Comparison Of APOD And POD Control Techniques For A Cascaded H-Bridge Multi Level Inverter

K.Vijay Kumar[1]
I.Thulasiram[2]
Asst.Professor,EEE Department,M.L.E.C[1],
Asst.Professor,EEE Department,M.L.E.C[2],

Abstract

A multi level inverter is a power electronic device built to synthesize a desired Ac voltage from several levels of DC voltages .Multi level inverters have been an important development in recent years, owing to their capability to increase the voltage and power delivered to the motor with semi conductors which are available today. This paper presents a comparison of APOD and POD in both unipolar& bipolar multi carrier pulse width modulation techniques for the cascaded H-bridge multi level inverter. The effective results have been demonstrated by simulation results. The results indicate that the Cascaded(MLI) Triggered by the developed by the sinusoidal PWM strategy exhibits reduced THD. The THD analysis has been done for different Modulation indices

1 INTRODUCTION

Multilevel inverters have gained more attention in high power applications because it has got many advantages.It can realize high voltage and high power output by using semiconductor switches without the use of transformer and dynamicvoltage balance circuits. When the number of output levels increases, harrmonics of the output voltage and current as well as electro magnetic mnterference (EMI) decrease.

The basic concept of a multilevel inverter is, to achieve higher power by using a series of power semiconductor switches with several lower voltage dc sources,to perform the power conversion by synthesizing a staircase voltage waveform .To obtain a low distortion output voltage nearly sinusoidal,a triggering signal should be generated to control the switching frequency of each power semi conductor switch. In this paper the triggering signals of multi level inverter are designed by using the sinusoidal PWM scheme.In this paper a three phase cascade H-bridge multi level inverter has been taken to prove the simulation results for the APOD and POD control techniques.

The Fig1 shows a 3-phase 5-level cascaded multilevel inverter.It requires a total of 6-D.C voltage sources for each phase two D.C voltage sources arranged in a cascaded manner.

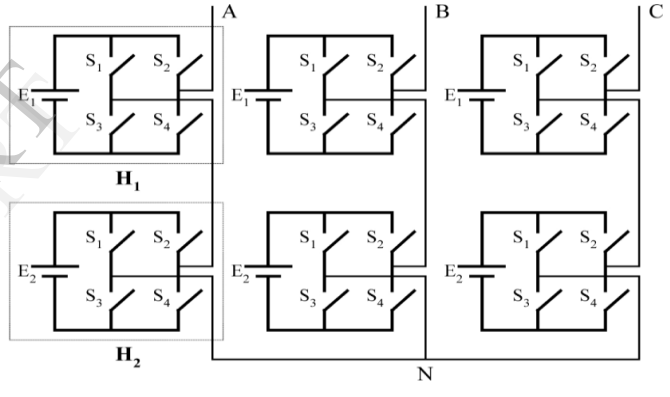
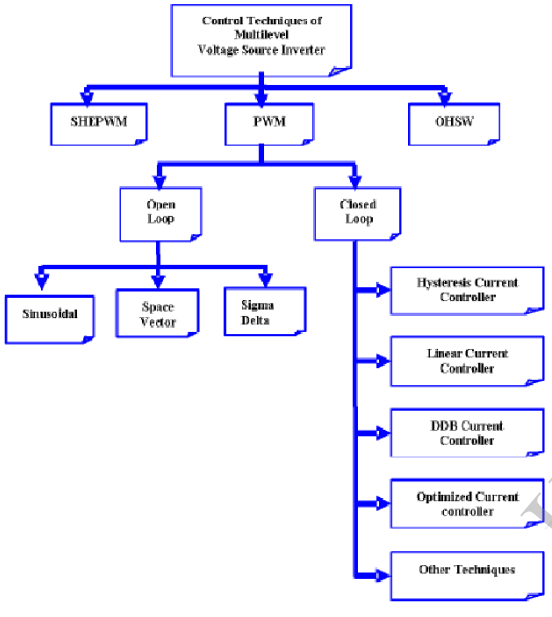


Fig.1 Conventional 3-phase 5-level Cascaded MLI

2. CONTROL TECHNIQUES FOR MULTI LEVEL INVERTER

There are different control techniques for a cascaded H-bridge MLI.In this PWM control technique is the most preferable one. Int his open loop and closed loop control techniques are there out of these open loop control technique has been chosen In this paper. In the open loop control techniques sinusoidal, space vector, sigma delta control techniques are most preferable. Out of these sinusoidal technique has been taken. In the sinusoidal PWM technique we are having the modulated signal and the carrier signal if the carrier signal is to be of single then it is called single carrier based pwm technique. if the carrier signal is to be of multiple in order then it is called multi carrier based PWM control technique. In the Modulating signal we have pure sinusoidal, third harmonic injection and dead

band signals are there out of these sinusoidal signals has been taken. In the carrier signal we have taken a multi carrier signal which is of Triangular in shape. here we have taken a 3-phase five level cascaded H-bridge MLI for this 5 level inverter the carrier signals are 4 in order. Out of these carrier signal generation APOD and POD control techniques has been taken .The THD analysis for the given APOD and POD control techniques in both Bipolar, unipolar mode of operation for different modulation indecies has been presented.



F

Fig. 2 Control techniques For a cascaded H-bridge MLI

3.SINUSOIDAL PWM

The multilevel sinusoidal PWM can be classified according to carrier and modulating signals as shown in Fig.3.

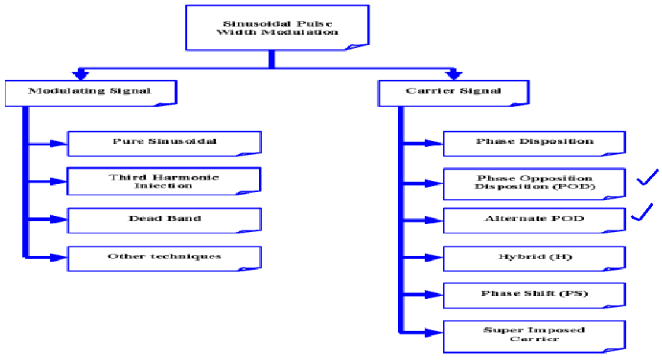


Fig 3. Classification of Sinusoidal PWM Multicarrier PWM Techniques

Multi carrier PWM techniques having the single modulating signal or reference wave form typically of sinusoidal waveform.The carrier signal is of triangular which is 4 in number.

1)**Alternative phase opposition Disposition(APOD**)

This technique requires each of the m-1 carrier waveforms, for an m-level phase waveform, to be phase disposed from each other by 180 degree alternatively as shown in fig4.Here for the desired control technique there are four carrier signals have been taken. In the upper half the two signals are 180 degrees out of phase each other and the same case will repeat for lower half also.

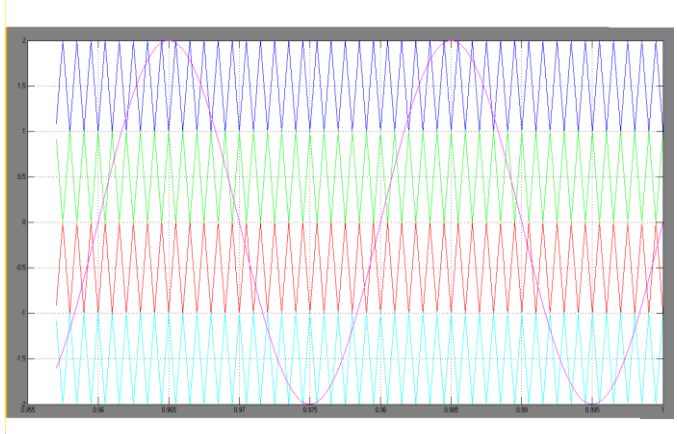


Fig4.APOD carrier technique for Bipolar Mode

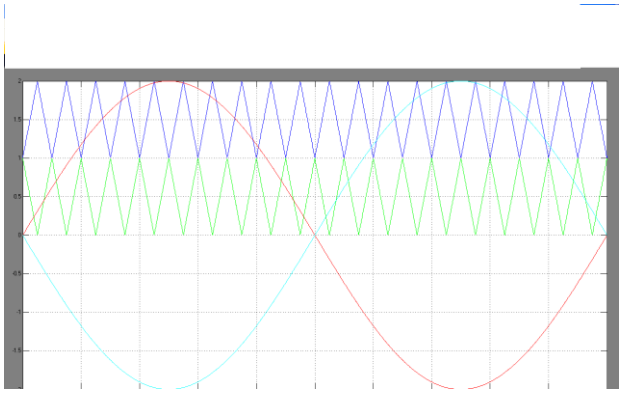


Fig.5.APOD carrier technique for unipolar mode

2) **Phase opposition Dispositions(POD)**

This technique requires each of the m-1 carrier waveforms, for an m-level phase waveform, to be phase disposed from each other by 180 degree as shown in fig5.here for the desired control technique there are four carrier signals have been taken. In the upper half the two signals they are in same phase and the lower half will be 180 degree out of phase with the upper half.

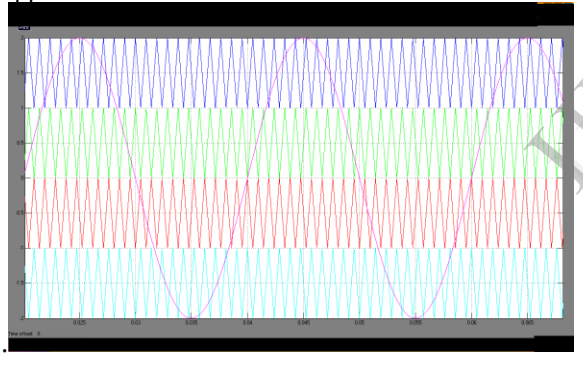


Fig.6.POD carrier technique for bipolar mode

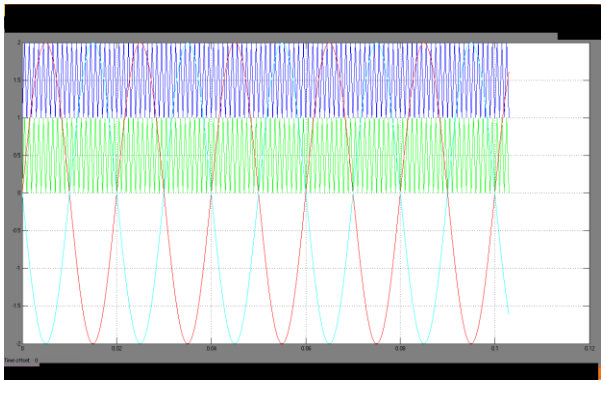


Fig.7.POD carrier technique for unipolar Mode

4. MATLAB / SIMULINK MODEL

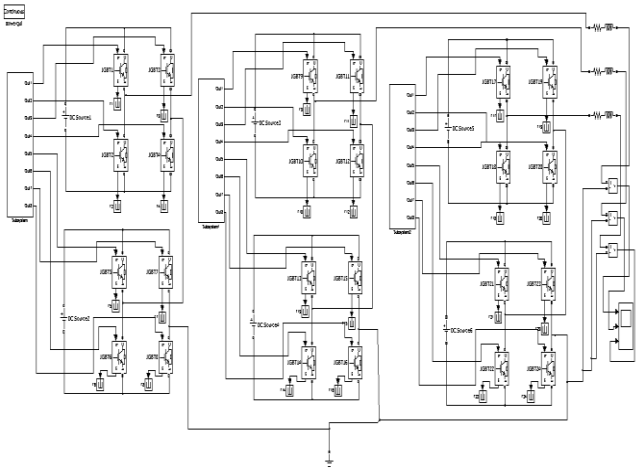
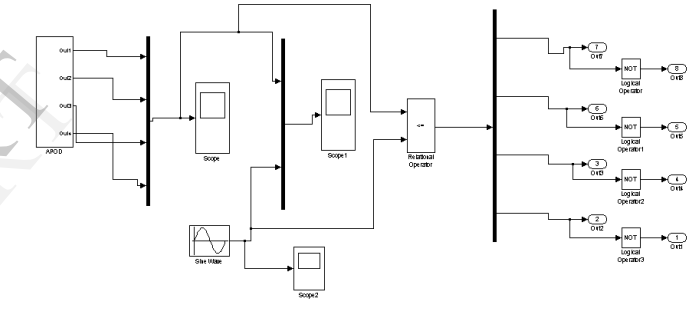


Fig.8.Simulation circuit for the 3-phase cascaded H-bridge MLI fed with R-L load



The Fig.9. shows the multi carrier sinusoidal PWM signal generation for the APOD and POD control technique in bipolar mode of operation.

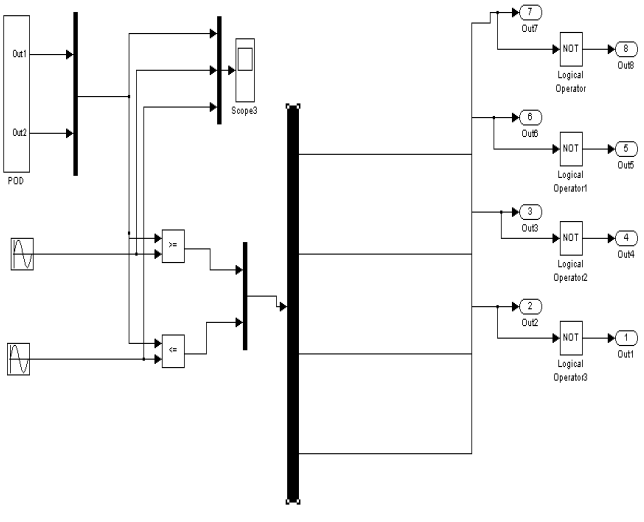


Fig.10.Simulink model for carrier signal generation for unipolar mode

5. SIMULATION RESULTS

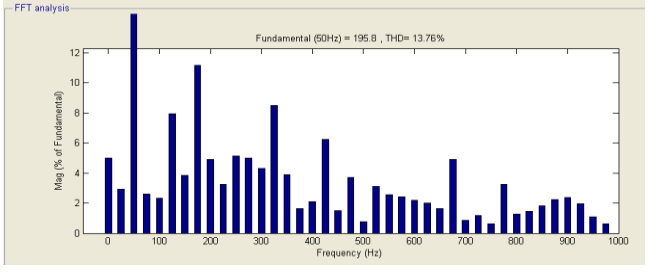


Fig.11 Modulation index 0.8 frequency spectrum for APOD technique in Bipolar mode

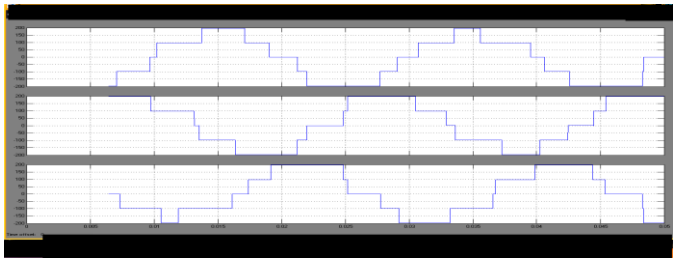


Fig.12 Modulation index 1.2 phase voltage spectrum for APOD technique in unipolar mode

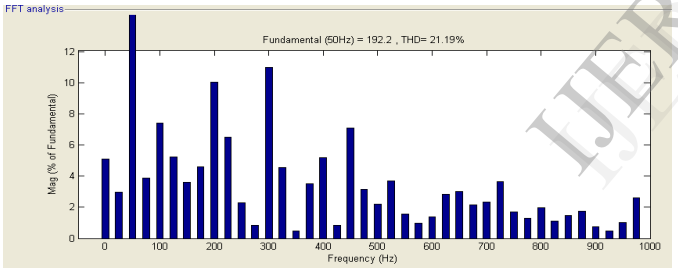


Fig.13 Modulation index 1.2 frequency spectrum for APOD technique in unipolar mode.

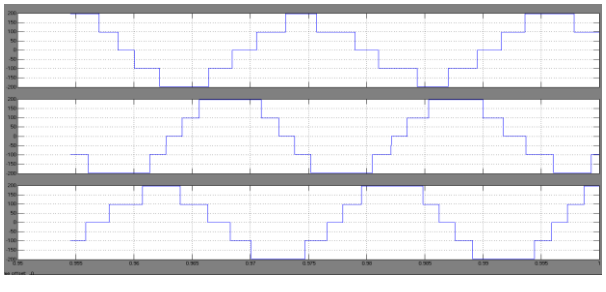


Fig.14 Modulation index 0.8 phase voltage spectrum for POD technique in Bipolar mode

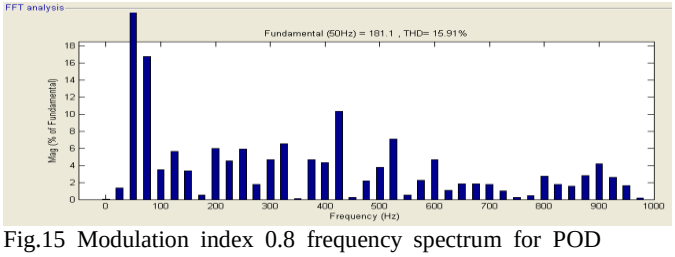


Fig.15 Modulation index 0.8 frequency spectrum for POD technique in Bipolar mode.

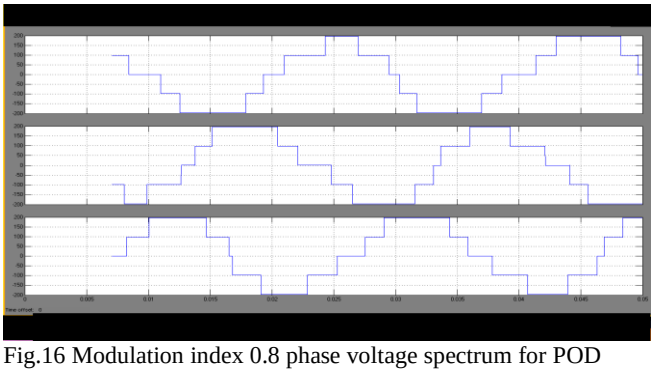


Fig.16 Modulation index 0.8 phase voltage spectrum for POD technique in Unipolar mode

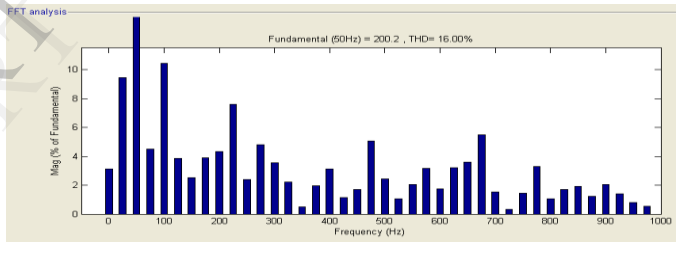


Fig.17 Modulation index 0.8 frequency spectrum for POD technique in unipolar mode.

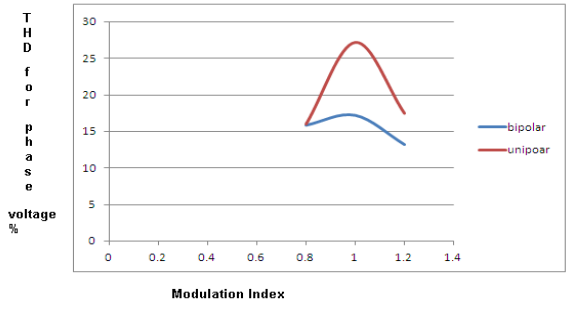


Fig.18.M.I.Vs T.H.D graph for POD control technique

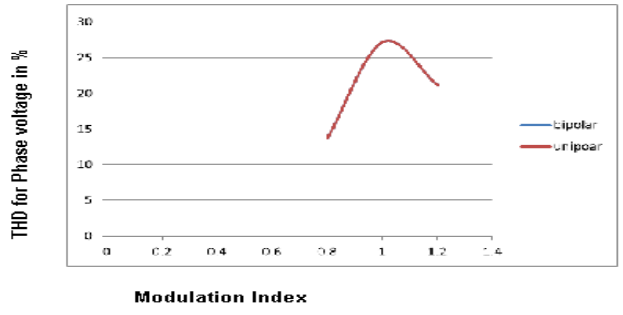


Fig.19.M.I.Vs T.H.D graph for APOD control technique

Table1.THD Values for APOD Control technique for different M.I

Modulation index	APOD(bipolar)	APOD(unipolar)
0.4	14.71	14.71
0.8	13.76	13.76
1.0	27.23	27.23
1.2	21.19	21.19

Table2:THD Values for POD Control technique for different M.I

Modulation index	POD(bipolar)	POD(unipolar)
0.4	14.71	14.71
0.8	15.91	16
1.0	17.30	27.23
1.2	13.21	17.49

5. CONCLUSION

In this paper the simulation of 3-phase 5-level cascaded Multi level inverter has been simulated by using the APOD & POD control techniques.The THD analysis has been done for different Modulation indices.From the THD analysis we can say that the THD for POD techniques less when compared with APOD technique. For 0 to 1 modulation indecies the THD is increasing and then after THD is decreasing for both the techniques.so finally from the above analysis we can conclude that POD is going to be the better technique when compared with APOD.

References

1.SERBIAN JOURNAL OF ELECTRICAL ENGINEERING Vol. 4, No. 2, November 2007, 171-187 171 Inverted Sine Carrier for Fundamental Fortification in PWM Inverters and FPGA Based Implementations S. Jeevananthan1, R. Nandhakumar1, P. Dananjayan1.

2. International Journal of Engineering Studies ISSN 0975- 6469 Volume 1, Number 2 (2009), pp. 71–82Multicarrier Pulse Width Modulation Based Three Phase Cascaded Mulitilevel Inverter Including Over Modulation and Low Modulation Indices 1P. Palanivel and 2Subhransu Sekhar Dash.

3. IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 23, NO. 1, JANUARY 2008 MulticarrierPWMWith DC-Link Ripple Feedforward Compensation for Multilevel Inverters Samir Kouro, *Student Member, IEEE*, Pablo Lezana, *Member, IEEE*, Mauricio Angulo, and José Rodríguez, *Senior Member, IEEE*

4.J. Rodríguez, B. Wu, S. Bernet, J. Pontt, and S. Kouro, "Multilevel voltage-source-converter topologies for industrial medium-voltage drives," *IEEE Trans. Ind. Electron.*, vol. 54, no. 6, pp. 2930–2945, Dec. 2007.

5. A. K. Gupta and A. M. Khambadkone, "A general space vector PWM algorithm for multilevel inverters, including operation in overmodulation range," *IEEE Trans. Power Electron.*, vol. 22, no. 2, pp. 517–526, Mar. 2007.

6. International Journal of Recent Trends in Engineering, Vol 1, No. 3, May 2009 129 Optimized Hybrid Phase Disposition PWM Control Method for Multilevel Inverter by C.Govindaraju1 and Dr.K.Baskaran.

7. B.S.Jin, W.K.Lee, T.J.Kim, D.W.Kang, and D.S.Hyun, " A Study on the multicarrier PWM methods for voltage balancing of flying capacitor in the flying capacitor multilevel inverter, " in proc.IEEE Ind. Electron.Conf.Nov.2005, pp.721-726.

8.international conference on "control, automation, communication and energy conservation -2009, 4th-6th June 2009 "Comparative Study on Unipolar Multicarrier PWM Strategies for Five Level Flying Capacitor Inverter" B. Shanthi and S.P. Natarajan