Five Level Cascaded H-Bridge Multilevel Inverter using Pulse Width Modulation, In-Phase and Alternate Phase Opposition Deposition Techniques

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***Abstract*- Multilevel Power Inverter are often used to convert DC to AC voltages. This kind of converter allows high power quality with low output harmonics and lower commutation losses with respect to the traditional ones. In order to optimize this aspect, This paper presents a novel simulation analysis Multicarrier Sinusoidal Pulse Width Modulation (MC SPWM) techniques. B-Spline function is based to control the switches of Five-Level single phase cascaded H-bridge inverter. To verify the performance of the converter, the harmonic content of the voltage due to modulation techniques has been taken into account. The results highlight the comparison between different B-Spine functions.**

***Index Term*- Multilevel power converter , Multicarrier modulation techniques, B-Spline function.**

I. INTRODUCTION

Multilevel Power Inverter(MPI) represent a valid alternative in spite of converter". The use of MPIs is now very widespread in that applications with medium voltage and high power.

[1] because for medium and high voltage power applications, power semiconductor switches present operativelimits. Moreover, these types of converters are widely used to interface with the electrical grids the renewable energy systems like PV systems, wind farms, Fuel Cell based systems [2] and are also used in electrical drive systems [3-14].One of the main advantages of this kind of converters is the low harmonic content in output voltage waveforms. In literature, the harmonic content reduction in output voltage and current waveforms of the converters have been largely discussed in the last years. In fact, in order to minimize the harmonic content in voltage and current waveforms have been developed different modulation techniques like that ones reported in [15-16]. Many modulation techniques, i.e. the pulse width modulation based ones, uses triangular waveform as carrier signals. In some studies, have been developed new modulation techniques in which the carrier signals are changed [17-20]. In particular, the use of carrier signals with different harmonic content, respect triangle waveform, allows to change the harmonic content in the output voltage waveform of the converter.

The purpose of this paper is to present a simulation analysis of performance if the multicarrier sinusoidal pulse width modulation with periodic B-Spline functions based for a single-phase, five-level cascaded H-bridge inverter. The converter's structure topology and the main multicarrier modulation techniques are described below .. Through the convolution process have been obtained by the B-Spline. The simulation analysis described in Section IV has been developed in a Mat lab/Simulink environment and the results have been compared among the different modulation techniques. . The computed Total Harmonic Distortion percentage values is the parameters of comparison study among the different modulation techniques, based on B-Splin$_s$ functions

II. SYSTEM OVERVIEW

1.CASCADEDE H-BRIDGE MULTILEVEL INVERTER

In a five level cascaded H-bridge multilevel inverter The inverter consist of two H-bridge with series connection and each H-bridge having separate dc source. Which is fed by self-sufficient dc voltage source. In this figure two H-bridge consist of 8-MOSFET switches each H-bridge having 4-MOSFET switches. This two H-bridge switches are worked as two H-bridge series connection. So, first H- bridge switches are S1, S4 and second H-bridge switches are S1', S4' open at time S2, S3 same as second bridge S2', S3' are off. So output will be wave form of staircase. If number of level increase the number of dc source increases. It will be effect on cost of dc source and switches with complexity of inverter design circuit. This is disadvantages. The multilevel inverter are used where the demand of high power and power quality are essential, for example UPS, photo voltaic power conversion and hybrid power trains. Fig3 show the methodology of 5-level inverter analysis in matlab. First we have taken modulation index that is indicates of the ratio of peak magnitude of the modulation waveform and carrier waveform. It is relates the inverter dc-link voltage output of inverter. The modulation signal and magnitude of triangular signal vary between the peak magnitude and lower magnitude. The ratio of peak magnitude of modulation wave and the carrier wave is define as modulation index. Then comes to comparison of sine and triangular wave. In this comparison sine wave is fixed and four triangular wave vary by the modulation index. It will be given wave form of pulses. Then comes to PWM (pulse with modulation) generation .That is indicates comparison of sine and triangular wave form and it gave wave form of pulses that is given to switches. After then comes to FFT analysis.

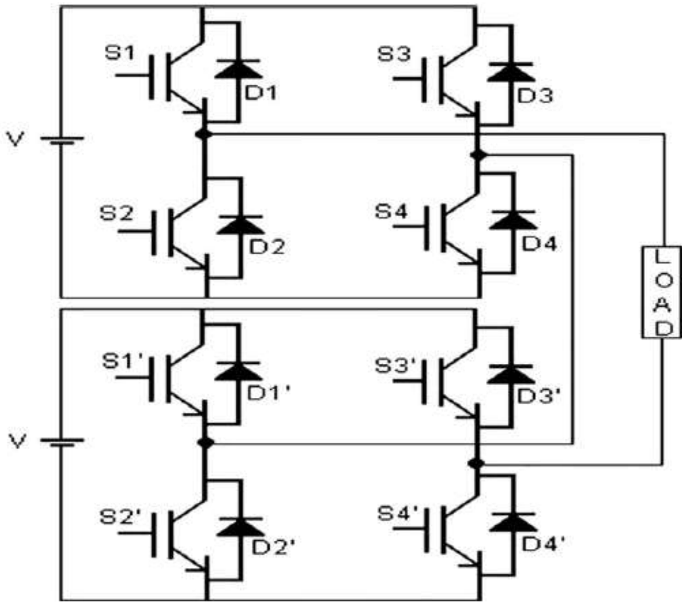

Fig 1. Five level cascaded H-bridge multilevel inverter.

2.SINUSOIDAL PULSE WIDTH MODULATION

In sinusoidal PWM instead of maintaining the width of all pulses the same as in the case of multiple PWM, the width of each is varied in proportion to the amplitude of a sine wave evaluated at the same pulse. The distortion is reduced significantly compared to multiple PWM .A high frequency triangular wave, called the carrier wave, is compared to a sinusoidal signal representing the desired output, called the reference wave. Usually, ordinary signal generators produce these signals. Whenever the carrier wave is less than the reference, a comparator produces a high output signal, which turns the upper transistor in one leg of the inverter on the lower switch off. In the other case the comparator sets the firing signal low, which turns the lower switch ON and upper switch OFF. The number of pulses per half cycle depends on the carrier frequency. Within the constraint that two transistors of the same arm cannot conduct at same time, the instantaneous output voltage is shown in Figure the same gating signals can be generated by using unidirectional triangular carrier wave as in Figure this method is preferable and easier to implement. The output voltage can be varied by varying the modulation index 'm'. The area of each pulse corresponds approximately to the area under the sine wave between the adjacent mid points of off-periods on the gating signals

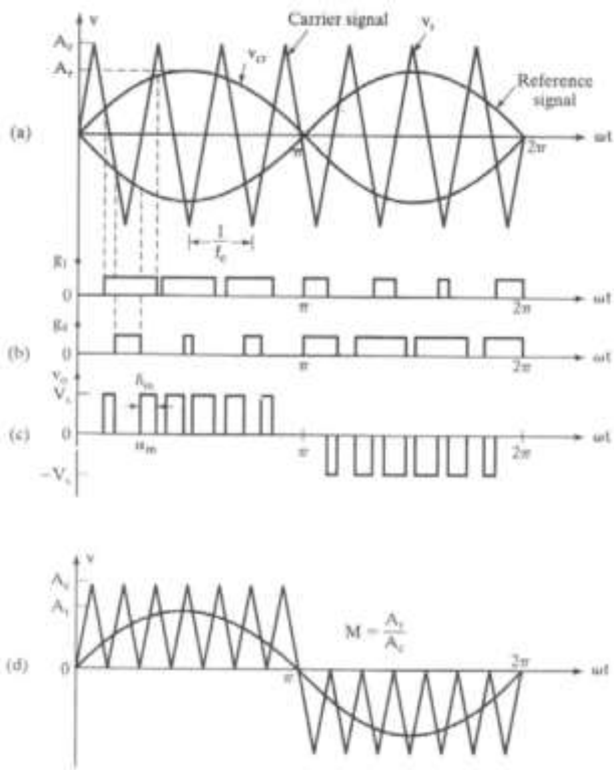

Fig 2. Sinusoidal pulse width modulation

The SPWM, which is most commonly used, suffers from certain drawbacks like low fundamental output voltage. The other techniques offer improved performances are

1.Trapezoidal modulation
2.Staircase modulation
3.Stepped modulation
4.Third harmonic injected modulation

III. SPACE VECTOR PULSE WIDTH MODULATION (SVPWM):

SVPWM is a digital modulating technique where the objective is to generate, PWM load line voltages that are in average equal to a given reference load line voltages. With PWMs, the inverter can be thought of as three separate push pull driver stages, which create each phase waveform independently. SVM treats the inverter as a single unit; specially, the inverter can be driven in to eight unique states .Modulation is accomplished by switching the state of the inverter. SVM can be implemented by properly selecting the switch states of the inverter and the calculation of the appropriate time period for each state in each sampling period

IV. PRINCIPLE OF VOLTAGE SHIFTED MODULATION

Voltage shifted modulation is way based on the carrier modulation. If the DC side capacitor voltage is equal to four, the carrier number is m-1 when five level diode clamped inverter level number is m. all of these carriers have the same frequency and the same amplitude. This (m-1) a triangular carrier in the space is distributed vertically, and the occupied area is continuous, with each other closely connected, symmetrically distributed on the horizontal axis on both sides, and then with a sinusoidal modulation wave are compared, to generate a trigger pulse. Voltage shifted modulation mode have three kinds of pattern:

(a)with phase array (In-phase Disposition, IPD);
(b)anti-phase arrangement (Phase Opposition Disposition, POD);
(c)Alternately reverse phase array (Alternative Phase Opposition Disposition, APOD).

V. MULTICARRIER PWM TECHNIQUES

Multicarrier PWM techniques entail the natural sampling of a single modulating or reference waveform typically being sinusoidal same as that of output frequency of the inversion system, through several carrier signals typically being triangular waveforms of higher frequencies of several kilo Hertz discussed by McGrath et al (2002) and Samir Kouroetal (2008). They can be categorized as follows

5.1 IN- PHASE DIPOSITION (IPD)

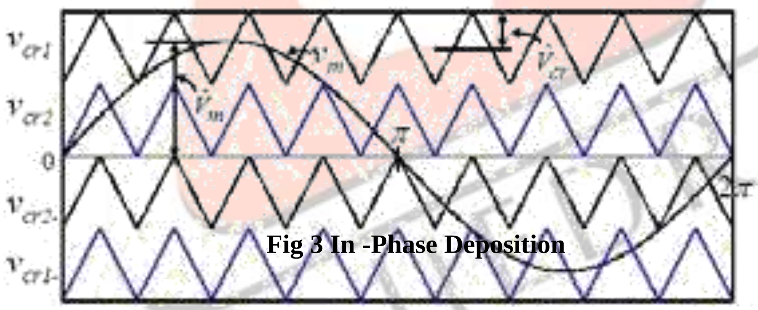

Fig 3 In -Phase Deposition

5.2 PHASE OPPOSITION DISPOSITION (POD)

The carrier waveforms are all in phase above and below the zero reference value however, there is 180^0 phase shift between the ones above and below zero respectively as shown in Figure 4. The significant harmonics, once again, are located around the carrier frequency fc for both the phase and line voltage waveforms. The three disposition PWM techniques that are Alternate Phase Opposition Disposition(APOD), Phase Apposition Disposition and(POD) and In-Phase Disposition (IPD)generate similar phase and line voltage waveforms. Furthermore, for all of them, the decision signals have average frequency much lower than the carrier frequency.

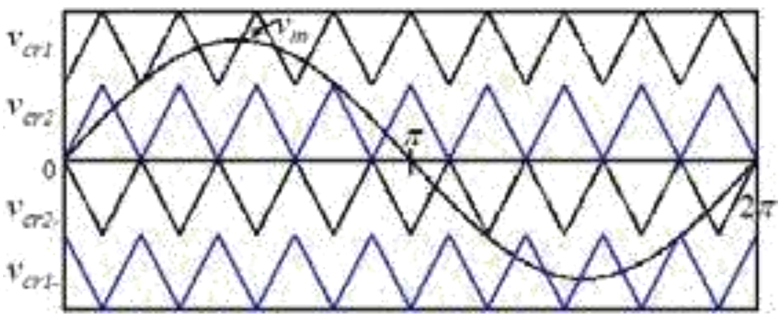

Fig. 4 Phase Opposition Disposition

5.3 ALTERNATE PHASE OPPOSITION DISPOSITION(APOD)

This technique requires each of the (m – 1) carrier waveforms, for an m-level phase waveform, to be phase displaced from each other by 180^0 alternately as shown in Figure 5.. The most significant harmonics are centred as sidebands around the carrier frequency fc and therefore no harmonics occur at fc

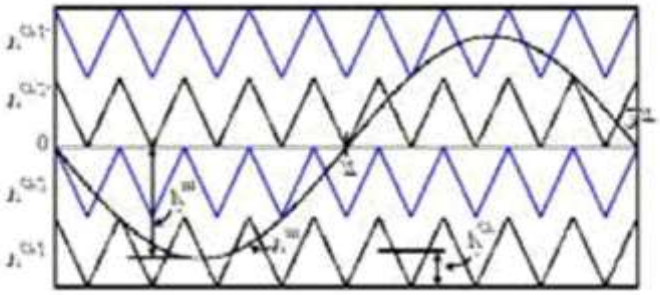

Fig. 5. Alternate Phase Opposition Disposition.

VI. ADVANTAGE OF PULSE WIDTH MODULATION TECHNIQUES

1.Using Pulse Width Modulation techniques lower order harmonics can be eliminated or minimized along with its output voltage control. The filtering requirements are also minimized..Both the output voltage and frequency control is possible in a single power stage of the inverter without any additional components.
2.The presence of constant DC supply permits the parallel operation of several independent Pulse Width Modulation inverters on the same rectifier power supply.
3.Pulse Width Modulation inverter has a transient response which is much better than that of quasi-square wave rectifier.
4.The commutative ability of Pulse Width Modulation inverters remain substantially constant compared to variable dc link inverter, irrespective of the voltage and frequency settings.
5.The power factor of the system is good, as a diode rectifier can be employed on the line side.

VII. SIMULATION RESULT

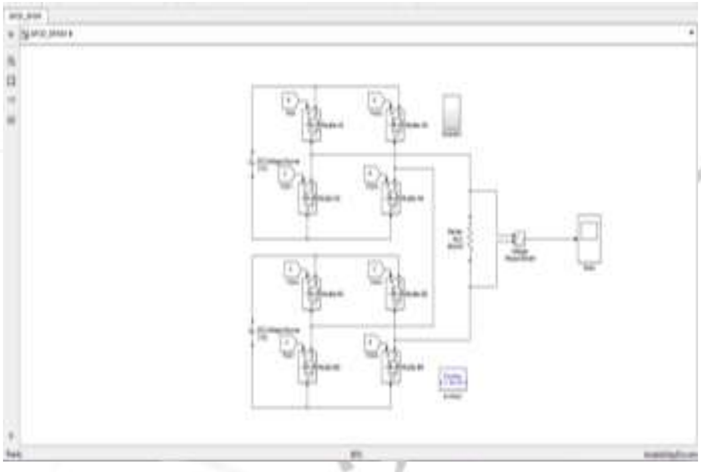

Fig 6.Simulation Model

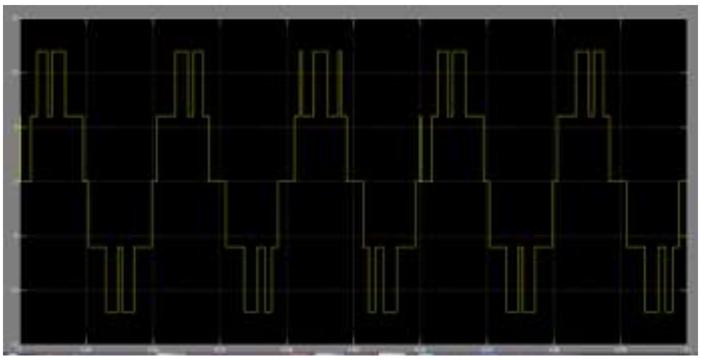

Fig 7.Simulation Result of Single phase 5-level inverter

VIII. C0NCLUSION

This paper deals with the design and implementation of single-phase five-level inverter for a resistive and inductive charge. To generate a 5-level output voltage, the proposed multilevel inverter requires a single dc voltage source. The PWM control technique used here is very simple and helps in reducing the Total Harmonic Distortion (THD). The results shows that the developed Multilevel inverter has many merits such as reduce number of switches lower EMI, less harmonic distortion. Thus the proposed inverter can be a good candidate, which can be used in place of conventional PWM inverters in the power rating of a common use In the Present Work , performance of cascaded five level inverter using hybrid pulse width modulation technique has been analyzed. The topology used in this technique reduces the number of power switches and switching losses. In the Cascaded H-bridge multilevel inverter is popular in the multilevel inverter family. Out of various PWM techniques level gives a good harmonic performance. The modified PWM technique has also been developed to reduce switching losses Thus the proposed method will reduce the cost, and also used only 6 switches, harmonic reduction and the heat losses

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