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Commutation Torque Ripple Reduction in BLDC motor Using M-SEPIC Converter

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***Abstract*- The paper presents new power converter topology to suppress the torque ripple reduction due to the phase current commutation of brushless DC motor. The modified sepic converter is used in a converter circuit it has high static gain for a given duty cycle and step –up-output. Cuk converter has produce the inverted output. The M-SEPIC is a modification of the basic SEPIC. It is superior to the opposite converters each in terms of the input current, purity and potency. It shows very little overshoot or ringing. And also the switching loss is reduced and has low THD value than Cuk converter so it has high static gain and increased efficiency. The theoretical analysis and framework, using MATLAB/ Simulink environment, are given to illustrate the proposed method and the performance is compared with conventional system. And the experimental results are provided for verification of the BLDC drive system.**

***Keywords* -BLDC motor, modified SEPIC, PIC16F877A, DCMLI, Sensor less.**

I. INTRODUCTION

Brushless DC motors square measure common in industrial applications across the planet. At the foremost basic level, there square measure brushed and brushless motors and there square measure DC and AC motors. Brushless DC motors, as you'll imagine, don't contain brushes and use a DC current. It typically helps to clarify however a brushed DC motor works 1st, as they were used for a few time before brushless DC motors were obtainable.

Brushless DC motor is actually flipped within out, eliminating the requirement for brushes to flip the magnetic attraction field. In brushless DC motors, the permanent magnets square measure on the rotor, and therefore the electromagnets square measure on the stator coil. A computer then charges the electromagnets in the stator to rotate the rotor a full 360-degrees.Brushless DC motors generally have Associate in nursing potency of 85-90%, whereas brushed motors square measure sometimes solely 75-80% economical.

Brushes eventually wear out, generally inflicting dangerous sparking, limiting the period of time of a brushed motor. Brushless DC motors square measure quiet, lighter and have for much longer life spans. Because computers management the electrical current, brushless DC motors can do way more precise motion management. Because of of these benefits, brushless DC motors square measure typically utilized in trendy devices wherever low noise and low heat square measure needed, particularly in devices that run unendingly. They may even be the main power source for service robots, which will require very careful control of force for safety reasons. An original analytical study the commutation torque ripple, which reaches 50% of the average torque, can be reduced by keeping the non-commutated phase current steady. Different PWM methods are adopted to keep the non-commutated phase current steady during commutation period, the motor speed is divided into high speed and low speed, and different two-phase modulation methods during the commutation period are used respectively according to different speed ranges.

However, when the motor operates near the switching condition of high speed and low speed, the frequent switch of the modulation methods caused by speed fluctuation will appear which may reduce the stability of the system. Thereby, the three-phase modulation methods are used during the commutation period to maintain the steady non-commutated phase current over the entire speed range. However, the switch of modulation methods between the normal conduction period and the commutation period is required, which complicates the modulator design.

In order to reduce the commutation torque ripple in high speed range, DC-DC converter is introduced to increase the input voltage of the three-phase bridge inverter. Z-

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source inverter is added, and the required input voltage of the inverter is obtained by adjusting the duty cycle of shoot-through vectors to keep non-commutated phase current steady. However, the input voltage of the inverter is larger than the power supply voltage during both the normal conduction period and commutation period. During normal conduction periodssssss, the BLDCM is supplied by power voltage and the desired voltage for commutation period is adjusted by SEPIC converter.

II.COMPONENTS

1. PIC16F877A

PIC16f877a finds its applications in an exceedingly Brobdingnagian range of devices. It is employed in remote sensors, security and safety devices, home automation and in several industrial instruments. An EEPROM is additionally featured in it that makes it potential to store a number of the knowledge} for good like transmitter codes and receiver frequencies and a few alternative connected data. The cost of this controller is low and its handling is additionally straightforward.

2. Modified SEPIC converter

A modified SEPIC converter is the new form of SEPIC converter to get a high static gain and step-up output. For that in the basic SEPIC converter a multiplier diode and multiplier capacitor is added. The voltage multiplier technique is used to increase the static gain of ingle-phase and multiphase boost dc–dc converters.

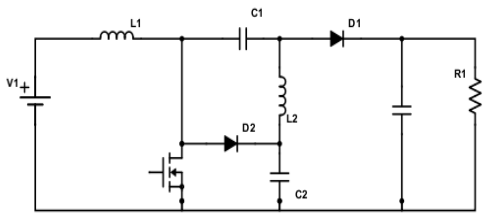

Fig.1 Modified SEPIC Converter.

3. DCMLI

The diode clamped construction electrical converter employs clamping diodes and cascaded DC capacitors to supply AC voltage waveforms with multiple levels. This chapter discusses varied aspects of the three level (3L) neutral point clamped (NPC) electrical converter, as well as the electrical converter topology, in operation principle, and device commutation. It conjointly discusses a standard house vector modulation (SVM) theme for the agency electrical converter. The DC input voltage of the electrical converter is generally split by 2 cascaded DC capacitors, providing a floating neutral purpose.

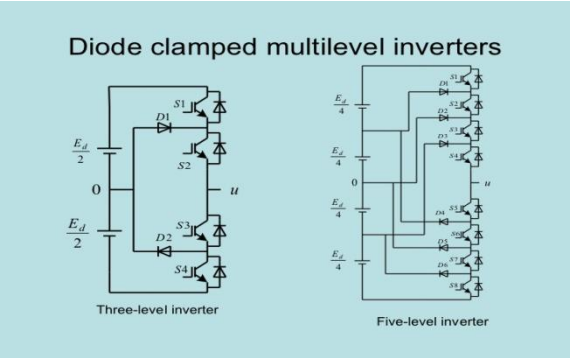

Fig. 2 Circuit Diagram of DCMLI.

His chapter elaborates management of the neutral point voltage deviation and introduces the operation of four and five level diode clamped inverters with carrier based modulation techniques. The neutral point voltage will be controlled by adjusting the time distribution between the p and n type states of a little voltage vector. There always exists a small voltage vector in each switching sequence, whose dwell time is divided into two sub periods, one for its p type and the other for its n type switching state.

4. Drive Circuit

A gate driver could be power electronic equipment that accepts a low-power input from a controller IC and produces a high-current drive input for the gate of a dynamic semi conductor device such as an IGBT or power MOSFET.

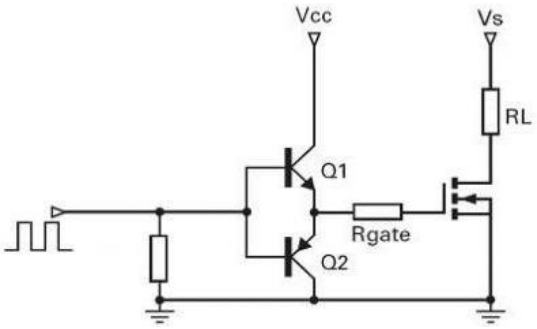

Fig.3 Drive Circuit Diagram.

Gate drivers may be provided either on-chip or as a separate module. In essence, a gate driver consists of a level shifter in combination with an amplifier Charge pumps are often used in H-Bridges in high side drivers for gate driving the high side n-channel power MOSFETs and IGBTs. These devices area unit used owing to their sensible performance but require a gate drive voltage a few volts above the power rail. When the centre of a half bridge goes low the capacitor is charged via a diode, and this charge is used to later drive the gate

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of the high side transistor gate some volts higher than the supply or electrode pin's voltage thus on switch it on. This strategy works well provided the bridge is frequently switched and avoids the quality of getting to run a separate power provide and permits the additional economical n-channel devices to be used for each high and low switches.

III. PROPOSED STRATEGY TO REDUCE COMMUTATION TORQUE RIPPLE

The general block diagram consist of two power supply unit are 5volt dc battery and 12 v dc battery. The supply is given to the microcontroller circuit, buffer circuit, and inverter and modified SEPIC converter. PIC microcontroller's 17th pin RC2/CCP1 pin has connected with the gate of the MOSFET (IRF540N) in the modified SEPIC converter. The gate of MOSFET is controlled by programming the PIC microcontroller

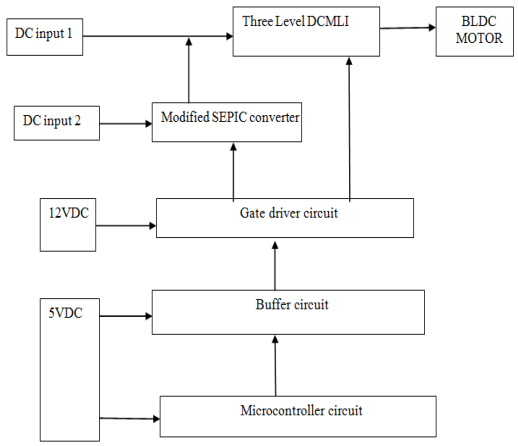

Fig.4 Block Diagram.

The MOSFET control the value of the modified SEPIC converter and the BLDC motor is the load of the modified SEPIC converter. The commutation torque ripple in BLDC motor is reduced by making such a closed loop connection in the system using PIC microcontroller.

1. Buffer Circuit- In general usage, a buffer is a few things that is a protecting barrier. There ar a minimum of 2 completely different meanings for the word in physical science vernacular. A buffer in circuit style is electronic equipment that has AN interface between mismatched circuit components. In computing, the term refers to a storage device used for temporary storage. It could also be an area of general memory that a computer program allocates for holding large amounts of data it's processing**.**

IV. WORKING AND CIRCUIT DIAGRAM

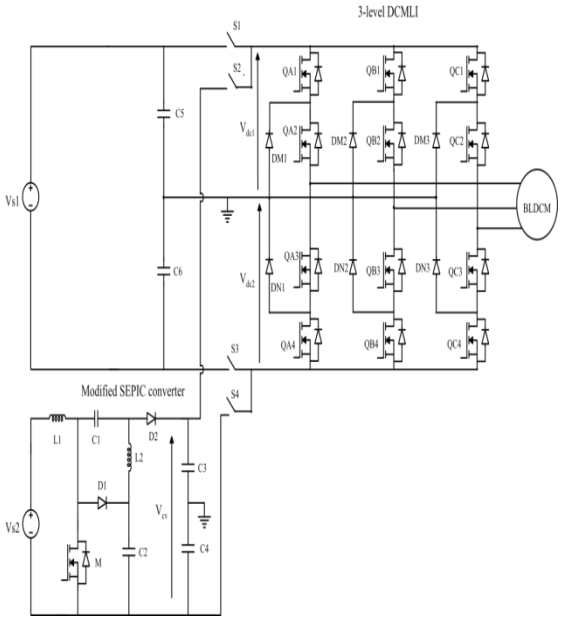

Fig.5 Circuit diagram.

2. Operating mode 1- The inverter output voltages well as load current (i1) both, are positive. The power MOSFETs QA1, QA2, and clamping diode DM1 are active in this operating mode. The commutation current alternates between the MOSFET QA1 and clamping diode DM1 during the commutation process. The current (i1) flows from the positive terminal of the power supply through the MOSFETs QA1 and QA2 as long as MOSFET QA1 is switched on. If MOSFET QA1 is turned off, load current transfers from MOSFET QA1 to clamping diode DM1. The current now flows from the neutral l point (N) to inverter output terminal through the clamping diode DM1 and MOSFET QA2. The MOSFET QA2 remains conducting at all times.

2. Operating mode 2- In this operating mode, the inverter load current (i1) remains positive but the inverter output voltage is negative. The commutation of current goes back and forth between clamping diode DM1/ MOSFET QA2 and the diodes DA3/DA4.

3. Operating mode 3- The inverter output voltage as well as load current (i1) both, are negative. In this operating mode, the commutation current goes back and forth between clamping diode DN1 and MOSFET QA4. When MOSFET QA4 is switched on, the load current (i1) passes through MOSFETs QA3 and QA4 from the inverter output terminal. If MOSFET QA4 is turned off, load current transfers from MOSFET QA4 to clamping diode DN1. As a result, the load current now passes

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through MOSFET QA3 and clamping diode DN1 from the inverter out putter minal A to the neutral point (N). The MOSFET QA3 remains conducting at all times.

4. Operating mode 4- In this operating mode, the inverter load current becomes negative and the output voltage is still positive. The commutation of current goes back and forth between camping diode DN1/MOSFET QA3 and the diodes DA1/DA.

V. SIMULATION RESULTS

To validate the performance, the BLDCM drive system is simulated in MATLAB/Simulink environment.the simulated result shows that the rotor rated current and obtained current are shown in fig(b) and the rated speed and obtained result of speed is shown in fig(c) and the electromagnetic torque is shown in fig(d). It can be seen that under the appropriate input voltage of the inverter during commutation, torque pulsation is significantly reduced by using the proposed method.

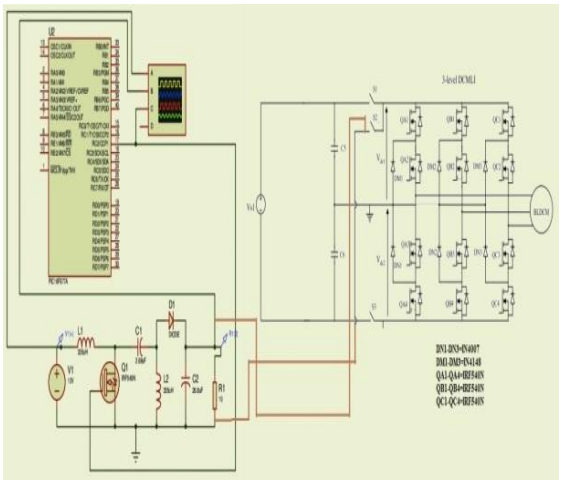

Fig.6 circuit diagram of proposed system.

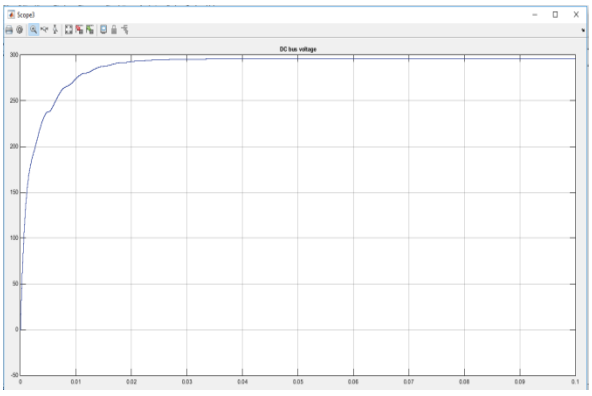

Fig.7 Simulation of dc bus voltage.

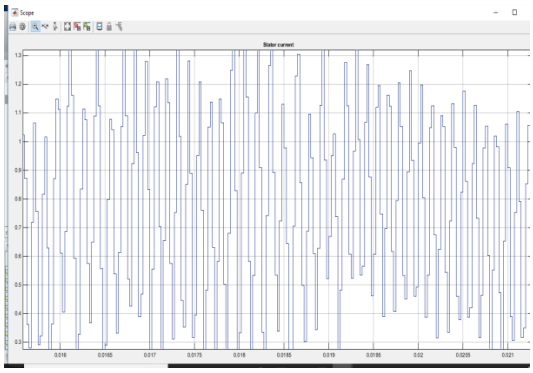

Fig.8 Simulation of stator current.

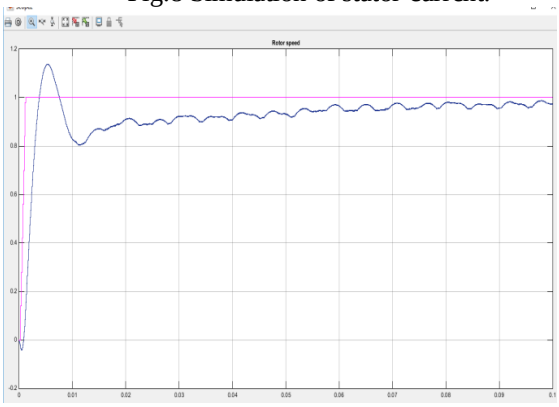

Fig.9 Simulation of rotor speed.

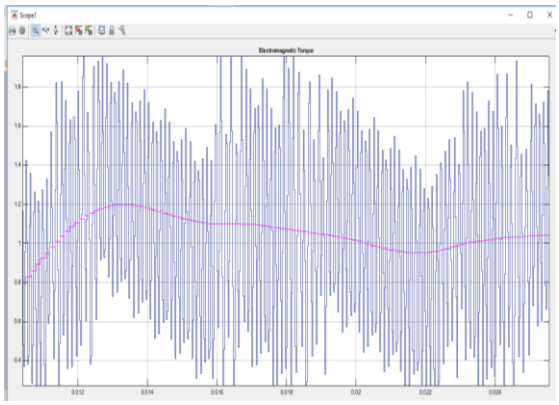

Fig.10 simulation of electromagnetic torque.

VI. CONCLUSION

In this planned system, a commutation torsion ripple reduction circuit has been planned exploitation 3-level DCMLI with changed SEPIC convertor and a dc-bus voltage selector circuit. The urged dc-bus voltage management strategy is more practical in force ripple reduction within the commutation interval. The planned topology accomplishes the productive reduction of force ripple within the commutation amount and experimental results area unit conferred. In order to obtain significant

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torque ripple suppression, quietness and higher efficiency, 3-level DCMLI with modified SEPIC converter and the voltage. Selector circuit is a most suitable choice to obtain high-performance operation of BLDCM. The proposed topology may be used for the torque ripple suppression of BLDCM with the very low stator winding inductance.

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