NINE LEVEL MULTILEVEL INVERTER BY USING MATLAB

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Abstract: This research presents an optimum nine level multilevel inverter by using different fashion of switch and source combination. Multilevel inverter is a proved method to avoid the filter requirements or size of the filter can be reduced. In this technique, two kind of circuit designs has been used, one for inversion purpose and another one is used for level decider. The level decider circuit comprises of 4 number of sources with a fixed voltage, 4 IGBT switches and 4 diodes. The inversion circuit is a normal H Bridge comprises of 4 switches and load.In between the each level high frequency PWM also incorporated which aims to decrease the fundamental. The MATLAB based nine level single phase inverter is tested with R load and reported less THD at the end of the paper.

Key words: Multilevel inverter, Pulse width modulation, Total harmonic distortion.

I. Introduction

In recent years, there has been an extensive increase of interest in the area of multilevel power conversion circuits[1]-[3]. Multilevel Inverters (MLI) are a very attractive, favorite in high and medium voltage applications. MLIs are able to achieve almost pure sinusoidal voltages with very low Total Harmonic Distortion (THD) from medium voltage sources. MLIs enjoys significant advantages over the two level inverters in terms of lower harmonic issues, lower THDs, better efficiency, enhanced output quality, and lower switching stresses. Recent advanced multilevel inverter provides a solution on the limitations of conventional multilevel inverters. Recent advanced multilevel inverter topologies required less number of power devices as compared to conventional multilevel inverters. Less number of clamping diodes is used in the diode clamped MLI topology[4]-[6]. In 7-switches and 9switches MLI topologies are explained to provide 7-level output voltage. These MLI topologies gives more number of output levels using less number of power switches, but these topologies required more number of DC voltage sources[7]-[10]. Industrial applications use multi-level inverter techniques to decrease the voltage stress developed on power devices and to produce output voltages of good quality. The use of multilevel inverters is increased considerably in different utilities like UPFC, Industrial Drives, Electric Vehicles, Renewable Energy Conversion, Distributed Generation, and Active Filtering. Multilevel inverters have lesser Total Harmonic Distortion, voltage stress across the switch, Electromagnetic Interference effect, and higher power rating as compared to two-level inverter. The unique structure of multilevel voltage source inverters allows them to reach high voltages with low harmonics without use of transformers or series connected synchronized-switching devices. As the number of voltage levels increases, the harmonic content of the output voltage wave form decreases significantly. A multi-level inverter is an electronically operated device. In multi-level inverter we deal with more than 2-level voltage to generate a smooth and stepped waveform of output voltage, more than 2-level output voltage is having lower dv/dt ratio as well as lower harmonic distortions. The smoothness of the output voltage is in proportion with the voltage levels; with increase in the voltage levels the output waveform becomes smoother.

A multilevel inverter has several advantages over a conventional two-level converter that uses high switching frequency Pulse Width Modulation.The attractive features of a multilevel inverter can be briefly summarized as follows:

- Staircase Waveform Quality: Multilevel inverters not only can generate the output voltages with minimum distortion, and also reduce the dv/dt stresses; therefore Electro Magnetic Compatibility (EMC) problems can be reduced.

- Common-Mode (CM) Voltage: Multilevel inverters produce smaller Common mode voltage; so that stress in the bearings of a motor get reduced which is connected to the multilevel inverter. Furthermore, CM voltage can be eliminated by using advanced modulation strategies.
- Input Current: Multilevel inverters can draw input current with low distortion
- Switching Frequency: Multilevel inverters can operate at both fundamental switching frequency and high switching frequency PWM

In this research, the nine level multi level inverter has been investigated. In section II. Explains about the proposed method switching activities. In section 3 discussed about the results.

II. Proposed Method

In the proposed method is shown in Fig 1. Which consists of 8 switches and 4 diodes along with 4 same sources.Here 12 V dc supply has been used for individual source. Table 1 shows the various switching activity during one cycle. MATLAB 2013 has been used to analyze the MLI.

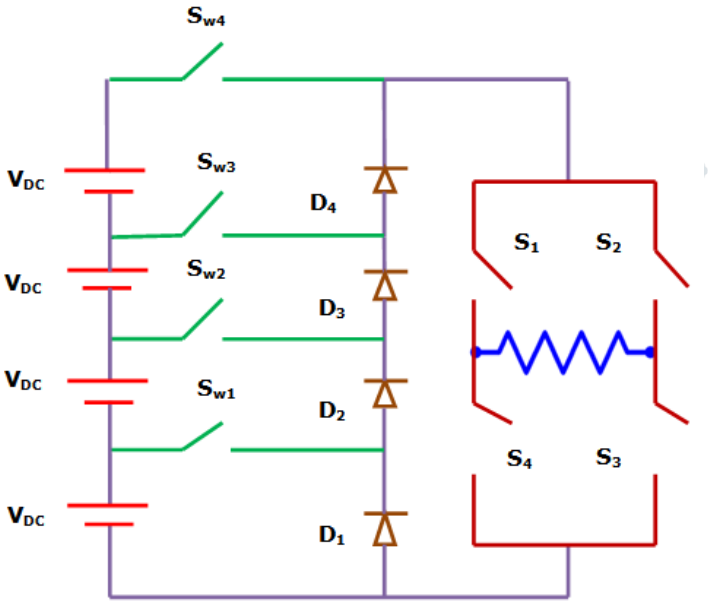

Figure 1. Skeleton Nine level MLI

Levels	SWITCH Position								output Voltage
	SW1	SW2	SW3	SW4	S1	S2	S3	S4	
Level 1	ON	ON	ON	ON	ON	OFF	ON	OFF	+4Vdc
Level 2	ON	ON	ON	OFF	ON	OFF	ON	OFF	+3Vdc
Level 3	ON	ON	OFF	OFF	ON	OFF	ON	OFF	+2Vdc
Level 4	ON	OFF	OFF	OFF	ON	OFF	ON	OFF	+1Vdc
Level 5	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	0
Level 6	ON	OFF	OFF	OFF	OFF	ON	OFF	ON	-1Vdc
Level 7	ON	ON	OFF	OFF	OFF	ON	OFF	ON	-2Vdc
Level 8	ON	ON	ON	OFF	OFF	ON	OFF	ON	-3Vdc
Level 9	ON	ON	ON	ON	OFF	ON	OFF	ON	-4Vdc

In this scheme, stress on the device has been reduced, because the frequency of the switches is less when compared with the two level inverters. The number of switching of devices is 2 only.

III. Results and Discussion

In this schemes is simulated with two loads with each Vdc=12 V. Fig. 2 shows the voltage and current of the load(R=10 ohm).

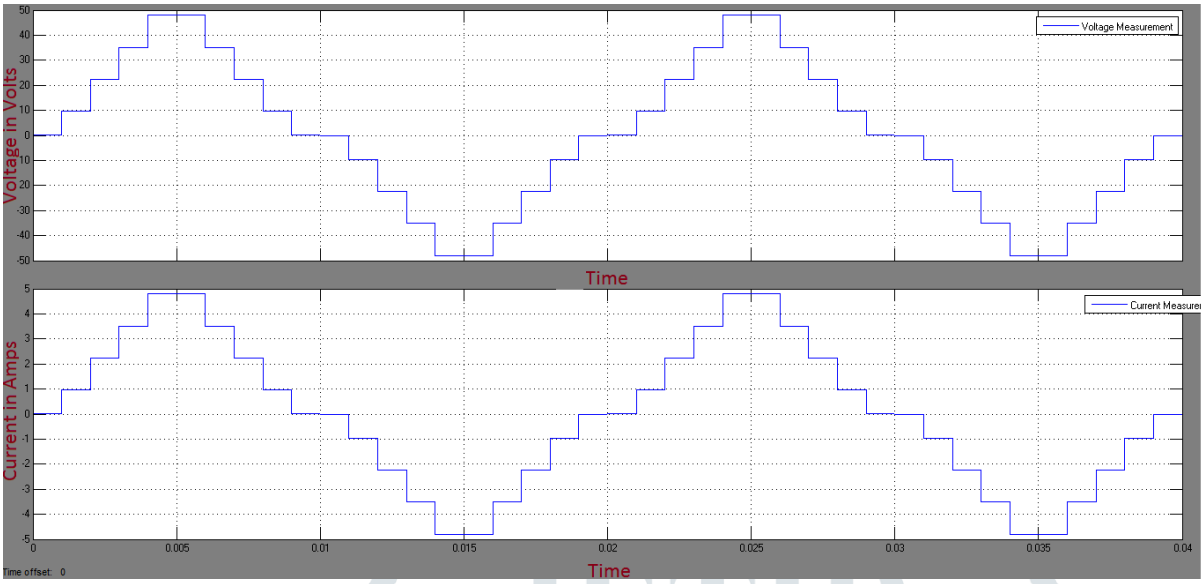

Figure 2. output voltage current of 9 level MLI R=10 ohm

Figure 3 and Figure 4 shows the spectrum of voltage and current with R load.

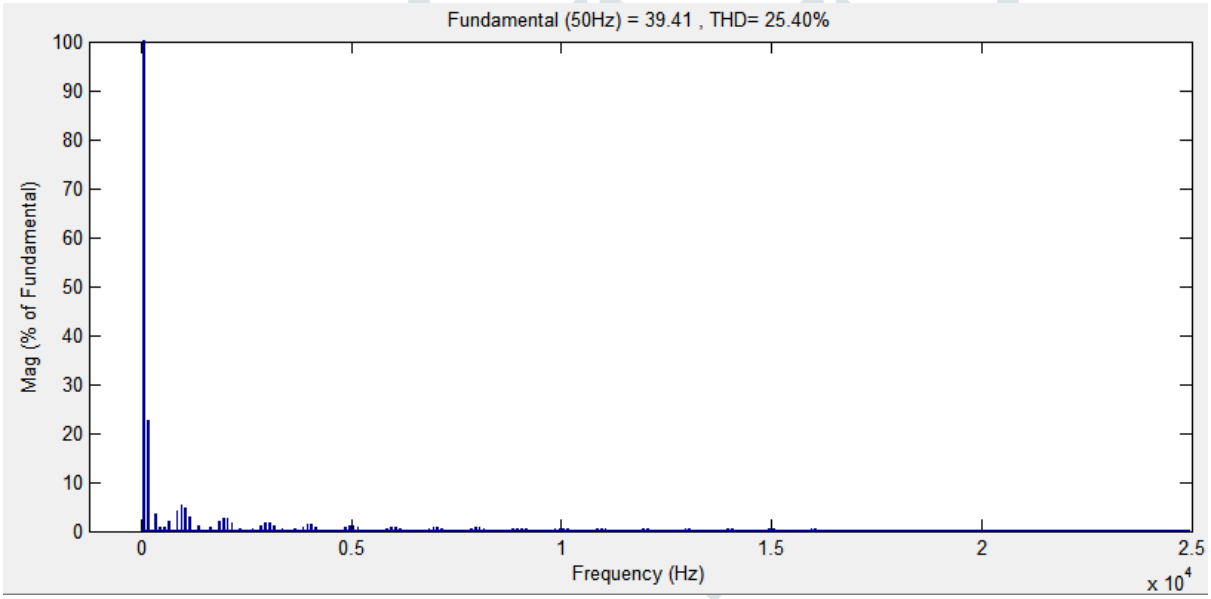

Figure 3. output voltage spectrum , R=10 ohm

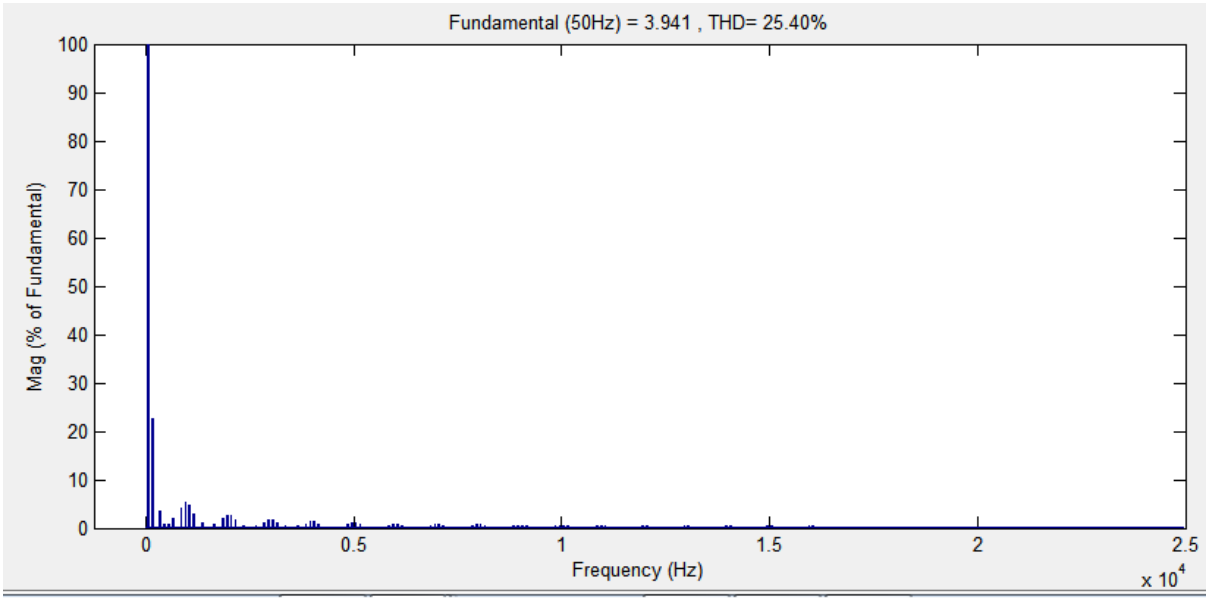

Figure 4.output current spectrum R=10 ohm

As per the theory of MLI, the advantage of MLI has been achieved in this MLI scheme.

1. Stresses on the switch will be less
2. Total harmonic distortion is less
3. Filter requirements are nil
4. Dissipation of heat because of harmonics is reduced

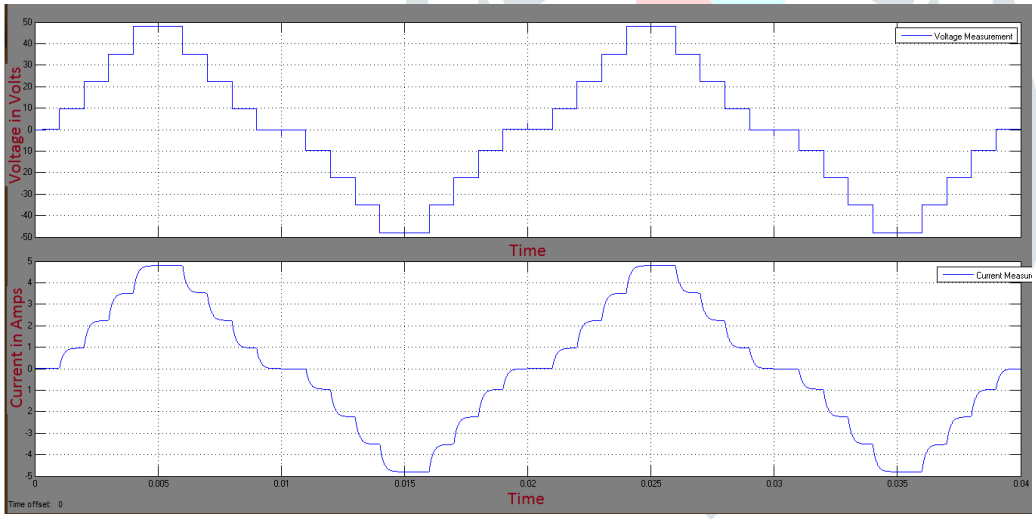

Figure 5. Voltage and current of MLI R=10 ohm and L=1.5 mH

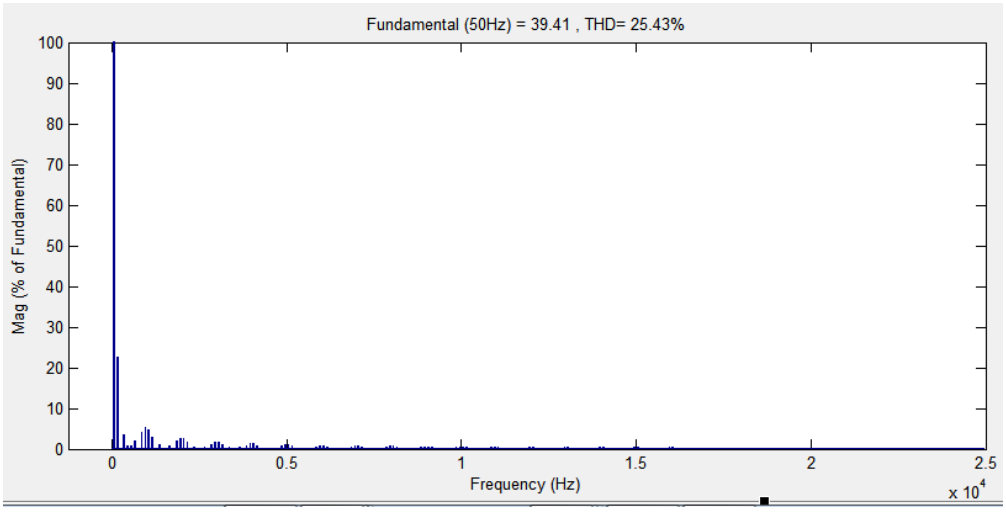

Figure 6 Voltage spectrum of MLI R=10 ohm and L=1.5 mH

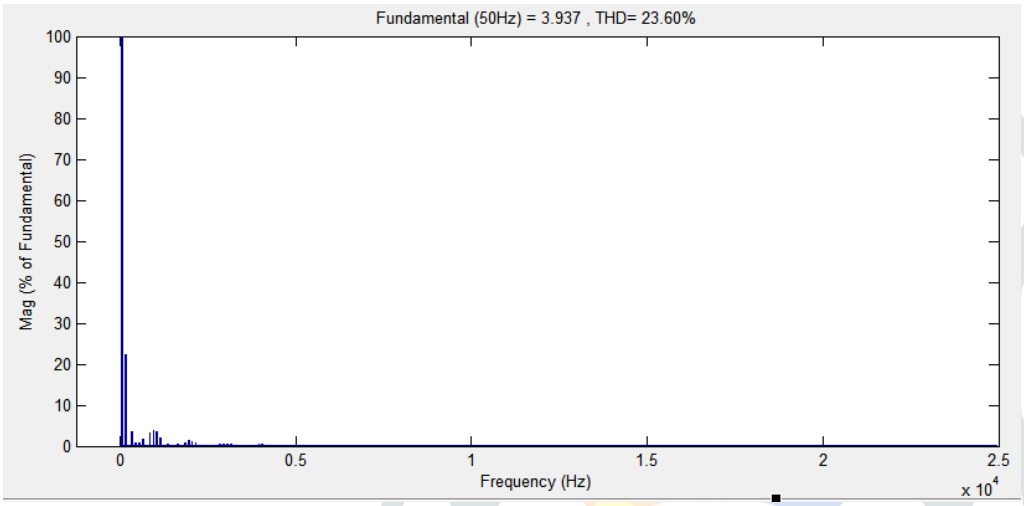

Figure 7. current spectrum of MLI R=10 ohm and L=1.5 mH

IV. Conclusion

In this research work achieved, the THD and fundamental comparison are made as below Table 3

Performance parameters	R Load R=10 ohm		RL load R=10 ohm and L=1.5 mH	
	Voltage	current	Voltage	current
Fundamental	39.41	3.941	39.41	3.937
THD	25.4	25.4	25.43	23.6

As per the table comparison, This scheme achieved more fundamental with less THD.

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