International Journal of advancement in electronics and computer engineering (IJAECE)
Volume 06, Issue 6, June 2017, pp.601-604, ISSN: 2274-1412

Reduce Distortion through Hybrid Cascaded Five-level Inverter

Sulbha Jain[1], Shiv Kumar Sonkar [2]

[1]*M.Tech Student, Department of Electrical & Electronics Engineering, Sagar Institute Of research Technology and Science, Bhopal, sulbha1311989@gmail.com, India;*

[2,] *Asst. Professor, Department of Electrical & Electronics Engineering, Sagar Institute Of research Technology and Science, Bhopal, India;*

Abstract *–This work proposes a new five-level inverter topology and modulation techniques are proposed. In this proposed work compared to 5-level ANPC because the most similar topology, this new topology needs 2 less switches at the price of a further capacitor and 6 diodes. However, since the capacitors still see the switching frequency and their size remain a similar, it's expected to reduce the inverter's total value. Sensible loss distribution among switches will increase the inverters rated power or offer higher switching frequency and smaller capacitor size. In this proposed modulation technique to realize a good loss distribution, avoid direct series connection of semiconductor devices, and keep the balanced operation of dc-link capacitors whereas keeping the amount of costly parts like capacitors and switches low. The desired modulation strategy is developed and also the operation of the projected topology is studied. Simulation results are provided to verify the performance of the converter for medium voltage applications. . To overcome the problem for the selective harmonic elimination methodology, the resultant methodology is used to find all the solutions to the harmonic equations and also the active harmonic elimination methodology is projected to eliminate any range of harmonics and may be applied to the total modulation index vary for multilevel converters to satisfy the application requirements.*

Keywords*: Battery cell, charging and discharging, electric vehicle (EV), hybrid cascaded multilevel converter, voltage balance,*

I. Introduction

One application for multilevel converters is distributed power systems. Multilevel converters are often implemented using distributed energy resources like photovoltaic and fuel cells, and then be connected to an AC power grid. If a multilevel device is formed to either draw or provide purely reactive power, after that the multilevel converter is utilizing just like a reactive power compensator. As an example, a multilevel converter being use sort of a reactive power compensator might be placed in parallel with a load connected to an AC system. This can be because a reactive power compensator can help to enhance the power issue of a load [14].

Another application for multilevel converters is to interrelate various power grids. For instance, 2 diode-clamped multilevel converters are often utilizing to supply such a system. One multilevel converter acts as a rectifier for the utility interface. Different multilevel converter performs as a device to supply the specified AC load. Such a system may be used to connect 2 asynchronous systems and acts as a frequency changer, a part shifter, or a power flow controller.

In recent years many efforts are created to analysis and use new energy sources because the potential for an energy crisis is increasing. Multilevel converters have gained a lot of attention among the area of energy distribution and control due to their advantages in high power applications with low harmonics. They not only achieve high power ratings, but in addition modification the use of renewable energy sources. The general perform of the multilevel converter is to synthesize a desired high voltage from several levels of dc voltages which can be batteries, fuel cells, etc. [1, 2].

In 1975, the conception of multilevel converters was initial introduced [3]. Multilevel implies that the inverter can generate a lot of output voltage levels than those of the common three- level converter. Subsequently, several multilevel converter topologies are developed [2, 4]. the basic principle of a multilevel convertor to achieve higher power is to use a series of power semiconductor switches with several lower voltage dc sources to perform the power conversion by synthesizing the way voltage wave kind. Capacitors, batteries, and renewable energy voltage sources are usually used because the multiple dc voltage sources. The commutation of the power switches aggregate these multiple dc thusurces so on achieve high voltage at the output; however, the rated voltage of the power semiconductor switches depends only upon the rating of the dc voltage sources to that they are connected.

II. Multilevel Inverter

The A convertor is a device that converts direct current (DC) to alternating current (AC); the regenerate AC is at any required voltage and frequency with the use of applicable transformers, switching, and control circuits. Static inverters do not have any moving parts and are used during a giant vary of applications, from very little switch power provides in computers, to large electrical utility high-voltage direct current applications that transport bulk power. Inverters are sometimes used to provide AC power from DC sources like star panels or batteries. The electrical inverter could also be a high power electronic generator. It's so named as a result of early mechanical AC to DC converters was made to work in reverse, and so was "inverted", to convert DC to AC. The inverter performs the other operate of a rectifier.

Multilevel inverters have gained interest throughout the last three decades due to the increasing demand for medium to high voltage converters for a range of high power applications. Totally different topologies are planned to fit the requirements of varied applications. For medium voltage inverters, cascaded H-bridge (CHB), neutral purpose clamped (NPC), and flying capacitor (FC) are the primary topologies. Among them, NPC and FC provides a normal dc-link that might be a strict demand for many applications FC inverter uses capacitors to induce output voltage levels. The supply of intra-phase redundant states throughout this topology can provide every capacitor voltage balancing and power loss distribution among switches. However, increased numbers of flying capacitors at higher levels which will increase the initial value and maintenance surcharges and reduces the reliability of the inverter at the facet of the capacitor recharge in some applications are the most drawbacks of this topology.

Hybrid topologies are viable solutions wherever higher range of levels is needed. Combining the benefits of CHB, FC, and NPC, hybrid inverters will offer loss and voltage balancing whereas keeping the quantity of elements low. Samples of hybrid topologies combining FC and NPC will be found in [10]–[12], a number of that has already found industrial applications. The 5-level FC-ANPC is an example of hybrid topologies that made its way to the business. The ACS2000 family of medium voltage drives, commercialized by ABB, uses this topology with each active and passive front configuration. The most advantage of this topology is that the use of one flying capacitance to generate the output 5 levels.

II.1. Types of Inverters

There are different types of high level inverters such as

- PWM current source inverter
- Load commutated inverter
- Multilevel inverter
- High power voltage source inverter

Inverters can be broadly classified into two types based on their operation:

- Voltage Source Inverters (VSI)
- Current Source Inverters (CSI)

III. Proposed Method

A multilevel inverter not only achieves high power ratings, but additionally permits the use of renewable energy sources. Renewable energy sources like photovoltaic, wind and fuel cells are usually simply interfaced to a multilevel converter system for high power applications.

Classical multilevel inverter is often classified into 3 types:

1) Diode clamped inverter.
2) Flying capacitance inverter
3) Cascaded H-bridge inverter

III .1. Diode Clamped Multilevel Converter

The first invention in multilevel converters was the supposed neutral purpose clamped inverter. It had been initially planned as a three level inverter. It's been shown that the principle of diode clamping can extended to any level. A diode clamped leg circuit is shown in Figure 1.

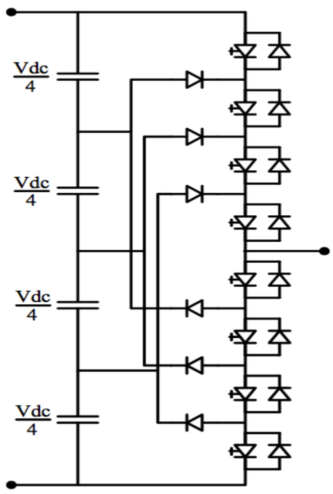

Fig.1.Diode clamped multilevel inverter

III .2. Flying Capacitor Multilevel Converter

As an alternate for the diode clamped inverter is that the capacitor clamped inverter planned by Meynard and Foch that shared many of the advantages. The structure of the capacitor clamped inverter} is similar to that of the diode clamped converter. The most difference is that the diodes used for the clamping are replaced by capacitors. A Flying capacitor converter leg circuit is shown in Figure 2.

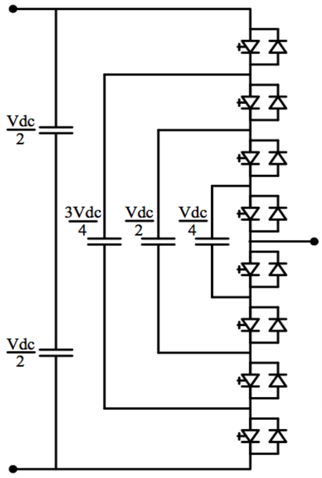

Fig.2.Flying capacitor multilevel inverter

III .3. Cascaded Multilevel Inverter

The CMLI produce a sinusoidal voltage from whole totally different sources of DC. The inverter depends on the full-bridge inverter (cell), that allows increase sort of levels 2m+1 (where m is that the amount of cells that build the inverter). This type of inverter avoids the use of interlocking diodes, capacitors voltage balancing float in addition a low ThD is also obtained by controlling the gate trigger of the varied voltage levels.

IV. Result

To verify the operation of the proposed topology and a model is developed and simulated with MATLAB software. The performance of the natural balancing technique for a three phase inverter is used.

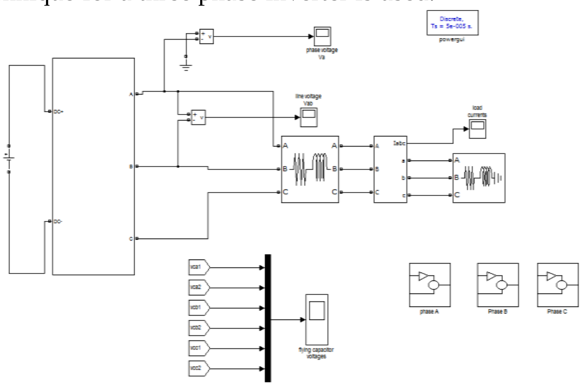
Fig. 3 Model of the proposed system

The fig.3 shows a proposed model. In this model discuss the operation of a multilevel converter based on the cascaded interconnection of a 3L-ANPC converter and individual H- bridges for each phase. The configuration of the circuit is shown in Fig. 3.

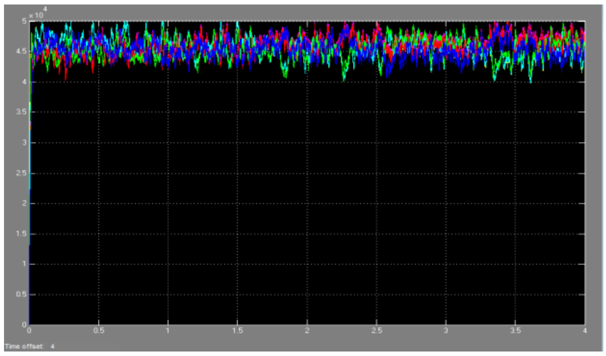
Fig. 4 Simulation result of flying capacitor voltages

In this fig.4 shows frequency 5 kHz. The dc-link voltage is set at 18kV and flying capacitors are 330μF. It can be seen that even without an RLC balance booster, the capacitor voltage errors are limited to less than 4%.

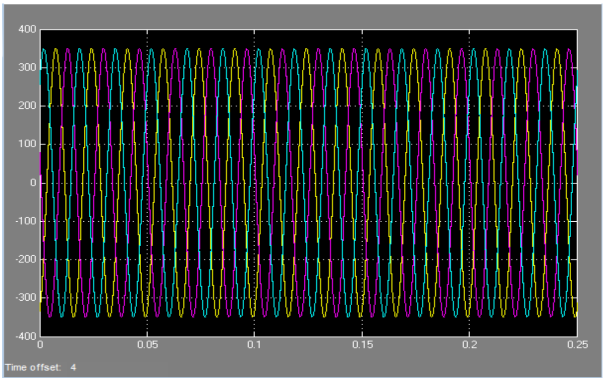
Fig. 5 Simulation result of Load current

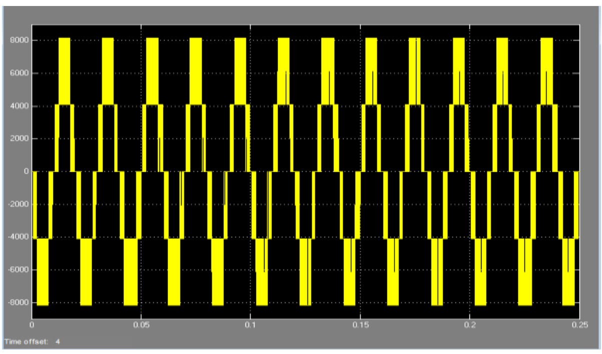
Fig.6 Simulation result of Phase voltage

Fig.6 shows the output phase voltage (VrO), while the voltages of the 5L -ANPC output voltage (VwO) and H-bridge output voltage (Vrw), respectively.

V. Conclusion

A new hybrid 5-level inverter topology and modulation technique is projected. Compared to 5-level ANPC because the most similar topology, this new topology needs 2 less switches at the price of a further capacitor and 6 diodes. However, since the capacitors still see the switching frequency and their size remain a similar, it's expected to reduce the inverter's total value. Also, unlike 5-level ANPC, all switches should withstand a similar voltage that eliminates the requirement for series connection of switches and associated simultaneous turn on and off drawback. Sensible loss distribution among switches will increase the inverters rated power or offer higher switching frequency and smaller capacitor size.

References

[1] Zedong Zheng, Kui Wang, Lie Xu, and Yongdong Li, "A Hybrid Cascaded Multilevel Converter for Battery Energy Management Applied in Electric Vehicles", IEEE Transactions On Power Electronics, Vol. 29, NO. 7, JULY 2014

[2] L. Anil Kumar, P. Jagadeesh "A Hybrid Cascaded Multilevel Converter for Battery Energy Management Applied in Electric Vehicles", 2015 IJIT.

[3] Aishwarya Panday and Hari Om Bansal "A Review of Optimal Energy Management Strategies for Hybrid Electric Vehicle", International Journal of Vehicular Technology Volume 2014.

[4] Yuanmao Ye, K. W. E. Cheng, Junfeng Liu, and Kai Ding "A Step-Up Switched-Capacitor Multilevel Inverter With Self-Voltage Balancing", IEEE Transactions On Industrial Electronics, Vol. 61, NO. 12, DECEMBER 2014.

[5] N Mukherjee, D Strickland, A Cross, "Second Life Battery Energy Storage Systems: Converter Topology and Redundancy Selection", IEEE 2014.

[6] Sulaiman, N., et al. "A review on energy management system for fuel cell hybrid electric vehicle: Issues and challenges." Renewable and Sustainable Energy Reviews 52 (2015).

[7] P.Ganesh, K.Madhuri "A Hybrid Cascaded Multilevel Converter for Battery Energy Management Applied in Electric Vehicles", International journal & Magazine of Engineering Technology, Management and Research, Vol No. 03 2016.

[8] URADALA.RAJARAO, GRANDHI RAMU "Cascaded multilevel inverter for large hybrid-electrical vehicle applications with variant DC sources", IJCSIET--International Journal of Computer Science information and Engg., Technologies ISSN 2277-4408 || 01092014-052.

[9] S.Jyothi, K.V Eswararao "A Novel Analysis Of A Hybrid Cascaded Multilevel Inverter By Fuzzy Controller Based Energy Management", International Journal of Engineering In Advanced Research Science and Technology, January 2016 VOLUME -1 ISSUE-1 Page: 7791-98.

[10] Kumar, Naveen. "DC Smart Grid Connected with Fuel Charging Station and AC Load by Hybrid MLI." International Journal of Power Electronics and Drive Systems 3.3 (2013).

[11] S. M. Lukic, J. Cao, R. C. Bansal, F. Rodriguez, and A. Emadi, "Energy storage systems for automotive applications," IEEE Trans. Ind. Electron., vol. 55, no. 6, pp. 2258–2267, Jul. 2008.

[12] H. M. Zhang and S. P. Ding, "Application of synergic electric power supply in HEV," in Proc. 8th World Congr. Intelligent Control Autom., 2010.

[13] A. Emadi, Y. J. Lee, and K. Rajashekara, "Power electronics and motor drives in electric, hybrid electric, and plug-in hybrid electric vehicles," IEEE Trans. Ind. Electron., vol. 55, no. 6, pp. 2237–2245, Jun. 2008.

[14] K. Jonghoon, S. Jongwon, C. Changyoon, and B. H. Cho, "Stable configuration of a Li-Ion series battery pack based on a screening process for improved voltage/SOC balancing," IEEE Trans. Power Electron., vol. 27, no. 1, pp. 411–424, Jan. 2012.

[15] L. Yuang-Shung, T. Cheng-En, K. Yi-Pin, and C. Ming-Wang, "Charge equalization using quasi-resonant converters in battery string for medical power operated vehicle application," in Proc. Int. Power Electron. Conf., 2010.

[16] Y. C. Hsieh, C. S. Moo, and W. Y. Ou-Yang, "A bi-directional charge equalization circuit for series-connected batteries," in Proc. IEEE Power Electron. Drives Syst., 2005.

[17] S.Yarlagadda, T. T.Hartley, and I.Husain, "Abatterymanagement system using an active charge equalization technique based on a DC/DC converter topology," in Proc. Energy Convers. Congr. Expo., 2011.

[18] K. Chol-Ho, K. Young-Do, and M. Gun-Woo, "Individual cell voltage equalizer using selective two current paths for series connected Li-ion battery strings," in Proc. Energy Convers. Congr. Expo., 2009.

[19] H. Shen, W. Zhu, and W. Chen, "Charge equalization using multiple winding magnetic model for lithium-ion battery string," in Proc. Asia- Pacific Power Energy Eng. Conf., 2010.

[20] P. Sang-Hyun, P. Ki-Bum, K. Hyoung-Suk, M. Gun-Woo, and Y. Myung- Joong, "Single-magnetic cell-to-cell charge equalization converter with reduced number of transformer windings," IEEE Trans. Power Electron., vol. 27, no. 6, pp. 2900–2911, Jun. 2012.