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A 15-Level Asymmetrical Cascaded Sub Multilevel Inverter Using RES With PD-PWM Technique

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***Abstract* — Multilevel inverters have evolved as one of most commonly power conversion devices for variety of applications such as in medium voltage and high-power applications. These inverters are an alternative to two-level inverters for the best benefits such as low harmonic distortion, less complex filters, better wave capability with a sinusoidal output, and reduced dv/dt up on the switches used. In this research work a 15 level H-bridge asymmetric multilevel inverter is proposed for renewable energy harvesting. The proposed inverter's basic module consists of a smaller number of switches i.e., seven, three blocking diodes and three asymmetric dc links. The proposed inverter is capable of producing seven positive voltage states, which are polarized negatively by the end-side H-bridge unit i.e., via polarity changer circuit.**

***Index Terms*— Multi Level Inverter (MLI), Phase disposition pulse width modulation (PD-PWM), Total harmonic distortion (THD), SIMULINK / MATLAB.**

I. INTRODUCTION

IN present times renewable energy sources are considered as an alternative of existing energy sources. These sources are sun, wind, ocean, fuel cell and small hydro based power plants have received much interest over the conventional sources. The renewable energy sources are free and available in plenty. Therefore, energy produced requires less cost with possible green energy effect. [1]. Of all these renewable energy sources solar energy is considered as the most efficient of these. The power intercepted by the earth from the sun is around 1.8* 1011 MW, which considerably greater than the current rate of total energy use. Another sources of converting light into electrical energy is a photo voltaic cell which uses voltaic effect. The output of solar cell is dc therefore a need of an inverter is realized. Inverter convert the DC output into AC output. Fuel cell is also best renewable resource that can be used to produce power for a variety of applications, this comprises of domestic and industrial applications, additionally transportation, and commercial use too. Fuel cells are widely used due to their advantages if compared with existing technologies that are currently used in numerous power plants and vehicles. Fuel cells own better efficiencies, and they have ability of conversion chemical energy to electrical energy with efficiencies exceeding 60%. In comparison to combustion engines, fuel cells emit little or no pollution. At full load, the fuel cell can produce up to 0.7 volts of electricity; the desired voltage can be gained by connecting the fuel cells in series, and the desired current can be obtained by connecting the fuel cells in parallel arrangements. [2]. Mahfuz-Ur-Rahman et. al, [3] presented a hybrid cascaded multilevel inverter for aim to harvesting renewable energy. In 2018, Yong et. al. [4], presented introduced a control strategy for the off-board EV charger by using V-control in three phase system, which provide voltage regulation to the grid while charging the vehicle. R. K. Lenka et. al. [5], proposed a bidirectional cascaded H-bridge topology in 2020 for grid connected electric vehicle battery charger. .Dhanamjayulu, C. et. al., proposed hybrid cascaded MLI topology with reduced components and reduced power sources and electronic switches [6].

In recent years, industry has seen a tremendous development in higher power appliances. Medium voltage service appliances require high-power and medium voltage levels; by option that if one power electronic switch is connected to the medium power grid which seems difficult. In 1975multilevel inverts was introduced first. which were considered as a replacement in medium voltage high-power applications [7]. Multilevel inverters are alternative to two-level inverters for their variety of benefits such as low harmonic distortion, a simple design of filters, and best output voltage resembling the ac waveform [8]. Multilevel inverters find its applications in variety of household and domestic applications including the core advantage of power quality.

MLI can produce several numbers of voltage levels at the output as a stepping waveform using multiple active switches, diodes and some DC sources which could be PV, batteries and other renewable energy sources [9]. Diode clamped, flying capacitors and cascaded H- bridge multilevel inverter are three basic classifications of MLI based on their operation and regarding the quantity of switches, capacitors, and diodes [10]. Fig.1 shows the primary classification of multilevel inverters used.

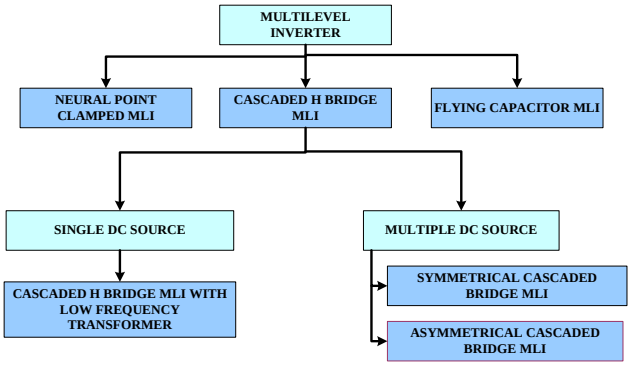


Fig. 1. Block diagram showing classification of Multilevel inverter

II. ASYMMETRICAL H-BRIDGE SUB MULTILEVEL INVERTER:

In this paper, level shifted PD-PWM technique is used with reduced switched count with DC sources has been designed. Number of switches and topologies of this technique is presented in Fig 2.

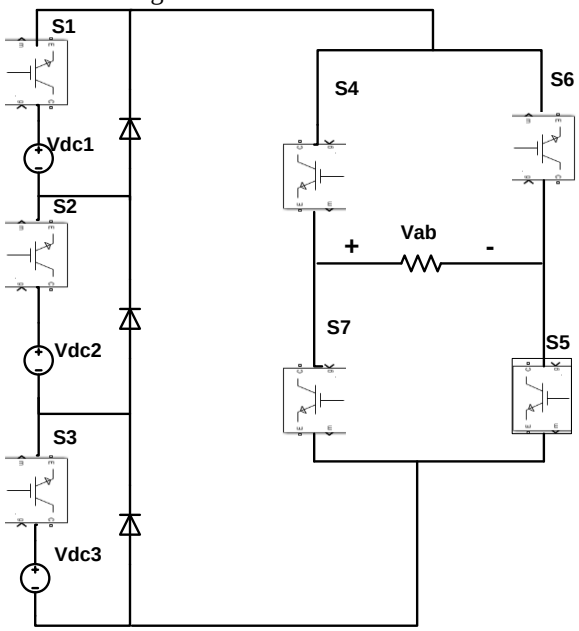


Fig. 2. Asymmetrical H-bridge multilevel inverter with switching devices and diodes

Following set of equations represents number of sources identified by 'n'. IGBTs and diodes are connections are showing asymmetrical H bridge multilevel inverter topology.

$$N\_\text{Level} = 2(n+1) - 1$$
$$N\_\text{IGBT} = n + 4$$

The key feature of using Asymmetrical H-Bridge Multilevel Inverter topology is it uses less number of switches, and therefore less losses. In Fig.2, the magnitudes of DC sources are unequal. The DC sources are designed as 12V, 24V and 48V respectively. Asymmetrical MLI is built to maintain a 1:2:4 ratio i.e. the unequal DC source magnitudes. The primary benefit of the asymmetric topology and its algorithms relates to their capacity to generate a substantial number of output voltage levels while utilizing a minimal number of DC voltage sources and power

III. PHASE DISPOSITION PULSE WIDTH MODULATION:

Pulse Width Modulation (PWM) is control technique in which duty cycle and frequency are key parameters. This is the most common method of controlling the output voltage and is known as PWM control. In this research work, Phase Disposition Pulse Width Modulation has been used.

This method of multiple carrier level shifting pulse width modulation in which all carrier signals are at 0-degree phase shift i.e. Phase Disposition PWM, or PDPWM. The waveform of PDPWM is shown in Fig 3

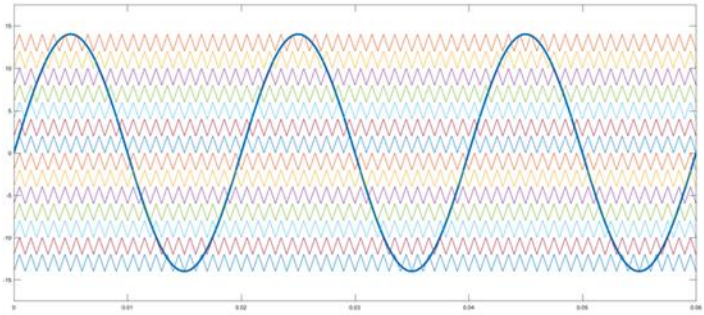


Fig. 3. PD-PWM Technique shown by a reference and ac wave

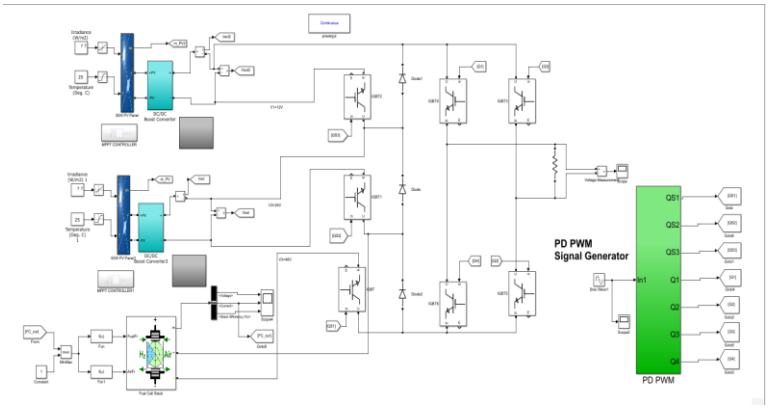
The technique compares triangular carrier waves with frequencies of 1 kHz to a Sinusoidal wave with a frequency of 50 Hz. The PWM output is then used as the gate driver signal for the IGBTs.

IV. SIMULINK MODEL OF ASYMMETRICAL H BRIDGE SUB MLI WITH RES

A. POWER CIRCUIT

The power circuit is made up of two PV panels and fuel cell, each of which generates a constant DC voltage output. The P & O MPPT control algorithm is used to ensure maximum supply to the load. The 15level MLI output is fed to the resistive load. The simulation model with fuel cell and PV panels is shown in Fig 4.

Fig. 4. Simulation model of power circuit



B. CONTROL CIRCUIT

In order to trigger the switches, the control circuit generate the necessary gating signals. Fig 5. shows a generalized control scheme for a cascaded multilevel inverter.

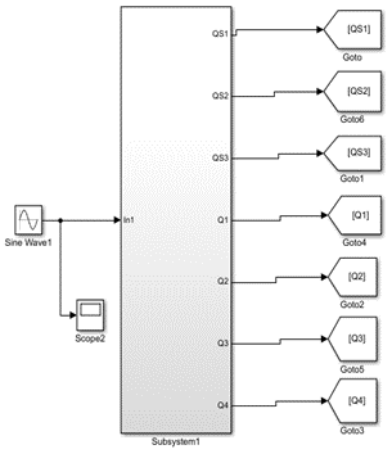


Fig. 5. Control circuit of CHB-MLI

V. SIMULATION RESULTS

A. Outout Voltage

Figure 6 shows the 15-level AC voltage output of proposed MLI. The peak voltage of AC output voltage is 84 V in magnitude. The output voltage is produced at each level by using a distinct switching pattern.

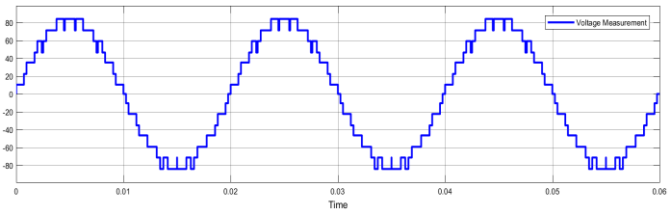


Figure 6. 15 level output voltage

B. THD Analysis

The harmonic content of the output is measured by using FFT tool of MATLAB software. The harmonic spectrum of output voltage is shown in Fig.7. FFT analysis tool is used to calculate the total harmonic distortion THD. The THD is found to be 8.42%.

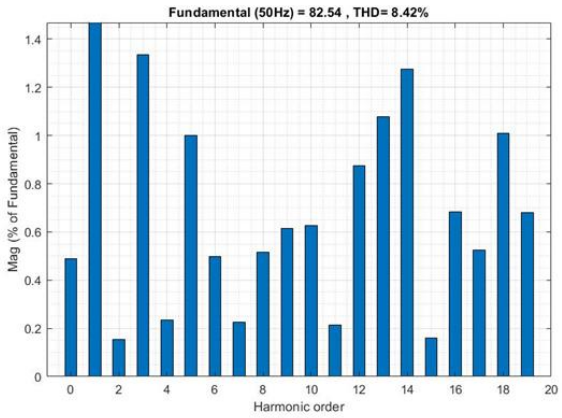


Fig. 7. THD output

VI. ACKNOWLEDGMENT

Foremost, I would like to Thank to Almighty Allah and express my since gratitude to my Teachers .

VII. CONCLUSION

The proposed multilevel inverter topology is successfully presented and results are showing evidence that the proposed multilevel inverter has significantly reduced number of switches and it is therefore most suited in renewable applications. The PD-PWM level shifted switching technique is successfully implemented with proposed MLI. The basic operation of the proposed multilevel inverter topology, as well as the mechanism for obtaining the required voltage level on each stage, has been carefully addressed. As compared to conventional inverters which uses more switching devices the proposed scheme is therefore utilized less number of devices.

VIII. FUTURE WORK

Multilevel inverter with proposed idea has been successfully implemented in the simulation model. The results obtained are satisfactory and that number of electronic switches with optimal number of stages are also reduced. in this paper, the sole purpose of this research was to model a multilevel inverter which would produce better outcome. The proposed model will definitely help in a cost effective and less complex with less switching and conduction losses due to reduced number of switched used.

REFERENCES

[1] Lee, W. and Kang. S., 2011. "Protection for distributed generations in the DC microgrid," Proceedings of 2nd IEEE PES International Conference and Exhibition on Innovative Smart Grid Technologies (ISGT Europe), Volume.3 pp.1-5.

[2] Wang, S. and Jiang, S.P., 2017. Prospects of fuel cell technologies. *National Science Review*, *4*(2), pp.163-166. [3]Kumar, Atul & Khan, Muhammad & Pandey, Bishwajeet. (2018). Wind Energy: A Review Paper. Gyancity Journal of Engineering and Technology. 4. 29-37. 10.21058/gjet.2018.42004.

[3] Kumar, Atul & Khan, Muhammad & Pandey, Bishwajeet. (2018). Wind Energy: A Review Paper. Gyancity Journal

of Engineering and Technology. 4. 29-37. 10.21058/gjet.2018.42004.

[4] J. Y. Yong, V. K. Ramachandaramurthy, K. M. Tan and J. Selvaraj., July 2018. "Experimental Validation of a Three-Phase Off-Board Electric Vehicle Charger With New Power Grid Voltage Control," in IEEE Transactions on Smart Grid, vol. 9, no. 4, pp. 2703-2713.

[5] R. K. Lenka, A. K. Panda, A. R. Dash, N. N. Venkataramana and N. Tiwary., 2021. "Reactive Power Compensation using Vehicle-to-Grid enabled Bidirectional Off-Board EV Battery Charger," 1st International Conference on Power Electronics and Energy (ICPEE), 2021, pp. 1-6.

[6] Dhanamjayulu, C., Prasad, D., Padmanaban, S., Maroti, P.K., Holm-Nielsen, J.B. and Blaabjerg, F., 2021. Design and implementation of seventeen level inverter with reduced components. IEEE Access, 9, pp.16746-16760.

[7] M. H. Mondol, S. P. Biswas, M. A. Rahman, M. R. Islam, A. M. Mahfuz-Ur-Rahman and K. M. Muttaqi., March-April 2022. "A New Hybrid Multilevel Inverter Topology With Level Shifted Multicarrier PWM Technique for Harvesting Renewable Energy," in IEEE Transactions on Industry Applications, vol. 58, no. 2, pp. 2574-2585

[8] Krishna, Dileep &Vadhera, Shelly. (2020). COMPARATIVE STUDY OF HYBRID AND CASCADED H-BRIDGE MULTILEVEL INVERTERS. International Journal of Research in Engineering and Technology. 2321-7308.

[9] J. Zhao, Y. Han, X. He, C. Tan, J. Cheng and R. Zhao., Aug. 2011. "Multilevel circuit topologies based on the switched-capacitor converter and diode-clamped converter", *IEEE Trans. Power. Electron.*, vol. 26, no. 8, pp. 2127-2136,

[10] Prabaharan, N., Salam, Z., Cecati, C. and Palanisamy, K., 2019. Design and implementation of new multilevel inverter topology for trinary sequence using unipolar pulsewidth modulation. IEEE Transactions on Industrial Electronics, 67(5), pp.3573-3582.