COMMUTATION TORQUE RIPPLE REDUCTION IN THE BLDC MOTOR WITH SUPERLIFT POSITIVE LUO CONVERTER

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Abstract: This paper displays another power converter topology to stifle the torque swell because of the stage current replacement of a brushless dc engine (BLDCM) drive framework. A combination of a two level inverter (2-level inverter), a Super lift positive luo converter (SPLC), Fuzzy logic controller and a dc-bus voltage selector circuit is employed in the proposed torque ripple suppression circuit. For efficient suppression of torque pulsation, the dc-bus voltage selector circuit is used to apply the regulated dc-bus voltage from the positive super lift luo converter during the commutation interval. In order to further mitigate the torque ripple pulsation, the two level inverter is used in the proposed circuit. Finally, simulation results show that the proposed topology is an attractive option to reduce the commutation torque ripple significantly at low- and high-speed applications.

Keywords: Brushless direct current motor (BLDCM), dc-bus voltage control, modified single-ended primary-inductor converter, three-level diode clamped multilevel inverter (3-level DCMLI), torque ripple, Fuzzy logic controller, Matlab / Simulink

I.INTRODUCTION

This paper is mainly based on Superlift positive luo converter, a novel commutation torque ripple reduction strategy is proposed for the brushless DC motor. which can decrease compensation torque swell over the whole speed extend. A super-lift Luo-converter has been employed in front of the 2-level inverter to lift the dc-bus voltage to the desired value for the torque ripple suppression at high-speed work conditions. In a novel circuit topology with superlift positive luo converter (SPLC) and a switch selection circuit has been proposed for torque ripple suppression of BLDCM drive with dc-bus voltage control. To diminish the recompense torque swell, a voltage control system has been proposed to level the huge number rates of approaching and active stage flows. A circuit topology has been proposed for torque ripple suppression of the BLDCM drive system which is built by a two-level inverter (2-level inverter), an average torque control method using one-cycle control has been proposed using dc-bus voltage and current measurements, without using back EMF and accurate rotor position information in order to suppress the torque ripple for BLDC Motor.

For low-voltage dc energy sources, a Power Conditioning System (PCS) is need to convert the energy sources to a higher-voltage dc before making it to ac for grid-tie applications. Solar photovoltaic (PV) and fuel cells are perhaps the most well-known and prospective energy sources with low-voltage dc output. A thermoelectric generator, a battery, and an ultra capacitor are also examples of such low-voltage dc energy sources. As of late, various circuit topologies for the power change from low-voltage dc to high-voltage air conditioning for matrix attach applications were proposed to manage explicit issues, for example, high effectiveness, ease, and wellbeing. The point of this article is to present and talk about the principle highlights of these generally new circuit topologies that manage these viable plan issues. The causes of torque ripple in BLDCM during commutation interval have been investigated for both 120° and 180° electrical conduction modes of the inverter and a composite switching mode has been proposed for effective torque ripple suppression at all speeds [8]. In [9], variable input voltage method has been proposed for the effective torque ripple suppression during the freewheeling period of BLDCM. In this method, the period of the freewheeling region and optimized voltage have been estimated using the Laplace transformation.

A novel current control scheme using deadbeat current controller has been reported for the torque ripple reduction of BLDCM using a single dc-bus current sensor [10]. Various hybrid converter topologies have been proposed with a dc–dc converter to improve torque performance of two-level (2-level) inverter-fed BLDCM [11]–[14]. In [11], a buck converter has been employed between the dc supply and conventional 2-level inverter for the speed control of BLDCM, which can significantly reduce the torque ripple at lower speeds. A super-lift Luo-converter has been employed in front of the 2- level inverter to lift the dc-bus voltage to the desired value for the torque ripple suppression at high-speed work conditions [12]. In [13], a novel circuit topology with single-ended primary inductor converter (SEPIC) and a switch selection circuit has been proposed for torque ripple suppression of BLDCM drive With dc-bus voltage control.

To reduce the commutation torque ripple, a voltage control strategy has been proposed to equalize the slew rates of incoming and outgoing phase currents. A novel circuit topology has been proposed for torque ripple suppression of the BLDCM drive system which is built by a three-level diode clamped multilevel inverter (3-level DCMLI) with two SEPICs and a commutation voltage selection circuit [14]. In [15], an average torque control method using one-cycle control has been proposed using dc-bus voltage and current measurements, without using back EMF and accurate rotor position information. In order to suppress the torque ripple for BLDCM, a current optimization technique has been proposed in both conduction mode and commutation mode using integral variable structure control [16]. In [17], a vector approach has been reported for the suppression of torque ripple of BLDCM drive by synthesizing the motor current supply. For low inductance BLDCM, a novel torque ripple reduction techniques have been proposed based on the instantaneous torque control approach.

A compensation method has been developed to correct the position error due to misalignments of magnets and Hall-effect sensors which improves the accuracy of instantaneous torque estimation. Also, adaptive asymmetry compensation function has been developed to eliminate a problem related with a voltage unbalance between three phase windings [18], [19]. A hybrid two- and three-phase switching mode has been proposed to improve the torque performance of direct torque controlled BLDCM drive [20]. A direct adaptive controller has been proposed to improve inverter current regulation during large back EMF operation, which results in significant torque ripple suppression [21]. A novel current control algorithm has been reported for torque ripple suppression of BLDCM drive using Fourier series coefficients [22].

In most industrial low- and medium-power applications, a conventional 2-level inverter is a preferred choice. The multilevel-inverter-driven ac machines are used in many industrial high-power applications due to lower harmonic distortion of the output currents and operate with reduced *dv/dt* stress as compared to the 2-level inverter-driven ac machines [23]–[25]. The BLDCM is widely used in more electric aircraft applications in a power range of 100–150 kW and dc-bus voltage is from 270 to 540 *V*dc. The multilevel converters such as flying capacitor (FC) inverter, cascaded H-bridge (CHB) inverter, and neutral-point clamped (NPC) inverter have been widely used in high-power medium-voltage applications [26]. For FC inverter, the capacitor clamping requires a large number of expensive and bulky capacitors to clamp the voltage. It requires a complex control for voltage tracking of capacitors, difficult to control precharging of capacitors to the same voltage level, and operates with poor efficiency. In [27], a five-level CHB inverter has been proposed for harmonics and torque ripple suppression of BLDCM drive with current and speed closed loop control.

This converter needs galvanically isolated dc source for each of the H-bridge. In recent years, the MOSFET-based 3-level DCMLIs are preferred to drive BLDCM for low and medium power applications, which produce low current total harmonic distortion (THD) in the stator windings, smaller voltage steps, reduced switching loss under high switching frequency, and lower common mode voltage amplitude than the conventional 2-level inverter [28], [29].

II. EXISTING SYSTEM

The clamped inverter, also known as a neutral clamped converter is difficult to be expanded to multilevel because of the natural problem of the DC link voltage unbalancing. The flying capacitor inverter is difficult to be realized because each in capacitor must be charged with different voltages as the voltage level increases. Besides, the clasped inverter, otherwise called an unbiased clipped converter is hard to be extended to staggered as a result of the characteristic issue of the DC connect voltage unbalancing. It comprises of two capacitor voltages in arrangement and utilize the middle tap as the unbiased. Each stage leg of the three dimension converters has two sets of exchanging gadgets in arrangement. The focal point of every gadget pair is braced to the unbiased through clasping diodes. The waveform got from the three dimension converters is a semi square wave yield.

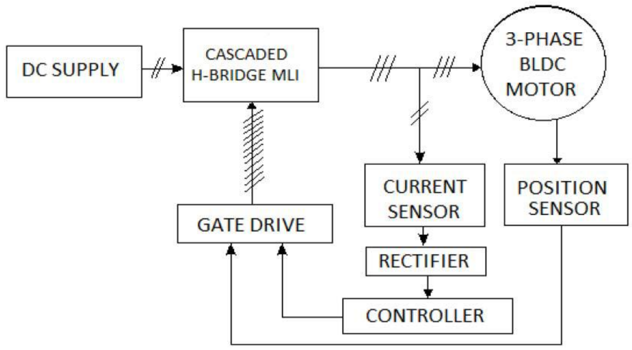

Figure 1: Block Diagram for Existing System

III. PROPOSED SYSTEM

Brushless direct current motor (BLDCM) drives are becoming more popular due to their high power efficiency, high torque to weight and inertia ratios, high power density, high dynamic response, high reliability, compact size, and simple control. The BLDCMs with trapezoidal back electromotive force (EMF) are used extensively in medical, aviation, electric vehicles, industrial, and defense motion-control applications.

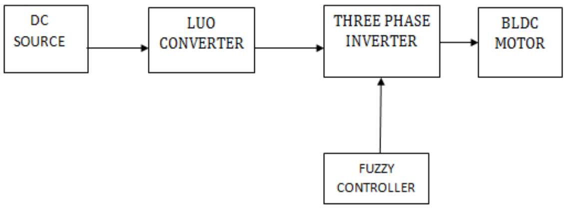

Figure 2: Block diagram of proposed system

Electronically commutated BLDCMs are highly reliable and require less maintenance due to the elimination of high-wear parts such as standard mechanical commutator and brush assembly. However, the pulsating torque is one of the key issues in BLDCM. The BLDCM has a trapezoidal back EMF waveform, and a stator is fed by quasi-square wave line current. Usually, phase winding self-inductance distorts the ideal quasi-square wave line current, which creates the torque ripple. Abnormal vibration, unwanted speed fluctuation, and sound are mainly generated by commutation torque pulsation of BLDCM therefore, reducing the torque pulsation is essential to improve the torque performance of the BLDCM drive system . The causes of torque ripple in BLDCM during commutation interval have been investigated for both 120° and 180° electrical conduction modes of the inverter and a composite switching mode has been proposed for effective torque ripple suppression at all speeds. In variable input voltage method has been proposed for the effective torque ripple suppression during the freewheeling period of BLDCM. In this method, the period of the freewheeling region and optimized voltage have been estimated using the Laplace transformation. A novel current control scheme using deadbeat current controller has been reported for the torque ripple reduction of BLDCM using a single dc-bus current sensor.

Various hybrid converter topologies have been proposed with a dc–dc converter to improve torque performance of two-level(2-level) inverter-fed BLDCM . In a buck converter has been employed between the dc supply and conventional 2-level inverter for the speed control of BLDCM, which can significantly reduce the torque ripple at lower speeds.

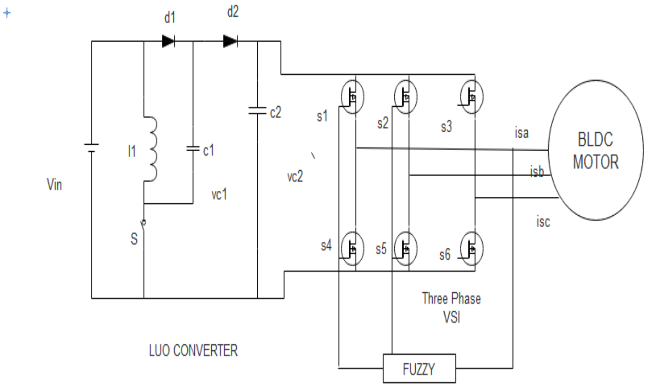

Figure 3: Circuit diagram for proposed system

A circuit diagram of a proposed new converter topology for the BLDCM drive system based on a 3-level inverter and a SPLC. In this topology, the 3-level inverter is proposed to reduce current ripple, and SPLC is included to adjust the dc-bus voltage based on the rotational speed of the BLDCM. The dc-bus voltage selector circuit is constructed with power MOSFETs (S1, S2, S3, S4, S5 and S6). It is used to select the desired dc-bus voltage for significant torque ripple reduction during commutation interval. The MOSFET-based 2-level inverter is operated at a switching of 80 kHz, which provides significant torque ripple suppression than the conventional 2-level inverter. In this 2-level inverter, the dc-bus voltage is divided into 2 levels by the capacitors C1 and C2. To obtain the desired commutation voltage, the duty cycle of the SPLC can be adjusted during the non commutation period to maintained. At the start of commutation period, the regulated voltage from the SPLC is instantly applied by voltage selector circuit for significant torque ripple suppression. The commutation path of two-level inverter. The following modes of operation of the 2-level inverter are discussed based on the polarity of the voltage at the inverter output terminals and direction of the load current.

IV. SIMULATION AND RESULTS

Simulation Diagram

Electrical power frameworks are mixes of electrical circuits and electromechanical gadgets like engines and generators. Architects working in this order are continually improving the execution of the frameworks. Necessities for definitely expanded proficiency have constrained power framework creators to utilize control electronic gadgets and modern control framework ideas that assessment customary investigation devices and procedures. Further complicating the analyst's role is the fact that the system is often so nonlinear that the only way to understand it is through simulation .Land-based power generation from hydroelectric, steam, or other devices is not the only use of power systems. A common attribute of these systems is their use of power electronics and control systems to achieve their performance objectives. SimPower Systems is a modern design tool that allows scientists and engineers to rapidly and easily build models that simulate power systems. SimPower Systems uses the Simulink environment, allowing you to build a model using simple click and drag procedures. Not only can you draw the circuit topology rapidly, but your analysis of the circuit can include its interactions with mechanical, thermal, control, and other disciplines. This is possible because all the electrical parts of the simulation interact with the extensive Simulink modeling library. Since Simulink uses MATLAB® as its computational engine, designers can also use MATLAB toolboxes and Simulink blocksets. SimPower Systems and Sim Mechanics share a special Physical Modeling block and connection line interface. The graphical user interface makes use of the Simulink functionality to interconnect various electrical components. The electrical components are grouped in a library called powerlib.

The positive output super lift Luo converter is a newly developed advanced DC-DC converter. The object of this paper is to design and analyze a positive output super lift Luo converter (POTLLC). Properties of the proposed converter are: robustness around the operating point, good performance of transient responses under varying loading conditions and/or input voltage, and invariant dynamic performance in the presence of varying operating conditions. The positive output Super lift Luo converter performs the voltage conversion from positive source voltage to positive load voltage. The simulation model of the super output triple lift Luo converter with its control circuit was developed in Matlab/Simulink. DC-DC switching converters are a traditional benchmark for testing nonlinear controllers, due to their inherent nonlinear characteristics. After the pioneering studies of Middle brock, a great deal of research has been directed at developing techniques for averaged modeling of different classes of switching converters and for an automatic generation of the averaged models. The motivation of such studies was the selection of continuous models as simple as possible, but adequate to capture all the main features of the switching converters in terms of stability, dynamic characteristics and effectiveness for designing closed loop regulators. A large number of possible nonlinear controllers have been proposed.

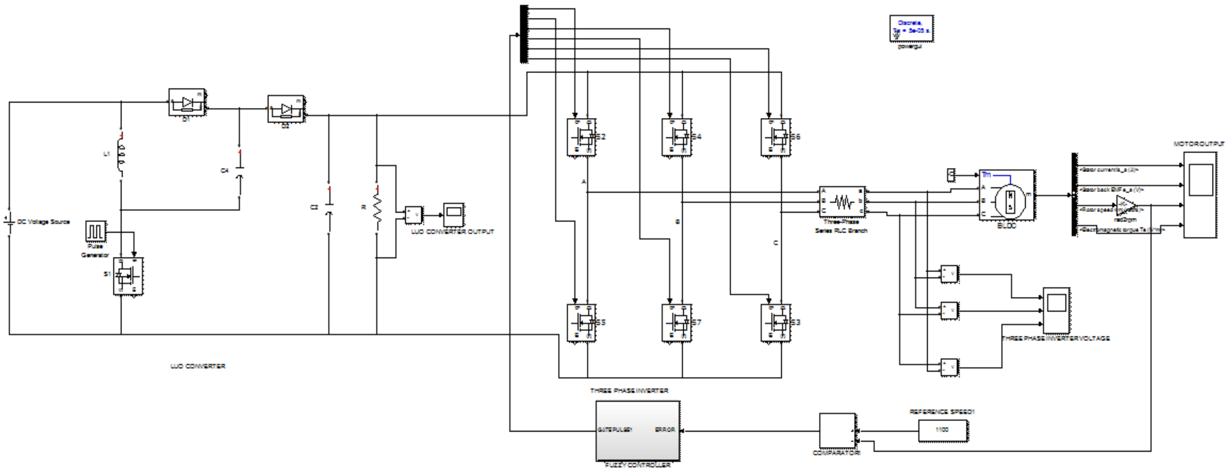

Figure 4: Simulation Diagram for Proposed System

V.SIMULATION RESULTS

Input voltage:

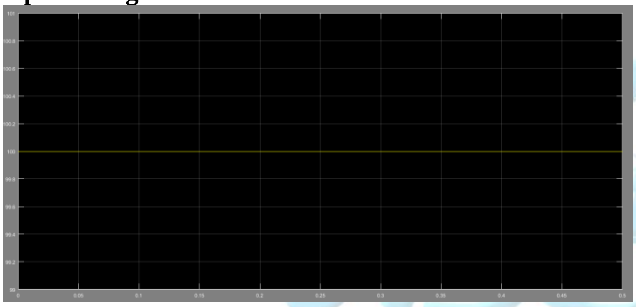

Figure 5: Diagram of input voltage

Pluses:

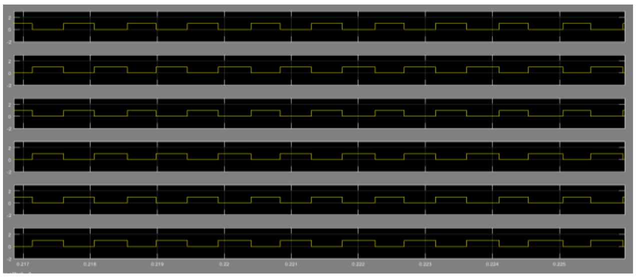

Figure 6: Diagram of pulses

LUO converter output:

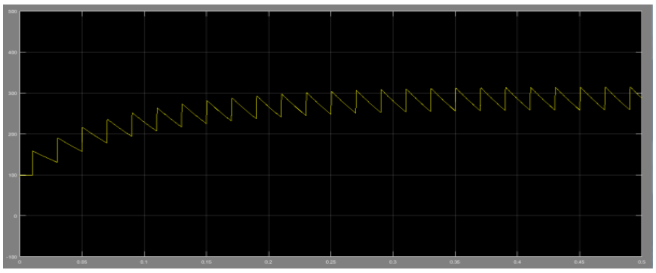

Figure 7: Diagram of luo converter output

Three phase inverter output:

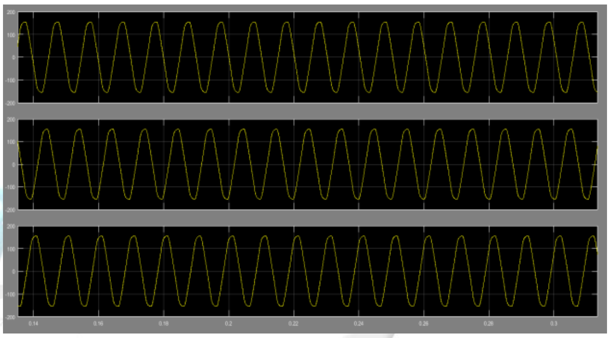

Figure 8: Diagram of three phase inverter output

Motor output:

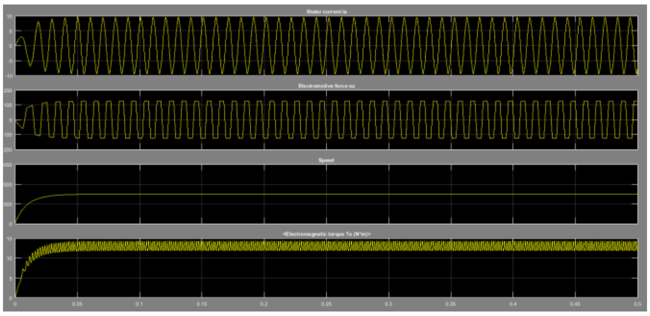

Figure 9: Diagram of motor output

VI.CONCLUSION

Commutation torque ripple reduction circuit has been proposed using 2-level inverter with superlift luo converter and a dc-bus voltage selector circuit.. The suggested dc-bus voltage control strategy is more effective in torque ripple reduction in the commutation interval. when compared the performance of conventional 3-level DCMLI, 2-level inverter with SEPIC and the switch selection circuit-fed BLDCM. The proposed topology accomplishes the successful reduction of torque ripple in the commutation period and simulation results are presented in order to obtain significant torque ripple suppression, quietness, and higher efficiency, 2-level inverter with superlift luo converter and the voltage selector circuit is the most suitable choice to obtain high-performance operation of BLDCM.

VII.REFERENCES

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