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An Efficient Modified Z Source Grid Tied Inverter System

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ABSTRACT- In this paper presents the controlling the power of using quasi-Z source inverter for renewable source application. The proposed quasi z source is single stage DC to AC converter it delivered buck-boost operation with respect to input. These buck-boost converter is highly suitable compare to the normal dc to dc converter for photovoltaic applications. The proposed single stage converter are reliable and suitable for renewable energy source application. The source impedance quasi network offers high gain compare to the exciting system and reduced the total harmonic level. The quasi-z source followed by single phase H bridge converter uses to convert DC to AC with high reliability output. A proposed system-built Simulink and the hardware made for the open loop control. The conventional voltage and current source inverter have its own limitation of the output voltage low compare to the input source in the voltage source inverter, it is just opposite in the current source inverter. These limitations overcome by designed novel modified z source inverter was developed and controlled pulse using unipolar and bipolar concept. The output of the inverter after filter, it produces the less harmonics result 7.6% on fifth harmonics level compare with conventional inverter.

Keywords: Modified z source network; single phase inverter; quasi converter; grid integration.

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1. INTRODUCTION

The voltage and current source inverter have own conceptual demerits. The voltage source inverter output of AC is low compare to the input of DC. When we look the current source inverter output of AC is high compare to the input of DC. To overcome these demerits the Z source inverter, play a role to compensate these problem [1]-[6]. So, the Z source connected between DC source and inverter. The z source includes the impedance network circuits attached with DC link point [2]-[8]. The impedance network play role to overcome the limitation of conventional current and voltage source inverter. The sequence of controlling switches and pulse width modulation scheme-based duty cycle apply to each switch [3]-[7]. The Z source inverter produce the desired output of high or low value of the prescribed [4]-[9]. The Z source inverter offers the desired functional capability while various conditions such as fluctuating input voltage, harmonic mitigation problem, power quality improvement, *etc*.

Recent days fast charging of the electrical vehicle battery and reduce the charging time with help of Z source circuit. The z source inverter uses to function both buck and boost operations. The merits of the Z source is uses to reduce the multiple stages of conversion into single stage of the conversion [5]-[10]. The z source is popular on the photovoltaic and Grid integration method. The impedance source converter is called Z source converter. It is generally used on various converters such as inverter, rectifier, cyclo converter and chopper power conversion operations [11]-[15]. Z source contains unique impedance circuit it uses to couple the converter between source and converter. The z source circuit contains capacitance and inductance. The z source uses to provide the novel converter because it is uses to overcome the limitation of conventional voltage and source inverter problem. The conventional circuits contain theoretical barriers and conceptual problem. The z source is applicable to all type of power converter circuits. Most of the applications such as chagrining electrical vehicle, fuel cell applications, etc. the Z source inverter played the vital role [16]-[21].

2. LITERATURE SURVEY

The Z source circuit employs a unique impedance circuit couple to the power source and converter, load, or connected to another converter between, etc. [8]-[13]. the general z source network contains two inductance and two capacitance and connected in the shape of X is developed an impedance source circuit. The source may be current or voltage source [6]-[9]. If DC source means it may be Solar photovoltaic, fuel cell, battery, etc. The z source uses to make several possibilities, the details of the

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possibility as given below. The z source connected between DC voltage or current source and converter or inverter. The most of the converter are DC to AC or DC to DC converter [10]. The second possibility is the z source connected between dc source and three phase inverters. The inverter switches may be anti-parallel or series of switch and diode. The third possibility is z source connected between two converters, for example between dc-to-dc converter and inverter [11]. The z source concept can be suitable for entire spectrum types of power converter schemes. So, the source impedance network is uses to control the speed drive, the output of z source converter or inverter can generate the output voltage is heighted than the input voltage source [12]. This type of boosts is not possibility for conventional method. In this article deals into MATLAB simulation implementation of Modified Z source inverter for Grid integration application for real-time realization. The proposed system helps to solve the limitation of the conventional voltage and current source inverter. In this article described the modified z source inverter for AC load and grid integrated application. The modified z source impedance network uses to eradicate the issues of the conventional voltage and current source inverter problem [13]. When we compare to current source inverter, the inductor is used in the dc link to get high source impedance [14]-[17]. These two limitation is overcome by impedance source inverter includes the inductor and capacitor in the dc link, to get high constant impedance voltage source [18]-[20]. The power loss of the converter is too low and it produce good efficiency with less loss of power [19]. The z source are acceptable for misfiring switches. The output of harmonics distortion and electromagnetic interference are low [17]-[21].

3. PROPOSED SYSTEM

In this session described the proposed z impedance modified circuit connected between source power supply and single-phase inverter. The output of the inverter is AC source, it will connected to AC load application and excess is connected to AC grid system. The input DC source may use as Fuel source, solar photovoltaic, or battery sources. The proposed modified Z source network circuit diagram shows in *figure 1*. The z impedance circuit contains two inductance and two capacitances.

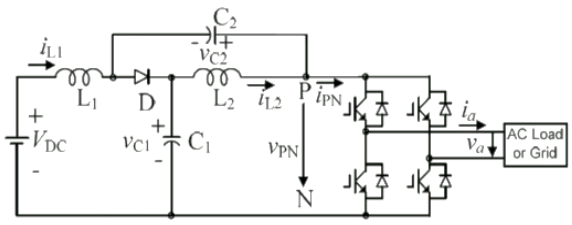
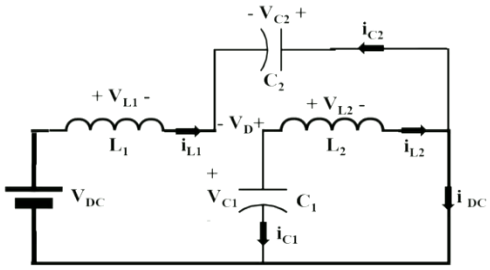
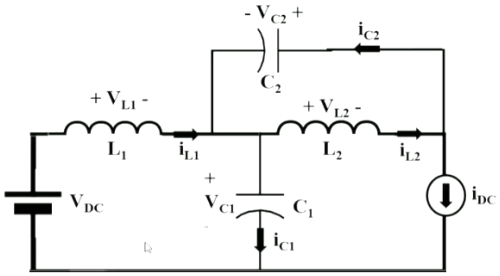


Figure 1: Proposed completed Z source modified inverter

The proposed system The Capacitance C2 is connected between the starting point of inverter and output of L1. The capacitance C1 connected between diode cathodes and starting point of L2. The mode of operation as shown in *figure 2*. The *figure 2* contains the two modes of operation. Mode 1 period the diode one is off. So, the L1 energy passes to C2, C2 to inverter. During mode 1 operation the L2 and C1 are connected in series, these two devices are connected across to the source. It is connected to the inverter circuit. During mode 2 operation the diode is On. So, the input current passes into split into two. One is going to C2 another one connecting to L2 and C1.



(a) Step 1 mode-diode is non conduction



(b) Step 2 mode-diode is conduction

Figure 2: Modes of operation of the z source inverter

The design of Capacitance and Inductance as shown in the *equation (1)* and *(2*) the Design of capacitance contains the output current, source voltage, maximum voltage, etc. the difference between Capacitance C and Inductance L are interchange of

$$C = \frac{I_o T_S (2V_m - E_S)}{2kE_S(4V_m - E_S)} \quad (1)$$

$$L = \frac{E_S T_S (2V_m - E_S)}{2kI_o(4V_m - E_S)} \quad (2)$$

4. RESULTS AND DISCUSSION

The proposed circuit designed the input 150v DC source and modulation index was 0.7, designed boost factor was 2.5, the duty ratio of designed 0.25, the frequency of switching was designed as 20Khz. The proposed converter design as follows. Switching frequency 20Khz, shoot through duty ratio was 0.25, input voltage was 150V dc, tolerance 5%, 40% for inductor current ripple, modulation index 0.7 and boost factor was 2.5. The finalized output voltage of inverter shows near pure sinusoidal waveform. The developed fundamental components of inverted sinusoidal pulse width modulation shown in *figure 3*. It has own phase shifted to DC to AC converter. It uses to balance the switching action of the converter. The difference between simple boost and proposed maximum boost as follows. The shoot through duty for simple boost was 0.25, maximum boost was 0.3797. voltage stress across simple boost 180, maximum boost was 230. The inverter output voltage of simple boost 340v, proposed boost was 450. THD percentage of simple boost 2.41, the proposed simulation was 1.32.

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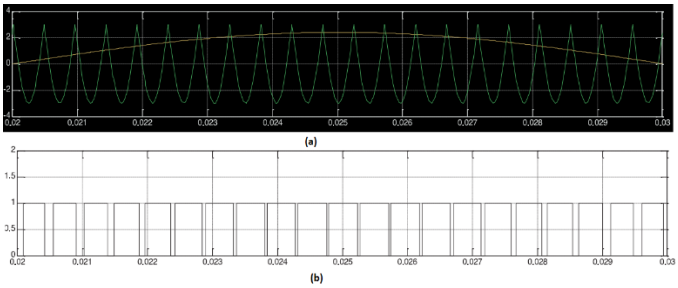

Figure 3: PWM generator (a) sinusoidal PWM comparison (b) PWM (scale X axis- Time)

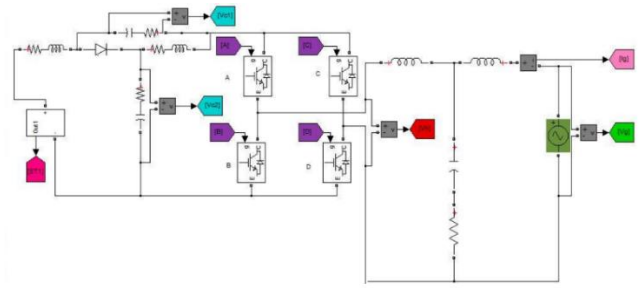

Figure 4: Simulation setup of the proposed system

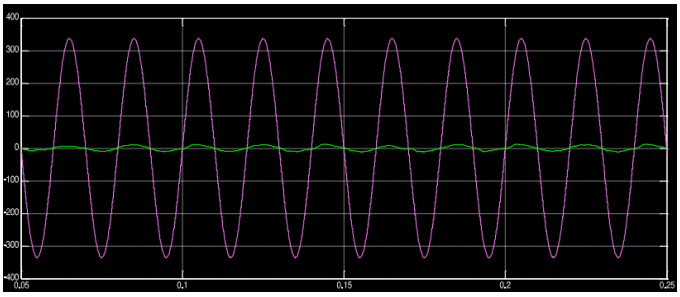

Figure 5: Proposed Peak values of output voltage and output current

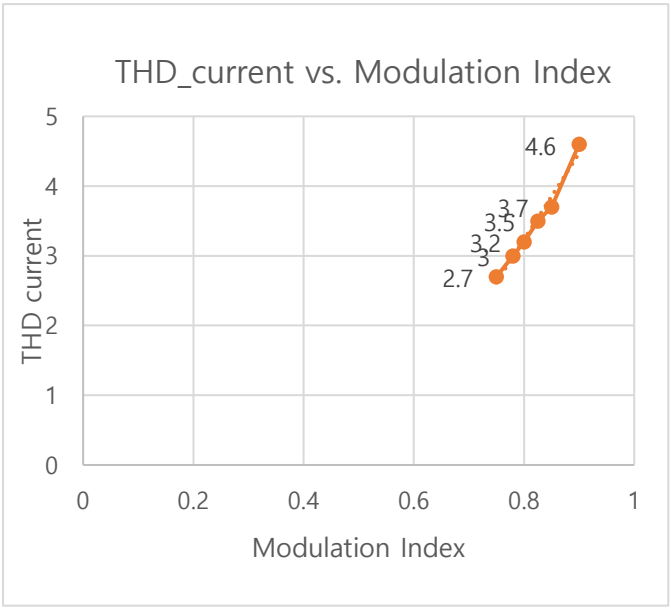

Figure 6: THD versus modulation index

Figure 4 shows the prosed modified z source inverter implemented into MATLAB Simulink environment. The output of z source is directly connected to single phase inverter. The proposed inverter used IGBT switches, the switching pulses of each cross was designed using unipolar and bipolar model. The rating of Simulink L =50 micro-H, Z source capacitance =240 micro-F, Input DC voltage =150. *Figure 5* represent the output peak value of the alternating current and voltage of the DC to AC converter. It shows that the phase locking of the output voltage and current has occurred. *Figure 5* represent the total harmonic distortion increases with respect to modulation index rises, So, it clearly shows that optimum value of modulation index decreases the current of total harmonics and enhanced boost output. *Figure 6* shows total harmonics versus modulation index waveform of the proposed system. The output waveform across the load as shown in *figure 7*.

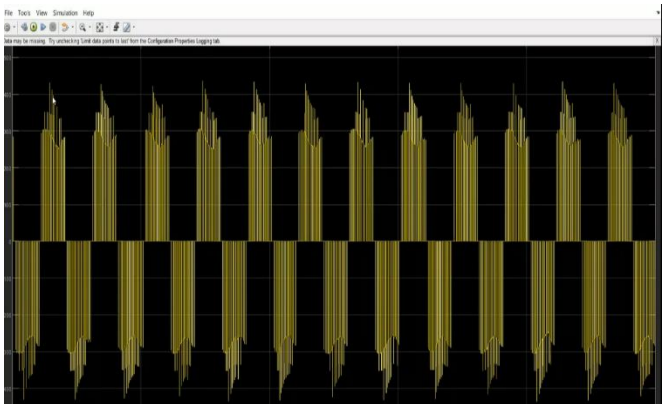

Figure 7: Output voltage waveform of the proposed z source inverter

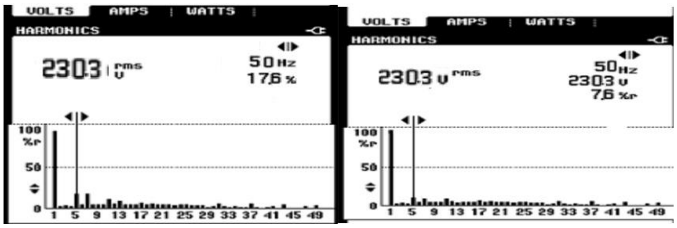

Figure 8(a): Conventional & proposed quasi Z source inverter

The proposed model used the ratings as follows inductance of z source impedance was designed 50 micro-Hendry, the capacitance value was 240 micro farads. *Figure 8(a)* illustrate the voltage harmonics level indication of conventional source inverter; the value was 17.6%. It was reduced to 7.6% in the proposed z source inverter. *Figure 8(b)* shows the voltage harmonic content lowest percentage compare to the conventional inverter.

5. CONCLUSION

This article presents a modified quasi-Z source single phase single stage H bridge inverter for renewable source application. The modified method controlled through voltage source conversion, so it can implement electric circuit easily. The proposed electric circuit implemented in to MATLAB SIMULINK modelling and hardware with open loos system. The hardware open loos implementation was slight difference

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appeared in the transient state recovery. Further extension of the work carry to reduce the total harmonic level from 7.5% to 4.5%, and connected to grid integration. The proposed controlling techniques indicates that the satisfactory of the dynamic level. The simulation setup validates the suitable performance under various scenarios with reflect on the switching. The average time was reduced 80% compared with existing model and improved the computation behavior.

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