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Power Factor Correction and Power Quality Improvement in BLDC Motor Drive using SEPIC Converter

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ABSTRACT: This project design SEPIC DC-DC converter feeding a BLDC motor drive as a cost effective solution for low power applications. In proposed circuit the single phase supply is fed to uncontrolled bridge rectifier. The output of bridge rectifier is fed to a Sepic DC-DC converter which is used to control the voltage of DC link capacitor which feeds the Voltage Source Inverter. The BLDC motor is fed from Voltage Source Inverter. Voltage of a DC link capacitor of SEPIC converter is controlled to achieve the speed control of BLDC motor. A MATLAB Simulation will used to simulate the developed model to achieve a wide range of speed control

KEYWORDS: BLDC motor, SEPIC converter, Power Factor Correction (PFC), Power Quality (PQ), motor drive, converter, DC motor, efficiency, power factor, reactive power

I. 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. A low power PMBLDC motor is fed from a single phase AC supply through a diode bridge rectifier (DBR) followed by a DC capacitor and a voltage source inverter (VSI). This PMBLDCM drive draws a pulsed current from AC mains having peaks higher than the amplitude of the fundamental input current due to uncontrolled charging of DC link capacitor. This result in power quality disturbances at input AC mains such as poor power factor, increased total harmonic distortion (THD) and high crest factor (CF) etc. these PQ disturbances are undesirable and should be within limits as imposed by the standard IEC 61000-3-2 for the drives in low power range. 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, cuk, sepik converter amongst which the cuk 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 [6].

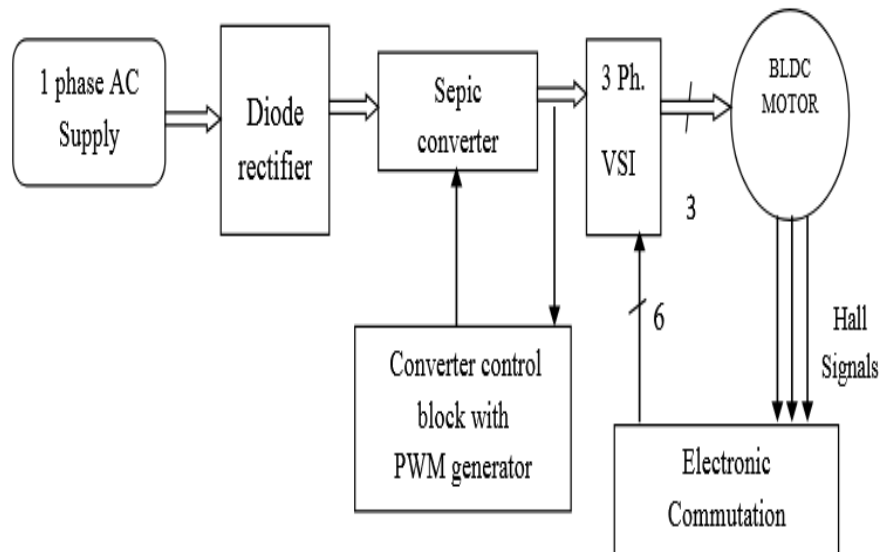
The buck-boost converter topology has advantages of its simplest construction and minimum component requirement over other topologies.. The buck-boost converter is designed for DCM operation to result in reduced sensor requirement with the desired speed control

II. OBJECTIVES

BLDC motors, particularly when operated with traditional inverters, often exhibit a lagging power factor, meaning the current and voltage are out of sync, leading to inefficiencies and increased energy consumption. The SEPIC converter in this project is designed to rectify the input current, making it sinusoidal and aligned with the input voltage. This results in a higher power factor, closer to unity, which reduces reactive power and improves overall system efficiency.

- The SEPIC converter, used for PFC, also contributes to power quality improvement by minimizing harmonic distortion in the input current. By ensuring a sinusoidal current waveform, the SEPIC converter reduces the impact of the BLDC drive on the power grid, making it a more stable and reliable system

III. BLOCK DIAGRAM



DC-DC converter feeding permanent magnet brushless motor drive is proposed here for low power application. sepic converter comes under the category of DC to DC converter. In proposed circuit single phase supply is feeding to uncontrolled rectifier and DC converter is to control the voltage of DC link capacitor. Voltage of DC link capacitors used to control the speed of BLDC motor. The output of DC link capacitor is fed to inverter and then BLDC motor to control the speed. A current multiplier technique is used to control the speed of BLDC motor.

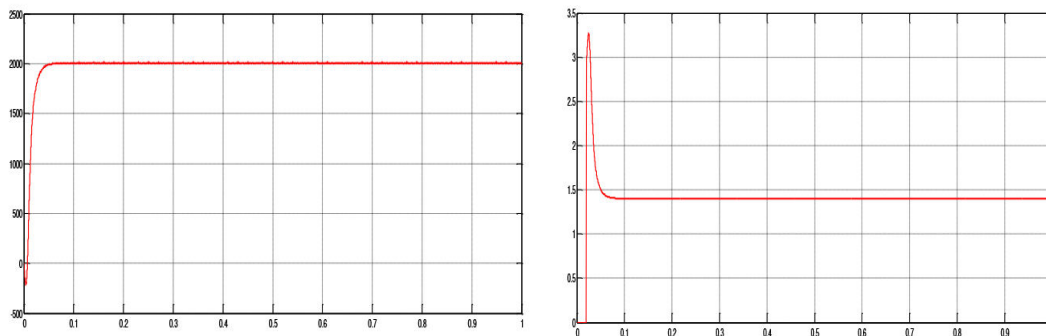
IV. WORKING

The proposed sepic converter based PMBLDCM drive operated with current multiplier follower approach. The proposed controller is operated to maintain a constant DC link voltage with PFC action at AC mains. It has a current control loop inside the speed control loop, for continuous conduction mode (CCM) operation of the converter. The control loop processes the voltage error (V_e) between sensed DC link voltage (V_{dc}) and a voltage (V_{dc}^*) equivalent to the reference speed, through a proportional-integral (PI) controller to generate modulating control signal (I_c). This signal (I_c) is multiplied with a unit template of input AC voltage to generate reference DC current (I_d^*) and compared with the DC current (I_d) sensed after the DBR. The resultant current error (I_e) is amplified and compared with saw-tooth carrier wave of fixed frequency (f_s) to generate the PWM pulse for the PFC converter. For the speed control, the speed signal derived from rotor position of the PMBLDCM, sensed using Hall effect sensor, is compared with a reference speed. The resultant speed error is passed through a speed controller to get the torque equivalent which is converted to an equivalent current signal using motor torque constant.

V. RESULT AND DISCUSSION

The simulation model primarily designed for the opportunity analysis of controlling the speed of BLDC, for their management in the design phase and for the study of problems that may occur due to the adopted solution. The adopted solution concerns the management solutions that can be adopted, but also the monitoring, control and command of controlling of speed DC motor. One of the advantages of Matlab software is that libraries offer a wide range of basic components for modeling the consumers. Thus, it can be modeled both single- phase or three phased consumers with

different powers, nature and types (e.g.: resistive, capacitive or inductive consumers). Basic components of simulink library are: Each of these components basically modeled on studies of mathematical models and has associated specific parameters. The interfacing with Matlab libraries components was realized in order to make a thorough study of the modeled of speed control systems to the centralized operational management system. By using different types of measurement and display blocks of Matlab, voltages, currents, Inverter powers and energy flows from the system.



VI. CONCLUSION

A simple control using a current multiplier approach has been used for voltage control of a PFC sepic converter fed BLDC motor drive. A single stage PFC converter system has been designed and validated for the speed control for a wide range of speed. The performance of the proposed drive system has also been evaluated for varying input AC voltages and smooth performance of motor is obtained. The proposed drive system has been found a suitable control technique among various adjustable speed drives for many low power applications. With help of comparison with buck converter it can be concluded that the sepic converter fed BLDC motor gives better performance.

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