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The Performance Evaluation of Novel Thirty One Level Photovoltaic Inverter

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ABSTRACT: In this paper a novel thirty one level inverter is designed and its performance in photovoltaic system is analysed. The novel multi level inverter produces thirty one level output by modified switching schemes. The output of the novel inverter has the less harmonics distortion with minimum number of voltage sources. Finally the harmonic profile is improved. Simulation of the novel inverter is simulated in MATLAB / Simulink and simulation model and result are presented.

KEYWORDS: PV Array, DC-DC boost converter, multi level inverter, harmonic distortion

I. INTRODUCTION

Now a day's the power electronics equipments are used in various power applications. Among this, the applications of converter and inverter are plays a major important role. These are used in power conversion process like DC to DC, AC to DC, AC-AC and as well as the DC to AC. All loads and utility take only AC voltage or power. During this power conversion we consider more on the efficiency and cost of the power electronics equipments. In the electricity generation the non-renewable resources are exist. So, we will concentrate in renewable energy power generating system. Among this, the solar power generation is one of the best solutions for electricity production to the utility or loads. In this type of solar power generation we need number of DC to DC converter to provide the different type of voltage for the DC power utilization and multi level inverter for reducing the total harmonic distortions and get pure sinusoidal output in AC power utilization.

II. LITERATURE SURVEY

The literature survey is performed in the area of multilevel inverter. A new general topology for cascaded multilevel inverters with reduced number of components based on developed H-bridge [1] was designed by E. Babaei, S. Alilu, and S. Laali . in this paper they reduced the number of switches used in the system and they can produce only nine level output. Moumita Das, Monidipa Pal, and Vivek Agarwal designed Novel High Gain, High Efficiency DC–DC Converter Suitable for Solar PV Module Integration With Three-Phase Grid Tied Inverters [2]. According to this paper they increase the efficiency of the system up to ninety five percentage but the number of converter usage will be increased while we increasing the PV module. Transformer-Less Grid Feeding Current Source Inverter for Solar Photovoltaic System was designed by Sandeep Anand, Saikrishna Kashyap Gundlapalli, and B. G. Fernandes [3]. In this paper earth leakage current will be suppressed without using isolation transformer. The problem in this system was we required additional current source inverter. A single-phase multilevel inverter using switched series/parallel DC voltage sources [4] was designed by Y. Hinago and H. Koizumi, in IEEE Trans. Ind. Electron., vol. 57, no. 8, pp. 2643–2650, on Aug. 2010. The proposed inverter is driven by the hybrid modulation method but the overall cost of the system was very high. The number of switches and DC voltage sources are reduced by the topology named as Hybrid multilevel inverter using switched-capacitor units [5]. This topology uses series and parallel combination of the basic unit. The speed and accuracy of the photovoltaic system was increased by A variable step size INC MPPT method [6].etc…

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III.BLOCK DAIGRAM AND WORKING

A. CONVENTIONAL SYSTEM:

The block diagram of the conventional system is given in the figure 1. It consist of five PV array, five DC-DC boost converter, stepped multilevel inverter, pulse width modulator, AC load. We used 12V photovoltaic array. Every PV array produced 12V as output. This output voltage is increased up to 20V by the dc/dc boost converter. The output of the boost converters were controlled by pulse width modulator. These boosted voltages are given as to the input of the Stepped multilevel inverter. Here, this conventional stepped MLI produces 11 level output voltage.

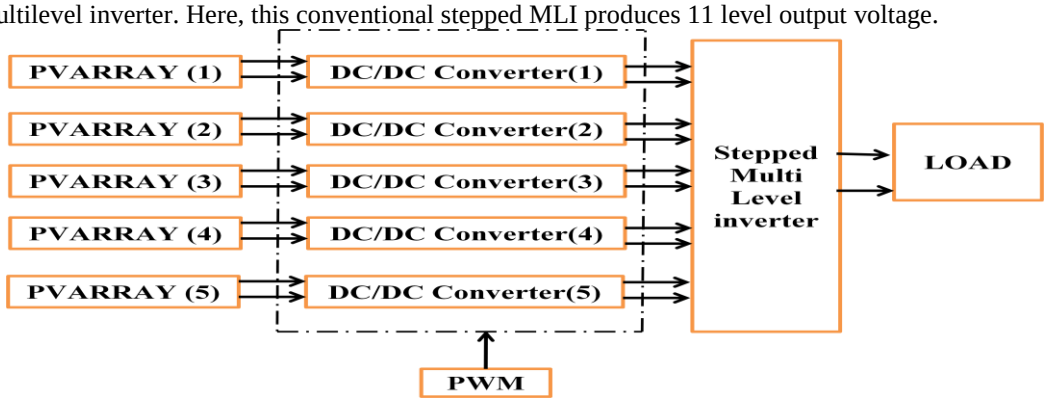

Figure1. Block diagram of the conventional system

The circuit diagram of the conventional inverter is shown in fig 2. In this circuit have the nine switches (S_1, S_2, S_3, S_4, S_5 and S_A, S_B, S_C, S_D), five diodes (D_{S1}, D_{S2}, D_{S3}, D_{S4} and D_{S5}) and five DC voltage source namely V_1, V_2, V_3, V_4 and V_5. The switches S_1, S_2, S_3, S_4 and S_5 are input switches. The switches S_A, S_B, S_C and S_D are output switches. In the output wave both the positive (odd) and negative (even) half cycles are produced by this output switches. The input switches are used to step up the output wave like voltage and as well as the current.

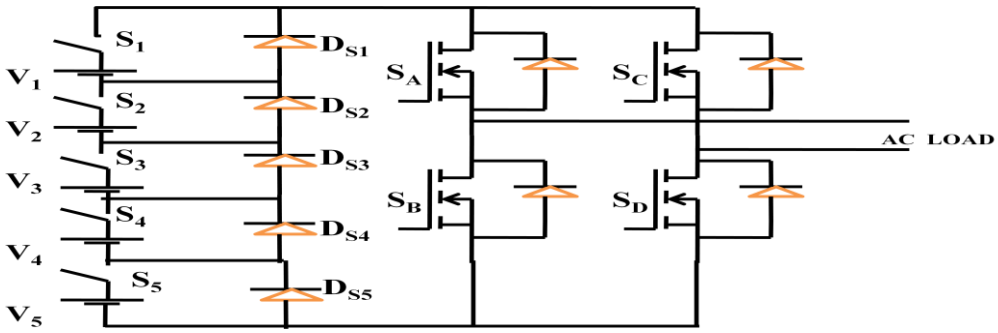

Figure2. Circuit diagram of the conventional inverter system

The output voltage wave has 11 level output only. This conventional inverter has more complexity while we built in MATLAB / Simulink. The power electronic devices which are used in this conventional system were more and it will increase the cost of overall system. The following below table switching algorithm are used to produced the 11 level output.

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Voltage level	Switches to be turned ON	Diode in conduction
0	Nil	DS1,DS2,DS3, DS4, DS5
P1	S5	DS1,DS2,DS3, DS4
2P1	S4,S5	DS1,DS2,DS3
3 P1	S3,S4,S5	DS1,DS2
4P1	S2,S3,S4,S5	DS1
5P1	S1,S2,S3,S4,S5	Nil

Table1. Operation of the conventional inverter system

The eleven level output is produced by eleven mode of operation for both positive and negative half cycles. In positive half cycle the output switches S_1 and S_4 are in ON condition. Similarly the negative half cycle the output switches S_2 and S_3 are in ON condition. The five modes of operations explained in following below table1.

B. PROPOSED SYSTEM:

The block diagram of the proposed system shown in figure3. It comprises of PV array (4), Stepped MLI, AC load, firing pulse generator. Here, the four PV arrays produce output voltages 6V, 12V, 24V, 48V respectively. The stepped MLI is used to produce stepped output voltage and current. The firing pulse generator is used to produce thirty one level output.

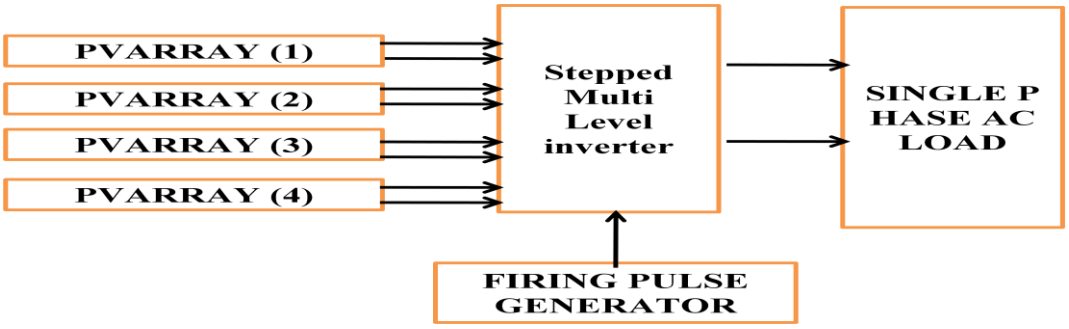

Figure3. Schematic diagram of the proposed system

The circuit diagram of the proposed inverter is shown in fig 4. In this circuit have only eight switches (S_A, S_B, S_C, S_D and S_1, S_2, S_3, S_4) four diodes (D_1, D_2, D_3 and D_4) and four DC voltage source namely V_1, V_2, V_3 and V_4. The switches S_A, S_B, S_C and S_D are input switches. The switches S_1, S_2, S_3 and S_4 are output switches. In the output wave both the positive (odd) and negative (even) half cycles are produced by this output switches. The input switches are used to step up the output wave like voltage and as well as the current. The output voltage wave produces step level up to 31 levels. In positive half cycle the output switches S_1 and S_4 are in ON condition. Similarly the negative half cycle the output switches S_2 and S_3 are in ON condition.

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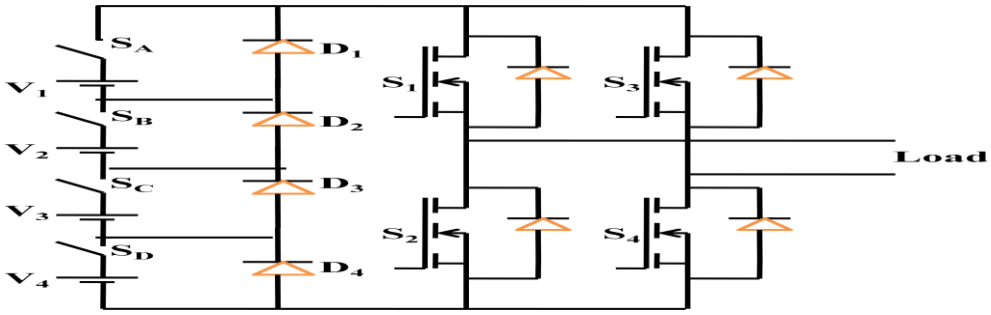

Figure4. Circuit diagram of the proposed inverter system

Mode 1: In this mode of operation, the switch SA is in on state and the rest of the switches are in off-state At this point, inverter output voltage is equal to V1 i.e., 6V. **Mode 2:** In this mode of operation the switch SB is in on state, therefore D1 is forward bias and the remaining diodes are reverse biased, hence the voltage path is through D1 At this point, inverter output voltage is 12V. **Mode 3:** During this mode of operation SA and SB switches are turned on. At this particular mode, V1 and V2 voltages are added, the output voltage across the inverter will be 18V. **Mode 4:** During this mode of operation the switch SC is closed and the voltage path is through forward biased D1 and D2 diodes. The output voltage of the inverter will be 24V. **Mode 5:** The switches SA and SC are closed, in this Situation the diode D2 is forward biased and the rest of the diodes are reverse biased. The output voltage across the inverter will be 30V. **Mode 6:** In this mode of operation, Both the voltages V2 and V3 are added to obtain an output voltage of 36V across the inverter. **Mode 7:** During this mode of operation, switches SA, SB and SC are closed such that the voltage V1, V2 and V3 are added to give a total voltage of 42V as the output of the inverter. **Mode 8:** The switch SD is in on-state, in this situation D1, D2 and D3 diodes are forward biased. Therefore output voltage across the inverter will be 48V. **Mode 9:** During this mode of operation, the switch SA and SD are in on-state. The diodes D2 and D3 are forward biased, therefore the voltages V1 and V4 are accumulated to obtain a voltage of 54V across the inverter. **Mode 10:** In this mode of operation, switches SB and SD are closed, as the diode D3 is forward biased both the voltage V2 and V4 are added and hence the output voltage of the inverter is 60V. **Mode 11:** The switches SA, SB and SD are closed. Due to this switching sequence, D3 diode gets forward bias and hence all the three voltages V1, V2 and V4 are added to get a 66V output voltage across the inverter. **Mode 12:** In this mode of operation, the switch SC and SD are in on-state. Therefore this switching phenomenon results in inverter output voltage as 72V. The voltage path is through D1 and D2 diodes, which are forward biased. **Mode 13:** During this mode of operation, the switches SA, SC and SD are closed. As the D2 diode gets forward bias all the three voltages are added. In this situation output voltage of the inverter will be 78V. **Mode 14:** The switches SB, SC and SD are closed these results forward bias of the diode D1. As the switches SB, SC and SD are in on-state, the output voltage of the inverter will be 84V. **Mode 15:** In this mode of operation all the four switches are closed. The final output voltage of the inverter will be 90V.

IV. RESULT AND DISCUSSION

Fig 5(a) shows the switching states of the proposed MLI. From Fig. 5(b), it is clear that the output voltage of the MLI has thirty-one levels and current in Fig. 5(c) is sinusoidal, such that MLI feeds utility in phase. Similarly, the voltage THD are depicted in Fig. (d) from the figure THD values are voltage is 14.65% . level inverter produced thirty one levels in the output voltage and current, which resembles sinusoidal waveform.

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1. SWITCHING STATES OF PROPOSED MLI:

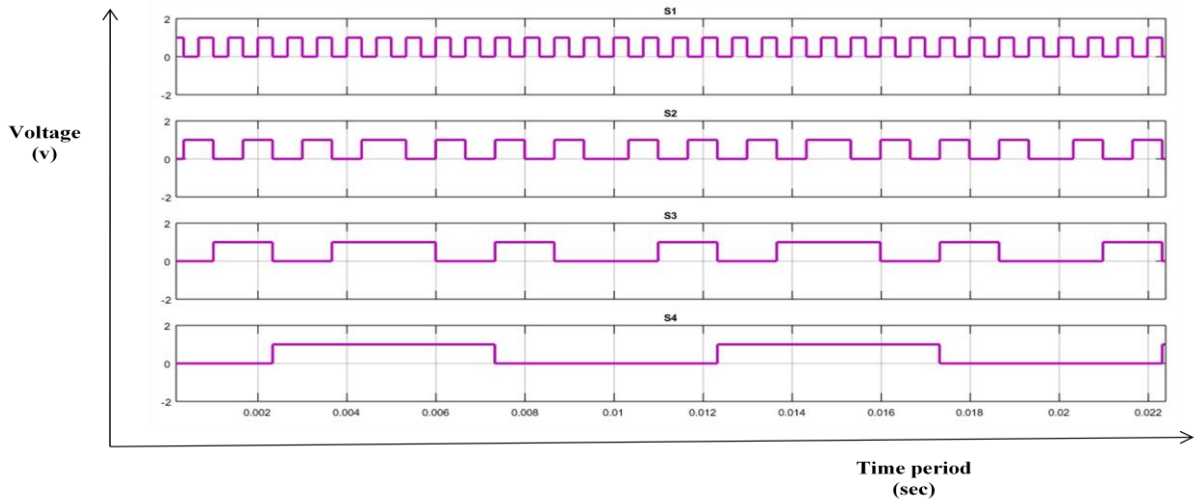

Fig 5(a) Switching States of proposed MLI

The switching states of the novel thirty one level photo voltaic inverter is shown in fig 5(a). This waveform was plotted between voltage and time period.

2. NOVEL MULTI LEVEL INVERTER OUTPUT VOLTAGE:

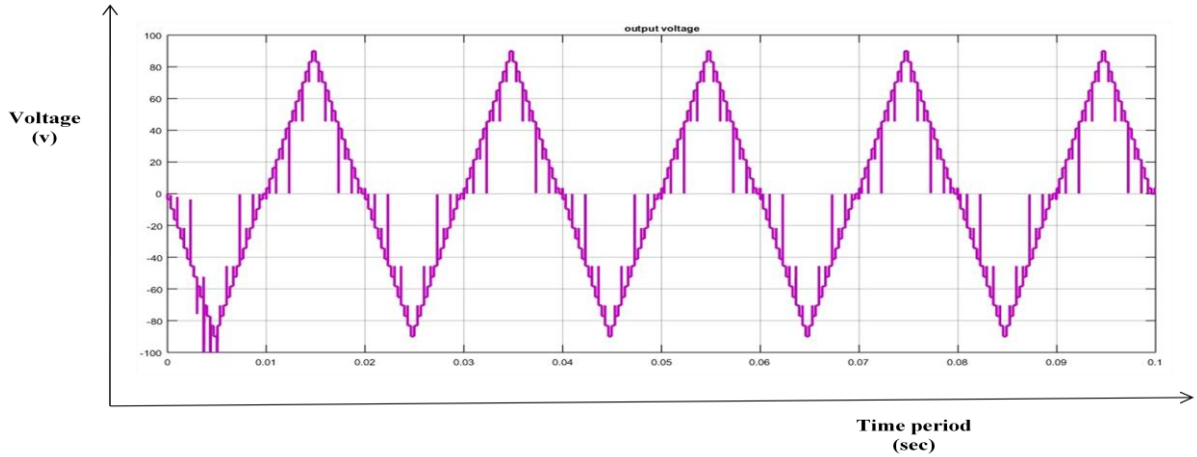

Fig 5(b) Novel Multi Level Inverter Output Voltage

The output voltage of the novel thirty one level photo voltaic inverter is shown in fig 5(b). This waveform was plotted between voltage and time period. From the above diagram we can understand the novel MLI produced up to 90V.

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3. NOVEL MULTI LEVEL INVERTER OUTPUT CURRENT:

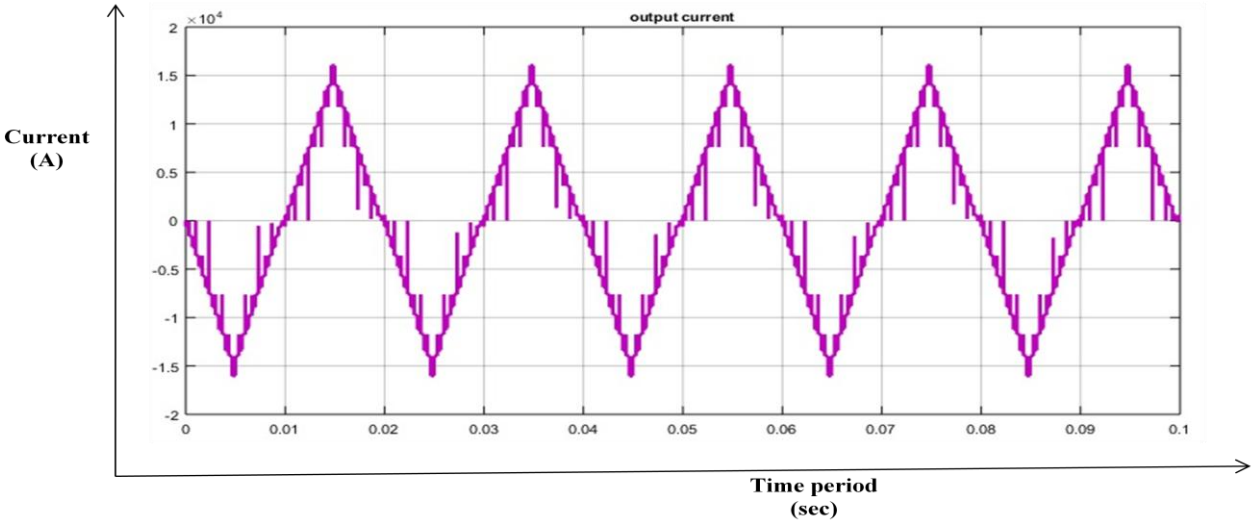

Fig 5(c) Novel Multi Level Inverter Output Current

The output current of the novel thirty one level photo voltaic inverter is shown in fig 5(c). This waveform was plotted between current and time period.

4. TOTAL HARMONIC DISTORTION:

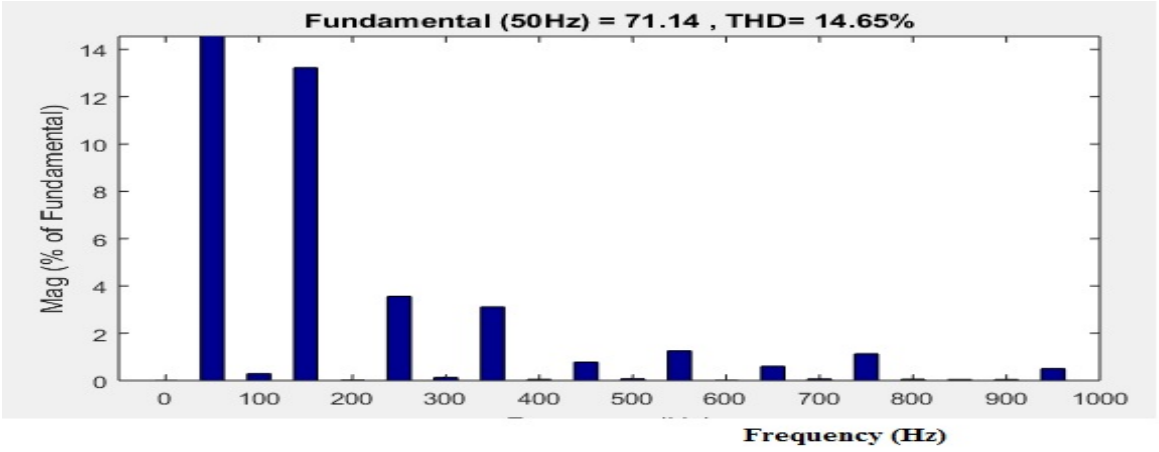

Fig 5(d) Total Harmonic Distortion

The total harmonic distortion of the output voltage of novel thirty one level photo voltaic inverter is shown in fig 5(d). This waveform was plotted between fundamental magnitude and frequency. The THD value is 14.65 %.

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V.COMPARATIVE ANALYSIS

The comparative analysis of the conventional inverter and proposed inverter is shown in table 3. In this comparative analysis the conventional and proposed system components and parameter was included.

S.NO	PARAMETERS	CONVENTIONAL SYSTEM		PROPOSED SYSTEM	
		CONVERTER	INVERTER	CONVERTER	INVERTER
1.	No of Devices	5	1	1	1
2.	Switches	5	9	2	8
3.	No of Dc Voltage Source	5	5	1	4
4.	Diodes	5	5	2	4
5.	Inductor	5	-	1	-
6.	Capacitor	5	-	1	-
7.	Input Voltage	12V	20V,20V,20V,20V,20V	40	6V,12V,18V,24V
8.	Inverter Voltage Level	-	11	-	31
9.	Output Voltage of each device	20V	100V	6V,12V,18V,24V	90V

Table 3 Comparative Analyses

The above table the following parameters number of devices and switches, number of voltage sources, diodes, inductor, capacitor, input voltage, inverter voltage level, the output voltage of each device is include.

VI.CONCLUSION

The performance evaluation of the novel multi level inverter is done in this project. The conventional Inverter system produces only 9 level output for using one H-bridge inverter and 4 DC voltage source. We produce the 31 level output voltage by modifying the switching schemes of the same MLI. Thus the cost of the system is reduced very well and the total harmonic distortion will be reduced by increasing the voltage level.

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