ²Dr.M.S.Chavan

¹*Electrical Engineering Department ADCET Ashta.(India)*

²*Electronics Engineering Department KIT Kolhapur.(India)*

ABSTRACT

In this paper a single phase supply is given to the zeta converter through diode bridge converter. Instead of two stage converters, a single stage Zeta converter is used for DC link voltage control and power factor correction. The controlled voltage is fed to voltage source inverter. The main objective of this paper is to control Output of Zeta converter to achieve speed control of BLDC motor

Keywords: Brushless DC(BLDC) motor, zeta converter, Power Factor Converter (PFC), Voltage Source Inverter (VSI).

I. INTRODUCTION

The brushless dc motor is rapidly gaining the popularity because of its performance, reliability, efficiency, wide speed control and also suitable for low power applications. The improved power quality converters required for many applications involving power converters [1-4].BLDC diode bridge rectifier and a smoothing DC link capacitor, which results pulsed currents from AC mains and various power quality disturbances such as poor power factor, total harmonic distortion, and high crest factor of current [5].Moreover, various international PQ standards for low power applications such as IEC 61000-3-2[6] emphasize on low THD of AC mains current and power factor is near unity, and therefore various PFC converter topology for BLDCM drive is essential[7].

Two stage PFC converters are widely in practice in which first stage is used for the power factor correction which is preferably a boost converter and second stage for voltage regulation which can be any converter topology depending upon the requirement [7]. This two stage topology is complex and results in higher cost and more losses; hence a single stage Zeta converter is proposed in this paper which is used for DC link voltage control and power factor correction. The operation is studied for a Zeta converter working in DICM (Discontinuous Inductor Current Mode) hence a voltage follower approach is used.

II. PROPOSED SPEED CONTROL OF BLDC MOTOR DRIVE

The proposed scheme for the Brushless motor drive fed by a Zeta based PFC converter operating in DICM mode is shown in Fig.2.1.The front end Zeta DC-DC converter maintains the DC link voltage to a set reference value. Switch of the Zeta converter is to be operated at high switching frequency for effective control and small size of components like inductors. A high frequency MOSFET of suitable rating is used in the front end converter for its high frequency operation whereas an IGBT's (Insulated Gate Bipolar Transistor) are used in the

VSI for low frequency operation. The proposed scheme maintains high power factor and low THD[8] of the AC source current while controlling rotor speed equal to the set reference speed. A voltage follower approach is used for the control of Zeta DC-DC converter operating in DICM.

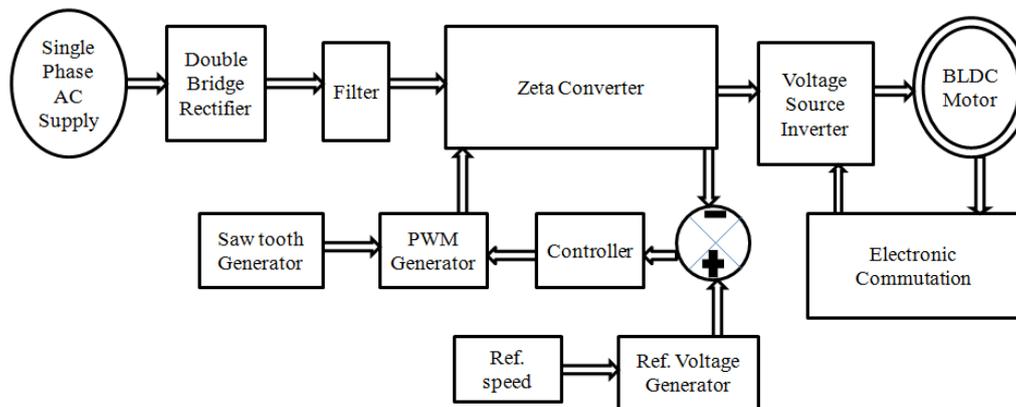


Fig.2.1. Proposed system block diagram

The DC link voltage is controlled by a single voltage sensor. V_{dc} (sensed DC link voltage) is compared with V_{dc}^* (reference voltage) to generate an error signal which is the difference of V_{dc}^* and V_{dc} . The error signal is given to a PI (Proportional Integral) controller to give a controlled output. Finally, the controlled output is compared with the high frequency saw tooth signal to generate PWM (Pulse Width Modulation) pulse for the MOSFET of the Zeta converter.

III. OPERATION OF ISOLATED PFC ZETA CONVERTER

This converter is the latest type of single-stage input current shapers. It also uses single switching device and inherently provides an overload, short circuit, and inrush current protections. Since zeta converters behave as a resistive load to input AC mains, this converters are also called resistance emulators. Zeta converter is fourth order converters that can step down or step up the input voltage. The ZETA converter also have a series capacitor sometimes called a flying capacitor and two inductors. The ZETA converter topology gives a positive output voltage from an input voltage.

The Zeta converter has many advantages, such as buck-boost capability, and continuous output current, input to output DC insulation, so it can be used in high reliability system. This topology offer high efficiency, especially by using the synchronous rectification. The synchronous rectification can be easily implemented in this converter, because this topology, unlike the SEPIC converter, uses a low-side rectifier. The equivalent circuit of the Zeta converter is shown in Fig.3

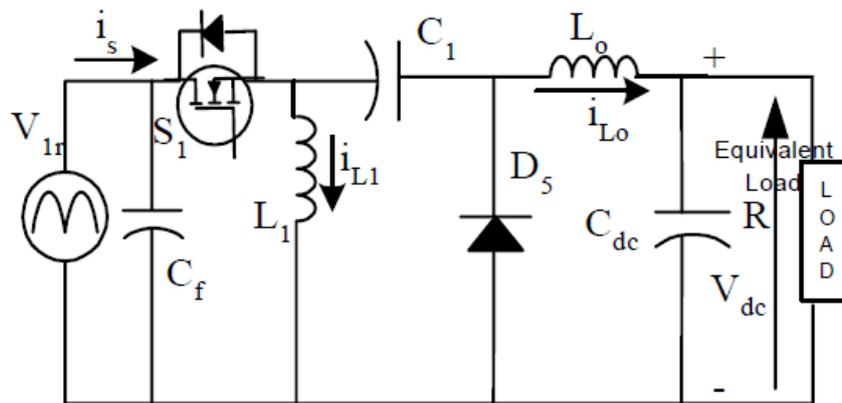
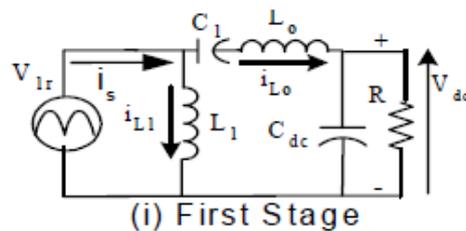


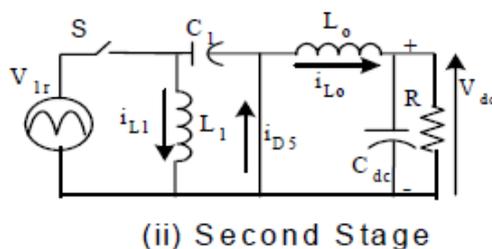
Fig. 3. Three modes of operation of an isolated zeta converter.

Three modes are shown in fig below. These modes are described as follows.

MODE I : In this stage, switch S_1 is turned on and the input source supply energy to the input inductor (L_1). This energy is then subsequently transferred to output inductor (L_o) through the intermediate capacitor C_1 . The current in the output inductor (i_{Lo}) and input inductor (i_{L1}) increase linearly. The intermediate capacitor voltage (V_{c1}) and the output DC-link capacitor voltage (V_{dc}) are considered constant in this stage. They are equal to the DC voltage (V_{dc}). This stage is shown in Fig.3(i).

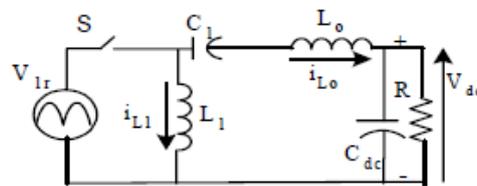


MODE II : In the second stage, switch S_1 is turned off and diode D_5 starts conducting. The stored energy from output inductance (L_o) and the input inductance (L_1) are transferred to the intermediate capacitor C_1 and the DC link capacitor filter (C_{dc}), respectively. This stage continues until i_{L1} becomes equal to the negative of i_{Lo} as shown in Fig.3(a)(ii). In this stage of Zeta converter operation, the MOSFET switch S_1 is in off stage and diode D_5 is in on stage.



MODE III : This freewheeling stage lasts until the start of a new switching period and is shown in Fig.3(a)(iii). In this stage of operation neither output diode „ D_5 ” nor switch „ S_1 ” conducts. The voltage applied across inductances L_o and L_1 is zero and their currents are constant until the new switching cycle starts. The currents i_{Lo}

and i_{L1} become equal and opposite at t_{off} time. Therefore, in this stage the current through the output diode is zero.[9]



(iii) Third Stage

IV. CONTROL DRIVE SYSTEM

The reference voltage generator is required to produce an equivalent voltage corresponding to the reference speed of the BLDC motor. The speed of BLDC motor is proportional to the DC link Voltage of the VSI. The controller circuit used is Proportional Integral controller. This PI controller is used to minimize the error signal and also produce a controlled output to the PWM generator to trigger the switch of zeta converter.[10] The function of an inverter is to change a DC input voltage to a symmetrical AC output voltage of desired magnitude and frequency. The output voltage could be fixed or variable at a fixed or variable frequency. A variable output voltage can be obtained by varying the input DC voltage and maintaining the gain of the inverter constant.

V. CONCLUSION

A simple control using a voltage follower approach has been used for voltage control and power factor correction of a PFC Zeta converter fed BLDC motor drive. A novel scheme of speed control using a single voltage sensor has been proposed. A single stage PFC converter system has been designed and validated for the speed control with improved power quality at the AC mains for a wide range of speed. The proposed drive system has been found a suitable candidate among various adjustable speed drives for many low power applications.

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