DESIGN OF GRID CONNECTED H BRIDGE MULTI LEVEL INVERTER WITH PV SYSTEM

Akanksha Kaiwartya[1], Abhijit Mondal[2], Shailesh Deshmukh[3]
Mtech Schloar[1], Asst Prof[2], HOD[3]
Department of electrical & electronics engineering
Disha Institute of management and technology, Raipur (CG)

ABSTRACT

This paper describes the various topologies and controlling strategies used in multi level inverter. MLI are used to improve the waveform output of the inverter to be nearly to sinusoidal so that the harmonic injection by that inverter is minimum. In this paper implement a multi level inverter used in photo voltaic grid integration. A cascaded asymmetric multi level inverter is proposed which contains minimum no. of switches and it can be employed in AC application using solar energy. The proposed topology consists of 25 output level using 10 switches with nearly sinusoidal output, thereby reducing gate driver circuit and layout of optimizing circuit. All the simulation are carried out by using MATLAB 2010a.

Keywords: PV system, inverter, switches, arrays , MATLAB.

INTRODUCTION

Due to the energy shortage, the integration of renewable energy sources to the electricity grid becomes more reliable for this purpose. The no. of renewable energy sources and distribution generator is increasing very fast which also brings some threats to power grid [1]. In order to improve the power system reliability and quality of the power system with distribution generator for the operation and management of the electricity grid, it is necessary to have some new strategies. Solar energy is one of the favourable renewable energy resources and the multi level inverter have been proven to be one of the importing enabling technologies in photo voltaic utilization. Conventional technologies compared with multi level voltage source inverter offen several advantages [2]. By synthesizing the ac output terminal voltage from several level of voltage, the waveform produced which is in shape of staircase, which approach the sinusoidal waveform with low harmonic distortion, for reducing this requirement of filter is necessary[3]. The need of several sources on the dc side of the converter makes the multilevel technology reliable for PV application. While the multi level inverter requires more components than conventional two level inverters, lower voltage rated device can be used and the multi level inverter offers advantages such as the possibility of lower switching frequency, for this which leads to higher efficiency and lower electromagnetic interference.

Cascaded multi level inverter with separate dc source is proposed in this paper, for supplying the load with the solar PV panel. It is assumed that with a proper maximum power point algorithm the output of the PV array is constant. DC source and simulation is being carried out for 25 output levels and 10 switches [3].

The multi level inverter requires too many semiconductor switches and thus its cost gets increased and thus the use of MLI are justified by showing the voltage and current burden on each switch and thus it is showed that in spite of the increased no. of switches there will not be much cost difference. Also it is shown that total harmonic distortion voltage and current gets reduced on increasing the no. of levels in a multi level inverter.

H BRIDGE MULTI LEVEL INVERTER

The traditional two or three levels inverter does not completely eliminate the unwanted harmonics in the output waveform. Therefore using the multi level inverter in the place of traditional PWM inverter is alternative option for that. In this topology the no. of phase voltage level at the converter terminals 2N+1, where N is the no. of cells or dc link voltage. In this topology each cell has separate dc link capacitors and voltage across the capacitor might differ among all the cells [4]. So each power circuit need only one dc voltage source. The no. of dc link capacitor is proportional to the no. of phase voltage levels. Each H bridge cell may have positive, negative and zero voltage [3]. Final output voltage is the sum of all the H bridge cell voltages and is symmetric with respect

ISSN: 2278 – 7798

to neutral point, so the no. of voltage level is odd. In cascaded H bridge multi level inverter, IGBT switches are used.

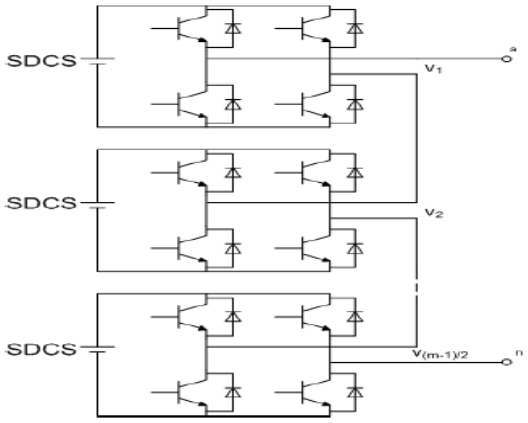

Fig.1 Cascaded H bridge multi level inverter topology

The cascaded inverter topology has several advantages that have made it attractive in medium to high power application. The main advantage of this is the modularity of inverter [6]. Each dc source is fed into and individual full bridge inverter so it is easy to plug into more separate dc sources without changing the dimension of the system. Moreover, the switching stress for each switch device would be less than the regular two level topology since the switch and diode need only one separate DC voltage source. For reducing the switching losses the harmonic selective modulation method is used. For the use of this method the switching frequency will be at the fundamental frequency which decreases the switching loss. For the use of this method ,the main advantage is the output voltage waveform is nearly sinusoidal which decrease the cost of the filter [7].

Table 1.1: Switching states of basic cell

S11	S12	S13	S14	S15	Vol (o/p volt.)
1	1	0	0	0	Vll+Vl2
0	1	0	0	1	Vll
0	1	0	1	0	0
1	0	1	0	0	
0	0	1	0	1	-V12
0	0	1	1	0	- (Vll+Vl2)

Table 1.1 is shown above, regarding switching states of proposed multi level inverters basic cell where logic '1' is considered as 'ON' and logic '0' is considered as 'OFF' state of switch. When the no. of voltage source in basic cell is increase, the no. of output level also increases.

Table1.2: Output levels for respective voltage sources in basic cell

No. of Voltage Sources	No. of Switches	No. of Output Levels
2	5	5
3	6	7
4	7	9
N	N+3	2N+1

Table 1.2 illustrates relation between no. of voltage sources in the basic cell and their respective no. of output levels with corresponding no. of switches.

METHODOLOGY

The proposed topology of multi level inverter is employed by cascaded arrangement of two basic cells. Here the fig 2 shows multi level inverter where 25 output levels are obtained by using only 10 switches. This arrangement can be further increased by cascading 'P' no. of basic cells in series, as the no. of output level is increased the output approaches close to sinusoidal waveform. This topology contains the two cascaded two basic cells. Each cell consists of two equal voltage sources. The voltage sources of second basic cells are in ratio of 1:5 with respect to voltage sources of first basic cells. This topology helps to generate 25 outputs level. This arrangement is defined as asymmetric multilevel inverter because the unequal voltage source in two respective cells.

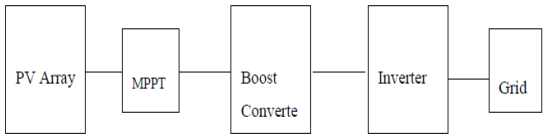

Fig. 2 Block diagram for PV based grid system

Cascaded H bridge multilevel inverter is proposed as a possible interface for the grid connection PV system. The separate DC source can be individual PV arrays, depending on the output power level. It is very beneficial for the high voltage & high power application. Since the output voltage level can be reached by interconnecting enough no. of PV arrays which also eliminate the use of step up transformer or dc-dc boost converter. In cascaded H Bridge multilevel inverter, the inherent improved power quality of multilevel converter reduce filter size and switching frequency, by this its improve the system efficiency.

ISSN: 2278 – 7798

Furthermore, each PV array is connected to a single DC-AC converter or inverter which improves the MPPT algorithm [6-8].

CONTROL & MODULATION STRATEGY

In this paper, the modulation method is PWM. However, it is different from normal PWM in which the state of each switch is determine by the comparison of the carrier waveform. In the place of the firing signals of the switches are obtained by comparing the control signal from the proposed control law with the carrier waveform as shown in fig 3.

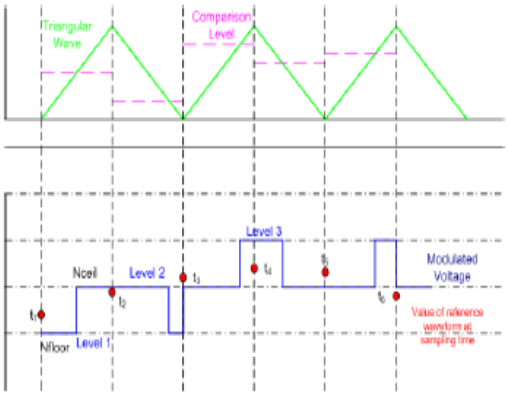

Fig.3 Modulation Energy

The selection of the switching frequency of the carrier waveform is the trade off between switching losses in the inverter and the harmonic distortion of the current injected into the power grid. Moreover, in high power application, the switching frequency should be limited to a certain level due to switching stress imposed on the switch device. Here the switching frequency f_{sw}=600 Hz is selected.

At each sampling time *tk*, the desired modulation index can be obtained by comparing the value of reference waveform at this time with the sum of DC voltages.

$$m(t_k) = \frac{v_{ref}\,(t_k)}{\Sigma_{j=1}^{6} vC_j(t_k)}$$

For each sampling time *tk*, the highest level that does not exceed the value of reference waveform *vref* (*tk*) at this time is called the floor level *Nfloor*(*tk*). Moreover, the lowest level which exceeds the *vref* (*tk*) is called the ceil level *Nceil*(*tk*).

The triangular waveform has a positive slope during one sampling interval and a negative slope during the consecutive sampling interval as shown in Figure 3 [9].

SELECTIVE HARMONIC ELIMINATION

It is a low switching frequency strategy. This strategy is used for calculate switching angles to eliminate certain harmonic in the output voltage. In the output signal, the amplitude of any odd harmonics is calculated by Fourier series analysis. Usually the switching angles are chosen so that the fundamental is set to the wanted output amplitude and the other harmonic is to zero. The switching angle must lower than 90 degree and if angles are greater than 90 degree a correct output signal would not be produced. For an inverter with m levels a= (m-1)/2. Higher harmonics can be filtered out with additional filters added between the inverter and the load [10]. For a 25 level inverter, a=12, so there are 12 switching angles available and a-1 = 11, angles can be used for harmonic component elimination.

RESULT

This paper presented a deep study on PV arrays with maximum power point traction. It works well under rapidly changing environment condition. This can always ensures that maximum active power can be injected into the grid. In addition by using the improved selection mechanism as the modulation method, reduces no. of switches used in multi level inverter is presented. Moreover, the output voltage of the inverter has 25 levels which makes the shape almost sinusoidal. Finally the reactive power control method realises the exchange of reactive power between the inverter and in the grid. An analysis on H bridge multi level inverter based PV system for grid connected system with reduce no. of switches is proposed here.

The simulation is proposed topology is done by using MATLAB, by 10 switches is shown in fig.4 and the voltage sources in second basic cell are equal to each other. The parameter of simulation model are frequency=50 Hz, R = 280 ohms, L = 35mH.

ISSN: 2278 – 7798

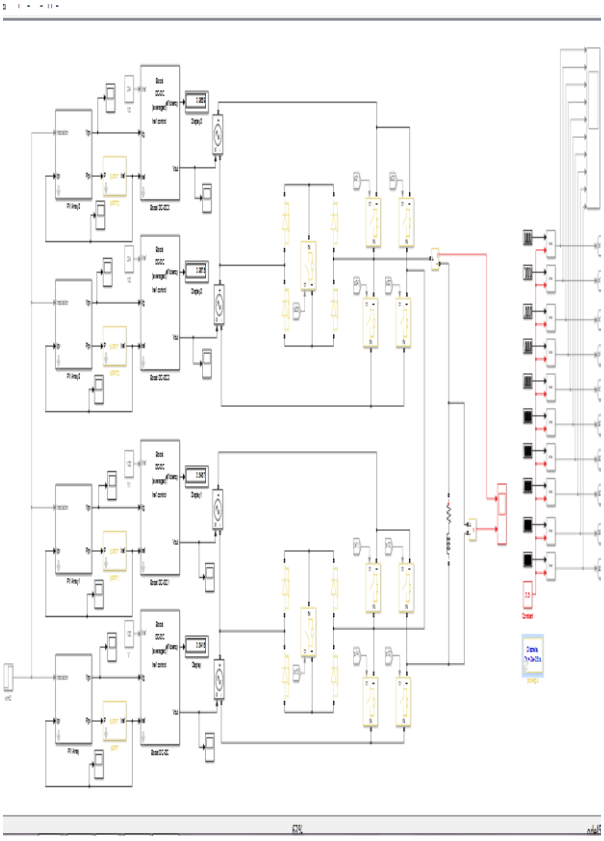

Fig.4 Simulation model of MLI

By the use of multi level H bridge inverter the total harmonic distortion is reduced from 4.7% to 2.7%. in fig.5 shows THD level of sinusoidal waveform or we can say that the output signal.

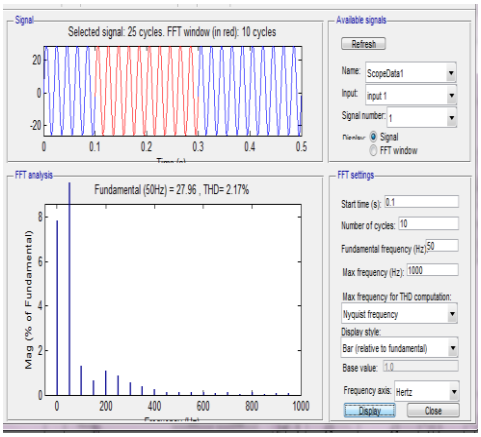

Fig.5 FFT analysis of output signal

CONCLUSION

In this research work, a cascaded multi level inverter is proposed which requires minimum no. of switches with increased output levels where output waveform is near to sinusoidal in fig.6. Compared with conventional multi level inverter it requires less no. of component to achieve same no. of output levels. Overall total harmonic distortion (THD) is very low and thus the quality of output waveform is improved.

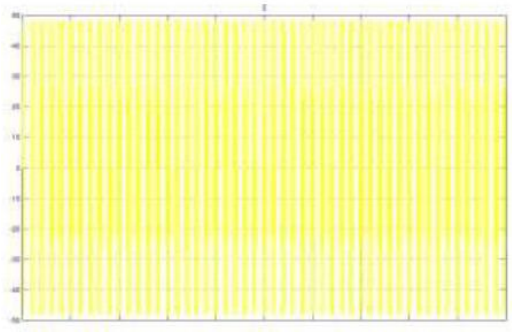

Fig.6 Output waveform of voltage level

REFERENCES

[1] AbbSace, "Technical Application Papers No.10 Photovoltaic plants.", A Division of ABB S.p.A. L.V. Breakers.

[2] Bret Bosma"A Novel Technique for Maximum Power Operation Of Photovoltaic Arrays Using Real Time Identification.", California State University, Chico

[3] Joe-Air Jiang, Tsong-Liang Huang, Ying-Tung Hsiao and Chia-Hong Chen"Maximum Power Tracking for Photovoltaic Power Systems.".Tamkang Journal of Science and Engineering, Vol. 8, No 2, pp. 147_153 (2005).

[4] TrishanEsram and Patrick L. Chapman "Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques.", IEEE Transactions 2010.

[5] Roberto Faranda, Sonia Leva"Energy comparison of MPPT techniques for PV Systems",.Wseas Transactions on Power Systems, Issue 6, Volume 3, June 2008, ISSN: 1790-5060.

[6] Bibek Mishra and BibhuPrasannaKar"MATLAB Based Modeling of Photovoltaic Array Characteristics",. Department of Electrical Engineering National Institute of Technology, Rourkela MAY 2012.

[7] David Sanz Morales"Maximum Power Point Tracking Algorithms for Photovoltaic Applications", Project Report-. Aalto University Published 14-12-2010

[8] W. De Soto, S.A. Klein , W.A. Beckman "Improvement and validation of a model for photovoltaic array performance",. Elsvier, Solar Energy 80 (2006) 78–88

[9] Ahmed Darwish"Immersion Cooling of Photovoltaic Cells in Highly Concentrated Solar Beams",. Project Report- University of Nevada, Las Vegas August 2011.

[10] Tyler N. Otto, "Comparative Study of Grid Connected Photovoltaic Arrays." Project Report- Master of Science in Physics San Diego State University, 2009

ISSN: 2278 – 7798