ISSN: 2455 - 1597

International Journal of Engineering Research and Generic Science (IJERGS)
Available online at: https://www.ijergs.in

Volume - 8, Issue - 2, March –April - 2022, Page No. 01 - 07

A Review on Brushless DC Electric Motor (BLDC) For Electric Vehicle

[1]Sumit Dadhich, M. Tech Scholar, Department of Electrical Engineering, Jaipur Engineering College, Jaipur, Rajasthan, India

[2]Dr. Bharat Bhushan Jain, Professor, Department of Electrical Engineering, Jaipur Engineering College, Jaipur, Rajasthan, India

Abstract

For applications requiring low and medium power, the DC (BLDC) motor is a great choice because to its high efficiency, high torque-to-inertia ratio, big energy volume, minimum maintenance needs, and broad range of speed control. By eliminating phase current sensors and adjusting voltage source inverter (VSI) fundamental frequency switching. In this paper present a study on the BLDC motor in details with operation principles and parameters.

Keywords: BLDC, Electric Motor, Brushless DC Motor Drive, Current Control, Electric Vehicle, Converter Topologies.

Introduction

Interestingly, brushless DC motors are a kind of permanent magnet synchronous motor. Based on the waveform of their induce emf, permanent magnet synchronous motors may be classified as sinusoidal or trapezoidal motors. Trapezoidal permanent magnet synchronous motors are larger than brush-shaped brushless PM (BLDC) machines. Permanent magnetic (PM) motors and electromagnetic fields are used to generate torque (or force) and motion in DC brushed brushless motors brushed with PR. For example, a DC motor's windings are wrapped around the stator's PM. Using a commutator and brushes, a DC motor's current is automatically transferred to different windings to create continuous motion.

The magnets are housed in the rotor of a brushless motor, whereas the windings are housed in the stator. Switching is done electronically without the use of a brush using a motor amplifier that uses semiconductor switches to change the current in the windings based on the feedback from the position of the motor rotor. According to this definition, the permanent magnet in BLDC motors rotates, but the conductors remain stationary, like a reversed DC commutator motor. As a consequence BLDC motors typically use internal or external sensors to detect the original rotor.

BLDC Motor Operation Principles

The brushless DC motor is a permanent synchronous machine that has feedback about the position of the rotor. Brushless motors are often powered by a three-phase semiconductor bridge. The motor is required to start the rotor position sensor and provide the appropriate switching sequence to operate the power components on the inverter bridge. Depending on the position of the rotor, electrical equipment is switched every 60 degrees. An electronic switch is used instead of a brush to change the current of the motor, hence it is called an electronic motor. Because the brush and commutator combination does not spark and the commutator brush arrangement does not wear out, the BLDC motor is more robust than a DC motor.

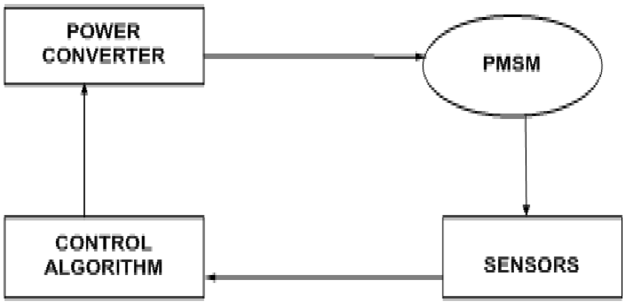

Fig. 1: BLDC Motors

Fig. 1 illustrates a brushless dc motor's fundamental block diagram. The brushless dc motor has four main components: a power converter, PMSM sensors, and a control algorithm. Energy from the source is transferred to PMSM through a power converter, It converts electrical energy into mechanical energy. The rotor position sensors of the brushless DC motor are one of its most important features. Based on the position of the rotor and command signals such as torque command, voltage command, speed command, etc., the control algorithms calculate the gate signal for each semiconductor in the electronic transducer. Control algorithms fall into two categories: voltage source-based drives and current source-based drives, which determine the type of brushless DC motor. It's possible to operate permanent magnet synchronous machines using both voltage and current sources, depending on whether the back emf waveform is sinusoidal or not. As seen in Fig 2, the torque may be adjusted to be nearly constant. If you want smaller inverters and lesser losses, you'll want to use a machine with non-sinusoidal back emf (Fig.2).

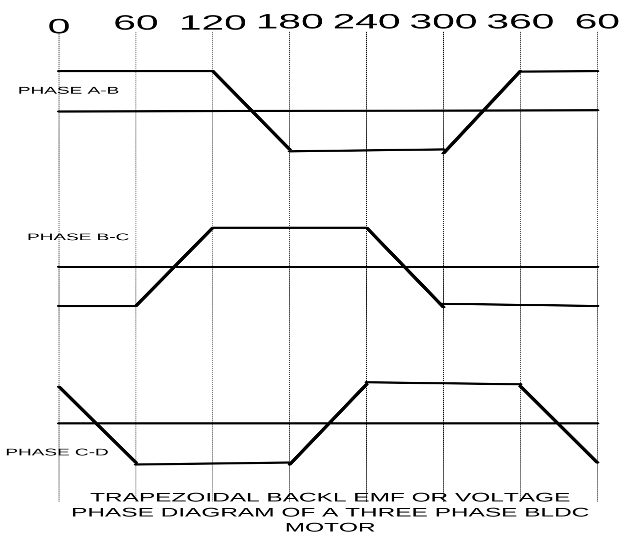

Fig. 2 Non Sinusoidal Back EMF

Permanent Magnetic Brushless DC Motor Body

Motors are offered in single phase, two phase and three phase BLDC**.** There are the same number of windings in each stator. Three-phase motors are the most common and extensively utilized of them. Three-phase motors are the subject of this article.

Stator

Stator windings are placed in slots that are axially carved around the inner perimeter of a BLDC motor's stator, which is composed of stacked steel laminations (as shown in Fig. 3.3). However, the windings are placed differently on the stator. A star-shaped arrangement of stator windings is common in BLDC motors with three stator windings each. One or more of these coils are placed in the stator slots. Since the stator has a fixed perimeter, each of these windings must be evenly distributed in order to produce an equal number of poles. The trapezoidal motors produce a back trapezoidal EMF, as their names suggest.

Fig. 3: The Inner Periphery is Axially Cut

In addition to the back EMF, the phase current in different kinds of motors includes trapezoidal and sinusoidal fluctuations. A sinusoidal motor's torque output is smoother than that of a trapezoidal motor as a result of this. However, due of the coil distribution on the stator periphery, sinusoidal motors need more winding interconnections, resulting in increased copper intake by the stator windings. A motor with an appropriate stator voltage rating can be selected based on the power supply capacities. Motors rated at 48 volts or less are utilized in automotive, robotics, tiny arm motions, and other applications. Appliances, automation, and industrial applications all utilize motors with 100 volts or greater ratings.

Rotor

The rotor has two to eight pairs of alternating poles between the north (N) and south (S) poles, which contain a permanent magnet. If the required magnetic field density is not met, the suitable magnetic material is chosen. Ferrite magnets have traditionally been used for permanent magnet pole components. Rare earth alloy magnets are used in almost all contemporary products. Although ferrite magnets are less expensive, they suffer from a low flux density per volume. Due to its high magnetic density, the alloy material can generate the same amount of torque with smaller components. Due to this, compared to ferrite magnets, alloy magnets have a better weight/size ratio and deliver greater torque per motor size.

For example, NdFeB (Neodymium, Ferrite and Boron) magnets are made from neodymium, samarium cobalt and samarium neodymium.Cross sections of several magnet configurations in a rotor are shown in the diagram below.

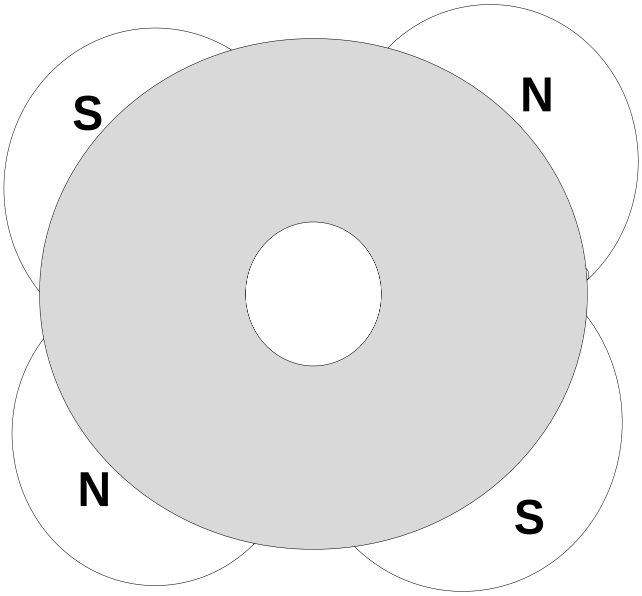

Fig. 4: Circular Core with Magnets on the Periphery

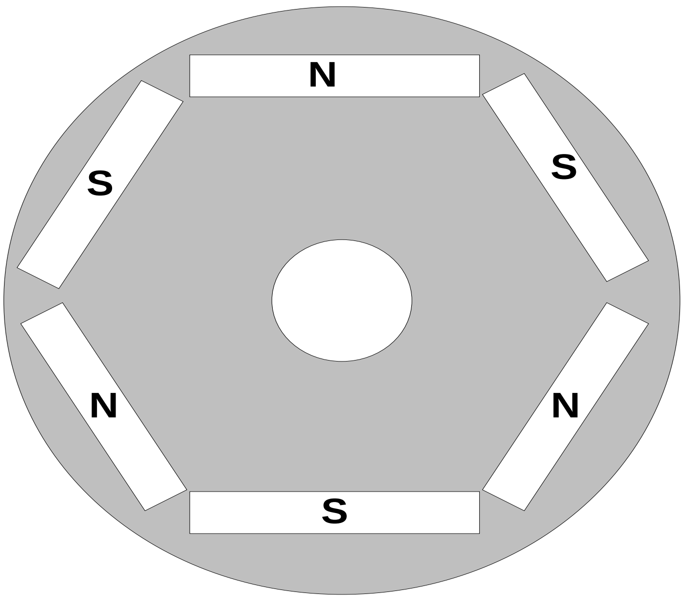

Fig. 5: Circular Core with Rectangular Magnets Embedded in the Rotor

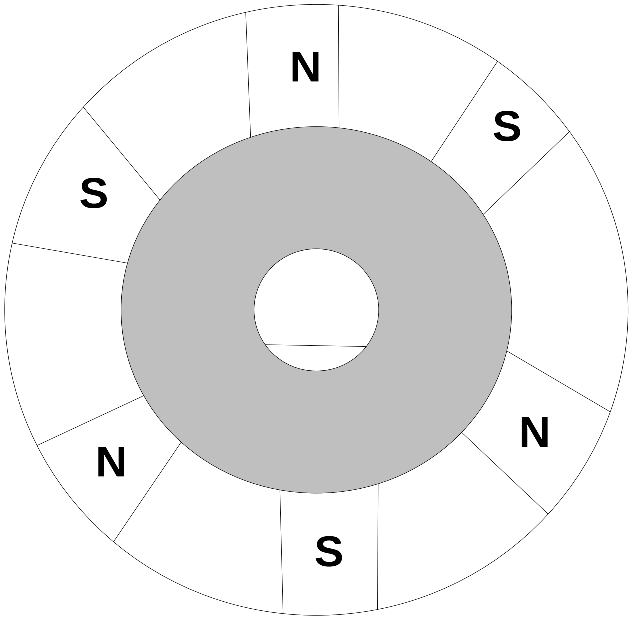

Fig. 6: Circular Core with Rectangular Magnets Inserted into the Rotor

Works With BLDC Inverter

Fundamentally, it is an electronic engine with a three-stage commentator at its front end. In self-sufficient mode, the inverter goes about as an electrical switch and gets the exchanging rationale beat from the outright mode sensors to begin exchanging. In general, the inverter may function in one of two modes.

Angle Switch-ON Mode

Operation of the inverter in this mode, using the waveform as a guide from Figure 3.7.This means that the input dc is positioned at zero advance angle between the current wave and voltage wave when the inverter has six switches (S1-S6). Notice that at any moment two switches are working, one at the bottom of the combination of switches. By putting a positive current through the offline (respectively A and B respectively), the conduction pattern changes the signal switching mode at full angle and changes from Famous B to phase C during Fame carrying + Id. Absolute Mode 3 sensor requires microwave switching or hardware switching. For all intents and purposes, the inverter acts as an electrical commutator that is sensitive to rotor position

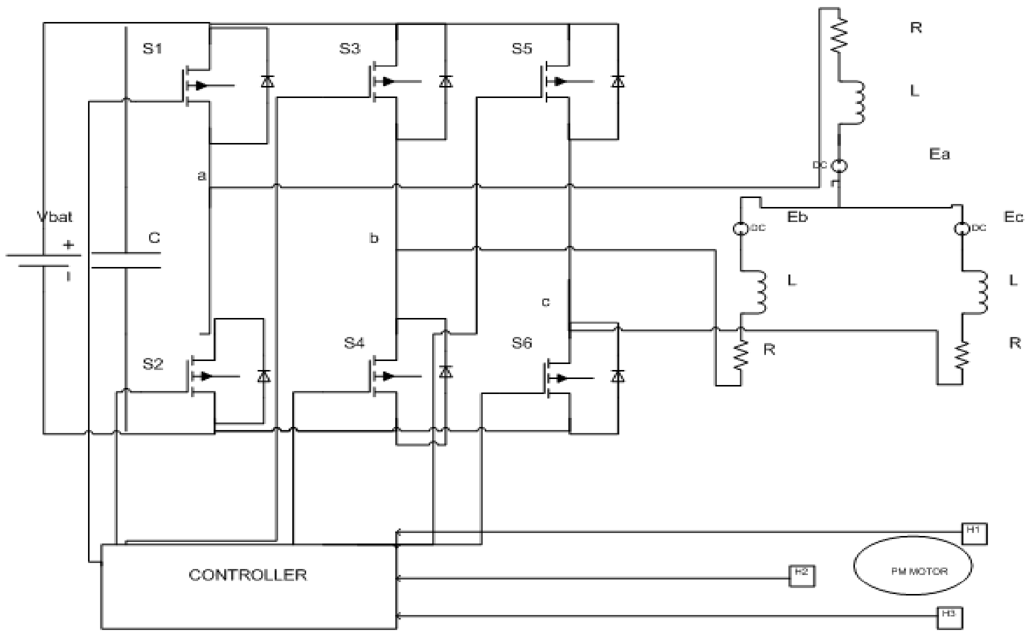

Fig. 7: Equivalent Circuit of BLDC Motor

PWM Mode for Voltage and Current Control

However, inverter switches could only offer commentator function when the devices were turned on and off sequentially. There are three other functions in addition to the switcher function. Alternatively, the switches may be operated in PWM chopping mode to maintain a steady voltage and current at the machine terminal's terminal. The inverter's current-regulated mode of operation includes two main types of chopping. The two fundamental cutting modes are feedback (FB) mode and freewheeling mode. As a result of the duty cycle of the devices, the average current of the I AV device and the average voltage of the VAV device are stored.

Conclusion

A Brushless DC Electric Motor (BLDC) is an electric motor powered by a direct current voltage supply and commutated electronically instead of by brushes like in conventional DC motors. For applications requiring low and medium power, the DC (BLDC) motor is a great choice because to its high efficiency, high torque-to-inertia ratio, big energy volume, minimum maintenance needs, and broad range of speed control. By eliminating phase current sensors and adjusting voltage source inverter (VSI) fundamental frequency switching. In this paper given an detailed overview about the BLDC motor in with operation principles.

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