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SIMULATION AND ANALYSIS OF MULTILEVEL GRID CONNECTED INVERTER FOR SOLAR PV SYSTEM WITH MAXIMUM POWER POINT TRACKING

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ABSTRACT

The purpose of this paper is to study and analysis of multilevel grid connected inverter for solar PV based system with MPPT. A multilevel inverter is power electronic systems which synthesize desired AC voltage from several DC sources as an input. The advantage of multilevel inverter is that it reduces total harmonics distortion, offer sinusoidal output waveforms, lower EMI, and low switching losses. This paper presents multilevel inverter topology for solar PV based system with MPPT. MPPT technique is used to track the maximum power from solar panel. In photovoltaic power system MPPT algorithm play an important role because they increase the efficiency of the solar panel. Multilevel Inverter offer better performances results as compared to line commutated inverter. The simulation result is based on MATLAB/SIMULINK environment.

Keywords: Multilevel Inverter, total harmonic distortion, MPPT, grid connected inverter.

INTRODUCTION

Energy Crisis is the biggest problems for entire world. To overcome a such problem the use of renewable energy sources is better solutions. Renewable energy has a several advantages i.e. its pollution free, cheaper, and required less maintenance. Now day's solar energy have become most popular and widely used. Photovoltaic (PV) sources are used today in many applications as they have the advantages of being maintenance and pollution free. Solar electric energy demand has grown consistently by 20% to 25% per annum over the past 20 years, which is mainly due to the decreasing costs and prices. This decline has been driven by the following factors

1) An increasing efficiency of solar cells
2) Manufacturing technology improvements
3) Economies of scale [1].

PV inverter which is used to convert dc power from PV modules into AC power. Output waveform of line commutated inverter is square shaped which contains high harmonics. Multilevel Inverters offers sinusoidal waveforms. In present work multilevel inverter circuits have been study and analysed which provides sinusoidal output waveforms and less Total Harmonics Distortion (THD).

PV SYSTEM

The basic unit of a PV module is the solar cell, which consists of a p-n junction that converts light energy directly into electrical

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energy. The equivalent circuit of a solar cell is shown in Fig.1

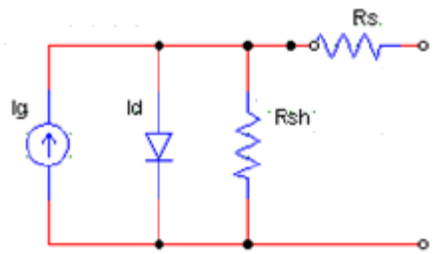

Fig. 1: Equivalent circuit of solar cell [2].

Here Ig is the light generated current, Id is the diode current, Rsh is the shunt resistance which describes the leakage current, Rs is the series resistance which describes the voltage drop as the charge carriers migrate from the p-n junction to the electrical contacts [2].

MULTILEVEL INVERTER

A multilevel inverter is power electronic systems which synthesize desired AC voltage from several DC sources as an input. Solar PV system provides output of square wave which contains large amount of harmonics. So to overcome such problems multilevel inverters is used. Multilevel inverter offer output waveform which is sinusoidal reduces total harmonics distortion (THD) and lower EMI.

There are three topologies for multilevel inverter

- Diode clamped (Neutral Clamped) multilevel inverter.
- Flying capacitor (Capacitor Clamped) multilevel inverter.
- Cascaded H-bridge inverter.

Diode Clamped (Neutral Clamped) Multilevel Inverter:

The neutral point converter proposed by Nabae,Takahashi, and Akagi in 1981 was essentially a three-level diode-clamped inverter [3]. It has been shown that the principle of diode clamping can extended to any level. A diode clamped leg circuit is shown in Figure.2

The main advantages and disadvantages of this topology are:

Advantages:

- High efficiency for the fundamental switching frequency.
- The capacitors can be pre-charged together at the desired voltage level.
- The capacitance requirement of the inverter is minimized due to all phases sharing a common DC link [4].

Disadvantages:

- Packaging for inverters with a high number of levels could be a problem due to the quadratically relation between the number of diodes and the numbers of levels.
- Intermediate DC levels tend to be uneven without the appropriate control making the real power transmission a problem.
- Uneven rating in the diodes needed for the converter [4].

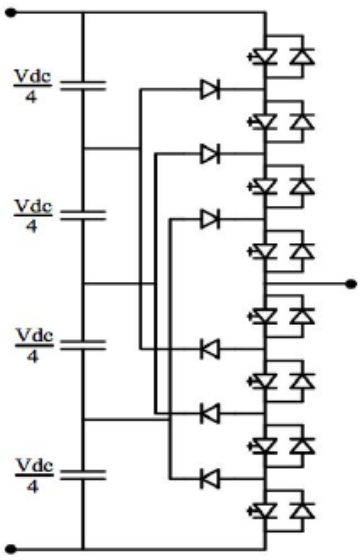

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Fig 2. 5-level structure of DCMI [4].

Flying capacitor (Capacitor Clamped) multilevel inverter:
Meynard and Foch introduced a flying-capacitor-based inverter in 1992 [5].The structure of the capacitor clamped inverter is similar to that of the diode clamped converter. The main difference is that the diodes used for the clamping are replaced by capacitors. A Flying capacitor Converter leg circuit is shown in Figure. For this topology the most common application is static VAR generation [4].

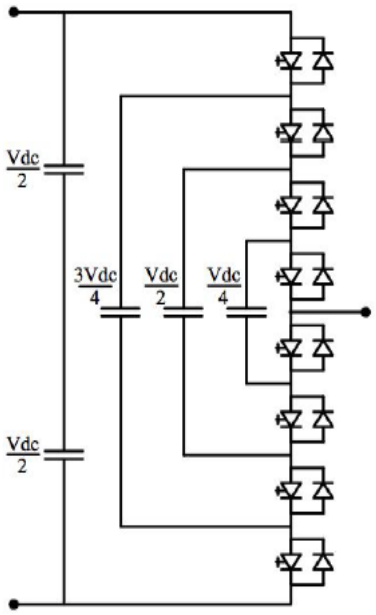

Fig 3. 5-level structure of FCMI [4].

PROPOSED SYSTEM

Grid connected multilevel inverter with MPPT will be simulate using MATLAB/SIMULINK. Solar PV module is used for DC sources. Using solar panel without MPPT controller result in wastage of power therefore for same power requirement installation of panels will be more. Hence MPPT is necessary which also reduces installation cost. Photovoltaic (PV) array is connected to the inverter via MPPT and dc-dc boost converter. MPPT is necessary to track the maximum power from solar module and for high dc bus voltage dc-dc boost converter is used. Power which is generated by the inverter is to be delivered to Grid. Multilevel converter works in inversion mode if the switching angle for each converter is greater than 90^0.

The circuit has been analyses and implement for five levels and for better performances can be extended to high level. As the number of levels increases the THD will be decreases but cost and number of secondary windings will be increased. In inversion mode of operation power is transfers from DC sources to AC source. The main advantages of proposed configuration are that output waveforms are stepped sinusoidal wave and hence reduces Total Harmonic Distortion (THD).

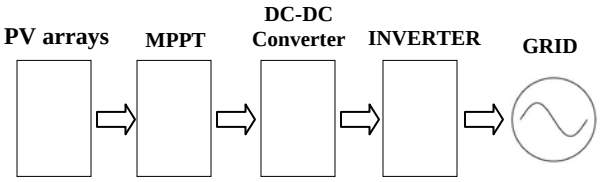

Fig. 3 A structure of grid connected PV systems with MPPT

CONCLUSION

This paper presented Multilevel (5-level) grid connected inverter for solar PV system with MPPT. Multilevel Inverter for five levels is analysed and implemented. We observed that as the level of inverter is increased, THD of grid-tie multilevel inverter has been reduced but on the other hand cost will be increased. THD can be further reduced by using proper filter circuits. Multilevel inverters offer reduced THD and improve output waveforms;

hence Multilevel Inverter can be better substitution for square shape inverters.

REFERENCE

[1] "A Multilevel Inverter for Grid Connected Photovoltaic System by employing PID Controller" R. Anand , G. Ashok Kumar, International Journal of Engineering and Advanced Technology (IJEAT) , ISSN: 2249 – 8958, Volume-2, Issue-1, October 2012

[2] "Multilevel Inverters for Grid Connected Photovoltaic System" Mary George, Anil kumar V M, IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 8, Issue 2 (Nov. - Dec. 2013), PP 26-32.

[3]"A New Neutral-point Clamped PWM inverter," A. Nabae, I. Takahashi, and H. Akagi, IEEE Trans. Ind. Applicat., vol. IA-17, pp. 518-523, Sept./Oct. 1981.

[4]"Voltage Balancing in Diode Clamped Multilevel Inverter Using Sinusoidal PWM " S.Shalini, International Journal of Engineering Trends and Technology (IJETT) – Volume 6 Number 2 - Dec 2013.

[5]"Multi-Level Conversion: High Voltage Choppers and Voltage-Source Inverters," T. A. Meynard, H. Foch, IEEE Power Electronics Specialists Conference, 1992, pp. 397-403.

[6] "Simulation and Analysis of Multistage Grid Connected Inverter Topology for Solar PV Based System" Deepak Shrivastava, Vinay Tripathi Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 5(Version 3), May 2014, pp.42-48

[7] A Review of Single-Phase Grid-Connected Inverters for Photovoltaic Modules." Soeren Baekhoej Kjaer, Member, IEEE, John K. Pedersen, Senior Member, IEEE, and Frede Blaabjerg, Fellow, IEEE ,IEEE Transactions on Industry Applications, vol. 41, no. 5, September/October 2005.

[8]"A Power Conditioner For A Grid-Connected Photovoltaic Generator Based On The 3-Level Inverter " C.J. Hatziadoniu, Member, F.E. Chalkiadakis, Student Member and V.K.Feiste, Life Member IEEE Transactions on Energy Conversion, Vol. 14, No. 4, December 1999.