A Novel PFC Bridgeless Buck–Boost Converter-Fed Bldc Multi-Motor Drive With Nine-Switch Inverter

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ABSTRACT

In this project, a novel PFC bridgeless Buck-Boost converter fed BLDC multi-motor drive system using nine-switch inverter has been proposed targeting low-power applications. The new nine-switch inverter structure is a recent reduced switch count inverter topology proposed for independently supplying two three-phase ac loads and operating the VSI at fundamental frequency for the electronic commutation of the BLDC motor for reducing the switching losses in Voltage source inverter. The BL buck–boost converter located in the front end has been operated in DICM for achieving an inherent power factor correction at ac mains. A BL configuration of the buck–boost converter is proposed which offers the elimination of the diode bridge rectifier, thus reducing the conduction losses in it. This proposed circuit topology is simulated using MATLAB 7.10.0 (R2010a) version.

Key Words: Brushless direct current (BLDC) Motor, Nine Switch VSI, Bridgeless (BL) Buck-Boost Converter, Hysteresis Control, discontinuous inductor current mode (DICM), power quality.

INTRODUCTION

The cost of a system and its efficiency is the major benchmark in the development of motor drives that run on low-power for applications such as fans, water pumps, blowers, mixers and such other applications. Due to their salient features like high efficiency and high flux density per unit volume, low electromagnetic-interference problems and also low maintenance requirements, Brushless direct current (BLDC) motors are widely used in these applications. When a BLDC motor works through diode bridge rectifier (DBR) with a high value of dc link capacitor draws peaky current which can lead to a THD of supply current of the order of 65% and power factor as low as 0.8. Hence, a DBR followed by a power factor corrected (PFC) converter is utilized for improving the power quality at ac mains. In this paper, a novel method of operating two BLDC motors with input from one nine switch inverter is proposed. The conduction and switching losses are reduced significantly and the power quality is improved with a reduction in the count of converters used. The proposed system will act as a multi-motor drive system.

Existing topology:

Block Diagram: It consists of a bridgeless rectifier, filter unit, buck-boost converter and voltage source inverter. A BLDC motor is fed by a diode bridge rectifier (DBR) that has the usage of high valued dc link capacitor. The control is using a sensor and sensor less operation is not feasible.

![Fig.1.Block diagram of existing topology](image-url)
It draws current with peaks that leads to total harmonics distortion (THD) in the supply current and the power factor also is affected. Switching loss and conduction losses are more in diode bridge rectifier uni and the power factor is poor. The power quality needs to be compromised and the circuit will not be suitable for multi-motor drive applications.

Circuit Diagram

![Circuit Diagram](image1)

**Fig.2. Circuit diagram of existing topology**

Proposed topology:

**Block Diagram:**

![Block Diagram](image2)

**Fig.3. Block diagram of proposed topology**
**Circuit Diagram:** It consists of a brush less (BL) buck–boost converter-fed BLDC multi-motor drive with variable dc link voltage of VSI for improved power quality at ac mains with reduced components.

![Circuit Diagram](image)

**Fig.4. Circuit diagram of proposed topology**

This reduces the switching losses in VSI due to the fundamental switching frequency operation for the electronic commutation of the BLDC motor and to the variation of the speed by controlling the voltage at the dc bus of Nine-switches VSI. The Nine-switch structure is a recent reduced switch count inverter topology proposed for independently supplying two three-phase ac loads.

**Modes of operation:**

**Mode 1: Positive Half Cycle:**

![Mode 1: Positive Half Cycle](image)

During positive half cycle Sw1 switch conducts and inductor Li1 gets charged and hence inductor current will increases; Diode Dp conducts, dc link capacitor Cd is discharged. Then the inductor Li1 discharges the stored energy to dc link capacitor Cd until the inductor is completely discharged. Then the current in inductor Li1 starts to reduce and reaches zero; inductor Li1 enters discontinuous conduction; dc link capacitor Cd supplies energy to the load. In Inverter J1, J5 and J6 gets ON and J7, J8 and J9 gets on adjacently which conducts the BLDC Motors. Both BLDC motors are supplied by the circuit.
Mode 2: Negative Half Cycle:

During negative half cycle Sw2 conducts, hence inductor Li2 gets charged and it leads to inductor current increases; Diode Dn conducts, dc link capacitor Cd is discharged. Then the inductor Li2 discharges the stored energy to dc link capacitor Cd until the inductor is completely discharged. The current in inductor Li2 reduces and reaches zero; inductor Li2 enters discontinuous conduction; dc link capacitor Cd supplies energy to the load. In Inverter J1, J5 and J6 gets ON and switches J7, J8 and J9 gets ON adjacently which conducts the BLDC Motors. Both BLDC motors are supplied by the circuit.

Simulation results and discussion:

Existing System THD Analysis

![THD analysis of existing topology](image-url)
Rotor speed and electromagnetic torque:

**Fig. 8. Simulation result of existing topology**

**Proposed System THD Analysis:**

**Fig. 9. THD analysis of proposed topology**
CONCLUSION

This paper presents a novel PFC bridgeless Buck-Boost converter fed BLDC multi-motor drive system using nine-switch inverter. It has been proposed targeting low-power applications. A new nine-switch inverter structure is a recent reduced switch count inverter topology proposed for independently supplying two three-phase loads and operating the VSI at fundamental frequency for the electronic commutation of the BLDC motor for reducing the switching losses in Voltage source Inverter. The BL buck–boost converter at the front side has been operated in DICM for achieving an inherent power factor correction at ac mains. This proposed circuit topology is simulated using MATLAB 7.10.0 (R2010a) version. Switching and conduction losses are less and the power factor is corrected and is greater than the existing system. Voltage and current stresses on the PFC converter switch is reduced. Medical equipments. Electric vehicle control and Precision movement control are some of the applications of the proposed system. Thus the proposed system shows more reliable operation and is suitable for multi-motor drive systems.

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