e-ISSN 2320 –7876 www.ijfans.org
Vol.10, Iss.4 2021
*Research Paper* © 2012 IJFANS. All Rights Reserved, **UGC CARE Listed (Group -I) Journal**

# Harmonic reduction in a multilayer inverter-fed hybrid solar/wind system

B.HARI,T.RAMANNA,V.HARINATH,VANKUDOTHU BALA

ASSISTANT PROFESSOR[1,2,3],STUDENT [4]

Department of EEE
Arjun College Of Technology & Sciences

***Approved by AICTE& Affiliated to JNTUH***

***SPONSORED BY BRILLIANT BELLS EDUCATIONAL SCOITEY***

***ABSTRACT:***Harmonics are reduced in a hybrid multi-inverter-fed solar and wind power system by using Space Vector PWM (SVPWM). In recent years, renewable energy sources have become more popular as a source of electricity. Since there is no pollution in the atmosphere, solar electricity is available to everyone on the world. For use in remote and dispersed locations. Wind and solar-powered renewable energy applications are needed in remote areas.SVPWM is utilized in a hybrid PV/wind model with a hybrid multilevel inverter to reduce harmonic distortion. Unlike the NLC approach, the SVM method does not need the development of a complex common-mode voltage for optimal switching patterns. As predicted by the models, this design works. MATLAB/SIMULINK is used to test the topology's performance.

***Keywords:*** Photovoltaic (PV), Wind, Hybrid multilevel inverter, Space Vector PWM (SVPWM)

## I.INTRODUCTION

Worldwide, distributed renewable energy generation is on the rise. There are no contaminants in renewable energy sources like the sun and the wind, such as hydroelectricity. A photovoltaic system may convert solar energy into electrical power. By the end of 2017, solar power capacity had increased by 104 GW and wind power capacity had increased by 539 GW [2], with an additional 50'1 GW of wind power capacity developed in 2018. The kinetic energy of the wind is harnessed by wind turbines to produce electricity. If wind turbines are installed in rural areas, people might reap the benefits of a sustainable energy source. Hybrid wind and solar resources are especially useful at night when the winds are greater than during the day and the sky is overcast. Hybrid power production systems are even more critical in distant places than traditional stand-alone systems. In distant and isolated places, wind–PV hybrid systems are both more difficult to manufacture and more beneficial [3]. This 5-level analysis of STATCOM's performance in both steady and dynamic states when linked to a grid-connected system makes use of a cascaded multilevel inverter with two distinct DC sources, powered by solar and wind hybrid energy sources independent hybrid generation of PV and wind systems has gained a lot of traction in the recent years. More and more high-power DC-AC converters and multilevel inverters have been developed in recent years. Many new multilevel inverter topologies employing three-level converters have recently been developed [5]. Switches in series with DC sources may be used to create staircase voltage waveforms. Many different types of DC power sources are available. By regularly turning on and off the power switches, the multilayer inverter is able to obtain a high output voltage when the switch voltage ratings are dependent on DC sources. When compared to standard two-level converters that use high pulse width modulation (PWM) switching frequencies, multilevel inverters provide a number of advantages. For example, the low dv/dt stresses and the outstanding staircase waveform quality decrease electromagnetic implications and increase overall quality, respectively (EMI). Advanced modulation methods may lessen the strain on a motor's bearings. A higher input current is made possible by multilayer inverters because of their reduced distortion. Multilayer inverter fundamental frequency and pulse width modulation are also employed at greater switching frequencies [6].It is because of this issue that traditional inverters cannot create smooth sinusoidal waveforms at low voltage levels. Higher voltage and higher resolution inverters produce a sinusoidal waveform [7]. For the modified cascaded H-bridge multilevel inverter, the researcher chose low-power switches instead of more common topologies (MCHBMLI). The old approach has its drawbacks, such as electromagnetic interference and voltage swings caused by a rise in current consumption. Rolling lines on televisions are a great illustration of this. The use of rolling lines powered by inverters One-phase, serially coupled inverter, the cascaded multilevel inverter bridge (9). The inverter generates three distinct output voltages from its DC sources: +EDC, 0V, and -EDC. Everything is linked to the inverter's output. MPPT's incremental conductance approach is used for solar and wind turbines. Switches are activated and deactivated using NLC in this suggested topology (nearest level control). It is necessary to use MATLAB/Simulink to calculate the system's total harmonic distortion (THD).

## II.EXISITNGSYSTEM

On the left, you can see a schematic of an H-bridge multilevel inverter and its major components. Renewable energy sources such as solar and wind power will be integrated into the microgrid. The DC-DC boost converter is coupled to the modified cascaded multilayer inverter. Solar and wind power can maintain a constant DC voltage by obtaining the maximum amount of energy from the PV/wind and batteries using an MPPT-Incremental Conductance algorithm. An RL load is connected to the power supply in the system represented in Figure 1.

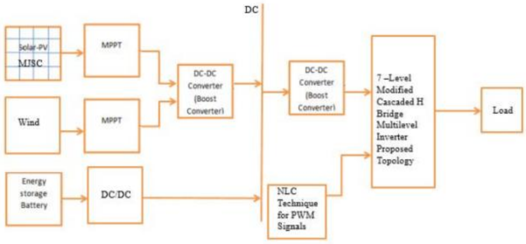


Fig1 Modified CHBMLI with NLC method Hybrid PV/Wind microgrid block diagram

The half-integer technique, known as the round function, may be used to accomplish this objective. In order to round up the closest integer number (x), it is compared to the nearest level. The round function may be used to round a variable's value to the closest integer. Rounding to an even number of 17 will give you an answer of 17 for a variable with 16.6 as its value. It is possible to round up and away from zero in the case of a tie. For example, an 11-rounding variable would result in 10.5 being converted to -11. The gate signal is created, as illustrated schematically in Fig. 2.

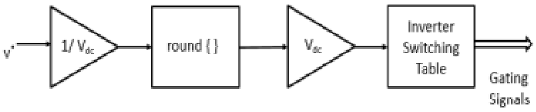


Fig 2 Control diagram for Nearest Level Control Technique

## III.PROPOSED SYSTEM

Fig. 3 depicts a hybrid PV/Wind microgrid that employs the SVPWM technique. A redesigned multilayer inverter and a load are shown in FIG. 3, which includes PV/WIND/BESS and boost converters. At the heart of modulation is the idea of improving the modulation ratio while simultaneously reducing harmonic distortion and switching losses. It was as a result of this that a variety of modulation approaches saw breakthroughs. Due to its success in achieving the aforementioned objectives, the SVPWM strategy has recently grown in popularity. Selection and sequencing of switching states are critical to the proper operation of an MLI. The basic component's peak voltage is half that of the dc link voltage in the SPWM technique. With this SVPWM has a higher fundamental voltage and better harmonic suppression compared to the typical PWM systems in use today. Current at neutral causes a waveform with an unstable output voltage, which puts unnecessary stress on the power electronics of NPC inverters. In order to reach a condition of neutral equilibrium, the switch on periods and switch states must be used appropriately. The SVPWM method may be used in this situation. It is also possible to build a DSP and to increase the dc link's efficiency. SVPWM focuses on the sequence of states and the order in which they occur.

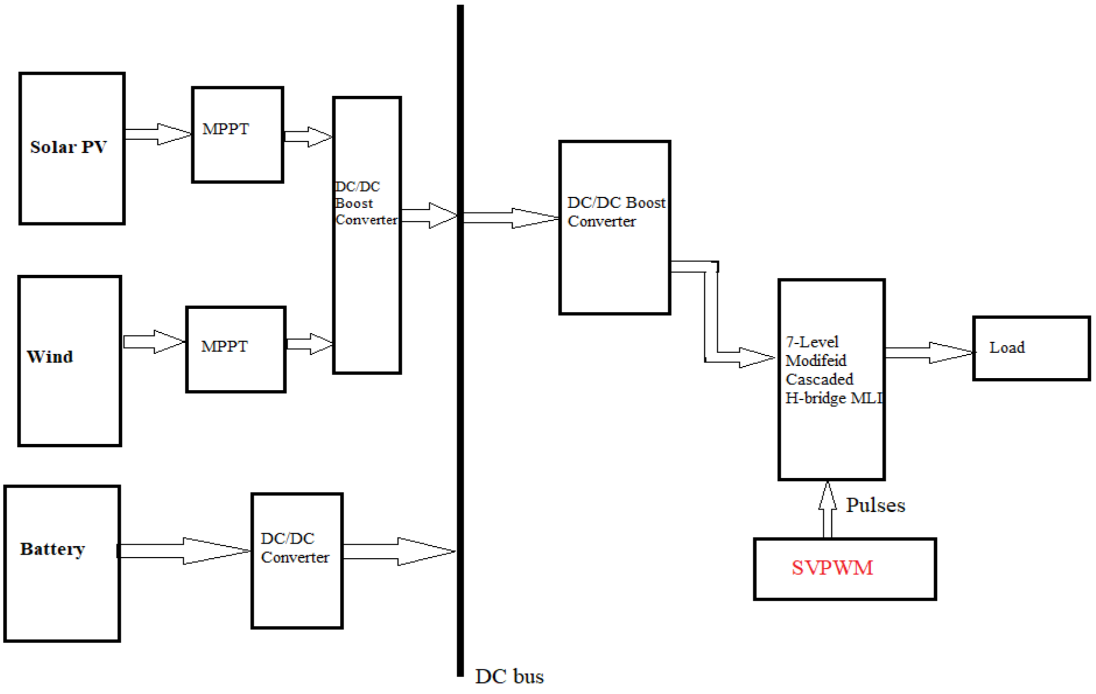


Fig.3 Block diagram of the SVPWM and a modified CHBMLI are proposed for a hybrid PV/wind microgrid.

**A) HYBRID MULTILEVEL INVERTER**

A previously unseen design for a multilayer inverter topology is shown here. The proposed multilayer inverter does not include a capacitor in order to prevent voltage imbalance caused by a capacitor. Seven-level inverters need an increased number of DC link switches [7]. Using three separate DC voltage sources, a seven-level multi-level inverter is constructed. The inverter is less costly and has fewer switches as a consequence of this effort. This reduces the losses associated with switching and conduction.

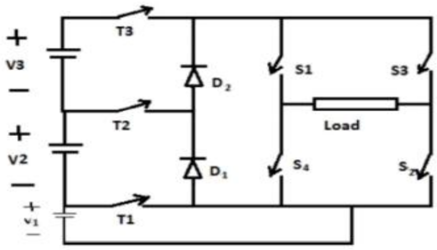


Figure.4 Suggested Hybrid multivlel inverter topology

Table-1 7-level MCHBLI switching ststates

| $S_1$ | $S_2$ | $S_3$ | $S_4$ | $S_5$ | $S_6$ | $V_o$ |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 1 | 0 | $V_1+V_2$ |
| 1 | 0 | 0 | 1 | 0 | 1 | $V_2$ |
| 0 | 1 | 0 | 1 | 1 | 0 | $V_1$ |
| 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | |
| 1 | 0 | 1 | 0 | 0 | 1 | $-V_1$ |
| 0 | 1 | 1 | 0 | 1 | 0 | $-V_2$ |
| 0 | 1 | 1 | 0 | 0 | 1 | $-(V_1+V_2)$ |

## B) PROPOSED SVPWM TECHNIQUE

To drive the multilayer inverter, SVPWM pulses are used to generate gate pulses. As you can see in Table I, the output voltage and various switch flipping states are listed. There are two numbers in this picture that represent the various states: 0 and 1. As shown in Table 1, when the two DC voltage sources are equal, the number of voltage levels reduces. As a result, new DC voltage sources with higher values are required in order to avoid damage to switches and sources. Voltage increases the method's capacity to decrease harmonics.

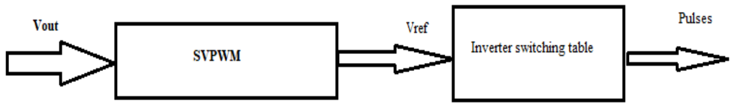


Fig 5 Control diagram for SVPWM Technique

Using modulation indexes, For each PWM cycle, the Space Vector PWM generator module generates the required gate drive waveforms. This section explains the SVPWM module in great depth.

Eight different switching states may be used to create the output voltage of the three-phase two-level inverter with dc link configuration. Voltage vectors V1 to V6 and V7 and V8 are generated by each inverter switching state in the Space Vector plane. It is 2/3 Vdc for each of the active vectors (V1-V6) (dc bus voltage).

The SVPWM module's gain characteristics are shown in the figure. Vertical axis indicates normalized peak motor phase voltage and normalized modulation index (V/VDC) (M).

If you know the value of the inverter, you may use this equation to forecast its output voltage (Vline).

$$Vline = Umag * Mod\_Scl * Vdc / \sqrt{6} / 2^{25} \qquad 1$$

The voltage on the DC bus is given in voltage units (Vdc).

What determines the linear operating range's maximum modulation (Umag L)?

$$Umag\_L = 2^{25} * \sqrt{3} / Mod\_Scl \qquad 2$$

It's possible to become overmodulated when the modulation of Umag exceeds that of Umag L. Voltage vector rescaling occurs when the voltage rises over the hexagonal limit shown in Figure. Even though the voltage vector's magnitude is constrained by the hexagon, the phase angle () is kept. PWM modulator transfer gain decreases and becomes non-linear in the over-modulation range.

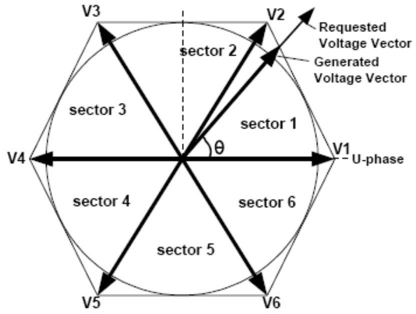


Fig:6 Rescaling of the Vector Voltage

As soon as it receives the modulation index instructions, SVPWM Tm begins its computations on the PWM Load signal's rise (UAlpha and UBeta). They are also picking the appropriated zero vectors, instead of 11 clock cycles (Tr), the SVPWM Tm module may require up to 35 clock cycles (Tr). PhaseU, PhaseV, and PhaseW PWM may be generated via submodule PWM production at the nSYNC threshold, which provides a new set of timings and vectors. The outputs of the gating pattern are delayed in time (PWMUH... PWMWL).

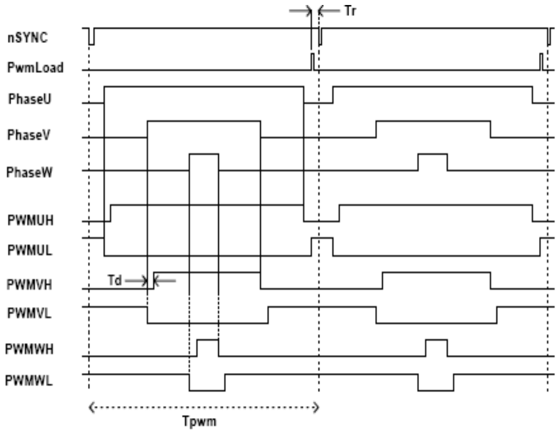


Fig.7 3-phase Space Vector PWM

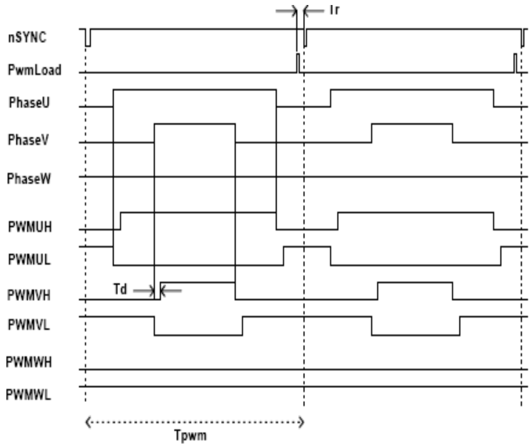


Fig.8 2-phase Space Vector PWM

## IV.SIMULATION RESULTS

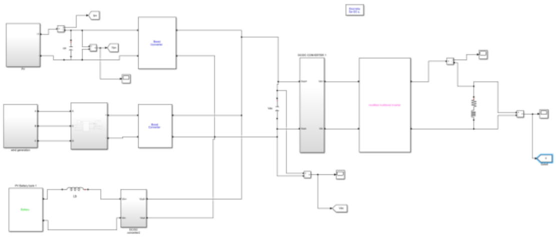


Fig.9 MATLAB/SIMULINK circuit diagram of the proposed system

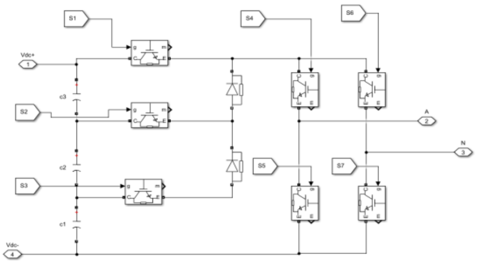


Fig.10 MLI susbsystem

## A)EXISITING RESULTS

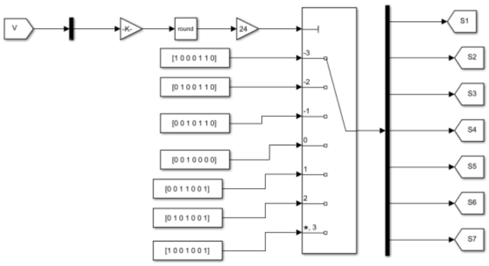


Fig.11 NLC technique subsystem

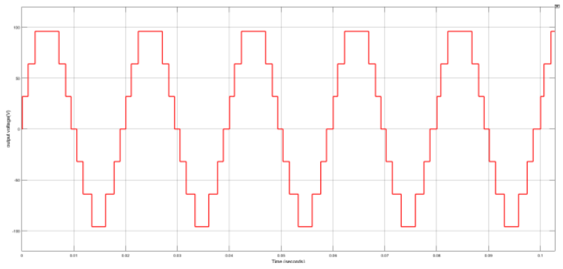
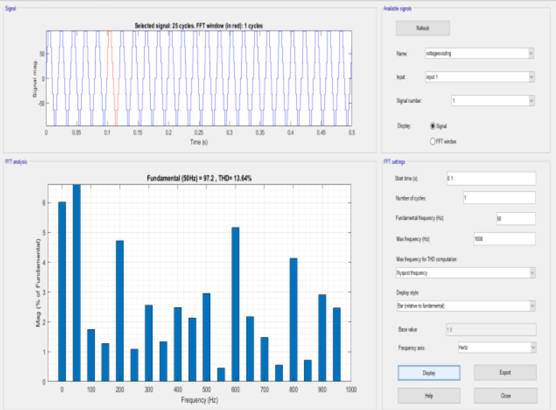


Fig.12 (Vout) Output voltage



Name: voltageexisting
Input: input 1
Signal number: 1
Display: ● Signal ○ FFT window
Start time (s): 0.1
Number of cycles: 1
Fundamental frequency (Hz): 50
Max frequency (Hz): 1000
Max frequency for THD computation: Nyquist frequency
Display style: Bar (relative to fundamental)
Base value: 1.0
Frequency axis: Hertz

Fig.13 Output voltage THD% (13.64%)

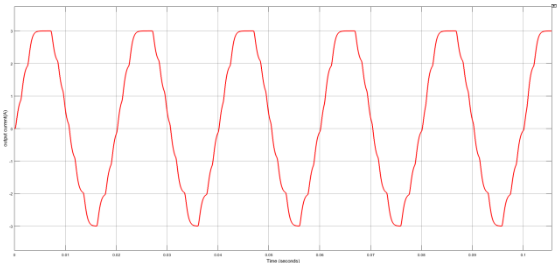
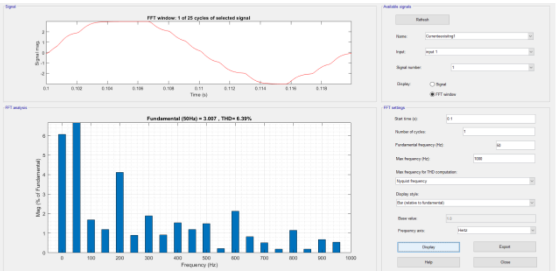


Fig.14 (Iout) Output current



Name: Currentexisting1
Input: input 1
Signal number: 1
Display: ○ Signal ● FFT window
Start time (s): 0.1
Number of cycles: 1
Fundamental frequency (Hz): 50
Max frequency (Hz): 1000
Max frequency for THD computation: Nyquist frequency
Display style: Bar (relative to fundamental)
Base value: 1.0
Frequency axis: Hertz

Fig.15 Output current THD% (16.39%)

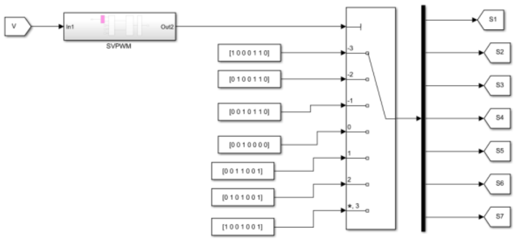


Fig.16 SVPWM technique subsystem

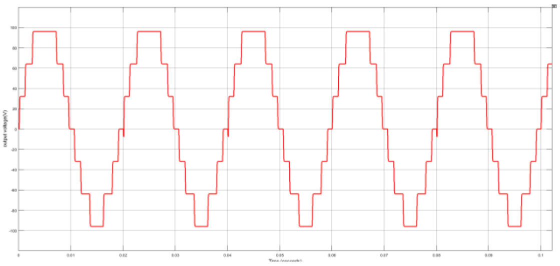


Fig.17(Vout) Output voltage

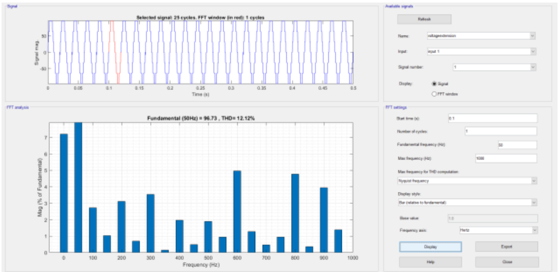


Fig.18 Output voltage THD% (12.12%)

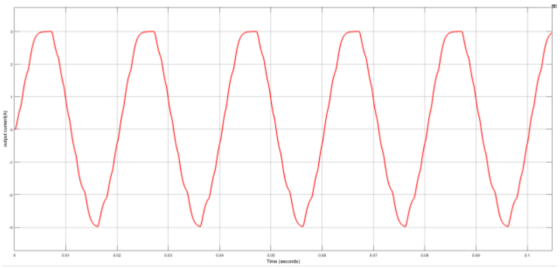


Fig.19 (Iout) Output current

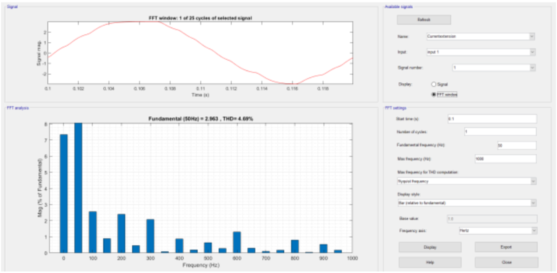


Fig.20 Output current THD% (4.69%)

**THD% COMPARISION TABLE**

| | Voltage THD in % | Current THD in % |
|---|---|---|
| NLC Technique | 13.64% | 6.39% |
| Proposed SVPWM Technique | 12.12% | 4.69% |

## CONCLUSION

We propose an asymmetrical modified CHBMLI design for a hybrid PV/wind microgrid. Higher levels may benefit from the proposed system's reduced number of switches. This is a viable alternative to the traditional CHBMLI's 100% switching losses. The output voltage from the MLI's hybrid renewable energy sources is sinusoidal and does not include harmonics. Because they have lower switching losses than standard CHBMLI inverters, modified CHBMLI inverters are more cost-effective for use in power systems. Overall, harmonic distortion in the MLI has been decreased using SVPWM technology, which has been implemented. As a consequence, rural areas may benefit from a hybrid PV/wind microgrid. It was shown that using MCHBMLI's closest level control method increased overall performance. The proposed topology is more efficient than current topologies. To decrease overall harmonic distortion, a hybrid PV/wind model will be constructed using SVPWM. With the SVM approach, switching patterns may be designed more easily without needing a complicated common-mode voltage. Based on the simulation results, it seems that the suggested topology works. Topology's performance is tested using MATLAB/SIMULINK. A higher voltage microgrid may need novel topologies with fewer switches, DC sources, and greater voltages in order to improve harmonic quality.