ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

A Three Level NPC Based Hybrid System Using Simplified Control Scheme



K. Bhaskar
M.Tech,
Department of EPS,
Brilliant Engineering College.

Vajramma
Assistance Professor,
Department of PE,
Brilliant Engineering College.

R Nagesh
Assistance Professor,
Department of PE,
Brilliant Engineering College.

Abstract:

The unbalance of the neutral point voltage is an inherent problem of three-level neutral-point-clamped (NPC) inverter, the effect of neutral point voltage balancing which is caused by voltage vector is analyzed, and the relationship of the voltage offset and neutral point voltage is studied in this paper. This paper proposes a PV input novel neutral point balance strategy for three-level NPC inverter based on space vector pulse width modulation (SVPWM). A voltage offset is added to the modulation wave, and a closed-loop neutral point voltage balance control system is designed. In the control system, the dwelling time of synthesis voltage vectors for SVPWM is varied to solve the problem of the unbalance of the neutral point voltage, the sequence of the voltage vectors maintains unchanging. Simulation results show the neutral point voltage balancing control strategy based on SVPWM is effective.

Key words:

PV panel, Space Vector PWM, NPC converter.

1. INTRODUCTION:

The NPC three-level inverter is widely implemented in medium-voltage high-power applications,compared to the convention two-level inverter, the voltage stress on switchingdevices is reduced, the output voltage and current are better with lower harmonics. Thus, thistopology has been widely applied in high-voltage power conversion systems [1-3]. Figure 1shows the NPC three-level inverter topology. However, one important problem of NPC three-level inverter is the unbalance of theneutral point voltage, which will increase the output voltage harmonics, damage the switching devices and dc-link capacitors. The causes of neutral point voltage unbalance can be non uniformdc-link capacitors, operating conditions and load types. There are two types of software-based control strategies, one is based on SVPWM method, and the other is based onsinusoidal pulse width modulation (SPWM) method. In SPWM scheme, a zero sequence signal is added to the modulation waves to balance the neutral point voltage.

II.PROPOSED SYSTEM:

As the switch is further away from the centre tap the switching time is shorter. Another difference between the conventional 2-level and multilevel NPC is the clamping diode. In case of 3-level NPC inverter,clamping diode, D1 and D4 clamped the DC bus voltage into three voltage level, +Vdc/2, 0 and -Vdc/2 Diode, D4 balances out the voltage sharing between S4in and S4out, with S4in blocking the voltage acrossC1 and S4out blocking the voltage across C2 the use of different parameters in the calculations and the regulations of the zero sequence signals complicate the control.

The SVPWM scheme uses the nearest three vectors to synthesize the reference vector. Two methods can overcome the neutral point voltage problems: changing the vector switching sequence and changing the dwell times of the redundant states. Redundant states of the small vectors can be selected to maintain the neutral pointvoltage balance. Each small vector has two redundant states: positive small vector and negative small vector. These two states generate the same output voltage vector, however, theyhave the opposite control effect on the neutral pointvoltage. Therefore, redundant small vectors are used for neutral point voltage control.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

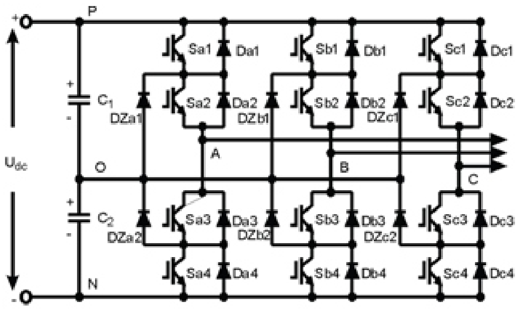


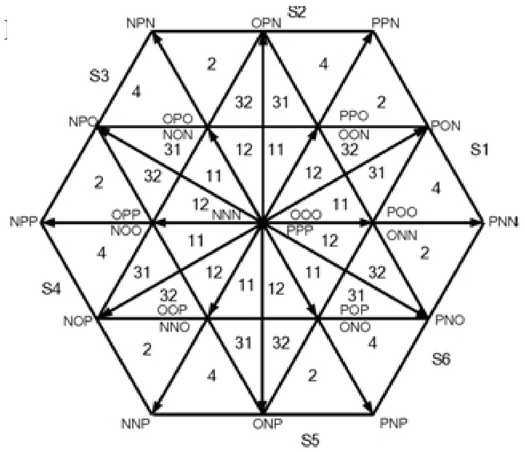
Fig. 1. Three-level NPC inverter structure diagram

In the present paper, a neutral point voltage balance control strategy based on SVPWM isproposed. A voltage offset is added to the modulation wave in the regions of all the sectors asshown in Figure 2, and the neutral point voltage is controlled by changing the dwelling time ofthe synthesis voltage vectors. Simulation and experimental results show that the strategy hasgood capability for neutral point voltage balance.

III.CONTROL STRATEGY

SVPWM scheme for NPC three-level inverter:

In the three-phase three-level NPC inverter, each phase has three output switching states"P", "O" and "N", which can be combined into a total of27 possible switching states, the total27 switching states correspond to 19 space voltage vectors, the space vector diagram is shownin Figure 2, it is composed of two hexagons. The plane is divided into six 600 sectors (S1, S2,S3, S4, S5 and S6) by large vectors. And each sector can be divided into four regions (R1, R2,R3 and R4, R1 contains two small regions R11 and R12, R3 contains two small regions R31,R32). For the nearest three vectors (NTV) SVPWM strategy, reference output voltage issynthesized by the nearest three vectors according to the equivalence of the volt-secondintegral. Based on the vector magnitude, space voltage vectors can be divided into four types: largevectors, medium vectors, small vectors and zero vectors. The lager vectors have the magnitudeof 2/3Udc, which are located at the vertices of the outer hexagon, the medium vectors have themagnitude of 3 / 3 Udc, which are located at the middle of the outer hexagon, the smallvectors have the magnitude of 1/3Udc, which are located at the vertices of the inner hexagon,and the zero vectors have the magnitude of zero. Each small vector has two switching states,one contains "P" state, which is called positive small vector, and the other contains "N" state,which is called negative small vector.



The four types of vectors have different effect on neutral point voltage deviation, it is summarizedthat the zero and large vectors do not affect the neutral point voltage; the mediumvectors affect the neutral point voltage, but the influence depends on the operation conditionsthe small vectors have specific effect on the neutral point voltage, the neutral point voltagewill rise when positive small vector operates, and the neutral point voltage will drop whennegative small vector operates in motoring mode.

The power flow is from DC-link to the loadwhen the system is in motoring mode; and the power flow is from the load to DC-link whenthe system is in regenerative mode. The mode depends on the direction of the DC-link current.In contrary, the neutral point voltage will rise when positive small vector operates, and theneutral point voltage will drop when negative small vector operates in regenerative mode.

3. Neutral point balance control based on SVPWM:

In this paper, a SVPWM strategy is proposed to maintain the neutral point voltage balance.The switching sequence of this strategy is the same as that of conventional NTV SVPWMalgorithm. The negative small vector is chosen to be the first given vector, Figure 3 shows thesynthesis vectors sequence when the reference voltage vector ref Vris located in S1, R11. Forthe proposed neutral point voltage balancing strategy, in each region of the sixsectors, a voltageoffset is add to the adjusting phase uk (k is a, b or c), and the dwelling times of operationvectors change. The adjusting phase uk is the phase whose absolute value is thelargest of threephases,

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

IV.SIMULATION RESULTS:

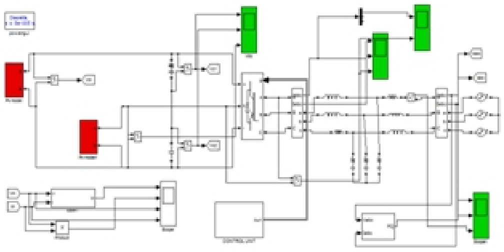


Fig.3 Matlab circuit

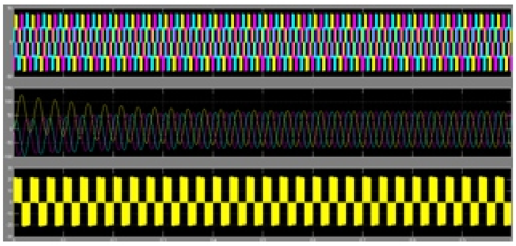


Fig.4. Five level inverter voltage, Inverter Current & 3 level V0n

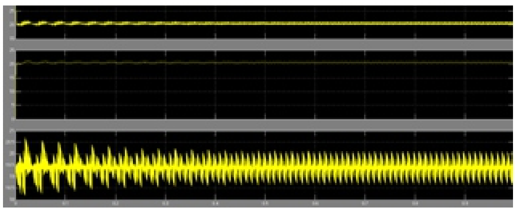


Fig.5. Vc1 & Vc2 & PV dc Input

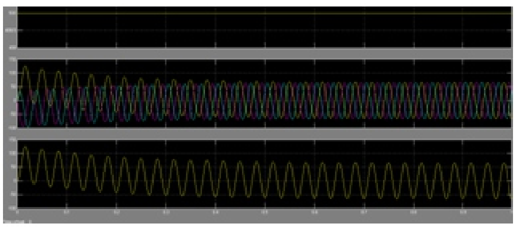


Fig.6 Output power, 3 ph Load current & 1ph load current

V. CONCLUSION:

In this paper, PV input neutral point voltage balance control strategy based on SVPWM for threelevel inverters is presented. This strategy maintains the neutral point voltage balance by addinga voltage offset to the modulation wave of the adjusting phase. The causes of the neutral-point unbalance are studied in detail, and the influence of the voltage offset on neutral pointbalance is investigated, in motoring mode, when the voltage offset is positive, neutral pointvoltage will increase.

In contrast, when the voltage offset is negative, neutral point voltage will decrease. In regenerative mode, neutral point voltage will increase when voltage offset is negative, and neutral point voltage will decrease when the voltage offset is positive. The new simple and effective strategy for neutral point voltage control is verified by simulations results.

REFERENCES:

[1] Celanovic N., Boroyevich D., A comprehensive study of neutral-point voltage balancing problem in three-level neutral-point-clamped voltage source PWM inverters. IEEE Trans. Power Electronics 15(2): 242-249 (2000).

[2] Bruckner T., Bernet S., Guldner H., The active NPC converter and its loss-balancing control. IEEETrans. Industrial Electronics 52(3): 855-868 (2005).

[3] McGrath B.P., Holmes D.G., Multicarrier PWM strategies for multilevel inverters. IEEE Trans.Industrial Electronics 49(4): 858-867 (2002).

[4] Qiang S., Wenhua L., Qingguang Y., Zhonghong W., A neutral-point potential balancing algorithmfor three-level NPC inverters using analytically injected zero-sequence voltage. Proc. IEEE 8thAnnu. Conf. Applied Power Electronics, Miami, USA, pp. 228-233 (2003).

[5] Ogasawara S., Akagi H., Analysis of variation of neutral point potential in neutral-point-clampedvoltage source PWM inverters. Conf. Rec. IEEE 29th Annu. Meeting Industry Applications Society,Toronto, Canada, pp. 965-970 (1993).

[6] Yongdong L., Chenchen W., Analysis and calculation of zero-sequence voltage considering neutralpointpotential balancing in three-level NPC converters. IEEE Trans. Industrial Electronics 57(7):2262-2271 (2010).

[7] Yamanaka K., Hava A.M., Kirino H., Tanaka Y., Koga N., Kume T., A novel neutral point potentialstabilization technique using the information of output current polarities and voltage vector. IEEE Trans. Industry Applications 38(6): 1572-1580 (2002).

[8] Tolbert L.M., Habetler T.G., Novel multilevel inverter carrier-based PWM method. IEEE Trans.Industry Applications 35(5): 1908-1107 (1999).

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

[9] Busquets-Monge S., Alepuz S., Rocabert J., Bordonau J., Pulse width Modulations for the ComprehensiveCapacitor Voltage Balance of n-Level Three-Leg Diode-Clamped Converters. IEEE Trans.Power Electronics 24(5): 1364-1375 (2009).

AUTHOR DETAILS:

K. BHASKAR, Received degree from Brilliant Inst. Of Engineering and technology, hayatnagar, rangareddy dist, telangana in 2012. And currently pursuing M.Tech in Electrical power system at "Brilliant Grammar School Educational Society's Group of Institutions-Intigrated Campus", hayatnagar,rangareedy dist.,hyd.

VAJRAMMA, Obtained her B.Tech (EEE) degree from Y.P.R College of Engg & Technology in 2011, M.Tech (Power Electronics) from Sri Sai Educational Society Group of Institution in 2014. She worked as Asst. Prof in GATE Engg college in Kodhada.She has been working as Asst. Prof. in dept. of EEE at Brilliant Grammar School Educational Society's Group of Institutions. Her area of interest includes Control Systems, electrical machines, and power systems. She is having 4 years teaching experience.

R NAGESH, Obtained his B.Tech (EEE) degree from Vignan Institute of Technology and science in 2010, M.Tech (Power Electronics) from Aurora's Engineering College Bhongir in 2012. He worked as Asst.Prof. in Aurora's Engineering College, Bhongir. He has been working as Asst. Prof. & H.O.D in dept. of EEE at Brilliant Grammar School Educational Society's Group of Institutions. His area of interest includes FACTS devices, electrical machines, and power semiconductor devices. He is having 3 years teaching experience.