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Switched Boost Inverter with Different Control Strategy

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ABSTRACT: Single-phase Z-source inverter and a single-phase switched boost inverter (SBI) both have same properties, but SBI has reduced voltage ripples and reduced passive elements. Both of the inverters are single-stage inverters are investigated and compared. For the same operating conditions, SBI has the following advantages over ZSI 1) three capacitors are saved; 2) input current is continuous 3) its boost factor is higher with an equivalent parasitic effect; and 4) its efficiency is higher. However, SBI has one more active switch and output voltage can be increased different control over the converter and inverter switches is analysed for avoiding unwanted short circuiting and this minimizes the EMI noise so that efficiency can be further increased. The simulation results is done in MATLAB 2014a and a prototype based on Arduino is built in order to verify the setup.

KEYWORDS: Z – Source Inverter, Voltage Source Inverter, Switched Boost Inverters, Shoot through.

I.INTRODUCTION

The current and emerging investigations on Z-source and SBI are presented in this paper. Inverters are the key devices in PV power systems, where traditional two-stage or single-stage inverter topologies are widely employed. The SBI in single-stage topology and overcomes the limits of traditional voltage source inverters (VSIs). Hence, Switched boost inverters (SBIs) have been proposed [4], in order to reduce the size, weight, and cost of power inverters, but the current drawn from the source is discontinuous. Advantages of SBI are boost factor is high, Lower voltage rating for the capacitor and the current drawn from the source in SBI is continuous. Conventional Inverter has boost factor is lower than that of ZSIs. While embedded SBIs[1] have the same features as ZSIs, with a shoot-through state that is used to boost the voltage, SBIs have one more active switch and a lower number of passive components than ZSI. The shoot through is the state at which switches inthe same leg of the inverter is turned on at the same time. Another major advantage of SBI when compared toZSI is that it can supply both dc and ac loads simultaneously from a single dc voltagesource. In SBI a different control strategy can also be appliedso that the boosting of voltage can be obtained without shoot through state and adiode can be reduced. The control to all the switches are given through non invertingdriver TLP2500 and the sinusoidal pwm strategy is used, so that the converterswitches reduces the number of states of turning on. Therefore the switching losses anbe reduced. The switching frequency of the converter switch is doubled as comparedto inverter switches. Therefore, the SBI topologies can replace the ZSI topologies inapplications such as for a micro-inverter, qSBI-cascaded multilevel inverter, etc.

II.OPERATING PRINCIPLES OF SWITCHED BOOST INVERTERS

Switched boost inverters (SBIs) have been proposed [4], in order to reduce the size, weight, and cost of power inverters, but the current drawn from the source is discontinuous. Advantages of embedded-type SBI are boost factor is high, Lower voltagerating for the capacitor and the current drawn from the source in SBI is continuous. Conventional Inverter has boost factor is lower than that of ZSIs. While SBIs have the same features as ZSIs, with a shoot-through state that is used to boost the voltage, SBIs have one more active switch and a lower number of passive components than ZSI. Another major advantage of SBI when compared to ZSI is that it can supply both dc and ac loads simultaneously from a single dc voltage source. A single input,two-output (one dc output and one ac output) power converter is possible in SBI. In SBI a different control strategies can also be applied so that the boosting of voltage can be obtained without shoot through state and a diode can be reduced. The circuit of this inverter is in Fig 1.

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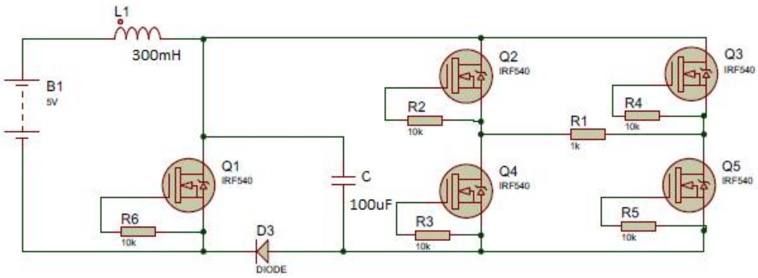

Fig. 1. Switched Boost Inverter

III.WORKING

The Switched Boost Inverter can b operated in two stages. During stage 1, the converter switch is turned on and during the second stage, the converter switch is turned off.

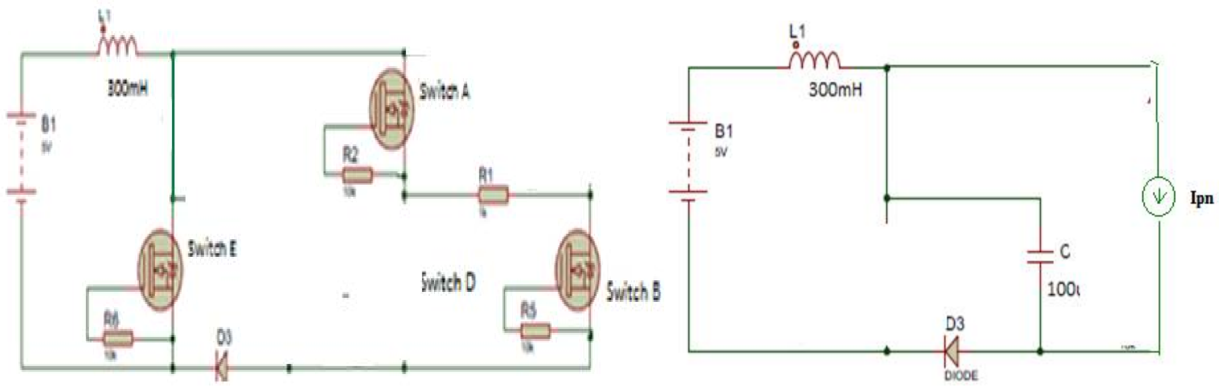

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Fig. 2 (a) Two complementary switches are on (b) No Switches are on

The switching frequency is taken as fs = 10kHz.. In SBI; a different control strategy in Figure 3can also be applied so thatthe boosting of voltage can be obtained without shoot through state [1] and a diode canbe reduced. Unwanted short circuiting can be avoided. The converter switch is operated depending on the states of the inverter switches.

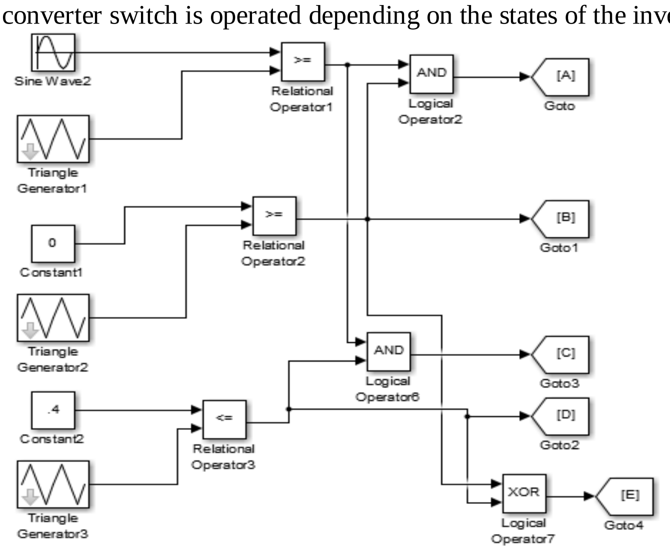

Fig. 3. Control strategy for SBI

The control circuit to the gate is shown in Fig 3to implement SBI system and Fig 4 shows the signals required and generated by this control circuit.The gate signals are generated by comparing the reference signal with a triangular carrier signal. The control to five switches A, B, C, D and E are fed through a non inverting gate driver TLP250. PWM controlled Converter switch turns on four times in a switching cycle. This leads to more losses as compared to sinusoidal pwm strategy as in Fig 3.

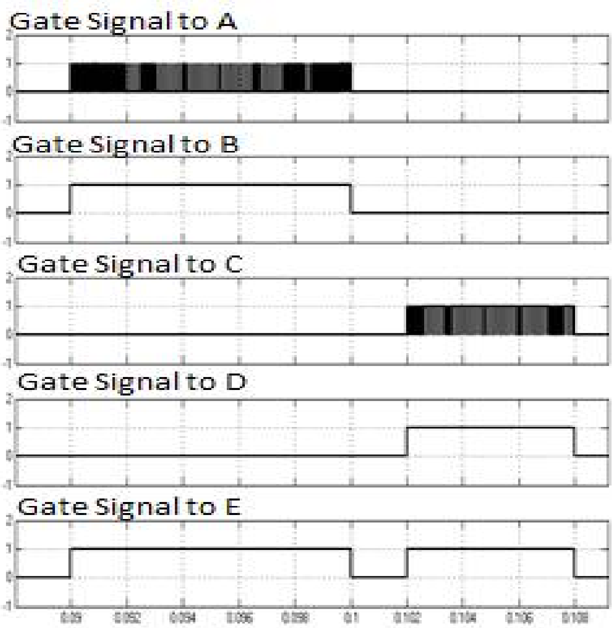

Fig. 4. Switching pulses for SBI

IV.SIMULATION AND EXPERIMENTAL RESULT

Simulation and experimental systems have been tested to verify the inverter working. Simulations are carried out by using MATLAB R2014A.Simulations are carried out for an input voltage of 5V. The switching frequency is selected as 10 kHz.

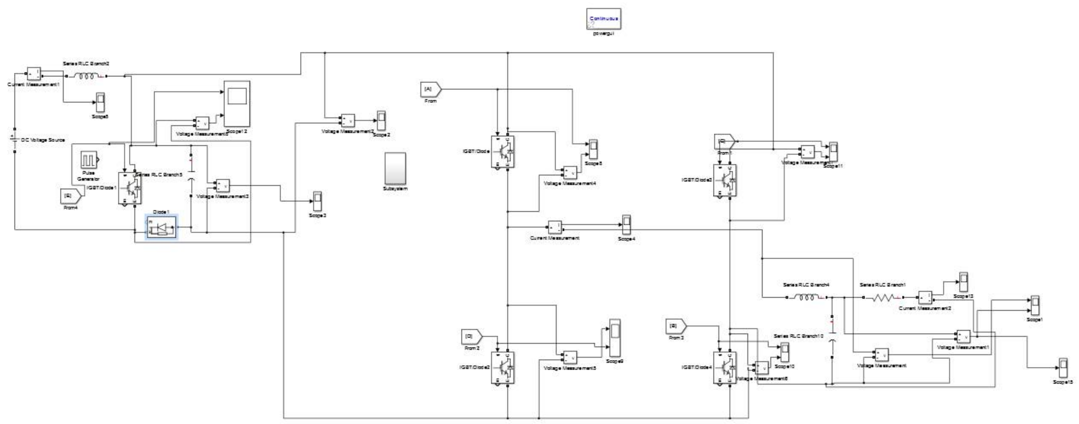

Fig. 5. SIMULINK Model of SBI

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A. DESIGNING OF COMPONENTS

(i) Design of Inductor

$$L = \frac{2(1-D)TV_{in}}{(b\%(1-2D)I_L} = 300uH$$

V_i = Input voltage=5V
D = Duty Ratio =0.4
V_o = Inductor Current=0.6A
b% = current ripple, 16%I_L

(ii) Design of Capacitor

$$C = \frac{T_S D\ (1-2D)I_L}{(2a\%V_o)} = 100\mu F$$

V_i = Input voltage=5V
D = Duty Ratio =0.4
V_o = Inductor Current=0.6A
a% = Voltage ripple, 0.1%I_L

COMPONENTS	VALUES
Input voltage	5V
Switching frequency	10kHz
Output Voltage	50V
Capacitor	100µF
Inductor	300 uH

Table 1.parameters of the SIMULINK model

B.SIMULATION RESULTS
Different results obtained from SIMULINK model is shown below.

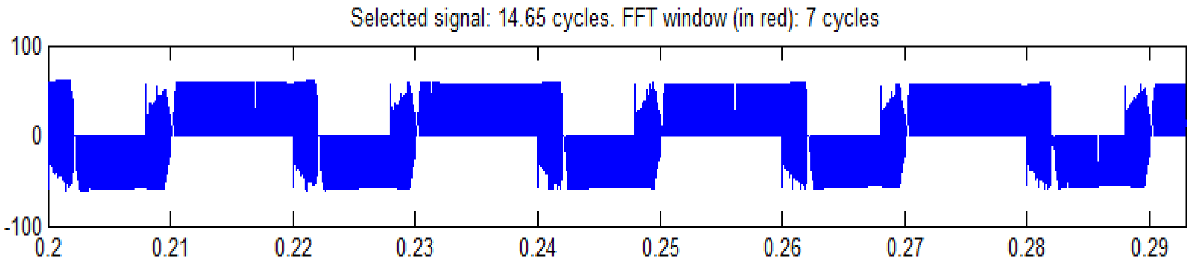

Fig.6. Inverter voltage of Single-phase embedded-type qSBI

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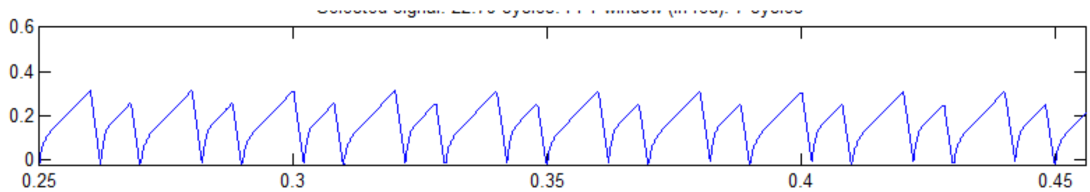

Fig. 7Input Current of SBI

The simulink model of Switched Boost Inverter with reduced number of diode and different control strategy. In this inverter the voltage is boosted by avoiding a shoot through. This avoids unwanted short circuiting and the input current is continuous.

C. HARDWARE SETUP

Experimental Setup of Switched Boost Inverter as done on dot board. It consist of supply section, driver section, converter section and inverter section.IRF540 is used as the power switch. Each consists a 10K resister across gate and source for reliable switching. Gate pulse is given through a 1K resister.

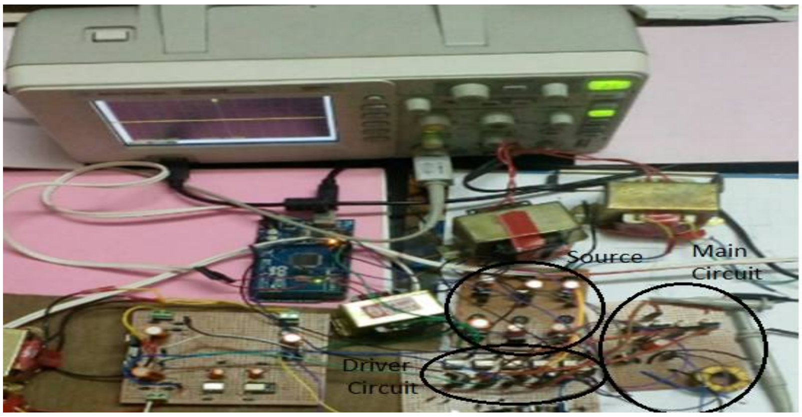

Fig. 12. Experiment setup

D. EXPERIMENTAL RESULTS

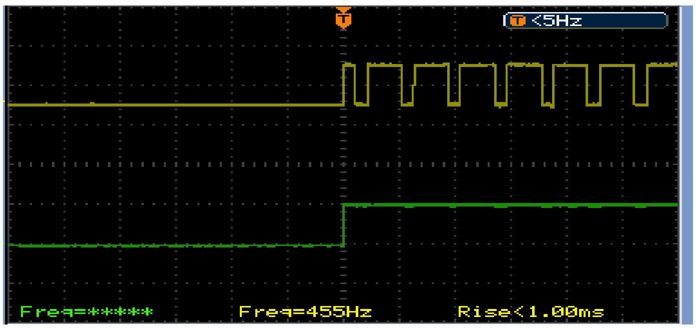

Fig. 8 (a)pulse for Switch A (b)pulse for Switch B

Fig 8 shows the gate pulses to switches SA and SB, gate Signal to A is sinusoidal pwm.

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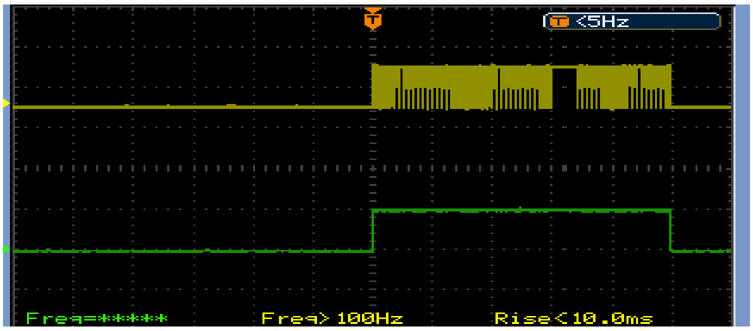

Fig. 9 (a)pulse for Switch C (b)pulse for Switch D

Fig 9 shows the gate pulses to switches S_C and S_D, gate Signal to C is sinusoidal pwm.

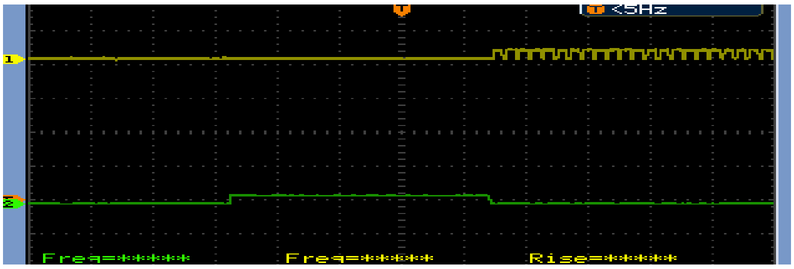

Fig. 10 (a)pulse for Switch D (b)pulse for Switch E

Fig 10 shows the gate pulses to switches S_D and S_E, gate signal to E is turned off before the switch D id turned on.

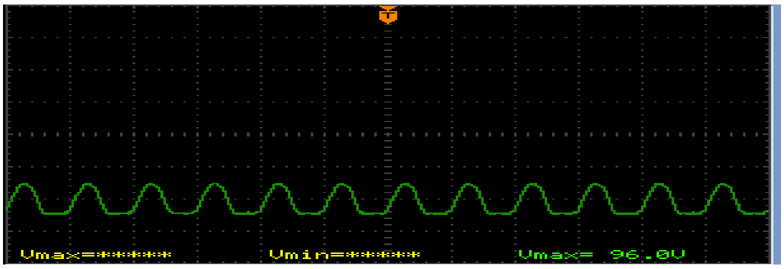

Fig. 11Converter Output for SBI

The converter output voltage and inverter output voltage of the Switched Boost Inverter is obtained as in Fig 11 and Fig 12 respectively.

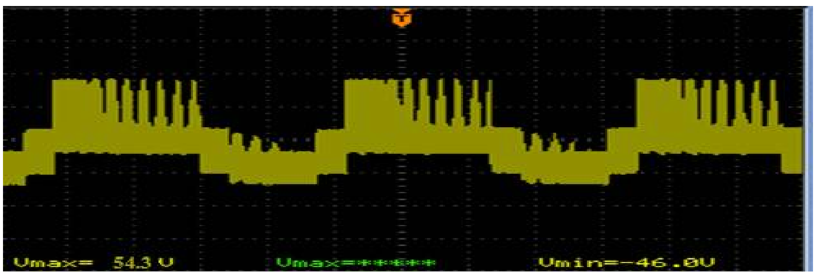

Fig. 12Inverter Output for SBI

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V.CONCLUSION

This project is based on the development and analysis of Inverters . Compared withpopularly used Z Source inverters, SBI has more same characteristics but less numberof passive elements. DC and AC outputs can be obtained from a single stage input. Forthe hardware section, switching signals generated is using Audrino mega2560 modulefor inverter section and driver IC used is TLP250. For an input voltage of 5 V anoutput voltage of 50 V is obtained by using the converter and inverter module converts. Different control strategies are proposed using MATLAB/SIMULINK 2014a. TheTHD was found to be 3:95 % . A prototype of inverter and converter section is testedand results are experimentaly verified. In Future the topology can be extended todecrease in dead time in SBI in with no shoot through state.

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