Effect of Switching Frequency and Voltage Levels on Total Harmonic Distortion in Multilevel Inverters Fed BLDC Drive

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I.ABSTRACT: Cascade Multilevel Inverter are very popular and have many application in electric utility and for industrial drives. When these inverters are used for industrial drive directly, the THD contents in output voltage of inverters is very significant index as the performance of drive depends very much on the quality of voltage applied to drive. In this article, the THD content of 5 level cascade multilevel inverters have been analyzed. The THD depends on the switching angles for different units of multilevel inverters. The most popular cascade H-bridge apart from other multilevel inverters is the capability of utilizing different dc voltages on the Individual H-bridge cell which results in splitting the power conversion amongst higher-voltage lower frequency and lower-voltage higher-frequency inverters. In this paper multi level converter fed BLDC drive with different voltage levels are considered and simulation results are presented in terms of total harmonic distortion.

II.INTRODUCTION:- The Several topologies for multilevel inverters have been proposed over the years; the most popular cascaded H-bridge apart from other multilevel inverters is the capability of utilizing different dc voltages on the individual H-bridge cells which results in splitting the power conversion amongst higher-voltage lower-frequency and lower-voltage higher-frequency inverters. In this paper multilevel converter fed BLDC drive with different voltage levels are considered and simulation results are presented in terms of total harmonic distortion (THD). Finally generalized expression for highest order harmonic based on switching frequency and number of levels is derived.

In High performance applications reliability and low maintenance are essential in the aerospace industries and computer peripheral this force for the development of brushless D.C. motors. Now large numbers of brushless D.C. motors are used, mostly in size up to a few hundred watts. The small ratings machine is increasingly made with all the power electronics circuits and control integrated at one end of the motor, so that they can be directly retrofitted as an alternate for a conventional d.c. motor. Higher specific outputs can be achieved because all the heat dissipating area is on the stator, cooling is much better than in a conventional motor. The rotor inertia can also be less than that of a conventional machine, which means that the torque to inertia ratio is higher and, giving a higher acceleration. The attractive features of a multilevel converter can be briefly summarized as follows.

A BLDC motor is a permanent magnet synchronous that uses position detectors and an inverter to control the armature currents. The BLDC motor is sometimes referred to as an inside out dc motor because its armature is in the stator and the magnets are on the rotor and its operating characteristics resemble those of a dc motor. Instead of using a mechanical commutator as in the conventional dc motor, the BLDC motor employs electronic commutation which makes it a virtually maintenance free motor.

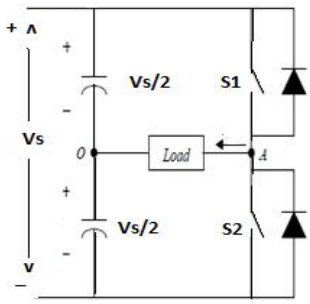
There are two main types of BLDC motors: trapezoidal type and sinusoidal type. In the trapezoidal motor the back-emf induced in the stator windings has a trapezoidal shape and its phases must be supplied with quasi-square currents for ripple free operation. The sinusoidal motor on the other hand has a sinusoid ally shaped back – emf and requires sinusoidal phase currents for ripple free torque operation. The shape of the back – emf is determined by the shape of rotor magnets and the stator winding distribution.

The sinusoidal motor needs high resolution position sensors because the rotor position must be known at every time instant for optimal operation.

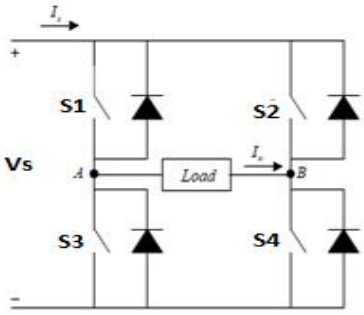
III. CASCADED H-BRIDGE MULTILEVEL INVERTER

Recent advances in the power-handling capabilities of static switch devices such as IGBTs with voltage rating up to 4.5 kV commercially available, has made the use of the voltage source inverters (VSI) feasible for high-power applications. Multilevel inverters include an array of power semiconductors and capacitor voltage sources, the output of which generate voltages with stepped waveforms. Capacitors, batteries, and renewable energy voltage sources can be used as the multiple dc voltage sources.

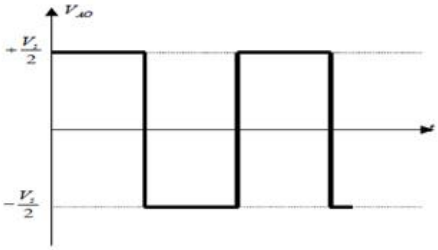
Switch-mode dc-to-ac inverters used in ac power supplies and ac motor drives where the objective is to produce a sinusoidal ac output whose magnitude and frequency can both be controlled. Practically, we use an inverter in both single-phase and three phase ac systems. A half-bridge is the simplest topology, which is used to produce a two level square-wave output waveform. A center-tapped voltage source supply is needed in such a topology. It may be possible to use a simple supply with two well-matched capacitors in series to provide the center tap. Today, multilevel inverters are extensively used in high-power applications with medium voltage levels. The field applications include use in laminators, mills, conveyors, pumps, fans, blowers, compressors, and so on.



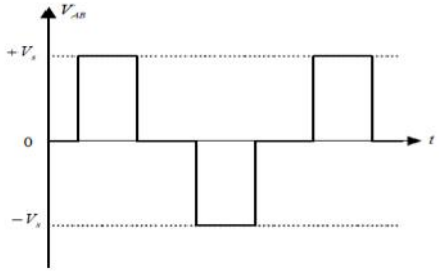
Half Bridge Inverter



Full Bridge Inverter



Output waveform of Half Bridge Inverter



Output waveform of Full bridge Inverter

FIVE LEVEL CHB INVERTER

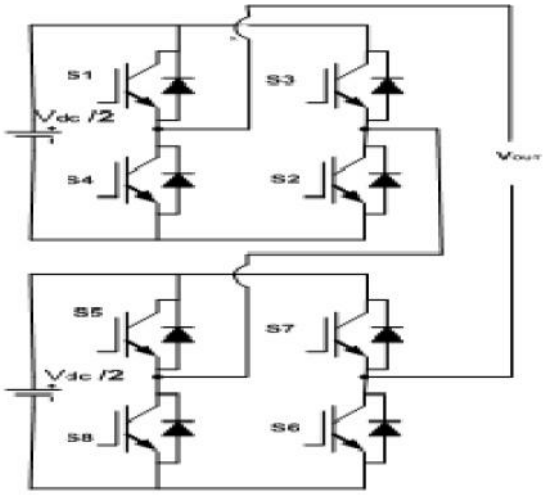


Fig 3.1 Five level CHB inverter

The below table shows the switching states of the 5level inverter. Here even though we have eight switches at any switching state only two switches are on/off at a voltage level of Vdc/2, so switching losses are reduced. In three level inverter dv/dt is Vdc, bi9t in five level inverter dv/dt is Vdc/2.

Switches Turn ON	Voltage Level
S1,S2,S6,S8	Vdc/2
S1,S2,S5,S6	Vdc
S2,S4,S6,S8	0
S3,S4,S6.S8	-Vdc/2
S3,S4,S7,S8	-Vdc

SEVEN LEVEL CHB INVERTER

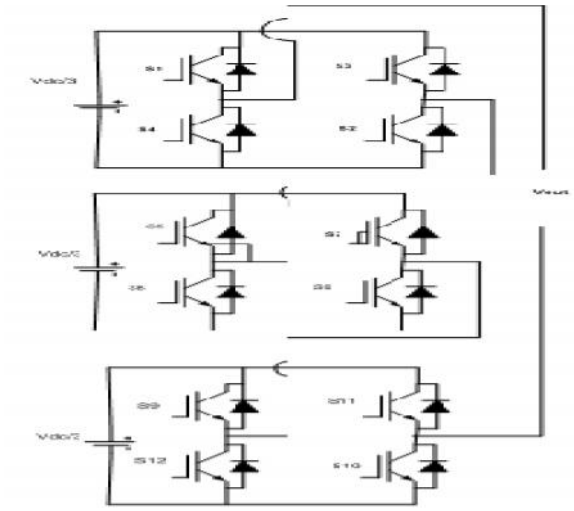


Figure 3.2 shows the seven level multilevel inverter

IV . MATLAB/SIMULINK CIRCUIT DIAGRAM

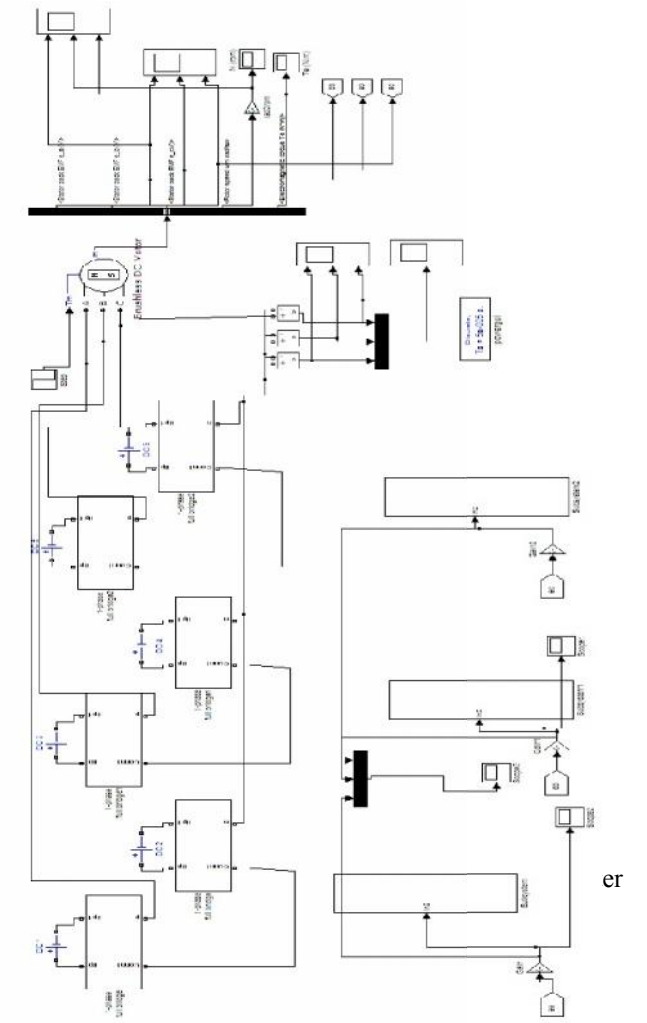


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Figure4.2: Electromagnetic torque(T_e) with respect to time (t)

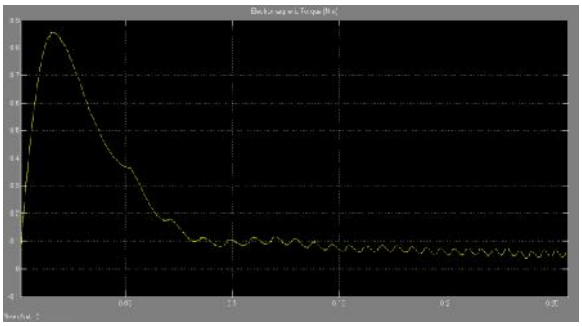


Figure 4.3 Response of BLDC Stator back EMF, speed (N), electromagnetic torque

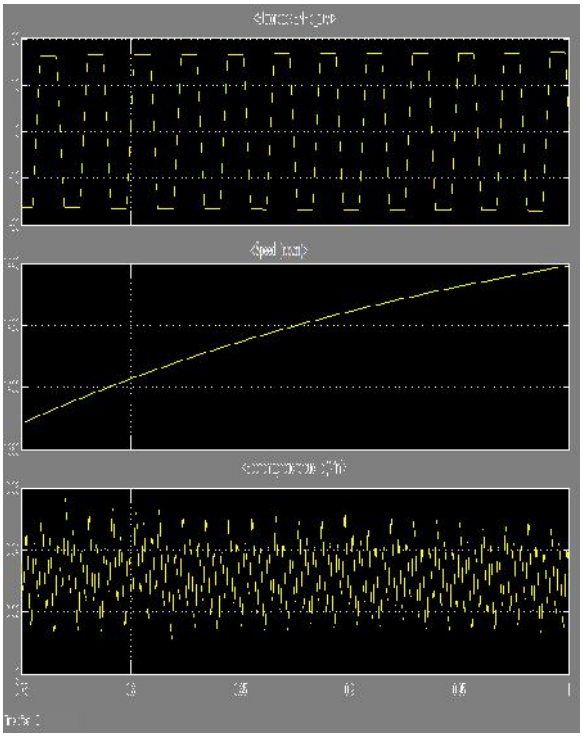
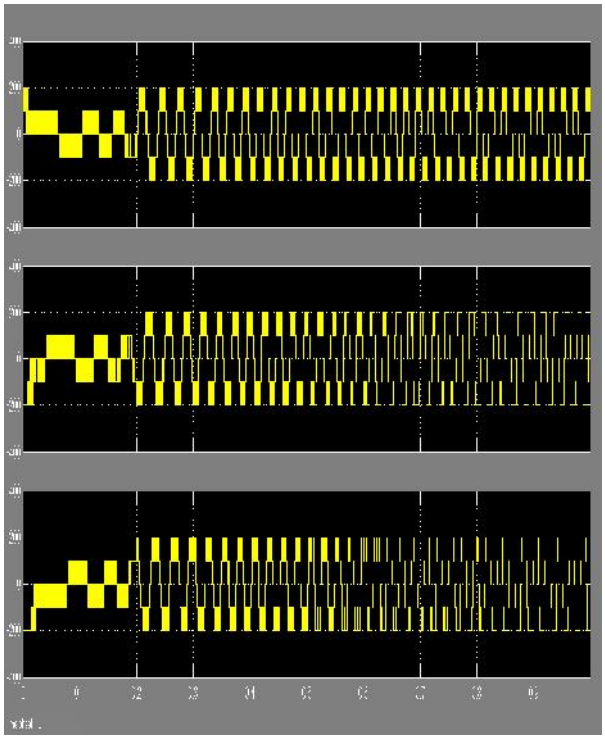


Figure 4.4 output wave forms of five level inverter



V. CONCLUSION

In this paper, we had simulated multilevel converters with different voltage levels and simulation results of voltages output and THD are presented and applied to the BLDC motor. For future scope, Here we obtained the response for five level inverter if we increased the number of levels in multi inverter then we may get better results by reducing the harmonics.

REFERENCES

[1] T. Meynard, M. Fadel, and N. Aouda, "Modeling of multilevel converters," iEEE Trans. ind. Electron., vol. 44, pp. 356-364, June 1997.
[2] F. Forest, J. Gonzalez, and F. Costa, "Use of softswitching principles in PWM voltage converters design," in Proc. Eur. Power Electron. Conf., 993.
[3] J. G. Cho, J.W. Baek, D.W. Yoo, and C. Y.Won, "Three level auxiliary resonant commutated pole converter for high power applications," in PrOC. IEEE PESC Coni,1996, pp. 1019-1026.
[4] Y.S. Lai and F.S. Shyu, "Topology for hybrid multi level inverter", lEE Proc-Electr. Power Appl. Vol. 149, No. 6, Nov. 2002.
[5] M.D. Manjrekar, P.K. Steimer, and T.A. Lipo. "Hybrid multilevel power conversion system: A competitive solution for high power applications". IEEE Transations on Industry Applications, 36(3):834-841, May/June 2000.
[6] K.A. Corzine, S.D. Sudhoff, and C.A. Whitcomb. "Performance characteristics of a cascaded two-level converter". IEEE Transactions on Energy Conversion,14(3), September 1999.71
[7] A.K. Ali Othman "Elimination of harmonics in multi level nverters with non equal DC [8]D. Soto, T. C. Green, "A comparison of high-power converter topologies for the Implementation of FACTS Controller," IEEE Transaction of Industrial Electronics, 49, N 5, pp. 1072-1080, 2002.
[8] T.A Lipo, D.G. Holmes, Pulse width modulation for power converters: principles and practice. NJ: John Wiley, 2003, pp. 396--411