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A SINGLE-PHASE MULTILEVEL INVERTER USING SERIES OR PARALLEL COMBINATION OF DC VOLTAGE SOURCES

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Abstract: A novel multilevel inverter with a small number of switching devices is proposed. It consists of an H-bridge and an inverter which outputs multilevel voltage by switching the dc voltage sources in series and in parallel. The proposed inverter can output more numbers of voltage levels in the same number of switching devices by using this conversion. The number of gate driving circuits is reduced, which leads to the reduction of the size and power consumption in the driving circuits. The total harmonic of the output waveform is also reduced. The proposed inverter is driven by the hybrid modulation method. In this paper, the circuit configuration, theoretical operation, Fourier analysis, simulation results with MATLAB/SIMULINK, and experimental results are shown. The experimental results accorded with the simulation results.

Index Terms **- switching devices, harmonic, MATLAB, gate driving, multilevel.**

1.INTRODUCTION

A power inverter is basically a power electronic device which is generally used to changes direct current type quantity to alternating current type quantity. The primary function of an inverter is to change the form of power as in direct current (DC) to standard power in alternating current (AC). We need to covert DC to Ac because, whereas AC is the power supplied to industry and homes from the main power grid also known as public utility, where as the batteries of alternating power systems used to store only DC power. Also all renewable energy sources can generate and store dc power , So to utilized stored power which in dc format for majority of the appliances which need ac power to work we need inverter for that purpose.

Basically a multilevel inverter is used for generation of desired output voltage from various available dc voltage sources at its input side. Where as the input side voltage levels are generated from renewable type energy resources, fuel cells, capacitor type sources etc. Mostly multilevel inverters are used for high power and medium voltage type of applications in industries. Also the multilevel inverter has large numbers of application in industrial domain as it helps in purpose of the multilevel topology to reduce the voltage rating of the power switch. By combining output voltages in multilevel form, it shows advantages of low dv/dt also low input current distortion along with lower switching frequency. The highlighting feature of this new method is the reduction of overall power components.

Here is the new method of multilevel inverter with the main focus on reducing the overall switching components. In this method we have H-bridge and an inverter which gives multilevel output voltage by using different series and parallel combinations of voltage source. The new method in this paper is method can output more numbers of stepped output waveform similar to sinusoidal with less number of switching components compared to old type of H bridge method. Here in this new method, number of gate triggering circuits are comparatively less, which helps for reducing both the size and power consumption for triggering circuits. Here the overall output waveform distortion significantly less end. This method is driven by the hybrid modulation method. In this paper, the block diagram, theoretical operation, simulation output results with MATLAB results are shown.

1.1 Proposed work

The proposed work in this dissertation aims at designing and implementing of h bridge inverter with switching series or parallel dc voltage sources to achieve desired output voltage level.

It consists of following steps.

1. Study of various available traditional multilevel inverters and difference between them
2. Development of basic h bridge model for 11 level output
3. Implementation of H-bridge with series and parallel combination of voltage source using MATLAB.
4. Based on the PWM concept, design control systems for triggering of switches in h- bridge.
5. Real time simulation on MATLAB system and analysis of the acquired results.

1.2 Objectives

I. To investigate the performance of H-bridge inverter using series or parallel combination of DC voltage sources.
II. To design MATLAB simulation for multilevel inverter using new type of series or parallel combination of DC voltage sources.
III. To evaluate the results on the basis of harmonics and THD

2. LITERATURE REVIEW

1. In Application of Inverter Drives,"(Published in :IEEE Transactions on Industry and General Applications Volume: IGA-5, Issue: 1, Jan. 1969 electronics) , Authors Edward.w.Ddavis and Ralph.w.meier have mentioned about knowledge gained in past years in the topic of adjustable power frequency inverters in industrial domain. Also they mentioned about various operating parameters such as frequency, flexible nature, reliable operation, accurate voltage etc. Here required nature for proper operation and comparisons with rotating type drives is explained in the field of installation and maintenance along with the overall performance. That is in summary authors have explained about various upcoming trends related to the adjustable-frequency inverter topic.

2. In Multilevel inverters: a survey of topologies, controls, and applications,"(Published in:-IEEE Transactions on Industrial Electronics Volume: 49, Issue: 4, Aug 2002), authors J.Rodriguez, Fang Zheng Peng, Jih- Sheng Lai have mentioned about Multilevel output inverter methods as new emerging technology as improving alternative to high-power medium-voltage type of energy control. They focused on commonly used methods such as diode-clamped method , flying capacitor method, and cascaded multicell with separate DC sources, with their working principle, basic circuit diagram, with advantage and disadvantages. They also explained about most resent type of control and modulation methods for these type of converters such as multilevel SPWM, multilevel selective harmonic elimination, and space-vector modulation.

3. In Multilevel voltage-source inverter with separate DC sources for static VAr generation,"(Published in: IEEE Transactions on Industry Applications (Volume: 32, Issue: 5, Sep/Oct 1996), authors Fang Zheng Peng, Jih- Sheng Lai, J.Makeever, J.Vancoevering have mentioned about new method for cascading multilevel inverter with less number of gate triggered components and power transmission through switches is explained. The new method helps in reducing installation area and cost of for it with simple type of control system. This new method provide emphasis on series type connected various multilevel inverter blocks, also they have explained three different methods in selecting required number of dc voltage source magnitudes.

3.MLI INVERTER USING SWITCHED SERIES & PARALLEL DC VOLTAGE SOURCES

DC voltage sources V1,V2,V3 are independent of each other, and V0 : V1 = 1 : 2 is assumed. Switches Sa1, Sb1, and Sc1 are the switches which switch the dc voltage sources in series and in parallel. Fig. 1 shows this series/parallel conversion of the proposed 11-level inverter. When the switch Sa1 become OFF and the switch Sb1 and Sc1 become ON, the current flows in switch Sb1and Sc1, which connect voltage sources V1−V2 in parallel. Then, when the switch Sa1 becomes ON and the switches Sb1 and Sc1 become OFF, the current flows in the switch Sa1, which connect the voltage sources V1 and V2 in series via the switch Sa1. Using this series/parallel conversion of dc voltage sources, the lower H-bridge outputs vbus2 in 3 levels, while the upper H-bridge outputs vbus1 = V0. The proposed inverter outputs 7 levels by vbus1 + vbus2 or vbus2 − vbus1.

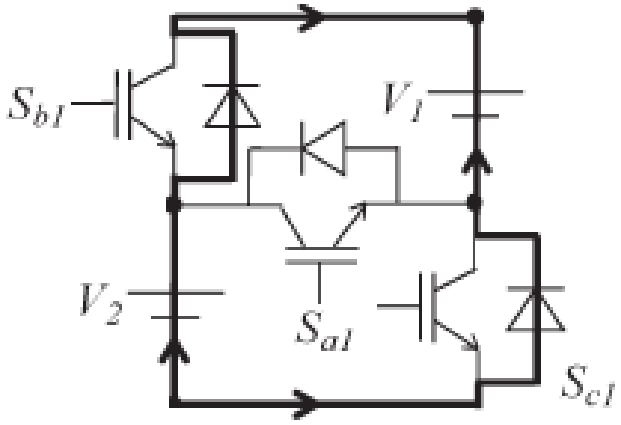

Figure 1 Series Parallel combination

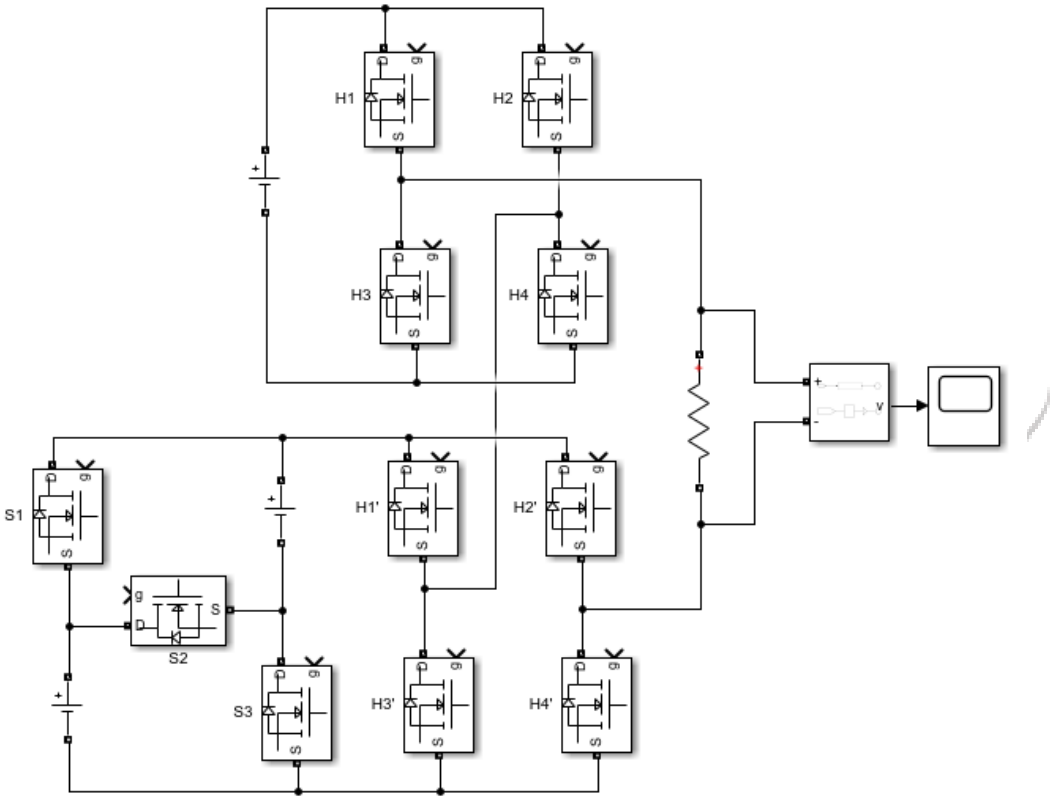

Figure 2 Circuit Diagram

When the conventional CHB inverter is driven by the HM method, 12 switching devices are needed for 11 levels and 16 switching devices are needed for 15 levels. On the other hand, the proposed inverter requires 11 devices for 11 levels and 14 devices for 15 levels. When the ratio of the voltages of the sources V0 : V1 = 1 : 3 is assumed, the proposed inverter requires 11 devices for 15 levels and 14 devices for 21 levels. The proposed inverter can also increase the number of output voltage levels by changing the ratio of the voltages of the sources like conventional CHB inverters. Therefore, the more output levels, the larger the difference between the required number of switching devices for the proposed inverter and the conventional CHB inverters. Although the same number of voltage sources is needed compared with conventional CHB inverters, the proposed inverter can be smaller than conventional CHB inverters because the number of switching devices is reduced.

4.RESULTS

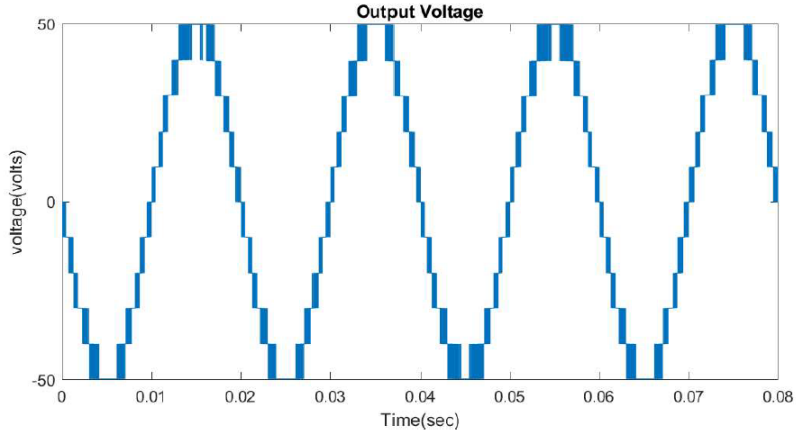

Figure 3 Output Voltage VS Time

The above figure shows the final output voltage of the multilevel inverter with proposed topology with 11 levels as output.

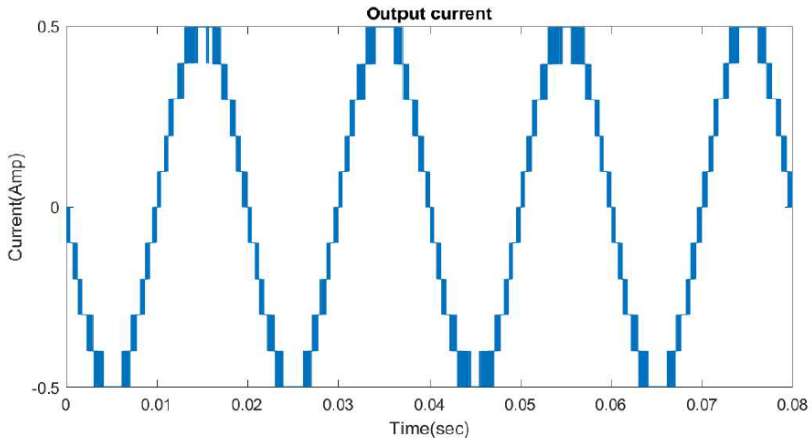

Figure 4 Output current VS Time

The above figure shows the final output current of the multilevel inverter with proposed topology with 11 levels as output.

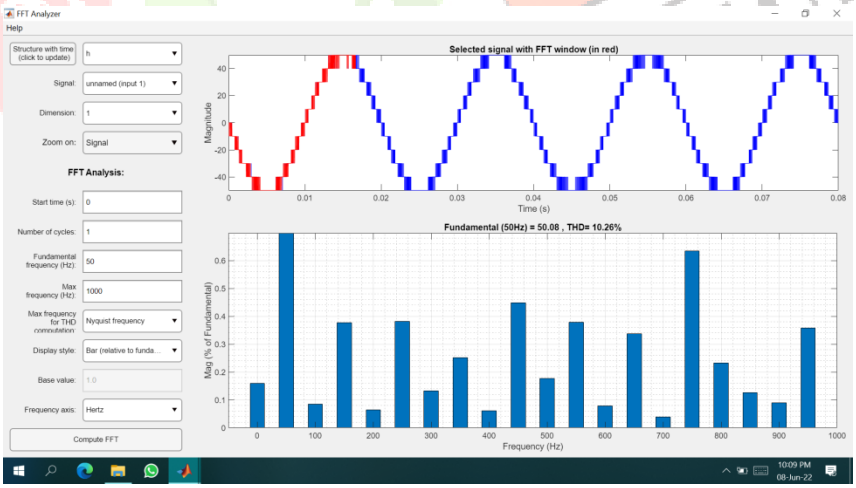

Figure 5 Output Voltage THD

The above figure shows the total harmonic distortion present in final output voltage of the multilevel inverter with proposed topology with 11 levels as output.

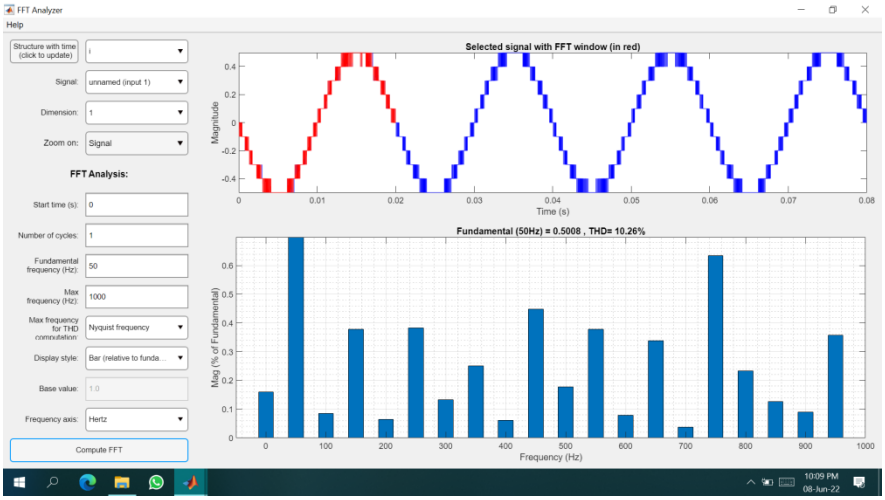

Figure 6 Output current THD

The above figure shows the total harmonic distortion present in final output current of the multilevel inverter with proposed topology with 11 levels as output.

CONCLUSIONS

In this paper, a multilevel inverter which reduces the number of switching devices by switching the dc voltage sources in series and in parallel has been proposed. The analysis of the harmonics in its output voltage waveform and simulation results is shown.

The proposed inverter can reduce the number of switching devices compared with conventional multilevel inverters in the same number of output voltage levels. The proposed inverter can also reduce the THD of its output waveform. In the proposed inverter, switching devices designed for low-voltage high-frequency operation and high-voltage low-frequency operation are properly used following the characteristics. Therefore, the proposed inverter can be applied to medium- and high power applications.

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