

Review of Controlling of SEPIC Converter Fed Permanent Magnet Brushless DC Motor Drive by using MATLAB Simulation

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ABSTRACT: We are know about dc motor but it has more loses in brush and those part which are attached to the brush part of the motor having also loss of them, we want to reduce the loss in dc motor by using the brushless motor . 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 feds 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. A three-phase voltage-source inverter is used as an electronic commutator to operate the PMLBDCM 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 PMLBDCM. The stator currents of the PMLBDCM 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.

KEYWORDS: Permanent Magnet Brushless DC Motor (PMLBDCM), Voltage Control, Voltage Source Inverter

I. INTRODUCTION

The fundamental qualities of a permanent magnet brushless DC Motor (PMLBDCM) such as wide speed range, high efficiency, rugged construction and ease of control make it suitable for air-conditioning compressor application . A low power PMLBDC 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 PMLBDCM 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 PMLBDCMs 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, SEPIC converter amongst which the SEPIC converter topology is used in this work. It provides controlled DC voltage to the PMLBDCM drive from an uncontrolled DC output of a single phase AC mains fed DBR while improving the PQ at AC mains. 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. Permanent magnet brushless DC Motors (PMLBDCMs) are preferred Motors for a compressor of an air-conditioning system due to its features like high efficiency, wide speed range and low maintenance requirements. The operation of the compressor with the speed control results in an improved efficiency of the system while maintaining the temperature in the air-conditioned zone at the set reference consistently. Whereas, the existing air conditioners mostly have a single phase induction Motor to drive the compressor in on/off control mode. This result in

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increased losses due to frequent on/off operation with increased mechanical and electrical stresses on the relationship between current and torque, voltage and rpm. It is an electronically controlled commutation system, instead of having a mechanical commutation, which is typical of brushed Motors. The control of BLDC Motors can be done in sensor or sensor less mode, but to reduce overall cost of actuating devices, sensor less control

II .LITERATURE REVIEW

The concept behind converting electrical energy into mechanical energy has been known since the late 1820's when the first electric Motor was successfully tested. British scientist Michael Faraday first experimented with the idea of the electromagnetic induction Motor in the early 1800's. By 1828 the DC Motor was introduced with three main components: the stator, rotor, with the high cost of battery power, the demand was too small to keep them successful. In 1886, Frank Julian Sprague introduced the first practical DC Motor that was capable of a commutator. During that time, DC Motor operated similar to Brush DC Motor today, in that they had current flowing through the windings of the Motor. In 1837 Americans Thomas and Emily Davenport transformed Faraday's DC Motor into one that could be used for commercial use. This DC Motor became popular in printing presses and powered machine tools. However constant speed under variable loads. With the development of power electronics device it seemed to be feasible that the mechanical switching part of a brush type DC Motor could be replace by electronic switching. However a simple translation of a brush type Motor designed to operate as a brushless type is impractical since the use of semiconductor device will be very inefficient.

[1] Sanjeev Singh and Bhim Singh

This paper represented Voltage Controlled PFC SEPIC Converter fed PMBLDCM Drive for an Air-Conditioner. This uses a single ended primary inductor converter (SEPIC) as a power factor correction (PFC) converter which is operated in voltage control mode for the speed control of a permanent magnet brushless DC motor (PMBLDCM) driven air-conditioner (Air-Con). In this use of current controller take place due to that stress on MOSFET of SEPIC converter.

[2] B.Chandra Krishna & M. Nageswar rao

This paper represented speed control of BLDC Motor using modified buck-boost converter. This paper presents a power factor corrected (PFC) bridgeless (BL) modified buck-boost converter fed brushless direct current (BLDC) Motor drive as a cost effective solution for low power application. An approach of speed control of the BLDC Motor by controlling the dc link voltage of the voltage source inverter (VSI) is used with a single voltage sensor. This facilitates the operation of VSI at fundamental frequency switching by using the electronic commutation of the BLDC Motor which offers reduced switching losses to control the DC-DC voltage between VSI & the output.

[3] R.GeshmaKumari & Dr.S.TaraKalyani

This paper represented modeling & control of PMBLDCM using PFC half & full bridge converter. In this paper the proposed converter used for controlling the PMBLDC Motor this draws sinusoidal AC current from the supply & converted into DC but output voltage can be controlled by varying the firing angle of switch hence speed of motor can be control.

[4] Sanjeev Singh and Bhim Singh

This paper represented Power Quality improved PMBLDCM Drive for adjustable speed application with reduced sensor buck-boost PFC Converter. This paper presents a electric drive systems used in many industrial applications require higher performance, reliability, variable speed due to its ease of controllability. The speed control of BLDC Motor is very important in application. Where precise & wide speed control are essential. In proposed paper an improved power quality buck-boost converter fed permanent magnet brushless DC Motor (PMBLDCM) drive is employed for adjustable speed operation of PMBLDCM. This can be operated with voltage follower control in discontinuous conduction mode (DCM) operation for sensor reduction. The proposed control scheme with PFC converter based PMBLDCM drive is designed modeled & simulated in MATLAB-simulink environment.

[5] Sanjeev Singh & Bhimsingh

This paper represented PFC Buck converter fed PMBLDCM drive for low power application. This paper evaluates the various control strategies & operating principle of a buck PFC converter for feeding a PMBLDCM (permanent magnet brushless DC Motor drive) in various mode of operation. A buck PFC converter fed PMBLDCM drive are carried out for wide range of speed control with PWM current control of the Motor. A buck PFC converter is operated with the

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current multiplier control & voltage follower control schemes for the operation of PMBLDCM drive under wide range speed control.

III. SYSTEM DESIGN & DESCRIPTION

Working

The proposed buck-boost converter based PMBLDCM drive operated with voltage follower control. The proposed controller is operated to maintain a constant DC link voltage with PFC action at AC mains. The DC link voltage is sensed and compared with a reference voltage which results in a voltage error. This voltage error is passed through a voltage controller to give a modulating signal which is amplified and compared with saw-tooth carrier wave of fixed frequency to generate a pulse width modulated signal for the switching device of the DC-DC 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. This current signal is multiplied with a rectangular unit template waveform which is in phase with top flat portion of Motors back EMF so that reference three phase current of the Motor are generated. These reference current are compared with the sensed Motor current and current error are generated which is amplified and compared with triangular carrier waves to generate the PWM signals for the VSI switches.

IV. SOFTWARE TOOLS AND MATLAB SIMULATION

MATLAB started as an interactive program for doing matrix calculation and has now grown to high level mathematical language that can solve integrals and differential equations numerically and plot a wide variety of two and three dimensional graphs. In this subject you will mostly use it interactively and create MATLAB script that carry out a sequence of commands. MATLAB also contains a programming language that is rather like Pascal. The first version of MATLAB was produced in the mid 1970's as a teaching tool. The vastly expanded MATLAB is now used for mathematical calculations and simulation in companies and government labs ranging from aerospace, car design, signal analysis through to instrument control and financial analysis. Other similar programs are mathematical and Maple. Mathematical is somewhat better at symbolic calculations but is slower large numeric calculation.

MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming. Using MATLAB, you can analyze data, develop algorithms, and create models and applications. The language, tools, and built in math functions enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java®. You can use MATLAB for a range of applications, including signal processing and communications, image and video processing, control systems, test and measurement, computational finance, and computational biology. More than a million engineers and scientists in industry and academia use MATLAB, the language of technical computing.

Key Features:

High-level language for numerical computation, visualization, and application development Interactive environment for iterative exploration, design, and problem solving Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration, and solving ordinary differential equations. Built-in graphics for visualizing data and tools for creating custom plots Development tools for improving code quality and maintainability and maximizing performance Tools for building applications with custom graphical interfaces Functions for integrating MATLAB based algorithms with external applications and languages such as C, Java, .NET, and Microsoft® Excel® 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.

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Simulation

Computer is provided engineers with immense mathematical powers, which can be used to simulate dynamic systems without the actual physical setup. Simulation of dynamic systems has proved to be immensely useful when it comes to control design, saving time and money that would otherwise be spent in prototyping a physical system. Simulink is a software add-on to MATLAB which is a mathematical tool developed by the Mathworks, a company based in Natick. MATLAB is powered by extensive numerical analysis capability. Simulink is a tool used to visually program a dynamic system (those governed by differential equations) and look at results. Any logic circuit or a control system for a dynamic system can be built by using standard building blocks available in Simulink libraries. Various toolboxes for different techniques, such as PI Controller, MOSFET, IGBT, diodes etc. are available with simulink, which enhance the processing power of the tool. The main advantage is the availability of templates / building blocks, which avoid the necessity of typing code for small mathematical processes. A simulation of a system is the operation of a model of the system. The model can be reconfigured and experimented with usually, this is impossible too expensive or impractical to do in the system it represents. The operation of the model can be studied, and hence, properties concerning the behavior of the actual system or its subsystem can be inferred. In its broadest sense, simulation is a tool to evaluate the performance of a system, existing or proposed, under different configurations of interest and over long periods of real time. Simulation is used before an existing system is altered or a new system built, to reduce the chances of failure to meet specifications, to eliminate unforeseen bottlenecks, to prevent under or over-utilization of resources, and to optimize system performance. Simulink is a graphical extension to MATLAB for modeling and simulation of system. In Simulink, systems are drawn on screen as block diagrams. Many elements of block diagrams are available, such as summing junctions etc. Simulink is integrated with MATLAB and data can be easily transferred between the programs. Simulink is supported on UNIX, Macintosh, and Windows environments and is included in the student version of MATLAB for personal computers.

V. RESULT & DISCUSSION

The simulation model of the proposed system is presented in the previous chapter. Now, the results obtained after the simulation of the above model is presented below. Various output waveforms like stator current, rotor speed, emf, torque are presented below. In this system use of SEPIC converter take place for controlling the speed of permanent magnet brushless DC motor by using voltage source inverter & diode bridge rectifier.

VI. CONCLUSION

The design, modeling and simulation of a SEPIC converter fed PMSM drive has been carried out in detail for its operation under speed control. The SEPIC converter is operated with voltage follower control to get a sensor controller. Therefore, the non-isolated SEPIC converter fed PMSM drive on voltage follower control has potential for many low cost and low voltage speed control application operated for utility AC mains. It is concluded that the proposed drive has demonstrated performance with sensor as a variable speed and improved power quality at input AC mains.

VII. LIMITATION & FUTURE SCOPE

The controlling of BLDC Motor by using DC-DC converter with PWM technology is done. In this technology the controlling of BLDC Motor can be done in simplified manner so that, in future there will be a successive scope for controlling the proposed Motor. Also we can control the Motor of low rated rpm as well large rpm Motor so that in future we can implement this technique on the large rpm Motor in various applications. This technology is more advantageous because of wide range of speed controller, hence useful for various low power applications.

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