

BLDCM Drive with Two-Leg Inverter for High-Speed Applications

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Abstract

Traditional motor technology is used in small and big scale applications such as car industries, residential appliances such as refrigerators, washing machines, and air conditioning units. These traditional motors have low torque, costly maintenance, and low efficiency. The use of BLDCM improves numerous performance parameters such as better efficiency, higher torque, high power density, minimal maintenance, and lower noise when compared to traditional motors. The biggest disadvantage is the expensive cost. This study proposes a two leg inverter fed BLDCM drive with just four switches and two current sensors, as opposed to six switches and three current sensors in the case of a three leg inverter fed BLDCM drive. The use of fewer switches and current sensors results in reduced switching loss and lower costs. A two-leg inverter-fed BLDCM drive with two input DC sources is suggested in this study. In MATLAB / SIMULINK, the suggested PMBLDCM drive is modelled and its performance is simulated. This suggested technique is simple, cheap cost, and results in improved driving performance, such as decreased torque ripple, less voltage stress, low current THD, and quick dynamic performance of the PMBLDCM drive.

Keywords: - MATLAB / SIMULINK, BLDCM, PMBLDCM, Two Leg Inverter, DC sources

INTRODUCTION

The induction motor has been released from its historical position as a harsh and rapid speed machine thanks to modern static frequency conversion methods. The inherent benefits of variable frequency operation cannot be fully realised unless a suitable management method is used. The technology used is critical in determining the features and performance of the drive system. Furthermore, the facility device has very little surplus current capability; during typical operation, the management approach should ensure that motor action is limited to areas of high torsion per ampere, matching the electrical converter ratings and reducing system losses. Overload or fault circumstances should be addressed with tact rather than style.

Brushless DC motors are permanent magnet synchronous motors that are driven by dc voltage via an inverter that generates an alternating current electric signal to operate the motor. Because the torque-speed characteristics of the BLDC motor are comparable to those of the BRUSHED DC motor, the term BLDC was coined. Instead of brushes, commutation in BLDCM is done electronically.

It is simply controlled via the rotor position sensors and performs admirably,

particularly in terms of speed/torque. With these benefits, the motor will be used in more applications. BLDCM applications are expanding, and it is competing with induction and dc motors. The inverter's output voltage and frequency are determined by the inverter's switching state. The inverter switches are controlled using several PWM approaches, the most common of which being sine PWM and space BLDC PWM, which have numerous benefits. In compared to the SPWM approach, SVPWM is easier to digitalize, has lower switching losses, less harmonics, and makes better use of the dc-bus voltage.

Brief Theory of BLDC Control (Field Oriented Control)

Because flux and torque are inherently dissociated, controlling separately-excited dc devices is simple. As a result, torque linearization is simple to do using armature current regulation with constant field flux. DC motors have been widely employed in high-performance domains such as robots, rolling mills, and tracking systems that demand quick dynamic torque control. Because of their simpler and more sturdy structure, alternating current machines are always preferred over direct current machines; there are no mechanical commutators. The electrical architecture of ac machines, on the other hand, are very

nonlinear and involve multivariable inputs and outputs. As a result, more work is necessary to detach and liberalise control of these devices.

Speed Controlling

Variable speed drive systems are essential in many industrial applications. In the past, DC, are require to high speed synchronous circuit because these improved efficiency of induction motor, since their control flux and armature current of induction motor. Dc motors have certain disadvantage they are totally depends for brushes and large current loss. That is, they have require for large periodicity of torque; they cannot be used in explosive or corrosive environments and they have limited commutator these properties are high speed and higher alternate current and rugged Structure of motor. That is providing high maintainability and good economy.

Permanent Magnet Brushless Direct Current (Pmbldc) Advantages

Permanent magnet Brushless direct current (PMBLDC) motors have more advantages than any other motors like induction motors, dc motors due to compact size, higher efficiency, noiseless operation , higher dynamic response, longer life, and electronic commutation [1]. BLDC motor

has trapezoidal back EMF and phase current is rectangular waveforms which gives zero torque ripple [2]. The BLDC motor is controlled using three phase voltage source inverter.

Advantages of Proposed Algorithm

- The sensors are eliminated.
- The dynamic performance of the indirect BLDC control is better than the direct BLDC control
- The cost factor is decreased.
- There is no drift problem as in direct BLDC control.

Proposed Method and Its Description

1. Direct BLDC Control Method

In direct BLDC control method we have seen that it determines the magnitude and position of the rotor flux BLDC by direct flux measurement or by a computation based on terminal conditions. It also called flux feedback control is method in which required information regarding the rotor flux is obtained by means of direct flux measurement or estimation. The flux is measured by the sensors like Hall Effect sensor, search coil and this is a part of the disadvantages. Because fixing of number of sensors is a tedious job and this increases the cost factor.

The quantities generated from flux sensors are used in the outer loop of the drive control structure. Alternatively, in place of flux sensors, the flux models can also be used for which the stator currents and voltages become the feedback signals and the rotor flux angle is given as its estimated output.

2. In-direct bldc control method:

The basic block diagram of induction motor operating in indirect BLDC control mode. The motor speed is used as

feedback signal in the controller. The controller calculates reference values of the two decoupled components of stator current space BLDC in the SRRF which are i_{qs}^* and i_{ds}^* for the control of torque and flux respectively. [2] The two components of the currents are transformed into three phase currents which are i_{as}^* , i_{bs}^* , i_{cs}^* in the stationary reference frame of reference. Now as a balanced load, two of the phase currents are sensed and the third one is calculated from the two sensed currents.

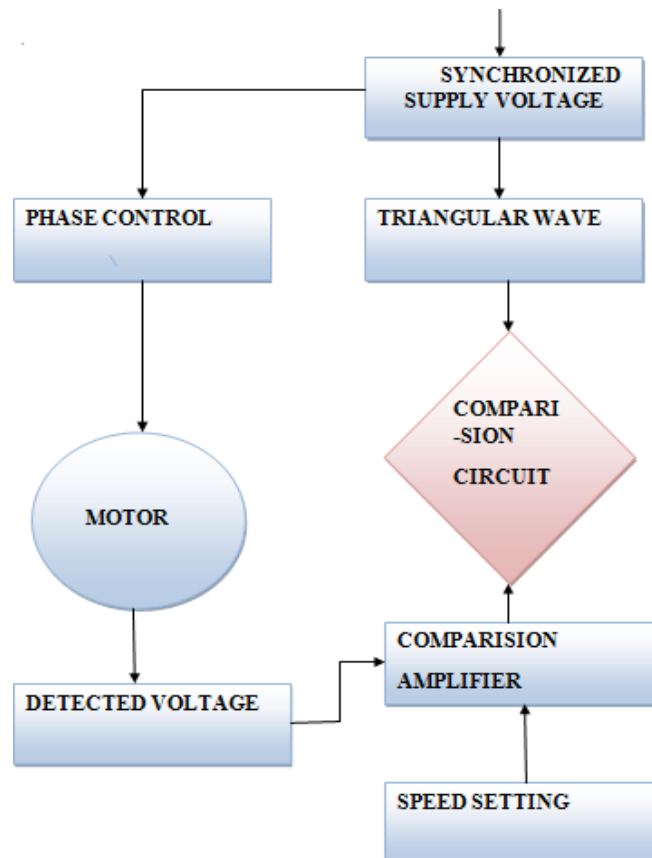


Figure 1 Algorithm flow chart

RESULT AND SIMULATION

1. Simulink modelling in BLDC control technique

Brushless DC Motor Fed by Six-Step Inverter

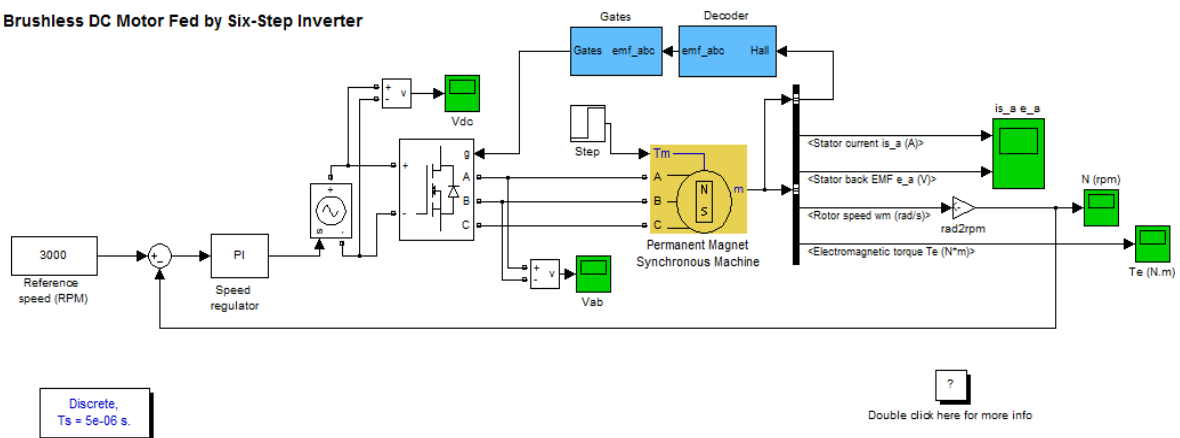


Figure 2 Simulink Modeling in BLDC controlling DC Motor

2. Output waveform in BLDC controlling dc motor

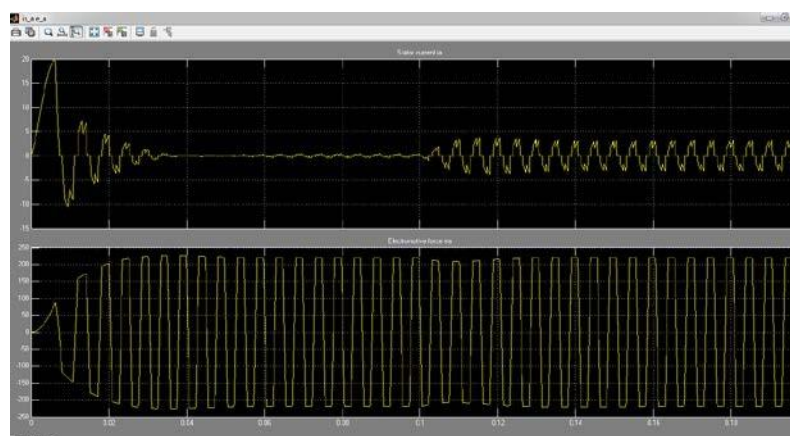


Figure 3 Vab PWM output, Iab Current, Rotor speed ,Electromagnetic Torque induced in Induction MOTOR

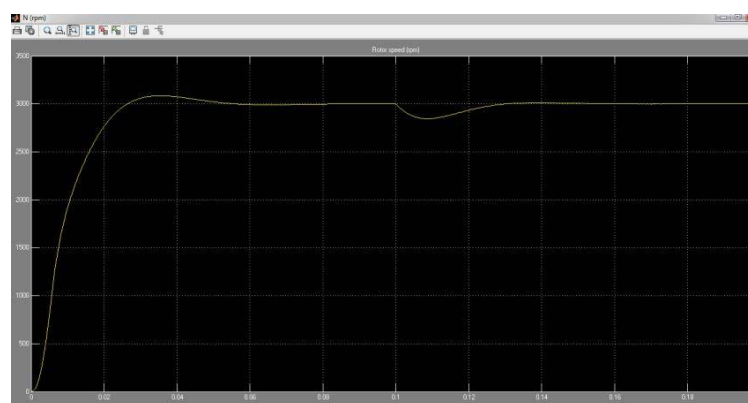


Figure 3 DC regulated output.

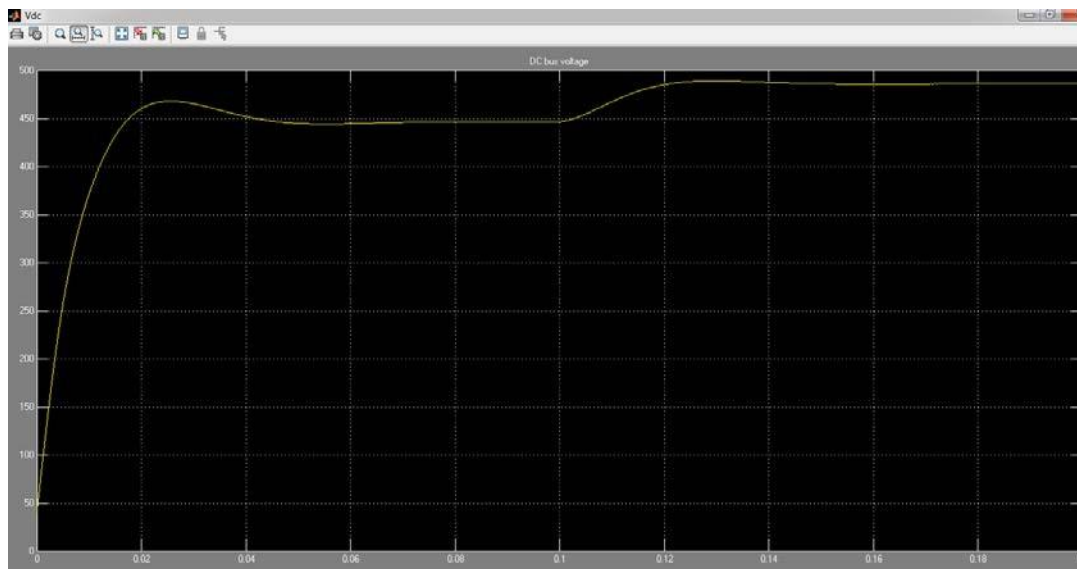
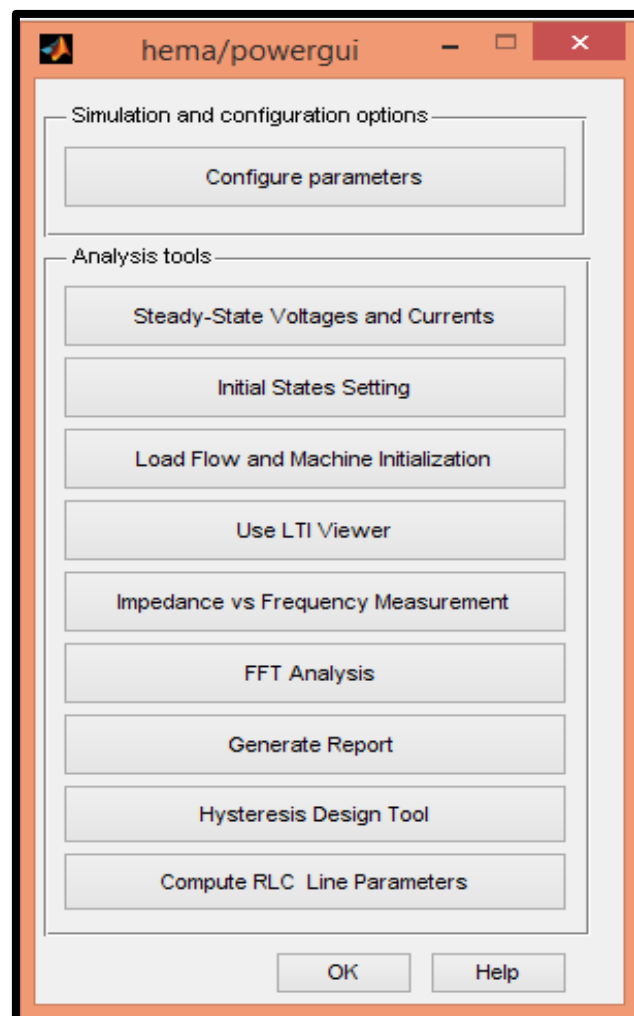


Figure: - 4PI Controller

Power GUI in Project



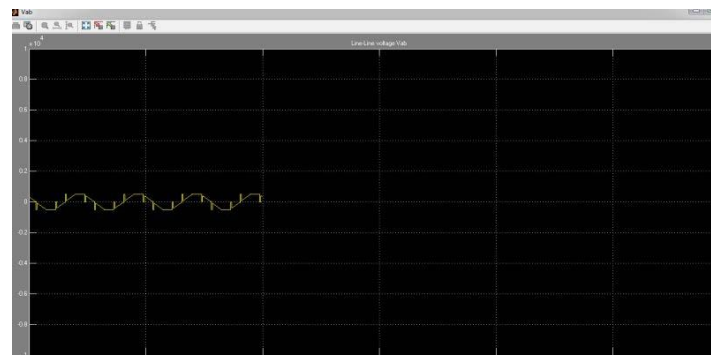


Figure: - 5 SIX steps output

4. Single-phase asynchronous machine - BLDC control

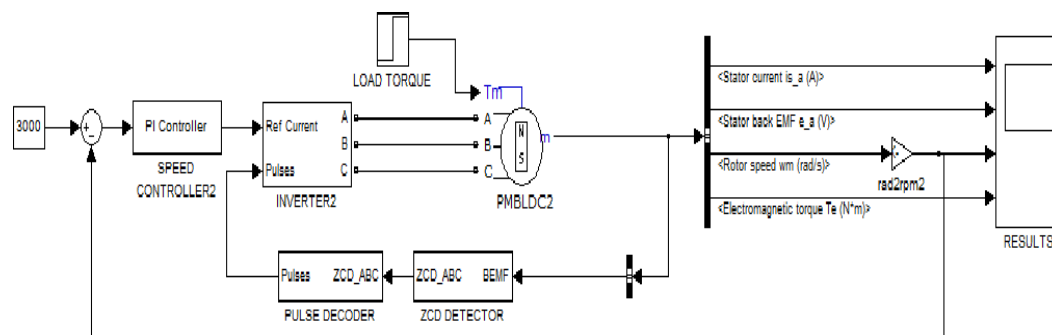


Figure 6 Asynchronous motor output

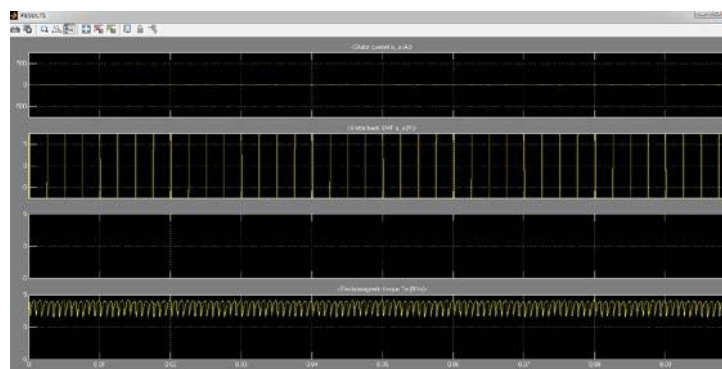


Figure: - 7 Single-phase BLDC machine

Improved Efficiency Parameter & My Implementation Work

1. Lower Time Consume To Increased Load Current and Motor Torque

This diagram indicates that in the early condition of the motor, the current signal

has a high value because a large torque is required to increase the rotor speed. The motor torque only has to adjust for friction and load torque in the constant speed area, hence the current is smaller. Finally, the

current increases at time $t = 1$ s since the load torque has been increased.

2. Enhancement motor torque same time

The motor torque as in the case of the current the motor torque has a high initial value speed in the acceleration zone, then the value decreases in a constant region and finally increases due to the load torque increment.

3. $T=1$ s higher mechanical inertia and higher frequency range

In this figure it may be seen that in the motor torque appears the so-called chattering phenomenon, however, this high frequency changes in the torque will be filtered by the mechanical system inertia.

Table-1: Step Change in Reference Speed for Low Value of Speed

TIME SECOND	0	2.5	4
SPEED (RPM)	1000	50	20

Table-2: Step Change in Load Torque

TIME SECOND	0	3
SPEED (RPM)	1000	1000
TORQUE	0	10

Table-3: Step Change in Reference Speed

TIME SECOND	0	2.5	4
SPEED (RPM)	1200	800	500

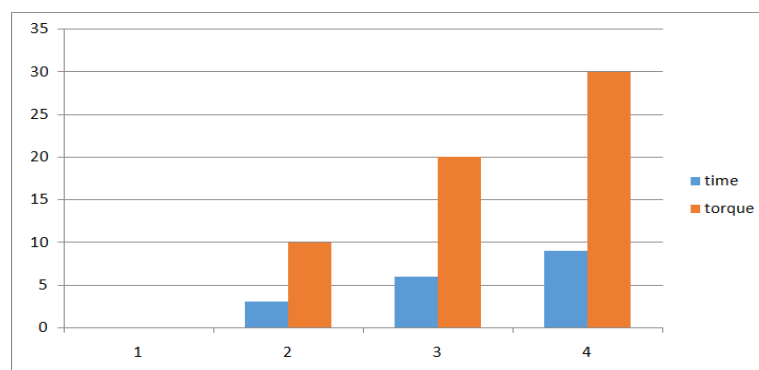


Figure (7.c) Graph between Speed and torque

CONCLUSIONS AND FUTURE STUDY

Sliding Mode Control (SMC) is a resilient control strategy that changes the structure of the controller in response to the changing state of the system to get the desired response. The most significant feature of this system is that its stabilising qualities are maintained even in the presence of massive disturbance signals.

The system's dynamic behaviour may be modified by selecting a certain switching function, and the closed-loop reaction becomes completely insensitive to a specific type of uncertainty. Furthermore, the ability to explicitly determine performance makes sliding mode control appealing from a design standpoint.

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