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Inductor Cell Topology for Multilevel Inverter Applications

Er. Prerna S. Lautre[1], Dr. Harikumar Naidu[2]

[1]M.Tech, IV[th] Sem, (IPS), T.G.P.C.E.T, Nagpur, Maharashtra, India

[2]Dean Electrical Department, T.G.P.C.E.T, Nagpur, Maharashtra, India

Abstract: ***This paper presents a new circuit configuration of single-phase multilevel current-source inverter (CSI). In this new topology, a basic H-bridge CSI working as a main inverter generates a multilevel current waveform in cooperation with inductor cells connected in parallel as auxiliary circuits. Each inductor cell is composed by four unidirectional power switches with an inductor across the cell circuit. The inductor cells work by generating the intermediate level of the multilevel current waveform with no additional external dc-power sources. A simple proportional integral controller is applied to control the intermediate-level currents of the multilevel output waveform.***

Keywords: Cascaded H-bridge inverter, Level shifting Pulse Width Modulation

1. Introduction

The Voltage source inverter fed induction motor drives are mostly used in medium power applications. The voltage waveform level inverter show that the voltage across the motor contains not only the required fundamental sinusoidal components, but also pulses of voltage i.e. ripple voltage. The output of inverter voltage is applied to the induction motor the performance of the motors are degrades. Because of the ripple voltages the rate of change of voltage with respect to time is more. Also high voltage rating of the power semiconductors devices is required for inverters used to run the high voltage motors. The medium and high.

Voltage induction motor drives required high level inverter to produce the waveforms nearer to sinusoidal and to minimize the ripple content. As the number of levels increases, the synthesized output waveform adds more steps, producing a staircase wave which approaches the sinusoidal wave with minimum harmonic distortion. The stepped waveform is synthesized by selecting different voltage levels generated by the proper connection of the load to the different capacitive voltage sources. This connection is performed by the proper switching of the power semiconductors. The three and five level cascaded H-bridge inverters are analyzed how to produce the sinusoidal voltage and how the switches are operates with the level shifting PWM.

This paper is organized into five sections. Following the introduction in section I, different levels of inverters are discussed in section II, the basics of the level shifting PWM in section III, the simulation of three, five and seven level inverters with results and comparison between them insection IV. Finally conclusion from section V.

2. Cascaded h-Bridge inverter

The cascaded multilevel inverter consists of a series of H-bridge inverter. The general purpose of this multilevel inverter is to synthesize a desired voltage from several separate dc sources, like batteries, fuel cells, solar cells, and ultra-capacitors. A single-phase structure of a cascade inverter with separate dc sources [1]. Each separate dc source is connected to a single- phase full-bridge inverter. Single phase topology of the hybrid multilevel inverter is shown in Fig.1;thebottom is one leg of a standard 3-leginverter with a dc power source V_{dc}, the top is a hybrid in series with each standard inverter leg that the H-bridge inverter can use a separate dc power source the top is a hybrid in series with each standard inverter leg that the H-bridge inverter can use a separate dc power source($V_{dc}/2$).Considering the output voltage V_1 of this leg is either+($V_{dc}/2$)when S1 is closed-Vdc/2 when S2 is closed. This leg or is connected in Series with a full H – Bridge inverter, then the

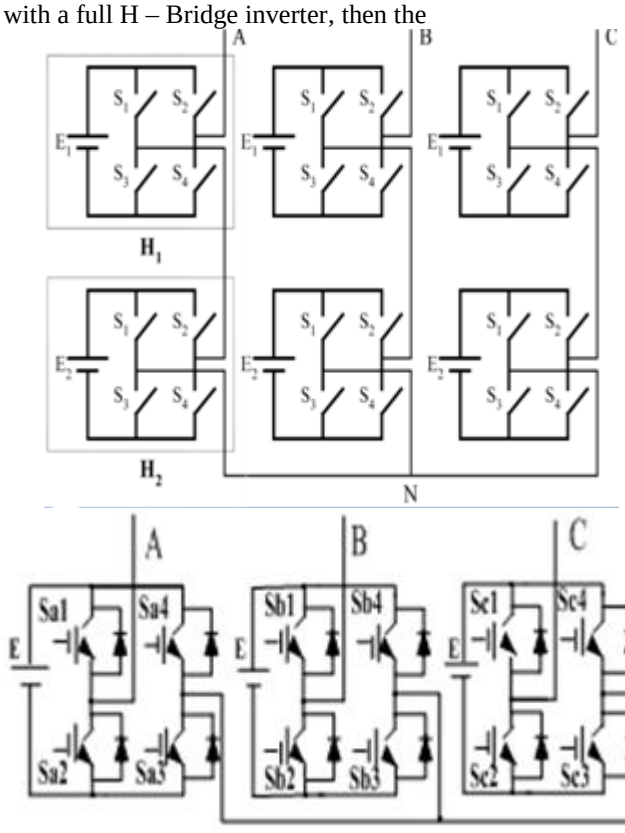

Figure 4: Five level cascaded H-Bridge inverter

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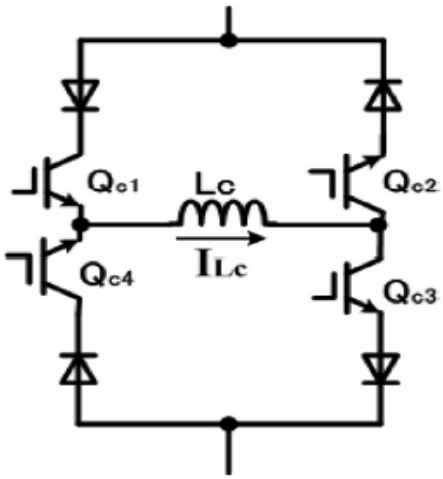
3. Inductor Cell Topology



This paper proposes a new circuit configuration of the multilevel CSI. In this new topology, a basic H-bridge CSI, working as a main inverter circuit, is connected in parallel with inductor cells working as auxiliary circuits. The inductor cells generate the intermediate levels of the multilevel output-current waveform, with no additional external dc-power sources. The operating performance of the proposed multilevel CSI is examined and is tested through some computer simulations. Furthermore, a laboratory experimental prototype of a five-level CSI circuit was set up to verify the proposed multilevel CSI topology.

4. Operating Principle

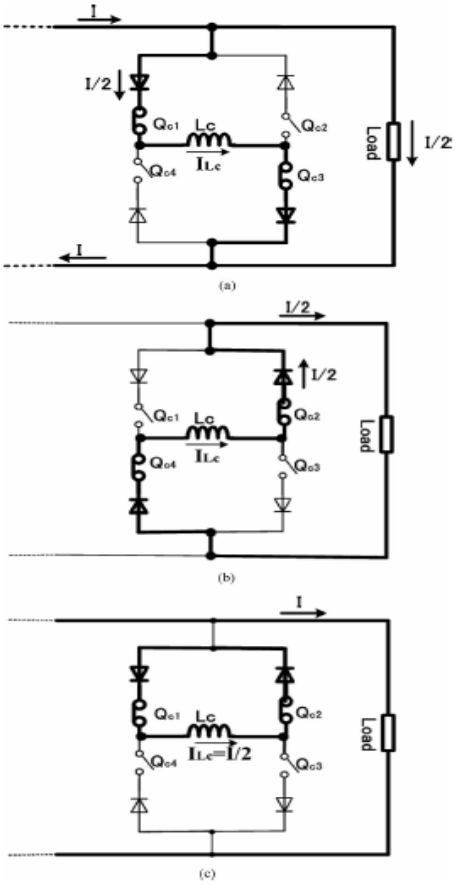
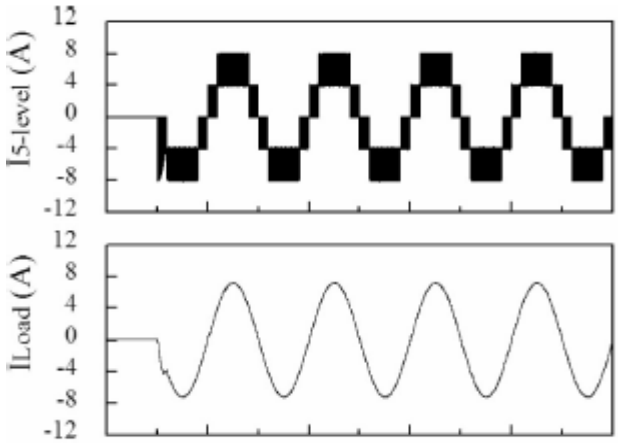


Fig. shows a configuration of the proposed inductor cell circuit composed by four unidirectional power switches Q*C* 1, QC2, Q*C* 3, and Q*C* 4, and an inductor *LC* connected across the cell circuit. The newly proposed configuration of the multilevel CSI can be obtained by connecting the H-bridge CSI in parallel with a single or more inductor cells, as shown in a schematic diagram of the proposed multilevel CSI in Fig. 3. A five-level CSI configuration is obtained by connecting a single inductor cell, a nine-level CSI configuration is achieved by connecting two inductor cells in parallel with the main three-level H-bridge CSI, and so forth. The relation between the level number of the output-current waveform (*M*) and the number of the inductor cells (*N*) can be formulated as follows.

$$M = 2(N+1) + 1$$

Q_1	Q_2	Q_3	Q_4	Q_{c1}	Q_{c2}	Q_{c3}	Q_{c4}	Output	Operation Mode of Inductor-Cell
1	0	1	0	1	1	0	0	+I	circulating mode
1	0	1	0	0	0	1	1	+I	circulating mode
1	0	1	0	1	0	1	0	+I/2	charging of inductor-cell
1	0	0	1	0	1	0	1	+I/2	discharging of inductor-cell
1	0	0	1	1	1	0	0	0	circulating mode
1	0	0	1	0	0	1	1	0	circulating mode
0	1	0	1	0	1	0	1	-I/2	charging of inductor-cell
0	1	1	0	1	0	1	0	-I/2	discharging of inductor-cell
0	1	0	1	0	0	1	1	-I	circulating mode
0	1	0	1	1	1	0	0	-I	circulating mode

5. Results



6. Conclusion

Compared with the conventional two-level power converter, the proposed multilevel CSI can generate multilevel output-current waveform with less distortion by connecting a single or more inductor cells across the H-bridge CSI. It results in a smaller *di/dt* produced by the circuit. Furthermore, a smaller size of the output capacitor filter can be used to filter the harmonic components of the output current.

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