Grenze International Journal of Engineering and Technology, Jan Issue

Design and Simulation of Z-Source Inverter

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***Abstract*—This intent discussed is about of an impedance source inverter with pulse duration modulation technique. In conventional converters power is limited to smaller or less than the input power and the main circuit is non- interchangeable. More harmonic content occur owing to the dead time and time lap are observed. The z-source converter is substitute to overcome these imperfections. The output power can be step up and down it uses the shoot through mode to improve the dc voltage using a single period pulse width variation of the z source make significant contribution. The distinctiveness of the PWM control is the potentially of the shooting mode to increase the DC link voltage under a single Phase process at the chosen output power greater than the DC link voltage. This can be accomplished by gating switches of same leg. The Z-source inverter with simple boost control is implemented as it enhances the boosting factor in comparison with other techniques.**

***Index Terms*— Z-source inverter (ZSI), Pulse width modulation (PWM), Harmonic distortion, Shoot through.**

I. Introduction

Power electronics is comprehensively used in all areas of life, be it domestic or industrial use. For converting DC to AC the inverter is broadly used that may be used for motor drives heating, continuous AC power installation, AC power supply, distribution generation, active power filters and static VAR generators and compensators etc. [1]. Inverters are dissect into two types as voltage source and current source inverters. Both have triggered with some limitations that is slandered output range and, the output is less than the input. For applications such as fuel cell, PV inserts DC link input voltage cannot be maintained regularly [2]. Increase in converter distortion is increased and reliability can be reduced. Starting two switches on the same leg cannot be done to avoid short rotations in the system. Power disturbances may be due to improper pulse [2]. For security reasons, there is always a dead time (3 to 10) to ensure that two switches will not be turned on at the same time. High impedance Z-source inverter used to overcome most of the power source and current switching power limits, Z-source inverter uses the Z-network between the input source voltage and the inverter bridge [3]. Increasing the voltage of high power applications Z-network can be heard intentionally. Of the two types of voltage levels considered one is higher than the DC link voltage and less than the DC link voltage. To be considered as a buck-boost converter in this case we can use the output power you want to overcome the limitations of the voltage source inverter and the current power converter. Also, without the need for deadlines, distortions of waveform emissions can be evaded [4].

A. Frame Work of Proposed System

The proposed topology of designing z-source inverter has shown in above fig.1. which is basically a block diagram. A DC source, Impedance circuit, three phase inverter, Resistive Load, Simple boost PWM control.

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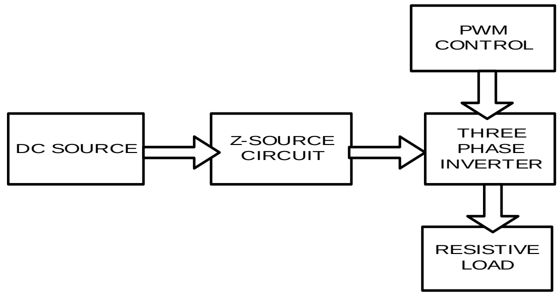

Figure 1.Proposed system block diagram

II. METHODOLOGY

The eccentric aspect of the impedance-source inverter is that the output may be of any value that varies from zero to larger values nevertheless of the input provided. The Z-source inverter have three modes of operation: active mode, null mode, and shoot-through mode. In fig.2 active mode and null mode, it acts as a normal inverter with pulses. This inverter make use of the shoot-through states to increase the dc bus voltage by shorting out both the upper and lower switches of a same phase leg. Accordingly, the impedance-source inverter can buck and boost voltage to a output voltage which could be higher than the input voltage. Furthermore, the security of the inverter is improved as the shoot-through state cannot damage the circuit so that it could be of minimum-cost, prominent, and highly structured for stepping up and stepping down the voltage.

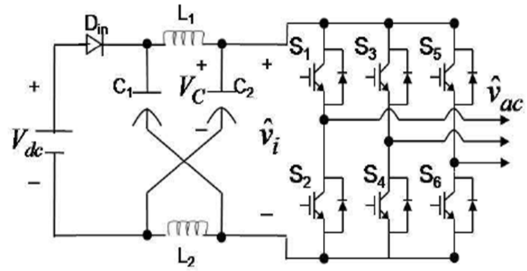

Figure 2.Circuit model of the Z-Source inverter (ZSI)

A. Shoot through state

When the the system is in shoot through state diode D1 is reverse biased then thae inductor gets cgarded and capacitor gets discharged so that the energy flows across load through inductor.

$$V_{L1} = V_{C1}; V_{L2}=V_{C2.} \tag{1}$$

Voltage across capacitor is assuming constant inductor current will increase linearly during this period due to symmetry in the circuit.

$V_{L1}=V_{L2}=2=V_L$,

$I_{L1}=I_{L2}=I_L$, and $V_{C1}=V_{C2}=V_C$.

$V_L=V_C$

$V_d = 2V_c$

$V_2=0$

B. Non Shoot through state

When inductor charges, capacitor discharges, diode is in forward bias. In this mode, the input current flows from the dc source becomes:

$$V_L = V_g - V_c \tag{2}$$

$$V_{dc} = V_C - V_L = 2V_C - V_g$$

$$\frac{V_C}{V_g} = \frac{T_1}{T_1 - T_0} = \frac{1 - D}{1 - 2D}$$

$$V_C = \frac{T_1}{T_1 - T_0} V_0 \tag{3}$$

$$B = \frac{T_1}{T_1 - T_0}$$

$$V_{ac} = M * B * \frac{V_{dc}}{2} \quad (4)$$

The designing reactive power components like inductor and capacitor is challenging in ZSI. The values should be suitable for low voltage values of the reactive power component so that the current stresses becomes maximum when boost factor is applied. The estimation of the inductor current has discussed below.

$I_L = P / V_{in}$

The boost factor of the input voltage is

$$B = \frac{1}{1 - 2D_0} = \frac{V_{IN1}}{V_{IN}}$$

Where D_0 is the shoot-through duty cycle

$$D_0 = \frac{B-1}{2B} \quad (5)$$

III. Control Technique of The System

A. Simple Boost Control

The most commonly used firing method for ZSI is boost control method by using sinusoidal PWM(SPWM) control technique is used. For the generation of gate pulses there should be two waves one is reference wave and another is carrier wave in this case a balanced three phase supply has been compared with the carrier wave of triangular in nature. The production of zero state in ZSI is observed when the carrier signals are less than or greater than the reference wave signals. For the introduction of shoot through state in the converter V_p and V_n named two signals has been used the amplitudes are equal to sinusoidal wave form. Here V_p and V_n can be expressed as positive and negative peaks of the signal which is shown in fig.3.The shoot through occurs when triangular wave is less than or greater than the V_p and V_n. Boosting factor of simple boost converter is relatively higher than other converters. The carrier frequency is higher than the reference wave signals. The control strategy of the inverter has depended on the pulses generating from the comparison of carrier wave and reference wave. When the DC voltage is low to generate the required dc output voltage in that case modified PWM strategy can be used for the boosting of voltage levels from lower value to higher values. Zero state is observed when the upper(or lower) switches turned off simultaneously and these creates zero voltage at the load terminals.

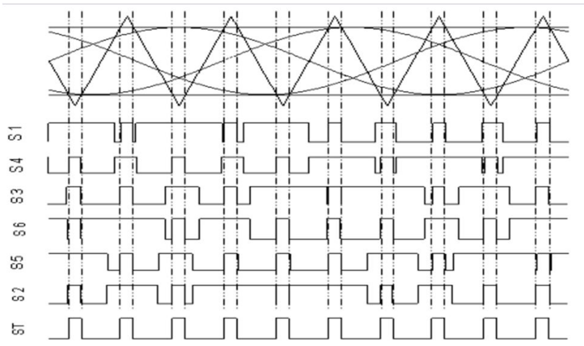

Figure 3.Comparision of carrier wave with reference wave

TABLE-I

Parameter	Value
Carrier frequency	10 KHZ
Modulation index	0.75
Reference wave magnitude	8
DC input	100V
Capacitor	1300 µF
Inductor	5 mH

IV. SIMULATION DIAGRAMS AND RESULTS

The Z-source inverter using simple PWM method is designed as discussed in the above sections and it is simulated using MATLAB/Simulink.

A. Simple Boost Method

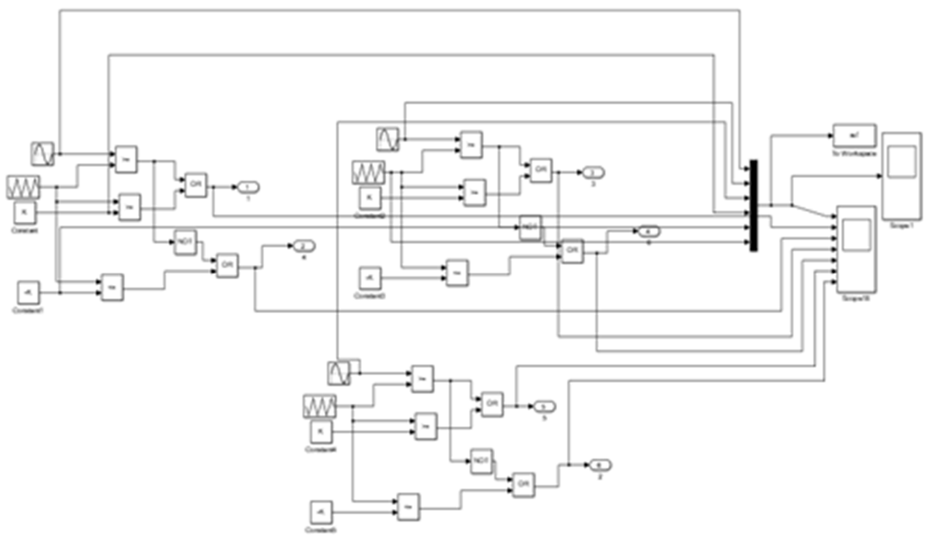

Figure 4.Simulation diagram of control technique of the system in simple boost mode

B. Z-source inverter

The results shows the waveform in fig.5 across each resistive load. The output is similar to the input which are pulsating but the change at starting of waveform indicates the voltage across capacitive and inductive load. The boosting factor is similar to theoretical calculations. The voltage is boosted 260v with input voltage of 100volts.

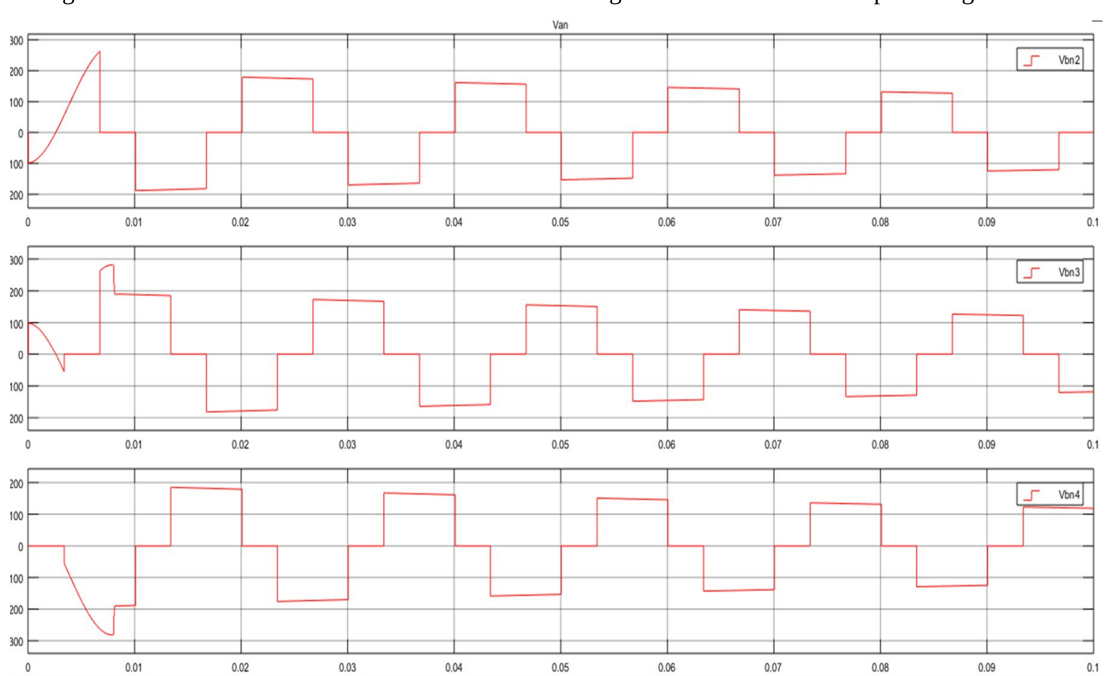

Figure 5.Output voltage and current of the inverter

C. Simple Boost Control

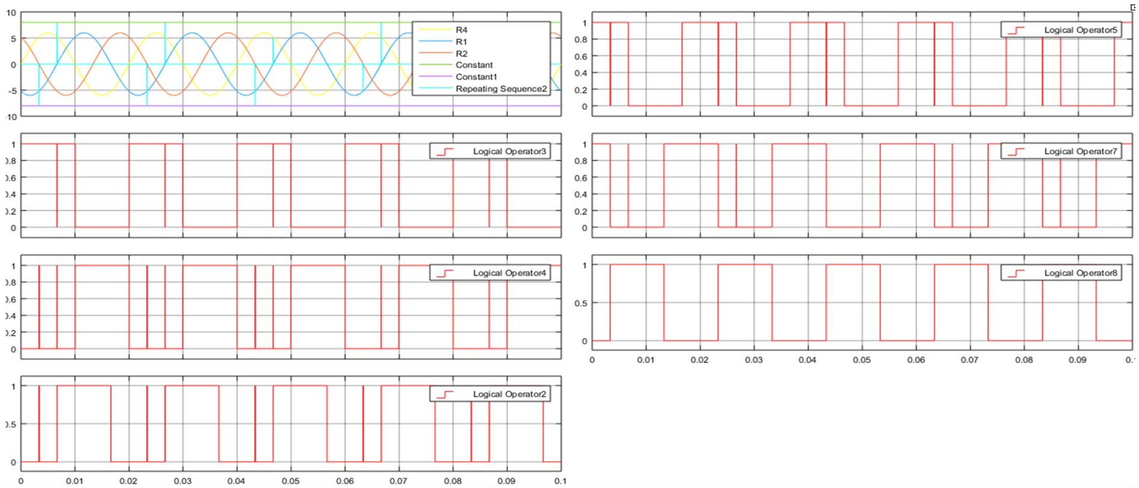

Figure 6.Output voltage and current of Boost converter

First waveform in fig.6.shows the carrier wave, triangular wave and three phase sinusoidal wave used for generation of pulses. Remaining waveforms depicts the different gating signals used to turn on the switches.

V. CONCLUSIONS

Power converters are progressively growing in most of the applications such as alternative power sources and hybrid electric vehicles. Efficiency, cost-effectiveness and authenticity are the main veracity for electrical developer. Even though former methods still provide satisfactory results with escalated outcome, new developments are being instigated and yield preferable outcomes. The Z-source converter is a new optimistic converter that provide conditioned power in applications such as HEVs and utility interfacing. This inverter overcome the snags by abolishing double stage conversion.

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