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Implementation of Landsman Converter for Power Factor Correction in BLDC Motor

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ABSTRACT: Power factor correction of BLDC motor deals with a highly reliable electrical drive utilizing the Brushless DC Motor. The motor is fed by Voltage source Inverter (VSI) with a dc-dc converter power factor correction circuit (PFC) as the VSI's predecessor. The Performance of dc-dc converters is analyzed and the results are discussed to arrive at the best suited converter. PID Logic Controller is used as the Intelligent Controller for the BLDC motor. Reliable, low cost arrangement is thus provided to achieve unity power factor and speed regulation with accuracy. The Landsman Converter performs power factor correction and DC voltage control in single stage using only one controller. The designed PFC converter results in an improved power quality at AC mains in a wide range of speed control and input AC voltage. The voltage source inverter (VSI) is used as an electronic COMMUTATOR of PMBLDCM.

KEYWORDS: Power factor correction (PFC), Discontinuous conduction mode (DCM), Diode bridge rectifier (DBR), Landsman converter, Metal oxide semiconductor field effect transistor (MOSFET), Hall sensor, PIC Microcontroller, Regulated power supply (RPS) .

I. INTRODUCTION

The air-conditioning is energy intensive application which normally uses single phase induction motors for driving its compressor and fans. The efficiency of these motors is between 70-80%. More over the on-off control employed for the temperature control is not energy efficient and introduces many disturbances in the distribution system along with increased wear and tear of the motor and reduce power factor. The use of PMBLDCM for driving the compressor results in energy efficiency improvement of the Air-Con. Moreover, the temperature in the air-conditioned zone can be maintained at these preference smoothly while operating the Air-Con under speed control. This paper presents to improve the power factor using Landsman Converter for PMBLDC motor application. Mainly in air conditioning systems to achieve the below, which is difficult in conventional system. Smooth start-up of air conditioning systems without fluctuations in input voltage. Achieve the study and smooth speed control to maintain the constant Room temperature. Avoid the Harmonics in the power system due to the continuous switching millions of Air conditioners and main higher efficiency.

II. LITERATURE SURVEY

Shanmugasundram, R., K. Muhammad Zakariah, and N. Yadaiah. "Implementation and performance analysis of digital controllers for brushless DC motor drives." IEEE/ASME transactions on mechatronics 19, no. 1 (2014): 213-224.

This paper presents design and digital implementation of a fuzzy controller for achieving improved performance of Brushless dc (BLDC) servomotor drive. The performance of fuzzy and PID controller-based BLDC servomotor drives is investigated under different operating conditions such as change in reference speed, parameter variations, load disturbance, etc. BLDC servomotors are used in aerospace, instrumentation systems, space vehicles, electric vehicles, robotics, and industrial control applications. In such applications, conventional controllers like P, PI, and PID are being used with the BLDC servomotor drive control systems to achieve satisfactory transient and steady-

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state responses. However, the major problem associated with the conventional PID controller is that the tuned gain parameters obtained for such BLDC servomotor drive control systems do not yield better transient and steady-state responses under different operating conditions such as parameter variations, load disturbances, etc. In this paper, design and implementation of fuzzy controller is presented and its performance is compared with PID controller to show its capability to track the error and usefulness of fuzzy controller in control applications.

Singh, Sanjeev, and Bhim Singh. "A voltage-controlled PFC Cuk converter-based PMBLDCM drive for air-conditioners." *IEEE transactions on industry applications* 48, no. 2 (2012): 832-838.

This paper deals with a CUK dc-dc converter as a single-stage power-factor-correction converter for a permanent-magnet (PM) brushless dc motor (PMBLDCM) fed through a diode bridge rectifier from a single-phase ac mains. A three-phase voltage-source inverter is used as an electronic COMMUTATOR to operate the PMBLDCM driving an air-conditioner compressor. The speed of the compressor is controlled to achieve optimum air-conditioning using a concept of the voltage control at dc link proportional to the desired speed of the PMBLDCM. The stator currents of the PMBLDCM during step change in the reference speed are controlled within the specified limits by an addition of a rate limiter in the reference dc link voltage. The proposed PMBLDCM drive (PMBLDCMD) is designed and modeled, and its performance is evaluated in MATLAB-SIMULINK environment. Simulated results are presented to demonstrate an improved power quality at ac mains of the PMBLDCMD system in a wide range of speed and input ac voltage. Test results of a developed controller are also presented to validate the design and model of the drive.

Bist, Vashist, and Bhim Singh. "PFC Cuk converter-fed BLDC motor drive." *IEEE transactions on Power Electronics* 30, no. 2 (2015): 871-887.

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.

Wang, Haoyu, Yichao Tang, and Alireza Khaligh. "A bridgeless boost rectifier for low-voltage energy harvesting applications." *IEEE transactions on power electronics* 28, no. 11 (2013): 5206-5214.

In this paper, a single-stage ac-dc power electronic converter is proposed to efficiently manage the energy harvested from electromagnetic micro scale and meso scale generators with low-voltage outputs. The proposed topology combines a boost converter and a buck-boost converter to condition the positive and negative half portions of the input ac voltage, respectively. Only one inductor and capacitor are used in both circuitries to reduce the size of the converter. A 2 cm × 2 cm, 3.34-g prototype has been designed and tested at 50-kHz switching frequency, which demonstrate 71% efficiency at 54.5 mW. The input ac voltage with 0.4-V amplitude is rectified and stepped up to 3.3-V dc. Detailed design guidelines are provided with the purpose of minimizing the size, weight, and power losses. The theoretical analyses are validated by the experiment results.

III. PROPOSED SYSTEM

In this project to improve the power factor using bridgeless SEPIC converter for BLDC motor application. The bridgeless SEPIC converter is configured from a buck controller that drives a high-side PMOS FET. The bridgeless SEPIC converter is another option for regulating an unregulated input-power supply. The rotor position signals are required only for electronic commutation of BLDC using switching of voltage source inverter.

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Block Diagram of the System

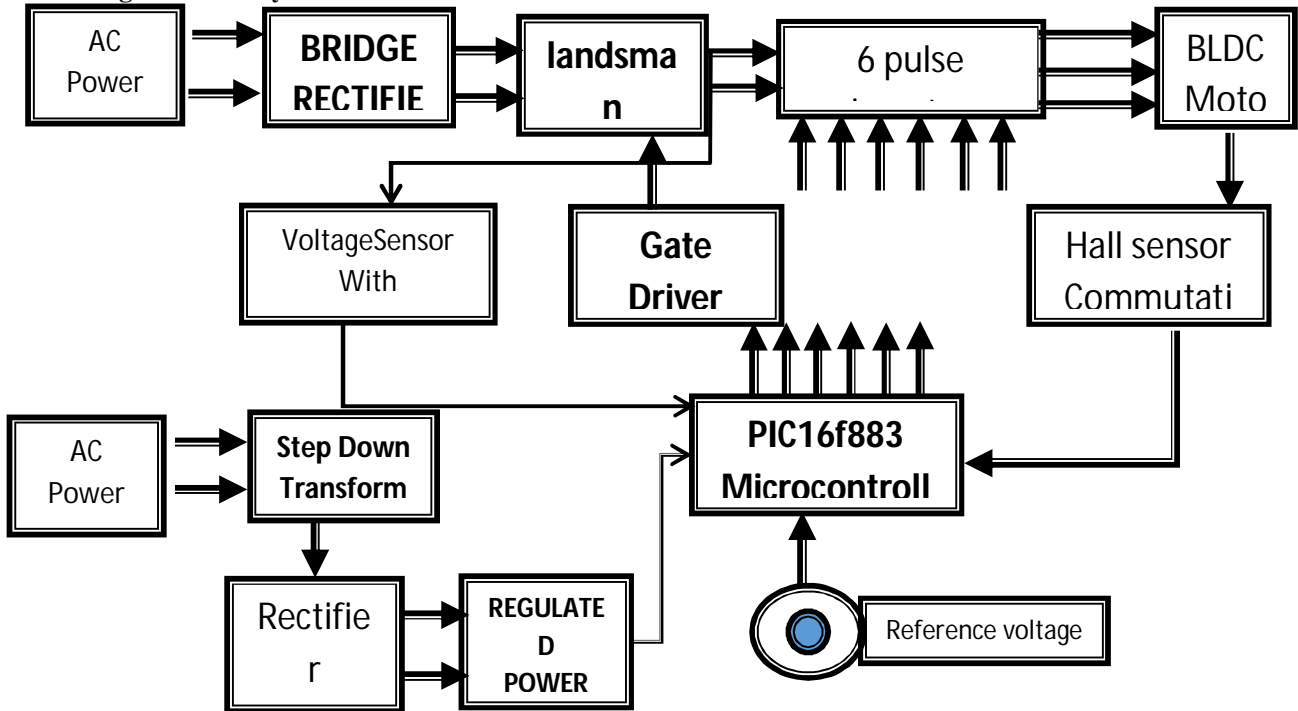


Fig.no.8.1. Block Diagram of the System

The block diagram of the experimental set-up is shown in Fig.8.1. The experimental set-up consists of four components. They are MOSFET power inverter, BLDC Motor, fuzzy logic controller and RF Transmitter and Receiver units. The BLDC motor is an electronically commutated motor. The built-in hall sensors generate three signals according to the rotor position. Here the input is given as available single phase AC source. It is passed to a phase controlled rectifier where it is converted from AC to DC. The filter present is used to remove the harmonics in the DC source. Then it is passed through the single phase to three phase inverter where the uncontrolled DC is converted to pulsed or controlled DC.

The pulsed DC current is used to start or run the BLDC motor. The rotor position is sensed by the Hall Effect sensor and the signal is amplified by the signal conditioner. The amplified signal is passed to the microcontroller. Using an embedded C coding program is burned in the IC 16F877A by using CCS compiler. The set speed is transmitted by the RF transmitter and at the receiving end, the receiver receives this analog value on a single data line and passes this data to the decoder. It converts the single bit data into eight bit data and gives it to the microcontroller which does the further processing. Here the controller compares the reference set speed and the actual speed and it varies according to it and determines the error speed and generates the control signal which sends them to the MOSFET inverter circuits. These signals energize the appropriate windings by switching the appropriate switches in the power inverter. Thus the speed of the BLDC motor is controlled by using the microcontroller.

PROPOSED SYSTEM TECHNIQUE

This project uses the LANDSMAN converter topology, which provides a positive output from an input voltage. The LANDSMAN converter also needs two inductors and a series capacitor, sometimes called a flying capacitor. Unlike the SEPIC converter, which is configured with a standard boost converter, the LANDSMAN converter is configured

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from a buck controller that drives a high-side PMOS FET. The LANDSMAN converter is another option for regulating an unregulated input-power supply, like a low-cost wall wart.

Design and Component Selection

The overall hardware design was broken down into the following subsystems:

- Block Diagram of the System
- Landsman converter
- BLDC Motor
- Hall Effect sensor interface
- MOSFET bridge
- Gate drive circuit
- Power supply
- PIC Microcontroller

INVERTERS

A device that converts dc power to ac power at desired output voltage and frequency is called an inverter. Inverters can broadly classify into two types: VSI and CSI .A VSI, is one in which the dc source has small or negligible impedance. In other words a voltage source inverter has stiff dc voltage source at its input terminals. A CSI is fed with an adjustable current from a dc source of high impedance, i.e. from a stiff dc current source. In a CSI fed with stiff current source, output current waves are not affected by the load. In VSIs using THYRISTORS, some type of forced commutation is usually required. In case VSIs are made up of using power MOSFETs self commutation with gate drive signals is employed for their turn-on and turn-off.

IV. RESULT



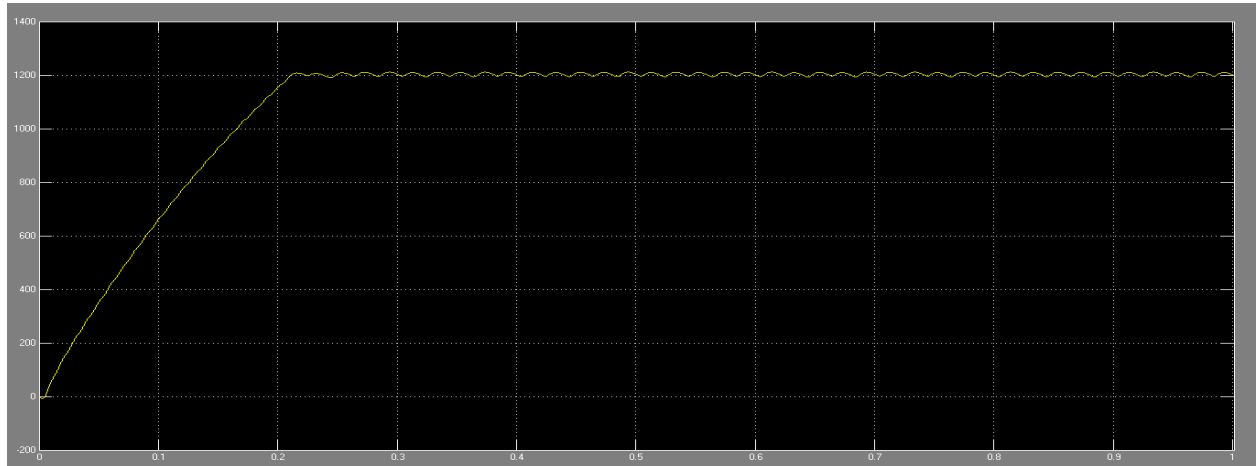
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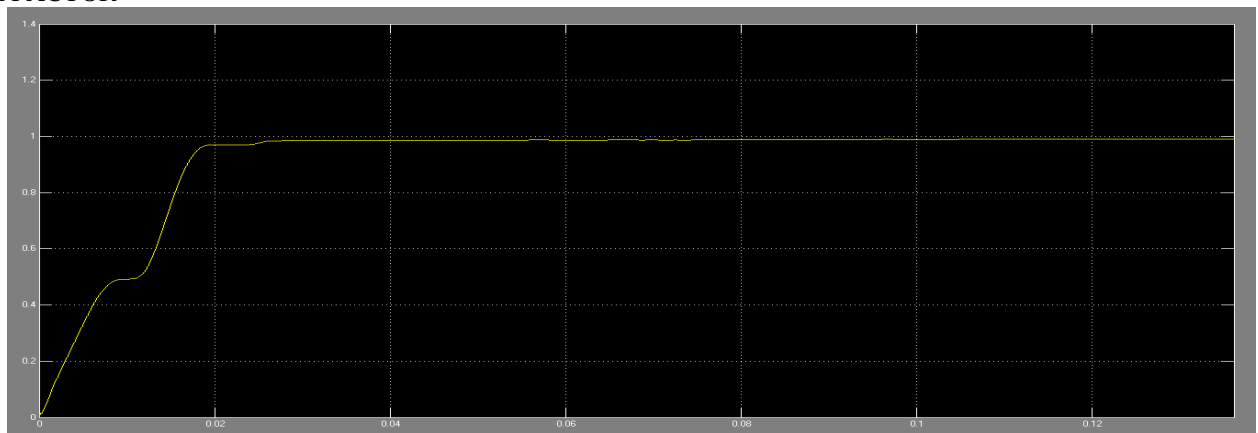
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MOTOR SPEED



POWER FACTOR



V. CONCLUSION

The power factor correction has been successfully implemented using the Landsman Converter. It shows a much improved result as it not only provides better power quality, but also the converter removes the necessity to smooth out the dc output from ripples. The PID controller widely increases application range of the motor by increasing the reliability. The motor is presently used in areas such as aerospace, aircraft and mining applications because of the enhanced reliability that the motor offers. This is further enhanced by the usage of NFLC and the PFC converters. The NFLC is used to control the motor speed and the Landsman Converter is used for the power factor improvement. It is found that the Landsman Converter is found to provide better power quality. The Analysis has been done for Continuous conduction in the Landsman Converter as both are not capable of self .A prototype model is implemented in laboratory and detailed experimental studies are carried out. It is observed that the experimental results are consistent with the simulation results. In the simulation the Input voltage will be 30V AC and motor operated on the 24V maximum in the BLDC motor. The voltage control is implemented for the simulation. And we calculate the power factor from active power and apparent power. In Hardware we use the input as 24V AC and 12V for motor operation is utilized. The voltage control will be implemented. The power factor will be shown in the input voltage and Current.

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