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A PWM BASED MULTILEVEL RENEWABLE ENERGY SYSTEM

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Abstract – Recently, Development and the utilization of single phase based multilevel inverters has been increased. This paper proposes concept based new topology based seven level inverter with less number of power electronics switches with utility grid connection. This proposed multilevel inverter operates with only eight power electronics switches at their fundamental frequency. This inverter produces seven level output from the input here we considered as a photovoltaic system. The cost, complexity, switching losses are small due to because of usage of less number of switches. The DC/DC converter receives input from which the three positive output voltages are generated and the multilevel inverter performs as a polarity reversal that provides both the positive and negative cycle output. For further enhancement in the output waveform, the filter circuit can be integrated in the output terminal of the multilevel inverter. The simulation results are observed by means of MATLAB simulink toolbox.

Key Words: Multi-Level Inverter, ANFIS, THD, Solar Panel.

I.INTRODUCTION

In numerous rural areas uninterrupted electricity is not accessible from grid. Mostly the grid gets power from hydro power station as well as from thermal power station. As the conservative energy sources are diminishing hasty, in the midst of consequent mount in cost, solar and wind energy offers a superior substitute resource along with free from pollution. The renewable energy resources are profitable and they will not cause any detriment effects on the surroundings. A Single phase PV based seven-level inverter is discussed in paper [1]. The PV power generation is a budding modern trend owing to its various advantages resembling inexpensive, ecological responsive power generation.

Multilevel inverter possibly will generate almost sinusoidal output voltage waveform along with output current which will compress the harmonic distortion furthermore improve its power quality [2].When the level increases, harmonic possibly will decrease however the switches necessary for the conduction of converters may increase. Due to the increase in number of switches, the switching stress may arise that leads towards switching losses.

Conventional different concepts of multilevel inverters such as clamping circuits with diode based multilevel inverter [3], flying capacitor based multilevel inverter and cascaded based multilevel inverter the switches required for the conduction are improved according to the multi levels. In diode-clamped inverter, additional number of diodes is mandatory to generate the number of levels. For flying capacitor inverter, the charges are stored into the capacitor and for that it needs hefty amount of capacitors consequently the cost of switches is amplified. To prevail over these conventional systems, a novel modified multilevel inverter is projected meant for generating seven level of output [4].

The neuro-fuzzy controlled photovoltaic energy generation system consisting of dc/dc boost converter, capacitor selection circuit and 7-Level inverter. This method plays a crucial task in reducing the amount of switches designed for generating seven level of output. It consisting of no more than six power electronic switches moreover only one switch will activate at high frequency at any instant. The solar panel dc outputs are boost up by means of boost converter along with its switches are embarrassed through the maximum power point technique (MPPT) [6]. In favour of supplying power towards the utility, the dc power is rehabilitated to ac by means of single Multi level inverter combined in the company of the capacitor selection circuit. The positive cycle of output are fashioned by the three pathways: 1) power from boost converter 2) commencing transformer 3) from single Multi level inverter. The single Multi level inverter breed negative half cycle. Ultimately, the proposed topology is simulated and results are obtained.

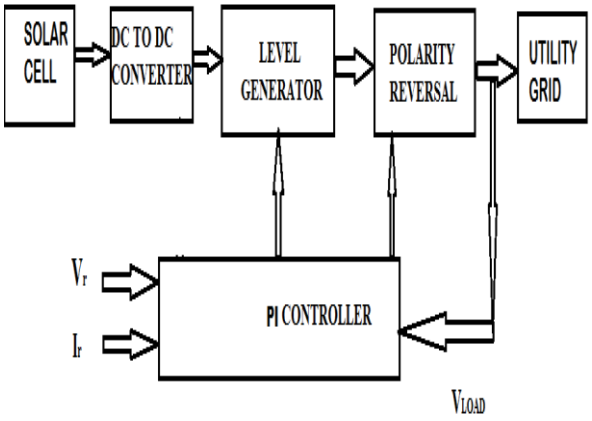
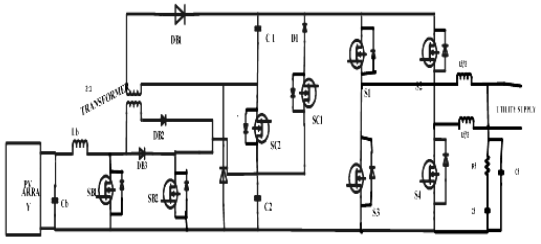


Figure 1: Block Diagram of Proposed converter with Neuro-Fuzzy Controller

The intensity of sunlight and radiations present on the earth surface varies time to time; thereby it causes the changes in input voltage and current. The aim of this concept is to attain maximum regulated output power to utility. Generally, the maximum power is trapped using a dc-dc converter with the help of maximum power point tracking controller. In this paper we considered a basic perturb & observe method. Thereby it improves the efficiency of power generated by the solar panel [7].

The neuro-fuzzy control switches present in the converter, capacitor selection circuit and inverter as shown in figure.1. It shows the block diagram of the anticipated level generator controlled by the neuro-fuzzy controller. In favour of PV system there will be change in irradiance as it depends on the environment aspects, for that reason necessitate of boost converter for raising the voltage rating.

In figure.2 show the circuit configuration of proposed seven level inverter which consists of photovoltaic array, direct boost converter along with the multi-level inverter. The capacitor selection circuit is used to send the voltages of seven-levels to the utility grid system [8]. The transformer connected along with the boost converter which will pick up voltage rating with its first level. Other levels are shaped commencing the multi-level and its negative voltage levels are formed from the polarity reversal which will afford positive cycle and negative cycle of output voltages.



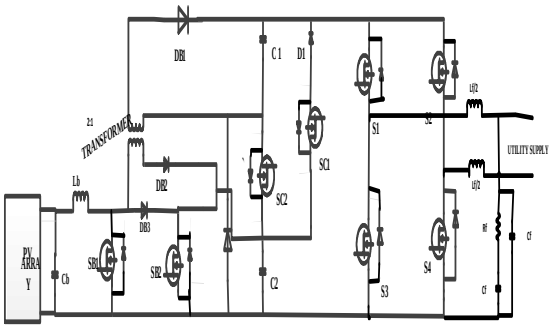


Figure 2: Proposed Circuit Configurations

PHOTOVOLATIC SYSTEM BASED DC-DC CONVERTER:

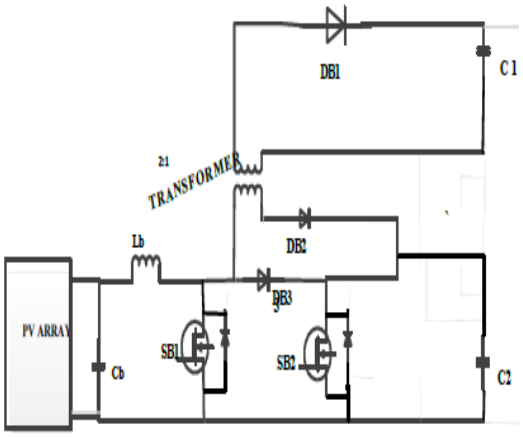


Figure 3: Photovoltaic system along with boost converter

The boost converter is effectively helps for improving the solar power. Because the power generated from the solar system is very small and it depends on the sun radiations. A boost converter is basically a dc to dc voltage converter with an output dc voltage more than input voltage.

Figure 3 shows the circuit configurations for the dc to dc boost converter based solar array system. Irrespective to the irradiance variation, regular output voltage and current are maintained in the proposed power generation system [9]. Then the transformer is used in this topic is to boost up the voltage levels which forms the output voltage levels. The charges will be stored in the two capacitors through transformer and boost converter.

Sc1	Sc2	S1	S2	S3	S4	Vo
0	0	1	0	0	1	Vdc/3
1	0	1	0	0	1	2Vdc/3
1	1	1	0	0	1	Vdc
0	0	0	0	1	1	0

Table 1: Switching Pattern for Seven Level Inverter

SEVEN-LEVEL INVERTER:

An inverter is installed in the system to convert the DC power generated into AC power for use in appliances. The proposed multilevel inverter shown in figure.4 consists of single Multi level inverter at which seven levels of voltages and current are generated. For the negative power flow, this inverter will provide polarity reversal by which the positive and negative cycles are formed. The filter inductor at the load side reduces the harmonic content and maintains the sinusoidal waveform. The PWM signals are given for all the switches present in the boost converter and single Multi level inverter.

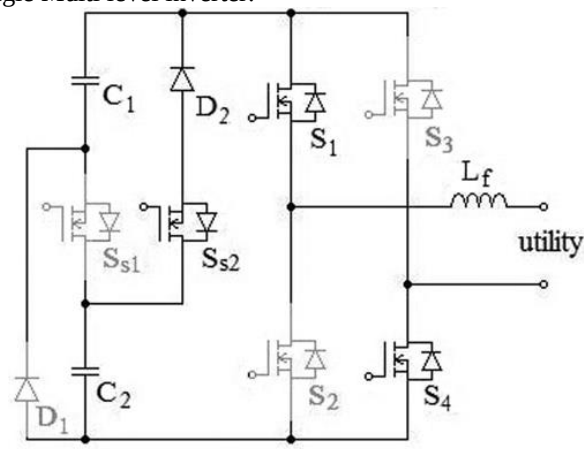


Figure 4: Multilevel Inverter Circuit Configuration

Modes of Operation for Seven-Level Inverter:

1) In mode 1 the switches S1 and S4 are in on state while the switches Sc1, Sc2, S2 and S3 are in off state condition. During this mode the capacitor C1 is discharged through diode. And the output voltage during this mode is Vdc/3.
2) During this mode 2 operation, the switch Sc1 is conducts along with the switch S1 and S4. Then the capacitor discharges through the diode and the output voltage during this mode is 2Vdc/3.
3) In case of mode 3 the switches Sc1, Sc2, S1 and S2 four switches are in conduction, then the capacitors c1 and c2 discharges through the diodes then the output voltage appears in this mode is Vdc.
4) In this case the switches S3 and S4 are conducts by turn off the all other switches. Therefore the output voltage appears is zero.
5) The remaining switches S2 and S3 conducts for generating the negative seven level voltage.

CONTROL BLOCK DIAGRAM:

This proposed control diagram is designed for controlling the boost converter and the seven level inverters. These seven level inverter converts the dc power at low levels to high level ac system and provides these power to utility grid system. In this selection capacitors C1 and C2 are used for improving the voltage levels. The dc to dc converter is supplied by the solar power generation system along with the maximum power point tracking system for improving the voltage of the solar power plant [10]. These control diagram for multi-level and dc-dc converter are shown in figure 6 and figure 7.

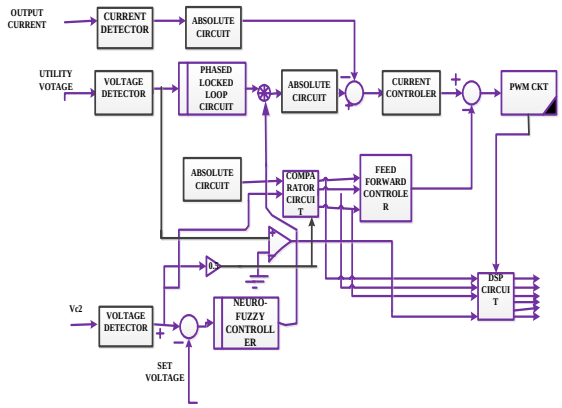


Figure 6: Closed Loop Control Diagram for Multi-Level Inverter

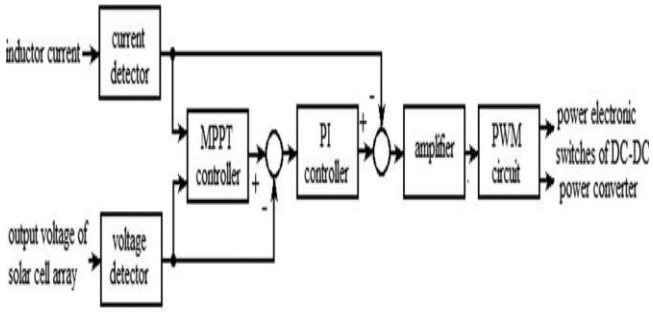


Figure 7: control block diagram for dc-dc converter

SIMULATION EXPLANATIONS:

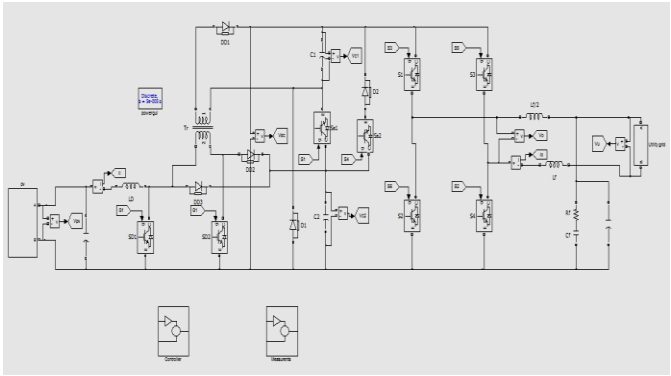


Figure 8: Simulation Diagram for Proposed System

For verifying the performance of the proposed photovoltaic system, a configuration was developed with a closed loop controller based on the fuzzy controller. The simulation diagram for this proposed system is as shown in figure 8.

In the above shown solar power generation system, the solar system generates the output voltage is nearly 75.6V and this voltage is boosted to approximately 95V with the help dc to dc power converter and again this dc voltage is increased to nearly 180V with the help of dual switch controlled dc-dc boost converter. This boosted voltage is applied to seven level converter system with the use of charged capacitors C1 and C2.

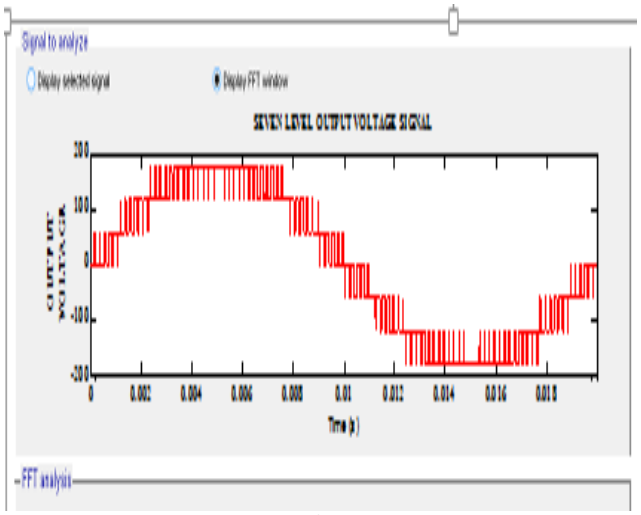


Figure 9: Simulation Result for Seven Level Output Voltage

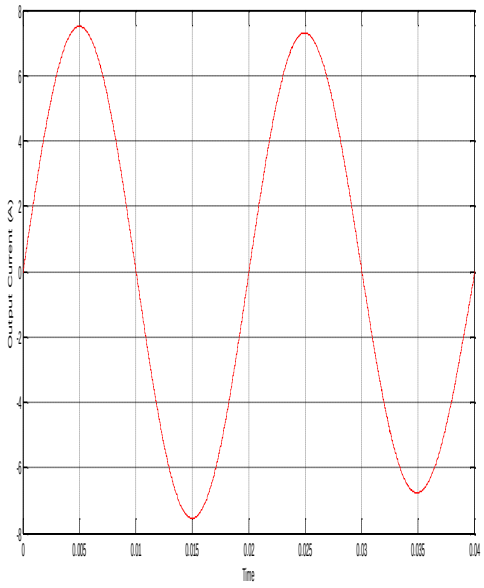


Figure 10: Simulation Result for Output Current

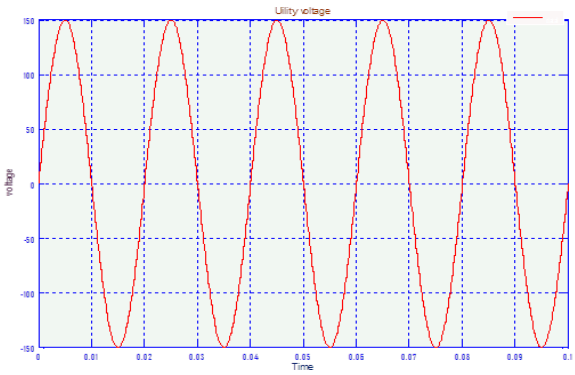


Figure 12: Simulation Result for Utility Grid Voltage

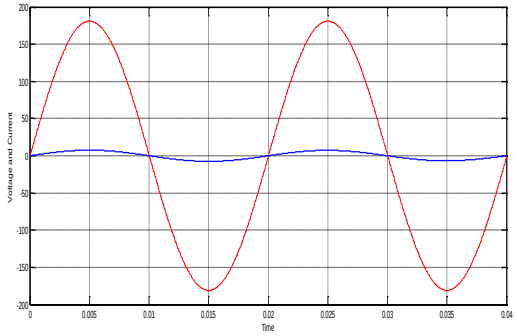


Figure 13: Simulation Result for Utility Grid Voltage and Current for Unity Power Factor

Figure 13 shows the simulation result of utility grid voltage and current waveforms shows unity power factor conditions. And figure 14 shows the total harmonic distortion value of output voltage for Multilevel Renewable Energy System.

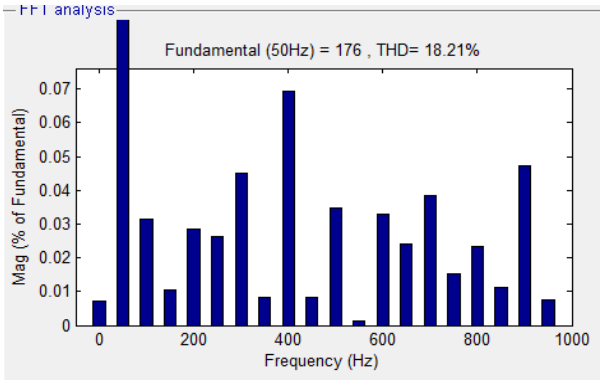


Figure 15: THD for Output Voltage

ADVANTAGES:

1. No capacitor Unbalance Problems
2. Improved the THD and power factor
3. Compactness
4. Low switching losses

CONCLUSION:

The main features for this proposed converter has less cost, reduced size, and have high efficiency. By the help of reduced number of switches, seven-level of output voltages are generated thereby it reduces the switching and conduction losses. The THD of seven-level inverter is less compare to the five-level and three-level inverter. The PI controller could control the switches present in the boost converter and multilevel inverter. For generating the seven levels of the output voltages we are used only six power electronic switches at high frequency at any time. As the inverter level increases, the filter requirements and harmonic content decreases.

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