Solar Connected Multilevel Inverter Technique with Less Number of Switching System

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Abstract— A multilevel inverter is a power electronic device that is used for high voltage and high power applications the increase in the level of output, number of switching equipments besides with the switching states enhances. As a consequence, higher switching losses occurs that prompts power loss .moreover due to high power loss its necessary to reduce the number of switching device. Keeping this in mind, this paper presents a multilevel inverter with switching approach considering less number of power electronics equipments. The proposed idea has not only achieves high power ratings but also enables the use of renewable energy source in the form of PV cell. By using this technique it reduces the switching losses; cost and low order harmonics. The significant characteristics of this submitted work is that the module can be accomplished as sub multiple level assembly. Progressively, with minimal rise in the switching elements, all number of levels can be elongated.

Keywords: Multi-level Inverter, Inverter switching technique, THD (Total Harmonic Distortion), Simulation

I. INTRODUCTION

In the field of power electronics with renewable energy recourses and its applications in the various filed necessitates renovation stages such as from AC to DC or vice versa. The photovoltaic effect is very important, renewable and sustainable mode because solar energy is a never ending source of energy. Among this, the inverters play a vital role in low and high power applications. The need of PV Multi Level Inverters (PVMLI) with less number of switching devices has become the necessity to interface the power semiconductor devices to the high voltage circuit. The multilevel inverter was established in the year of 1975 at first time [1].

On comparison to five level inverter PVMLI has various special features such as less number of switching system low level of harmonic distortion, able to function in both fundamental and high switching frequency PWM, more efficiency and less electromagnetic interference and renewable energy source. The inputs to the MLI can be supplied either from renewable or conventional DC sources.

The most popular approaches of MLI are listed below:

1) Cascaded H Bridge MLI
2) Diode clamped MLI
3) Fly back MLI

By many researchers Cascaded H Bridge MLI [4] has been employed because it has the capability to prepare more level of output with less cost. In addition to that, this type does not require high quantity of transformers and clamping diodes. The output of the system is multistep stair case voltage waveform that corresponds to a sinusoidal waveform with the amplification in the number of levels.

The diode clamped MLI gives multi level voltages by connecting the each phases with the cascaded bank of capacitors. The generalized equation for the number of diodes needed for each phase is given by (m-1) (m-2), where „m" is level inverter output. From the equation, it is found that with the increment in the level of output, the number of diodes essential becomes difficult. So it is infeasible to implement it practically [3]. In search of flying capacitor MLI, it is found that huge amount of capacitors are mandatory to clamp the voltage.

an m level converter, the quantity of capacitors for each phase is given by, (m-1) (m-2)/2.

The rise in voltage level also arise the quality of the output power, also it necessitates large number of power switching devices besides with gate triggering equipments. If we reduce the switching equipment's then the voltage level also reduce. Many research reveals that THD level for these types of cases is high that shows clearly the poor quality of output power delivered to the load side

With more level of output the complexity of the circuit arises with low efficiency. By considering this reducing the complications in the real time implementation, it is fascinating to reduce the number of switches. This gives fewer switching losses. Therefore it is preferable not reducing the level of MLI output, if the switches used in the circuit arrangement is minimized, it is feasible to mean in between the switches utilized and the number of levels.

So far various research works has been submitted [9-13] focusing in the deterioration of less number of equipments utilized. This reduction is not only enhancing the compactness of the circuit, also driver circuits adopted for each switch and anti parallel diodes are decreased. All these benefits will bring the modular circuit configuration this reduces the size of the circuit but also it is very economical. This arrangement can be predictable as sub multiple level configurations adopting the positive output voltage only with the support of single H bridge circuit.

II. METHODOLOGY

By applying two dc sources as an input, the proposed work circuit diagram shown in figure 1. The multilevel output positive half cycle voltage is produced across AB. This is connected by conventional H bridge interpreted by the switches T1 to T4 to generate output in both positive and negative half cycles and then connected to the load.

This circuit can give seven distinct levels i.e. three at positive and three at negative side and one at zero level. For all the switching state for all feasible cases is in table. Here 1 represents ON and 0 represents OFF state of the switching circuit.

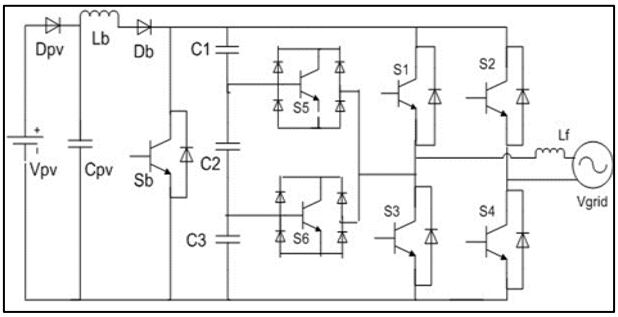


Fig. 1: Recommended basic unit fed by PV dc sources.

Mode	1		2	3	4	5
S1	0	0	1	0	1	1
S2	0	1	0	1	0	1
S3	1	0	0	1	1	1
S4	1	1	0	1	0	0
S5	1	0	1	0	1	0
S6	0	1	1	0	0	0
V0	0		V1-V2	V2	V1	V1+V2

In the above table all proportion of the switches are represented for the output voltage. When same amplitude of DC source is chosen with same configuration the output voltage level minimizes. For the increment of the voltage levels the unequal voltage (asymmetric configuration) lie PV cell are chosen. Voltages are fed to the H- Bridge to produce possible output levels in positive and negative at Vo.

The same concept can be used for all circuit for a specific number of dc sources for a definite number of switches.

DC voltage input for the MLI are designed in equation 1 to 3

N sourse = n…… (1)

N switch =4n-2…… (2)

N driver = N switch = 4n-2…. (3)

With the dc voltage inputs of asymmetrical MLI having binary relationship is given in equation 4 to 6.

Vdcn= 2(i-1) Vdc……..(4)

Where i = 1, 2, 3….n

Nstep = 2(n+1) - 1…… (5)

V0max = (2n -1) Vdc…… (6)

With the dc voltage inputs of asymmetrical MLI having binary relationship is given in equation 7 to 8.

Vdcn = 3(i-1) Vdc

Where i = 1, 2, 3…..n

N step = 3n

V 0max = (3n -1)/2) Vdc

By above equations, seven levels of positive output voltage are found. The similar positive voltage can be achieved by ON the switches S1 and S4 of the H bridge except the zero output voltage. In table 1 the measure of output voltage of the suggested configuration when works at symmetric and asymmetric techniques. Correspondingly, for n number of separate dc sources, for symmetric & asymmetric MLI under both binary and tertiary relationships, output measures can be obtained [14-15].

III. SIMULATION AND EXPERIMENTAL RESULTS

For implementing the switching technique in MLI circuit, MATLAB/SIMULINK is chosen as the software platform. Switching sequence mentioned in Table 1 is followed. Figure 2 and 3 represents the inverter output voltage and current. Quality of output power is measured by calculating THD level of the voltage and current by using FFT tool in MATLAB support for this execution. The spectrum output of THD level for voltage 0.38%. Here MOSFET gate pulses shown in figure 6.

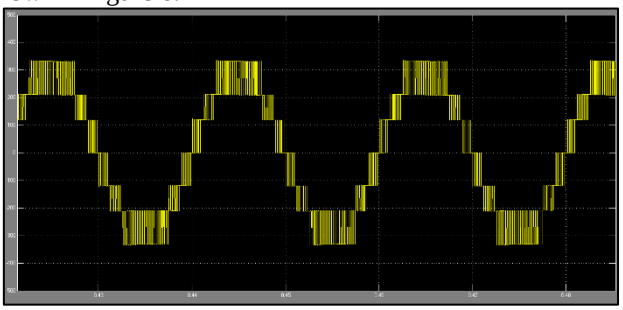


Fig. 2: Multilevel inverter output voltage

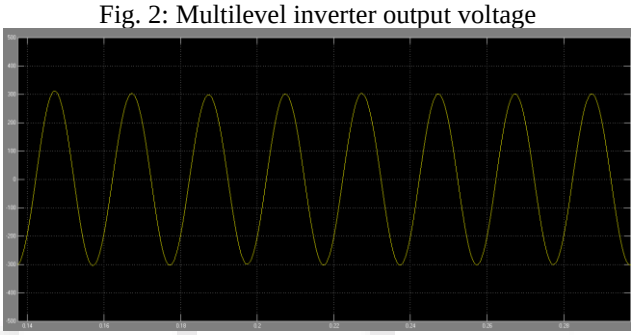


Fig. 3: Multilevel inverter output current

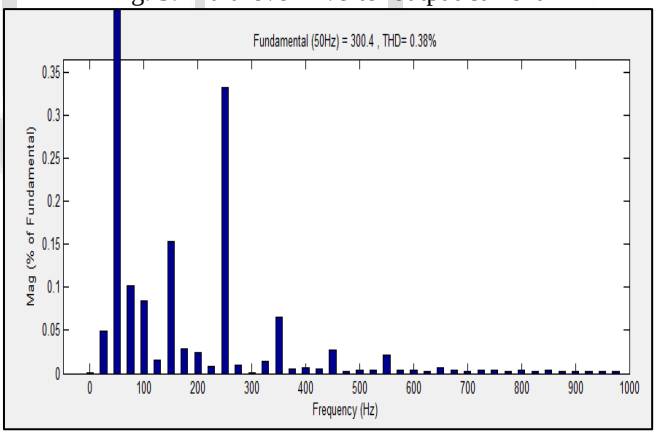
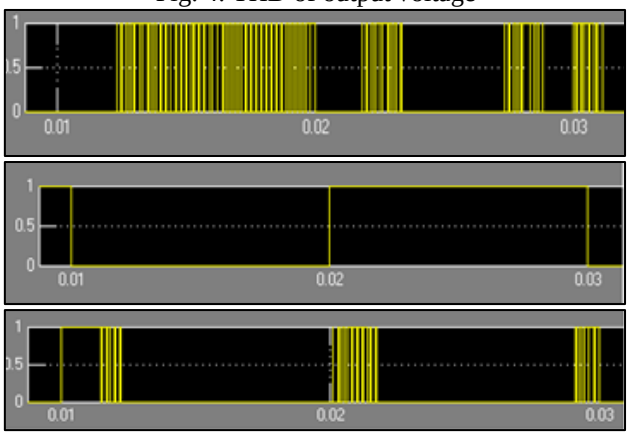


Fig. 4: THD of output voltage



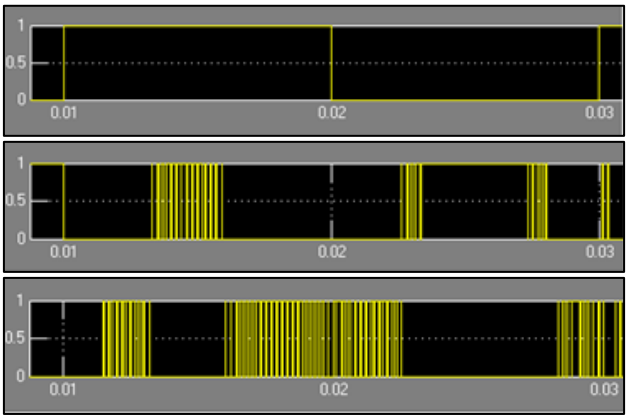


Fig. 5: Simulation gate pulses

IV. CONCLUSION

In this paper, a new approach for multilevel inverter can be prolonged to n‟ number of levels of positive output voltages is given. The same kind of arrangement can be extended to derive positive and negative level output. In order to achieve quality power in an inverter circuit with reduced switching loss and high efficiency, it is compulsory to reduce the number of switches for a high MLI. This is focused as the main concern in this work. Symmetrical and asymmetrical categories are analyzed for both binary and tertiary relationship through the employment of H bridge inverter connecting with PV Cell. The simulation outcomes ensure the quality of the output power through THD calculation. It proves clearly that even with less number of switches for MLI, the efficiency and modularity are improved with less cost.

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