# Reduction of Harmonic Distortion and Power Factor Improvement of BLDC Motor using Boost Converter

<sup>1</sup>Parmar Dipakkumar L., <sup>2</sup>Kishan J. Bhayani, <sup>3</sup>Firdaus F. Belim
<sup>1</sup>PG Student, <sup>2</sup>Asst.Prof. Electrical Dept., <sup>3</sup>Asst.Prof. GEC Palanpur
<sup>1</sup>Electrical Engineering Department
<sup>1</sup>V.V.P Engineering College Rajkot, India

*Abstract*— The Technique to improve the power quality of Brushless DC motor by power factor correction play an important role in the energy saving during Energy Conversion. In BLDC motor the ac-dc conversion of electric power is usually required; nevertheless, it causes poor power factor and many current harmonics in the input ac mains. In this Paper DC-DC converter used as a single-stage power factor correction (PFC) converter for a brushless dc motor fed through a diode bridge rectifier (DBR) from a single-phase AC mains. The DC-DC converter shows conformity to international power quality standards with improved performance of BLDC Motor drive, such as reduction of AC main current harmonics, near unity power factor and reduction of speed and torque ripples. To operate the BLDC Motor a Three-phase voltage source inverter is used as an electronic commutator.

Index Terms-Brushless DC motor, Boost Converter, Voltage Source Inverter, PFC

#### I. INTRODUCTION

Brushless Direct Current (BLDC) Motors are one of the Motor Types Rapidly Gaining Popularity. BLDC Motors are used in Industries Such as Appliance, Automotive, Aerospace, Consumer, Medical, Industrial Automation equipment and instrumentation [4]. Brushes are not used in BLDC Motor for Commutation. BLDC Motors are electronically commutated motors.

There are Many Advantages of BLDC Motor Compared to Brushed DC Motor and Induction Motor [4].

- Better Speed versus Torque Characteristics
- High Dynamic Response
- High Efficiency
- Long Operating Life
- Noiseless Operation
- High Speed Ranges
- High Reliability
- Reduced Maintenance

They can Compete on Cost alone Due to Three Major Factor[5]:

- Advances in Magnet Technology
- Improvement in Motor Control Electronics
- Capital investment By BLDC Manufacturers

As a result, brushless DC motors are being used in a wide range of cost sensitive Applications.

BLDC Motors are sometimes referred to as "Inside-Out Permanent Motors" Because Their Speed-Torque Curves are very similar to Those of PM Motors. However, BLDC Motors have their Magnets on the Rotating Part of the Motor instead of on Stationary part and Winding on Stationary part. Operation of a BLDC Motor is similar except that the Winding Phases are Switched On and Off Electronically by Means of Control Device. The Controlling is done by Hall Effect Sensors. The Rotor Assembly may be internal or external to the Stator in a DC Brushless Motor. The Combination of an Inner Permanent Magnet rotor and Outer Winding offers the Advantages of Lower Rotor inertia and more efficient Heat Dissipation than DC Brush type Construction [4].

#### II. OPERATION OF BLDC MOTOR WITH HALL SENSOR



The Hall sensors require a power supply. The Voltage May Range from 4Volt to 24Volt. And Current required is 5mAmp to 15mAmp[3].



When Speed Ranges up to the rated Speed then The Torque Remains Constant. The Motor Can Run Up to The Maximum Speed, Which Can be Up to 150% of Rated Speed but at that Time Torque Starts Dropping[3].

## **III. IDENTIFICATION OF PROBLEM**

A PMBLDCM has the developed torque proportional to its phase current and its back-emf is proportional to the speed. Therefore, a constant current in its stator windings with variable voltage across its terminals maintains constant torque in a PMBLDCM under variable speed operation. A speed control scheme is proposed which uses a reference voltage at DC link proportional to the desired speed of the PMBLDC motor. However, the control of VSI is only for electronic commutation based on the rotor position signals of the PMBLDC motor.



Figure 1.3 Current waveform at AC mains without PFC



Figure 1.4 Harmonic Spectra for the PMBLDCM drive without PFC

The AC mains current waveform, as shown in Fig 1.3, is far from sinusoidal, because of the fact that the DBR does not draw any current from the AC network when the AC voltage is less than the DC link voltage, as the diodes are reverse biased during that period; however, it draws a peaky current when the AC voltage is higher than the DC link voltage. This results in pulsed input current waveform featuring a peak value higher than the peak of the fundamental input current, thereby, 62.53% total harmonic distortion (THD) in the input current and power factor (PF) of 0.77 at AC mains. The PMBLDC motor have to be operated from utility supply, therefore they should conform to the international Power Quality standards such as IEC 555-2, and IEC 61000-3-2. Total Harmonic Distortion is measured in PSIM using FFT analysis.

Table 1.1 Problem Identification Data	
Supply Voltage(Vs)	230V
Supply Current(Is)	3.74A
Fundamental frequency	50Hz
(%)THD of Is	62.53%
Power Factor	0.77

#### IV. SOLUTION USING BOOST CONVERTER



(a) Current Waveform of Phase A(Ia)



(b) Current Waveform of Phase B(Ib)





FFT Analysis of Supply Current



(d) Supply Current



- (e) FFT Analysis of Supply Current
- Supply Current and Voltage Waveform



(f) Supply Voltage and Current Waveform



(g) Speed Waveform of BLDC Motor



## **V. CONCLUSION**

The DC-DC Converters like Boost Converter for brushless DC motor is analyzed in this Paper. The DC-DC Converter topologies for power quality improvement in Brushless DC Motor drives are design and their performance is simulated in PSIM. The speed of Brushless DC motor has been found proportional to the DC link voltage, thereby a smooth speed control is observed while controlling the DC link voltage. The result of simulation shows that total harmonic distortion in AC supply current is reduced and power factor is improved near unity with the help of Boost Converter as per International power quality standards.

## **VI. APPENDIX**

Power rating = 1500 Watt, Voltage rating = 300 Volt, Current rating = 5 Amp, No. of Poles-4, Stator Resistance(R)=11.9 $\Omega$ , Stator Self Inductance(L)=0.00207H, Vpk / krpm = 32.38, Vrms / krpm = 22.9.

#### REFERENCES

- [1]. Sanjeev Singh, Bhim Singh "A Voltage Controlled PFC Cuk converter based PMBLDCM Drive for Air-Conditioner" IEEE TRANSACTION ON INDUSTRY APPLICATION, VOL.48, NO.2, MARCH/APRIL 2012.
- [2]. J.Karthikeyan, Dr.R.Dhana Sekaran "DC-DC converter CSI fed BLDC motor for Defense Application" International Conference on Recent Advancements in Electrical, Electronics and Control Engineering, 2011.

- [3]. B. Singh, S. Singh "Single-phase power factor controller topologies for permanent magnet brushless DC motor drives" IET Power Electronics, Vol. 3, Iss. 2, pp. 147-175, 2009.
- [4]. Brushless DC (BLDC) Motor Fundamentals, Author: Padmaraja Yadmale, Microchip Technology Inc.
- [5]. Brushless DC Motor, Author: K.B. Shah
- [6]. Handbook, Industrial Electronics series, edited by TIMOTHY L.SKVARENINA, Purdue University West Lafayette, Indiana.

