



SIMULATION OF 5-LEVEL H BRIDGE , DIODE CLAMPED & FLYING CAPACITOR TYPE MULTILEVEL INVERTER

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Abstract: Multilevel inverters are introduced for high power applications. It also uses the renewable energy sources like photovoltaic, wind and fuel cells which can easily used to supply to inverter system. This paper includes simulation of 5-level H bridge , Diode Clamped & Flying Capacitor multilevel inverter .Multilevel inverter promises a lot of advantages over conventional inverter especially for high power applications. Some of the advantages are that the output waveform were improved since multilevel inverter produced nearly sinusoidal output voltage waveforms, hence the total harmonic distortion also low. The switching losses also become less. And, the filter needed to smooth the output voltage is small; hence, the system is compact, lighter and much cheaper.

Index Terms – simulation, topology, multilevel inverter

I. INTRODUCTION

The basic principle of a multilevel inverter is to connect semiconductor switches in series so that the converter can operate with power ratings of several megavolt amperes and at medium voltage levels that exceed the individual switch voltage ratings. Multilevel inverter output voltage produce a staircase output waveform, this waveform look like a sinusoidal waveform.

Multilevel inverters have some advantages as compared to conventional inverter as listed below.

1. Possible to operate at high voltage with lower dv/dt per switching.
2. Higher Efficiency.
3. EMI (Electromagnetic Interference) is low.
4. Magnitude of sinusoidal voltage is high with low distortion at fundamental frequency can be produced at the output

II. SIMULATION OF FIVE LEVEL H BRIDGE MULTILEVEL INVERTER

The multilevel inverters generate output voltages with lower distortion and very low dv/dt stress. It also draws input current with very low distortion. Cascaded H Bridge multilevel inverter is highly reliable and achieves the fault tolerance in its modularity, and it enables the inverter to continue operating at lower power levels after failure. But the main disadvantage is that when the voltage level increases, the number of switches increases and also the sources, this in effect increases the cost and weight.

Figure 1 shows the circuit diagram and switching sequence of 5 level inverter using two full H- bridges. The output voltage level can be obtained by using only two full bridge inverter. The separate DC voltage are V_1 and V_2 given to the Multilevel Inverter, it operates with eight switches $S_1, S_2, S_3, S_4, S_5, S_6, S_7$ and S_8 shows. The different output voltage level can be obtained by closing the appropriate switches as shown in switching sequence. The output voltage of both the bridges is either added or subtracted by closing respective switches to get 5 different voltage levels i.e., $v_1, v_2, 0, -v_1, -v_2$. Here level one indicates switch is ON and level zero indicates switch is OFF.

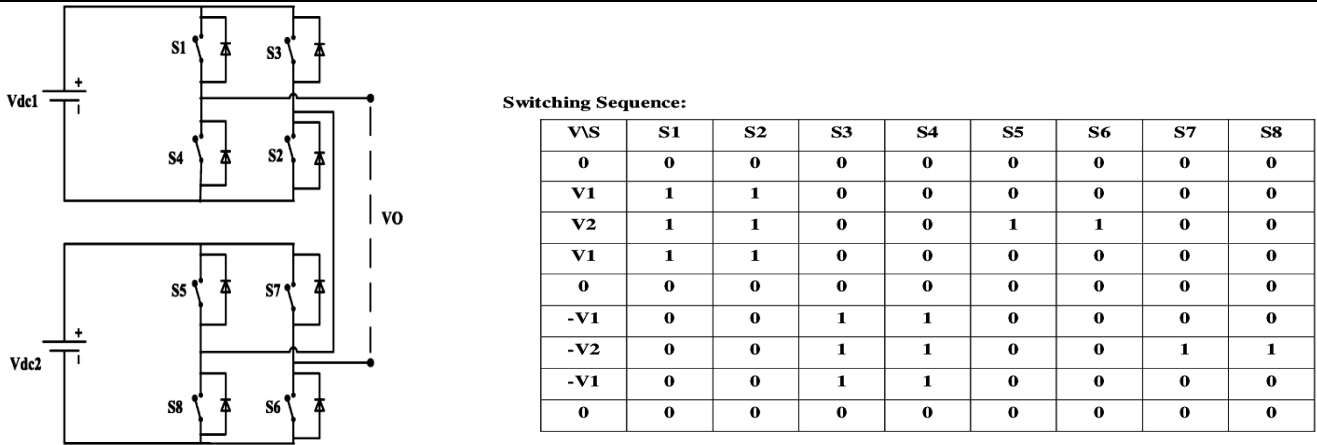


FIGURE 1 CIRCUIT DIAGRAM AND SWITCHING SEQUENCE OF FIVE LEVEL H BRIDGE MULTILEVEL INVERTER

Figure 2 shows simulation model and output waveform which was designed using MATLAB / Simulink Software. The gating signals for the inverter are generated by pulse generator using switching sequence mentioned above. In Simulation circuit, two separate 50 V Dc voltages are applied to 8 Switches. Output voltage waveform of 5 levels H Bridge type multilevel Inverter which shows five level in positive half cycle of 0,50,100,50,0 value of DC voltage and 0,-50,-100,-50,0 value in negative half cycle.

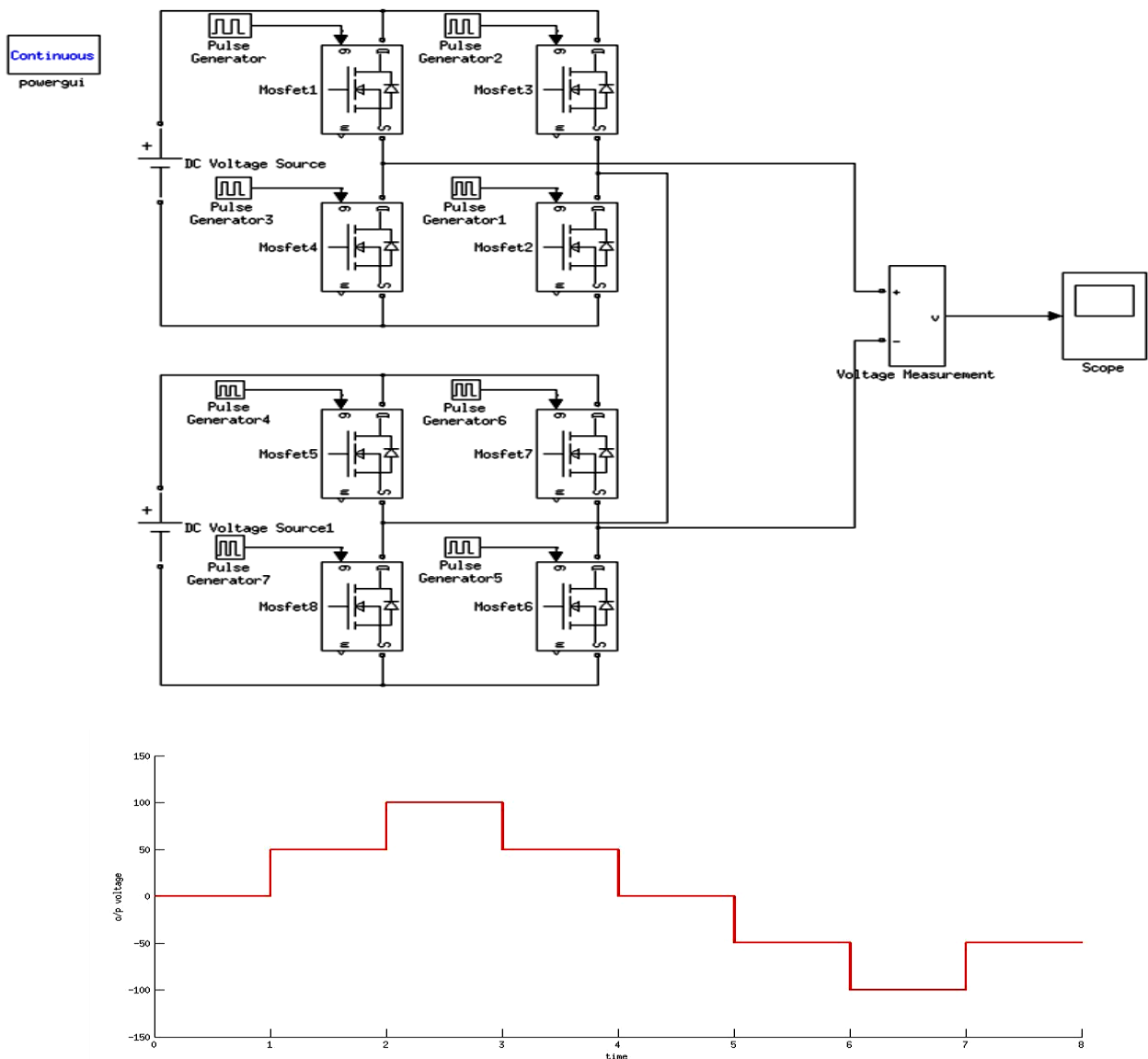


FIGURE 2 SIMULATION CIRCUIT DIAGRAM AND OUTPUT WAVEFORM OF FIVE LEVEL H- BRIDGE MULTILEVEL INVERTER

III. SIMULATION OF FIVE LEVEL DIODE CLAMPED MULTILEVEL INVERTER

The main concept of this inverter is to use diodes and provides the multiple voltage levels through the different phases to the capacitor banks which are in series. A diode transfers a limited amount of voltage, thereby reducing the stress on other electrical devices. The maximum output voltage is half of the input DC voltage. It is the main drawback of the diode clamped multilevel inverter. This problem can be solved by increasing the switches, diodes, capacitors. Due to the capacitor balancing issues, these are limited to the three levels. This type of inverters provides the high efficiency because the fundamental frequency used for all the switching devices and it is a simple method of the back to back power transfer systems.

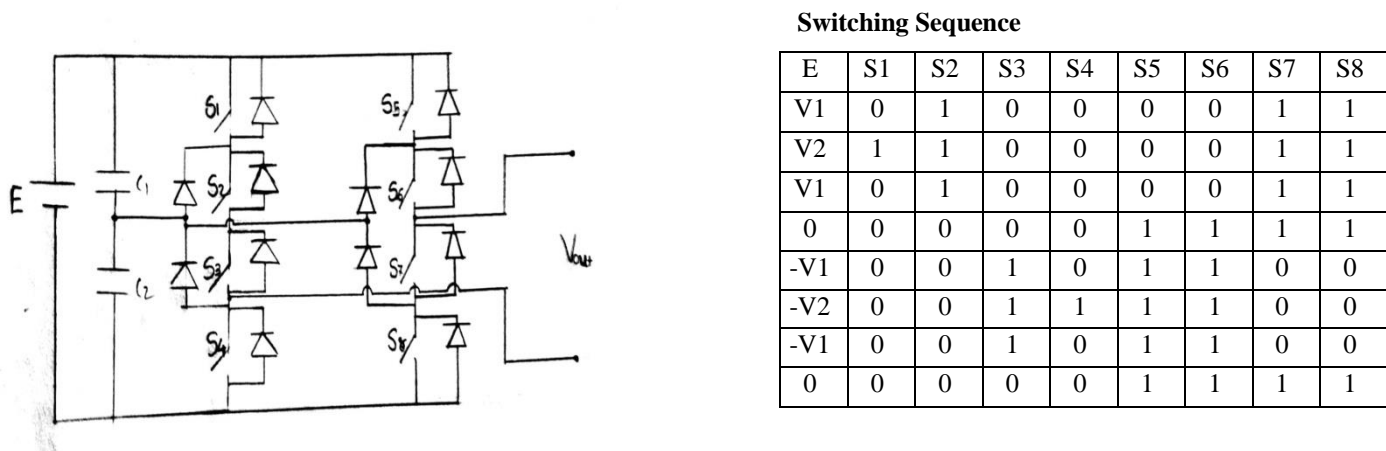


FIGURE 3 CIRCUIT DIAGRAM AND SWITCHING SEQUENCE OF FIVE LEVEL DIODE CLAMPED MULTILEVEL INVERTER

Figure 3 shows the circuit diagram and switching sequence of 5 level Diode Clamped multilevel Inverter. DC bus voltage is split up as shown. Five-level diode-clamped converter in which the DC bus consist of two capacitor C_1, C_2 for DC bus voltage E , the voltage across each capacitor is $E/2$ & each device voltage stress will be limited to one capacitor voltage levels $E/2$ through clamping diodes.

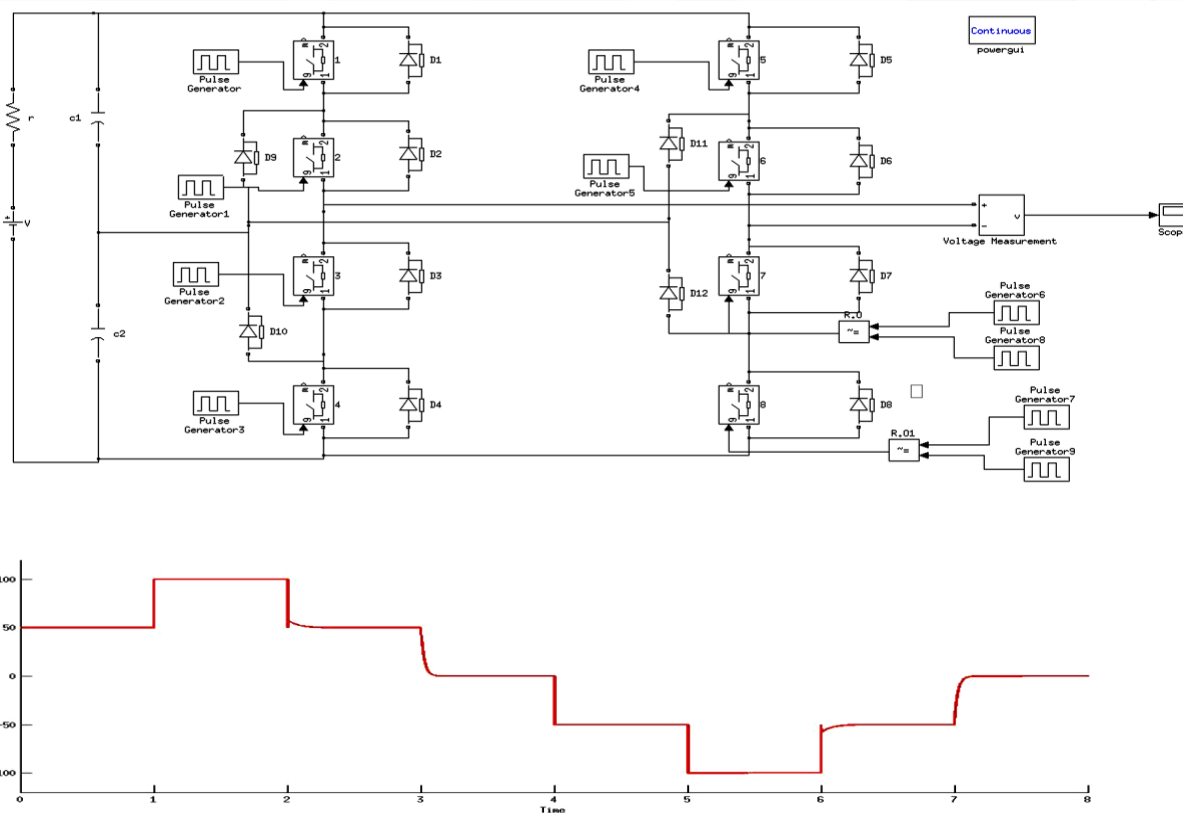


FIGURE 4 SIMULATION CIRCUIT DIAGRAM AND OUTPUT WAVEFORM OF FIVE LEVEL DIODE CLAMPED MULTILEVEL INVERTER

Figure 4 shows simulation model and output waveform which was designed using MATLAB / Simulink Software. The gating signals for the inverter are generated by pulse generator using switching sequence mentioned above. In Simulation circuit, DC voltage with resistive load split into two capacitors which are applied to 8 Switches and 4 diodes. Output voltage waveform of 5 levels Diode Clamped type multilevel Inverter is shown.

IV. SIMULATION OF FIVE LEVEL FLYING CAPACITOR MULTILEVEL INVERTER

The main concept of this inverter is to use capacitors. It is of series connection of capacitor clamped switching cells. The capacitors transfer the limited amount of voltage to electrical devices. In this inverter switching states are like in the diode clamped inverter. Clamping diodes are not required in this type of multilevel inverters. The output is half of the input DC voltage. It is drawback of the flying capacitors multi level inverter. It also has the switching redundancy within phase to balance the flying capacitors. It can control both the active and reactive power flow. But due to the high frequency switching, switching losses will takes place.

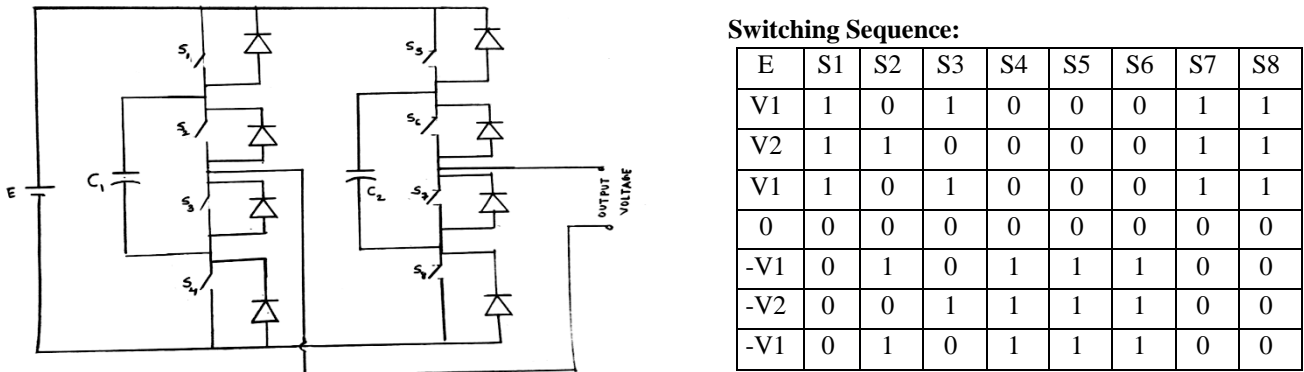


FIGURE 5 CIRCUIT DIAGRAM AND SWITCHING SEQUENCE OF FIVE LEVEL FLYING CAPACITOR MULTILEVEL INVERTER

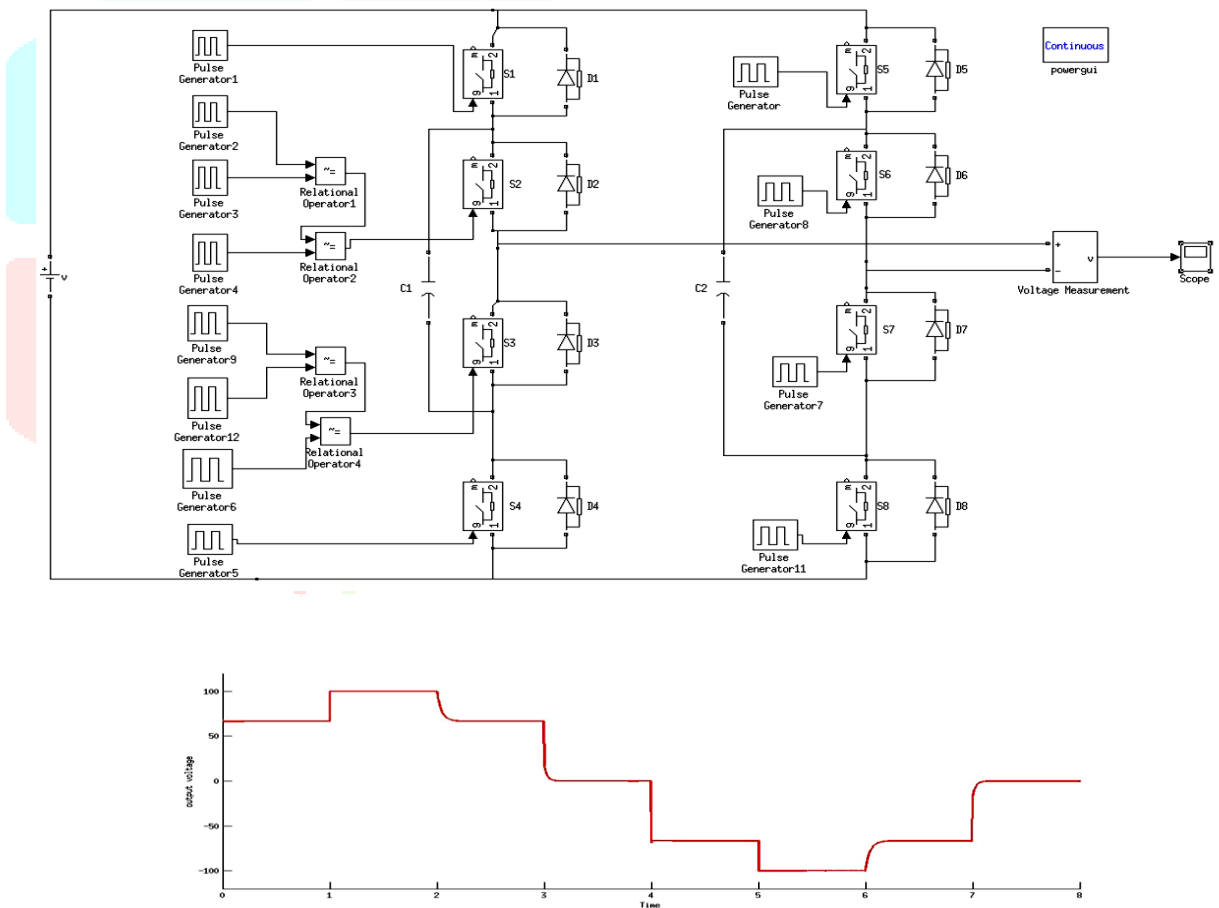


FIGURE 6 SIMULATION CIRCUIT DIAGRAM AND OUTPUT WAVEFORM OF FIVE LEVEL FLYING CAPACITOR MULTILEVEL INVERTER

Figure 5 shows the circuit diagram and switching sequence of 5 level flying capacitor multilevel Inverter. DC bus voltage is given to eight switches and two capacitor C_1, C_2 are connected across switches. Figure 6 shows simulation model and output waveform which was designed using MATLAB / Simulink Software. The gating signals for the inverter are generated by pulse generator using switching sequence mentioned above.

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