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Space Vector PWM Based Z-Source Inverter

Peddada V.P.S Nikhil[1] Y. Punith Kumar[*]
[1](Department of ECE, K L University Vaddeswaram, India)
[*](Academic Consultant, Department of EEE, UCE&T, MG University Nalgonda, India)
Corresponding Author:Y. Punith kumar

ABSTRACT: *This paper proposes a topology which can be said as a hybrid model that utilizes the principles of z-sourceinverter along with space vector pulse width modulation. Here the proposed topology is basically a Z-Source inverter that adopts SPWM technology to have better harmonic profile.*

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I. Introduction

The Z-Source inverter which is a recent trend of inverter technology has got many control strategies. The most important concept of this technology is the self-boasting unidirectional nature. The Z-source inverter is comprised of a Z-source to boast the voltage, the inverter after this point can be controlled by various PWM techniques. Considering the different strategies of PWM .Their harmonic elimination capacity, the size of filter required and other aspects of all the techniques, we come to an understanding that the PWM technique using space vectors is one of the best choices available. The Z-source inverter that we discuss here is an implementation that involves a single phase being produced by the normal inverter operation and the remaining two phases are obtained separately using a 2-leg 2-phase inverter. This two leg two phase inverter utilizes the concept of Space Vector Pulse Width Modulation.

II. Z-Source Inverter And Its Implementation

Z-Source inverters find their application in the field of renewable energy utilization systems. They are used in producing a.c. output after the d.c voltage is boasted by a considerable amount.

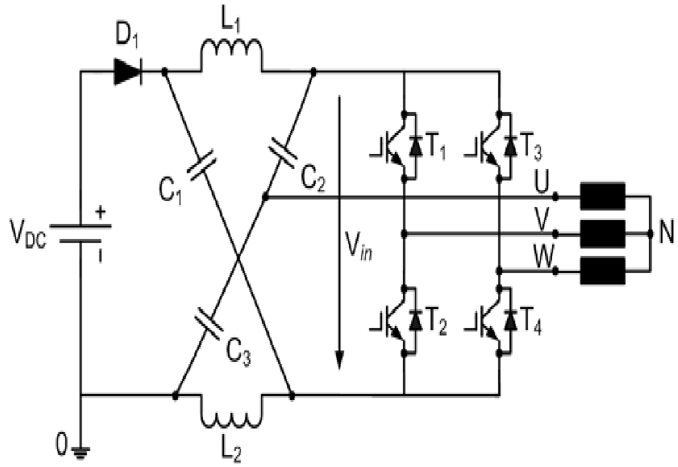

Fig1. Three phase Z-source Inverter

The proposed four-switch z-source three-phase inverter is shown in fig. 1.In essence, topology shows that one of the capacitors in the Z network is split into two and the middle point is connected to one phase of the load. This 50% voltage drawback of conventional four-switch three-phase inverter is eliminated by the proposed four-switch Z-source inverter because the shoot-through state produces not only the voltage boost but it produces also an active voltage vector, thus generating non-zero output voltage. The equivalent scheme of the shoot-through state of the proposed inverter (when all four transistor are conducting) in Fig. 2 clearly shows that during the shoot-through state the voltage seen by the load is equal with the voltage across capacitor C2.
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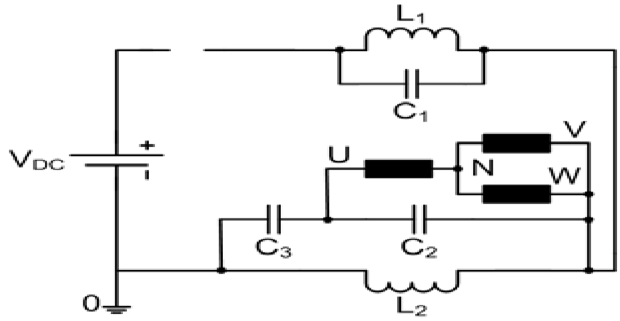

Fig 2. Equivalent during shoot through

The voltage across capacitor C1 has a voltage equal to V_{DC} and the voltages across C 2 and C3 sum up to form V_{DC} .The diode is always conducting during non-shoot through period.Hence we obtain a single phasea.c. output voltage at the midpoint of C 2 and C 3.Now the remaining two phases take their turn to produce the two phase waves which are 120 degrees apart from each other. The above objective can be achieved by using of Space Vector Pulse Width Modulation for two phase two leg inverter.

III. Space Vector PWM Implementation For

Two Phase Two Leg Inverter

In this paper, the SVPWM technique for the two-phase inverter- fed symmetrical two-phase induction motors is proposed. There are four space vectors and no zero vectors in the two-phase inverters, while the three-phase inverter has six space vectors and two zero vectors. It is difficult for the two-phase inverters to realize the SVPWM technique because it has no zero vectors. In this paper, the SVPWM technique for the two phase inverter is proposed without zero space vectors. Also, the switching sequence for the proposed SVPWM is proposed to minimize the ripple content of the output current. Finally, the computer simulations using the software MATLAB are carried out and results are presented to confirm the capabilities of the new technique.The switches are shown below with their operation in two phase inverter. The output is obtained with two phases differed by an angle of 90 degrees, but we need them to be 120 degrees lagging and leading with respect to the voltage obtained from the Z-Source operation .This can be obtained by using suitable compensators .

The outut voltages obtained at the two phases are $V_a$andV_b

$V_a= V_0 \sin\ wt(1)$

$V_b= V_0 \sin\ (wt - 90)$ (2)

The circuit shown below operates with the utilization of SVPWM in four sectors.

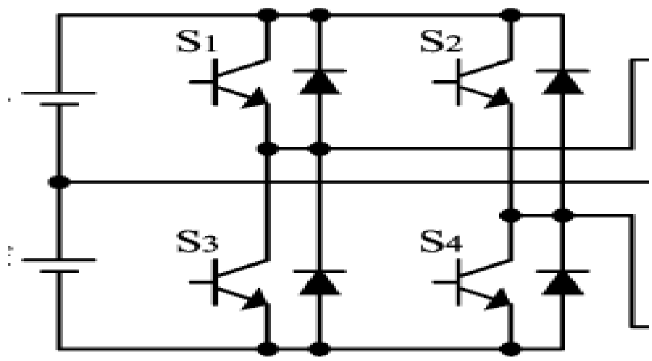

Fig 3. Two phase two leg inverter

3.1 Four Space Vectors of Two-Phase Inverter

Fig. 3 shows a typical two-phase half-bridge inverter for the two-phase induction motors, which consists of four switches, four diodes, and a center-tapped dc voltage source. The dc link can be supplied from a single-phase ac source by inserting a diode rectifier, which needs two electrolytic capacitors to maintain the ground and to reduce the dc-link ripple.

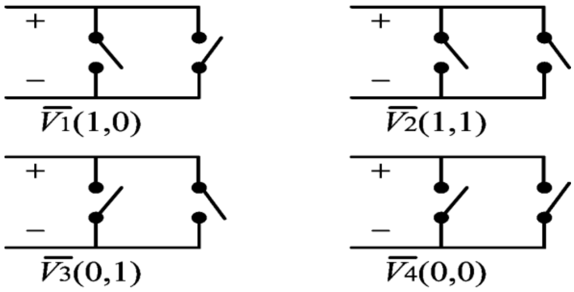

Fig 4. Switching topologies

The switching topologies describe the switching in such a way that `0' represents negative and `1' represents positive.

3.2 Space vectors and switching times

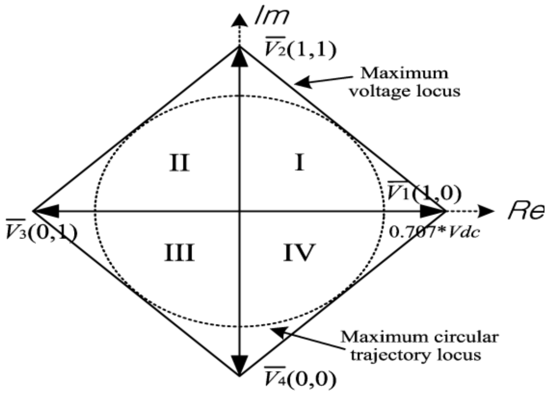

Fig 5. Space Vectors in two phase inverter

Fig 5 describes the sector positions with their respective switching. For an instance consider the sector I. The reference vector V^* be in sector I at an angle of Θ .It continues in sector I on V1 and V2 for t_{10},t_{20} and in diagonal Sector III for t_{11},t_{21} and touches the locus .

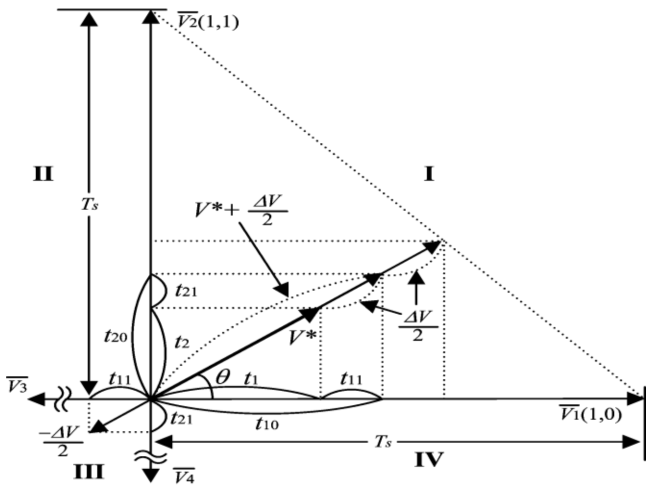

Fig 6. Space Vectors in two phase inverter

$V_{max} = [V_{dc}/\sqrt{2}] . [1 /(\sin \Theta + \cos \Theta)]$ (3)

The maximum voltage is the sum of reference voltage and ΔV. The ΔV voltage is supplied by switching time extension in both main and diagonal sectors.

$\Delta V = ([V_{dc}/\sqrt{2}] . [1 /(\sin \Theta + \cos \Theta)]) - V^*$ (4)

The timing durations are given by the equations

$t_{10} =[\sqrt{2}T_S/V_{dc}].[([V_{dc}/\sqrt{2}] . [1 /(\sin \Theta + \cos \Theta)])+(V^*/2)].\cos \Theta$ (5)

$t_{20} \quad =[\sqrt{2}T_S/V_{dc}].[([V_{dc}/\sqrt{2}]\ .\ [1/(\sin\Theta+\cos\Theta)])+(V^*/2)].\sin\Theta$(6)

$t_{11} \quad =[\sqrt{2}T_S/V_{dc}].[([V_{dc}/\sqrt{2}]\ .\ [1/(\sin\Theta+\cos\Theta)])-(V^*/2)].\cos\Theta$ (7)

$t_{21} \quad =[\sqrt{2}T_S/V_{dc}].[([V_{dc}/\sqrt{2}]\ .\ [1/(\sin\Theta+\cos\Theta)])-(V^*/2)].\sin\Theta$ (8)

IV. Computer Implementation

Phase A and Phase B obtained by the two leg inverter are to be 90 degrees apart from each other which is obtained by selection of suitable switch timings derived by the above equations. Here we have a 230V d.c. supply at a reference voltage of 60 V .The output obtained is 50 Hz for a specified sample time.

The output of Z-Source inverter along with the output of two phase two leg inverter are to be fed to a filter which eliminates the harmonics to give a desired 3-Phase output

The switching done as per Fig 7 gives the output voltages 90 degrees apart .By the insertion of a compensator we make them 120 degrees lead and lag respectively as shown in the Fig 8. The current wave obtained is shown in the Fig 9.

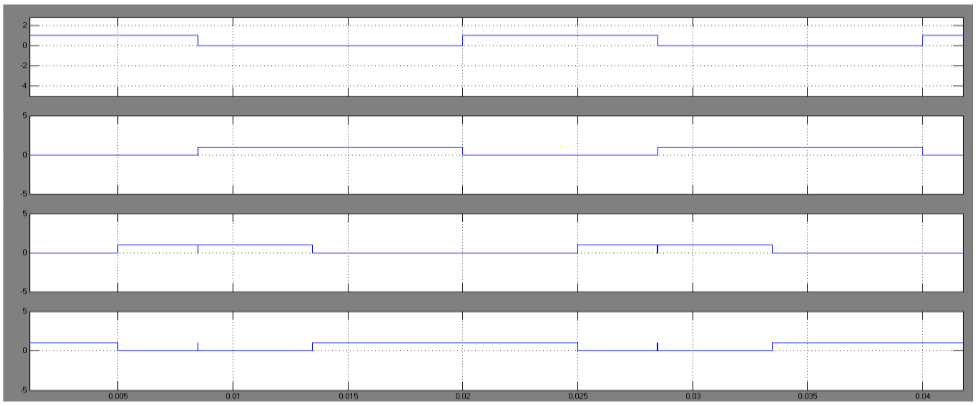

Fig7. Firing pulses

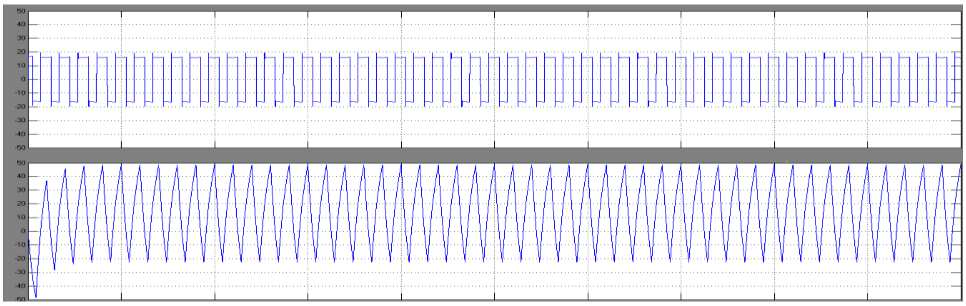

Fig8. Two Phase 2 leg inverter outputs after adding the compensator

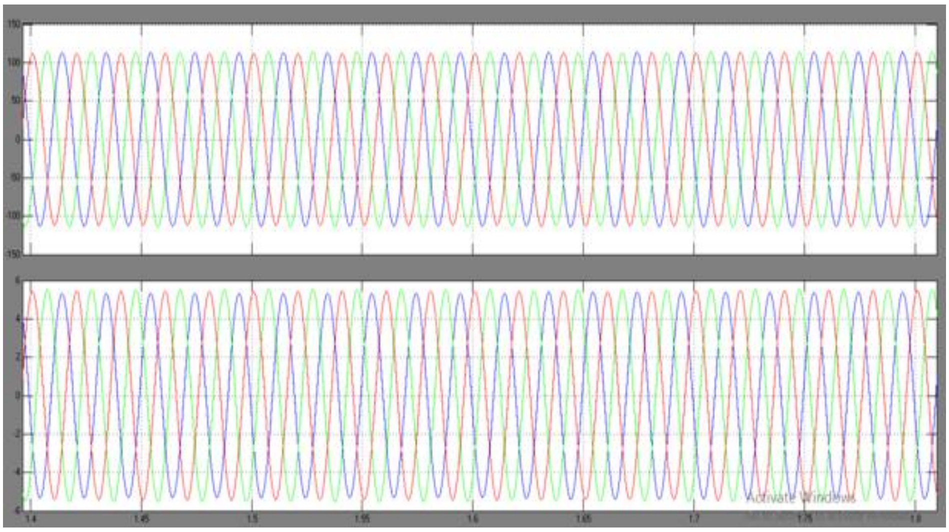

Fig9. Output voltage and Current

V. Conclusion

The proposed inverter is thus a revolutionary implementation which counters the drawbacks of conventional methods to a great extent. It thus produces an output which is harmonically free three phase power. The output of the inverter can be controlled by controlling the switching, thus providing a smoother control of three phase motors.

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