Design And Performance Analysis of a Five Level Asymmentric Cascade H Bridge Inverter

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Abstract- **Power electronic converters, especially DC/AC Sinusoidal Pulse Width Modulation inverters have been extending their range of use in industry because of their numerous advantages. They typically synthesize the stair –case voltage waveform (from several dc sources) which has reduced harmonic content. This paper aims to extend the knowledge about the performance of Five level Cascaded H-Bridge MLI topology with DC/DC Boost Converter using SPWM for fixed DC Source. The output voltage is the sum of the voltage that is generated by each bridge. The switching angles can be chosen in such a way that the total harmonic distortion is minimized. This topology incorporates Boost Converter in the input side which magnifies the fundamental output voltage with reduction in total harmonic distortion. It also incorporates LC filter and hence output is drawn near the sine wave because of more levels. Results of experiments proved efficiency of 95%.The performance of the proposed SPWM strategy in terms of output voltage and THD has studied successfully and shown using MATLAB / Simulink.**

Keywords-DC/DC Boost converter,H-bridge Inverter,LC filter,SPVM,R Load.

I.INTRODUCTION

Multilevel converters are now well-established and standard solution for medium and high-voltage, high power applications and power-quality demanding solutions. The advantages of multilevel converters over two-level converters are higher voltage operating capability with medium voltage semiconductor devices, improved output voltages with less harmonic distortion, lower common-mode voltages, less dv/dt stress, near sinusoidal input currents, smaller input and output filters, increased efficiency due to possibility of low switching operation, reduced electromagnetic interference problems and possible fault-tolerant operation. In high-power applications, the switching losses contribute to major portion of total device

In addition, modularized circuit layout and packaging is also possible with CHB topology because each level has similar structure. However, one major drawback of this topology is requirement of multiple numbers of dc- sources, which is not feasible in many applications.[1] One of the method for reducing the number of dc sources is to replace H-Bridge cell with NPC or FC converters. However, an important issue with the topologies having NPC or FC converters is voltage unbalance of dc-link capacitors that further adds to harmonic distortion of output voltage waveforms. An auxiliary capacitor-based balancing approach has been proposed to equalize the dc-link capacitor voltages for NPC five-level converter.

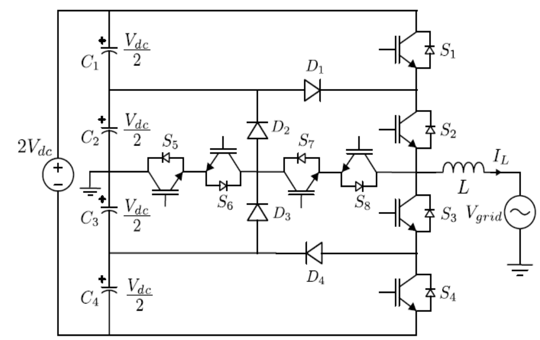

Fig 1. Neutral point clamped inverter

Several low switching frequency modulation techniques have been proposed for high-power applications. A new modulation method for modular multilevel converter operating at fundamental switching frequency while successfully eliminating fifth harmonic was proposed .

II.PROPOSED 5-LEVEL CASCADED H-BRIDGE MULTILEVEL INVERTER

The cascaded multilevel inverter using a reduced number of switches .The proposed topology result in reduction of installation area and converter cost has simplicity of control system. It is especially suitable for utility interfacing of renewable energy sources. The modularized structure allows easy packaging and storage and quantity of possible voltage levels is more than DC and FC type. It can be implemented as an effective and efficient power electronic interface source of energy with utility grid.

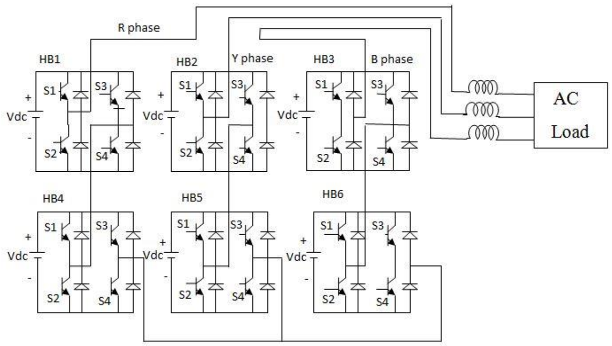

Fig 2.Circuit diagram for cascade H-bridge inverter

Multilevel inverters generate sinusoidal voltages from discrete voltage levels, and pulse width modulation (PWM) strategies accomplish this task of generating sinusoids of variable voltage and frequency. Modulation methods for Hybrid Multilevel Inverter can be classified according to the switching frequency methods. Many different PWM methods have been developed to achieve the following: Wide linear modulation range, less switching loss, reduced Total Harmonic Distortion (THD) in the spectrum of switching waveform: and easy implementation and less computation time. Multilevel inverters generate sinusoidal voltages from discrete voltage levels, and pulse width modulation (PWM) strategies accomplish this task of generating sinusoids of variable voltage and frequency. Modulation methods for Hybrid Multilevel Inverter can be classified according to the switching frequency methods. Wide linear modulation range, less switching loss, reduced Total Harmonic Distortion (THD) in the spectrum of switching waveform: and easy implementation and less computation time. The most widely used techniques for implementing the pulse with modulation (PWM) strategy for multilevel inverters are Sinusoidal PWM (SPWM) and space vector PWM (SPWM).

III.SPACE VECTOR PULSE WIDTH MODULATION TECHNIQUE

Space vector modulation (**SVM**) is an algorithm for the control of pulse width modulation. It is used for the creation of alternating current (AC) waveforms; most commonly to drive 3 phase AC powered motors at varying speeds from DC using multiple class-D amplifiers. There are variations of SVM that result in different quality and computational requirements. One active area of development is in the reduction of total harmonic distortion (THD) created by the rapid switching inherent to these algorithms.

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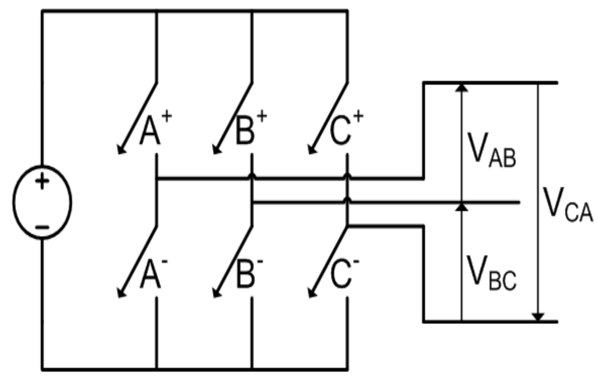

Fig 3. Topology of a basic three phase inverter

The switches must be controlled so that at no time are both switches in the same leg turned on or else the DC supply would be shorted. This requirement may be met by the complementary operation of the switches within a leg. i.e. if A^+ is on then A^- is off and vice versa. This leads to eight possible switching vectors for the inverter, V_0 through V_7 with six active switching vectors and two zero vectors.

To implement space vector modulation, a reference signal V_{ref} is sampled with a frequency f_s ($T_s = 1/f_s$). The reference signal may be generated from three separate phase references using the transform. The reference vector is then synthesized using a combination of the two adjacent active switching vectors and one or both of the zero vectors. Various strategies of selecting the order of the vectors and which zero vector(s) to use exist. Strategy selection will affect the harmonic content and the switching losses.

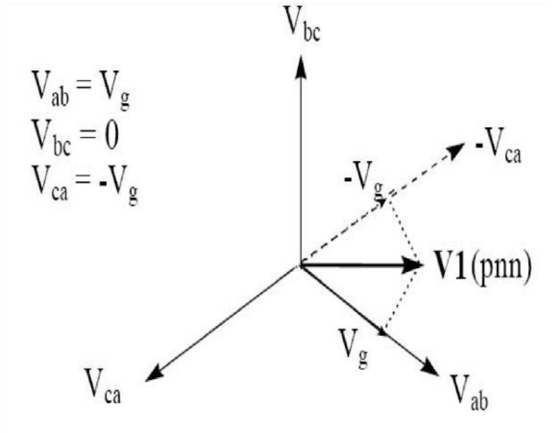

Fig 4. Space vector modulation diagram

Space vector (SVM)for three –leg VSI is based on the representation of the three phase quantities as vectors in a two-dimensional plane.

Vab= +Vdc,

Vbc=0 ,

Vca=-Vdc,

This can be represented in the plane .The voltages Vab,Vbc,Vca are three line voltage vectors displaced in 120 in space.

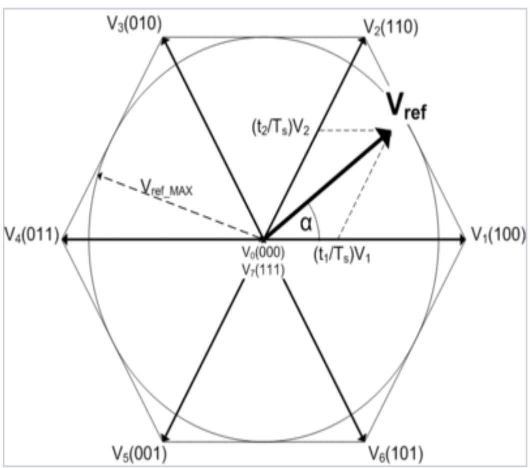

Fig 5. switching of space vector modulation technique

All eight possible switching vectors for a three-leg inverter using space vector modulation. An example V_{ref} is shown in the first sector. V_{ref_MAX} is the maximum amplitude of V_{ref} before non-linear over modulation is reached

Vector	A^+	B^+	C^+	A^-	B^-	C^-	V_{AB}	V_{BC}	V_{CA}	
V_0 = {000}	OFF	OFF	OFF	ON	ON	ON	0	0	0	zero vector
V_1 = {100}	ON	OFF	OFF	OFF	ON	ON	$+V_{dc}$	0	$-V_{dc}$	active vector
V_2 = {110}	ON	ON	OFF	OFF	OFF	ON	0	$+V_{dc}$	$-V_{dc}$	active vector
V_3 = {010}	OFF	ON	OFF	ON	OFF	ON	$-V_{dc}$	$+V_{dc}$	0	active vector
V_4 = {011}	OFF	ON	ON	ON	OFF	OFF	$-V_{dc}$	0	$+V_{dc}$	active vector
V_5 = {001}	OFF	OFF	ON	ON	ON	OFF	0	$-V_{dc}$	$+V_{dc}$	active vector
V_6 = {101}	ON	OFF	ON	OFF	ON	OFF	$+V_{dc}$	$-V_{dc}$	0	active vector
V_7 = {111}	ON	ON	ON	OFF	OFF	OFF	0	0	0	zero vector

Fig 6 .Table for switching time calculation

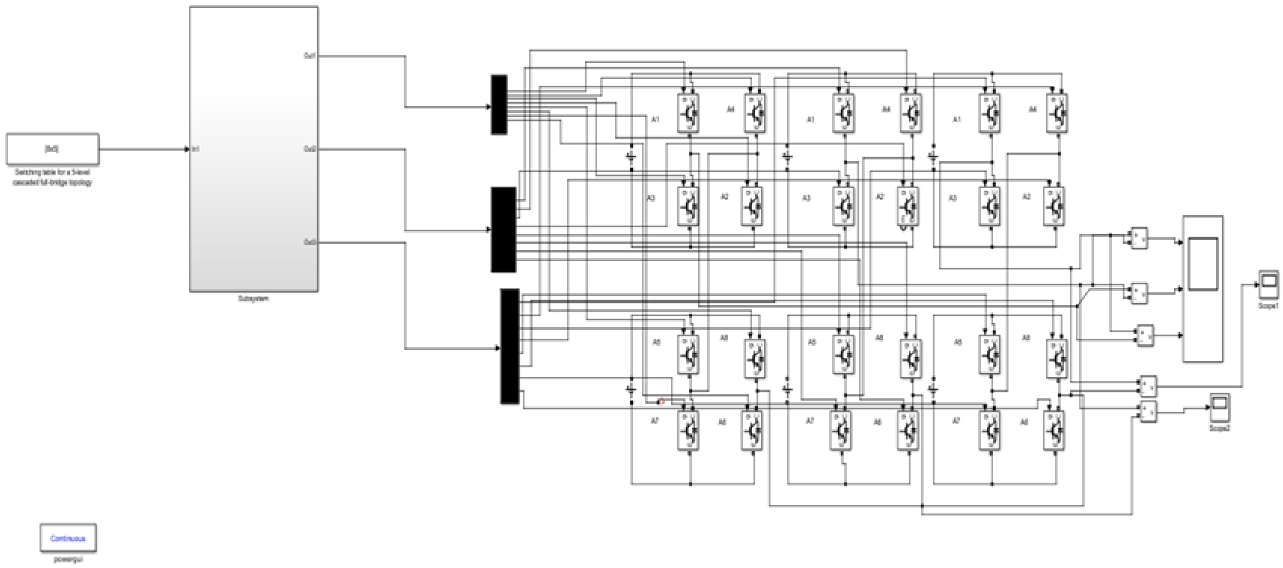

Fig 7 simulation circuit of cascaded multilevel inverter with space vector modulation technique

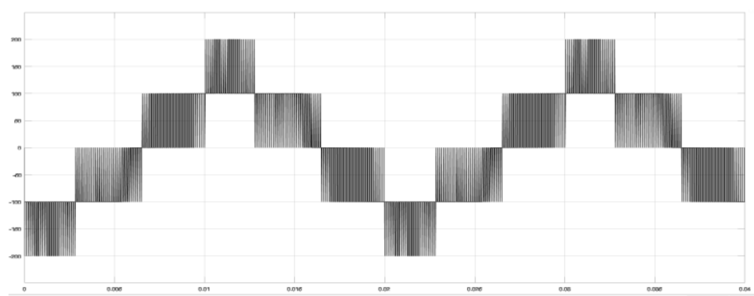

Fig 8 simulation results for 5L-CASCADED H-BRIDGE INVERTER

CONCLUSION

The proposed inverter is capable of exchanging reactive power with the grid. Therefore, with excellent performance in reduces the performance indexes, improves multilevel output voltage and high efficiency, the proposed inverter provides an exciting alternative to the conventional transformer less grid-connected PV inverters. Moreover, due to its superiority over the 5L-DCMLI in terms of efficiency and cost parameters, the pertinence of the proposed inverter is not limited to grid connected PV inverters and it can find its way for all the applications where currently 5L-DCMLI are employed.

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