A NOVEL Z-SOURCE INVERTER WITH LOW CAPACITOR VOLTAGE STRESS AND SMALL INDUCTANCE

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ABSTRACT:

In this paper author has proposed a novel approached for Z source inverter. The proposed z source network capacitor is designed to produce very minimum voltage stress than the traditional one and it possesses the capabilities like maximum limitation to inrush current while starting. Another major advantage of this system is, it can be used with wide range of load though it has very small inductor. As it has small inductor when compared with conventional z source inverter, the proposed converter has lower cost and less weight. The operating principle and various parameters are analyzed in a great detail and same is been verified with MATLAB simulink. And it has found that newly proposed z source inverter has more advantages than conventional z source converter.

KEYWORDS: Z source inverter.

INTRODUCTION:

Z source proposed till now by various researcher has advantages like

1. it can produce output voltage more than input DC voltage even without use of DC-Dc boost converter
2. as z source network is been used, the risk of dead time of switch is completely eliminated.

The z source is commonly used in renewable energy system because the PV cell needs a very high gain for voltage for boosting inverter voltages to the grid level. The traditional z source inverter is shown in fig. no.1.

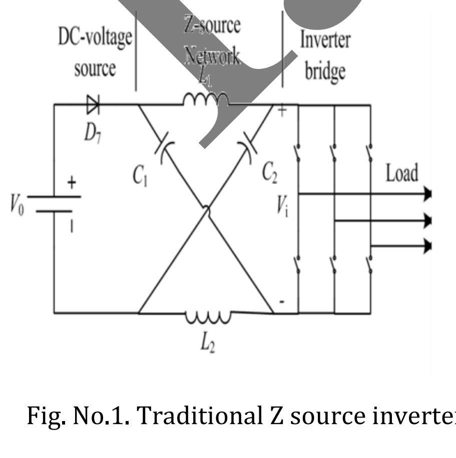

Fig. No.1. Traditional Z source inverter

DISADVANTAGES OF CONVENTIONAL Z SOURCE INVERTER:

1. Loading capacity is poor as it operates with small value of inductance.
2. Voltage stresses on the z source inverter are very high, which brings few problems while selecting the capacitors. It may cause system to become bulky and heavier.
3. Startup inrush current is very high.

Operating Principle and Circuit Analysis

While analyzing the principle and carrying out circuit analysis all circuit components are ideal and capacitor has a constant voltage across it terminals.

[MODE 1]:

Switch *SW7* is in off-state and inverter is in shoot through state. As shown in fig 2, inductor current flows in reverse direction and it can't change immediately. In this case, for particular duration inductor current pass through freewheeling diodes of the bridge inverter.

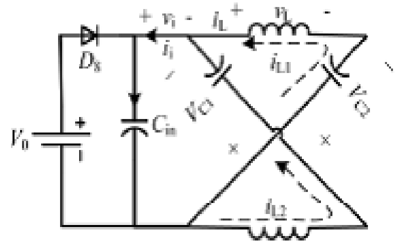

Fig. No.2. Z source inverter operation in mode 1

[MODE 2]:

Switch *SW*7 is in off-state and inverter is in shoot through state. Bridge inverters switches are in on state, because of capacitors are charging the inductor making the current through inverter to flow.

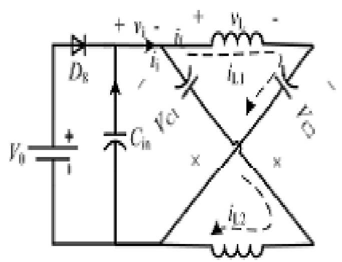

Fig. No.3. Z source inverter operation in mode 2

[MODE 3]:

The inverter is just to get ON, or in other language it is in traditional zero state and input current of the z source inverter is zero. The input network capacitors are charging from the input voltage and inductors in z source network are charging from z source network capacitors.

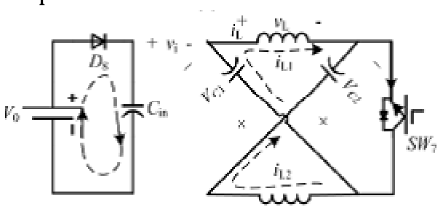

Fig. No.4. Z source inverter operation in mode 3

[MODE 4]:

In this mode inverter is in active state, inductor current and freewheeling diode current and the current of SW7 meets inequalities $i_D > 0, i_L > i_i$

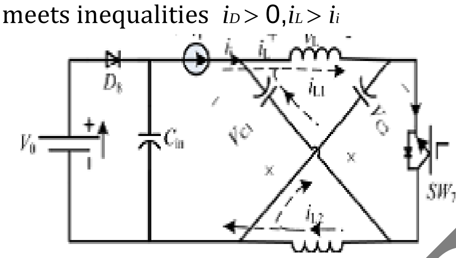

Fig. No.5. Z source inverter operation in mode 4

[MODE 5] :

In this mode inverver is in active mode, and inductor current meets following inequality

$$\frac{1}{2}i_i < i_l < i_i$$

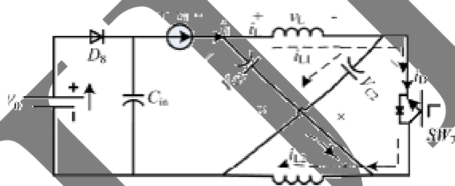

Fig. No.6. Z source inverter operation in mode 5

[MODE 6]:

The inverter is in one of the active states but inductor current meets the following inequality

$$0 < i_L < 0.5i_i$$

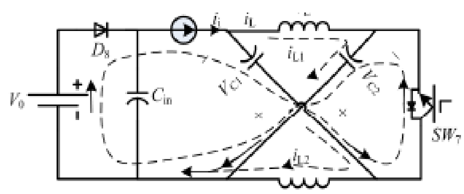

Fig. No.7. Z source inverter operation in mode 6

[MODE 7]:

In this mode the inverter is in active state and SW7 is still conducting. But current through the inductor is increasing in reverse direction as voltage across inductor is opposite to the voltage across capacitor.

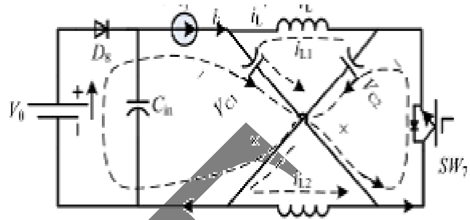

Fig. No.8. Z source inverter operation in mode 7

[MODE 8]:

In this mode inverter is in traditional zero stage. Input capacitor is getting charge from the input and SW7 is conducting. Current though the inductor already started flowing is reverse direction as voltage across inductor is opposite to voltage across capacitor.

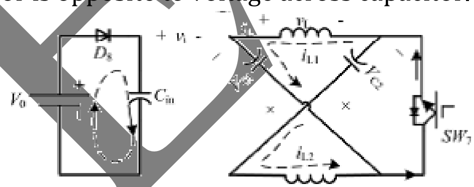

Fig. No.9. Z source inverter operation in mode 8

EXPERIMENT ANALYSIS:

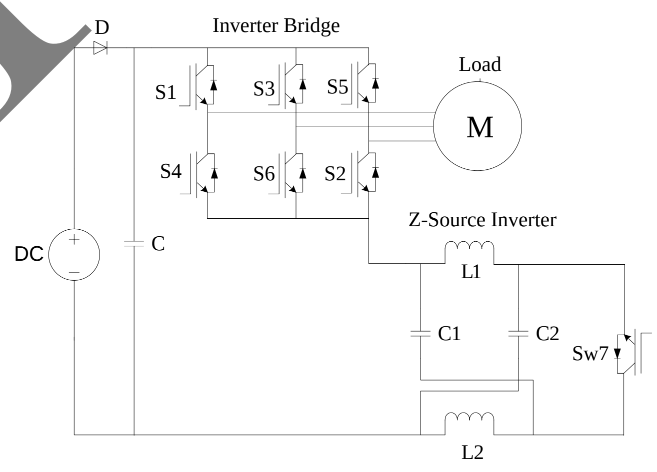

Fig. no.10 proposed z source inverter model

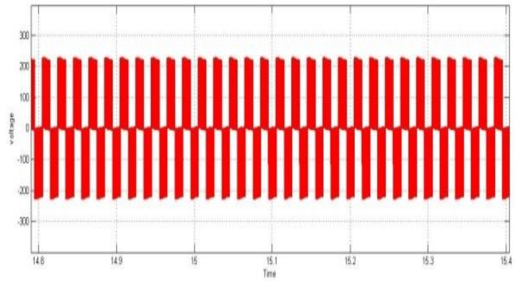

Fig.11 output phase voltage of proposed inverter

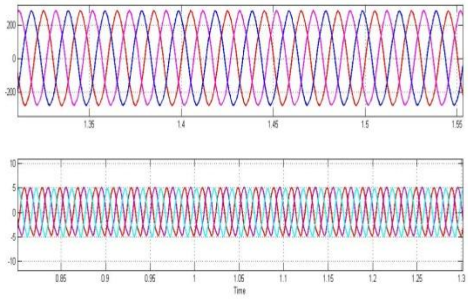

Fig.12: three phase output voltage and current waveform of proposed system

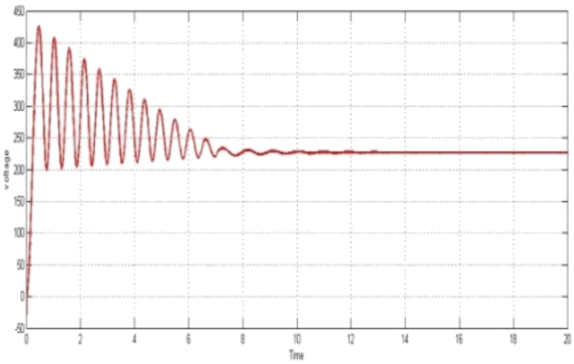

Fig.13 output voltage of High performance Z-source network

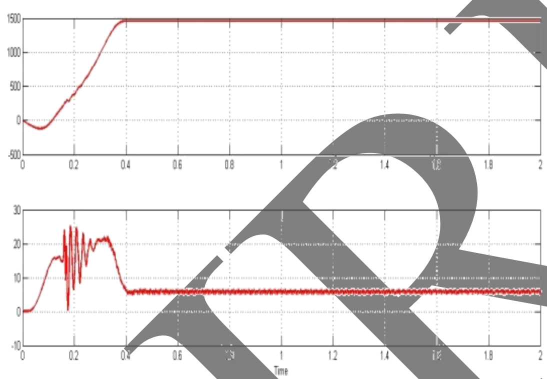

Fig.14: waveform of speed and torque of proposed drive

RESULTS AND DISCUSSIONS:

Table No.1. Voltage stresses of devices in the proposed inverter

Devices	Voltage Stress
Switches of inverter bridge	$\frac{1}{1-2d}V_0$
Switch SW_7	$\frac{1}{1-2d}V_0$
Capacitors C_1 and C_2	$\frac{d}{1-2d}V_0$
Capacitor C_{in}	V_0

The implemented very high performance z source inverter is implemented in MATLAB simulink environment. The simulation parameters are: $V0$ = 100V, d = 0.15, Cin = 470uF, fs = 100kHz and M = 0.8. Z-source network parameters are: $L1$ = $L2$ = 500uH and $C1$ = $C2$ = 470uF as the size of the z source network parameters are smaller the newly implemented system will have a smaller sizes of inductor and capacitor. According to literature survey z source inverter can work on loaded condition as well. Fig. no.11. shows the output voltage of the porposed high performance z source inverter. It can be seen that the dc-link voltage vi of both the traditional converter and proposed converter are exactly the same when they are operating under same condition. However, the capacitor voltage VC of the proposed converter is much smaller than that of the traditional converter and the difference between them is the value of the input voltage $V0$, which is in accordance with the theoretical analysis. Moreover, it is observed that, inrush current is not observed at startup and it shows better dynamic performance as compared to dynamic traditional z source inverter.

CONCLUSION:

A unique high performance z source inverter is implemented in this paper which is specially designed to overcome the disadvantages of traditional inverter. A switch SW7 is added in the proposed inverter is purely for better control which helps in shoot through at starting. Another advantage of adding this switch it helps in deciding the loading capacity of the proposed inverter as it provides path for reverse current. Few other merits of implemented z source inverter are; low voltage stress on the capacitor and limited inrush current and voltage during starting. The implemented high performance z source inverter is suitable for renewable energy systems and a power system as well as it is designed to operate very large variation in load.

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