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Speed Control of BLDC Motor Using PFC Bridgeless Buck Boost Converter

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ABSTRACT

This paper presents a power factor corrected (PFC) bridgeless (BL) buck–boost converter-fed brushless direct current (BLDC) motor drive as a cost-effective solution for low-power applications. An approach of speed control of the BLDC motor by controlling the dc link voltage of the voltage source inverter (VSI) is used with a single voltage sensor. This facilitates the operation of VSI at fundamental frequency switching by using the electronic commutation of the BLDC motor which offers reduced switching losses. A BL configuration of the buck–boost converter is proposed which offers the elimination of the diode bridge rectifier, thus reducing the conduction losses associated with it.

A PFC BL buck–boost converter is designed to operate in discontinuous inductor current mode (DICM) to provide an inherent PFC at ac mains. The performance of the proposed drive is evaluated over a wide range of speed control and varying supply voltages (universal ac mains at 90–265 V) with improved power quality at ac mains. The obtained power quality indices are within the acceptable limits of international power quality standards such as the IEC. The performance of the proposed drive is simulated in MATLAB/Simulink environment, and the obtained results are validated experimentally on a developed prototype of the drive.

INTRODUCTION

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.

LITERATURE SURVEY

Singh and Singh have projected a buck–boost convertor feeding a BLDC motor supported the thought of constant dc link voltage and PWM-VSI for speed management that has high shift losses. A single-ended primary-inductance convertor (SEPIC)-based BLDC motor drive has been projected by Gopalarathnam and Toliyat however has higher losses in VSI owing to PWM shift and a better range of current and voltage sensors that restricts its pertinence in affordable application. Singh and Singh [8] have projected a Cuk converter-fed BLDC motor drive with the thought of variable dc link voltage. This reduces the shift losses in VSI owing to the elemental shift frequency operation for the electronic commutation of the BLDC motor and to the variation of the speed by dominant the voltage at the dc bus of VSI. A CCM operation of the Cuk convertor has been used which needs 3 sensors and isn't inspired for low value and low power rating. For any improvement in potency, bridgeless (BL) converters are used which permit the elimination of DBR with in the side. A buck–boost convertor configuration is best suited among varied BL convertor topologies for applications requiring a good vary of dc link voltage management (i.e., bucking and boosting mode). Jang and Jovanovi´c and Huber et al. have conferred BL buck and boost converters, severally. These will offer the voltage buck or voltage boost, that limits the operative vary of dc link voltage management. Wei et al. have projected a BL buck–boost convertor however use 3 switches that isn't an economical answer. a replacement family of BL SEPIC and Cuk converters has been reported with in the literature however needs an out sized range of parts and has losses related to it. This project presents a BL buck–boost converter-fed BLDC motor drive with variable dc link voltage of VSI for improved power quality at ac mains with reduced parts

BLDC MOTOR

INTRODUCTION

The Brushless DC (BLDC) motor is the ideal choice for applications that require high

reliability, high efficiency, and high power-to-volume ratio. Generally speaking, a BLDC motor is considered to be a high performance motor that is capable of providing large amounts of torque over a vast speed range. BLDC motors are a derivative of the most commonly used DC motor, the brushed DC motor, and they share the same torque and speed performance curve characteristics. The major difference between the two is the use of brushes. BLDC motors do not have brushes (hence the name "brushless DC") and must be electronically commutated.

STATOR

Similar to associate degree Induction AC motor, the BLDC motor stator coil is formed out of laminated steel stacked up to hold the windings. Windings in an exceedingly stator coil are often organized in 2 patterns; i.e. a star pattern (Y) or delta pattern (Δ). The key distinction between the 2 patterns is that the Y pattern offers high force at low rate and also the Δ pattern offers low force at low rate. this is often as a result of within the Δ configuration, 1/2 the voltage is applied across the winding that\'s not driven, so increasing losses and, in turn efficiency and torque. Steel laminations within the stator coil are often slotted or slot less as shown in Figure one. A slot less core has lower inductance, so it will run at terribly high speeds. as a result of the absence of teeth within the lamination stack, needs for the cogging force conjointly go down, so creating them a perfect suitable low speeds too (when permanent magnets on rotor and tooth on the stator coil align with one another then, as a result of the interaction between the 2, associate degree undesirable cogging force develops and causes ripples in speed).

ROTOR

The rotor of a typical BLDC motor is formed out of permanent magnets. Relying upon the applying needs, the quantity of poles within the rotor might vary. Increasing the quantity of poles will provide higher force however at the value of reducing the utmost attainable speed Another rotor parameter that impacts the utmost force is that the material used for the development of permanent magnet; the upper the denseness of the fabric, the

upper the force.

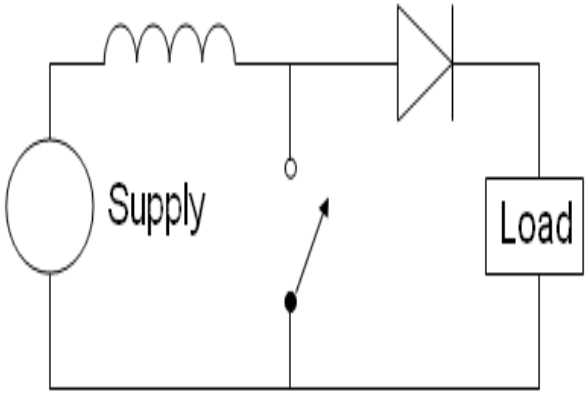
DESCRIPTIONS ON THE COMPONENTS & CIRCUITS USED

INTRODUCTION

The capabilities and economy of power electronics system are find out by the active devices that are existing. Their characteristics and limitations are a key element in the design of power electronics systems. Formerly, the mercury arc valve, the high-vacuum and gas-filled diode thermionic rectifiers, and triggered devices such as the thyratron and ignitron were mostly used in power electronics. As the ratings of solid-state devices improved in both voltage and current-handling capacity, vacuum devices have been nearly entirely replaced by solid-state devices

BOOST CONVERTER

Boost converter (step-up converter): is a power converter with an output dc voltage greater than its input dc voltage. It is a sort of switching-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy chargeable element. Filters made of inductor and capacitor combinations are often added to a converter's output to improve performance.



This is the basic schematic of boost converter. The switch is typically a MOSFET, IGBT ,BJT.

Step up an unregulated direct current input voltage to generates a regulated dc output voltage using a circuit known as Boost Converter or Step-Up SMPS.

CIRCUIT ANALYSIS

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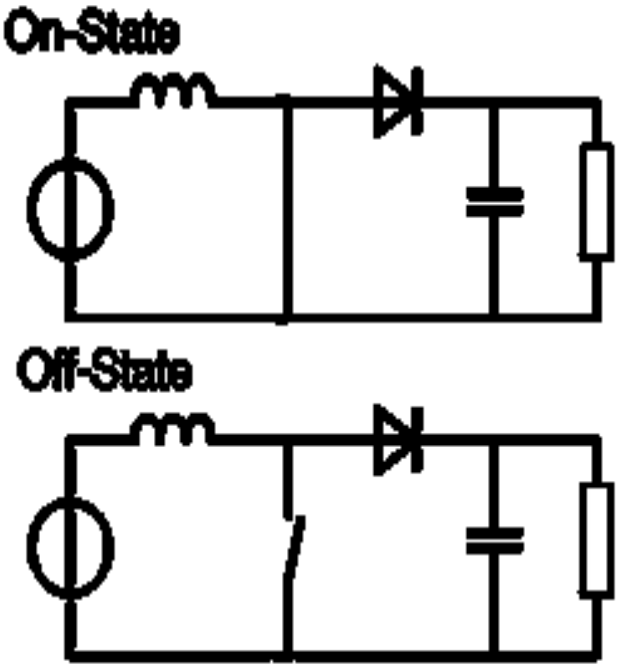

PROPOSED PFC BL BUCK–BOOST CONVERTER-FED BLDC MOTOR DRIVE

INTRODUCTION

The parameters of the BL buck–boost convertor are designed such it operates in discontinuous electrical device current mode (DICM) to attain Associate in nursing inherent power issue correction at ac mains. The speed management of BLDC motor is achieved by the dc link voltage management of VSI employing a BL buck–boost convertor. This reduces the shift losses in VSI thanks to the low frequency operation of VSI for the electronic commutation of the BLDC motor. The performance of the projected drive is evaluated for a large vary of speed management with improved power quality at ac mains. Moreover, the result of provide voltage variation at universal ac mains is additionally studied to demonstrate the performance ofthe drive in sensible provide conditions. Voltage and current stresses on the PFC convertor switch are evaluated for decisive the switch rating and warmth sink style. Implementation of the projected BLDC motor drive is dispensed to demonstrate the practicability of the projected drive over a large varies of speed management with improved power quality at ac mains. The projected configuration of the BL buck–boost

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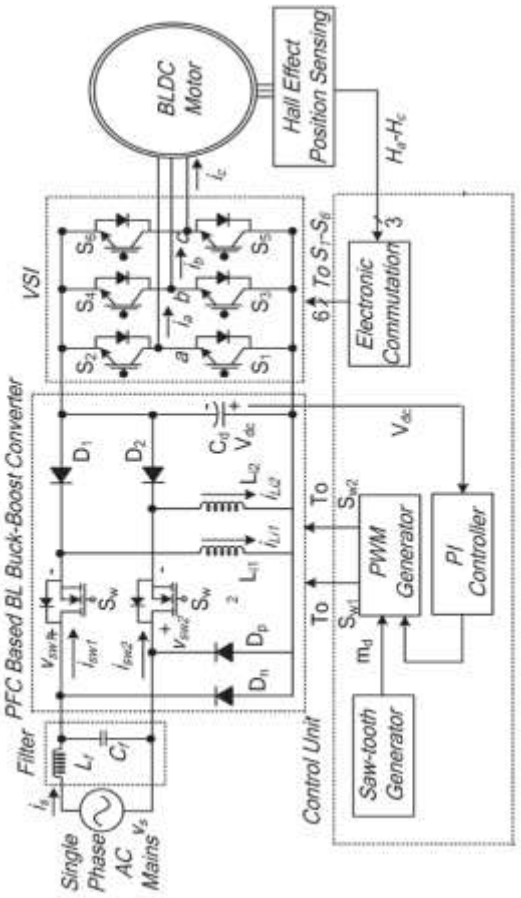
convertor has the minimum range of elements Associate in nursing least range of physical phenomenon devices throughout every 0.5 cycle of provide voltage that governs the selection of the BL buck–boost convertor for this application

CIRCUIT



SIMULINK MODELS & SIMULATION RESULTS

INTRODUCTION

Matlab is an elite dialect for specialized processing. It coordinates calculation, visualization, and programming in a simple to-utilize environment where issues and arrangements are communicated in well known scientific documentation. Average uses incorporate Math and processing Algorithm improvement Data obtaining Modeling, recreation, and prototyping Data dissection, investigation, and visualization Scientific and building illustrations Application advancement, including graphical client interface building.

Matlab is an intelligent framework whose fundamental information component is a show that does not oblige dimensioning. This permits you to tackle numerous specialized processing issues, particularly those with lattice and vector details, in a small amount of the time it would take to compose a project in a scalar no intelligent dialect, for example, C or Fortran. The name matlab remains for framework lab.

SIMULINK MODELS

Simulink is a product add-on to matlab which is a numerical device created by The Math works,(http://www.mathworks.com) an organization situated in Natick. Matlab is fueled by far reaching numerical dissection ability. Simulink is an apparatus used to outwardly

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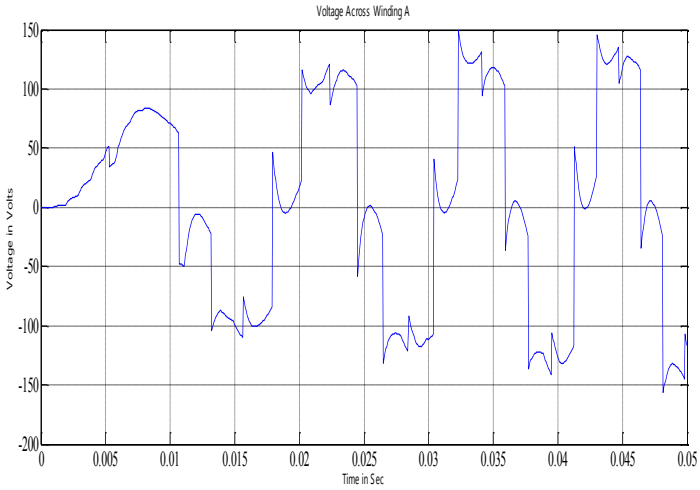
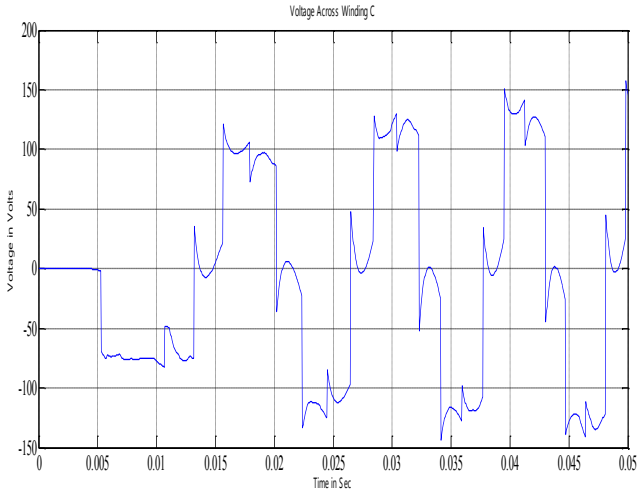
program an element framework (those legislated by Differential mathematical statements) and take a gander at results. Any rationale circuit, or control framework for an element framework can be constructed by utilizing standard building squares accessible as a part of Simulink Libraries. Different tool kits for distinctive systems, for example, Fuzzy Logic, Neural Networks, DSP, Statistics and so on are accessible with Simulink, which improve the preparing force of the apparatus. The principle playing point is the accessibility of layouts/ building squares, which keep away from the need of writing code for little scientific methods. Idea of sign and rationale stream:

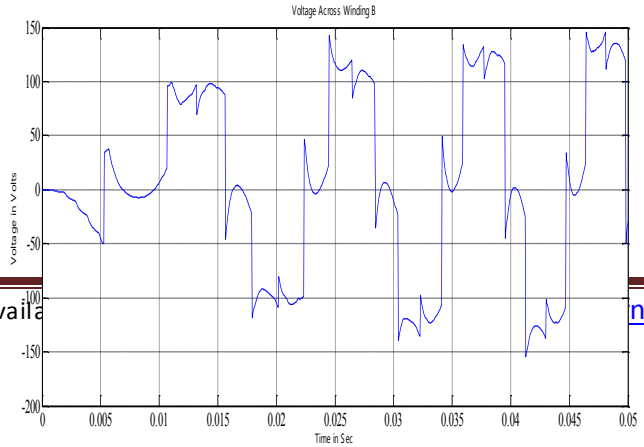
WAVEFORMS



(a)

(b)





CONCLUSION & FUTURE SCOPE

CONCLUSION

A PFC BL buck-boost convertor primarily based VSI FED BLDC motor drive has been projected, objective of low power applications. A replacement technique of PI controller speed control has been utilised by dominant the voltage at DC link and in operation the VSI at fundamental frequency for the electronic commutation of the BLDC motor for reducing the switch losses in VSI convertor. The front-end BL buck-boost converter has been operated in DICM for achieving associate inherent power factor correction at ac mains. speed management is satisfactory performance has been achieved and supply voltage variation with power quality indices at intervals the appropriate limits. The dynamic characteristics of the brushless DC motor like current, voltage, torque, and speed, of the convertor components triangular observed and analyzed pattern the developed MATLAB model. Projected mathematical logic controller system features as mart ability and powerful strength whenever the system is disturbed. The simulation model that's implemented throughout a customary manner below MATLAB setting permits dynamic characteristics like part currents, rotor speed, and mechanical torsion tobe effectively well thought-out.

FUTURE SCOPE

There are possible ways to control the speed of either single phase motors or three phase motors. By the guidance of this paper, controlling of speed of motors is possible. The proposed work can be implemented for a wireless control of three-phase BLDC motor using a Zigbee protocol. Zigbee is a low-cost, lowpower. Conventional PI controller was considered in this research work. A fuzzy logic or adaptive control procedure may be used to get improved performance characteristics.

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