MAT JOURNALS
Journal of Power Electronics and Devices
Volume 4 Issue 2

Single Input Multi Output Switched Boost Inverter for Small Scale Solar Distributed Generation

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Abstract
This paper presents switched boost inverter for small scale roof top solar electric power generation. The traditional converter like buck or boost converter produces only dc output voltages and inverter only produces ac voltages. But proposed converter produces both ac and dc simultaneously from single input DC. With thisfeature SBI has more advantages compare to the conventional DC- AC or DC-DC converter. It also exhibits better electromagnetic interface when compare to conventional VSI. The size and switching losses are less. This is single stage power converter which produces both AC and DC voltages. With this feature of SBI it is used to supply the power to the grid and also we can store the power in the batteries for emergency power backup. SBI is simulated using MUTLISIM software and tested with hardware implementation.

Keywords:*Switched Boost Inverter, Distributed Generation, PWM Generation, Arduino*

INTRODUCTION

Solar power generation now a days is growing in size. There are many researches are done and continuously going on, to improve the performance and efficiency. Now the government is providing the subsidy to install the solar roof tops on the open Terrence. But voltage generated by the photo voltaic cell is not constant though out the days it depends upon the availability of solar rays. Therefore the output is low voltage, continuously varying from the solar cells. But it is clean and environmentally friendly source of energy. The output of PV cells unregulated low level dc. To make costumer participation in energy management, the system should provide some flexibility to them in order to produce ac or dc.The SBI converter should produces both ac and dc voltages, such that either it should connected to grid or can be used for battery storage. This is kind of converter which will produces both dc and ac voltage with single converter so that access power can be fed to the grid or power can be stored in batteries for emergency conditions. Hence SBI gives both dc and ac output simultaneously with single converter. It has advantages that compact size, low switching losses and reduced stress on the switches. This has more advantages compare the conventional ac-dc, dc-dc converters. The block diagram shows the operation of the switched boost inverter.

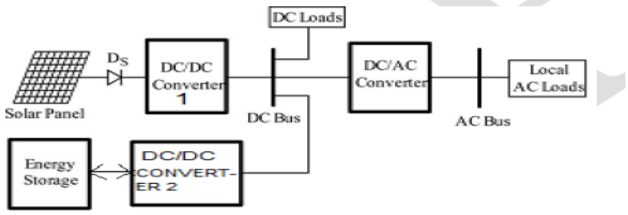


Fig. 1. *Schematic of PV cells with SBI conveter*

Fig.1 shows the schematic of a Photo Voltaic cells with SBI converter consisting of a solar panel as an energy source, a storage unit, and some dc and local ac loads. The diode is connected in series with the solar panel to avoid reverse power flow.The proposed Switched Boost Inerter uses PWM control technique. It also employed in the DC NANOGRID applications. The SBI is single stage power converter which provides both ac ad dc output with single dc input this the special characteristics of this converter

The concept of DC and AC micro grids are now playing important role in the power system because of distributed generation. This concept is implemented in 21st century power generation and utilization system. The advantages of micro gird are to minimizes the line losses and improve the stability of the system.The main advantages of micro grid are it operates in standalone mode. Because of this it is used to supply thepower to the remote located areas. The micro grids are usually specific to some utilities, here generation and loads are connected with low voltages to the consumers. In the past, there was single entity to control, now this traditional loop can be overcome. Nano-grid are the little micrograds, consistently serving a singular building or alone weight. Navigant research has developed its own specific significance of aNanogrid as being 100 kW for lattice tied systems and 5 kW for remotestructures not interconnected with a utility system.

Problem Formulation

As per the literature survey there are more advantages of SBI compare to the conventional power converter. Which will gives simultaneously two outputs DC and AC. DC voltages can be stored in the batteries as power back up under emergency conditions or to feed dc load and AC supply can be directly fed to the utility grid. Therefore problem formation is done to design and implement the switched boost inverter which will gives dual outputs simultaneously depending upon the type of the load with reduced switching losses.

METHODOLOGY

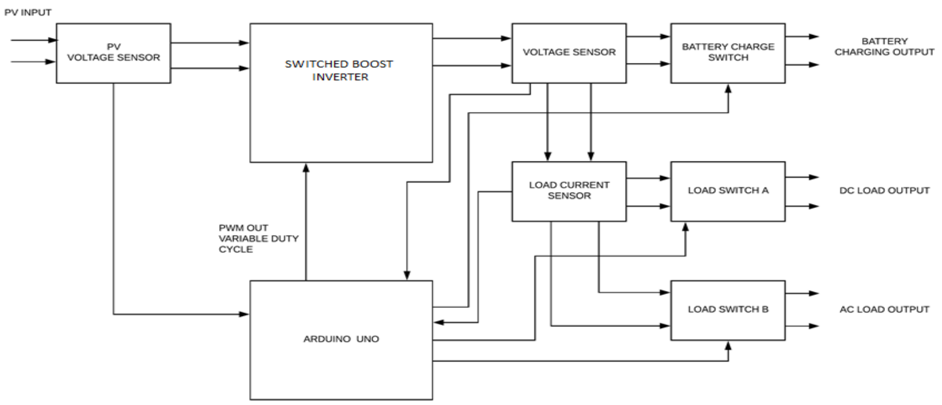


Fig.2: *Block Diagram of SBI*

The fig 2 shows proposed block diagram of switched boost inverter which is suitable for micro grid application. In solar power generation output voltage depends on the radiation of the sun rays. This converter provides constant boosted output voltage. Access Ac voltages can feed to the grid and dc voltages can be stored in the batteries form emergency power supply. The proposed SBI has following advantages

1. It generates PWM signal simultaneously for both converter and inverter switches.
2. Low electromagnetic interfaces and shoot through tolerance.
3. Low switching losses.
4. Compact design and high efficiency

Design and Working of SBI

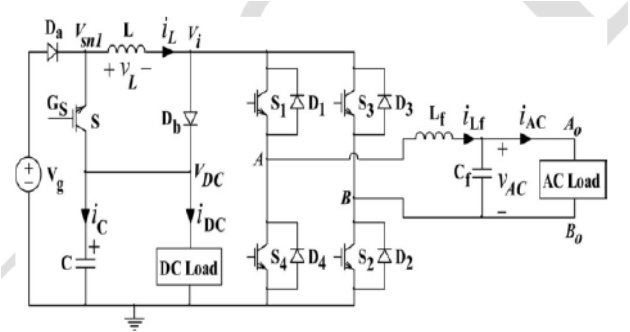
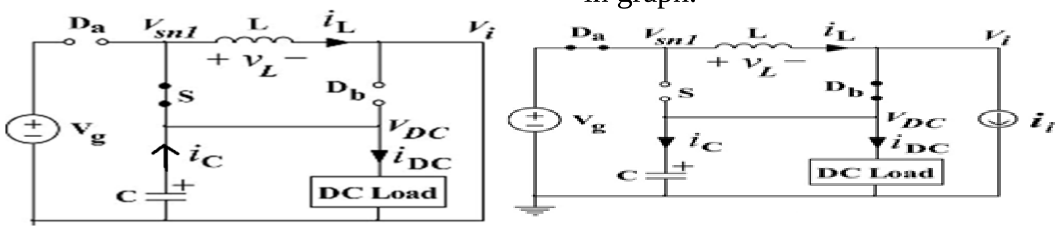


Fig. 3: *Circuit diagram of Switched Boost Inverter*

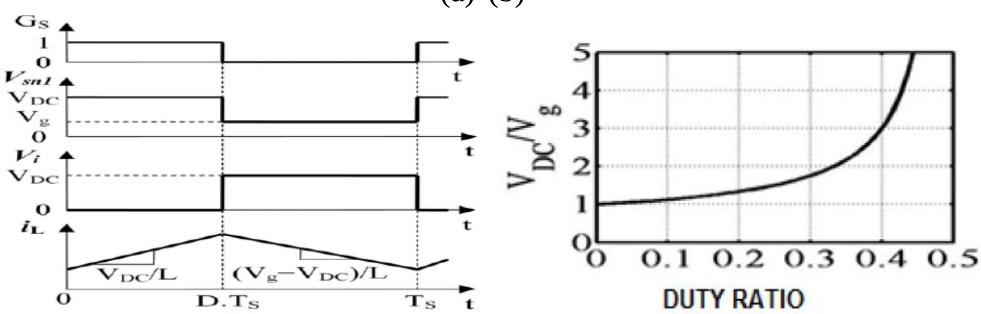
The fig.3 shows the circuit diagram of SBI. This consists of active switch for DC-DC conversion, inductor, and capacitor for filtering action. Two diode are used for avoid the reverse power flow. A low pass LC filter is connected across the output of the inverter bridge to filter the switching frequency components in the inverter output voltage. Here, the capacitor(c) connected between Vdc and ground acts as a dc bus for dc loads and, the capacitor (Cf) acts as an ac bus for ac local loads.

Operation of Switched Boost Inverter (SBI)

The operation is divided into 2 modes, when switch S is ON converter operates in shoot through mode, in this mode both diodesreverse biased. In this condition the capacitor charges through inductor L. when switch S is off the both diodes forward biases and converter operates in non shoot through mode, the inverter operates as current source. The variation of output voltage with the duty ratio is shown in graph.



(a) (b)

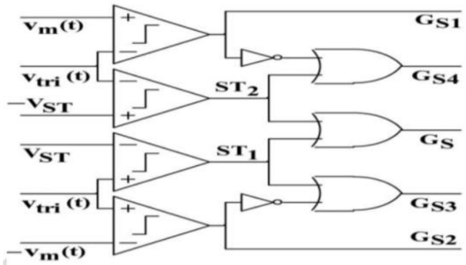


(c) (d)

Fig. 4. *(a) Equivalent circuit of SBI in D·TS interval. (b) Equivalent circuit of SBI in (1 – D) ·TS interval. (c) Steady-state waveforms. (d) Transfer (dc–dc) characteristics.*

PWM CONTROL OF SBI

The control technique for the SBI is sine-triangular PWM with unipolar switching. This control technique is as shown in fig.6, for both positive and negative half cycles.



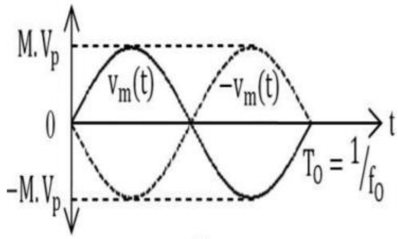


Fig.5 *Schematic of the PWM control circuit (t) > 0* ***Fig. 6 Sinusoidal*** *Modulation Signals*

Simulation of SBI

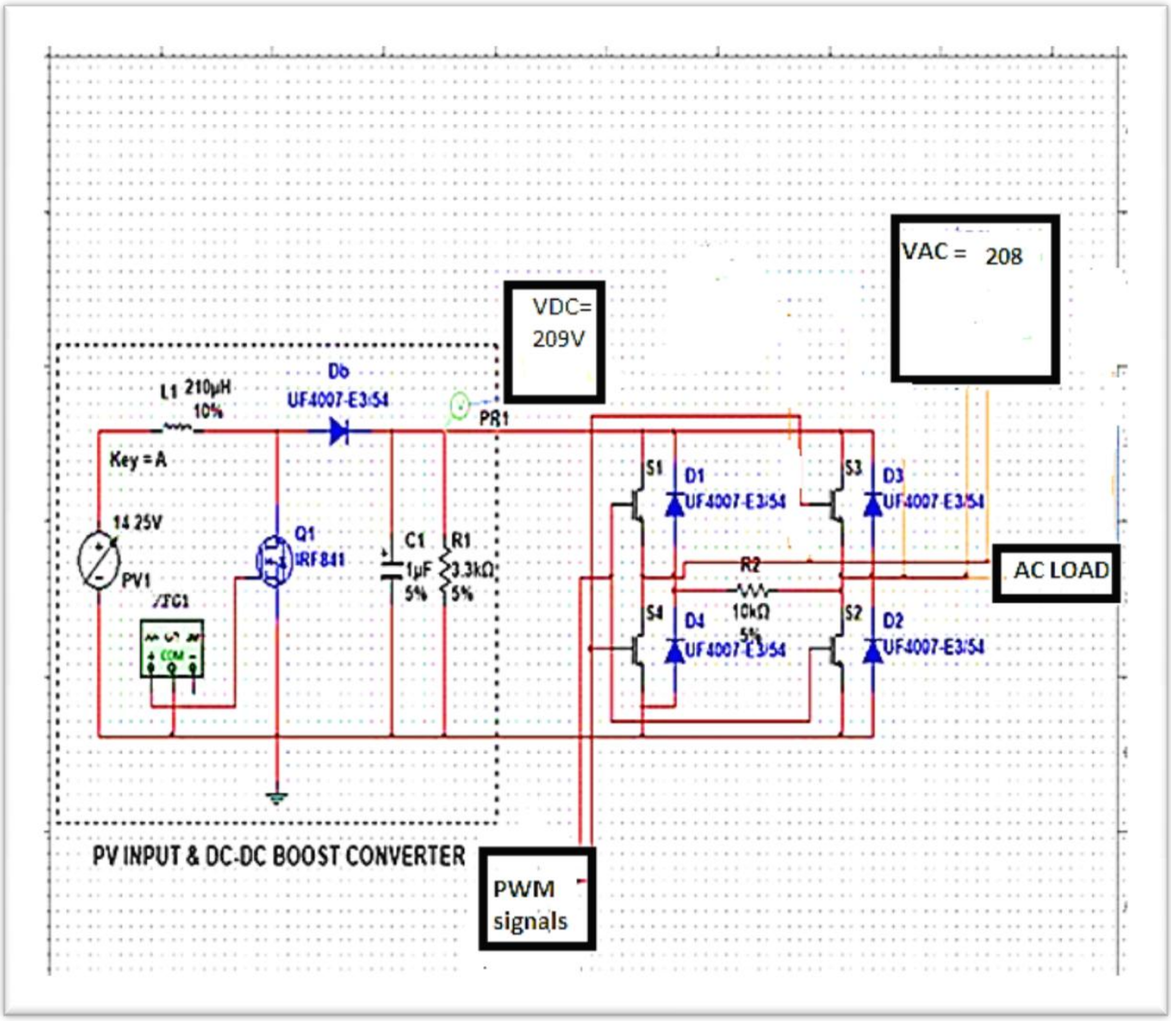


Fig.7 *Simulation circuit using MULTISIM*

The above simulation is done using MULTISIM software. The simulated results are
Dc input voltage = 12 Volts
Dc output voltage= 209Volts
Ac output voltage = 208.8 Volts

Outputs of PWM for Different Duty Cycle

Fig.8. Output With duty cycle 66.2%

Fig.9.Output With duty cycle 74.4%

Hardware Implementation

Rooftop and Installation Requirements

Rooftop installation require area which is exposed to sun radiation, in The sense the shadow-free area required for installation of a rooftop solar PV system is about 12 m^2 per kW (kilowatt). The solar plates are installed on the roof for 1KW output power. The approximate roof plates area $12m^2$. They are installed facing towards south with an angle of 25^0 to 30^0.For installation and maintenance considerable area is required. Noticeably 0.6m is required for cleaning and servicing in between 0.6m.Shading can be avoided by proper adjustment of rows. The placement of the inverter is done indoor only to avoid external interference.

System Components

A PV system which is connected to grid require following equipment.

- Array of PV cell
- Support structure for PV cell.
- Solar grid inverter
- System Protection devices
- Cables
- Solar PV System Capacity Sizing

The size of the PV plates should be more that energy consumption of the building. So that excess power is feed to the grid.
Assumption made for calculating the solar PV system size

1. Rooftop area and size of panels for 1KW power is $12m^2$.
2. Assuming the efficiency PV cells about 25%.

Following Steps involved in designing PV cells depending on the requirement.

1. Capacity = rooftop area in square meter/12.
2. Capacity= 120 % of annual energy consumption(KWh)/1500

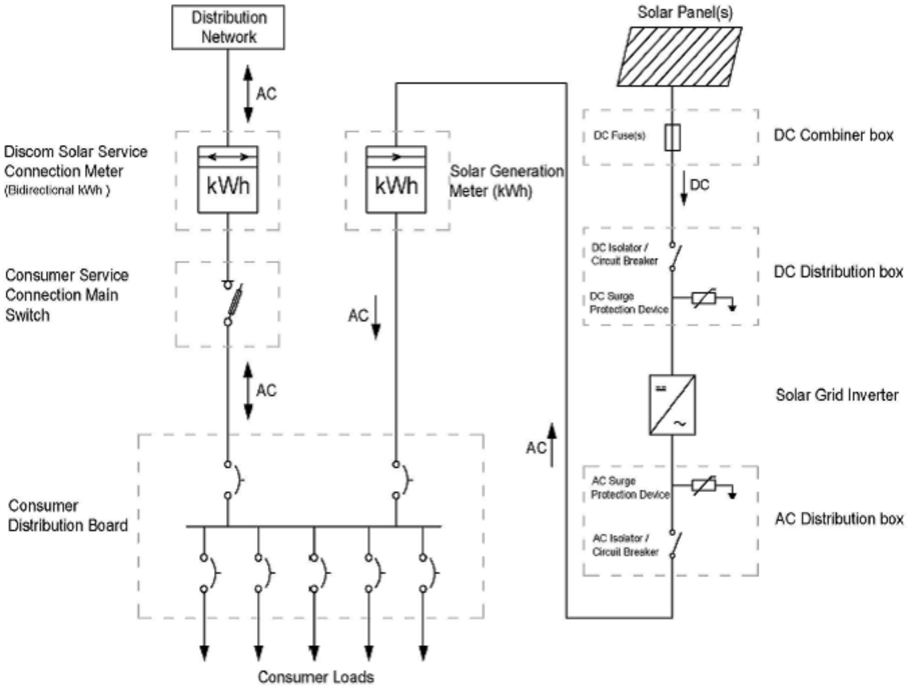


Fig.10 Schematic Wiring Diagram of micro Grid

RESULTS AND DISCUSSION

***Fig.11** hardware model of SBI with Solar Panel*

***Table.1** Hardware output*

Input	Output
12 V	180V (AC)
	220V (DC)

CONCLUSION

In this paper the concept of Switched boost inverter (SBI) is presented whichgives anAC and DC output voltages greater than that of the dc input voltage. Electro Magnetic Interference (EMI) noise immunity is very good compared conventional VSI, which produce the greater design improvements. The switching state will help in boosting of the output with reduced switching losses compare to conventional converter.The proposed converter system consumes has compact size, less cost and improved efficiency. Single source is used to supply multi system. The proposed is tested using MUTLISIM software and tested with hardware implementation.Thesystem had number of advantages if it is used with DC and AC Nano grid applications and backup power source.

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