"Review on Three Level Diode Clamp Inverter Fed Induction Motor Drive using SPWM Technique"

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***Abstract*— The main objective of this paper is to control the speed of an induction motor by changing the frequency using three level diode clamped multilevel inverter. To obtain high quality sinusoidal output voltage with reduced harmonics distortion, SPWM control scheme is proposed for diode clamped multilevel inverter. This method is implemented by changing the supply voltage and frequency applied to the three phase induction motor at constant ratio. The proposed system is an effective replacement for the conventional method which produces high switching losses, results in poor drive performance. The simulation & implementation results reveal that the proposed circuit effectively controls the motor speed and enhances the drive performance through reduction in total harmonic distortion (THD). This paper deals with simulation and comparison of Three Phase Two Level, Three Level. The Two Level and Three Level are realized by Diode clamped (DC) inverter using sinusoidal pulse width modulation (SPWM) technique. Now-a-days harmonic reduction using PWM is most popularly used in industries for a Variable Frequency Drives (VFDs). All the circuits are implemented using MATLAB software**

Keywords-- Diode clamped multilevel inverter (DMLI); Sinusoidal pulse width modulation (SPWM); Total harmonic distortion (THD); induction motor

I. INTRODUCTION

DC motors have been used during the last century in industries for variable speed control applications, because its flux and torque can be controlled easily changing the field and armature currents respectively. Furthermore, four quadrant operation of induction motor was also achieved. Induction motor is popularly used in industries due to ruggedness and robustness. The induction motors were mainly used for constant speed applications because of the unavailability of the variable-frequency voltage supply. The advancement of power electronics has made it possible to vary the frequency of the voltage. Thus, it has extended the use of induction motor in variable speed drive applications. The concept of multilevel inverter control has opened a new possibility that induction motors can be controlled to achieve dynamic performance equally as that of DC motors.

Depending on voltage levels of the output voltage waveforms, the inverters can be classified as Two-level inverters and Multi-level inverters. The inverters with voltage level 3 or more are referred as Multi-level inverters. Multi-level inverters have been attracting recently, particularly because of the increased power ratings, improved harmonic performance and reduced EMI emission that can be achieved with the multiple DC levels that are available for synthesis of the output voltage waveforms. In this paper, a three phase diode clamped multilevel inverter fed induction motor is described. The diode clamped inverter provides multiple voltage levels from a series bank of capacitors.Performance of multilevel inverters depends on the PWM converter topology.The principle reason for doing so is to be able to vary the ac output voltage and to reduce the low-order harmonics. PWM switching strategies not only addresses the primary issues viz, less THD, effective dc bus utilization etc. but also take care of secondary issues like EMI reduction, switching loss, better spreading of harmonics over the spectrum. Among various modulation techniques for a multilevel inverter, sin-triangle pulse width modulation (SPWM) is an attractive candidate due to the following merits.It proportionally varies the width of each pulse to the amplitude of a sine wave evaluated at the centre of the same pulse.It is suitable for MATLAB/SIMULINK implementation.

II. LITERATURE REVIEW

[1] Darshan Prajapati, Vineetha Ravindran, Jil Sutaria, Pratik Patel, This paper deals with study of Three Phase Two Level, Three Level and Five Level Voltage Source Inverter (VSI). The Three Level and Five Level are realized by Neutral point clamped (NPC) or Diode clamped (DC) inverter using Sinusoidal pulse width modulation (SPWM) technique. Similarly three phase VSI (two level) is also simulated using SPWM technique. SPWM technique is one of the most popular PWM techniques. Now-a-days harmonic reduction using SPWM is most popularly used in industries for a Variable Frequency Drives (VFDs). All the circuits are implemented using MATLAB software and their outputs are shown in figures step by step. Finally, this paper compares all the three inverters i.e., Two Level, Three Level and Five Level based on the total harmonic distortion of the output voltage waveform.

[2] R.Dharmaprakash, Joseph Henry, This paper proposes a switching table based 2-level inverter and 3-level diode clamped multilevel inverter (DCMLI) for the purpose of direct torque control of induction motor. The proposed scheme determines the sector of reference vector and the voltage vector is selected from switching table to generate gating signals for the inverter. The 2-level inverter and 3-level DCMLI are used to explain this scheme. This can be extended to n-level inverter and to all major topologies. The performance measures in terms of total harmonic distortion (THD) and fundamental voltage of line voltage and phase voltage are computed and compared with and without filter. The results show that the performance is greatly improved by increasing the number of levels. The significant feature of the proposed scheme is that it can be utilized for direct torque control of induction motor with affecting its simplicity.

[3] Ashwini Kadam, A.N.Shaikh, This paper is to control the speed of an induction motor by changing the frequency using three level diode clamped multilevel inverter. To obtain high quality sinusoidal output voltage with reduced harmonics distortion, multicarrier PWM control scheme is proposed for diode clamped multilevel inverter. This method is implemented by changing the supply voltage and frequency applied to the three phase induction motor at constant ratio. The proposed system is an effective replacement for the conventional method which produces high switching losses, results in poor drive performance. The simulation & implementation results reveal that the proposed circuit effectively controls the motor speed and enhances the drive performance through reduction in total harmonic distortion (THD). The effectiveness of the system is checked by simulation using MATLAB 7.8 simulink package.

III. DIODE CLAMPED INVERTER

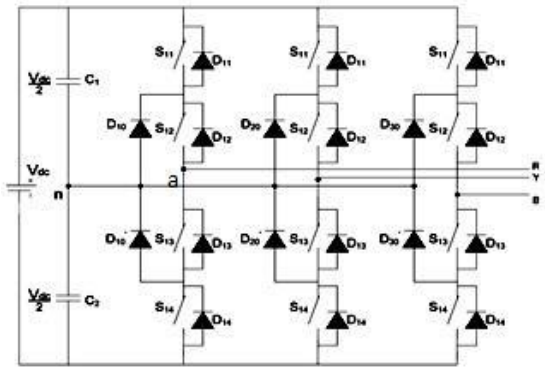

Fig. I. Three level Diode Clamped Inverter

The power circuit diagram of three level diode clamped multilevel inverter is as shown in the figure. The Mid-level voltage is defined as a neutral point. So it is also called as Neutral Point Clamped Multilevel Inverter. The basic operation of three level Diode clamped inverter is explained by understanding the inverter shown in fig. 1. In this circuit, the DC bus voltage is split into three levels by two series connected capacitor, C1 and C2.The mid-point of two capacitors is called the neutral point n. The switchesS11 and S14 are called as main switches. Switches S12 andS13 are called auxiliary switches which helps to clamp the output voltage to the neutral point with the help of clamping diodes D10 and D10'.It is called the three level multilevel inverter because it has three output voltages 0,+Vdc/2, -Vdc/2.

For output voltage Vdc/2, switches S11 and S12 needs to be turned on; for –Vdc/2, switches S13 and S14 needs to be turned on and for 0, switches S12 and S13 needs to be turned on. The clamping diodes D10 and D10' in this topology distinguishes it from conventional two level inverter. These two diodes clamp the switch voltage to half the level of DC-bus voltage. When switch S11 and S12 turned on, the voltage across a and n is Vdc/2, i.e, Van=Vdc/2.In this case, the capacitor D10' balances out the voltage sharing between S13 and S14.S13 blocks the voltage across capacitor C1 and S14 blocks the voltage across C2.When switches S12 and S13 turned on, Van=0; when switches S13 and S14turned on, Van=-Vdc/2.

IV. SINUSOIDAL PULSE WIDTH MODULATION

Sinusoidal Pulse Width Modulation technique is most used effective technique to reduce the harmonic contents ascompared to any other PWM technique. In SPWM technique the desired frequency sine wave is compared with the high frequency triangle wave. Intersection of these two waves determines the commutation of the modulated pulse and switching instants of it. The compared triangular wave is called as carrier waves and the desired sine wave is termed as reference wave. Both these waves are compared in a comparator and the output of the comparator is given to the switching devices like TCRs, MOSFETs, IGBTs or any other switching devices. The comparator output is high when the magnitude of the sine wave is higher than the magnitude of the triangular wave and vice-versa.

The modulation index (MI) is:

$$MI=Vr/Vc$$

Where Vr =Magnitude of the reference sine wave Vc=Magnitude of the carrier triangular wave. The MI can never be more than unity i.e., 1.So the Output voltage can be controlled by varying Modulation Index .As the number of levels increases in multilevel inverter the switching devices required is increases.

V. SWITCHING STRATEGY

The switching strategies of each switch for three level output voltage is shown in table I.

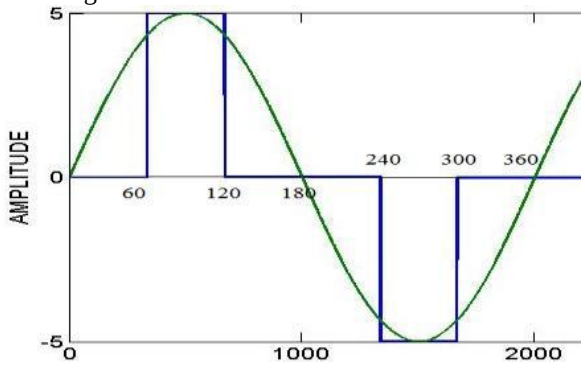

Fig. II.Desired pole voltage for three level DCMLI

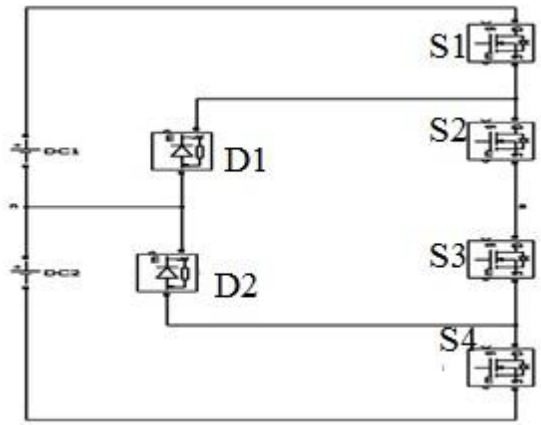

Fig.III. One Leg of Three Level Diode Clamped Inverter

TABLE I

SWITCHING STRATEGY FOR ONE LEG OF THREE LEVEL DCMLI

Period	S1	S2	S3	S4	Vo(pole voltage)
0°-60°	0	1	1	0	0
60°-120°	1	1	0	0	$\frac{Vdc}{2}$
120°-180°	0	1	1	0	0
180°-240°	0	1	1	0	0
240°-300°	0	0	1	1	$-\frac{Vdc}{2}$
300°-360°	0	1	1	0	0

VI. CONCLUSION

The IM drive performance had been improved with multilevel inverter fed topology. The MLI fed system has better torque performance, lesser torque ripple, better speed response and less harmonic distortion compared with conventional 2-level. The simulation and analysis of three phase VSI, three phase three level Diode Clamped inverter has been done using MATLAB software. The PWM technique used is SPWM which is easier to implement in hardware. It has been observed from the output voltage waveform that it appears more like sine wave as the number of level increases.

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