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A Photo Voltaic Source Fed Novel Boosting Switched Z-Source Multilevel Inverter

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ABSTRACT

This paper presents a new switched z-source multilevel inverter powered from a photovoltaic source. Addition of a power electronic switch in conventional z-source network provides excellent voltage boosting capability with moderate power rating which makes it suitable for low voltage photo voltaic applications. Proposed topology consists of single DC source, six power switches, two diodes, four capacitors and two inductors comparing to conventional five level schemes proposed topology contains less number of switches and passive elements. This scheme produces voltage waveform with lesser harmonics and shows lesser THD percentage by using different modulation index of multi carrier level shifted PWM technique. Proposed switched z-source multilevel inverter is implemented using MATLAB software and results are presented to verify merits of the scheme.

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1. INTRODUCTION

In the last few decades, there has been a drastic increase in the demand for electricity. This has led to rapid use and depletion of fossil fuels. These factors have led the researchers to renewable energy sources such as wind, solar PV and fuel cell stack. Solar Photovoltaic (PV) and fuel cell energy sources play a prominent role among the existing renewable sources poses major challenges such as: (a) Optimal utilization of the source due to their non-linear characteristics (e.g. Maximum Power Point Tracking (MPPT) is required to track maximum available power from a PV source)

Problem Description

PV inverters are shown great focus in new research; inverters have to be designed for higher power quality and performance keeping cost in mind. According to IEEE and IEC standards PV inverters designed for low voltage utility purpose should have THD content in voltage less than 8%. In general MLI use more number of DC sources, power switches and does not have ability to boost input voltage

Background

Literature [1] proposed a multi level inverter for renewable energy applications based on z-source network. In reference [2] different multi carrier PWM techniques has been discussed for cascaded z source multilevel inverter. However space vector PWM created good scope for multi level inverters but implementation for higher level inverters is difficult task [3]. Literature [4] proposed a quasi z-source three phase multi levelinverters for induction motor drives, while applying multi level inverter for drives power balance is a major problem because multilevel output shows low power output it has to be overcome while implementing drives using multi level inverter. Literature [5] proposed a z-source multi level inverter suitable for distributed energy resources, in multi level topology maximum power extraction is a taunting

task hence PWM technique should be taken care optimum performance of multi level inverters. Converter Topology for Grid fed Operations [6] was based on the modelling of photovoltaic system. Photo catalytic degradation of triazine dyes over N-doped TiO2 in solar radiation is described in [7]. Predictive Direct Power Control (PDPC) of Grid-Connected Dual-Active Bridge Multilevel Inverter is explained in [8]. Proportional Integral Estimator of the Stator Resistance for Direct Torque Control Induction Motor Drive is discussed in [9]. Comparison Performances of Indirect Field Oriented Control for Three-Phase Induction Motor Drives is presented in [10]. Sensor less Control of BLDC Motor using Fuzzy logic controller for Solar power Generation is discussed in [11].

2. PROPOSED TOPOLOGY

In the proposed scheme photo voltaic source is simulated by using its equivalent circuit and modeling by mathematical equation of PV parameters. A power switch is added in series before conventional z-source network which boosts the input voltage to a desired level. Then boosted voltage output is fed into level selection switch for achieving multi level in output voltage waveform and an conventional H-bridge single phase four switch circuit is used for generating ac voltage i.e both positive and negative cycle. Multi carrier level shifted PWM technique is used for PWM generation of inverter side switches and for switch at Z-source network high frequency square pulse at duty cycle greater than 50% is applied. Multi carrier PWM uses one reference sine wave and two different level carrier wave and involves conventional sine carrier comparison PWM technique. Figure 1 shows the overall block diagram of proposed system.

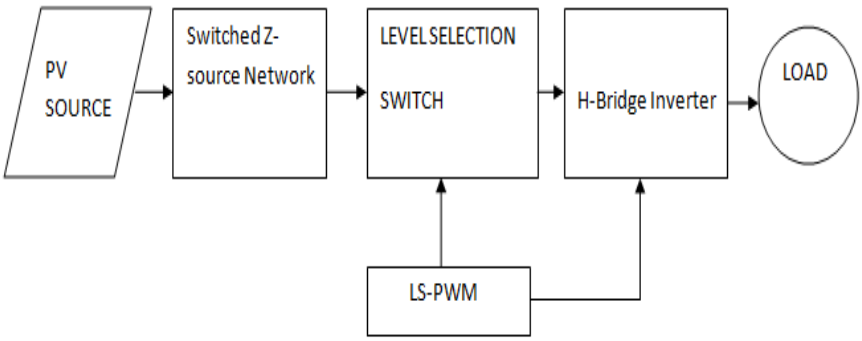

Figure 1. Block Diagram of Proposed System

3. SIMULATION RESULTS AND DISCUSSION

The proposed switched z-source multi level inverter powered from photovoltaic source is simulated in MATLAB Simulink software and results are shown below. Figure 2 shows the simulation implementation of proposed topology.

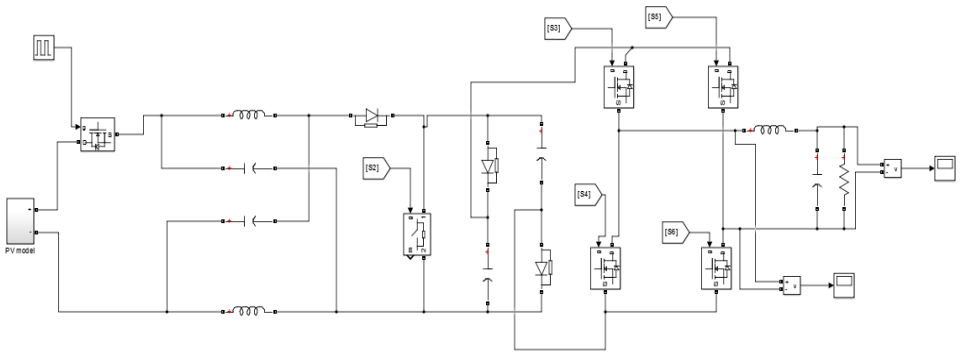

Figure 2. Simulation Implementation of Proposed Circuit

Table 1. Simulation Parameters

Parameters	
PV Voltage	12v
Output Voltage	72v
Z-source Inductor	70mH
Z-source Capacitor	100uF
Capacitor C1, C2	2200uH
Load resistor	100 ohms

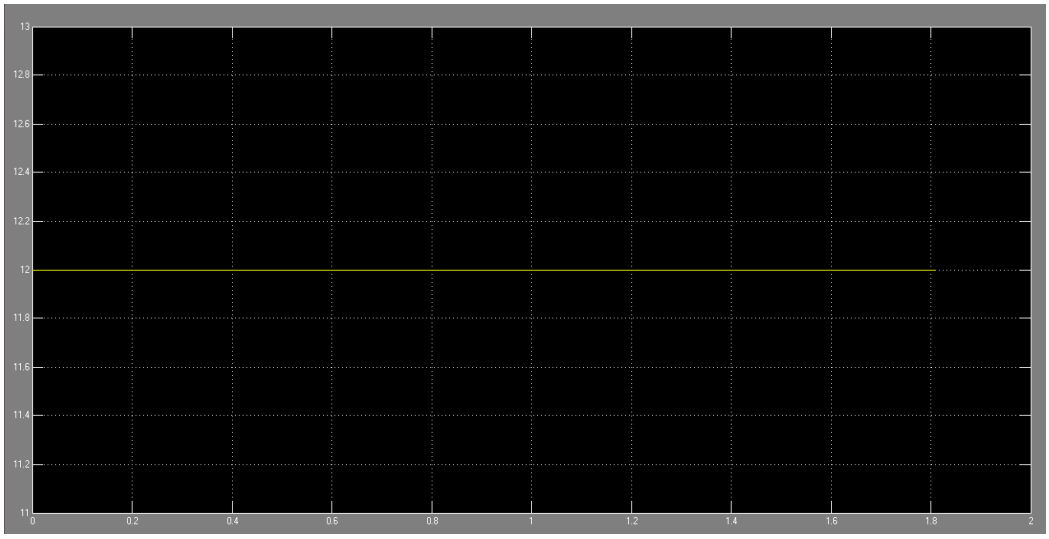

Figure 3. PV Model Response

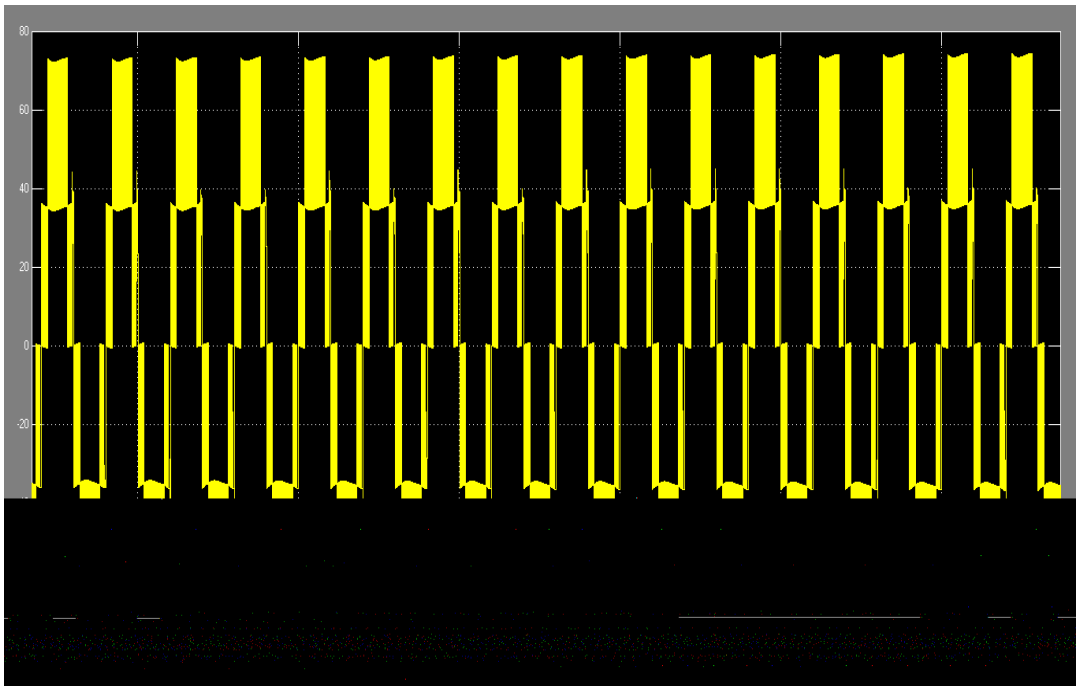

Figure 4. Five Level Output Voltage Waveform

Table 1 shows simulation parameters applied in proposed implementation circuit Figure 3 shows PV source response in simulation and Figure 4 shows generated five level inverter output voltage with lesser

harmonics and from we can observe excellent voltage boosting capability of proposed scheme. Achieved boost ratio is 1:6 which is higher in comparison with conventional boosted multi level inverters.

Table 2. Number of components Used in Multilevel Inverter

Component	
Power electronic switch	6
Inductors	2
Capacitors	4
Diodes	2
Source	1

4. CONCLUSION

The proposed switched z-source multi level inverter is simulated in Simulink software and results are presented. Results shown in previous section verifies the merits of the proposed scheme. It shows excellent voltage boosting capability in the range of 1:6 and THD of output voltage without LC filter is under 20% which is far lesser value of THD compared to conventional five level inverter schemes. THD of output value with LC filter is 4% which shows a higher power quality of proposed inverter.

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