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Design and Analysis of Switched Inductor Impedence Source Inverter

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Abstrct:
The conventional voltage source inverter is restricted by its only step-down operation and the current source inverter is restricted by exclusively current step down mode. In order to get extra boosting ability while keeping the number of active semiconductors unchanged the voltage type and current type impedance source inverters are initially proposed. These new type categorize of inverters are normally high robust and less sensitive to electromagnetic noises, but their boosting capabilities are unapparent compromised by high component stress and poorer spectral performances caused by exhausted modulation ratios. So their boosting gains are limited. To overcome these shortcomings z-source inverter by using switched inductor and switched capacitors are proposed. These extra boosting abilities and other advantages have been verified in simulation

Keywords: *voltage source inverter, current source inverter, switched inductor impedance source inverter*

1. Introduction

Inverters are the dc to ac converters. The input dc supply is either in the form of voltage or current is converted into variable ac voltage. The output ac voltage can be controlled by varying input dc supply or by varying the gain of the inverter. These are two types of traditional inverters based on input source used in industries for variable speed drive and many other applications. Those are

- Voltage source invert
- Current source inverter

In more precise , the voltage source inverter (VSI) can performed voltage step down operation and the current source inverter (CSI) can performed in the current step-down mode(assume that constant power delivered). So the voltage and current step-up performance can be increased by connecting the appropriate dc-dc converters to the conventional inverters. We are put the some intellectual efforts to finding the alternatives that have some new features, solve the existing problems and reduces the component size. To solve the above problems we are development various dc to ac inverters found in the literature. Among them most recognizable inverters are voltage and current type of impedance source inverters with switched inductor and switched capacitors are proposed. In these inverter we are connect the cross (X) shaped inductor and capacitor and switches as diode, inductor and capacitor with small values. In this paper interest is directed to the switched inductor configuration.

2. Existing Method

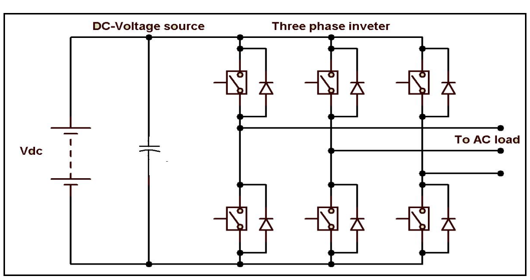


Figure 1: Voltage source inverter

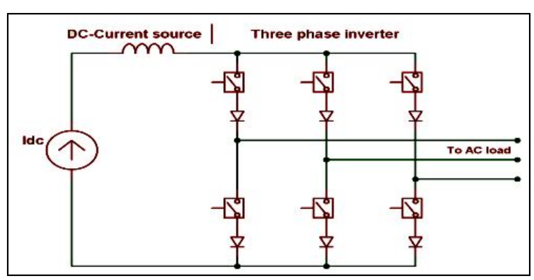


Figure 2: Current source inverter

The conventional voltage source inverter operated in only voltage step-down operation mode, while, the current source inverter operated in current step down mode. Traditionally in most of industries these VSI and CSI are used in adjustable speed drives. But these conventional inverters are many limitations as explained below:

- They are either a buck or a boost converter operation but cannot a buck-boost converter [1]. That is the output voltage is either smaller or greater than the input voltage. The voltage of VSI is always less than input voltage so it is called as buck

inverter; hence for additional voltage the booster circuit needs to be added. While CSI the output voltage is always greater than the input voltage hence it is called boost inverter, so additional voltage regulated circuit need to be added. This increase additional component cost.
- The VSI and CSI bridge inverters cannot be interchangeable. And also the voltage-source inverter circuit cannot be used in current-source inverter and vice versa.
- The shoot-through problem in voltage source inverter and open circuit problems in current source inverter to the electromagnetic interference (EMI) are reduces the reliability of inverters. In the shoot through, the inverter circuit may damage due to large current.
- In case of current source inverter the upper and lower switches cannot be switched of simultaneously, otherwise it would caused for open circuit along the bridge arm, this damage inverter circuit due to large voltage drop across open circuit. Hence overlap time where both lower and upper device conduct simultaneously needs to be providing for safe operation, which cause waveform distortion.

3. Proposed Method
- Design of Switched Inductor Impidance Source Inverter

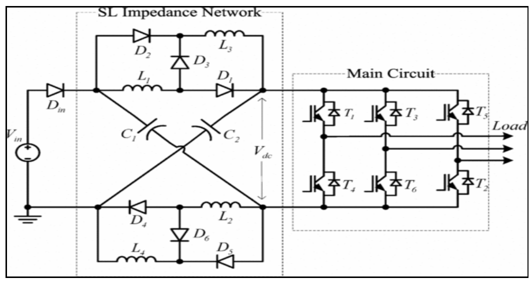


Figure 3: SL voltage type impedance source inverter

This impedance type power inverter that is termed as switched-inductor impedance-source inverter. To enlarge voltage adjustable ability, the proposed Inverter employs a unique switched-inductor impedance network to couple the main circuit and power source. In this switched inductor we are used the one input diode Din, two inductors L1, L2 , two capacitors C1,C2 and the two diodes D1,D2 are connected series with inductor, and one diode D3conected parallel with other diodes. In these the lumped elements values is very small. Compared with the existing method the proposed inverter increases the voltage boost inversion ability significantly, and only a very short shoot-through zero state is required to obtain the high voltage conversion ratios. In addition, the voltage buck inversion ability is also provided in the proposed inverter for those applications that need low AC voltages. Same to the classical voltage source inverter, the proposed concepts of switched-inductor impedance-source inverter can be applied to various applications of dc-ac, ac-ac, dc-dc and ac-dc power conversion.

4. Analasys of Switched Inductor Impedence Source Inverter
The voltage type SL impedance source inverter can operate both shoot-through and nonshoot-throug states. The features and expressions accompanying for both states are represented as follows:

4.1. Shoot Through Operation
In these turning on two switches simultaneously from at least a phase leg of the VSI Bridge. Upon doing so diodes D, D3, and D_3 reverse-bias, whilediodesD1, D2, D_1, andD_2 conduct. The two inductors per SL cell are hence in parallel with their voltages expressed as vL = vL1 = v_L1 = vL2 =L2 = VC1 = VC2 = VC.

4.2. Nonshoot-Through Operation
Referred to any of the traditional six active and two null states of a VSI. In this state, diodes D, D3, and D_3 conduct, while diodes D1, D2, D_1, andD_2 block. The two inductors per SL cell are thus in series, leading to VL = (Vdc−VC)/2.

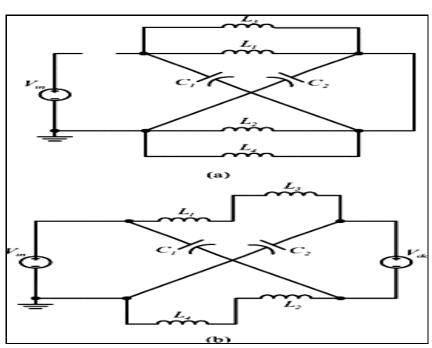


Figure 4: Shoot-through zero state (switching-on) (b) Non-shoot-through states (switching-off).

Averaging *vL* over a switching period to zero then gives rise to the following governing equations are for the capacitor voltage *VC*, peak dc-link voltage ˆ*vi* , and peak ac output voltage ˆ*v*ac, in terms of the source voltage *V*dc are

$$V_C = \frac{1-d_{\mathrm{ST}}}{1-3d_{\mathrm{ST}}}V_{\mathrm{dc}}; \quad \hat{v}_i \frac{1+d_{\mathrm{ST}}}{1-3d_{\mathrm{ST}}}V_{\mathrm{dc}}$$

$$\hat{v}_{\mathrm{ac}} = \frac{M(1+d_{\mathrm{ST}})}{1-3d_{\mathrm{ST}}}\frac{V_{\mathrm{dc}}}{2}$$

Where M <=1.15 and dst < 1/3 represents the VSI modulation ratio after adding the triple offset and normal shoot-through time per switching period, respectively. The dst can be evaluated by ratio of switch turnoff time to total time i.e. T0/T. The obtainable duty ratio of the shoot-through state can be regarded as a constant value, and its maximum value is limited to (1-M). The boost ratio B can be written as B = (1 + dST) / (1 − 3dST). It is larger than normal voltage source inverter. The gain of the SL impedance source can be written as G=Vac / (Vdc/2). And the gain also calculated using the M and B expressed as G=MB

5. Simulation Diagram

Simulation is performed using

MATLAB/SIMULINK software. Simulink library files include inbuilt models of many electrical and electronics components and devices such as diode,

Capacitors, inductor, IGBT, power supplies and so on. The circuit component is connected as per design without error, parameters of all components are configured as per requirement and simulation is performed. The complete simulation diagram as shown in the fig. the component values are chosen as per LI=L2=4mh and capacitors C1=C2=1000uf. The frequency of the reference signal is 50 Hz.

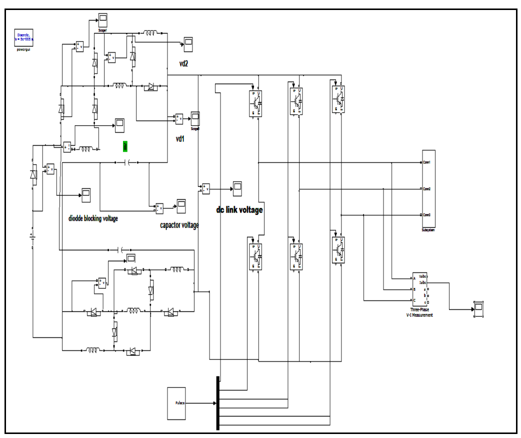
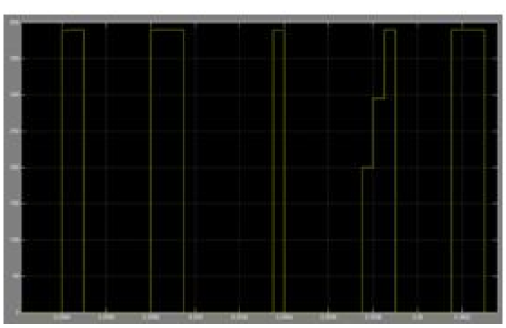
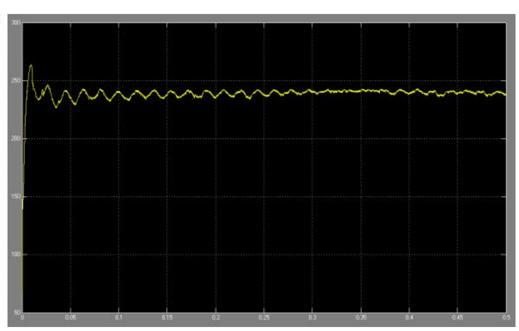


Figure 5: Simulation configuration of SL impudence Source: Inverter

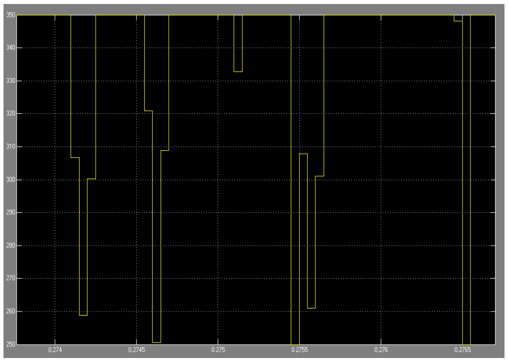
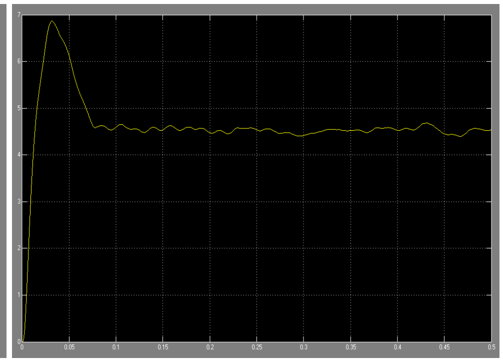
The analysis of the experiment is given below when we give 180V DC input voltage. The shoot-through duty ratio can be calculated as T0/T = 0.29. The boost factor B = 2.59. Gain of the inverter = G= 2.075

6. Simulation Results

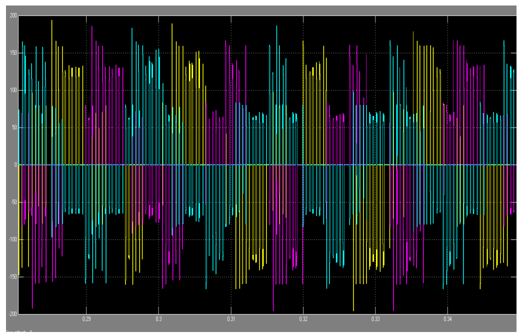



Diode blocking voltage Vd(v) = 380v. Voltage on y-axis and time on x-axis

Inductor current IL = 4.8A. Current on y-axis and time on x-axis

DC-link voltage Vi(v) = 380v. Voltage on y-axis and time on x-axis
Capacitor voltage Vc= 210v. . Voltage on y-axis and time on x-axis



Output voltage Vo (v) = 190v in AC. Voltage on y-axis and time on x-axis

In is compared with the traditional inverter the SL impedance source inverter get high output voltage. So the gain and efficiency of this type inverter is more.

7. Conclusion

The switched inductor impedance source inverter overcomes the conceptual and theoretical barriers and limitations of traditional voltage and current source inviter and provides an advanced power concept. The SL impedance source inverter system can be produce an output voltage greater than the dc input voltage by controlling the shoot-through duty ratio, which is impossible for the conventional ASD system. In this work described the operating principle, analyzed the circuit characteristics, and demonstrated its concept and superiority.

Result of simulation is compared with traditional inverter. Following results are observed,

- Shoot-through state is allowed by switching on all devices in the main inverter, thus EMI noise does not affect operation of SL Z-source inverter. This shoot-through state does not allowed in traditional inverter.
- The low frequency ripples in the inductor current and capacitor voltage are eliminated completely.
- Output voltage can be boosted to any desired value by varying shoot-through period T0, in zero states without changing active state for a fixed modulation index.
- Shoot-through state is determined by two straight lines, so it is easier to maintain constant shoot-through state and hence the boost factor for all the time.
- Component size (L & C) and hence cost required is less as compared to traditional inverter.
- Stator current is smooth as compared with traditional inverter. Small permissible ripples in stator current are observed at lower carrier frequency and at higher carrier frequency very smooth stator current is observed.

8. References

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