Harmonic Analysis of Five Level Inverter

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Abstract: **Multilevel Inverter technology has emerged recently as a very important alternative in the area of high power, high voltage energy control. It came into picture and it has gained more attention in market for various applications like renewable energy systems, industrial motor drives, etc. It can generate stepped waveform by reducing harmonic distortion with increase in the number of voltage level. The main advantages of this multilevel inverter are that it generates very less harmonics. In this paper, one carrier based PWM technique is proposed i.e. level shifted scheme which can minimize the total harmonic distortion and enhances the output voltage. Level Shifted [LS] Scheme is applied to the Cascade H-bridge multilevel inverter and the complete analysis of THD to five levels is done.**

Index Terms: **%THD, CHB multilevel inverter, carrier-based PWM scheme, MATLAB/Simulink software.**

INTRODUCTION

The tremendous increase in energy demand led to call of high power converter technology to transmit the power with high accuracy. When dealing with high voltages, conventional inverters produce output voltages of low quality and high harmonic content which affects the equipment performance. So new power converter topologies were invented known as multilevel inverters and gained importance in industry applications because of high power ratings and better harmonic performance suitable for medium and high power applications. The output voltage of multilevel inverters is in form of stepped waveforms and obtained easily without use of transformers which decreases the cost of inverter. Improved quality of waveforms can be obtained by increasing number of steps in the output waveforms and the harmonic content also comes down. Multilevel Inverters are classified into three topologies namely diode clamped, flying capacitor and cascaded type inverters. PWM is a technique in which width of gate pulses are controlled and used for various applications. Different types of pwm technique are proposed for multilevel inverters like sinusoidal pulse width modulation, selective harmonic elimination and space vector modulation. SPWM is considered as the best technique among other PWM methods because of various reasons like high power handling capacity, no temperature variation, easy to implement and control. Here SPWM is used for modelling of three level and five level cascaded H-bridge inverter. The design and modelling of three levels and five levels CHB is done in MATLAB/SIMULINK. In this proposed concept uses the IGBT semiconductor switches.

CASCADEMLIFEDINDUCTION MOTOR –

Three phase IM requires 3 phase ac supply in an attempt of limiting starter current and is powered using simplified cascaded MLI. It requires dc-inputs and transform it to alternating output wave with the triggering role of power-electronic switches. Mostly IGBTs occupy dominant choice compared to rest switches. For five level CHBMLI, five steps contribute to the output wave-shape. With Vdcas inputs, then the outputs take levels, +2Vdc, +V dc, 0, -Vdc, -2Vdc.

In brief, the MLI output levels, m= (2*i) + 1, where i = dc inputs. PWM leads the vital role in circuit action by firing the respective switches (IGBTs) at the exact instants to output the proper reaction. Various techniques exist and few are; Space vector, selective harmonic-elimination involving complex computations, Carrier PWMs etc. One adopts Carrier-based PWM (CB-PWM), if compactness is targeted. For m-leveled MLI, carriers must be (m-1). The different CB-PWMs are Phase disposition, Phase Opposition Disposition, and

Alternate Phase Opposition Disposition.

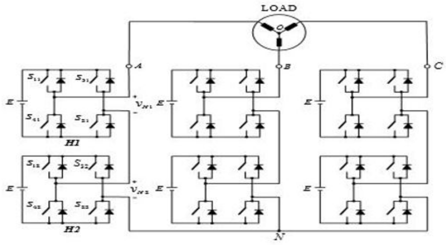

Fig. 1. Five level cascaded MLI

Harmonic Reduction Technique:

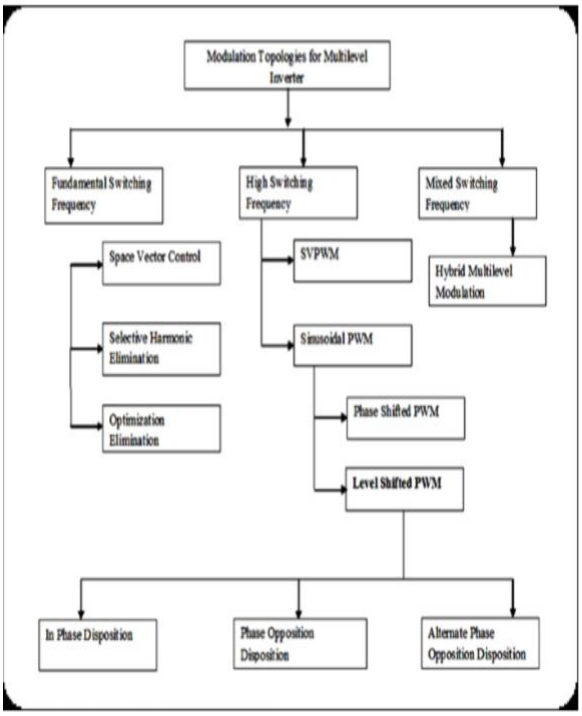

Fig.2.

The carrier-based modulation schemes for multilevel inverters can be generally classified into two categories: phase-shifted and level-shifted modulations. Both modulation schemes can be applied to the cascaded H-bridge inverters. Total harmonics distortion of phaseshifted modulation is much higher than level shifted modulation. Therefore, we have considered level-shifted modulation. An m-level multilevel inverter using levelshifted multicarrier modulation scheme requires (m-1) triangular carriers, all having the same frequency and amplitude. The (m-1) triangular carriers are vertically disposed such that the bands they occupy are contiguous. The frequency modulation index is given by mf = fcr/fm, which remains the same as that for the phase-shifted modulation scheme whereas the amplitude modulation index is defined as

$$m_a = \frac{\hat{V}_m}{\hat{V}_{cr}(m-1)} \qquad \text{for } 0 \le m_a \le 1$$

where $\widehat{V_m}$ is the peak amplitude of the modulating wave vm and ˆVcr is the peak amplitude of each carrier wave. The Level shifted pulse width modulation have three types named as In-phase Disposition (IPD), Phase opposition disposition (POD) and Alternate phase opposition disposition (APOD).

(a) in-phase disposition (IPD), where all carriers are in phase.

(b) alternative phase opposite disposition (APOD), where all carriers are alternatively in opposite disposition.

(c) phase opposite disposition (POD), where all carriers above the zero reference are in phase but in opposition with those below the zero reference.

SIMULATION AND RESULTS:

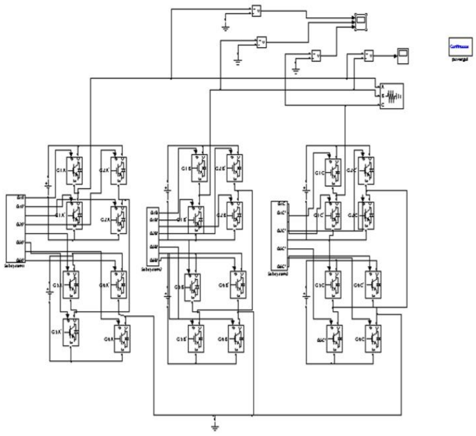

fig.3.

Simulation circuit diagram of 3 phase five level CHB inverter

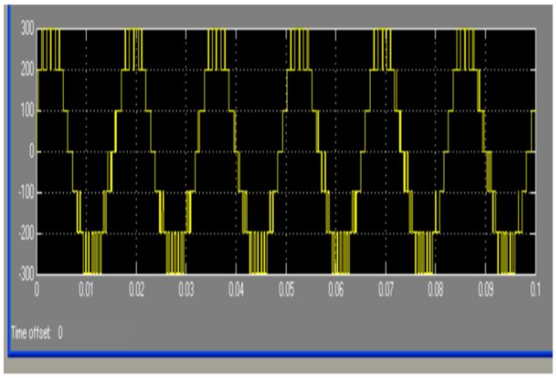

Fig -4: Showing the output voltage of 5level CHB inverter.

PWM Technique	No. of levels	% THD
IPD	5 Level	19.20 %
APOD	5 Level	28.50 %
POD	5 Level	33.43 %

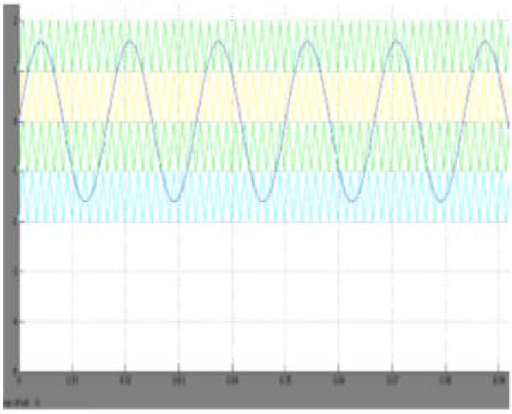

Fig-5: Showing Simulation result of IPD PWM scheme for 5level CHB inverter

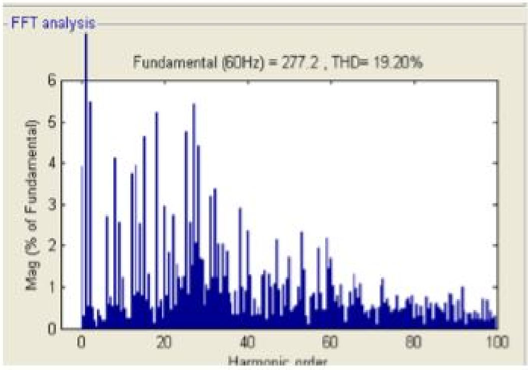

Fig- 6 : Showing THD Analysis of IPD for 5level CHB inverter

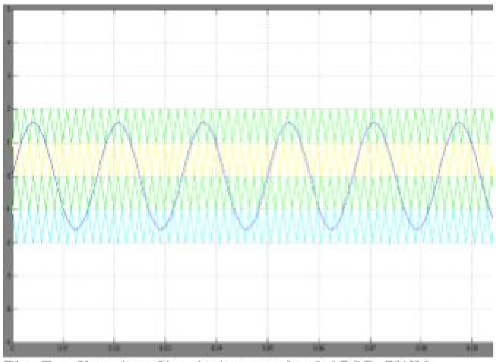

Fig -7 : Showing Simulation result of APOD PWM scheme for 5level CHB inverter

CONCLUSION

Multilevel inverter are very suitable for PV generation .H bridge cell with PWM control is very promising solution not only for having medium and high voltage but for improving the quality of the voltage i.e. reduction of THD. In this paper we discuss the CHB inverter topology using IPD, APOD and POD. Further it is observed that IPD is better and yield less THD as compare to APOD and POD in 5 level inverter.

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