A STUDY ON MULTILEVEL CURRENT SOURCE INVERTER IN VARIOUS APPLICATIONS

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ABSTRACT:
Traditionally DC-AC converters are considered with voltage source inverters (VSI); although less studied and discussed, it has started recently to be used current source inverters (CSI). Another possibility for DC/AC conversion is the multilevel configuration. DC/AC power converters are very much useful to provide ac output from DC power supply. Based on their operation, these converters find their way in lot of applications such as Flexible AC Transmission System (FACTS), Uninterruptible Power Supply (UPS), and HVDC Transmission System etc. These converters are often classified into voltage source and current source inverters. In these, multi level configuration is common for both converters which are suitable for high power applications. In this paper, a different multilevel CSI is proposed: the paralleled configuration.
Keywords: *7 level CSI, AC-DC converter, transmission system.*

1.0 INTRODUCTION:

Nowadays usage of DC/AC power converters have been increased vastly, because of its suitability in connecting non conventional energy sources like photo voltaic and fuel cells into electrical grid. The DC/AC converters plays vital role in DC micro grid system. In general DC/AC power converter topologies are generally classified as Voltage Source Inverter (VSI) and Current Source Inverter (CSI). Recently VSI has been studied more than CSI in literature, however CSI are mostly preferred where boosting capabilities are required. The CSI has lot of advantages compared to VSI such as Low switching dv/dt, high short circuit ratio, and Lagging VAr compensation and also used in adjustable motor drives. Bulky inductors are present at the input side of the CSI to have smooth DC current and also protect the circuit from over current. In CSI, multi level configuration is considered because the output can be stepped up to higher voltages levels even when the input current is very low. Moreover, these multi level CSI possess lots of benefits like lower switching losses, low electromagnetic interference (EMI), high quality power output and higher output voltage, improved power quality etc. Multi level CSI can be divided into two types namely embedded configuration and two stage configurations. In this study a different multi level configuration namely paralleled configuration is analyzed which is more prominent than other topology and requires single power supply with reduced number of semiconductor switches to get higher current levels at the output.

2.0 LITERATURE REVIEW:

J. Anitha Roseline et al (2016) the current source inverters are usually fed by

controlled current source rectifiers (CSR) with a large inductor to provide a constant supply current. A generalized control applicable for both CSI and CSR and their extension namely current source multilevel inverters (CSMLI) are dealt in this paper.

K.K. Saravanan et al (2015) A high efficiency and operating life of grid feeding solar photovoltaic (PV) inverters are demanded. Because of reduced dc link capacitor requirement, current source inverter (CSI) offers higher reliability than the voltage source based solar inverter. Nonetheless, conventional three-phase pulse width modulated (PWM) current source based solar inverter injects high earth leakage current into the grid.

Prajna Paramita Dash et al (2014) proposes a grid-connected Photovoltaic (PV) system based on a multilevel Current Source Inverter (CSI) topology. The topology proposed here consists of parallel-connected CSI modules operating at a very low switching frequency. For n number of inverter modules, 2n + 1 current level are resulted in the output. In the multilevel inverter topology, each inverter module has its own PV source, Maximum Power Point Tracking (MPPT) unit, and DC-link current controller

Nimrod Vazquez et al (2012) a different multilevel CSI is proposed: the paralleled configuration. To control the converter, a different sinusoidal pulse with modulation is employed; it consists of modifying the reference signal instead of using multiple carriers. Additionally, a balancing method for the inductor currents is given.

3.0 RESEARCH METHODOLOGY:

Paralleled MLCSI: In this study, three CSIs are connected in parallel to get the required seven levels output. Figure shows the traditional seven level circuit having three distinct voltage sources. If the values of the voltage sources are identical then the traditional circuit can be modified as shown in Fig. Higher levels can be obtained by just adding two switches and an inductor with traditional circuit.

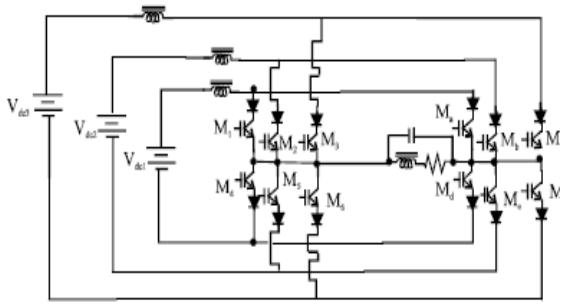


Fig shows traditional seven level inverters

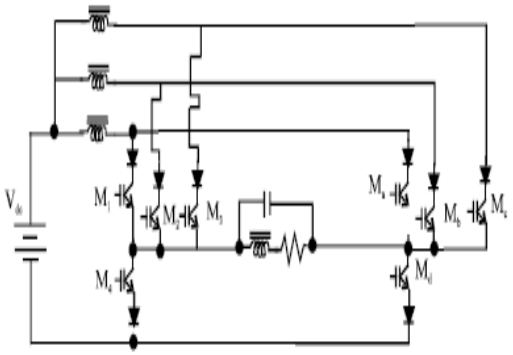


Fig shows Modified Inverter

Table shows Switching combinations of the 7-level CSI

Level	ON switches	Output current	DC bus current (IDC)
1	S_5, S_6, S_7	**0**	**0**

2	S_1,S_2,S_5,S_6 or S_1,S_2,S_5,S_7 or S_1,S_2,S_6,S_7	$\frac{2I}{3}$	$\frac{2I}{3}$
3	S_1,S_2,S_5 or S_1,S_2,S_6 or S_1,S_2,S_7	$\frac{2I}{3}$	$\frac{2I}{3}$
4	S_1S_2	**I**	**I**
5	S_3,S_4,S_5,S_6 or S_3,S_4,S_5,S_7 or S_3,S_4,S_6,S_7	$-\frac{I}{3}$	$\frac{I}{3}$
6	S_3,S_4,S_5 or S_3,S_4,S_6 or S_3,S_4,S_7	$-\frac{2I}{3}$	$\frac{2I}{3}$
7	S_3,S_4	**-I**	**-I**

The CSMLI topology is composed of two three-phase CSI modules connected in parallel. The power rating and the level can be increased by connecting N three phase modules in parallel. The inverter is assumed to be fed from an ideal current source. In practice it is obtained using current source rectifier. The performance of the proposed algorithm technique has been validated by simulation in the MATLAB/SIMULINK environment for 7 level CSI-MLI current source rectifier and 3 φ CSR fed CSI with RL load. The simulation parameters are shown

4.0 RESULTS:

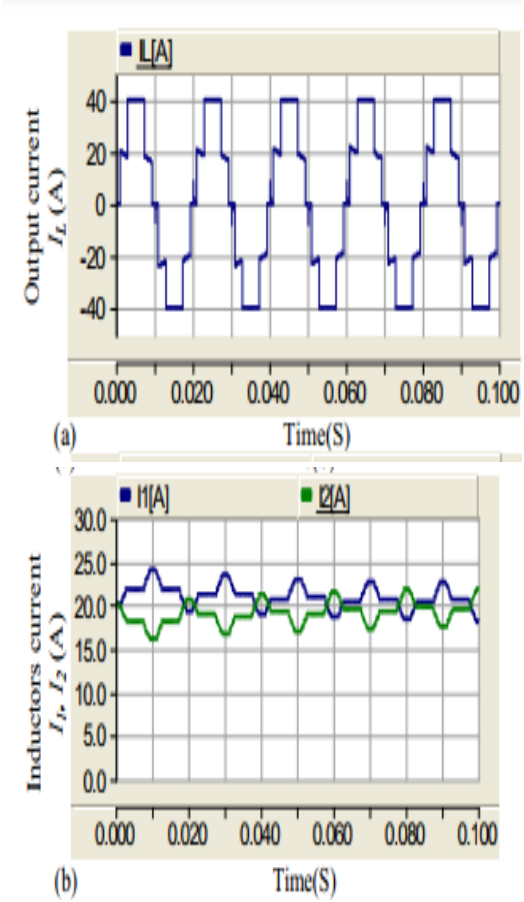
Comparison of Power Component Requirements per Phase Leg among seven levels Multilevel Inverter

Inverter Configuration	Diode Clamped	Flying – Capacitors	Cascaded– inverter
Main switching devices	2 (m–1)	2 (m–1)	2 (m–1)
Main diodes	2 (m–1)	2 (m–1)	2 (m–1)
Clamping diodes	(m–1)	**0**	**0**
DC bus capacitors	(m–1)	(m–1)	(m – 1)/2
Balancing Capacitors	**0**	(m – 1) (m – 2)/2	**0**

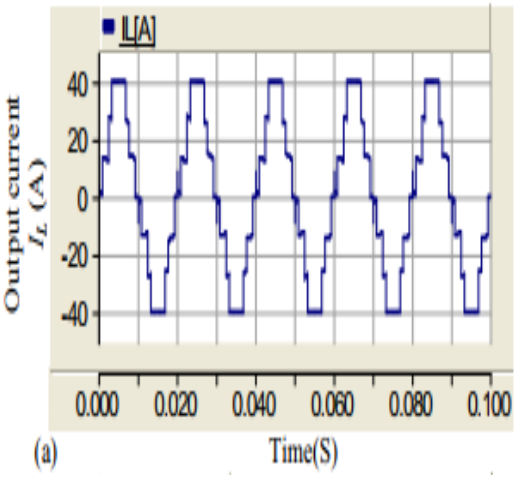
Input and Output Voltages of Three Invertershavng3 level inverters

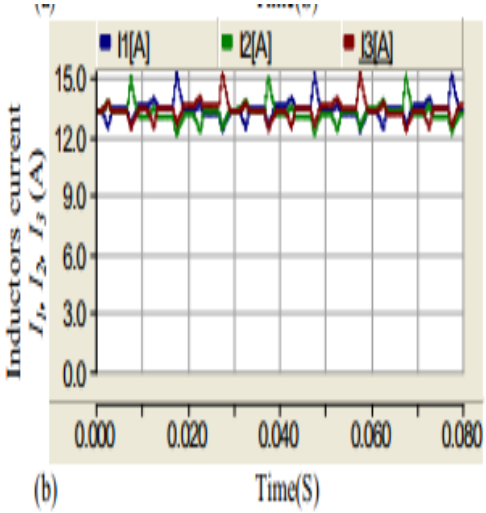
Name of the Inverter	Input voltage	Output voltage levels
Cascaded H-bridge (CHB) Inverter	200V	+200V, +100V, 0V.-100V, -200V
Neutral Point Clamped (NPC) Inverter	200V	+100V, +50V, 0V.-50V, -100V
Flying-capacitor (FLC) Inverter	200V	+100V, +50V, 0V.-50V, -100V

The proposed topology is able to generate the desired output current levels while current balance between current sharing inductors is completely satisfied that verifies the accuracy of the control method. It can be seen that the current balance of the inductors becomes better as time increases because the circuit reaches to its steady-state condition. Output current and current-sharing inductors current of the proposed 7-level CSI are shown.



Simulation results of the 7-level CSI (a) output current and (b) current-sharing inductors current at section A

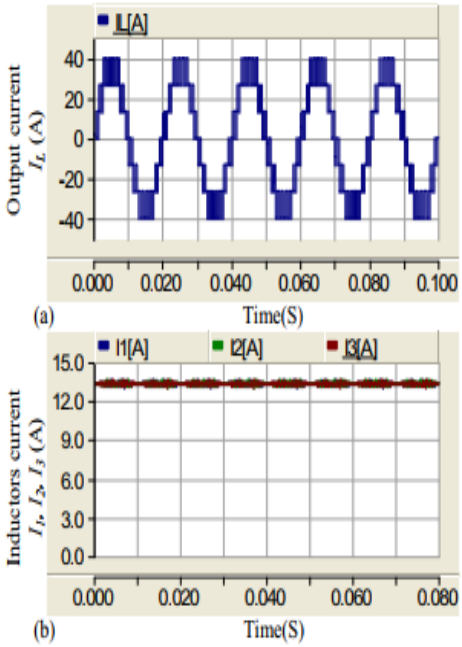




Simulation results of the 7-level CSI (a) output current and (b) current-sharing inductors current at section B.

Applying this control method, the current balance between current-sharing inductors improves considerably compared with the latter control method and the current through current-sharing inductors are almost the same and equal to one half of the output current. Moreover, output current magnitude Output current IL (A) I-276 can be linearly controlled by controlling the modulation index m, and also there are no low order harmonic components in the output current. The harmonic components of the output current are around the switching frequency which can be easily canceled out using a small LC filter. So this method is a suitable option to control the proposed multilevel CSI.

7-level CSI using carrier phase-shifted SPWM control shows the output current and the current of the current-sharing inductors that have the same values equal to one third of the total output current.



Operation of 7-level CSI using carrier phase-shifted SPWM modulation method (a) output current waveform and (b) current through current-sharing inductors

5.0 CONCLUSION:

A new multilevel CSI is proposed. The proposed topology uses reduced number of switches and is able to produce the desired output current while the current balance between current-sharing inductors is guaranteed using appropriate control method. The operation, analysis, and implementation have been exposed, and finally, the simulation and experimental results have been presented. The PWM employed considers just a single carrier instead of multiple carriers as in the traditional method. The reference is modified to fully modulate the converter.

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