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Multilevel Inverter using SPWM Technique for AC Power Supply

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ABSTRACT
This paper presents two multilevel inverter for AC power supply. The cascaded H bridge topology of multilevel inverter is implemented .The control strategy has been design using SPWM technique. The operation of multilevel inverter is analyzed. The output has controlled and reduction in harmonic and THD. The simulation model has been built in matlab simulink and results are observed**.**
Keywords – Bi directional switch, multilevel inverter, matlab simulink, spwm,

I. Introduction

In the recent years the demand for high-voltage high-power is increasing in the industrial applications .The requirement of medium voltage and megawatt power level were require for the medium voltage motor drives and utility applications. So there was problem to connect only single power semiconductor switch directly to a medium voltage grid. As an alternative in high power and medium voltage situations a multilevel inverter structure had been introduced. From the multiple voltage levels with less distortion, less switching frequency, higher efficiency, and lower voltage devices a synthesize output voltage waveform can be desired. There exits different types of multilevel inverter. The different types of multilevel inverter topologies are as follows

1. The diode clamped or neutral point clamped (NPC) [1] ,
2. The capacitor clamped or flying capacitor (FC) [2]
3. The cascaded H-bridge (CHB)[3].

The NPC uses the diode clamped on the input side of the inverter but the main drawbacks of diode clamped topology is the unequal voltage sharing among series connected capacitors. The FC multilevel inverter uses flying capacitor as clamping devices. These topologies have several advantages in comparison with the NPC inverter, including the advantage of the transformer less function and unnecessary phase leg states that allow the switching

stresses to be equally distributed between semiconductor switches [4],[5].But, these inverters require an excessive number of storage capacitors for higher voltage steps. In FC multilevel inverter if any of the internal module is faulty then the maximum output voltage remains constant, but the number of levels decreases. It is noticeable that multilevel inverters can sustain the operation in case of internal fault [6]. For high level applications and for good modularity and simplicity of control the CHB topologies are good option. In this topology, a large number of isolated dc voltage sources are required to supply each conversion module. It increases the inverter cost and complexity. However, it causes to the increasing number of switching devices and other components, and increases the cost and control complexity and tends to reduce the overall reliability and efficiency of the inverter. In the CHB inverter if an internal fault is detected and that faulty module is identified, it can be easily isolated through an external switch and replaced by a new operative module [7]. In the proposed system the modules are cascaded in the series connection. The output obtained in the proposed system is of high efficiency and the harmonics are also reduced. The strategy used in the proposed system is SPWM which is easy to control and thus obtained a high efficiency output.

II. Proposed System

Fig (1) shows the proposed multilevel system.

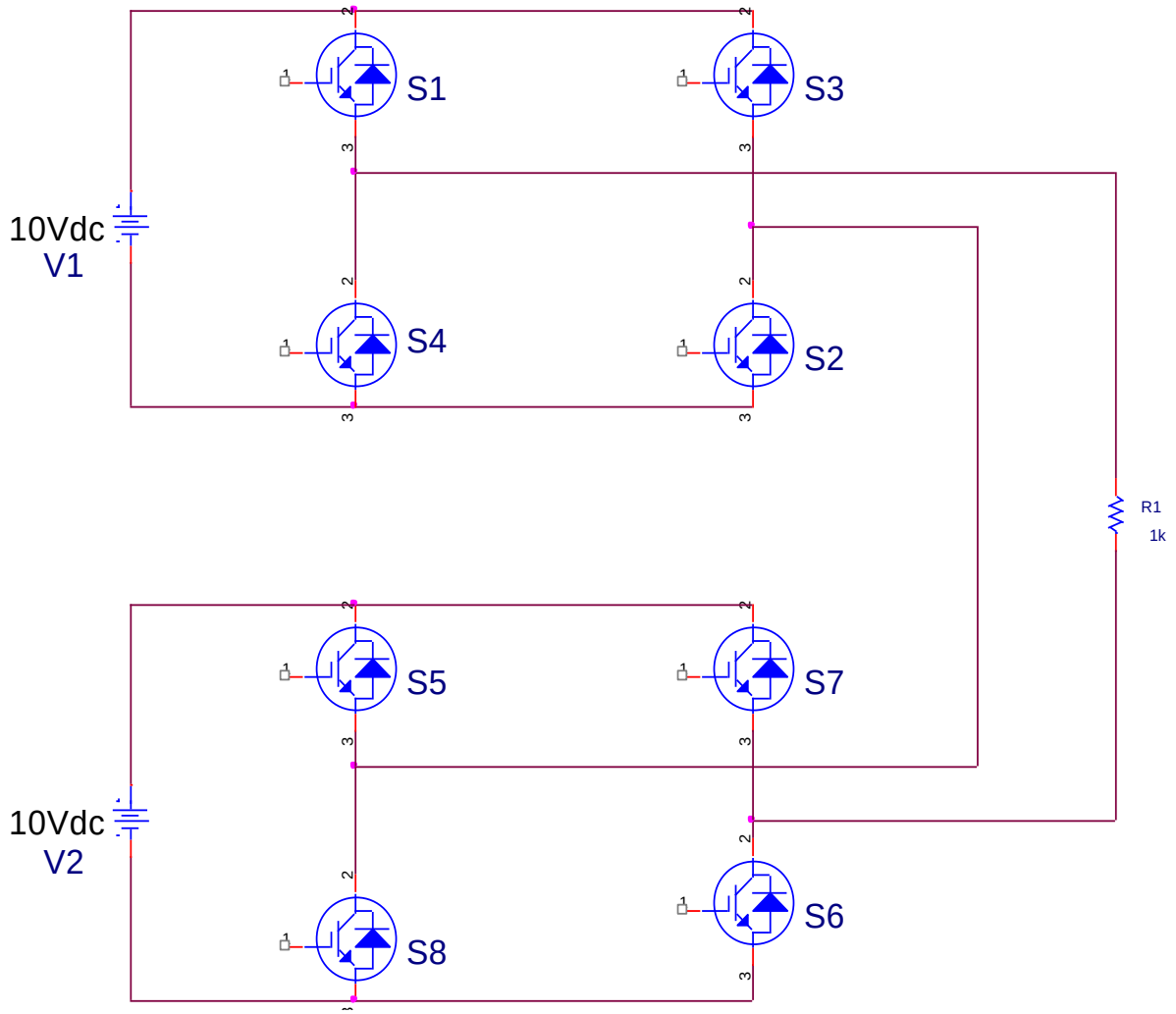

Fig 1: Proposed Multilevel System

The proposed system uses two modules which are connected in series. The two dc voltage sources are used for the proposed multilevel system. In symmetric mode the dc voltage sources have equal voltages and in asymmetric mode the voltages are unequal. In this case, the dc voltage sources are considered to be identical to V_{dc}.The proposed system includes 8 semiconductor switches. Antiparallel diode is connected to each switch. IGBT with an antiparallel diode is used as a switch and a diode. The IGBT used as switches are named as S1,S2,S3,S4,S5,S6,S7,S8 .V1 and V2 are the dc voltage sources. For different voltage level the operation of switching sequence will be following in the table1. For zero voltage the S1, S3, S5, S7 switches get ON. For 10V Voltage S2 S6 S8 S2 switches will be ON. For 20V voltage S1,S6,S5,S2 switches will be ON, For -20V voltage S3,S8,S7,S4 switches will be ON, For -10V voltage S3,S7,S5,S4 switches will be ON. The typical waveform for the multilevel inverter is as shown in the Fig 2. The waveform is of multilevel inverter which uses three modules which are cascaded in series. The proposed system controls the output of the circuit through the control technique in which SPWM strategy is used

Table 1
Switches Operating with Different Voltage Level

Sr no	Voltages levels	Operating switches
1	0	S1 S3 S5 S7
2	10V	S2 S6 S2 S8
3	20V	S1 S6 S2 S5
4	-20V	S3 S8 S4 S7
5	-10V	S3 S7 S4 S5

III. Modulation Technique used in Proposed System

The Sinusoidal Pulse Width Modulation (SPWM) is well identified as wave shaping technique as shown in Fig.3. The carrier signal (triangular), Vc, is compared with a sinusoidal reference signal, Vr. The modulation index (M) is given as the ratio of the magnitude of Vr to Vc. The crossover points are used to determine the switching instants. The magnitude of fundamental component of output voltage is proportional to M. The amplitude Vc of the triangular signal is generally kept constant. By changing the modulation index, the output voltage could be controlled.

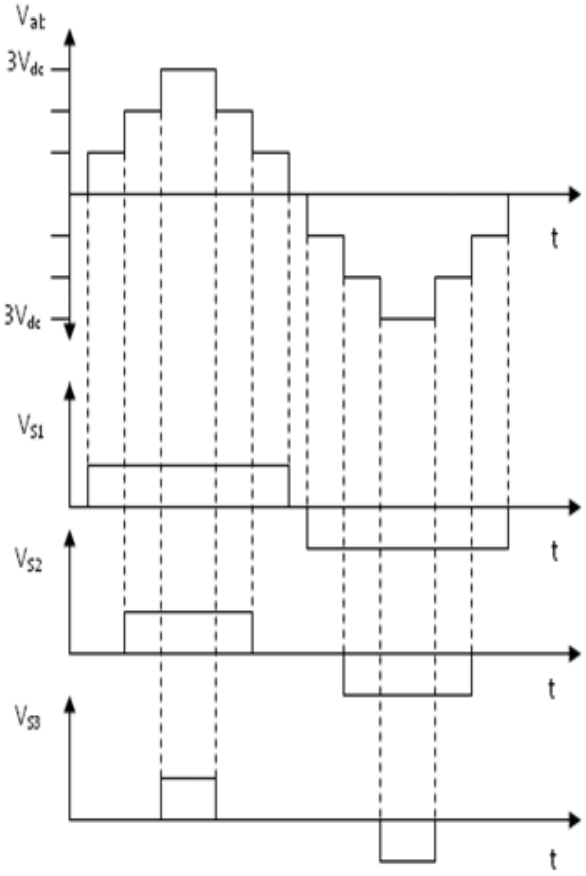

Fig 2 Waveform of multilevel inverter

IV. Simulation Model

In order to verify the operation of the proposed system the prototype model in the matlab, simulated model has been prepaid. The simulated model is as shown in the Fig 4 below. In the proposed system the two modules are used as seen in the Fig 4. A dc voltage is given at the input of the inverter and the output obtain is the AC waveform. The output of SPWM is as shown in fig 5.

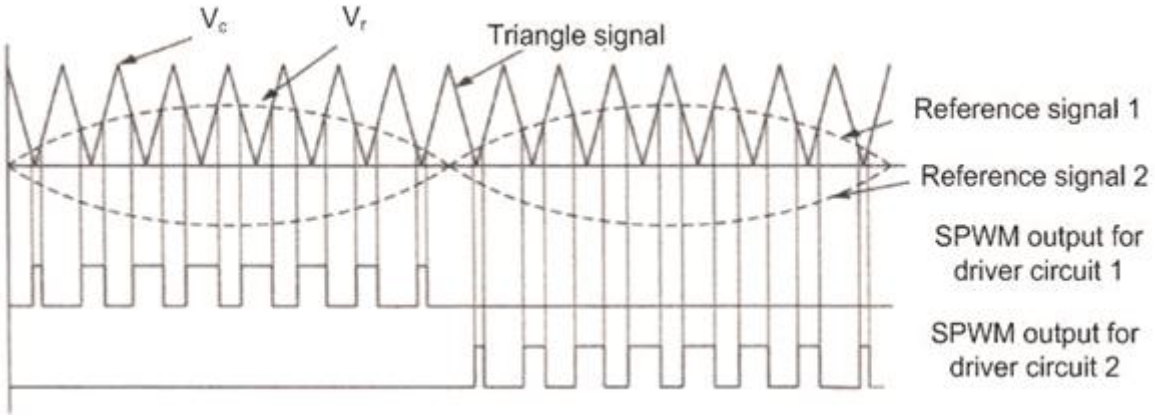

Fig 3 Structure of SPWM

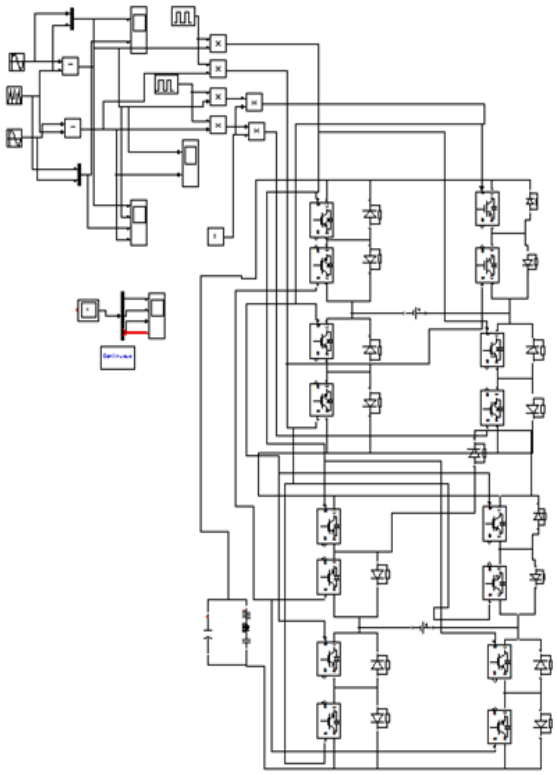

Fig 4: Simulated model of Proposed System (Multilevel Inverter)

V. Simulated Results

The output of the simulated model is shown in the Fig 5.The output is taken by applying different DC voltages at the input. The output waveform is shown in the Fig 5. In the Fig 5(a) the input voltage is given as 100 Vdc to each module in the model and the output is a 200V AC as seen in the Fig 5(a), in Fig 5(b) the input is given as 50 Vdc supply to each module and the output is 100V AC. In Fig 5(c) the input to first module is 50 Vdc and that of to second module is 20 Vdc and the output got is 70 V AC as seen in the Fig 5(c).

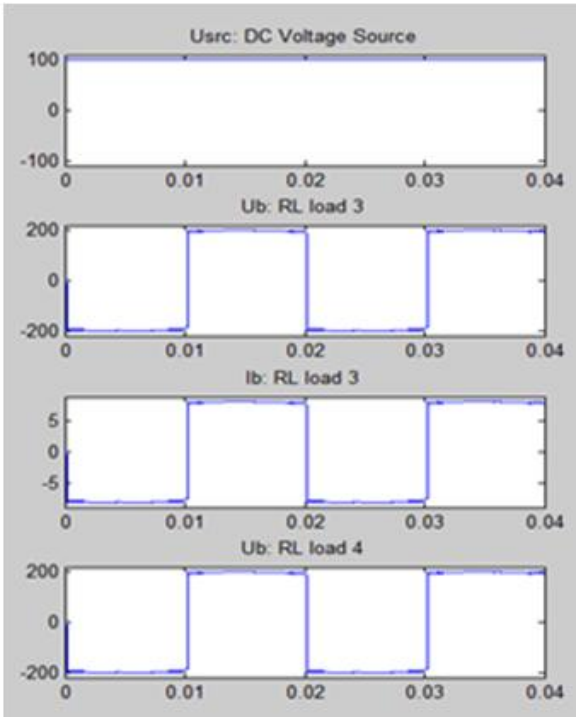

Fig 5(a) input 100 Vdc and output 200V

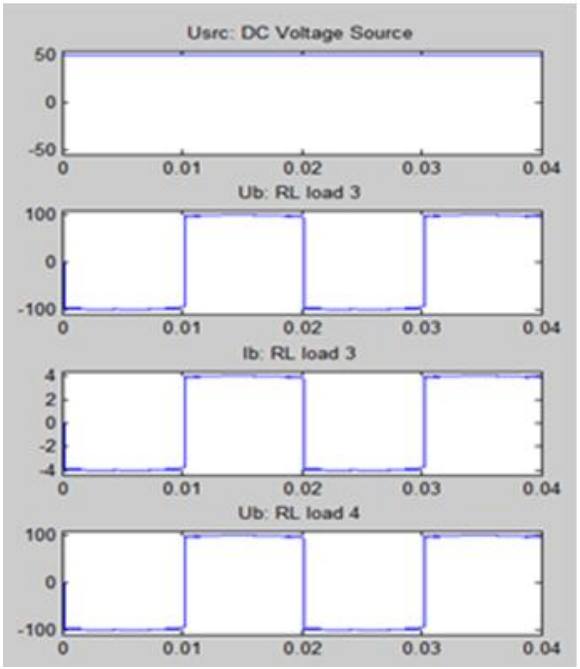

Fig 5(b) input 50 Vdc and output 100 V

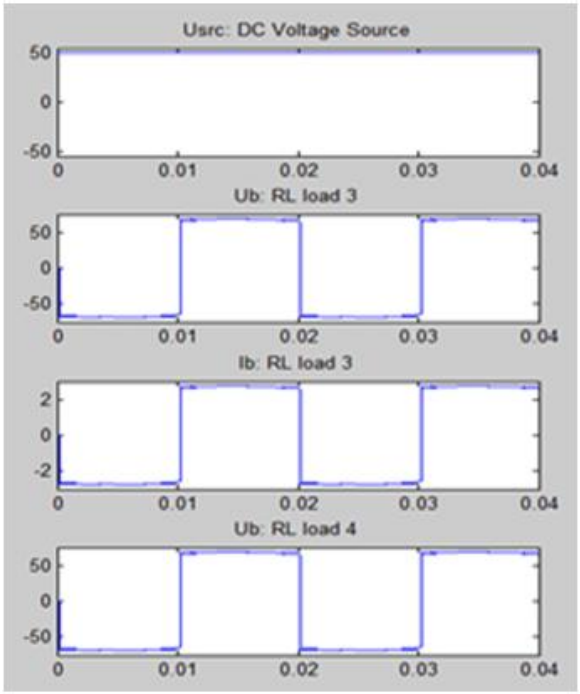

Fig 5(c) input 50 and 20 Vdc and output 70 V

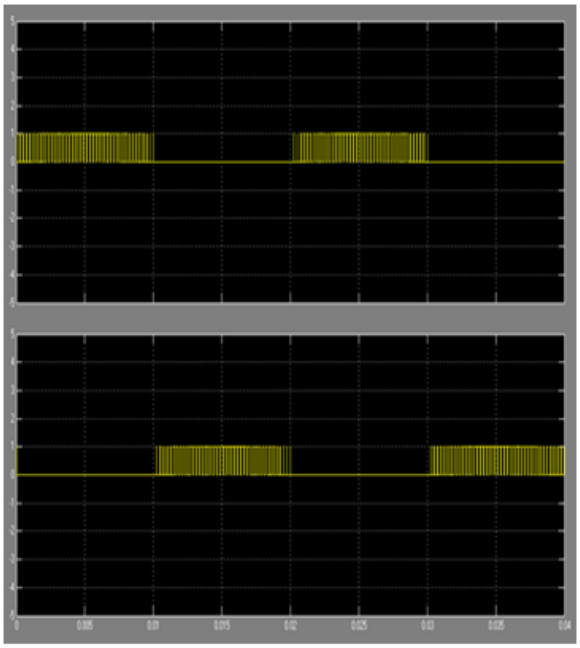

Fig 6: Output of SPWM

VI. Conclusion

The multilevel inverter with single phase and different DC voltage sources has been built. The output of the multilevel inverter is the sum of the output of each module. The proposed system has been successfully built in the matlab and has simulated in matlab. The expected results have been obtained. As the output obtained shows reduction in harmonics and THD.

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