International Journal of Interdisciplinary Innovative Research & Development (IJIIRD)

ISSN: 2456-236X

Vol. 01 Issue 02 | April-2017

STEP UP CONVERTERS AND THEIR VARIOUS CONTROLLING METHODS FOR PHOTOVOLTAIC SYSTEM

***Saurabh H. Thakare*[1] *,Nagendra B. Kute*[2] *Manoj wankhade*[2]**

[1]*Assistant Professor , Department of Electrical Engineering, Padm.Dr.V.B.K.C.O.E. , Malkapur, Maharashtra,India* [2]*PG student , Department of Electrical Engineering, Padm.Dr.V.B.K.C.O.E. , Malkapur, Maharashtra,India*

[3]*PG student , Department of E&TC Engineering, Padm.Dr.V.B.K.C.O.E. , Malkapur, Maharashtra,India*

[1]*saurabhthakare92@gmail.com*

[2]*wankhademanoj1@gm,ail.com*

[3] *kutenagendra@gmail.com*

ABSTRACT

The paper deals with the various methods of step up converter which can be use to increase output and performance of photovoltaic system. The non renewable energy sources like natural gas, oil, coal, fossil fuel are present in limited amount and they have certain limitations, due to this the importance of renewable energy sources like tidal, solar, wind, etc increasing rapidly. Out of these renewable energy sources, photovoltaic system plays vital role in the generation of energy. But the energy output of this system is low. Hence this paper deals with the step up converters and the various methods of step up converter which are use to increases the output of photovoltaic system.

Keyword: - Photovoltaic system, Step up converter, PWM technique, Hysteresis current control technique

1. Introduction

The values of sources of renewable energy growing rapidly because they are found in limitless amount and also they does not produce any harmful effect on the environment. They are the clean source of energy. These are the two main advantages of renewable energy sources over the non renewable energy sources. Hence the whole world is now concentrating on the maximum use of this renewable energy sources. The various renewable energy sources are sun, wind, tidal energy etc. Out of this renewable energy source solar energy has the great importance as the sun is giant source of energy. So the photovoltaic system plays an important role in the renewable energy source generation [1]. But this system has main disadvantages that the output of this system is very low[2].So we need to improve the output of the system for the better results.

To increases the output of the system, various types of step up converter are used[3].Also the voltage multiplier unit and step up converter are used[4.]The details of the various types and control methods of step up converter converters, also their merits and demerits for the photovoltaic system is discussed in this paper.

2. Block Diagram:

The photovoltaic system has four main parts namely consist solar module, high step up dc-dc converter, inverter and the load. The solar module has very low voltage output. As solar module is connected to step up converter, the output of solar module is acts as input to high step up converter. This step up converter increases the output voltage. The high valued output voltage is then given to the inverter to convert it into alternating voltage[6]. This alternating voltage is then given to the load for the use.

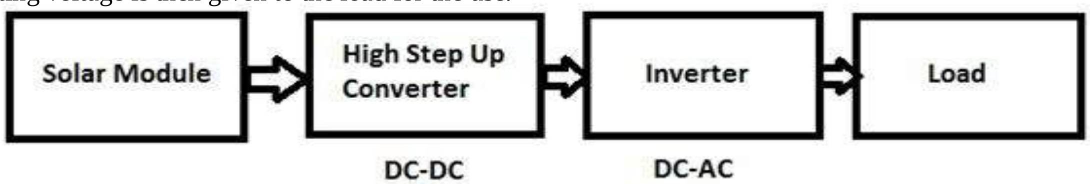

Fig.2.Block Diagram for the photovoltaic system

3. Various Types Of Boost Converter System:

The dc-dc converters are of various types like buck converter, boost converter, buck-boost converter, boost flyback converter, cuk converter. The input is same for all the dc-dc converters i.e. dc input. But they differs in outputs as some converters increases dc ouput voltage and some decreases dc output voltage.

3.1 Conventional Boost Converter System:

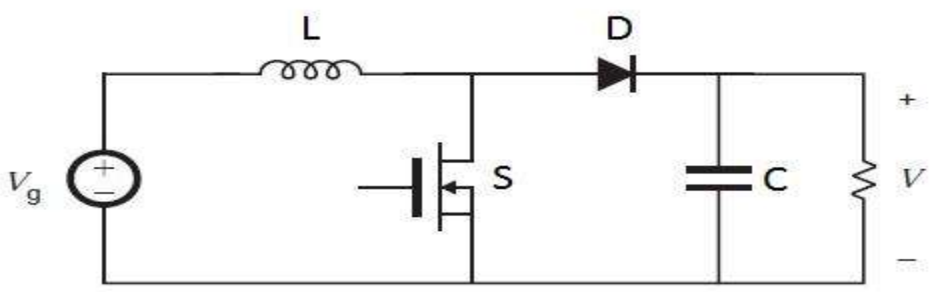

Fig.**3.1. Circuit Diagram of conventional boost converter system**

Boost converter is a DC to DC power converter for which output voltage is larger than input voltage. It consists of at least two semiconductors elements i.e. diode and transistor. Also it consist of at least one element for storing of energy like capacitor, inductor or the combination of both capacitor and inductor. Generally, the switch can be MOSFET, IGBT or BJT. Power can be supplied to a boost converter by using suitable DC source such as solar panel, batteries, DC generators or rectifiers. Sometimes a boost converter can also be called as Step-up converter as it increases or steps up the output voltage.

3.2 High Step Up Converter With Voltage Multiplier Module:

The converter combines the advantage of both boost converter and fly back converter. The system contains the voltage multiplier module which consist of two inductors which are coupled and the boost converter. The inductors which are coupled have primary windings and secondary winding. Primary windings contains Np turns and they are used for decreasing the ripple in input current. Secondary winding contains Ns turns and they are used to increase **gain in the voltage. Also, '.' and '*' is used f**or referencing the coupling of coupled inductors. The turns ratio are same in coupled inductors. As shown in fig.3 , S1,S2 are the switches, Lk1 ,Lk2 indicates leakage inductors, Lm1,Lm2 denotes magnetize inductors, Cb indicates the capacitor for lifting the voltage and Ns/Np is ratio of turns which is indicated by n. The operation of the converter is performed by using both methods.

The operation is performed in six modes. These modes are as follows,

Mode I (t0-t1): Here both switches S1,S2 are in ON, So diodes are in reverse bias. Hence due to this ,the magnetize Lm1,Lm2 and leakage inductors Lk1,Lk2 now charged by Vin.

Mode II(t1-t2): Here switch S2 is OFF, So diodes D2 ,D4 are in ON state. So the energy of Lm2 is used to charge C3,so ,the voltage of capacitor C1 increase .

Mode III (t2-t3): Lk2 is delivers complete energy to C1.Because of that D2 gets into OFF state. So Lm2 use to charges C3 through D4 up to the time period t3 . Mode IV (t3-t4): In this mode S2 is in ON state. It has same working as that of mode 1.

Mode V (t4- t5): Here S1 is in OFF state and because of that D1 ,D3 are in ON state. Hence, Lm1 energy is used for charging the C2., because of that Lm1 and Vin gives energy to Cb via D1 ,Cb Collect more energy.

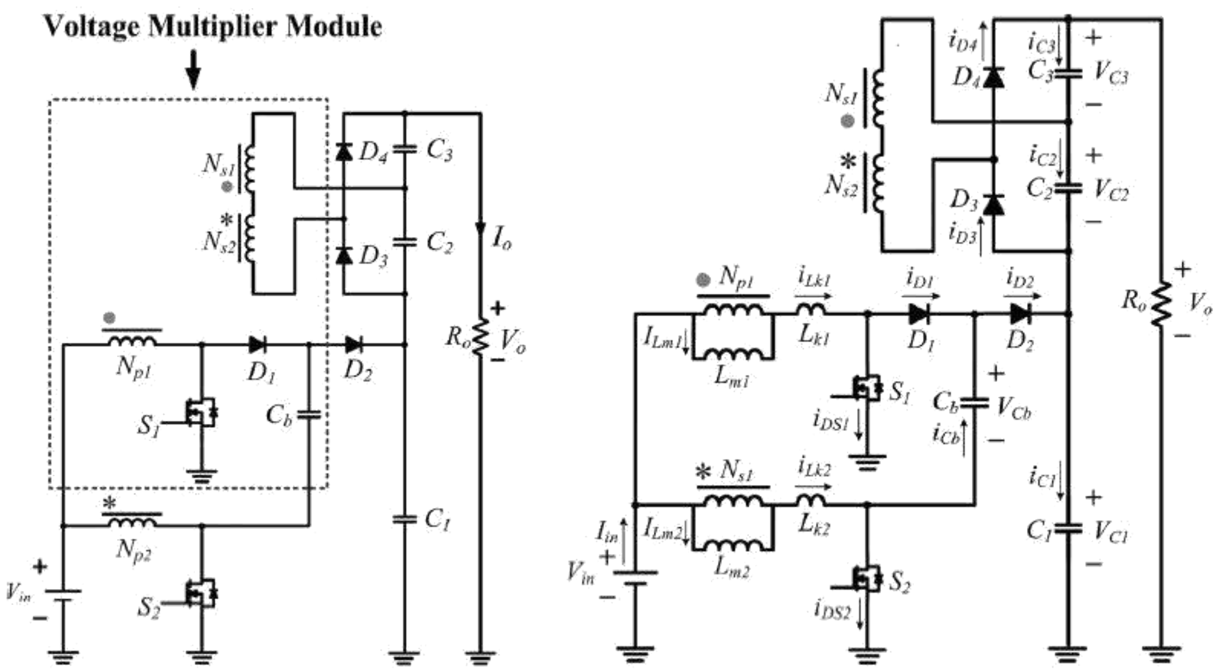

Fig.3.2.Circuit Diagram of Converter With Voltage Multiplier Module

Mode VI (t5-t0): Lk1 transfers complete energy to Cb. Because of that D1 is in OFF state.Hence, Lm1 energy is used for charging the C2 via D3 up to the time of t0.

4.Control Methods For The High Step Up Converter :

4.1 PWM Technique:

Pulse width modulation i.e. PWM is a technique which conforms width of signal, generally pulses which are based on modulator signal information. The main purpose of this technique is control of power especially the power supplied to the electrical devices. This technique is also used for encoding information for transmission. The switch which is placed between load and supply can be turn to on and off condition to control the voltage and **current given to load at very fast rate. If time period of switch in 'on' condition is greater than that of 'off' condition** then the power is supplied to the load is higher. The on-off behavior is responsible for changes in average power of signal.PWM uses rectangular pulse wave of which pulse width is modulated which results in variation of the average value of the waveform.

There are various methods used for generating PWM signal. These methods are as follows :

1. Analog Method : a)Intersective Method
2. Digital Method : a)Delta Modulation
   b)Delta Sigma Modulation
   c)Space Vector Modulation
3. Application Specific Method: a)Direct Torque Control
   b)Time Proportioning

Out of these methods Intersective method , Delta nodulation method and delta sigma modulation method are generally used.

4.1.1 Advantages of PWM Technique:

1. Average value is proportional to duty cycle.
2. Low power in transistor used to switch the signal.
3. Also, because of MOSFETS and power transistors fast switching is possible at speed in excess of 100 KHz.
4. By the use of resistive elements at intermediate voltage points , problems of high heating losses can be reduce.
5. Power loss is very less in switching devices.

4.1.2 Disadvantages of PWM Technique :

1. Complexity of circuitry
2. Radio frequency interference and electromagnetic interference limits circuit performance
3. Cost of integrated package of circuitry is high
4. Voltage spikes are occurred in pulse signal

4.2 Hysteresis Current Control Technique:

Hysteresis current control method is used generally because of its simplicity, accurate and fast response. They do not required components for feedback loop compensation. This is used for reducing number of components and also size of theoretical analysis for purpose of implementation. This also reduces design efforts for calculating values of circuit component like capacitor, inductor and input voltage etc. They respond quickly to load changes and disturbance after transient takes place. Due to this they give accurate and fast dynamic response. But the main disadvantage of this method is its variable switching frequency which causes extra switching losses and injection of harmonics having high frequency into system current. Such problem can be solved by using adaptive hysteresis current control method as it produce hysteresis bandwidth which gives result instantaneously into constant and smoother switching frequency. Another disadvantage of this method is non-zero steady state error. This error can be rectified by using PI block in series with the voltage feedback. There are various types of hysteresis controller such as hysteretic voltage mode controller, hysteretic current mode controller,V2 controller. This method have characteristics like high stability and accurate and fast dynamic behavior. Many switching methods are used for producing switching pulse for generating reference current. But, Hysteresis current control has been observed more than other current control techniques because of its characteristics like simplicity and quick dynamic response.

In hysteresis current control method, error signal is compared with the hysteresis band to generate triggering pulses which are to be required. It is also used to control voltage source inverter hence the output current which come out from the filter can follow the waveform of reference current as in fig. The voltage source inverter switches are controlled by this method to ramp inductor current up and down. Hence, it can follow the reference current. It is the simplest and easiest method for the implementation in real time.

Fig. shows current ramping between two limits i.e. upper limit and lower limit. Upper hysteresis limit is the addition of reference current and maximum error whereas the lower hysteresis limit is the subtraction of reference current and minimum error. If the value of both errors i.e. maximum error and minimum error are same then hysteresis bandwidth is equal to double of error.

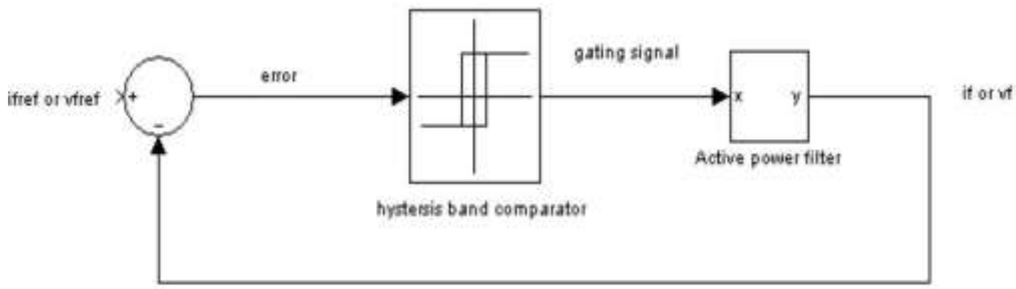

Fig.4.2.1 Hysteresis Control Method

According to the principle of operation of inverter, voltage output of each phase are significant to that of the switching pulses of switches in each leg. From this, switching gates is obtained for active power filter. The switching frequency is shown by the voltage across inductors. This frequency can be alter by adjustment of hysteresis tolerance band.

This technique is used for generation of the switching pulses. From the various current control methods, this method is used broadly because of its noncomplex implementation, very fast transient response, outstanding stability, inherent limited maximum current, absence of any tracking error and intrinsic robustness to load parameters variations. In comparison with PWM control technique, it provides better low order harmonic suppression than PWM control which is head target of the active power filter. It is easier to realize with high accuracy and fast response. However, as a disadvantage its switching frequency may be fluctuate.

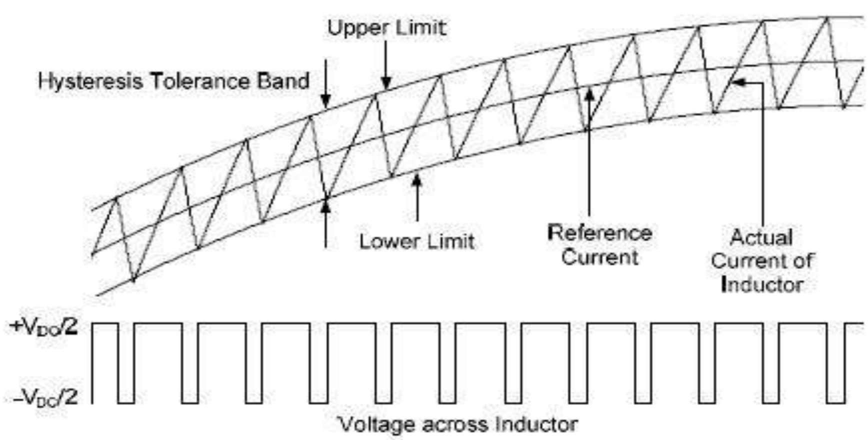

Fig.4.2.2 Hysteresis Band

In this technique, the error function is centered in a preset hysteresis band. When error get exceeds above upper or below lower hysteresis limit the controller takes an appropriate switching decision for controlling the error within the preset band limit and then send these pulses to VSI for producing the reference current as shown in Figure. The outputs of the hysteresis blocks are fed directly as the firing pulse of VSI switches. In fixed band hysteresis current control technique, hysteresis bandwidth is taken as small portion in comparison with system current. Generally, it has been taken as 5 % of system current.

4.2.1 Advantages:

1. It has excellent dynamic response.
2. It is simple for design and implementation.
3. It has outstanding stability.
4. Do not required components for feedback loop compensation.
5. Reduces design efforts for calculating the values of circuit component.
6. It has wide command on tracking of bandwidth.
7. It has fast response for load changes and disturbances.
8. It is more suitable for high power application.

4.2.2 Disadvantages:

1. Variable switching frequency
2. Non zero steady state error

5. Conclusion:

As the output voltage of photovoltaic system is low, we have to improve the output voltage and hence performance of the photovoltaic system. For this we can use step up converter to increases the output voltage. Also we can use voltage multiplier unit with step up converter which is more advance than normal step up converter. By using this more output voltage can be produce. Also we have studied various control methods for this voltage multiplier unit and step up converter i.e. PWM and Hysteresis current control methods. These methods are differ in their output voltage, total harmonic distortion losses etc. These methods can be then compare to get better results.

6. References:

[1] Kuo-ching Tseng, Chi-chih Huang, Wei-**Yuan Shih, " A high step up converter with voltage multiplier module** for a photovoltaic **system."IEEE** Trans.on power electronics.,vol.28, No.6,June 2013.

[2] Ching Tsai Pan and Ching Ming Lai, "A high-efficiency high step-up converter with low switch voltage stress for fuel-**cell system applications," IEEE Trans.** Ind. Electron., vol. 57, no. 6, pp. 1998–2006, Jun. 2010

[3] Wuhua Li,Yi Zhao, Jiande Wu,Xiangning He, "Interleaved High Step-Up Converter With Winding-Cross-**Coupled Inductors and Voltage Multiplier Cells," IEEE Trans.on power electronics,vol. 27, no. 1,** Jan 2012

[4] J. T. **Bialasiewicz, "Renewable energy systems with photovoltaic power generators: Operation and modeling,"** IEEE Trans. Ind. Electron., vol. 55, no. 7, pp. 2752–2758, Jul. 2008.

[5**] Rajasekhar S, "Solar photovoltaic power conversion using modular multilevel converter" senior member IEEE** in 2012.

[6] Jong-Won Shin, Hojoon Shin, Gab-Su Seo,Jung-Ik Ha, and Bo-**Hyung Cho," Low**-Common Mode Voltage H-**Bridge Converter with Additional Switch Legs,"** IEEE Transactions On Power Electronics, Vol. 28, No. 4, April 2013.