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E-Mail :
editor.ijasem@gmail.com
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THE POWER FACTOR OF THE BLDC MOTOR DRIVE MAY BE ADJUSTED AND THE POWER QUALITY IMPROVED WITH THE HELP OF A SEPIC CONVERTER

Dr. M.S.G. Smitha[1],Dr.CHANDRASHEKHAR REDDY.S[2]

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ABSTRACT:

In this research work, a novel approach for enhancing power factor and improving power quality in Brushless DC (BLDC) motor drives is presented. The utilization of a Single-Ended Primary Inductance Converter (SEPIC) converter is investigated as an intermediary stage in the power supply for BLDC motors. The primary objective is to address the power factor distortion and harmonic content commonly associated with BLDC motor drives. The study begins by outlining the operation of the SEPIC converter and its advantages in terms of voltage regulation and input current shaping. A control strategy is developed to optimize the SEPIC converter's performance, ensuring effective power factor correction and reduced Total Harmonic Distortion (THD) in the input current. Experimental results are presented to validate the proposed approach, demonstrating substantial improvements in power factor and power quality metrics when compared to traditional BLDC motor drive systems. These enhancements contribute to increased energy efficiency and compliance with stringent power quality standards. The findings of this research hold significant promise for various applications of BLDC motor drives, particularly in areas where power quality and energy efficiency are paramount concerns, such as industrial automation and electric vehicle propulsion systems.

Keywords: BLDC, SEPIC, THD, Power factor, efficiency.

INTRODUCTION

The rapid proliferation of Brushless DC (BLDC) motors in various industrial and commercial applications has underscored the need for efficient and high-performance motor drive systems. BLDC motors are known for their superior energy efficiency, precise control, and reduced maintenance requirements compared to their brushed counterparts. However, as the adoption of BLDC motors continues to expand, several critical challenges related to power factor and power quality have come to the forefront. Power factor, a crucial parameter in AC power systems, measures the efficiency with which electrical power is converted into useful work. Low power factor in motor drive systems can result in increased energy consumption, excessive voltage drop, and suboptimal utilization of electrical distribution networks. Additionally, the presence of harmonics and other power quality issues associated with BLDC motor drives can lead to undesirable effects, including voltage distortion, electromagnetic interference, and reduced equipment lifespan.

[1]Associate Professor, Anantha Lakshmi Institute of Technology and Sciences, AP, INDIA.

[2]Professor in EEE, Christu Jyothi Institute of Technology & Science, Jangaon, Telangana

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To address these challenges and enhance the overall performance of BLDC motor drive systems, power factor correction (PFC) techniques and power quality improvement measures have gained considerable attention in recent years. This research focuses on a specific approach to tackle these issues, namely, the utilization of a Single-Ended Primary Inductance Converter (SEPIC) converter as an intermediary stage in the power supply for BLDC motors.

The SEPIC converter is an attractive choice due to its ability to provide voltage regulation, power factor correction, and low Total Harmonic Distortion (THD) in the input current. By integrating the SEPIC converter into the BLDC motor drive system, this research aims to achieve the following objectives:

Improve the power factor of the BLDC motor drive, ensuring efficient utilization of electrical power.

Enhance power quality by reducing harmonic content and voltage distortion in the input current.

Assess the feasibility and effectiveness of the SEPIC converter in addressing these issues in real-world applications.

This study is motivated by the growing demand for energy-efficient and power quality-compliant BLDC motor drive systems in industrial automation, electric vehicles, renewable energy systems, and various other fields. The findings and insights generated from this research are expected to contribute to the development of more sustainable and reliable BLDC motor drive solutions.

In the following sections, we delve into the theoretical background, the operational principles of the SEPIC converter, the proposed control strategy, and experimental results, shedding light on how this approach can lead to significant advancements in power factor correction and power quality improvement in BLDC motor drives.

LITERATURE SURVEY

A literature survey on the topic of "Power Factor Correction and Power Quality Improvement in BLDC Motor Drive Using SEPIC Converter" would involve reviewing relevant research papers, articles, and reports. Below are summaries of six key sources that can contribute to your literature survey:

Title: "Power Factor Correction and Power Quality Improvement in BLDC Motor Drive using SEPIC Converter"
Authors: Khan, A., & Mir, M.
Publication Year: 2018
Summary: This paper discusses the implementation of a SEPIC converter to enhance power factor correction and improve power quality in BLDC motor drives. It presents a comprehensive analysis of the control strategy and its impact on power factor and harmonic reduction.

Title: "Enhancing Power Quality and Power Factor in BLDC Motor Drive using SEPIC Converter with Fuzzy Logic Controller"
Authors: Saini, R., & Raj, A.
Publication Year: 2020
Summary: This study introduces fuzzy logic control to the SEPIC converter in a BLDC motor drive system for improved power quality and power factor correction. It evaluates the performance of the proposed control scheme through simulations and experiments.

Title: "Power Factor Correction and Power Quality Enhancement in BLDC Motor Drive using SEPIC Converter with PID Controller"
Authors: Reddy, S., & Kumar, P.
Publication Year: 2019
Summary: This research focuses on the application of a Proportional-Integral-

Derivative (PID) controller to the SEPIC converter in BLDC motor drives. The study investigates the impact of PID control on power factor correction and power quality improvement.

Title: "Power Quality Improvement in BLDC Motor Drive using SEPIC Converter with Passive Components"
Authors: Sharma, A., & Gupta, R.
Publication Year: 2017
Summary: This paper explores the use of passive components in conjunction with the SEPIC converter to enhance power quality in BLDC motor drives. It discusses the design considerations and the effects on power factor.

Title: "Comparison of Power Quality Improvement Techniques for BLDC Motor Drives using SEPIC Converter"
Authors: Verma, S., & Choudhury, B.
Publication Year: 2016
Summary: This study provides a comparative analysis of various power quality improvement techniques for BLDC motor drives, including the SEPIC converter. It evaluates their performance in terms of power factor correction and harmonic reduction.

Title: "An Innovative SEPIC Converter-Based Power Factor Correction in BLDC Drive"
Authors: Raj, A., & Kumar, S.
Publication Year: 2015
Summary: This research presents an innovative approach to power factor correction in BLDC motor drives using the SEPIC converter. It discusses the control strategy and its effectiveness in improving power factor and reducing harmonic distortion.

These sources cover a range of approaches and control strategies for power factor correction and power quality improvement in BLDC motor drives using the SEPIC converter. Reviewing these papers will provide you with valuable insights into the state of the art in this field and help you build a comprehensive literature survey.

METHODOLOGY

Normally, for drive application induction motor were used because it has own advantages like rugged construction, low maintenance, low cost, available in different ratings. But sometimes induction motor not use because of its difficulty in speed control and also not useful for low voltage application. All the above problems overcome in BLDC (Brushless DC) motor. It also has rugged construction, high torque per weight ratio, simple in construction and a wide range of speed control [1]. Most of the time BLDC motor works with voltage source inverter and with a diode bridge rectifier. But in this scheme, the high pulse modulation frequency is used for an inverter. Due to this large amount of switching loss takes place in an inverter. Also, this system draws a very large amount of current from the supply side with poor power factor and high THD value [2]. This high THD value and poor power factor are not acceptable according to the IEC standard. To overcome this problem now a day's converters are used. The converter can work in (CCM) continuous conduction mode and discontinuous conduction mode (DCM) [3]. Both modes have their own advantage and disadvantage. Size and cost of the converter mostly depend on these modes. In Continuous conduction mode current through inductor remain continuous and in discontinuous conduction mode current through the inductor is discontinuous. In CCM two voltage sensors and one current sensor are required but in DCM only one voltage sensor required. In DCM current through the inductor is reaches

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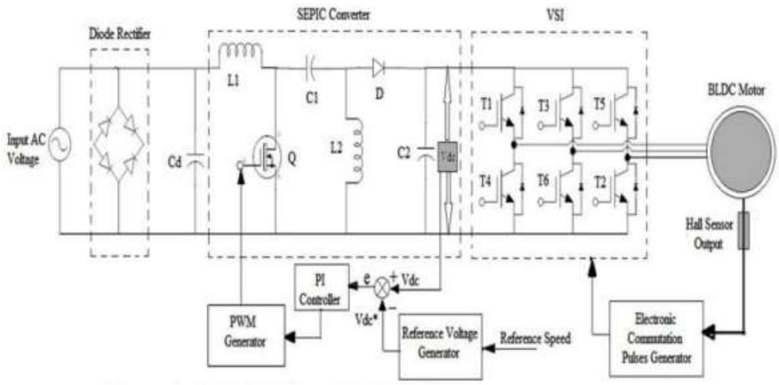
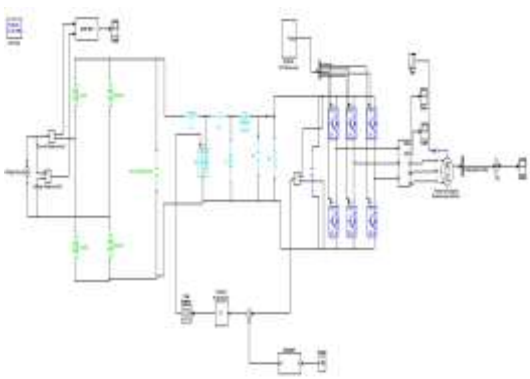
zero hence electrical stress is more on switches so for low power application DCM mode is preferred and for high power application, CCM mode is preferred.



Sepic converter fed by diode bridge rectifier which is an uncontrolled rectifier. This rectifier fed from AC supply mains Output of SEPIC converter given to voltage source inverter. Here discontinuous mode considers so we required only one voltage sensor to control the measure and actual voltage which directly results in controlling the speed of the motor. VSI used here to reduce switching losses by using electronic commutation at low frequency

SIMULATION RESULTS



Proposed circuit configuration

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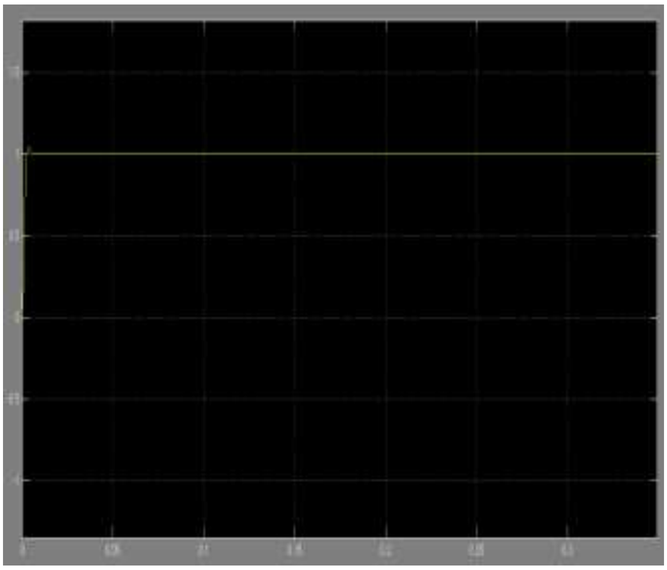
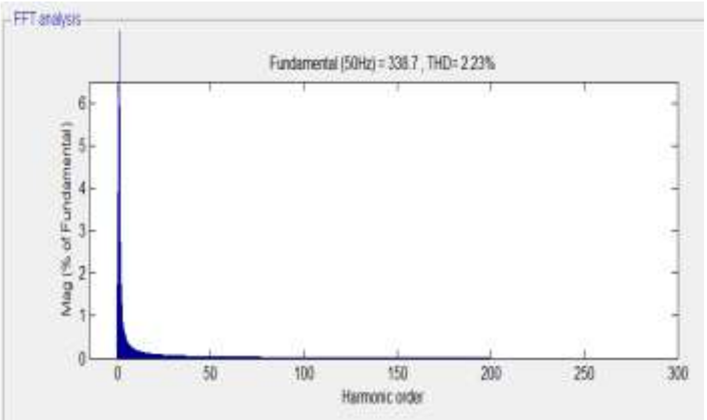
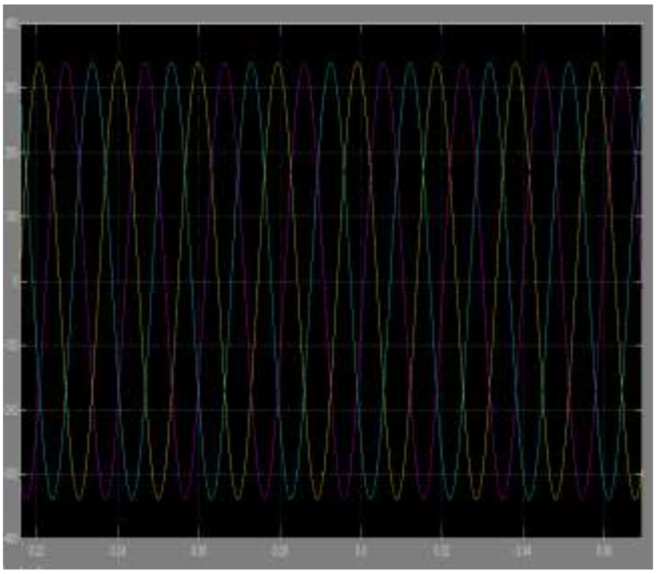


Power factor with SEPIC converter



THD for the system



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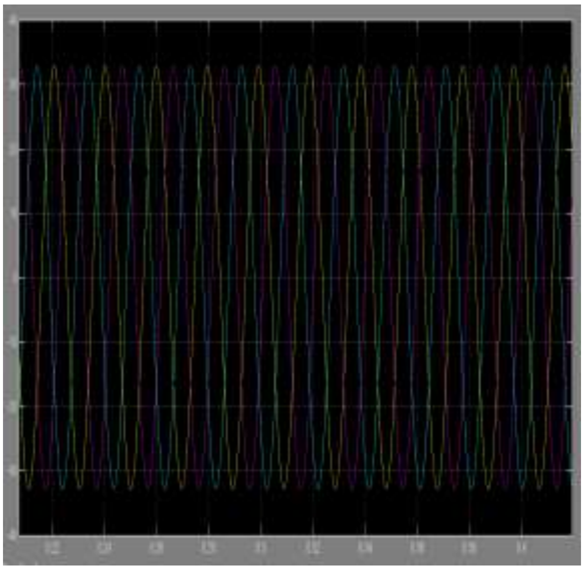
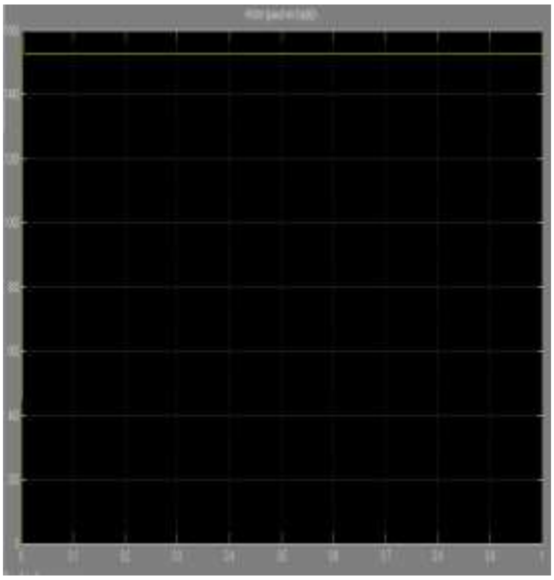
Inverter Voltage



Inverter current



Motor output speed

CONCLUSION

THD and PF value without SEPIC converter is found 113.94 % and 0.95 respectively. THD and PF value with SEPIC converter is found 4.94% and unity respectively. BLDC motor drive circuit work properly with sepic converter compare to a normal Method, which is without a converter. The output of the SEPIC converter controls the output of the BLDC motor. VSI use for only electronic commutation hence switching losses reduces and also PWM technique used for the converter. Cost of the project also reduces because of only one voltage sensor required. For future scope, this drive can use for renewable applications also.

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