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PFC Cuk Converter-–FED BLDC Motor and Neutral Drive

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ABSTRACT: This paper deals with a power factor correction (PFC)-based Cuk converter-fed brushless dc motor (BLDC) drive as a cost-effective solution for low-power applications. The speed of the BLDC motor is controlled by varying the dc-bus voltage of a voltage source inverter (VSI) which uses a low frequency switching of VSI (electronic commutation of the BLDC motor) for low switching losses. A diode bridge rectifier followed by a Cuk converter working in a discontinuous conduction mode (DCM) is used for control of dc-link voltage with unity power factor at ac mains. Performance of the PFC Cuk converter is evaluated under four different operating conditions of discontinuous and continuous conduction modes (CCM) and a comparison is made to select a best suited mode of operation. The performance of the proposed system is simulated in a MATLAB/Simulink environment and a hardware prototype of the proposed drive is developed to validate its performance over a wide range of speed with unity power factor at ac mains.

KEYWORDS: Power factor, Spectrum Sensing, Efficient Control, System Security.

I.INTRODUCTION

BRUSHLESS dc (BLDC) motors are recommended for many low- and medium-power drives applications because of their high efficiency, high flux density per unit volume, low maintenance requirement, low electromagnetic interference (EMI) problems, high ruggedness, and a wide range of speed control. Due to these advantages, they find applications in numerous areas such as household application [3], transportation (hybrid vehicle) , aerospace , heating, ventilation and air conditioning , motion control and robotics], renewable energy applications etc. The BLDC motor is a three-phase synchronous motor consisting of a stator having a three-phase concentrated windings and a rotor having permanent magnets It does not have mechanical brushes and commutator assembly; hence, wear and tear of the brushes and sparking issues as in case of conventional dc machines are eliminated in BLDC motor and thus it has low EMI problems. This motor is also referred as an electronically commutated motor since an electronic commutation based on the Hall-effect rotor position signals is used rather than a mechanical commutation

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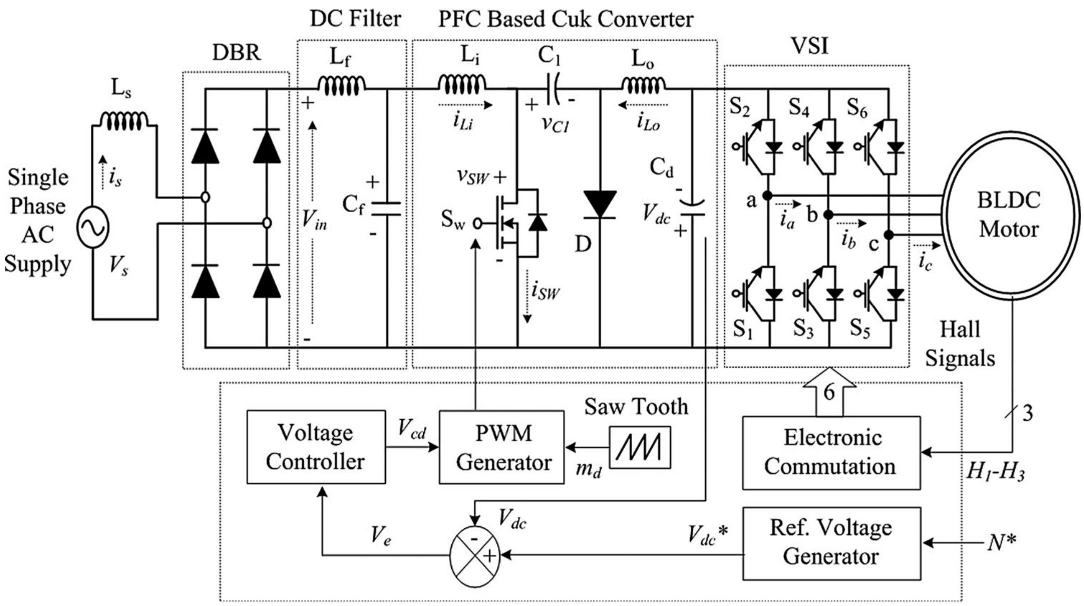
II. MODULES DESCRIPTION: CIRCUIT DIAGRAM



BLDC motor drive fed by a PFC Cuk converter using a voltage follower approach

III. OPERATION OF PROPOSED CONVERTER

The PFC Cuk converter-based VSI-fed\ BLDC motor drive using a current multiplier and a voltage follower approach, respectively. A high frequency metal–oxide–semiconductor field-effect transistor (MOSFET) is used in the Cuk converter for PFC and voltage control ,where as insulated-gate bipolar transistors (IGBTs) are used in the VSI for its low frequency operation. The BLDC motor is commutated electronically to operate the IGBTs of VSI in fundamental frequency switching mode to reduce its switching losses. The PFC Cuk converter operating in the CCM using a current multiplier approach is shown in Fig. 1; i.e., the current flowing in the input and output inductors (Li and Lo), and the voltage across the intermediate capacitor (C1) remain continuous in a switching period, whereas Fig. 2 shows a Cuk converter-fed BLDC motor drive operating in the DCM using a voltage follower approach. The current flowing in either of the input or output inductor (Li and Lo) or the voltage across the intermediate capacitor (C1)becomes discontinuous in a switching period for a PFC Cuk converter operating in the DCM.

IV. OPERATION MODES

The operation of the Cuk converter is studied in four different modes of CCM and DCM. In CCM, the current in inductors(Li and Lo) and voltage across intermediate capacitor C1 remain continuous in a switching period .Moreover, the DCM operation is further classified into two broad categories of a discontinuous inductor current mode (DICM) and a discontinuous capacitor voltage mode (DCVM). In the DICM, the current flowing in inductor Li or Lo becomes discontinuous in their respective modes of operation .While in DCVM operation, the voltage appearing across the intermediate capacitorC1 becomes discontinuous in a switching period .Different modes for operation of the CCM and DCM are discussed as follows.

V. DICM (LO)OPERATION

The operation of the Cuk converter in the DICM (*Lo*) is described as follows. the operation of the Cuk converter in three different intervals of a switching period and the associated waveforms in a switching period.

INTERVAL 1:

when switch Swin turned ON, inductor Li stores energy while capacitor C1 discharges through switch Swto transfer its energy to the dc-link capacitor Cd.

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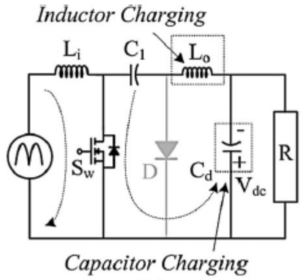
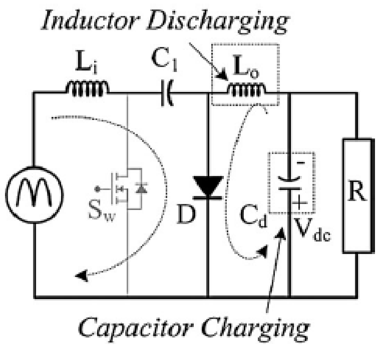


(a)

INTERVAL II:

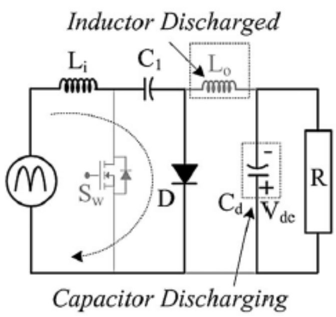
When switch *Sw*is turned OFF, the energy storedin inductor *Li* and *Lo* is transferred to intermediate capacitor*C*1 and dc-link capacitor *Cd* , respectively.



(b)

INTERVAL III:

In this mode of operation, the output inductor *Lo*is completely discharged; hence, its current *iLo*becomeszero.An inductor *Li* operates in continuous conduction to transfer itsenergy to the intermediate capacitor *C*1 via diode D.



(c)

V. SIMULATION DESIGN EXISTING SYSTEM

A simulation designsystem as shown in **Fig a.**is implemented in MATLAB SIMULINK with the help of switches and voltage sources we get desired output voltage level

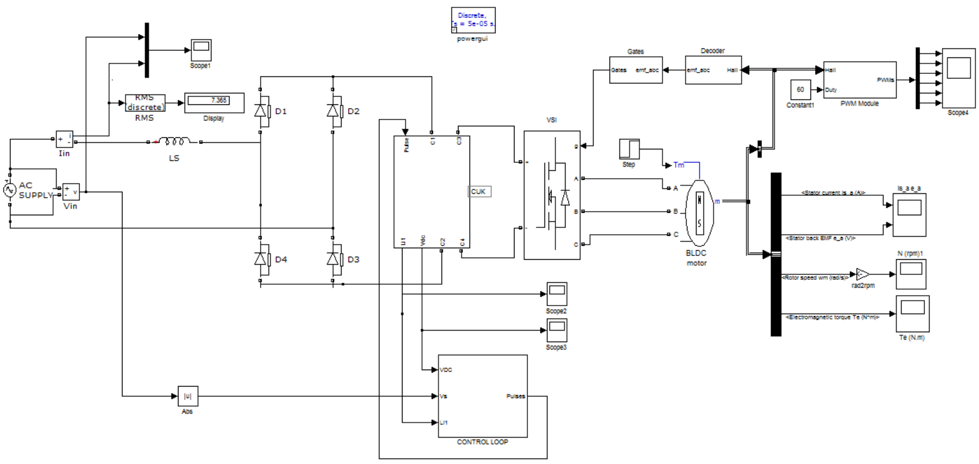
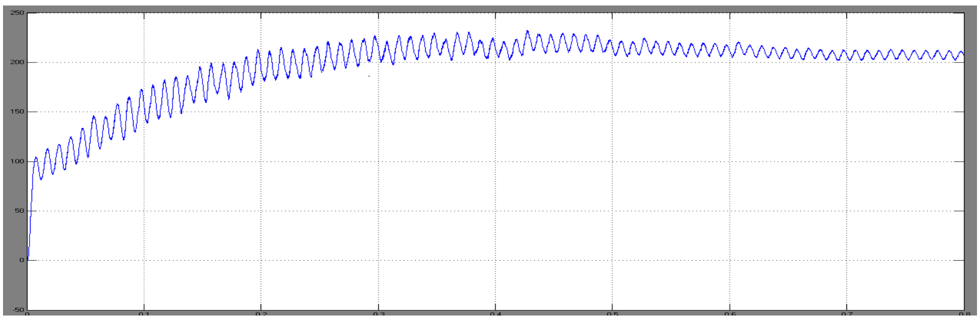
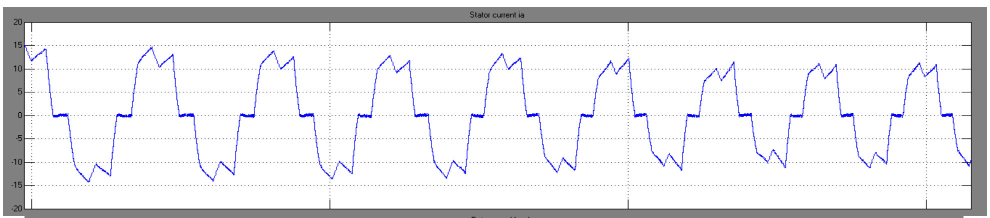
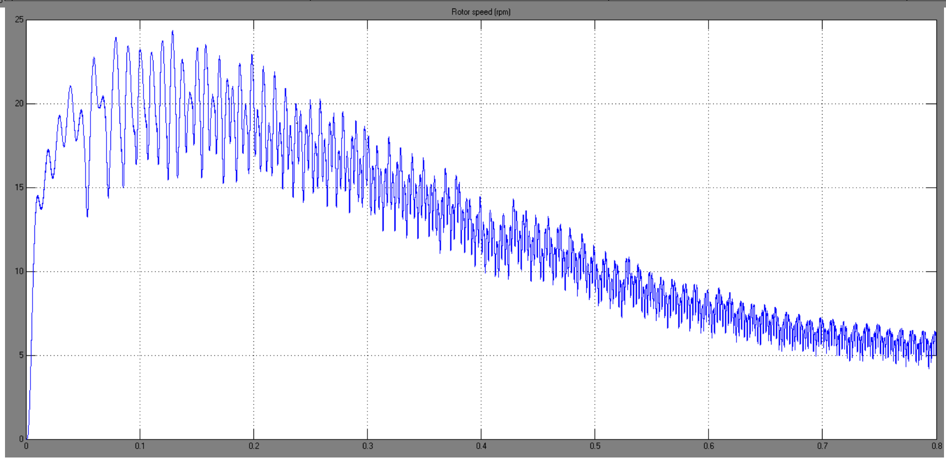


Fig a. BLDC motor drive fed by a PFC Cuk converter using a voltage follower approach

OUTPUT VOLTAGE WAVEFORM







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EXPECTED INPUT AND EXPECTED OUTPUT

aHere the Input given to the circuit is 230 VAC and the output is control of BLDC using cuk converter .

ADVANTAGES

- Near unity PF achieved.
- Switching losses can be reduced
- Efficiency of the system is improved.

SPECIFICATIONS

- Auto detection of programmer by software
- Regulated Power supply 5,13.5V
- Auto Flash upgrades through serial port
- 16 MHz crystal Oscillator
- Built in RS232 connector
- ZIF socket for easy programming
- External ICSP Interface for on board programming
- Programmable configuration and ID
- Selective Erase and programming for supported PIC Devices
- Manual / Auto Reset
- Configurable COM Port.
- Program, Read, Verify and Blank check Modes
- Hex Code Editor
- Program & Verify fly Window
- Switchable to MPLAB software
- Extensive Integrated Help
- Debug vector Read & write
- Oscal value read & program (for selected chips)

V. CONCLUSION

A Cuk converter for VSI-fed BLDC motor drive has been designed for achieving a unity PF at ac mains for the development of the low-cost PFC motor for numerous low-power equipment's such fans, blowers, water pumps, etc. The speed of the BLDC motor drive has been controlled by varying the dc-link voltage of VSI, which allows the VSI to operate in the fundamental frequency switching mode for reduced switching losses. Four different modes of the Cuk converter operating in the CCM and DCM have been explored for the development of the BLDC motor drive with unity PF at ac mains. A detailed comparison of all modes of operation has been presented on the basis of feasibility in design and the cost constraint in the development of such drive for low-power applications. Finally, abets suited mode of the Cuk converter with output inductor current operating in the DICM has been selected for experimental verifications. The proposed drive system has shown satisfactory results in all aspects and is a recommended solution for low-power BLDC motor drives.

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