International Journal of Emerging Trends in Science and Technology
4 (1), 2018, 14-17
http://www.publishingindia.com/ijetst

# Solar Multilevel Inverter with MPPT Technique and Harmonic Reduction

S. Banumathi*, S. Gowtham, R. Manoj, S. Praveen Raj, and N. Vigneswaran
Department of Electrical and Electronics Engineering, M. Kumarasamy College of Engineering,
Karur, Tamil Nadu, India. Email: bbanumathi1974@gmail.com
*Corresponding Author

**Abstract: This paper exhibits a single phase five level photovoltaic inverter with Maximum Power Point tracking which can be used for the implementation of grid connection. Now a days, connection between solar and grid are the most demanding topic. Sun based photovoltaic power is a monetarily practical and dependable innovation with huge latent in the future. PV systems are connected with modular topologies, which is to improve the efficiency and flexibility. It intends to lessen the quantity of switches alongside gateway drivers and spike removing switch included. This paper displays a PV sustained five level cascaded switched diode (CSD), MLI (Multi Level Inverter) where in the MPPT (Maximum Power Point Tracking) is completed through an ANN (Artificial Neural Network).**

**Keywords: Artificial neural network, DC-DC buck boost converter, Maximum power point tracking, PV panel.**

## I. Introduction

Electricity is a prime mover of financial development and it is fundamental to the sustenance of a today's economy. Upcoming money related improvement essentially depends upon the whole deal availability of essentialness from sources that are sensible, accessible and naturally welcoming. Government, industry and free investigations have demonstrated that financially savvy vitality effectiveness changes could decrease power use by 28% - 70% of aggregate national total use inside ten to twenty years without affecting manufacturing output or personal satisfaction. India is world's sixth biggest electrical customer, bookkeeping 3.4% of worldwide electricity utilization. The present installed power generation capacity of India remains at 1,236.39 TW has on 31.11.2017. Around 66% of the power expended in India is created by solar plants and 20.88% by hydro power plants and 2.57% by atomic plants and 11.20% from sustainable sources of power. As per International Energy Agency's projection at 2017 that, sun based power generators may deliver the majority of the world's power inside next fifty years, drastically decreasing the outflows of ozone depleting substances which damage our earth.

Both mechanical improvement and research in the zone of sustainable power sources are important to represent the expansion in vitality request and condition issues on the planet. Remain solitary PV systems are the finest arrangements, for example, water pumping, low power appliances in rural area and communication system. Such systems comprise of a photovoltaic generator, energy storing gadgets, DC or AC buyers and components for control forms. Photovoltaic module speaks to the basic power change unit of a photovoltaic generator system. The irradiance intensity and photovoltaic cell's temperature is non-linear has a major impact on the output characteristics of PV module, so it is important for the model to simulate the MPPT for stand lone photovoltaic system.

Nowadays, sunlight based PV cell is most important for generation of electricity because, it is renewable, abundant, pollution free and can be distributed throughout the world. Sadly, this system of generation of electricity also has some problems: the transformation productivity of electric power production is low (it is difficult when the sunlight level is less than 17%) and the climatic conditions also have a great impact on solar power generated by solar arrays. Additionally, the sun oriented cell V-I characteristics is non-linear and fluctuates with light and temperature.

By and large, there is an similar point on the V-P or V-I curve, called the MPP (Maximum Power Point), through this the whole PV system (converter, cluster, and etc.,) works with most extreme effectiveness and produces its greatest yield power. The area of the Maximum Power Point isn't known, however can be found, either through count models or via look calculations. In this way MPPT (Maximum Power Point Tracker) systems are expected to keep up the PV array's working point at its MPP. The incremental conductance (INC), P&O techniques are the most known strategies to track the MPP by refreshing continuously the working voltage of the PV arrays fluctuating the obligation cycle of the power converter with a fixed step size. In any case, by fusing MPP Tracking (Maximum Power Point Tracker) calculations, the PV framework's energy exchange proficiency can be enhanced altogether as it can ceaselessly keep up the working purpose of the PV cell at the MPP relating to that light and temperature.

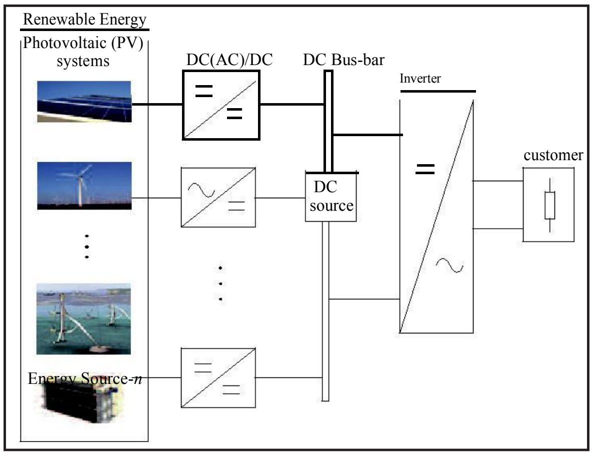


Fig. 1: Proposed System

In Existing system, normal voltage source inverter is used, which will cause high harmonics. And there is no renewable energy implementation in the existing system.

CSD five level multilevel inverter is implemented here, in this method number of switches is reduced. So harmonics in the inverter is less than 3%. Voltage regulation is used to give constant output voltage. SHEPWM (Selected Harmonics Eliminated Pulse Width Modulator) is used so harmonics in the inverter is very low. Losses are low so efficiency is high.

## II. System Model

### A. DC-DC Converter

A converter, which produce output DC voltage greater than the input voltage is known as boost converter (Fig. 1). It should contain at least two semiconductor switches (a diode and transistor) and at least one energy storing device. The output voltage will have some ripple which can be reduced by adding filters. Filters are made of capacitors.

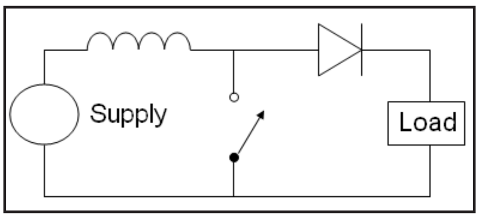


Fig. 2: Basic Diagram of a Boost Converter

There are several ways for DC source production, for example, sunlight based boards, batteries, DC generators and rectifiers. The process of conversion of one DC voltage to other DC voltage is known as DC to DC conversion. Mostly, the converters are to function in one direction through which the power can be moved in only direction to the output. By replacing all diodes with independently controlled active rectification, the converters can be made into bi-directional device. This kind of converters is used in regenerative breaking system.

## III. System Operation

### A. Circuit Operation

The double-stage cascaded switched-diode topology, comprises n CSD converter also has a spikes removing switch Sg and a full bridge inverter, as per the number of cascaded basic units. The essential unit 1 comprises of a DC voltage source or a capacitor consists of DC voltage as same as u1, a switch S11 with diode which is internally reversed and a D11 (Figure 2).

Obviously the parallel connection of the diode D11 maintains a strategic distance from the shoot-through phenomenon of an extension arm. Two output values can be attained for uo1 of the fundamental unit 1, which are u1 when switch S11 behaviors and 0 when turn S11 is removed. The spike evacuation switch Sg, associated between unit 2 and unit n, gives a flowing path to the reverse stack current. At the point when S11 is on, S21 • Sn1 is off, Sg is turned on. The cascading layout of n fundamental units and Sg frame the first stage. The most extreme output voltage of the main stage is given as takes after:

$$G = uo1 + uo2 + \cdots + uo\textit{n}. \tag{1}$$

and for states of switches S11, S21, · · · , S($n$−1)1, S$n$1, 2$n$ different values of ug are obtained, the first-stage of converter can produce positive output voltage waveforms which is in shape of staircase. For generating negative and positive output voltages, the second stage of conversion is required. From this, we came to know that service of both negative and positive halves of output. Under similar cases, i.e., every DC voltage sources are same as udc, the total number of switches NIGBT required and the number of output voltage levels N level are calculated as follows, respectively.

$$N\ level = 2n + 1 \tag{2}$$

$$NIGBT = n+5 \tag{3}$$

then total number of switches required for a N level output voltage is derived as follows:

NIGBT = N level+ 9

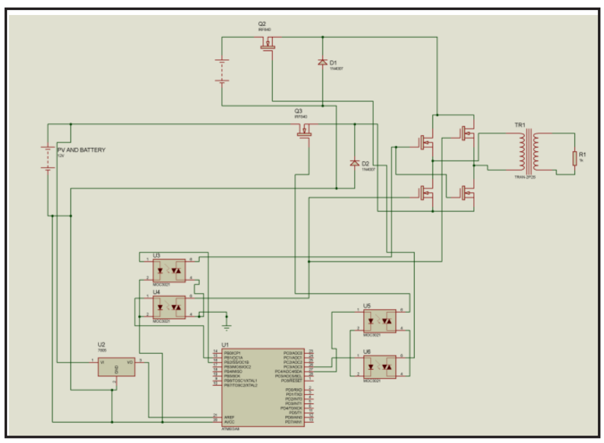

Fig. 3: Circuit Diagram

*B. System Simulation Operation*

The System simulation is basically programmable

Logic circuit's simulation. The code used for programming is embedded c coding.

The system simulation also gives the total harmonic distortion, which satisfies the standard IEEE requirement.

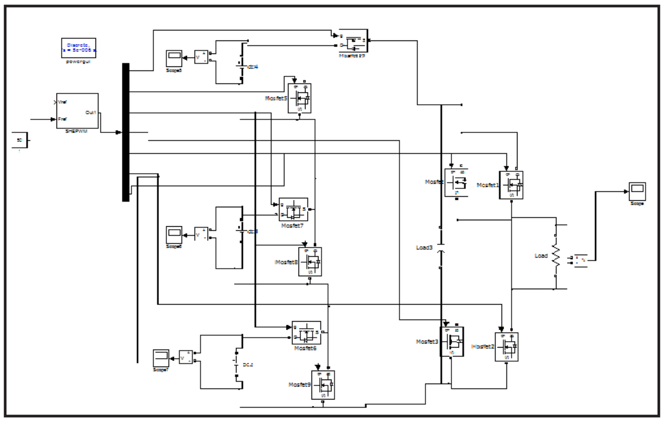

Fig. 4. Simulation Diagram

The simulation diagram of the proposed system is given in fig. 3. The supply is given to MOSFET through de-mux from the supply. Each series is connected with voltage source. When the pulse is given to the MOSFET it starts to invert the supply to the required level. This will reduce harmonics distortion from the supply.

More accurate sine wave can be achieved by increasing the number of switches, which also leads to increase in number of levels.

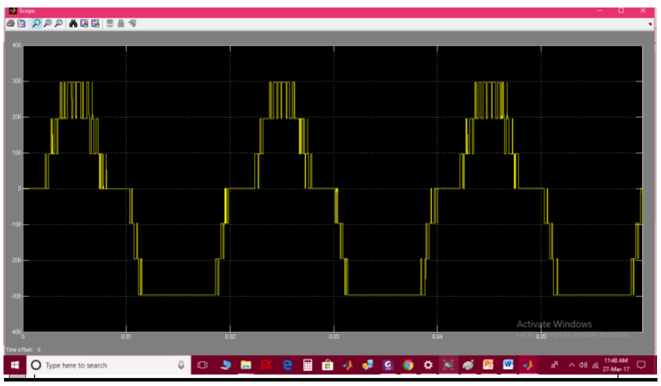

Fig. 5: Simulation Output

Fig. 4 gives the output of the simulation model. The output of the simulation is given into five levels. And the harmonics from the sine wave are reduced by the help of MOSFET. As the level of inverter increases, the accuracy of the sine wave will also increase.

(a)

(b)

(c)

Fig. 6: DC Voltage (a) 48V (b) 96 V (c) 192 V

Fig. 5 gives the three different input dc votages given to the inverter circuit, which are inverted into multi levels and gives the required ac voltge with the reduced harmonics.

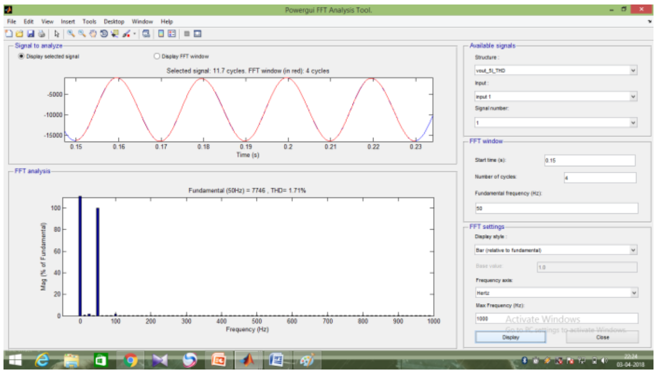


Fig. 7: FFT Analysis

As per the result of FFT Analysis, total harmonic distortion produced by the circuit is 1.7% (fig. 6). It is less than the standard IEEE requirement. So, the circuit produces very less amount of harmonic.

It has advantage over existing system, as existing system uses more number of switches, which leads to increase in cost. In proposed system, number of switches has been reduced. Thus, the cost for production is also reduced.

## IV. Conclusion

Single-stage multilevel inverter designed with CSD for PV cell application is proposed in this work. A carrier signal and two reference signals are used to produce PWM signals. The modulation law, operational principle, and circuit topologies of the proposed inverter were investigated in detail. An algorithm of advanced PI current control is actualized in ATmega8 to upgrade the execution of the inverter. The simulink model output showed that the Total Harmonics Distortion of the five-level inverter is substantially lesser than the ordinary three-level inverter. Moreover, The phase angle difference between grid voltage and current is nearer to zero and the power factor is approximately unity.

## References

1. M. S. B. Ranjiana, P. S. Wankhade, and N. D. Gondhalekar, "A modified cascaded H-bridge multilevel inverter for solar applications," *In 2014 International Conference on Green Computing Communication and Electrical Engineering*, pp. 1-7, 2014,.
2. F. S. Kang, S. J. Park, S. E. Cho, C. U. Kim, and T. Ise, "Multilevel PWM inverters suitable for the use of stand-alone photovoltaic power systems," *IEEE Transactions on Energy Conversion*, vol. 20, no. 4, pp. 906-915, 2005.
3. L. V. Nguyen, H. D. Tran, and T. T. Johnson, "Virtual prototyping for distributed control of a fault-tolerant modular multilevel inverter for photo-voltaics," *IEEE Transaction Energy Conversion*, vol. 29, no. 4, pp. 841-850, 2014.
4. J. Rodriguez, J. S. Lai, and F. Z. Peng, "Multilevel inverters: A survey of topologies, controls, and application," *IEEE Transaction on Industrial Electronics*, vol. 49, no. 4, pp. 724-738, 2002.
5. K. Sundararaju, and A. N. Kumar, "Cascaded and feed forwarded control of multilevel converter based STATCOM for power system compensation," *International Review on Modelling and Simulation*, vol. 5, no. 2, pp. 609-615, April 2012.
6. F. Z. Peng, and J. S. Lai, "Multilevel converters- A new breed of power converters," *IEEE Transactions on Industry Applications*, vol. 32, no. 3, pp. 509-517, 1996.
7. K. Sundararaju, and A. N. Kumar, "Cascaded control of multilevel converter based STATCOM for power system compensation of load variation," *International Journal of Computer Applications*, vol. 40, no. 5, pp. 30-35, February 2012.
8. R Karthikeyan, and S. C. Pandian, "Generalized Space Vector PWM Algorithm for Minimizing THD in Hybrid Multilevel Inverters," *International Review of Electrical Engineering,* vol. 6, no 5, pp. 2094-2099, September-October 2010.
9. E. Villanueva, P. Correa, J. Rodriguez, and M. Pacas, "Control of a single-phase cascaded H-bridge multilevel inverter for grid-connected photovoltaic systems," *IEEE Transaction on Industrial Electronics*, vol. 56, no. 11, pp. 4399-4406, 2009.
10. F. Khoucha, M. S. Lagoun, A. Kheloui, and M. E. H. Benbouzid, "A comparison of symmetrical and asymmetrical three-phase H-bridge multilevel inverter for DTC induction motor drives," *IEEE Transactions on E nergy Conversion*, vol. 26, no. 1, pp. 64-72, 2011.
11. M. Hamzeh, A. Ghazanfari, H. Mokhtari, and H. Karimi, "Integrating hybrid power sources into an islanded MV micro grid using CHB multilevel inverter under unbalanced and nonlinear load conditions," *IEEE Transactio ns on Energy Conversion*, vol. 28, no. 3, pp. 643-651, 2013.
12. S. A. Khajehoddin, A. Bakhshai, and P. K. Jain, "A simple voltage balancing scheme for m-level diode-clamped multilevel converters based on a generalized current flow model," *IEEE Transactions on Power Electronics*, vol. 23, no. 5, pp. 2248-2259, 2008.
13. A. Nami, F. Zare, G. Ledwich, A. Ghosh, and F. Blaabjerg, "Comparison between symmetrical and asymmetrical single phase multilevel inverter with diode-clamped topology," In *IEEE Power Electronics Specialists Conference,* pp. 2921-2926, 2008.
14. R. Karthikeyan, & S. C. Pandian, "A novel 3-D space vector modulation algorithm for cascaded multilevel inverter," *International Review of Electrical Engineering*, vol. 4, no. 6, pp. 2860-2865, November-December 2010.