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Integration and Performance Evaluation of Reduced Device Count Multilevel Inverter for Renewable Energy Resources

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***Abstract* — The most readily available form of energies nowadays are solar and wind energies as they are non-polluting thus contribute in reducing the greenhouse effect. These renewable energy resources produce DC output which is required to be converted into AC for utilization at large scale. Varieties of inverters are integrated in the system to perform this conversion. Conventional two level and fundamental multilevel inverters when integrated with these renewable energy resources then they generate power quality issues including switching losses and harmonic distortion. Thus, is a dire need to integrate renewable energy resources with reduced device count multilevel inverters such that as the voltage at output will go up, switches required to produce these levels do not increase significantly. Here, MATLAB has been used for modeling symmetrical developed H-Bridge MLI with PV and Wind energy resources. The PV and wind output is fed to symmetrical H-bridge Multilevel inverter for generating 5-level AC output. The THD calculated is 26.81%.Consequently, 5- level output which is AC is supplied to load.**

***Index Terms*— Multicarrier Pulse Width Modulation, Multilevel Inverter, MATLAB/SIMULINK,THD.**

I. INTRODUCTION

EXPANSION in populace and financial development, high reliance on usage of petroleum products and the natural effects changing definitely are dynamic reasons for the progression in sustainable innovation [1] [2]. Fossil fuels utilization may be economically cheaper to fulfill the increasing energy demand but on the other hand they are a huge threat to the environment as they are the major source to produce green house gas [3]. Looking over to these concerns, renewable energy resources have emerged out as far better alternatives. As the renewable energy resources produce DC power thus it is required to be switched over completely to AC power through inverter. Previously, conversion of power was done by using inverters which were capable to produce two=level and three-level output voltage [3]. These inverters have drawbacks which include high voltage stress, higher switching loss, poor power quality, low efficiency [4]. Thus, in order to overcome these demerits, multilevel inverters came. Output voltage waveform of this inverter consist of multiple steps such producing less distortion than two-level inverters. Multilevel inverters have excellent features like they occupy less space for installation, less complex. Lower cost, higher efficiencies and fewer devices in the overall structure thus lesser bulky. These qualities make multilevel inverters popular in high and medium power applications [5]. Flying capacitor (FC), Diode-cinched (DC) and Cascaded H-span (CHB) are three of its conventional topologies. However, several advanced topologies have also been introduced, one of which is utilized in this paper which is reduced device count multilevel inverter. Power inverters are triggered by several control techniques.. However, due to simplicity and low THD output, multicarrier PWM is most popular among all these techniques. This paper has introduced reduced device count multilevel inverter which is being integrated to two DC resources, one is solar and the other is wind. The control technique used is Phase Disposition Multicarrier PWM technique.

II. METHODOLOGY

MATLAB/SIMULINK software is used in this proposed model to perform the simulation. For the calculation of THD, power GUI tool is being used. Parameters of model are displayed in table 1.

TABLE I: Parameters of Model

Parameters	Values
Switches used	6
DC sources used	2
Frequency of sinewave	50 Hz
Switching Frequency	1000 Hz
Resistive load	10 ohms
Levels of Output Voltage	5
DC sources magnitude	24 volts

The proposed inverter is contained six unidirectional switches and 2 sources of DC as displayed in Fig. 1. Thus, utilizing lesser switches, sources of DC and driver circuits than that of the customary geographies.

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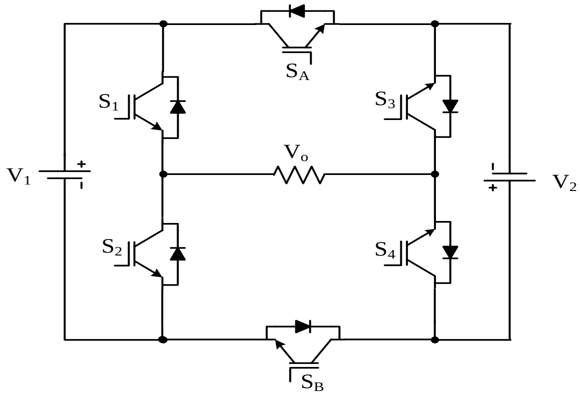

Fig 1. Reduced Device Count Multilevel Inverter

In the general proposed topology, the output levels (N_{level}), swtiches (N_{Switch}), DC sources used(N_{Source}) and the maximum generated output voltage $(V_{0,max})$ are being calculated as follows:

$$N_{Level} = 2^{2n} + 1 \quad (1)$$

$$N_{Switch} = 4n + 2 \quad (2)$$

$$N_{Source} = 2n \quad (3)$$

$$V_{0,max} = V_1 + V_2 \quad (4)$$

Where, n in the above equations is DC sources used on each leg of multilevel inverter.

The power circuit contains 50 W PV panel with a DC-DC boost converter and a wind power resource, both of them produces constant voltages. The most extreme inventory to the heap is finished by P and O calculation of MPPT. The 5-level MLI output is being given to load. Fig. 2 depicts generalized scheme for reduced device count multilevel inverter.

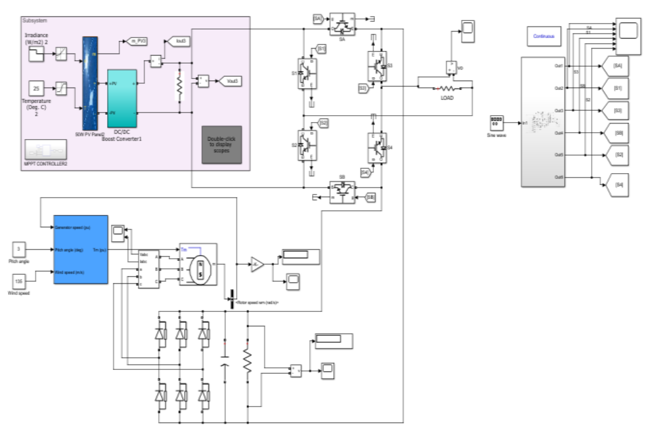

Fig 2. Simulation model for power circuit

The switches are set off by the gating signals created by the control circuit. A summed-up control plot for diminished gadget count staggered inverter has been displayed in Fig. 3. In this geography, the control conspire utilized is multicarrier stage PD-PWM. Four transporters are produced by using different comparators and legitimate administrators. The transporter waveform for PD-PWM has been displayed in Fig. 4.

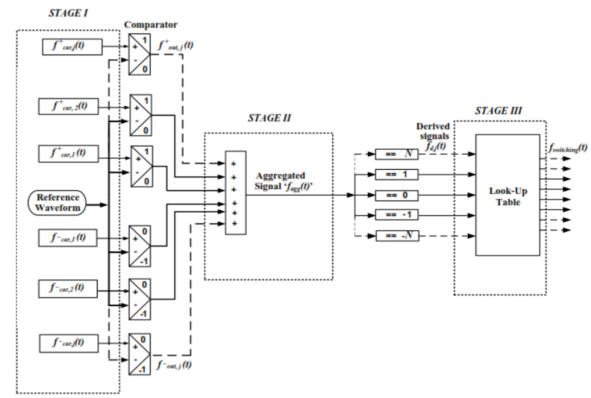

Fig 3. Generalized Reduced device count multilevel inverter control scheme

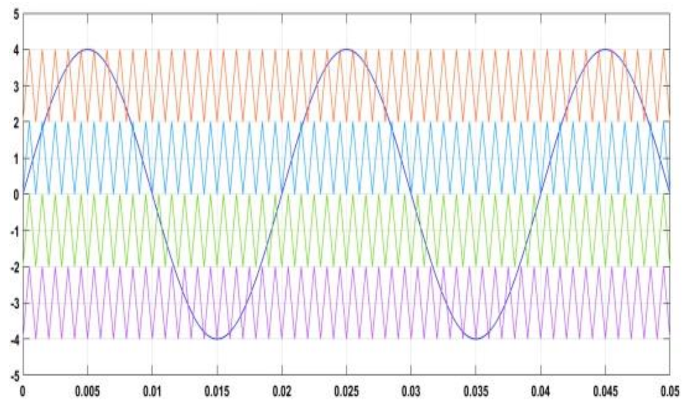

Fig 4. Multicarrier waveform

III. RESULTS AND DISCUSSION

Fig. 5 shows the 5-level AC yield voltage waveform. The size of the result voltage is roughly 45 V AC. Every one of the degree of result voltage waveform has explicit exchanging grouping. In mode 1, the result voltage will be Vdc1 when switches S1, S4 and Sb will be turned on while different switches will be switched off. In mode 2, the result at the heap will be Vdc1 + Vdc2 when the switches S1, S3 and Sb will be turned on while different switches will be switched off. In mode 3, the result at the heap will be zero when S2, S4 and Sb will be turned on while other will remain off.In mode 4, the result voltage at the heap will be - Vdc1.In mode 5, the result voltage at the heap will be - (Vdc1 + Vdc2). Consequently, in this way 5-level result is being produced.

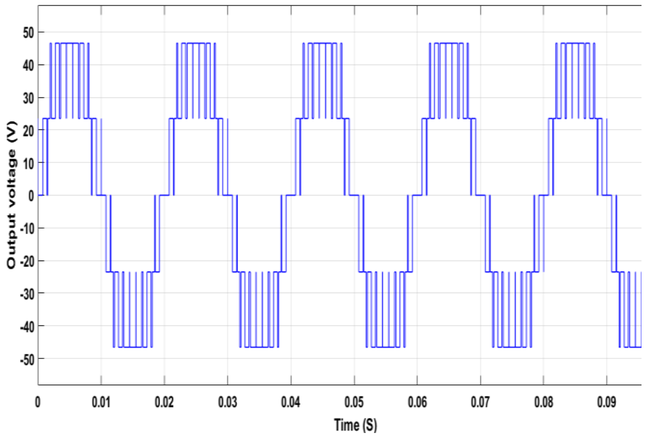

Fig. 5 Output Voltage

The measure of harmonic content in the output is known as THD. FFT analysis tool is used to calculate THD. The THD at 47.87 is calculated as 26.81% as shown in Fig. 6.

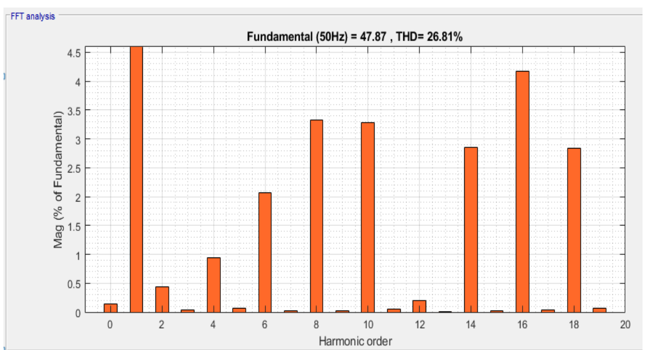

Fig 6. Output Voltage THD

IV. Conclusion

This research work focuses on solar and wind power applications for reduced device count multilevel inverters. The simulation for reduced device count multilevel inverter has been modeled using IGBT switches and multicarrier PD-PWM technique in the MATLAB/SIMULINK software. P & O control algorithm made the output voltage of MPPT constant . The THD computed at 47.87 by using FFT analysis tool is 26.81% producing 5-level AC stepped output voltage which can be further reduced by increasing voltage levels.

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