AN IMPROVED HIGH GAIN MULTILEVEL INVERTER FOR SOLAR ROOF TOP APPLICATION

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***ABSTRACT*: This Paper Implements a nine-level quadruple boost inverter topology for solar roof top application. The proposed topology operates on a switched capacitor technique to boost the voltage, and has self-voltage balancing of capacitors. A high-gain generalized Multilevel inverter is used in roof top implementation. The MLI topology has advantages such as a quadruple voltage boost and a reduced component count; it can also produce bipolar voltage inherently. Battery storage system is used to maintain constant voltage at dc link by using bidirectional dc-dc converter. THD values of voltage and current waveforms are reduced by connecting LC filter at load end, MLI is implemented in real time conditions by using solar panel, The performance of the proposed MLI topology is validated through the MATLAB-based simulations**.

Keywords: *High Gain Multilevel Inverter, battery storage system and LC filter*

1.INTRODUCTION

The escalating global energy demand necessitates the integration of renewable sources, particularly solar photovoltaic (PV) systems, alongside conventional power generation. While large-scale centralized PV installations face efficiency losses due to long-distance transmission, distributed generation through solar rooftops has emerged as a viable solution. Solar rooftop systems typically range from 0.5 kW to 2 kW in capacity, with voltage ratings between 50 Volts and 100 Volts. These systems offer advantages such as local generation, reduced grid dependency, and efficient space utilization. However, installation costs, proper orientation, maintenance, and grid connection remain important considerations.

The decreasing cost of solar technology has made it increasingly competitive with conventional energy sources. Despite its numerous benefits, solar energy faces challenges that need to be addressed for widespread adoption. These challenges include intermittency, as solar power generation relies on weather conditions and sunlight availability. To mitigate this limitation, researchers are developing energy storage technologies, such as batteries, to store excess energy generated during sunny periods for use during low-sunlight periods.

A novel nine-level switched capacitor-based multilevel inverter (MLI) with quadruple boost has been implemented for photovoltaic (PV) grid integration applications in small-scale PV grid integration scenarios, the input DC voltage is significantly lower than the grid voltages. Achieving compatible grid voltages with low-voltage PV panels necessitates increased gain and adherence to low total harmonic distortion (THD) limits. To full fill these requirements, the improved topology of the MLI achieves a nine-level output with a gain of four, resulting in better THD performance and reduced filter size requirements.

A level shifted pulse width modulation is used as pulsing scheme for multilevel inverter.one sine wave is referred to two or more reference waves to produce signals. When reference wave is greater than equal to sine wave a signal is produced.

Weather conditions effects a lot in generating electricity when you are using solar panels so, its necessary to maintain constant voltage at load end consumers for efficient operation of their equipment.so a battery storage system is implemented in this paper.

A buck-boost dc-dc bidirectional converter is used to storage energy during access solar energy and use in the deficient condition to maintain constant dc voltage. PI controller is used to in operating bidirectional converter.

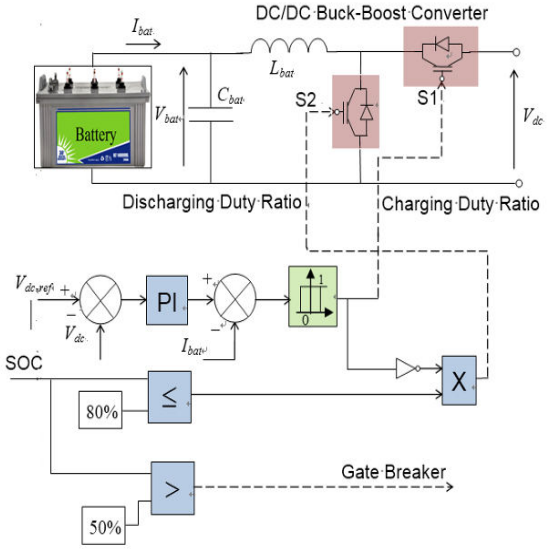
A Proportional Integral (PI) controller combines both proportional and integral control actions to regulate a process variable based on its setpoint and manipulated variable.

1.The proportional term calculates the error between the setpoint and the current manipulated variable output.

2. Integral Controller (I): Actuates the past error overtime. Eliminates accumulated

steady-state error, ensuring even small errors are corrected.

2.PROPOSED SYSTEM



a. Battery control

The control system's objective is to regulate battery current to achieve the required power. It includes charging and discharging current limits, as well as maximum state of charge (SOC) limitations. The battery energy storage system (BESS) connects to the DC grid via a bidirectional Buck-Boost DC/DC converter. The BESS operates in charging, discharging, or floating modes based on energy requirements, managed by the DC bus voltage at the BESS point of coupling. During charging, the converter acts as a boost circuit (switch S2 activated), while during discharging, it functions as a buck circuit (switch S1 activated). The choice of mode depends on the DC link voltage relative to the voltage reference.

The PI controller combines both proportional and integral control actions to regulate a process variable based on its setpoint and manipulated variable.

A lithium-ion battery is used to store or discharge dc power according to requirement at dc linK

b. Power management

It takes following steps in consideration in power management

Step 1: define the different powers involved in our hybrid system,

Step 2: If the power supplied is greater than the requested power, in this case the excess power will be stored in the battery,

Step 3: If the requested power is greater than that generated, the following two cases are distinguish:

a) If the state of charge SOC is greater than 50 %, the storage battery devices are switched on.

b) In the opposite case, the battery stops working, which forces the delesting.

c. DESIGN OF LC FILTER

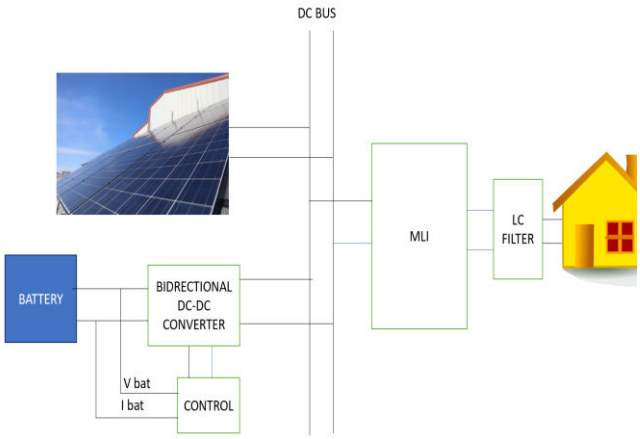
The design of a low-pass LC filter is as follows; Filter inductor is calculated, assuming voltage drop across it is less than 2% of the nominal voltage.

$$L_F = \frac{V_{orms} x 0.02}{2\pi x f_o x I_o} = \frac{V_{orms} x 0.02}{2\pi x f_o x P_o}$$

Capacitor is calculated as

$$C_F = \frac{1}{4\pi^2 x f_c^2 x L_F}$$

BLOCK DIAGRAM



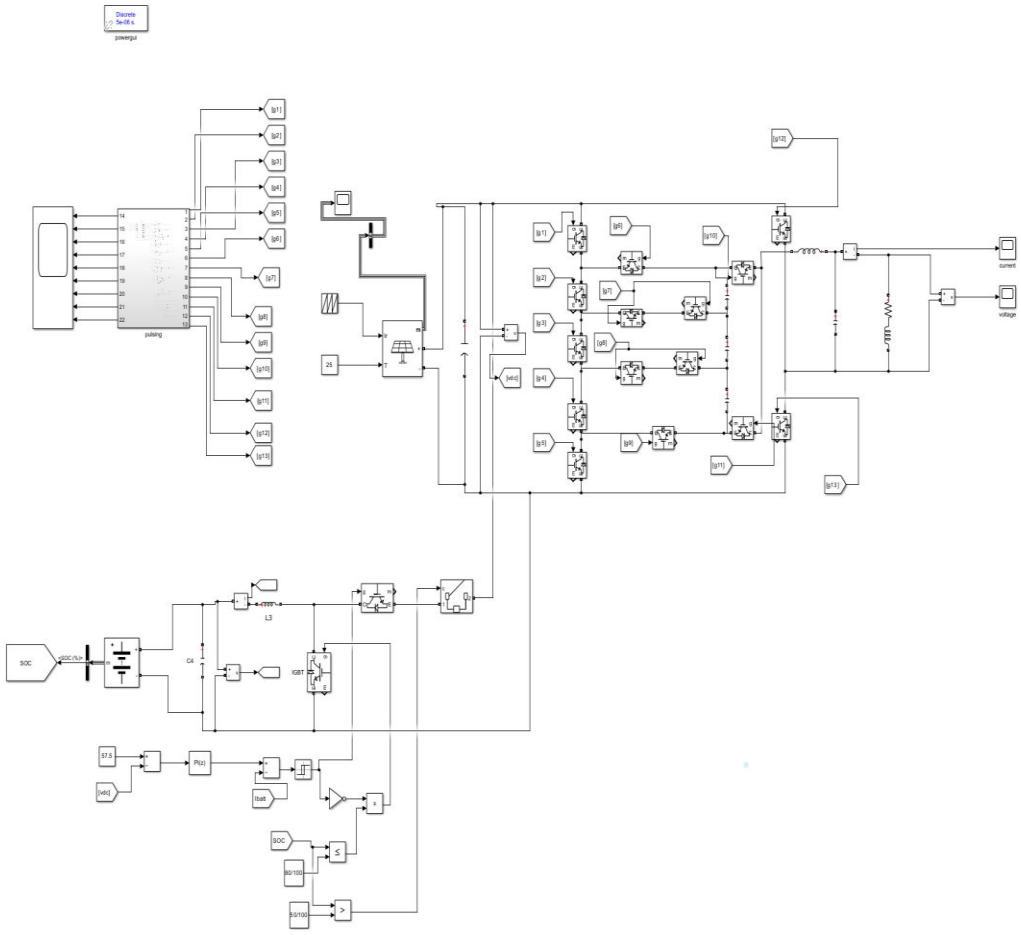
The implementation of multilevel inverter is done according to the above block diagram. The input of solar voltage is 57 volts, so directional converter ensures such that it maintains constant voltage at dc link to get constant ac supply at residential load.

MLI quadruple the voltage as input of solar panels is very low with its switched capacitor topology. A level shifted pulse width modulation is used for its pulsing scheme.

LC filter is used to reduce THD, with the help of LC filter THD values are below 5%.

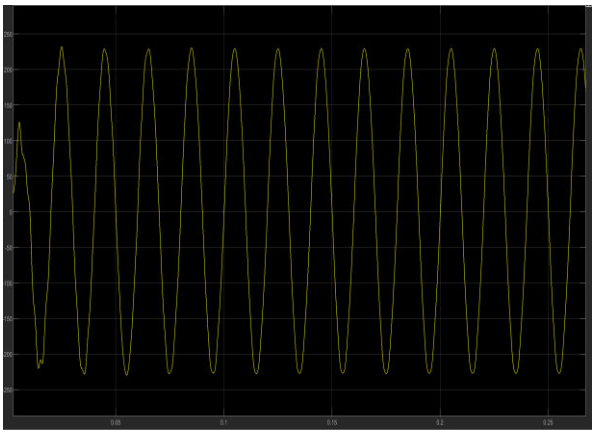
SIMULATION AND RESULTS

The performance of proposed model is analyzed using matlab/Simulink 2023b.

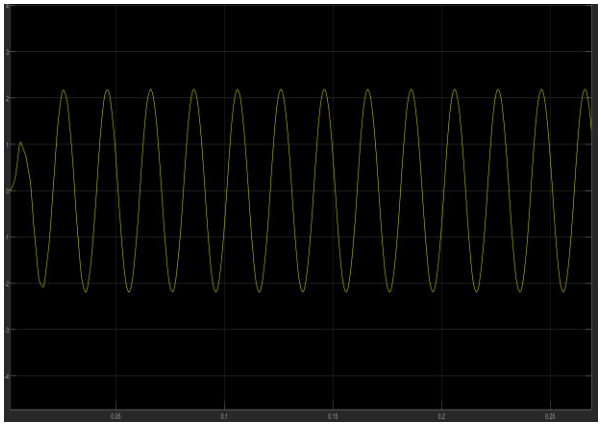


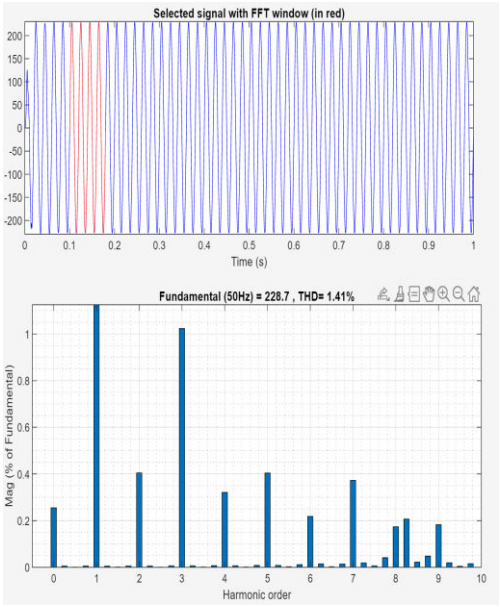
The output voltage of inverter is 230 volts, the voltage is quadrupled using a multilevel inverter. The Reference of pi controller given as 57.5 to get 230 volts at load end.

Output voltage waveform

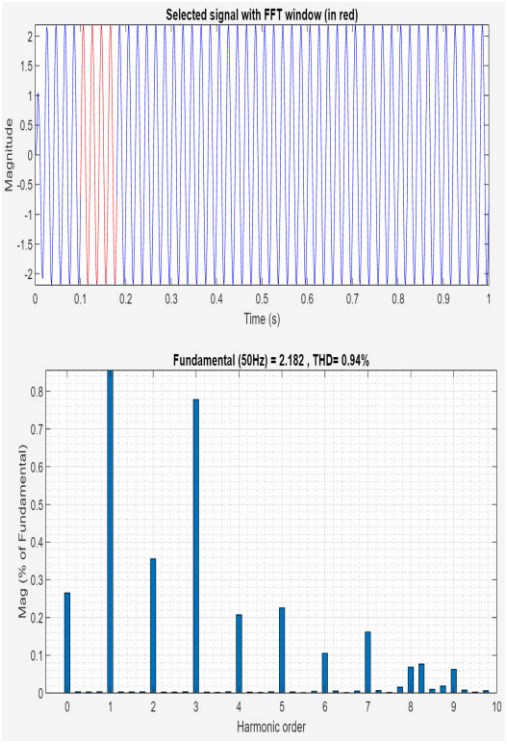


Output current waveform





THD of current and voltage waveforms are 0.94% and 1.41% respectively.



CONCLUSION

The proposed model is implemented in matlab/ simulation and results are obtained. The MLI quadruples the low voltage solar panel, a constant dc voltage is obtained at dc link with the help of bidirectional converter. THD values of voltage and current waveforms are 1.41% &0.91% respectively. Rooftop solar PV installation with use of MLI offers less transmission losses with advancing technology, this practice is poised to become even more widespread in the future, shining as a bright spot in the new energy sector.

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