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A Cascaded Multi Level Inverter with Symmetric Configurations

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Abstract: Nowadays multi level inverter has become favored. Predominantly due to their greater in output voltage magnitude and to diminish the harmonic content in the output voltage and current. A high quality in voltage level and less number of switching devices has been acquired in symmetric mode. In this pwm technique only two switches are operating in each mode. The remaining switches are in off position. This will diminish the losses and total harmonic distortion. Symmetric mode five level inverter are used to create nearly sinusoidal current waveform. The proposed multi level inverter has been examined in symmetric operation mode can be studied in matlab simulink model.

Key words: Multi level inverter · Sinusoidal pulse width modulation · Symmetric configuration · Reduced component count

INTRODUCTION

Multi level power converters have widely used because of their advantages such as possibility of high voltage and high power operation. High attribute and low deviation of output voltage and a low cut off voltage can be cited as the essential benefit of the multi level inverter related to the regular voltage source inverter. The other occupational and commercial conditions for the multi level inverters are

- Standard awareness;
- High feasibility;
- Breakdown management;
- Expenditure and life duration cost.

A multi level converter is a power electronic system that incorporates a demanded yield voltage from many levels of dc voltages as inputs [1]. Distinction with the normal two level voltage source converter the favor of multi level converter is their lower output voltage step which produces high power quality, lower harmonic segment, admirable harmonic suitability and minor switching troubles. The main divisions of multi level inverters are Flying capacitor, Diode Clamped and cascaded multi level inverter [2]. A multi level inverter can be used for many applications, such as an active power cleaner, a static var compensator and electric vehicles[3]. This paper focuses on the analysis of symmetric multi level inverter by using fewer amounts of switches and reduces the harmonics[4]. The pulse width modulation strategies are the most effective control method to curtail the power deficiency by declining the power electronic apparatus. When the output voltage balance is raised, then the number of power electronic apparatus also raised. This also expanding the number of isolated DC sources. This constitutes a CHB inverter more complex. Further, larger in number of DC sources in order to rising the number of output voltage balance direct to additional system problems. Large amount of switches are used in existing method. This will increase the cost and also the harmonics. But the proposed system is used to reduce the switches and losses. Some applications of this multi level inverter include industrial drives flexible ac transmission and electric vehicles.

Proposed System: Proposed multi level inverter is examined in a symmetric mode. In this symmetric mode merest numbers of switching devices are used. This is a modified version of symmetric mode multi level inverter. In the proposed Multilevel Inverter comprise six IGBT switches with six anti parallel diode. It also include the two voltage sources. If the two voltage source is balance it evaluated in symmetric mode. If the two voltage sources are unbalance it examined in asymmetric mode. The proposed multi level inverter evaluated in symmetric mode.

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Symmetric Mode: The five level output voltages are developed by the proposed symmetric mode multi level inverter. Properly moving the relevant IGBT switches on or off yield the normal level of the output voltage. The same switch is operated in all modes. This will reduce the turn on time of other devices. So the switching losses and harmonics are reduced. All the voltage sources are balanced in proposed symmetric multi level inverter. In proposed block the two voltage source is kept in hundred volt. The various output voltage levels are represented in table I. Each mode only two switches are turned on. The remaining switches are turned off. So the power consumption is also lower level.

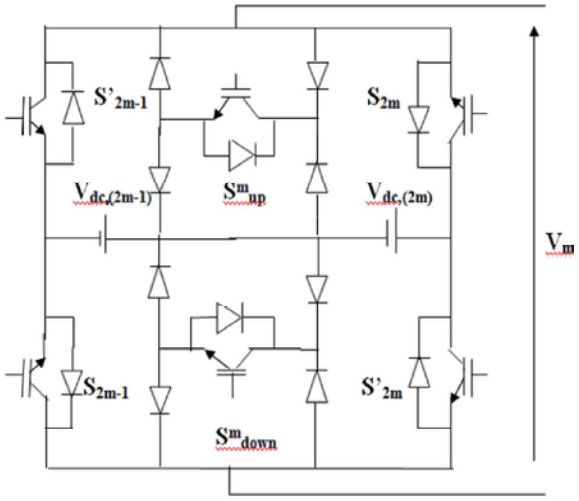

Fig. 1: Proposed block diagram

Table 1: Switching Operation in Symmetric Mode

State Number	Switch state S_{2m-1}	S'_{2m-1}	S_{2m}	S'_{2m}	S^m_{up}	S^m_{down}	Output voltage
1	1	0	1	0	0	0	$+2V_{dc}$
2	0	0	1	0	0	1	$+V_{dc}$
3	0	0	1	1	0	0	0
4	0	0	0	1	1	0	$-V_{dc}$
5	0	1	0	1	0	0	$-2V_{dc}$

Modes of Operation: There are several modes of operation are possible. In these operation only positive half cycle is defined. The related procedure occures in the negative half cycle.

Mode1: Output voltage +Vdc: Only two switches are conducting in each mode of operation. The remaining switches are in off state. So switching losses are reduced. In this mode the current passes through the switches s_{2m} and s^m_{down}.Switches S_{2m} and S^m_{down} are turned on and the load is connected to the source with half voltage of $+V_{dc}$.

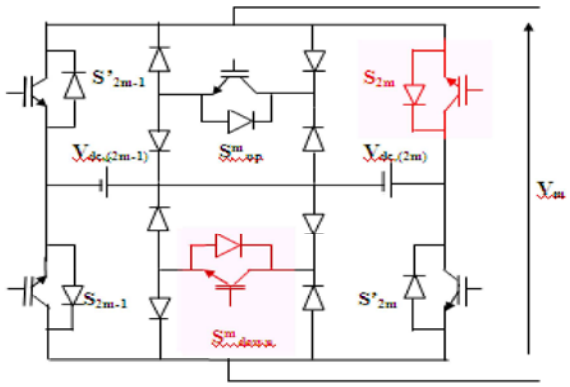

Fig. 2: Output Voltage = + V_{dc}

So the current flows in a positive direction. So positive output voltage is produced. The remaining switches are in off condition. In each mode only two switches are conducted.

Mode2: Output voltage $+2V_{dc}$: In mode 2 Switches S_{2m} and S^m_{2m-1} are turned on and the load is connected to the source with a half voltage of $+V_{dc}$ In this mode the voltage passes through the switches s_{2m} and s_{2m-1}. There is two voltage sources conducting in between the switches. The two voltage sources are positive voltages. So the output voltage is$+2_{vdc}$. The remaining switches are in off condition. So the switching losses are reduced. Harmonics also reduced in this mode.

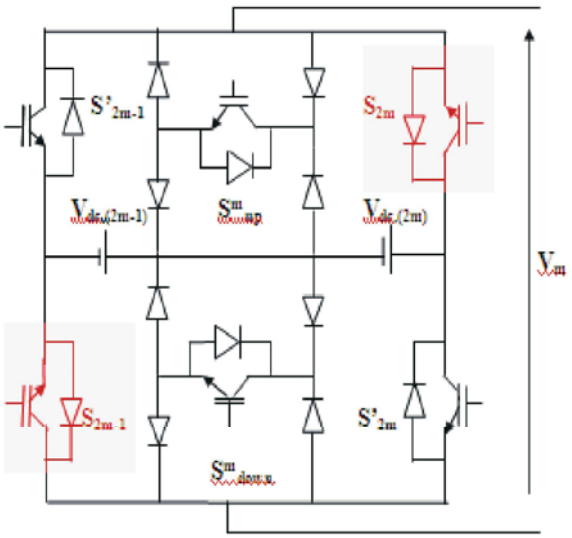

Fig. 3: Output Voltage =+ 2 $_{Vdc}$

MODE 3: OUTPUT VOLTAGE $+V_{dc}$: In mode 3 Switches S_{2m} and S^m_{down} are turned on and the load is connected to

the source with a half voltage of $+V_{dc.}$ In this mode the voltage passes through the switches s_{2m} and s^{m}_{down}. So the voltage flows in a positive direction. So positive output voltage is produced. The remaining switches are in off condition. In each mode only two switches are conducted.

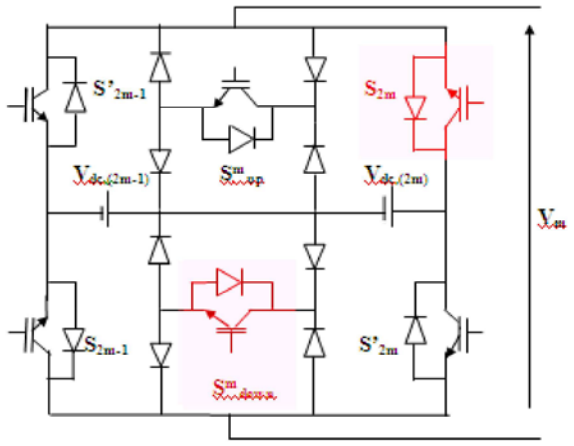

Fig.4. Output voltage=$+V_{dc}$

MODE 4: OUTPUT VOLTAGE 0V: In mode 4 Switches $S_{2m}$and S'_{2m} are turned on and the load is connected to the source with a full voltage of 0v.

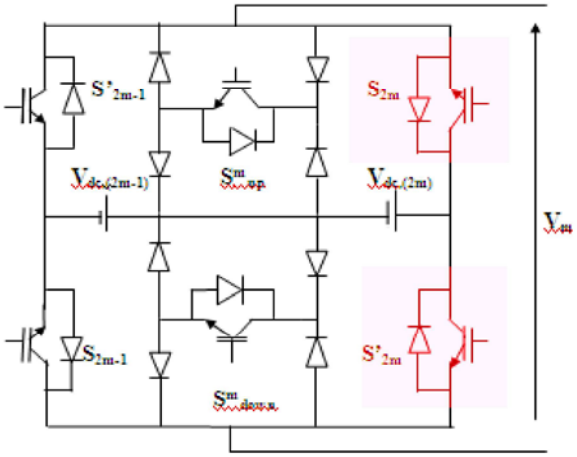

Fig. 5: Output voltage=0

In this mode the same leg of switches are in on condition. The remaining switches are in off condition. So there is no voltage appear across the switch. So the 0 output voltage is produced. Similarly in negative half cycle the same operation is occurred. In negative half cycle the order of operation is in the form of $-v_{dc}$, $-2v_{dc}$,$-v_{dc}$,0.

Simulation Results: SIMULINK is a software package for modeling and analyzing Dynamic system. It helps linear and nonlinear structures, modeled in continuous Time, sample time, or a hybrid of the two. Structure can also be multi rate, i.e., have Different segments that are evaluated or revised at different rates. MATLAB is a high-execution language for calculation, visualization and programs. It is an easy to use surrounding where problems and results are indicated in usual. It combines calculation, visualization and programs. It is an easy to use surrounding where problems and results are indicated in usual mathematical symbols. We have direct approach to all the analysis tools in MATLAB, so we can take the results analyze and anticipate them.

Output Voltage:

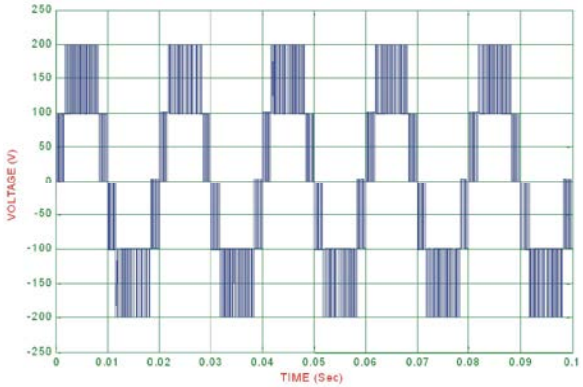

Fig. 6: Five-Level Output Voltage for symmetric Configuration ($V_1 = V_2$= 100 V)

Load Current:
Harmonic Analysis:

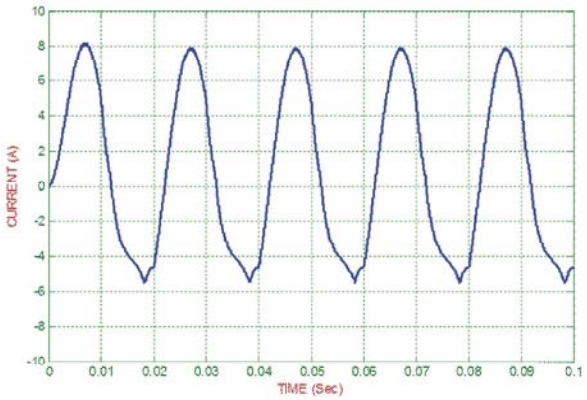

Fig. 7: Load Current Output for Symmetric Voltage Input ($V_1 = V_2$= 100 V)

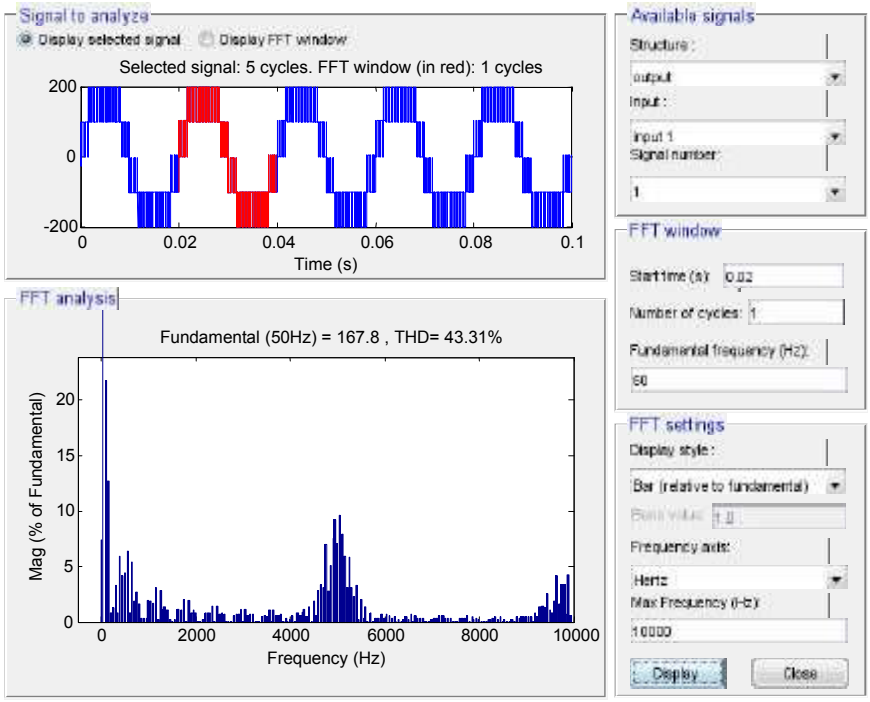

Fig. 8: Voltage Harmonics (THD) for Five Level Inverter

Pulse Generation in Symmetric Mode:

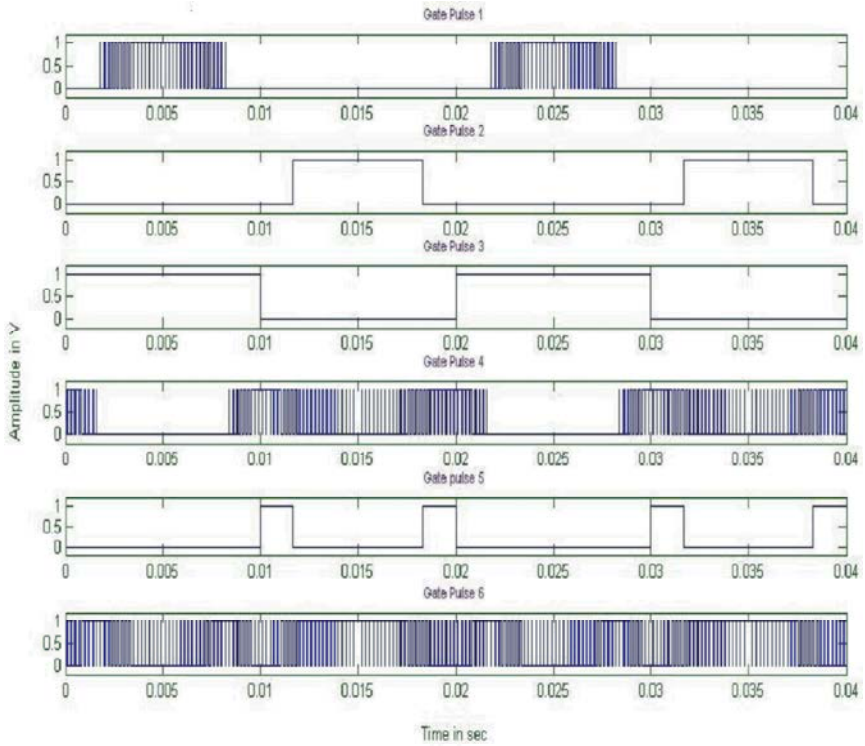

Fig. 9: Pwm switching sequence

Design Details:

- Voltage=100v, Resistance:20?
- Inductance=10e-3, Frequency=50hz
- Diode resistance=0.001?
- Diode voltage=0.8v

CONCLUSION

The proposed Multi level inverter is analyzed in symmetric mode. In this mode, minimum amount of switches are used in operation. Carrier based sinusoidal pwm approach is used to depress the switching strain and losses by using only two switches in each mode of operation. Total Harmonic Distortion is reduced by using this pulse generating technique. In future work, multi-level inverter will be analyzed in asymmetric mode by using MATLAB/SIMULINK model with different modulation techniques.

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