International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

FIVE LEVEL INVERTER USING APOD PWM TECHNIQUE FOR SOLAR ENERGY

UMMAR.M.A[1], MOHANKUMAR.G[2]

[1]P.G Scholar, Department of EEE, PRIST UNIVERITY, Thanjavur, Tamil Nadu (Puducherry Campus)
[2]Assistant Professor& Head, Department of EEE, PRIST UNIVERITY, Thanjavur, Tamil Nadu (Puducherry Campus)

Abstract *–In this paper multi carrier sinusoidal modulation technique (APOD) is used for five levels in cascade H Bridge which is an efficient method of producing control signals is designed. The DC voltage from solar panel used at the input side depends on the Cascaded H-Bridge performance output levels. Five level output can be obtained with the help of two DC voltage sources. Switching signal for H-bridge inverter structure which can improve harmonic performance. An efficient harmonic spectrum and reliable results have the ability to generate inverted output voltage can be obtained from these types of inverters. Harmonic performance can improve using Switching signal for H-bridge inverter structure. Using (APOD) carrier techniques, 5-level multilevel inverter is simulated for alternate phase opposition disposition. The performance of the symmetrical APOD is simulated using MATLAB-SIMULINK model.*

Key Words: Multilevel inverter, Modulation Techniques, Selective Harmonic Elimination and Total Harmonic Distortion

1.INTRODUCTION

Non-renewable sources are the key source of energy available like fossil fuels. Energy demand is getting increased day by day. The over utilization of these sources to meet our daily requirements have put it in a degradation state [1, 2]. An alternate source such as wind, solar, tidal, etc. has an rapid development in the research to produce energy. Among them, energy taken from photovoltaic systems plays an important role. The energy which is taken from a photovoltaic system (PV system) is DC in nature. The DC output from a PV system is converted into an AC and for this power inverters play a major role. Most of the equipments are used for domestic and industrial purposes which work on an AC source.

Both academia as well as industry attracts multilevel inverters concept over wide range. They combine switched waveforms with lower levels of harmonic distortion than an equivalently rated two-level converter [1–3]. Sinusoidal waveform are found that with the increase in level, the output waveform and steps increases approaches. With Demerits of complex control and voltage imbalance problem it reduces the THD. They are employed mainly for high-power, high-voltage/medium-power applications. Output inverter voltages in small increments by stepping up more switching states. Reduced electromagnetic compatibility and dv/dt lowering help in creating high-quality waveforms of smaller voltage steps. But more number of components is required and will make the circuit complex in order to increase the number of levels [2]. Reducing the passive component size and minimizing the output harmonics in the power circuit with High switching frequency employed in multilevel inverters.

The cascaded H bridge multilevel inverter output voltage waveform with independent DC voltage sources for each and every bridge requires more number of cascaded cells which increase the levels [2]. The output must be filtered to meet desired requirements related to total harmonic distortion can be improved. An efficient sinusoidal PWM based on multicarrier modulation technique is proposed to generate controlled pulses for switches used in multilevel inverter to meet the requirements related to this problem. It is a simple method to generate a waveform closer to the sine. Sine waveform along with reduced THD by providing this method of modulation, the results from the operation provides near result.

By using the multi-level voltage source inverter structure, as the PWM can withstand higher voltages in proportion to the number of levels the pressure in each switch can be minimized. The output voltage increases more like the waveform as a scale as the levels in the multi-level inverter increases. Multilevel inverters has extends to the application on adjustable electronic power variations, field of conditioning the power line and static VAR compensation. The concept of multi-level voltage source inverter was introduced and limited by the suitable practical applications only.

2. MULTILEVEL CASCADED H- BRIDGE INVERTER

General blocks present in MLI have been represented in the diagram given in Figure 1.

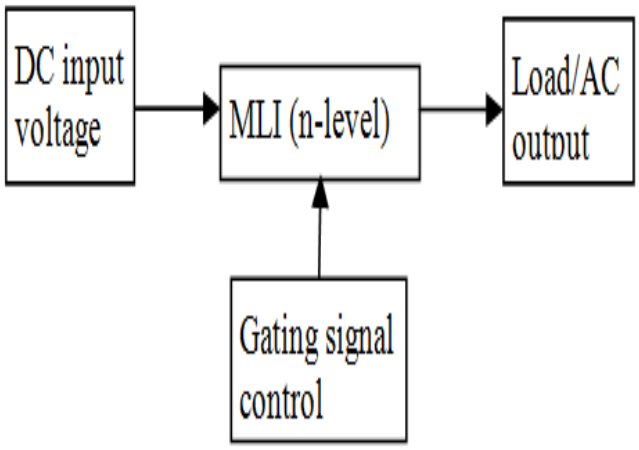

Figure 1 MLI Block diagram

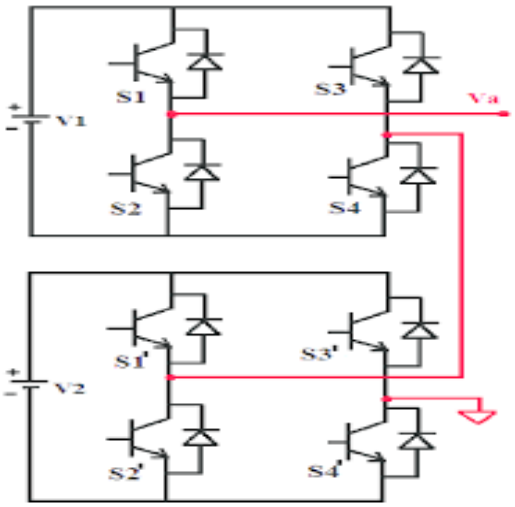

Figure 2 H-bridge cascaded five level inverter

In General H-bridge MLI consists of two types of configurations. The configurations are namely symmetrical and asymmetrical types of CHB MLI. The amplitude of the entire dc supply source to each H-bridge cells is equal in case of symmetrical cascaded H-bridge multilevel inverter [3]. In case of an asymmetrical based H-bridge multilevel inverter among the DC voltage sources present in the bridges of the CHB MLI, at least one of the DC power supplies has a different amplitude, that is to say that the H bridge cells are not supplied with all equal voltage and each cells in the inverter is going to have a different effect on the output voltage when compared with another cell with respect to steps to be present in the output voltage.

The five stages of the inverter bridge are linked together in the 2 H-bridges are shown in Figure 2. It embraces and operates by two different independent sources, even with the same voltage value that is V_1 and V_2. The first cell trips V_1 and V_2 are for another cell, which produces five levels given by number of levels, which is 2m + 1m. Synthesizes the maximum voltage of the waveform, which is the sum of two voltages given by V_1+V_2. Where m is voltage sources present in the inverter. The output voltage levels are in steps of 0, V, 2V, 0, -2V and -V.

In this case, when the source is added, which is necessary for the four switches to be required, that drives the fourth cell with other cells connected in series. Five stages can add a voltage source converter H-bridge multi-level inverter emperor of the seven levels.

Cascaded H-bridge MLI configuration has following Merits given below:

a) Electromagnetic compatibility can be reduced with improved quality of Stepped waveform.
b) Modularity of control can be possible.
c) When compared with the other type configurations of multi-level inverters, the same number levels in output voltage with this configuration can be obtained with less switches.
d) Input current with reduced distortions can be draw in this inverter.

Cascaded H-bridge MLI configuration has following Demerits given below:

a) The separate conversions of power source voltage are required.
b) Synchronization with the reference carrier waveforms must achieve between full bridges Communication.

3. OPERATING MODES OF FIVE-LEVEL CASCADED H-BRIDGE MULTILEVEL INVERTER

Mode1: The operating mode for getting output voltage of +2Vdc as shown Figure 3. In this mode, switches SW1, SW2, SW5 and SW6 are ON and all the other switches SW3, SW4, SW7 and SW8 are OFF. +2Vdc:

Mode2: The operating mode for getting output voltage of Vdc as shown Figure 4. In this mode, switches SW1, SW2, SW8 and SW6 are ON and all the other switches SW3, SW4, SW7 and SW5 are OFF. +Vdc

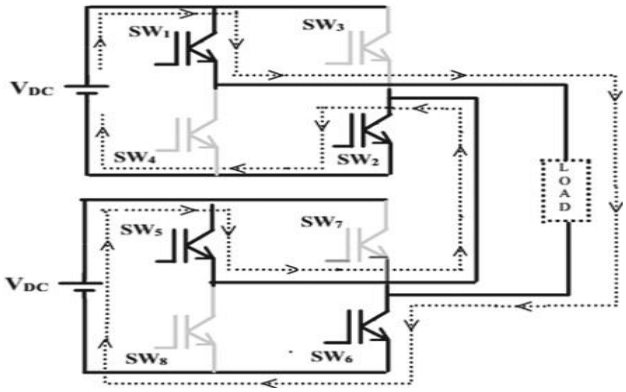

Figure. 3 Output voltage of +2Vdc -Operating mode

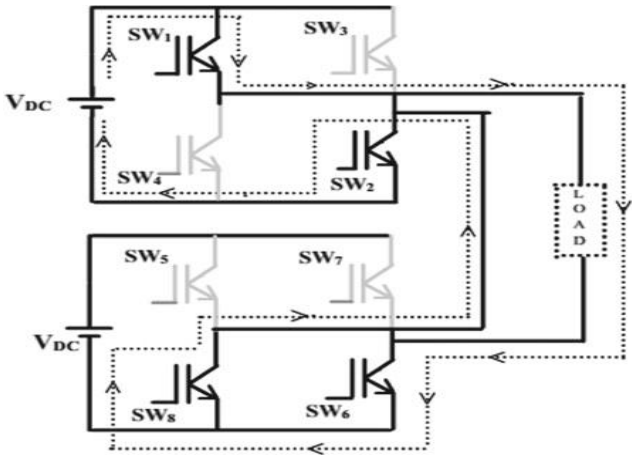

Figure. 4 Output voltage of +Vdc-Operating mode

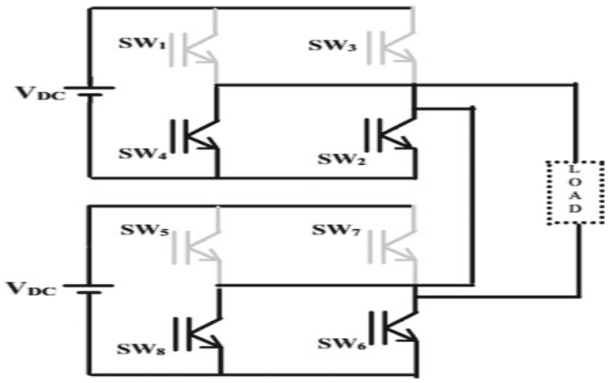

Figure. 5 output voltage of zero- Operating mode

Mode3: The operating mode for getting output voltage of zero as shown Figure 5. The lower-leg switches are triggered; hence, there will no flow of current in the power circuit.

Mode4: The operating mode for getting output voltage of −Vdc as shown Figure 6. In this mode, switches SW3, SW4, SW8 and SW6 are ON and all the other switches SW1, SW2, SW7 and SW5 are OFF. The flow of current is opposite to the load current. −Vdc:

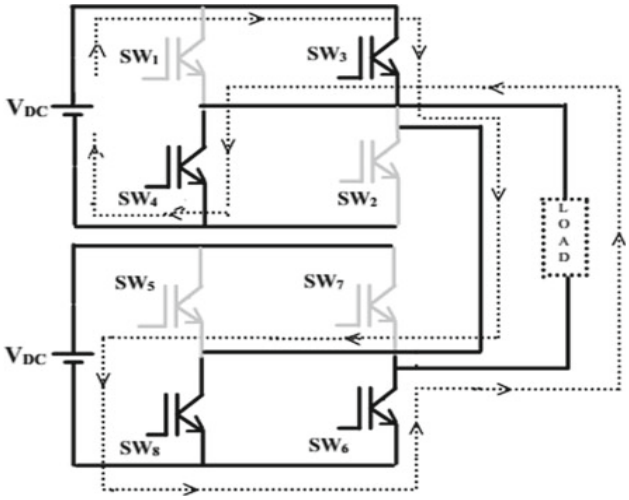

Figure. 6 output voltage of – Vdc - Operating mode

Mode5: The operating mode for getting output voltage of +2Vdc as shown Figure 7. In this mode, switches SW3, SW4, SW8 and SW7 are ON and all the other switches SW1, SW2, SW6 and SW5 are OFF. The flow of current is opposite to the load current, -2Vdc.

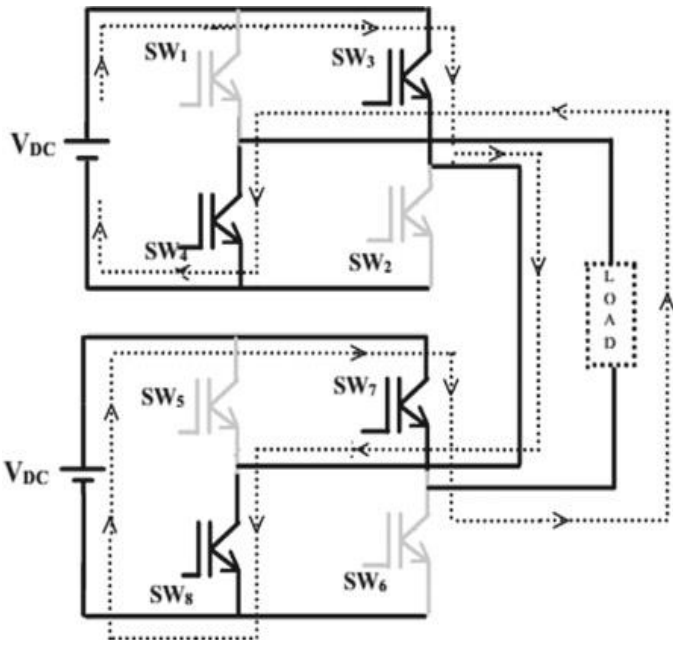

Figure. 7 output voltage of -2Vdc- Operating mode

4. DIFFERENT SINUSOIDAL PWM TECHNIQUES

A sinusoidal waveform reference voltage can be obtained by varying the amplitude, frequency and high frequency value to be considered output filtered chosen the better changes. Sinusoidal waveform to generate the output pulse waveform with a filtering by variable width the pulse width sinusoidal modulation technique (SPWM) is used [5].The SPWM technique, which is the desired one to

produce unequal widths without having equal widths which is possible with multi pulse width modulation method and can have modulation distortion and ordered lower harmonics much decreased significantly.

In this case, the time of the PWM signal can be obtained by comparing the reference sine wave (modulated wave) with the high frequency triangular wave (carrier). Sine wave PWM refers to the PWM output generation that uses a sine wave as a modulation signal which includes OFF and ON pulses to control the switching action of switches in inverter.

These are the fundamental changes in PWM and high frequency switching frequency called PWM based on multi-carrier and PWM space vector. Modulation of cascaded multi-level H-bridge inverters can be divided into two categories. Selective Harmonic Rejection and Multi-Level SPWM needs some career signals based on number of levels in the output of inverter. More sinusoidal output voltages can be obtained with inverter changes that have been modified by multi-carrier SPWM technology. Multi-carrier SPWM technology requires unique support for each independent DC voltage source.

4.1. ALTERNATE PHASE OPOSITION DISPOSITION:

If the alternate phase opposition disposition method (APOD) is used to arrange the three carrier waves in disposition group, i.e called as alternative phase opposition disposition. If all carrier signals are arrange the above the zero line reference voltage and below the line by 180 degrees as shown in below figure.8 this technique is similar to the phase opposition technique and also alternative phase opposition disposition technique was giving best harmonic results, but it was giving higher harmonics compare to the phase disposition and alternate phase opposition disposition.

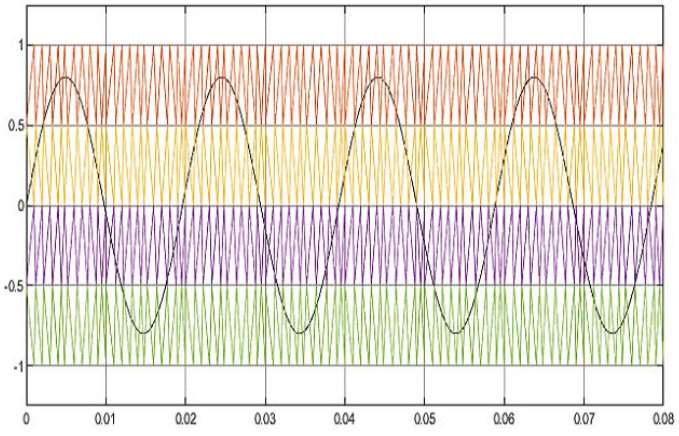

Figure 8 Carrier Wave using APOD

5. SIMULATIONS AND RESULTS

The simulation is carried out using MATLAB/SIMULINK software. The simulation diagram is shown in Figure 9.

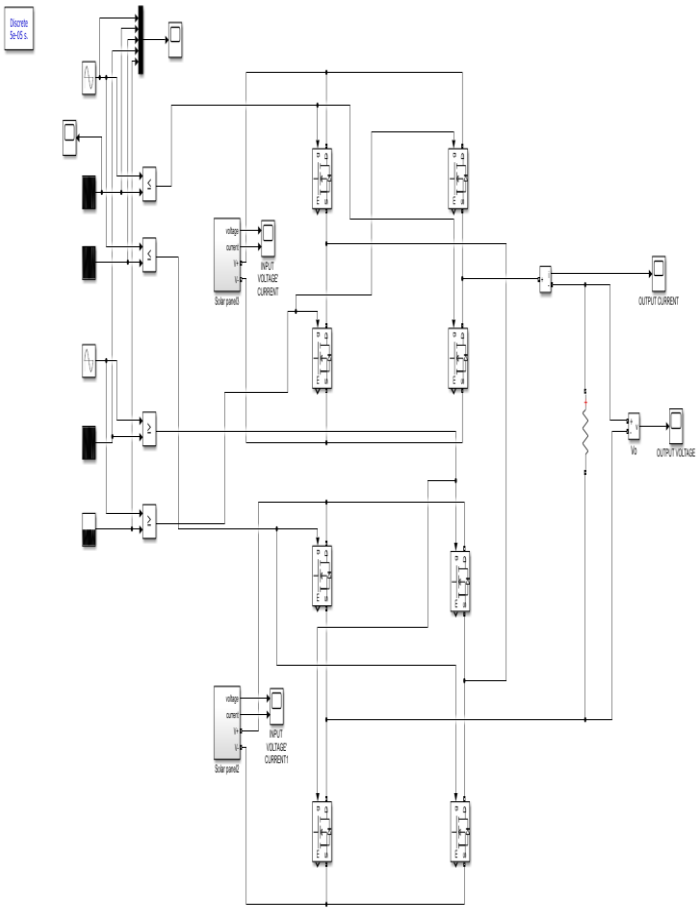

Figure 9 Simulation diagram of cascaded H-bridge multilevel inverter

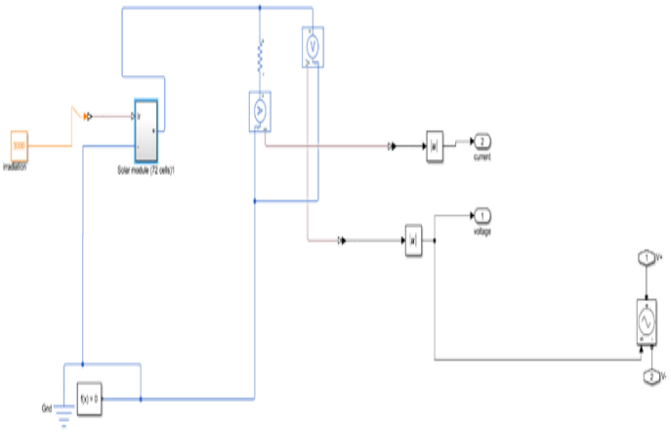

Figure 10 Solar Panel

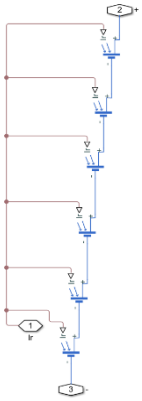

Figure 11 Solar Cell constructions

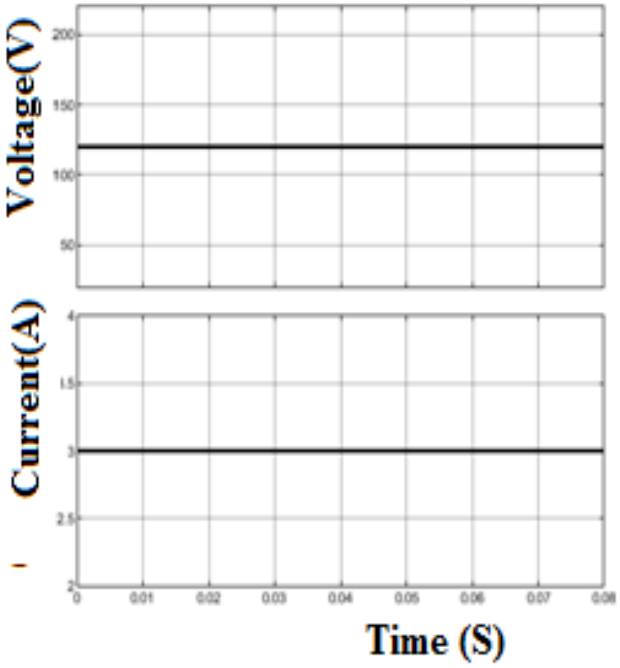

Figure 12 Input voltage and current from solar panel1

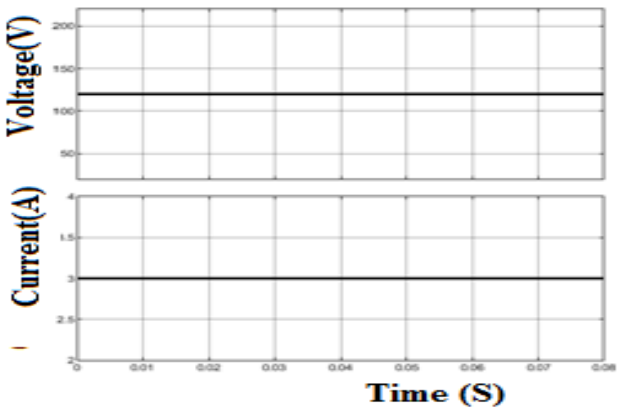

Figure 13 Input voltage and current from solar panel2

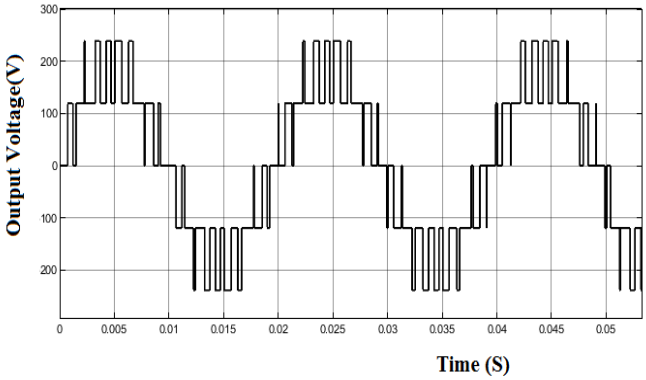

Figure 14 Output voltage

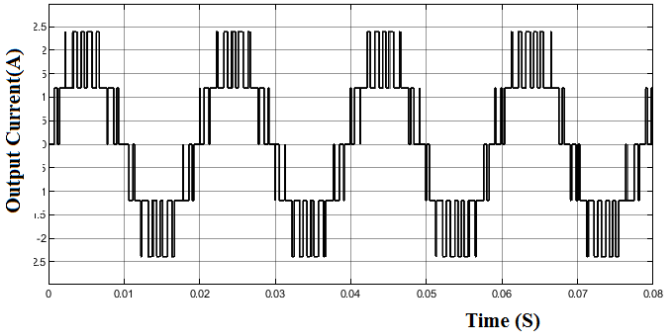

Figure 15 Output Current

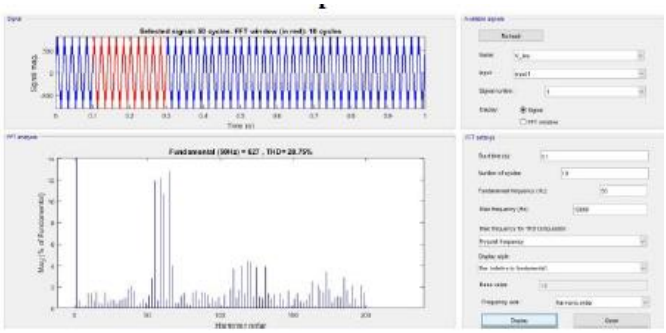

Figure 16 THD of 5-level inverter using APOD

5. CONCLUSION

This paper proposes a PWM technique which uses APOD to generate the desired multi-level voltage while switching the pulses of a 5-level cascade multi-level inverter with two H Bridges. Simulations result using MATLAB / SIMULINK software traditional THD of the 5-level PWM APOD with 28.75%. The inverter is therefore very interesting for renewable energy conversion systems, because it increases the efficiency, while maintaining stable dynamics under the effect of a non-linear or unbalanced load. The work carried out the performance of H-bridge cascaded multilevel inverter, the control for the given

topology generates a higher complexity in the control algorithms. The solution presented uses the use of auxiliary circuits dedicated to balancing the voltages.

REFERENCES

[1]Su, Gui-Jia. "Multi-level dc bus inverter for providing sinusoidal and PWM electrical machine voltages." U.S. Patent 6,969,967, issued November 29, 2005.

[2]. Ebrahim Babaci. A cascaded multilevel converter topology with reduced number of switches. IEEE Trans on Power Electronics. 2008l; 23(6).

[3]. M Kavitha, A Arunkumar, N Gokulnath, S Arun. New cascaded H-bridge multilevel inverter topology with reduced number of switches and sources. JEEE. 2012: 26-36.W.-K. Chen, Linear Networks and Systems (Book style). Belmont, CA: Wadsworth, 1993, pp. 123–135.

[4]. Kumar Jagdish. THD Analysis for different levels of cascade multilevel inverter for industrials applications. IJETAE. 2012: 20-30.

[5]. Malinowski, M.; Gopakumar, K.; Rodriguez, J.; Pérez, M.A. A survey on cascaded multilevel inverters. IEEE Trans. Ind. Electron. 2010, 57, 2197–2206. [CrossRef].

[6]. Li, Y.; Wang, Y.; Li, B.Q. Generalized theory of phase-shifted carrier PWM for cascaded H-bridge converters and modular multilevel converters. IEEE J. Emerg. Sel. Top. Power Electron. 2016, 4, 589–605.

[7]. Marquez, A.; Leon, J.I.; Portillo, R.; Vazquez, S.; Franquelo, L.G.; Kouro, S. Adaptive phase-shifted PWM for multilevel cascaded H-bridge converters for balanced or unbalanced operation. In Proceedings of the IECON 2015—41st Annual Conference of the IEEE Industrial Electronics Society, Yokohama, Japan, 9–12 November 2015; pp. 5124–5129.

[8]. Carrara, G.; Gardella, S.; Marchesoni, M.; Salutari, R.; Ciutto, G. A new multilevel PWM method: A theoretical analysis. IEEE Trans. Power Electron. 1992, 7, 497–505.

[9]. Liu, H.; Ma, K.; Blaabjerg, F. Device loading and efficiency of modular multilevel converter under various modulation strategies. In Proceedings of the 2016 IEEE 7th International Symposium on Power Electronics for Distributed Generation Systems (PEDG), Vancouver, BC, Canada, 27–30 June 2016; pp. 1–7.

BIOGRAPHIES

M.A.UMMAR Received the Engineer degree in 2008 from M.G.R University, Maduravauyal, Tamilnadu. From 2000-2010 Worked as Technical Assistant in Various Field in TNEB and Served the public. From June 2010 to till now Working as Assistant Engineer/O&M in Gingee Division, TNEB. Her Specialization is Operation & Maintenence in Distribution Network.