Comparison of DC-DC Buck Boost and SEPIC Converter for Control of Electronically Commutated BLDC Motor

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Abstract: *In this paper, Brushless motor drives by comparing two DC-DC converter. Like buck boost and sepic converter. Power factor corrected converter is essential to improve the Power quality (PQ). Speed control is done by Voltage Source inverter (VSI). In order to reduce conduction loss and number of components, diode bridge rectifier is eliminated. DC – DC Converter feeding PMBLDC Motor drive is proposed here with adjustable speed operation for low power application. single ended primary inductor converter (SEPIC) as a power factor correction (PFC) converter which is operated in voltage control mode for the speed control of a permanent magnet brushless DC motor (PMBLDCM). The proposed converter combines the PFC and DC link voltage control in single stage and uses only one controller As the name implies, BLDC motors do not use brushes for commutation; instead, they are electronically commutated. The proposed speed control scheme controls reference voltage at DC link as an equivalent reference speed, thereby replaces the conventional control of the motor speed and a stator current involving various sensors for voltage and current signals. Moreover, the rotor position signals are used to generate the switching sequence for the VSI as an electronic commutator of the PMBLDC motor. A voltage follower and current follower technique is proposed for operation of BLDC motor under wide range of speed control. There are various DC-DC converter used for speed control of BLDC motor. This is review paper on the comparison of two DC-DC converter as sepic converter and buck boost converter.*

Keywords: *Brushless direct current motor(BLDC) Power Factor Correction, SEPIC converter*

1. INTRODUCTION:

The fundamental qualities of a Permanent magnet brushless DC motor (PMBLDCM) such as wide speed range, high efficiency, rugged construction and ease of control make it suitable for air conditioning compressor application and other household application such as fan, water pump, mixers, etc.. The BLDC motor not only used in household application but also these are suitable for other application such as computer disc drives, automobile starter, automobile wipers, medical equipment and many other industrial tools.

Brushless DC motors are recommended for many applications due to the absence of mechanical commutator. It causes less need maintenance and low EMI problem. Brushless DC motor is more energy efficient than brushed DC-motors. The Brushless DC motor is smaller because its body has less heat to dissipate. It is applicable in many household appliances. Electronically commutated motors are different from other motors like brushless DC motors. In brush-type motors; commutation is done with a commutator and brushes. In brushless motor with an electronically commutated, it is achieved by switching electronics. It obtains information on the position of the rotor by means of sensors with the help of microprocessor. Electronic commutation is achieved by using a three phase voltage source inverter (VSI).

1.1 OVERVIEW OF DC-DC CONVERTER

There are various DC-DC converter are available but this paper gives the comparison of single ended primary inductor converter (SEPIC) and Buck-Boost converter.

1.2 Buck-Boost Converter

A DC – DC Converter is connected between the VSI and the DBR fed from single phase AC supply to provide control voltage at DC link capacitor. There are many DC –DC Converter topologies available such as buck, boost, buck – boost converter topology is used. The buck – boost converter topology has advantages of its simplest construction and minimum component requirement over other topologies. The buck – boost converter is designed for DCM operation for controlling the speed of BLDC motor. Buck-Boost converter is a dc-to-dc converter that has the capability of stepping up or stepping down the output voltage.

Buck-Boost converter is a dc-to-dc converter that has the capability of stepping up or stepping down the output voltage. In other words, the output voltage can be higher or lower than the input (source) voltage. It is also labeled as indirect converter because the source is never directly connected to the load. It is the inductor in the circuit that controls the flow of energy from the input side to the output side. Figure-1 shows the buck-boost converter in its simplest form. Pay attention to the directions of the currents through the capacitor and the load resistor and the polarity of the output voltage. It is a type of DC to DC converter and it has a magnitude of output voltage. It may be more or less than equal to the input voltage magnitude. The buck boost converter is equal to the fly back circuit and single inductor is used in the place of the transformer. There are two types of converters in the buck boost converter that are buck converter and the other one is boost converter. These converters can produce the range of output voltage than the input voltage.

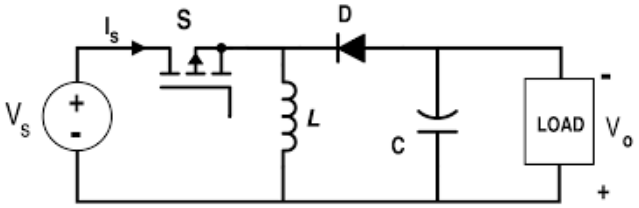

Fig.1 Circuit diagram of buck-boost converter

Input power (P_{in}) = output power (P_{out})

In step up mode $V_{in}<V_{out}$ converter, it follows then that the output current will be less than the input current.

Therefore for a Buck Boost converter in step up mode $V_{in}<V_{out}$ and $I_{in}>I_{out.}$ In step down mode $V_{in}>V_{out}$ converter, it follows then that the output current will be greater than the input current. Therefore for a Buck Boost converter in step down mode $V_{in}>V_{out}$ and $I_{in}<I_{out.}$

1.3 Single Ended Primary Inductance Converter(SEPIC)

Single-ended primary-inductor converter (SEPIC) is a type of DC-DC converter that allows the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input; the output of the SEPIC is controlled by the duty cycle of the control transistor. A SEPIC is similar to a traditional buck boost converter.

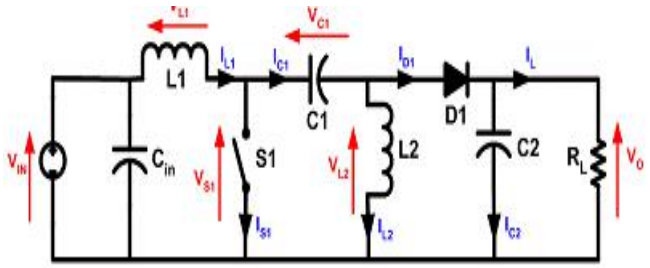

Fig.2 circuit diagram of sepic converter

The schematic diagram for a basic SEPIC is shown in Fig.2 Like other switched mode power supplies the SEPIC exchanges energy between the capacitors and inductors in order to convert from one voltage to another. The amount of energy exchanged is controlled by switch S1, which is typically a transistor such as a MOSFET. MOSFETs offer much higher input impedance and lower voltage drop than bipolar junction transistors (BJTs), and do not require biasing resistors as MOSFET switching is controlled by differences in voltage rather than a current, as with BJTs.

2. Simulation of SEPIC controller for BLDC motor drive :

The Main block diagram of the unipolar converter for BLDC drive system is shown in Fig. 3.

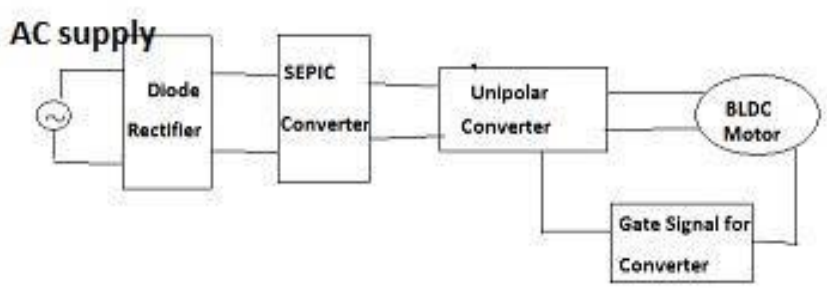

Fig.3 block diagram of BLDC motor control with SEPIC converter.

The Simulation diagram of SEPIC converter BLDC motor drive is as shown in fig.5. A voltage source of 50V, 50Hz AC supply connected to Drive. The AC input is rectified using diode rectifier and converted into DC supply. This DC power is regulated using DC-DC converter which is Single Ended Primary Inductance converter (SEPIC) here. This DC-DC converter is used to improve the input power factor of the AC supply and to minimize harmonics in the input current. Then the DC power is supplied to BLDC motor through unipolar power converter. The rotor position is sensed by hall sensors. The hall sensor signals and actual speed of BLDC motor are given to speed controller to generate gate signals for the unipolar converter in order to control the speed. The output of speed controller is connected to gates of the unipolar power converter. Based on switching of power converter devices, the BLDC motor stator winding is excited sequentially so as to develop electromagnetic torque in the motor to meet the load toque. The diode rectifier converts the AC input into uncontrolled DC. SEPIC controller is useful in input power factor improvement. This is implemented using simulink using MOSFET and other circuitry. The gate of MOSFET driven by the SEPIC Gate controller which uses of PI controller.

2.1 Hall Sensors

Unlike a brushed DC motor, the commutation of a BLDC motor is controlled electronically. To rotate the BLDC motor, the stator windings should be energized in a sequence. It is important to know the rotor position in order to understand which winding will be energized following the energizing sequence. Rotor position is sensed using Hall effect sensors embedded into the stator. Most BLDC motors embedded into the stator on the non motor. Whenever the rotor magnetic poles pass near the Hall sensors, they give a high or low signal, indicating the N or S pole is passing near the sensors. Based on the combination of these three Hall sensor signals, the exact sequence of commutation can be determined.

parameter	**Buck converter**	**Boost converter**	**Sepic converter**
Cost	Medium	Medium	High
Efficiency	Low	Low	High
Output9 current	High	Medium	High

2.2 Advantages of sepic converter

- Same input and output voltage polarity
- Low input current ripple
- Possibility of having multiple output
- Good power factor
- Good efficiency
- Stable operation

2.3 Applications

The cost of the Brushless DC Motor has declined since its introduction, due to advancements in materials and design. This decrease in price, coupled with the many advantages it has over the Brush DC Motor, makes the Brushless DC Motor a popular component in many different applications

- Heating and ventilation
- Industrial automation
- Motion control
- Positioning and actuating system
- Aero modeling
- Cooling fan

- **Buck-Boost Converter** – The buck–boost converter is a type of DC-to-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. It is equivalent to a fly back converter using a single inductor instead of a transformer.

- **SEPIC Converter-** The single-ended primary-inductor converter (SEPIC) is a type of DC/DC converter that allows the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input. The output of the SEPIC is controlled by the duty cycle of the control transistor.

- **Hall Sensor-**A Hall effect sensor is a transducer that varies its output voltage in response to a magnetic field. Hall effect sensors are used for proximity switching, positioning, speed detection, and current sensing applications.

3. REVIEW:

High torque and low power applications mostly prefer low voltage PMBLDCMs operated at constant current. Such applications require the DC link voltage lower than the average output of a DBR fed from a single-phase AC

mains. A DC-DC converter is connected between the VSI and the DBR fed from single phase AC supply to provide controlled voltage at DC link capacitor. There are many DC –DC converter topologies available such as buck, boost, buck-boost, sepic converter amongst which the sepic converter topology is used in this work. It provides controlled DC voltage to the PMBLDCM drive from an uncontrolled DC output of a single phase AC mains fed DBR while improving the PQ at AC mains. The sepic converter topology has advantages of its simplest construction and minimum component requirement over other topologies. The merits of sepic converter topology has input and output Current is ripple free. So that smooth speed control of BLDC Motor is possible The sepic converter is designed for DCM operation to result in reduced sensor requirement with the desired speed control. it suitable for household application such as water pump, fan, mixers, etc.. It not only used in household application but also these are suitable for other application such as computer automobile starter,disc drives, , automobile wipers, medical equipment and many other industrial tools. The BLDC motor is also known as electronically commutated motor because an electronic commutation based on rotor position is used for controlling the speed Permanent magnet brushless DC motors (PMBLDCMs) are preferred motors for a compressor of an air-conditioning system due to its features like high efficiency, wide speed range and low maintenance requirements. The operation of the compressor with the speed control results in an improved efficiency of the system while maintaining the temperature in the air-conditioned zone at the set reference consistently. Whereas, the existing air conditioners mostly have a single phase induction motor to drive the compressor in on/off control mode. This results in increased losses due to frequent on/off operation with increased mechanical and electrical stresses on the motor, thereby poor efficiency and reduced life of the motor. Moreover, the temperature of the air conditioned zone is regulated in a hysteresis band. Therefore, improved efficiency of the Air-Conditioning system will certainly reduce the cost of living and energy demand to cope up with ever increasing power crisis. Because of numerous application of BLDC motor in low power need to be smooth speed control. Propose methodology use dc dc sepic converter for smooth speed controlling and compare with buck converter topology.

4. CONCLUSION:

Comparative analysis of two types of DC-DC Converter topology for Control in BLDC drives has been discussed. Single Ended Primary Inductance Converter (SEPIC) is most suitable. It gives the high efficiency output, power factor near to unity, reduced torque ripples and good speed response for the BLDC drives while compare to the buck-boost converter.

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