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Method for Reducing Harmonic Distortion for Inductive Load using " Z-Source Inverter"

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Abstract- **In this proposed system to simulate Z-source inverter as a filter ,buck converter and boost converter with the help of MATLAB software and Z-source inverter reduces the harmonic distortion problem and compare with by taking conditions of with and without Z-source inverter weather harmonic distortion problems are minimised or not.**

Keywords- Z-source, Inverter, PWM , Buck – boost.

I.INTRODUCTION

The voltage source inverter and current source inverter have some common problem. The Z-source inverter is a novel power conversion topology that can buck & boost the input voltage using passive components. With its unique structure,Z-source inverter can utilize the shoot through states to boost the output voltage & provides an attractive single stage DC to AC conversion that is able to buck & boost the voltage. The shoot-through duty cycle is used for controlling the DC link voltage boost and hence the output voltage boost of the inverter. In this paper MATLAB/SIMULINK model of Z-Source Inverter has been developed and harmonics analysis is carriedout.

There are mainly two types of traditional inverters Voltage Source Inverters and Current Source Inverters However, above both types of inverters have some conceptual barriers.In Voltage Source Inverter [1] the output voltage range is limited.the inverter cannot output a higher voltagethan the DC bus voltage. For many applications, when the input DC voltage is not always constant, like a fuelcell, photovoltaic array, and during voltage sag etc. A DC/DC boost converter is often needed to boost the DCvoltage to meet the required output voltage. This increases the system complexity and the cost and reduces thesystem reliability. On the same time the two switches on the same phase leg cannot be gated, otherwiseinverter will be destroy because of shortcircuit. For safety to make sure that the two switches will not be turned on simultaneously.there is always a dead time. This dead time can cause harmonic & output voltage distortion problems & this problem can be solved by implementing a current/voltage feedback control. Howeverthe system complexityincreases.

Current Source Inverter [1] is basically a boost converter. Where a wide voltage range isrequired, extra circuitry has to be used this increases the circuit complexity and reduces the efficiency and reliability. At least one switch in the upper devices and one in the lower devices has to be turned on at the same time, or an open circuit will occur and destroythe inverter. To make sure that there will be no open circuit, overlap time is often needed, which will causelow frequency harmonic and output waveform distortionproblem. The switches of the Current Source Converterhave to block reverse voltage that requires a series diode to be used in combination with high performance and high-speed transistors such as Insulated Gate Bipolar Transistors (IGBTs).

The newly presented Z-Source Inverter has some unique features and it can overcome most of these limitations.

The purpose of this work is to simulate Z-Source Inverteras a filter ,buck converter and boost converter with the help of MATLAB software and Z-source inverter reduces the harmonic distortion problem and compare with by taking conditions of with and without Z-source inverter weather harmonic distortion problems are minimised or not.

II Z –SOURCE INVERTER

1.Circuit Diagram of Z-Source inverter as a filter.

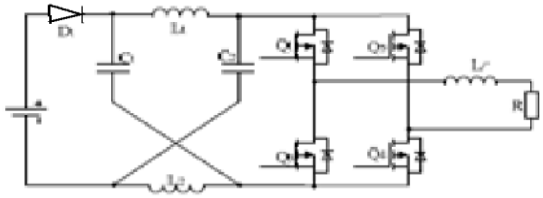

Fig No.1 (Circuit diagram of Z-source inverter)

The basic Z-source inverter topology, which consists of twoinductors($L1$ and $L2$) and two capacitors ($C1$ and $C2$) connected in X shape tocouple the inverter to the dc. voltage source. The ZSI can produceany desired ac. output voltage regardless of the dc. input voltage. Because of this structure, the Z-source inverter has an additional switchingstate, when the load terminals are shorted through both the upperand lower switching devices of any phase leg, which called the shoot-through state besides the eight traditional non-shootthrough states. The ZSI has two operating modes nonshoot-through mode and shoot-through mode, During the shoot-through switching state, the input diode is reverse biased the input dc. source is isolated from the load, and the two capacitorsdischarge energy to the inductors and to the load. During then on shoot-through switching states, the input diode turns ON, and the dc.Inputvoltage source as well as the inductors transfer energy to the loadand charge the capacitors, and because of that the dc.-link voltage of bridgeis boosted. In this proposed system firstly consider the Z-source as a filter than buck converter and boost converter. following Fig.5 shows MATLAB Simulation of current & voltage waveform of without Z-source inverter for Inductive

load and Fig 6 shows there Total harmonic distortion for inductive load. And for comparison purpose same thing is shown in Fig. 7 and Fig.8.

III. DESIGN OF IMPEDENCE NETWORK

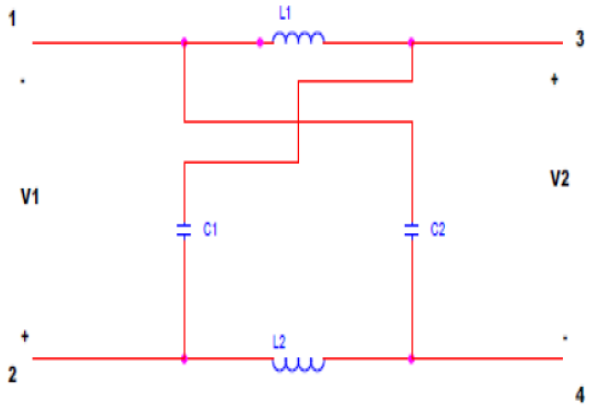

Fig No.2 (Impedance Network)

The impedance network is shown in Fig.5 [3] shows the equivalent circuit of the Z-source inverter for the

calculation of the impedance parameter.
Where L_1 and L_2 - series arm inductors
C_1 and C_2 - parallel arm capacitors
V_1 is input voltage
V_2 is output voltage
The network can be redrawn this way shown in Fig 2

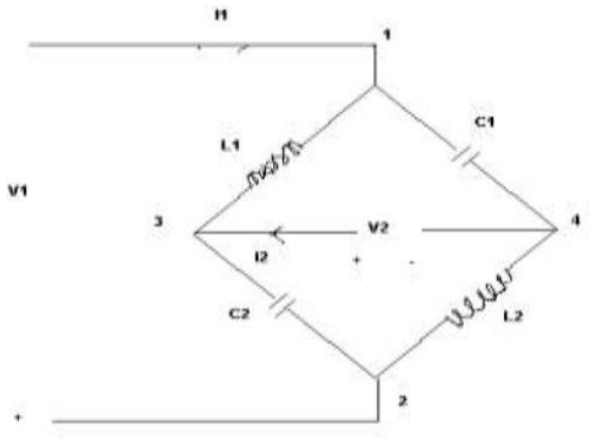

Fig No.3 (Impedance Network Circuit –Redrawn)

Now assume $I_2 = 0$, the current I_1 enters the bridge at point 1 and divides equally between the two arms of the bridge.Using Kirchhoff's law

$I_1.L/2+V_2 = I_1/2C$
$V_2 = I_1/2C - I_1.L/2$
$V_2 = I_1/2\ [1/C - L]$

Assume c=5.5 mF
440 = 5/2 [1/5.5*10-3- L]

L = 5.8 H

IV. PROPOSED METHOD

this proposed system we are using for Z-source as a filter ,buck converter and boost converter with the help of MATLAB software and Z-source inverter reduces the harmonic distortion problem. Practically it is easy for us to compare between both software and hardware by taking conditions of with and without Z- source inverter weather harmonic distortion is minimised or not.

As shown in fig.4 The proposed system Block Diagram.

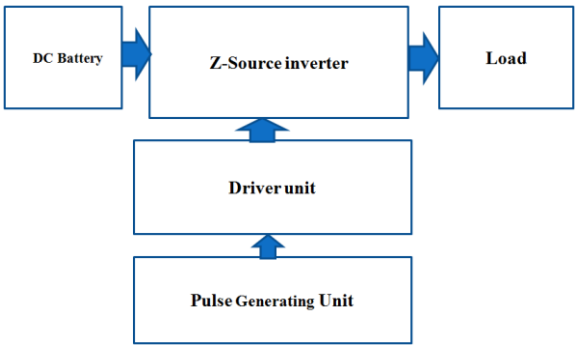

Fig.4 (Proposed system block digram)

The DC supply is given to the Z-source inverter, this contents two capacitor ,two inductors and four switch this switches is controlled by SPWM control method with the help of pulse generating unit Driver unit control the switching period of IGBT and overcomes the output voltage and current distortion of inductive load.

V.CURRENT & VOLTAGE WAVEFORM OF WITHOUT Z-SOURCE FOR 'L' LOAD

In without z-source inverter simple inverter is used. Input voltage ,one Diode and four switches are used
Following is the MATLAB Simulation of current & voltage waveform of without Z-source inverter for Inductive load

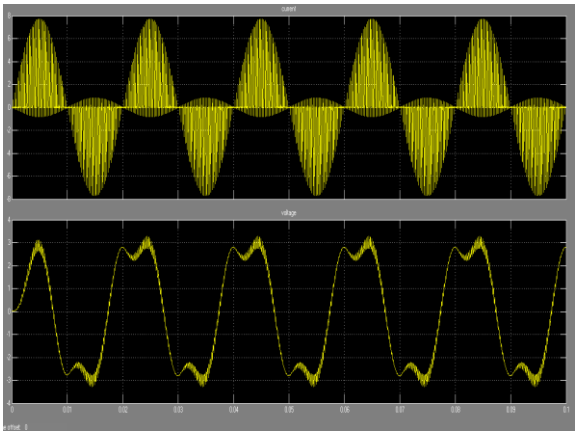

Fig.5(simulation result of current & voltage waveform without Z-source)

TOTAL HARMINIC DISTORTION FOR 'L' LOADWITHOUT Z-SOURCE.

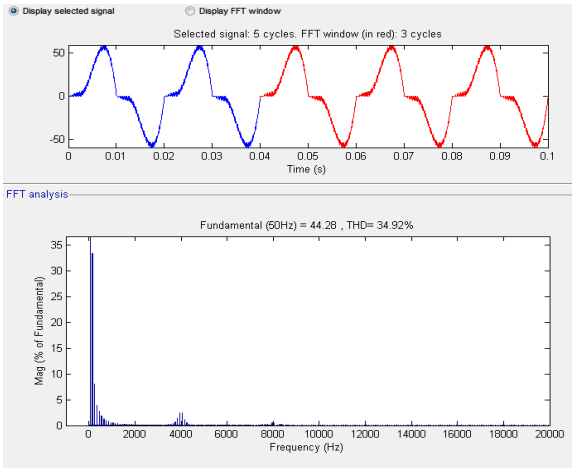

Fig.6(simulation result of Total harmonic distortion without z-source)

Without Z-source, total harmonic distortion in inductive 'L' load is 34.92% and the inductor value is 4.5 mH.

VI.CURRENT & VOLTAGE WAVEFORM OF WITH Z-SOURCE FOR 'L' LOAD

In Z-source inverter **i**nput voltage ,one Diode and four switches as well as two capacitors and two inductor is used.Following is the MATLAB Simulation of current & voltage waveform of with Z-source inverter for Inductive load

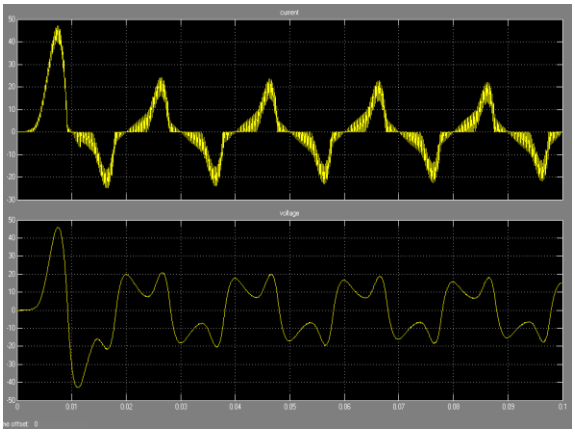

Fig.7(simulation result of current & voltage waveform with Z-source)

TOTAL HARMINIC DISTORTION FOR 'L' LOAD WITH Z-SOURCE.

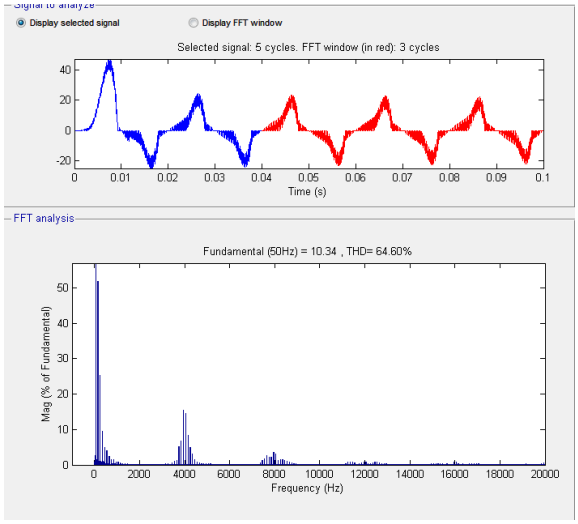

Fig.8(simulation result of Total harmonic distortion with z-source)

With Z-source the value of two inductor is 10µH and the two capacitor values are 10µF. The total harmonic distortion in inductive 'L' load is 31.85%&Without Z-source total harmonic distortion in inductive 'L' load is 34.91%witch is greater than with Z-source so that while using Z-source inverter harmonics is reduced.

VII.Z-SOURCE AS A BUCK CONVERTER

The Z-source can be used as buck converter by changing the value of capacitor C1 is 0.003F and C2 is 0.0003F. Fig no7 shows the result of MATLAB simulation of buck converter.

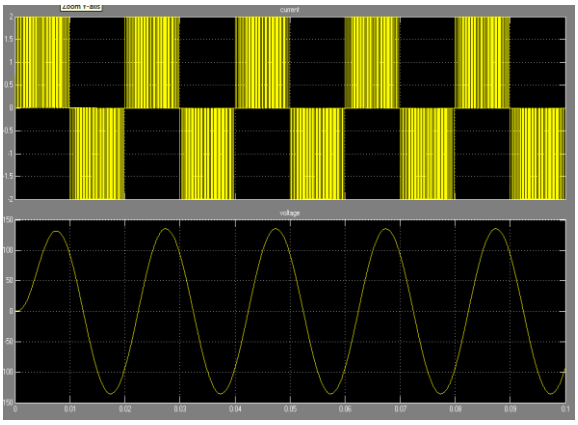

Fig.9(simulation result of current & voltage waveform with Z-source as buck converter)

The input is 200v and the buck converter output is 140v.

VIII.Z-SOURCE AS A BOOST CONVERTER

The Z-source can be used as boost converter by changing the value of inductor witch is 4.5mH. Fig no8 shows the result of MATLAB simulation of boost converter.

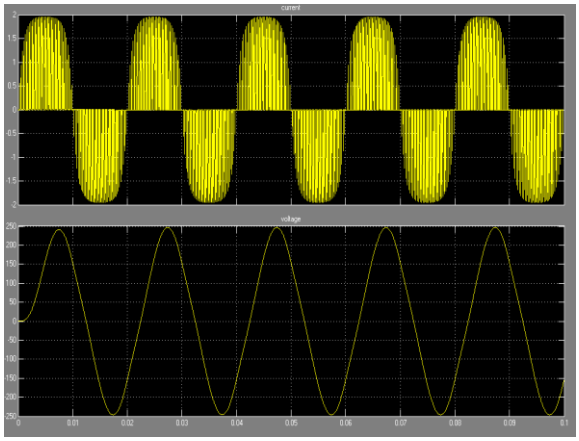

Fig.10 (simulation result of current & voltage waveform with Z-source as boost converter)

The input is 200v and the Boost converter output is 230v.

IX.CONCLUSION

In this proposed system the harmonicdistortion is reduced by using Z- source inverter .whereas Z-source is used as filter,buck converter and boost converter and by using SPWM control technique we can overcome output voltage and output current distortion problem in inductive load and also reduces switching time and switching losses in one cycle.. Practically to compare between both software and hardware by taking conditions of with and without Z- source inverter weather harmonic distortion problems are minimised or not.

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