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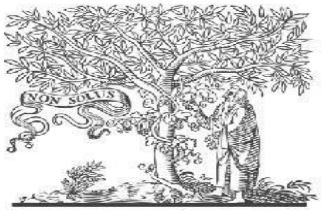

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BLDC MOTOR DRIVE BASED ON BRIDGELESS LANDSMAN POWER FACTOR CORRECTION CONVERTER WITH A SINGLE SENSOR AND REDUCED STRESS ON THE POWER DEVICES

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Abstract

To correct the power factor,BL converter is used in the bridgeless configuration which feeds the DC motor drive in brushless in proposal of low power household applications. Some conduction losses reduces by brushless configuration along with diodes and some switching losses switches of the VSI (Voltage Source Inverter) which might reduce by low frequency signals in electronic commutation solid state of Brushless Direct Current Motor. Landsman Converter operation is in discontinuous flow of inductor current mode based for front-end bridgeless power factor control and used for controlling the D.C link voltage. Naturally the p.f control is attained by reduction of conduction losses and switch stress. To control DC bus voltage a sensor of single voltage is used. And we are using the fuzzy logic controller(FLC) for improving the D.C link voltage. A simulation model is to be performed for power quality improvement and for the wide range of speed control. This simulation performance for Brushless Landsman DC motor drive which is based on functions of it at diverse varying voltages of AC Mains. The range of AC Mains voltage is 90V to 265V to present the limits defined with IEC61000-3-2 which is the standard one.

Keywords: BLDC and DC-DC Converters, Current and Voltage Source Inverters

Introduction

Brushless DC Motors are preferred due to their characteristics like high energy density, higher efficiency, and ruggedness, less maintenance, wide spread of speed choice in to adopt the lower power applications among several available electrical motors. Some of the Applications are in the medical,equipment heating,also ventilation air conditioning and some consumer electronics and so on. As with mechanical the commutator assembly and brushes like sparking, E.M.I,wear&tear are being erradicated using electronic commutation with some intrinsic issues are held in BLDCM with usage of voltage source inverter.This

inverter is based on the hall effect of rotor position sensing.

The diode bridge rectifier and DC bus capacitors are common schemes of brushless landsman DC motor drive as these follows voltage source inverter-based drive and draws nonlinear current for AC Mains as it results in lower power factor supply and results higher value in supply current of total harmonic distortion. Based on pulse width modulation 3-phase switching signals requires to drive the Voltage source inverters (6)switches of drive. Power factor correction are also known as built-in converters which embeds.These achieve the unity power factor at the AC Mains and results in the rich conduction losses. Power factor correction operation is major factor as it is straight affectedby rating at inert components by requirement of overall cost of the drive.Capacitor and inductors are energy storage elements. So, these are designed to operate in the continuous conduction mode and discontinuous mode of operations. To improve the power quality canonical switching converter is used to give output ripple voltage which results in landsman converter. For this operation uses one current sensor and two voltages as it is required for power quality of power factor correction. But this is not effective for lower power applications due to cost optimization.So, the Brushless Landsman power factor correction are working by following voltage mode with single voltage sensor.To the power loss switching of voltage source inverter and motor drive happens due to the high frequency of switching devices. The pulse width modulation controls speed and DC bus voltage continues at DC link capacitor of VSI.

Problem Solving

Proposed model of Permanent Magnet BL-DC Motor drive in the Matlab environment & evaluation is done for air conditioning load compression.Load compressor is considered as const. load torq. which is equal to the rated torq. with control of speed compulsory with air conditioner system. A 1500W rating Permanent Magnet BL-DC Motor is accustomed to drive air conditioning compressor,the speed at which is effectively controlled by D.C link voltage Control.Performance of proposed Power Factor Correction drive is assessed since numerous limitations such as crest factor & total harmonic distortion for current at i/p AC mains, displacement p.f, p.f and efficiency of system drive at various motor speeds.The new speed control strategy of PM BL-DC Motor is confirmed for load compression of air conditioner which takes ref. speed as equivalent DC link ref. voltage.Speed control and voltage control are proportional to each other at DC link.

BL-DC Motors

Brushless DC motors are the ones motor quickly attaining the popularity. These are employed in industrial appliances, Aerospace, Industrial automation and

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instrumentation equipment and so on. These brushless landsman motors are implemented to not use the brushes for commutation. So, these are electronically commuted and have so many advantages instead of brushes over brushed DC and Induction motors.

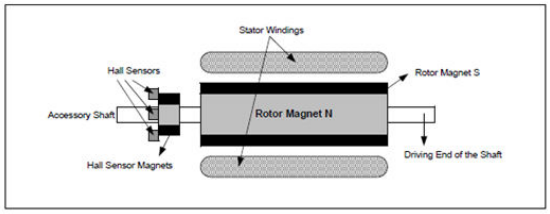

Fig1:Transverse section of BLDC Motor

The above fig1 is a brushless landsman DC motor which is in transverse section which has a capability of 2-pole PMs. Hall sensors are embedded into stationary side of the motor,i.e.,into stator which is a complex process due to misalignment of these sensors w.r.t rotor magnets to generate error to determine the rotor position.

DC To DC Converter Basics

DC to DC is a converter device that initiates the DC input voltage by producing output voltage. They produced output at various voltage levels than the input. These are used for power bus regulation, noise isolation and so on which is very popular of DC-DC topologies. The major DC-DC converters are listed below:

1. Buck converter: step down converter

The buck converter is also known as stepdown converter. In the above circuit there is a transistor at turn ON,the input voltage is at one end of inductor which tends to rise the inductor(L) current. During the transistor in the OFF state the current flows continuously flow through inductor and diode. The above figures represent the buck converter.

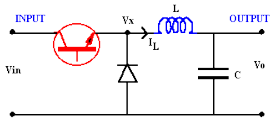

Fig 2: Buck Converter

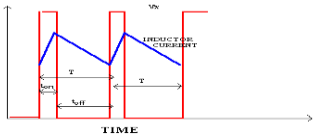

Fig 2.1: Voltage(V) and Current(I) changes

2. Boost or Step up converter

Fig.3represents the boost converter which is also known as step up converter which is used when o/p voltage is higher than i/p voltage. During ON state the input and output voltages are equal and in OFF state the inductor(L) current flows through diode.

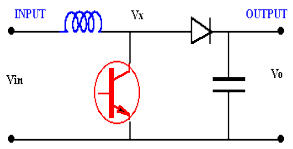

Fig 3: Boost Converter Ckt

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Since the duty cycle ratio D is b/w 0 & 1 where the o/p vtg is higher than the i/p voltage.-ve sign indicates reverse sense of o/p voltage.

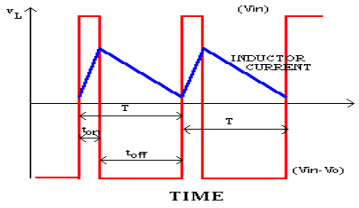

Fig 3.1 Voltage(V) and Current(I) waveforms

3.Buck,Boost converter

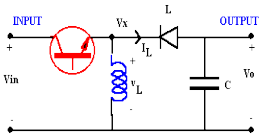

Fig4: Buck,Boost converter

Above figure represents the buck boost converter which works as both buck and boost converters. The o/p voltage is either greater [or] less than the i/p voltage.Mostly like boost converter.

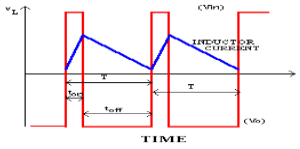

Fig.4.1: Waveforms of buck-boost converter

Since the duty cycle ratio "D" is b/w 0 & 1 the o/p voltage can vary b/w lower or higher than the i/p voltage in magnitude. The -ve sign indicates reversal of sense of the o/p voltage.

4.Converter Comparison

Voltage ratios is accomplishable by the DC to DC converters are summed up. Only buck converter shows linear relationship b/w control and o/p voltage which is duty ratio(D). The buck-boost reduces [or] increases voltage ratio with unit gain for duty cycle ratio of 50%.

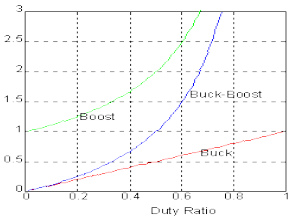

Fig 5: Voltage-ratio graph

Proposed model for motor drive with PFC based BL Converter

The below fig6 projects the BLDC motor drive serves through brushless landsman converter and this DC motor drive istuned with adjustment of DC bus voltage which is directly proportional to speed by allowing the low switching frequency switches. To eradicate switching losses of IGBTs of usages of inverters. Here we are using the VSI to eradicate losses happening in switching frequency. To reach p.f unity at AC Mains with range of 90volts-270volts to control speed and mainly implemented this landsman converter to improve the power quality effectively with voltage,current stress of power devices.

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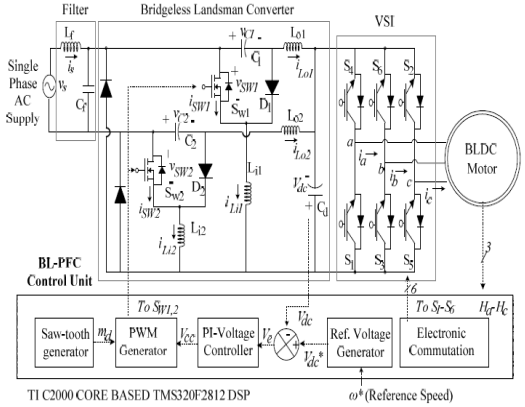


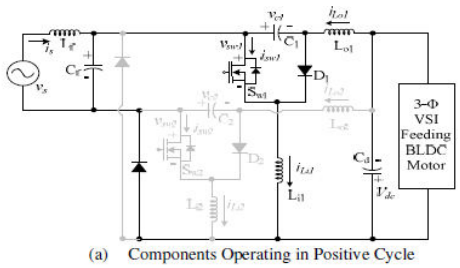
Fig 6: Proposed structure of BL converter

Operation of BLPFC Converter

The BL converter with PFCBL layout is designed for working in DICM for the built-in pf improving at Alternating supply.Operation principle of converter in -ve & +ve cycles of supply voltage in Fig.6.1. 3 operating steps of BL converter for voltage supply during +ve cycle are shown in the Figs.6.2.During switching period the current in i/p inductor becomes discontinuous. Fig.6.1 shows converter waveforms during -ve and +ve supply voltage cycles as it presents voltage & current waveforms of BL converter where inductor(L) currents switching gate voltage is in b/w capacitor voltages and DC bus voltage at switching period.Both changes & waveforms enlarged are shown in Figs.6.2 (a),(b).

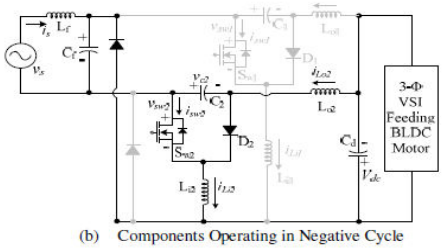
Mode I:According to the Fig.6.1(a), if the switch(sw1) is on, the energy out of the supply along with energy kept is in b/w capacitor which is carried to i/p inductor.O/p inductor starts and capacitor voltage starts decreasing at i/p inductor(L) current of D.C voltage where it starts increasing as revealed in Fig.6.2(b).

Mode II: Mode as per Fig.6.2(b) when the switch(sw1) is turned OFF during the part of converter operation. In b/w the capacitor and D.C bus the inductor starts charging by current from the supply and the input inductor(L) discharges.



(a) Components Operating in Positive Cycle

Mode III: Converter working in DCM, as i/p inductor is discharged & current becomes 0.



(b) Components Operating in Negative Cycle

Fig.6.1Converter working (a) +ve cycle for source voltage (b) -ve Cycle for source voltage.

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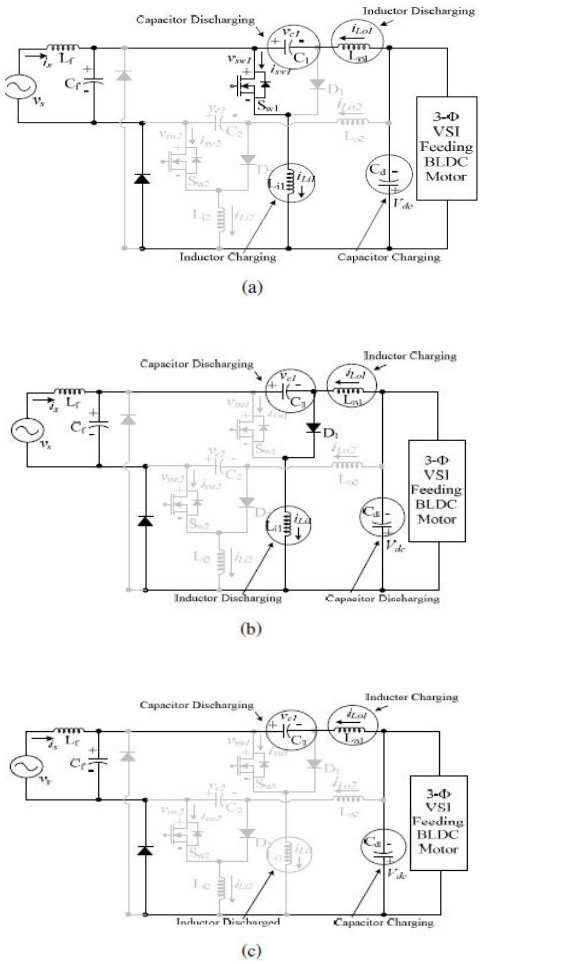


Fig.6.2 Operational modes of PFC converter for switching period as (a) Mode-1, (b) Mode-2, (c) Mode-3

Simulation

Following figure shows the Simulink model of project:

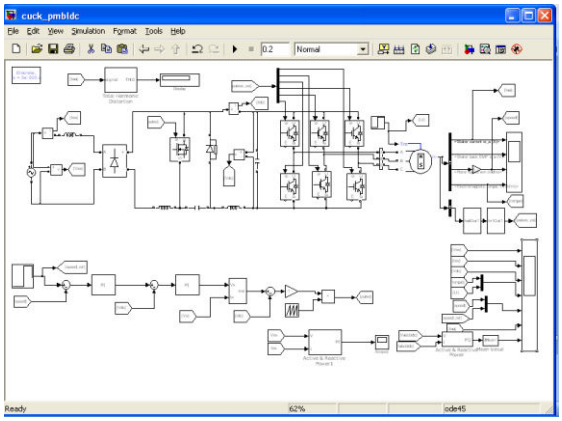


Fig.7 Simulink model of PMBLDC drive

Working Procedure

In this project by proposing the new control strategy of power factor correction technique by using buck dc-dc converter as it provides the 1-phase supply to the Air conditioner.

Control strategy includes pi controller with the PWM technique which has been used to control the speed of the rotor.

Diode bridge rectifier which converts AC-DC which supplied from the supply. The Simulink model of diode bridge rectifier as follows.

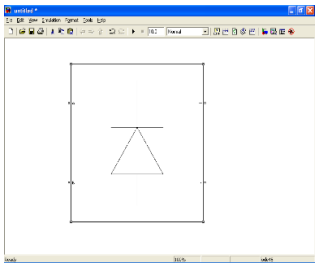


Fig 8Diode bridge rectifier

The D.C supply fed to dc link through buck converter which can improves the power factor. The buck converter can be capable of control the DC supply which is supplied to inverter.DC power is stored in the DC link, and it acts as an input to the inverter. The PMBLDC drive fed through inverter. To provide controlled pulse to the inverter a new control strategy has been proposed.

Control Strategy

The control of motor speed involves the utilization of several control blocks, including the SpeedController, Ref Current Generator,PWM Controller, which must be accurately controlled under varying operating conditions. The

Speed Controller block monitors ref speed as equivalent ref voltage, while Current Reference Generator is responsible for limiting stator currents to prevent excess. Finally, the PWM Controller provides gating pulses to the Voltage Source Inverter, with the ref i/p current of the buck converter comparing to its sensing current to generate current error, allowing for the generation of the switching signal for MOSFET power factor correction. This process is facilitated through the use of electronic hall sensors, which is known as Electronic Commutation.

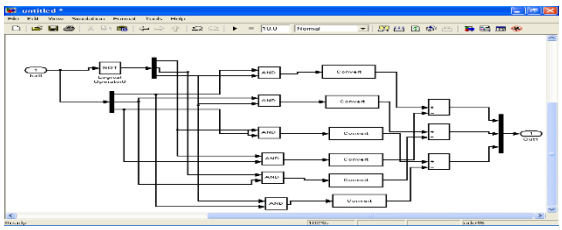
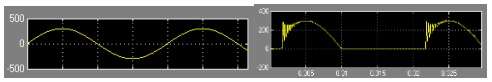


Fig.9 Simulink model of hall sensors

The above fig is a model for Simulink usage of hall sensors which signifies changing of state when polarity voltage state of back EMF crosses 2 ways i.e.,from +ve to -ve and from -ve to +ve. In ideal case back emf is zero but practically due to winding characteristics there might be a delay and compensated by the micro-controller.

Results



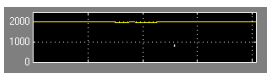


Fig.9.1 wave forms of voltages and currents in switching period (positive cycle)

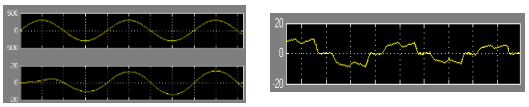


Fig.9.2 waveforms of voltage source of designed motor drive load

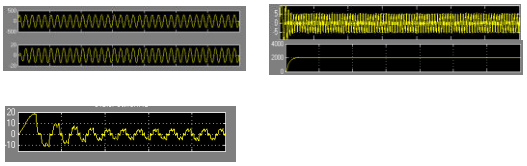


Fig.9.3 Dynamic performances of the drive

Conclusion

PFC Landsman converter is designed and implemented in development of low power applications like domestic purpose. Low freq switching operations of VSI are being achieved by switching losses in minimum case with variable voltage to control the speed of Brushless landsman DC motor. With some range of supply for control of speed which is established by performance of experiment. The strain of power factor control is there to determine practically, and some results are places adequately to founded over full speed at certain AC Mains.Finally leads to improvement of power quality by avoiding errors in power factor and promoting the near unit power factor.

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