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Implementation of Multilevel Inverter Based Drive System

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Abstract— The main aim of this paper is to control the speed of a three phase induction motor by using diode clamped multilevel inverter. To obtain high quality output voltage with low harmonics, multicarrier PWM control scheme is proposed for multilevel inverter. By using V/f control the speed of a three phase induction motor is controlled. . This method can be implemented by change the supply voltage and frequency applied to the induction motor at constant ratio. The simulation results prove that the proposed circuit effectively controls the speed of a motor.

Keywords—Pulse Width Modulation, Multilevel inverter

I. INTRODUCTION

Constant speed applications need induction motors because of unavailability of the variable-frequency supply voltage [2]. Mechanical gear systems were used for obtaining variable speed. Recently, power electronics and control systems have improved to allow these components to be used for motor control in place of mechanical gears. These electronics control the motor's speed, steady state and dynamic characteristics. Adjustable speed ac machine system is equipped with a power electronic device for speed control of an electric machine. It varies the speed of an electric machine by changing the fixed voltage and frequency to adjustable values on the machine side. Induction motor drives using classical three-phase converters have the disadvantages of poor voltage and current qualities. To improve these values, the switching frequency has to be increased which produces additional switching losses. An induction motor can be controlled by using multilevel inverter to achieve dynamic performance same as that of dc motors [2]. As the number of level increases, the output waveform adds high steps, producing a stepped waveform.

In this paper, a diode clamped multilevel inverter fed induction motor is explained. The diode clamped inverter produces more voltage levels from a series bank of capacitors [2]. Half of the dc bus voltage is appeared across the switches. The proposed inverter can decrease the harmonic contents by using multicarrier PWM technique. V/f technique is an efficient method for speed control in open loop. In this scheme, the speed of an induction machine is controlled by the adjustable magnitude of stator voltages and its frequency .Here the speed of an induction motor is effectively controlled by using three level diode clamped multilevel inverter.

The organization of the article is as follows. Section II explains multilevel inverter based drive circuit, Section III explains the block diagram of proposed scheme, Section IV contain modulation strategy used in multilevel inverter, Section V contain simulated module & output waveforms obtained from the module, Section VI concludes the results obtained from the simulated module.

II. DRIVE SYSTEM

A multilevel inverter is a power electronic device which is capable of providing desired alternating voltage level at the output using multiple lower level DC voltages as an input. The commutation of the switches permits the addition of the capacitor voltages, which reach high voltage at the output, while the power semiconductors must withstand only reduced voltages [7].

i. Structure of Three level diode clamped multilevel inverter

The three-level diode clamped inverter is shown in Fig.1. It contains 12 unidirectional active switches and 6 NP clamping diodes. The middle point of the two capacitors is pointed as "*n*" [7]. Each switch must block one-half of the dc link voltage. In order to produce three levels, only two switches in each phase leg should be turned on at any time. The dc-bus voltage is split into three levels by two series-connected capacitors, C_a and C_b. The diodes are all same type to provide equal voltage and to clamp the same voltage level across the switch, when the switch is in off condition.

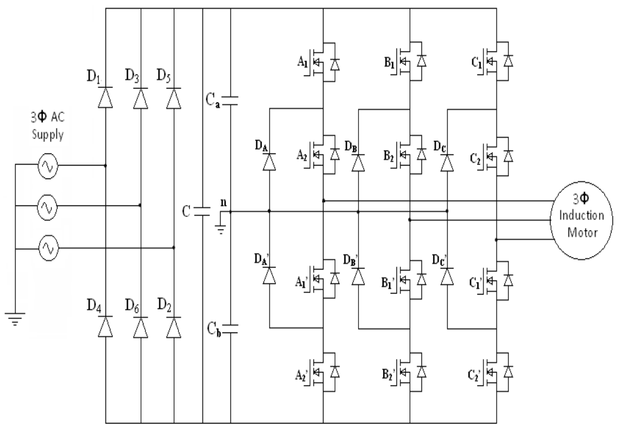

Fig.1. Multilevel inverter based drive circuit.

ii. Principle of Operation

To produce a stepped output voltage, consider one leg of the three-level inverter.

1. Turn on all upper-half switches A_1 and A_2. Output voltage V_{ao}=V_{dc},
2. Turn on one upper switch A_2 and one lower switch A_1'. Output voltage level V_{ao}=V_{dc}
3. Turn on lower half switches A_1' and A_2'. Output voltage level V_{ao}=0

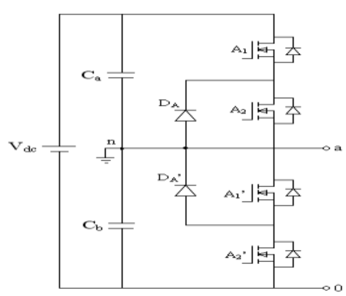

Fig.2. One leg of a bridge.

Table.1. shows the voltage levels and their switch states.

Table.1. Output voltage levels and their Switching states.

Output V_{ao}	Switch States			
	A_1	A_1'	A_2	A_2'
V_{dc}	1	1	0	0
$V_{dc}/2$	0	1	1	0
0	0	0	1	1

Fig.3. shows the phase voltage waveform of the three-level multi inverter.

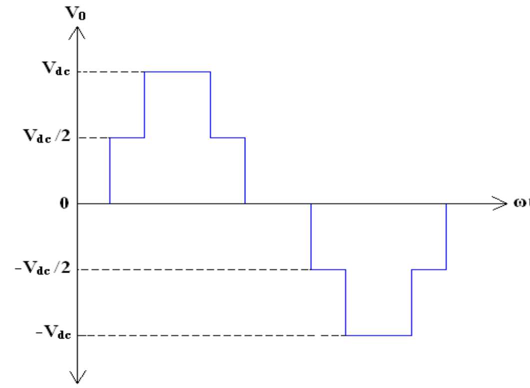

Fig.3. Three level inverter output voltage.

III. BLOCK DIAGRAM OF PROPOSED SCHEME

The block diagram of proposed scheme is shown in Fig.4. The power circuit consists of a power rectifier, filter capacitor, and 3Φ neutral point multilevel inverter. An induction motor is connected to the multilevel inverter. An ac input voltage is fed to a three phase diode bridge rectifier; it produces dc output voltage across a capacitor filter. A capacitor filter, removes unwanted ripple contents present in the dc output voltage. The ripple free dc voltage is applied to the three phase multilevel inverter through capacitor filter. The multilevel inverter has 12 MOSFET switches that are controlled in order to generate a reduced harmonic content ac output voltage from the dc input voltage.

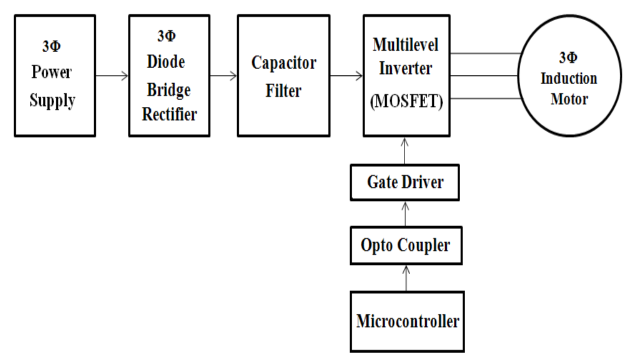

Fig.4.Basic block diagram.

The control circuit of the proposed system consists of microcontroller kit, opto-coupler and gate driver circuit. The microcontroller is used to generate gate signals required to drive the power MOSFET switches. To drive the power switches effectively an optocoupler and driver circuit is necessary. The output ac voltage is obtained from multilevel inverter can be controlled both in magnitude and frequency. The controlled output ac voltage is fed to an induction motor drive. Diodes are connected across the switches to give a path for the current to dissipate when the switches are off. The V/*f* control method allows the user to control the speed of an induction motor at various rates.

IV. MODULATION STRATEGY

The multicarrier PWM method uses many triangular carrier signals, keeping only one modulating sinusoidal signal. If an n-level inverter is needed, n-1 carriers will be employed. The carriers have the same peak to peak amplitude and same frequency. The zero reference is placed in the centre of the carrier set. A sinusoidal signal of frequency W_m and amplitude A_m is act as a modulating signal. Each carrier is compared with the modulating signal at every instant.

In this paper In-phase disposition technique is used for generating gating pulses for MOSFET switches.

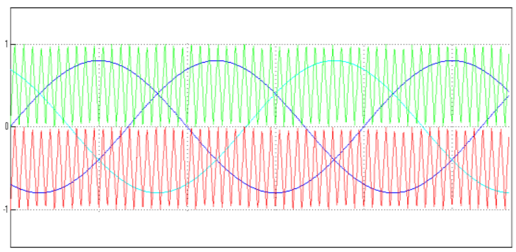

Fig.5.In-phase disposition technique.

V. SIMULATED CIRCUITS AND WAVEFORMS

Fig.6. shows the PWM circuit for generating the gating signals for the multilevel inverter switches.

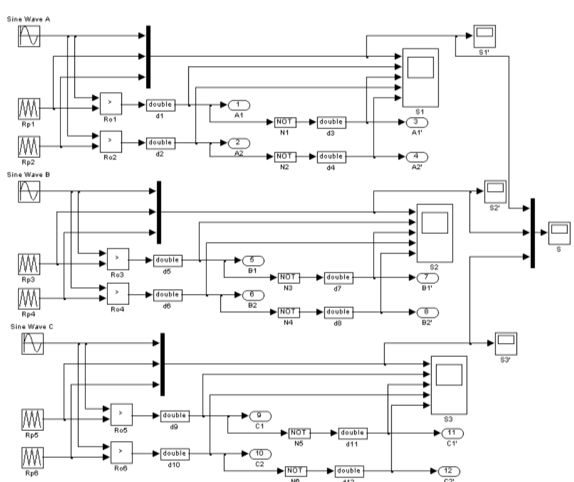

Fig.6. PWM simulation circuit.

Fig.7. shows the waveform of sine-triangle intersection. Two carriers together with sinusoidal signal have been used to obtain SPWM control. The intersection of the sinusoidal signal with the upper triangle signal results in the positive PWM phase voltage, whereas the intersection of the sinusoidal and the lower triangle signals results in the negative PWM phase voltage[3].

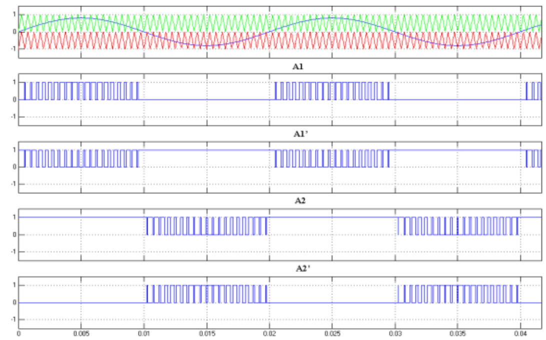

Fig.7. Gate pulses for leg A switches.

Simulated model for the circuit is shown in Fig.8.

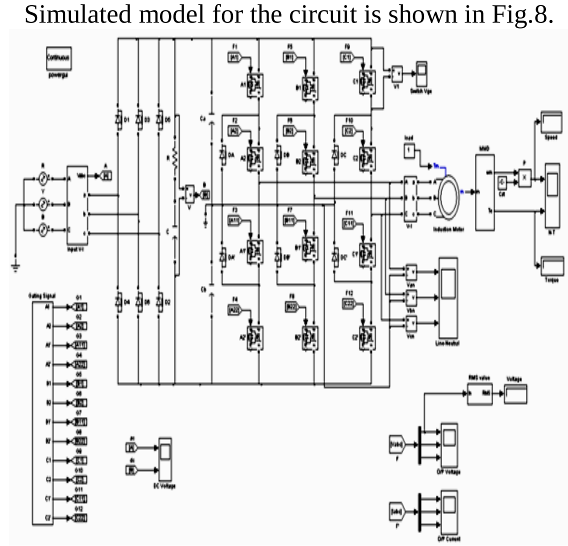

Fig.8. Simulated Module.

Output voltage waveform for 50 Hz frequency & 45 Hz frequencies are shown in below figures 9 and 10.

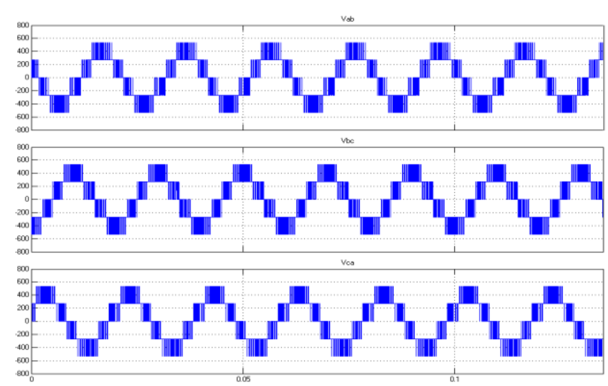

Fig.9. Output line-line voltage for 50 Hz frequency.

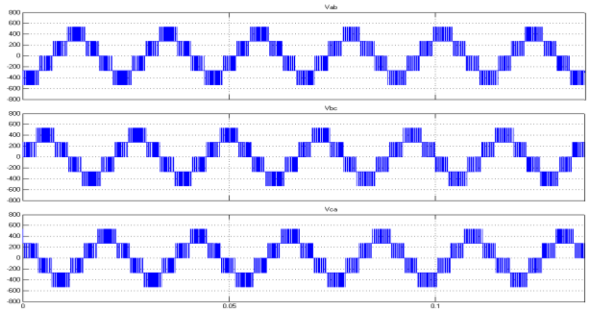

Fig.10. Output line-line voltage for 45Hz frequency.

Speed-Torque curves for 50 Hz and 45 Hz frequencies are shown in figures 11 and 12.

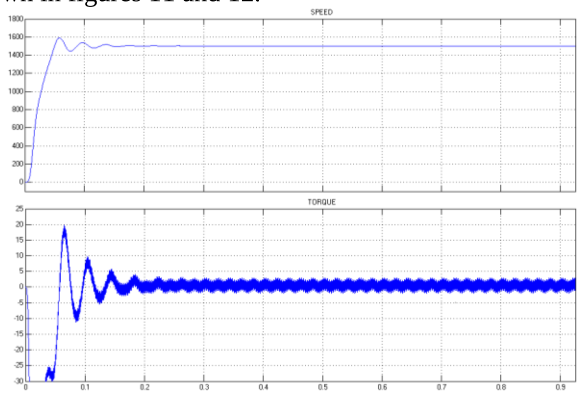

Fig.11. N-T curves for 50Hz frequency.

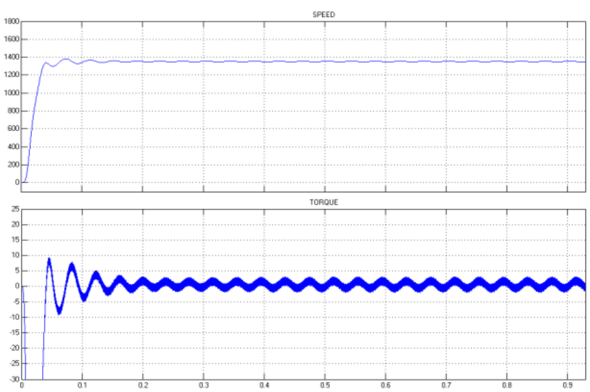

Fig.12. N-T curves for 45Hz frequency.

Table.2. Speed range for different m, frequency values.

Modulation Index (m)	Output Voltage (V)	Frequency (HZ)	Speed (RPM)
0.9	396.5	50	1500
0.81	356.1	45	1350
0.75	316.8	40	1200
0.65	277.1	35	1050
0.55	238.6	30	910
0.38	203.8	25	765

Fig.13. represents the graph drawn between different frequency values and its corresponding speed values. By gradually increasing the supply frequency, motor speed also increases proportionally.

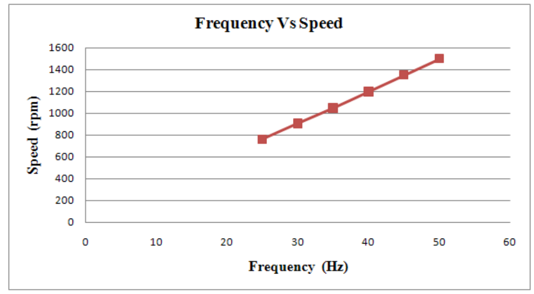

Fig.13 Graph for Frequency Vs Speed

In order to vary the speed of an induction motor, the drive would have an output characteristic is shown in Fig.14. The voltage is varied directly with the frequency by maintaining a constant V/*f* ratio.

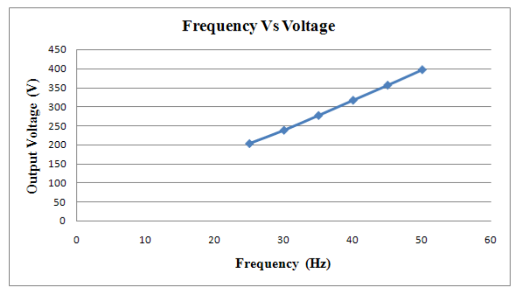

Fig.14. Graph for Frequency Vs Voltage

VI. CONCLUSION

In this paper a neutral point multilevel inverter has been presented for drive applications. The multicarrier PWM technique can be implemented for producing very low harmonic contents in the output. The open loop speed control was obtained by maintaining V/*f* ratio at constant ratio. The simulation results prove that the proposed system effectively controls the speed of an induction motor.

REFERENCES

[1] Jose, Steffen Sernet, Bin Wu, Jorge and Samir Kouro, "*Multilevel Voltage Source Converter Topologies for Industrial Medium Voltage Drives*", IEEE Trans on Industrial Electronics, Vol.**54**, No.**6**, December **2007**.

[2] Dr. Rama Reddy and G.Pandian, *"Implementation of Multilevel inverter fed Induction motor Drive"*, Journal of Industrial Technology, Vol **24**, No. **1**, April **2008**.

[3] Zhang, A.V. Jouanne, Shaoan Dai, A.K.Wallace and F. Wang, " *Multilevel Inverter Modulation Schemes to Eliminate Common Mode Voltages"*, IEEE Trans on Ind. Appl, Vol. **36**, No **6**, pp 1645-1653 Nov/Dec **2000**.

[4] N.Celanovic and D. Boroyevich, *" A Comprehensive study of neutral-pointvoltage balancing problem in three level neutral point clamped voltage source PWM inverters",* IEEE Trans on Power Electronics, Vol.**15**, No. **2**, pp. 242 – 249, March **2000**.

[5] K.Yamanaka, and A.M.hava, *"A novel neutral point potential stabilization technique using the information of output current polarities and voltage vector",* IEEE Trans on Ind. Appl, Vol. **38**, No. **6**, pp. 1572–1580 Nov/Dec **2002**.

[6] Fang Zheng Peng, *" A Generalized Multilevel Inverter Topology with Self Voltage Balancing"*, IEEE Trans on Ind. Appl, Vol. **37**, No**. 2**, pp 611-618 Mar/April **2001**.

[7] J. Rodriguez, J.S. Lai, and Fang Z. Peng, *"Multilevel Inverters: A Survey of Topologies, Controls and Applications*", IEEE Trans on Industrial Electronics, Vol.**49**, No.B, pp724-738 Aug **2002**.

[8] L.M.Tolbert and T.G.Habetler, *"Novel MultiLevel Inverter Carrier Based PWM methods",* IEEE Trans on Ind. Appl, Vol.**35**, pp. 1098- 1107, Sept.**1999**.

[9] Leon M.Tolbert, Fang Zheng Peng, and Thomas G.Habetler, *"Multilevel PWM methods at Low modulation Indices",* IEEE Transactions on Power Electronics, Vol.**15**, No.**4**, July **2000**.

[10] N.S. Choi, J.G.Cho, and G.H.Cho, *"A general Circuit topology of multilevel inverter"*, in Proc. IEEE PESC'91, **1991**, pp.96-103.

