International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 4 Issue 4, April-2015, pp: (113-117), Impact Factor: 1.252, Available online at: www.erpublications.com

Multilevel Inverter by using Switching Capacitor in PV Grid

Mr. Nagaraju. G[1], Mr. S. K. Mustafa[2], Mr. K.S. Mann[3], Dr. M. Narendra Kumar[4]

Abstract: In this paper, we are using multilevel inverter by using switching capacitor for PV grid. Now a day's multilevel inverters have become more popular over the years in electric high power application with the promise of less disturbances and the possibility to function at lower switching frequencies than ordinary two-level inverters. So by cascading multilevel inverter the output voltage will be increases. By using multilevel inverter the cost will be less. It will be required less space. Modulation strategies, component comparison and solutions to the multilevel voltage source balancing problem will also be presented in this work. By using the multilevel inverter we can reduce the total harmonic distraction compare to the other sources in PV grid for DC to AC converter. The proposed method is simulated in Matlab Simulink.

Keywords: multilevel inverter, switching capacitor, total harmonic distraction, pv grid.

Introduction

The multilevel inverter is one of the most important converters in power electronic fields. Now a day's non-conventional energies sources are photovoltaic (PV) and wind energy are developing more and more & used in many application. Because the conventional energy source are non-exhausted, these energy sources are available throughout the year [1-3]. The output is in the form of DC voltage. By using inverter the DC voltage will be converted in to AC voltage. Here the capacitor will be worked as boost up the output voltage without using transformer. By using transformer the cost of the system will goes more. The system will occupy more space and harmonic distraction is more. The efficiency is less by using transformer. By avoiding all these problems we are going to use capacitor and multilevel inverter. Because of the existing voltage unbalancing of capacitors in the switched capacitor multilevel inverters, there are some complicated method are used to balance the capacitor voltage [4].

In this paper the multilevel inverters are connected in series with the PV grid. By using these multilevel inverters the cost of the system is very less and total harmonic distortion is also very less. The most important use is that it improves the efficiency of a system. In this paper the calculation of losses and total harmonic distortion, are done at the end of the paper and the performance of the proposed topologies is verified by simulation and experimental results.

Multilevel Inverter Topologies

The function of inverter is to converter the Ac voltage in to Dc voltage. The inverter does not produce any power; the power is provided by the DC source. Multilevel inverter means cascading the inverter to build up the output voltage.

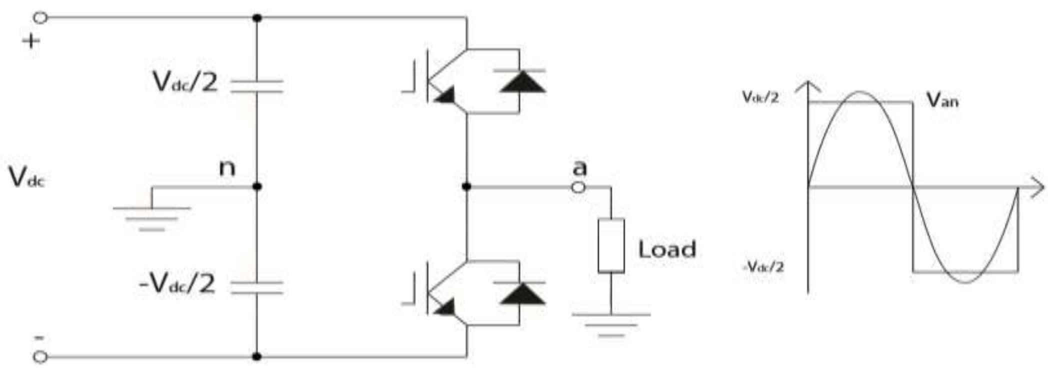

Fig 1. One phase leg of a two-level inverter and a two-level waveform without PWM.

In the above diagram is a two level inverter, it can gives the two output voltages at the load side i.e. $V_{dc}/\ 2$ (or) $-V_{dc}\ /2$ (when inverter is fed with V_{dc}). Two capacitor are connected across the inverter each capacitor fed-up with $V_{dc}/2$ and $-V_{dc}/2$. In between these two capacitors point N is connected to the ground and between the two inverter the load will be connected. But two diode are connected across the two inverters in opposite direction. When the negative half cycle the inverter will not conduct because it will act as reverse biased voltage, at that time the diode will act as a capacitor will gives continuous voltage to the load.[10]

The multilevel inverter does not depends on the two level of voltage to create an AC signal. Instead several voltage levels are added to each other to create a smoother stepped waveform, see Figure. 2, with lower dv/dt and lower harmonic distortions.

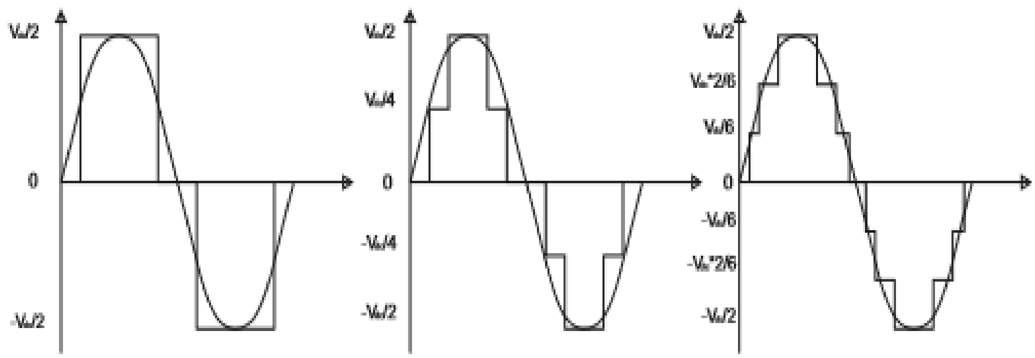

Fig. 2: Three level, five level and seven level wave forms

In the above three level, five level & seven level wave form multi-level wave form, switched at fundamental frequency. The output voltage at load side is more smother if more number of inverter are connected in cascade. The output of three level is $V_{dc}/2$, 0,-$V_{dc}/2$. The five level output is $V_{dc}/2$, $V_{dc}/4$, 0,-$V_{dc}/4$,-$V_{dc}/2$ .instead of this type ofmultilevel level inverter Multilevel diode clamped/neutral point inverter are used because in this type of inverter the clamping diode are connected across the inverters to improve the output voltage and to distract the total harmonic in the output voltage at the load side.

Multilevel Diode Clamped/Neutral Point Inverter, (NPCMLI)

In NPCMLI tropology, the use of voltage clamping diode is very important. The use of clamping diode is to block the reverse voltage. The required number of clamping diode are depending on the required number of voltage levels. The formula for required number of diodes are (M-1).Here m is the number of voltage levels.

In Fig 3 one phase-leg of a five-level NPC inverter is displayed. By adding two identical circuits the three phase-legs can together generate a three-phase signal where sharing of the DC-bus is possible.

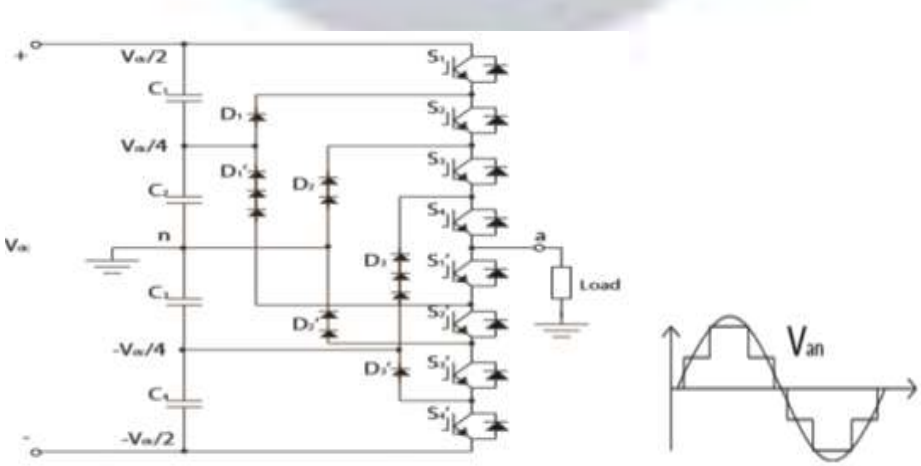

Fig.3: One phase-leg of a five level NPC inverter

In the above five level NPC inverter consisting of four inverter and four clamping diodes. For example, in Figure 3 all diodes are rated for V_{dc} /4 (V_{dc} m−1 in general) and the D1′ diodes need to block 3V_{dc}/ 4 and therefore there are three diodes in series. With this configuration five levels of voltage can be generated between point a and the neutral point n; V_{dc}/ 2 , $V_{dc/}$ 4 , 0,−V_{dc} /4 and−V_{dc}/ 2 , depending on which switches that are switched on. From Table 2.1 it can be seen that for the voltage Vdc/2 all the upper switches are turned on, connecting point a to the Vdc/ 2 potential, see Table 1 For the output voltage Vdc/ 4 switches S2, S3, S4 and S0 1 are turned on and the voltage is held by the help of the surrounding clamping diodes D1 and D0 1. For voltage levels –Vdc/ 4 or –Vdc/ 2 clamping diodes D2 and D0 2 or D3 and D0 3 hold the voltage, respectively. For the voltages ±Vdc 2 the current, when both voltage and current are positive (positive current goes out from the inverter), goes through the four top or bottom switches. For the other states positive current, while voltage is positive, goes through the D_x diodes and negative current through the $D_{x'}$ diodes and also through the switches in between the clamping diodes and the load.[11]

Table- 1: Switching states of one five-level phase leg. A "1" means turned on and "0" means turned off

Output voltage	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8
$V_{dc}/2$	1	1	1	1	0	0	0	0
$V_{dc}/4$	0	1	1	1	1	0	0	0
0	0	0	1	1	1	1	0	0
$-V_{dc}/4$	0	0	0	1	1	1	1	0
$-V_{dc}/2$	0	0	0	0	1	1	1	1

Multilevel inverter by using switching capacitor

In this multilevel inverter the input is normally using PV cell (grid) and fuel cell (grid) .Any one of the grid is connected to the converter to boost up the dc source. DC/DC, AC/DC and AC/DC conversion is required for several applications such as HVDC-transmission application and back-to-back configurations for asynchronous grid connection, The DC is connected to the inverter to convert the DC in to AC source. The AC (inverter) source is connected to the load. In this below circuit capacitor is connected at the input side capacitors for input smoothing circuits used on commercial voltages (100 VAC,200 VAC) and commercial frequencies (60 Hz,50 Hz) must have a high withstand voltage and a ripple current resistance complying with twice the commercial frequency.

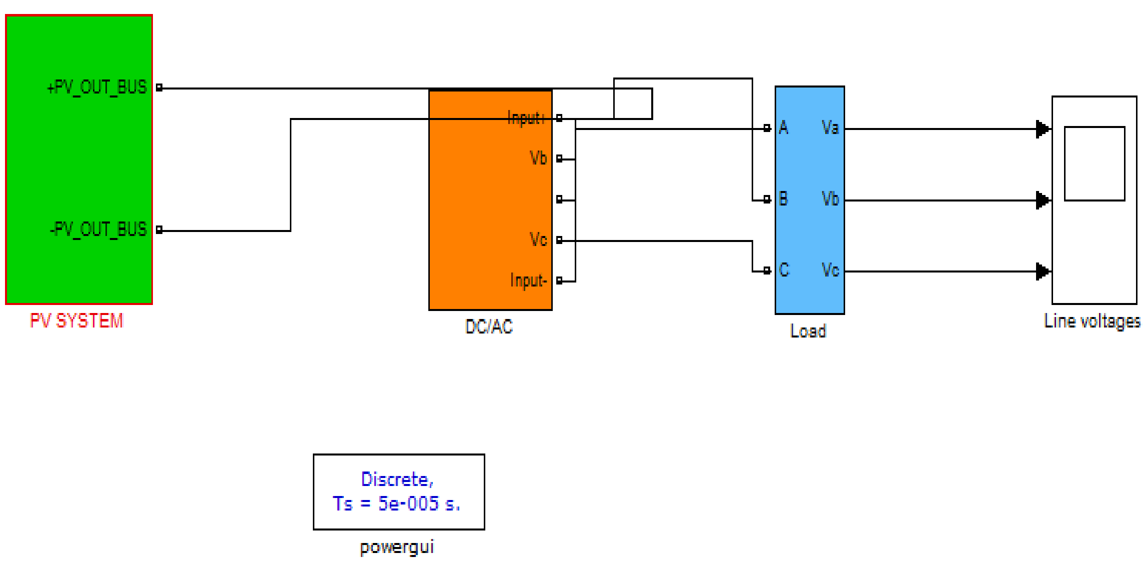

Figure 4: the block diagram of multilevel inverter by using capacitor by pv grid

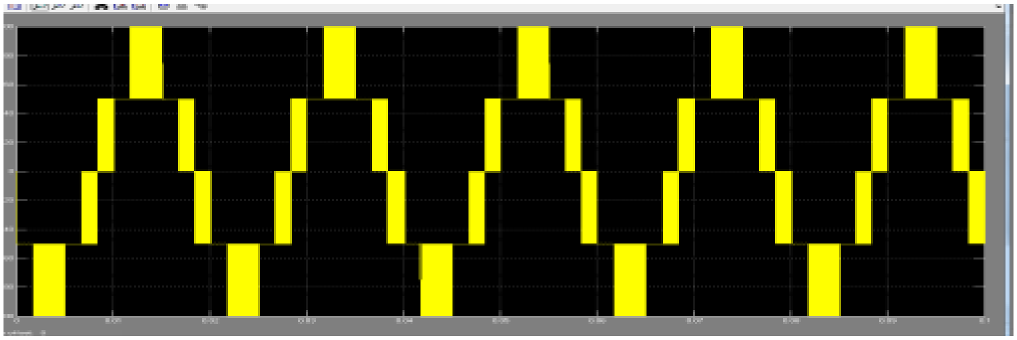

Figure 5: five level output voltage at load side

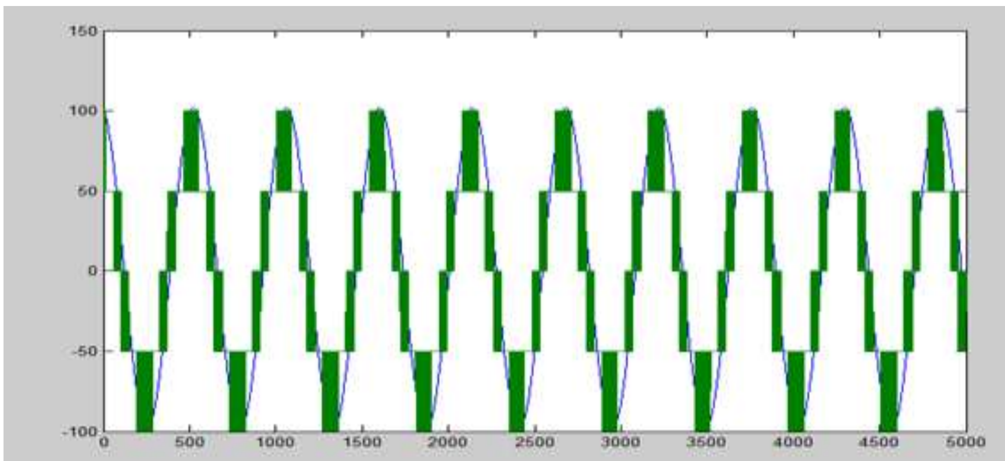

figure 6: load voltage with multilevel inverter by using switching capacitor in pv grid

Figure 4 shows the Multilevel inverter by using switching capacitor connected to PV Grid, which is simulated in Matlab Simulink. After simulation we analysis the output voltage from fig -6 is shown, is very close to the sine wave and the harmonic effect is eliminated from the source and load side. The switching capacitor are improving the performance of multilevel inverter in PV grid.

Conclusion

This work has presented several topologies for multilevel inverters (MLI), some of them well known with applications on the market. Every topology have been described in detail. Several modulation techniques have also been presented which are to be used with the presented topologies. Topology comparisons, such as number if components and their ratings, have been presented and shows that multilevel inverters compete with two-level inverters in the area of voltage ratings for their components (diodes, switches and such), even though the number of components needed for multilevel inverters, as shown, can be very high. For a five-level MLI case the voltage rating requirements is only one fourth of that of the two level inverter, but four times more switches are needed (for components with deferent ratings).

References

[1]. K. Bandara, T. Sweet, and J. Ekanayake, “Photovoltaic applications for off-grid electrification using novel multi-level inverter technology with energy storage,” Renew. Energy, vol. 37, no. 1, pp. 82–88, Jan. 2012.

[2]. J. Chavarria, D. Biel, F. Guinjoan, C. Meza, and J. J. Negroni, “Energy balance control of PV cascaded multilevel grid-connected inverters under level-shifted and phase-shifted PWMs,” IEEE Trans. Ind. Electron., vol. 60, no. 1, pp. 98–111, Jan. 2013.

[3]. N. A. Rahim, K. Chaniago, and J. Selvaraj, “Single-phase seven-level grid-connected inverter for photovoltaic system,” IEEE Trans. Ind. Electron., vol. 58, no. 6, pp. 2435–2443, Jun. 2011.

[4]. Ebrahim Babaei, “hybrid multilevel inverter by using switched capacitor unit” IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 61, NO. 9, SEPTEMBER 2014.

[5]. Jih-Sheng Lai; Fang Zheng Peng; , "Multilevel converters-a new breed of power converters," Industry Applications, IEEE Transactions on , vol.32, no.3, pp.509517, May/Jun 1996 doi: 10.1109/28.502161.

[6]. Rodriguez, J.; Jih-Sheng Lai; Fang Zheng Peng; , "Multilevel inverters: a survey of topologies, controls, and applications," Industrial Electronics, IEEE Transactions on , vol.49, no.4, pp. 724- 738, Aug 2002 doi: 10.1109/TIE.2002.801052

[7]. A. Nabae, I. Takahashi, and H. Akagi, "A new neutral point clamped PWM inverter," IEEE Trans. Ind. Appl., vol. IA-17, no. 5, pp. 518–523, Sep. 1981.

[8]. P. Hammond, "A new approach to enhance power quality for medium voltage AC drives," IEEE Trans. Ind. Appl., vol. 33, no. 1, pp. 202–208, Jan./Feb. 1997

[9]. E. Babaeiand S. H. Hosseini, "New cascaded multilevel inverter topology with minimum number of switches," Energy Convers. Manage., vol. 50, no. 11, pp. 2761–2767, Nov. 2009.

[10]. Hemant Joshi, P. N. Tekwani, Amar Hinduja, Implementation of a Five- Level Inverter Using Reversing Voltage Topology: A Competitive Solution for High- Power IM Drive Application. Indian Institute of Technology Roorkee. 2010.

[11]. Zhihong Bai; Zhongchao Zhang; Yao Zhang;, "A Generalized Three-Phase Multilevel Current Source Inverter with Carrier Phase-Shifted SPWM," Power Electronics Specialists Conference, 2007. PESC 2007. IEEE, vol., no., pp.2055-2060, 17-21 June 2007 doi: 10.1109/PESC.2007.4342322.