International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 08 | August -2020 ISSN: 2582-3930

Three Level NPC Inverter for Solar PV and Battery Storage Integration

Sandip P.Patil[1], V.S.Pawar [2]

[1]Electrical Department&SSBT's College of Engineering and Technology
[2]Electrical Department& SSBT's College of Engineering and Technology

---***---

Abstract -At present, Neutral Point Clamped (NPC) multilevel inverter is widely applied in new energy field. Multilevel inverters are a very attractive solution for medium-voltage high-power conversion applications; they convert DC power to AC power at required output voltage and frequency level. New three level inverter can improve the Utilization of DC voltage, and realize the neutral point potential balance with hysteresis Comparator. In this paper we have developed and implemented the Multi-level inverter for solar battery system. The inverter topology selected contains less number of switches and the output is obtained, that is the main objective of the Paper.

***Key Words*:**Solar System, Inverter, Irradiance, Power Measurement, Converter

1. INTRODUCTION

In many new energy power generation systems, such as photovoltaic power generation, wind power generation, multi-level inverters have been used more and more widely [1, 2]. Compared with the two level inverter, the multilevel inverter device has little stress and effectively improves the power level. Under the same switching frequency, the harmonic distortion is reduced and the quality of the output waveform is improved. However, in practical application, there are some problems such as low utilization of DC voltage and unbalance of neutral point potential in neutral point clamped multilevel inverters.[4]

At present, there is a method to increase the utilization ratio of DC voltage by using three harmonic injections. The space vector modulation theory can improve the DC voltage utilization to 1. The algorithm is complex. When the level is greater than 3, the switching state vector is too much, which makes it very difficult to achieve. Moreover, the multi-target of predictive control is also used. In the penalty function, the neutral point potential is increased, and the neutral point current is reduced effectively, thus suppressing the neutral point potential imbalance. All of the above methods improve the utilization of DC voltage and balance the neutral point potential from the point of view of control logic. It can't be applied to single-phase circuits and the level is greater than 3. In this paper, a new two stage single phase Multi level inverter is proposed by optimizing the topology. The fore-stage three-level DC/DC circuit is adopted to improve DC voltage utilization ratio, capacitor voltage balance can be achieved via monocyclic ring or hysteresis, backward stage modulation and control strategy are simplified. [3, 5].

2. MULTI-LEVEL INVERTER

A Three Phase Multi Level Inverter is a circuit which converts DC to three phases AC. Each phase is of 120degree phase shifted. To produce a three phase multi-level inverter here we use three single phase cascaded inverter with 120 degree phase shift. In the field of high voltage power conversion, the circuit designer often encounters a serious problem. There is no semiconductor switch independently capable of sustaining the desired voltage. For this reason, circuit designers proposed several converter topologies in which only a fraction of voltage applied to each switch. The concept of multilevel converters has been introduced (Baker & Bannister (1975). The term multilevel began with three-level converter. Subsequently, several multilevel converter topologies have been developed by Sule Ozdemir et al (2007). Multilevel inverters synthesize the AC voltage from several different levels of DC voltages. Each additional DC voltage level adds a step to the AC voltage waveform. By switching the DC voltages to the AC output, a staircase waveform can be produced which approaches the sinusoidal waveform with minimum harmonic distortion. Compared to full bridge inverter which can generate two or three level voltage waveforms at its AC output. [1, 2]

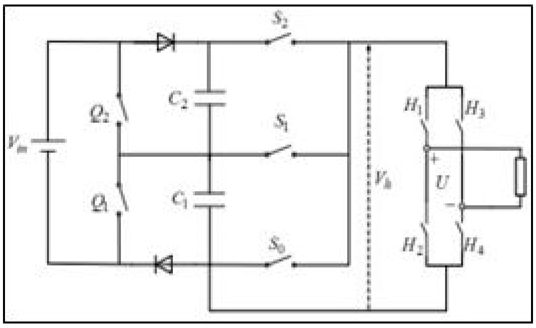


Fig.1 Multi-Level Inverter

There are 12 working modes for Multi-level inverters. When Vc1=Vc2, capacitance C1, C2 are equivalent as DC voltage source. 12 working modes are simplified to 6 modes, see Figure 2. Io is output current. Three working modes in positive semi-period are shown in Figure 2 (a), (b) and (c). It's worth noting that there is only one break over for S0, S1, and S2. When Si is connected, Vh=i (i=0, 1, 2), namely, output level of DC converter is decided by Si. When H1, H4 are connected and H2, H3 are cut off, then U= -Vh. The following analysis of the multi-level inverter works. It is assumed that the capacitor value of the DC side capacitor C1 and C2 of the front circuit is equal. The capacitance voltage is Vc1 and Vc2 respectively. During work, Q1 and Q2 alternate conduction. When Q1 is switched on, the capacitor C2 charges. When Q2 is switched on, the capacitor C1 charges. If Q1 and Q2 are alternately switched on, the duty cycle is 0.5, then Vc1=Vc2=Vin. Each half cycle of the inverter can be divided into ascending and descending stages. When the H bridge arm H1 and H4 are turned on and the H2 and H3 turn off, the inverter operates in the positive half cycle. Rising stage: switch tubes S0, S1 and S2 are connected in turn. Vh changes from 0 to Vin, to 2Vin, and outputs U=Vh. Descent stage: switch tube S2, S1, S0 alternately conduction. Vh has changed from 2Vin to Vin to 0, and output U=Vh. When the bridge arm H2 and H3 are turned on and the H1 and H4 turn off. The inverter operates in the negative half cycle. Rising stage: switch tubes S0, S1 and S2 are connected in turn. Vh changes from 0 to Vin, to 2Vin, and outputs U=-Vh. Descent stage: switch tubes S2, S1 and S0 are sequentially connected. Vh has changed from 2Vin to Vin to 0 and output U=-Vh. To sum up, Vc1 and Vc2 are decided by connection time of Q1 and Q2. The output level of three-level DC converter is decided by switch tube Si. The frequency and initial phase of inverter output waveform are controlled by switch tube Hj, Q1, Q2 and Si. Hj are separated for independent control. The frequency and phase of Si and Hj need to be synchronized. [6]

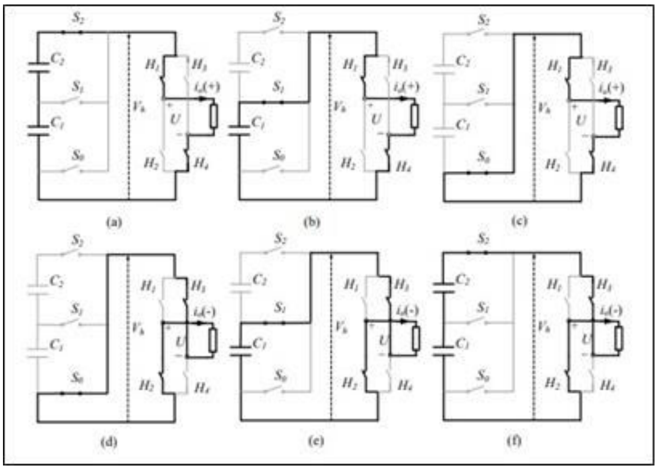


Fig 2. Working Mode of Multi-Level Inverter

3. SIMULATION MODELS

The electrical model of the PV is being made and the voltage rating is kept above 12v. Then using a buck converter the voltage is stored in a battery stack of 12v. The dc voltage is given to a Multi-level switch inverter (open loop) and is converted to ac form.

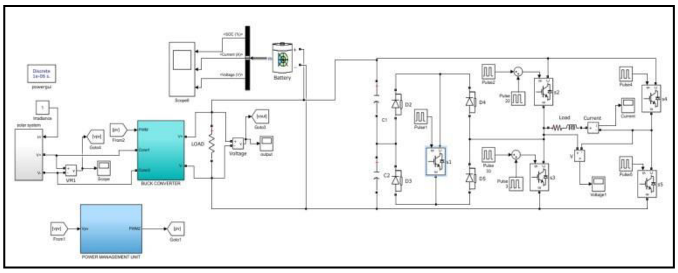


Fig.3 Complete Simulation model for Solar PV Battery with Multi level Inverter

In the simulation model we have used different components

A. Solar System

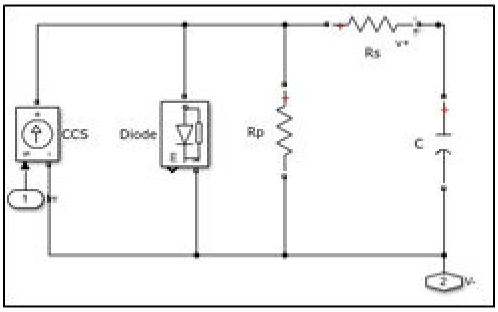


Fig 4. Schematic Diagram for Solar PV system

B. Buck Converter

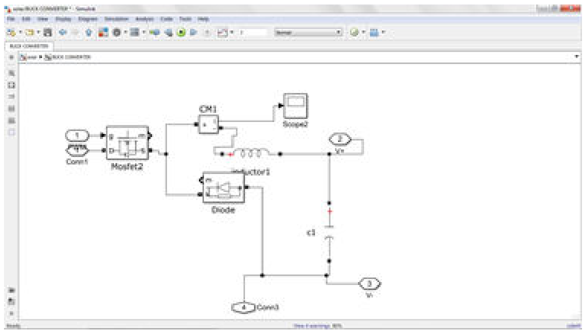
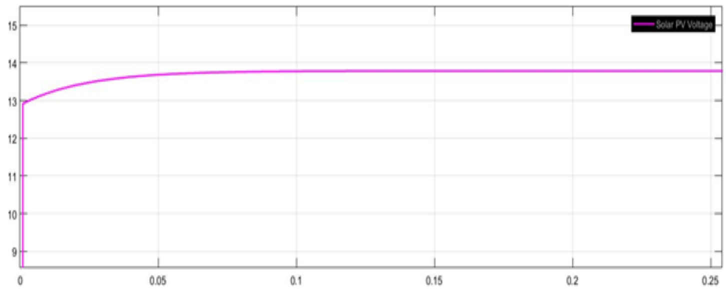


Fig 5. Circuit diagram for Buck Converter

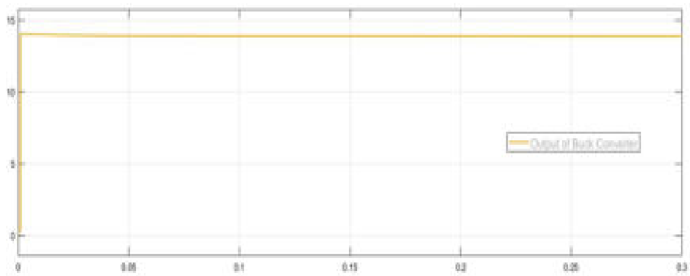
Then, Power Management is used for generating a PWM for Buck Converter. Then further Multi levels Inverter and Battery is connected. In this model we can change all the Parameters like, Solar Irradiance, Temperature towards solar system and also the rating of Solar pv system as per our load Requirement.

4.Simulation model: Results

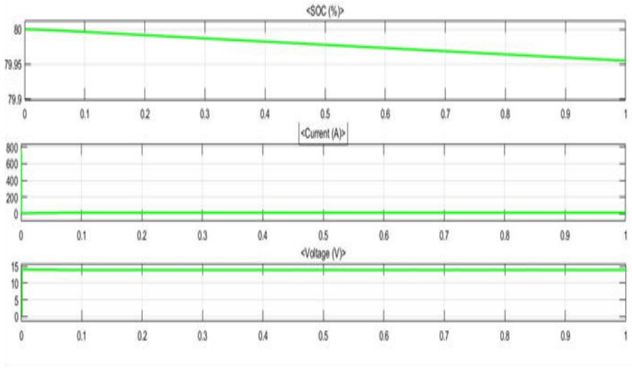
Solar System Output: VM1



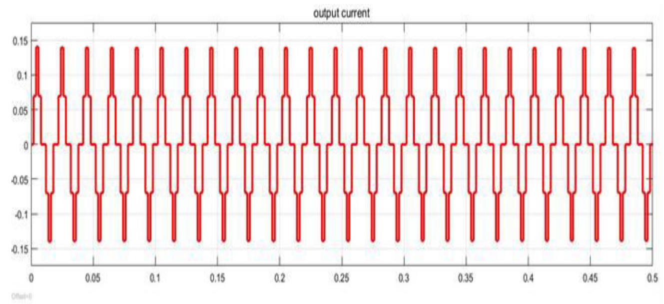
Buck Converter output Voltage:



Battery output:



Final Output:



This all Results show a step by step activity of the model.

CONCLUSIONS

As Compared with the conventional clamping multilevel inverters, the new Three-level inverter improves the utilization of DC voltage and achieves the neutral point potential balance. A model is built to simulate the effect of the inverter, which shows that the new inverter in this paper has good performance. Multilevel converters can operate at both fundamental frequency and high switching frequency PWM. It should be noted that lower switching frequency usually means lower switching loss and higher efficiency.

REFERENCES

1. Langer N, Bhat A H, Agarwal P. Neural-network-based space-vector pulse-width modulation for capacitor voltage balancing of threephase three-level improved power quality converter[J]. Iet Power Electronics, 2014, 7(4):973-983.
2. Pou J, Zaragoza J, Ceballos S, et al. A Carrier-Based PWM Strategy With Zero-Sequence Voltage Injection for a Three-Level Neutral-Point-Clamped Converter[J]. IEEE Transactions on Power Electronics, 2012, 27(2):642-651.
3. Song Y, Wang B. Survey on Reliability of Power Electronic Systems[J]. IEEE Transactions on Power Electronics, 2013, 28(1): 591-604.
4. Kouro S, Malinowski M, Gopakumar K, et al. Recent Advances and Industrial Applications of Multilevel Converters[J]. Industrial Electronics IEEE Transactions on, 2010, 57(8):2553-2580.
5. Mohan Vitthalrao Aware. Six-Phase Inverter Operation with Space Vector Pulse-width Modulation for a Symmetrical Single Neutral Load[J]. Electric Power Components & Systems, 2013, 41(16):1635-1653.
6. J. S. Lai and F. Z. Peng, "Multilevel Converters—A new Breed of Power Converters, IEEE Transactions on Industry Applications, Vol. 32, No. 3,1996, pp. 509-517.