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A THREE SWITCH- SINGLE PHASE SWITCHED COUPLED INDUCTOR INVERTER FOR BATTERY FED SYSTEMS

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ABSTRACT: Anovel single phase inverter configuration with an integrated switched coupled inductor that offers a better boost inversion ration and lesser device stress is presented. The performance of the circuit is compared with the conventional single phase H – bridge, two legged voltage source inverter and the same full bridge topology with a DC – DC boost converter inserted in between the source and the inverter side.Simulation results conclude that the inverter circuit has the advantages of having a higher voltage gain and lower voltage harmonic pollution. The presented circuit shares a common ground for source and load side unlike its counterparts; hence the leakage current problem is nullified. As an additional asset the numbers of switches used are also minimal. An experimental hardware prototype is developed for the three- switch, switched coupled inductor inverter, which is fed by a 12 V battery source to verify the results.

Index Terms: boost inversion ratio, device stress, inverter, modulation scheme, magnetic integration, switched coupled inductor.

INTRODUCTION

Inverter topologies are wide and vast ranging from a simple and common voltage/current source inverter to the very recent advancements in multi- level inverters. A conventional single phase VSI acts in buck mode and as a consequence, higher gain ration is not possible [1]-[4]. This drawback can be overcome by including a boost circuit in between the input source and the inverter, but there should be a different ground for input and output. A compromise can be achieved by adopting Z source inverters i.e., current fed Z- source or quasi Z – source or three switch three state Z source inverters.[5]-[12] The proposed circuit almost resembles the three state three switch inverter topology with three switches, three capacitors and three inductors [7]. But the distinction lies in the fact that the three inductors are coupled onto the same core thus forming a switched coupled inductor inverter. [6].

1. THREE SWITCH SWITCHED COUPLED INDUCTOR INVERTER

Fig.3 shows the schematic diagram of the proposed three switch single phase coupled inductor inverter. The inductors L_1 and L_2 are coupled with 1: n turns ratio and all the four inductors can be coupled together onto a single magnetic core [14] [1]. Hence the volume and size of the inverter is greatly reduced unlike the three state three- switch Z source inverter topology. The added 1: n coupled inductor contributes to the increase of voltage gain [6] [13]. The inductor pair also acts like a current limiter. There are two modes for a switching cycle, one in which S_1 and S_X are turned ON (S_2 OFF) and the other mode in which S_2 is turned ON (S_1 and S_X are OFF) [1]. Fig. 4 shows the modulation scheme for pulse signal generation of the three switches of the proposed inverter. Given below is the mathematical representation of the V_{Ref} (Reference/ Modulating Voltage).

$$V_{Ref} = \frac{n+1}{2n+3-M\sin\omega t}, (0 \leq M \leq n+2) \quad (1)$$

M − Modulation index

Triangular carrier is chosen and 1 and 3 are selected to be the values of nand Mrespectively.

The voltage gain for the full bridge inverter and the proposed circuit are given by the following expressions.

$$\frac{V_0}{V_{in}} = \frac{2D-1}{D} \quad (2)$$

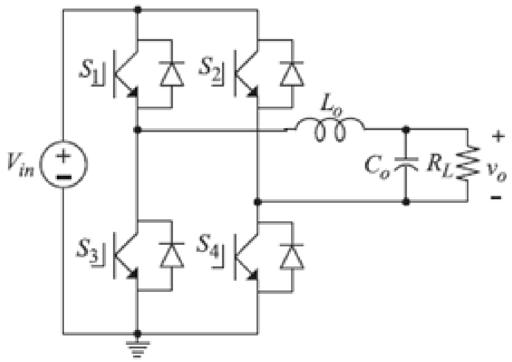

Fig. 1. A conventional VSI

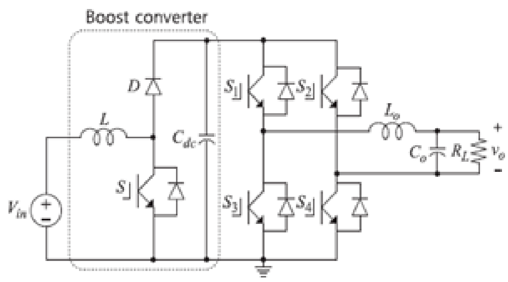

Fig. 2. A conventional VSI with a boost circuit.

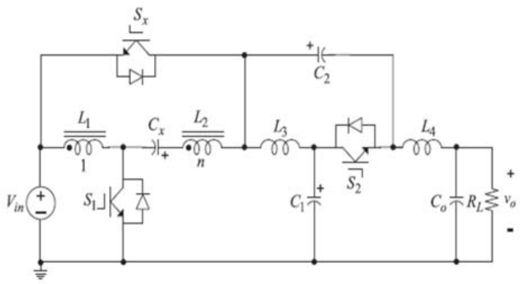

Fig. 3. Three- switch switched coupled inductor inverter

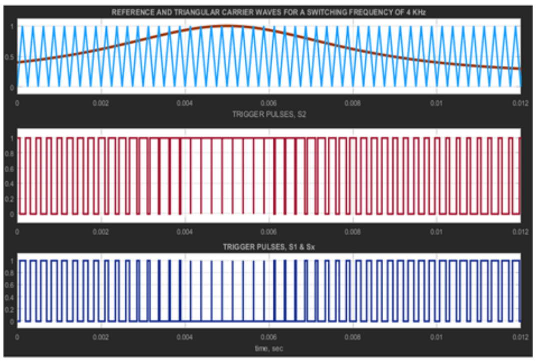

Fig. 4. Modulation Scheme

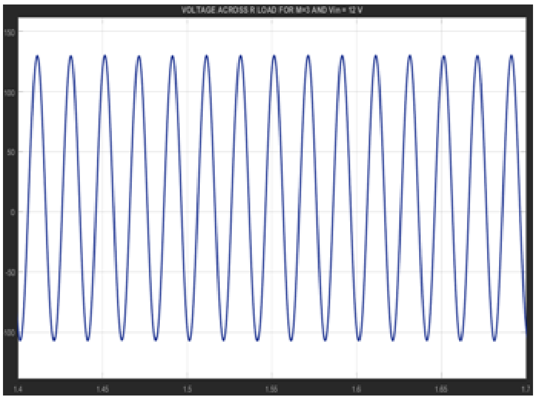

Fig. 5. Voltage across resistive load

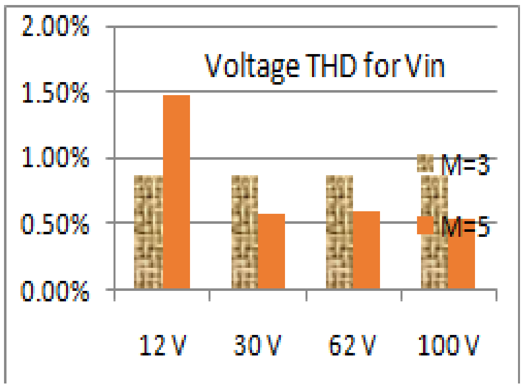

Fig. 6. Voltage THD Comparison

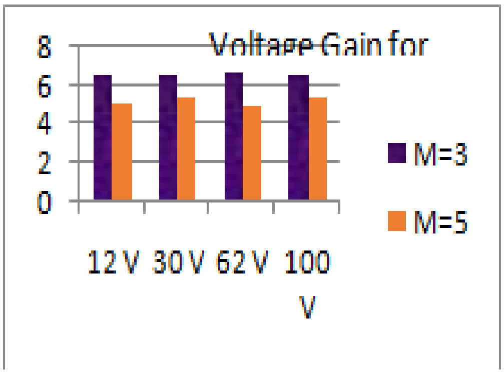

Fig. 7. Voltage gain comparison

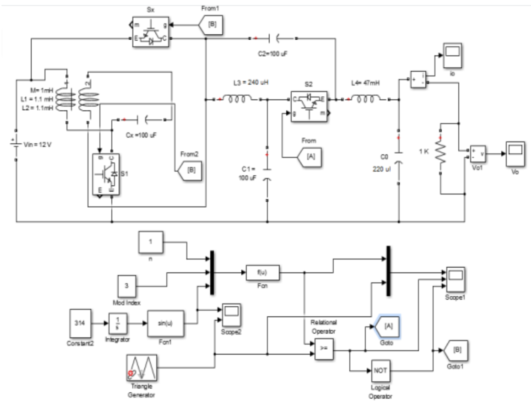

Fig. 8. Simulink model of the inverter circuit

$$\frac{V_0}{V_{in}} = \frac{(2n+3)(2D-1)+1}{2D} \leq n+2 \quad (3)$$

2. EXPERIMENTAL PROTOTYPE

The hardware prototype of the proposed inverter consists of the main, control and driver circuitry (Fig. 9). A 12 V rated battery as the DC source, the three numbers of switches, inductors and capacitors form part of the main circuit. The driver circuit in conjunction with the control circuit provides the necessary trigger pulses to the switches. A LC filter is used at the output stage to filter out the ripples. The load is a simple resistive load of 22 K 10 W rating.The voltage gain is found to be at least 4 times that of the given input thus validating the simulation.

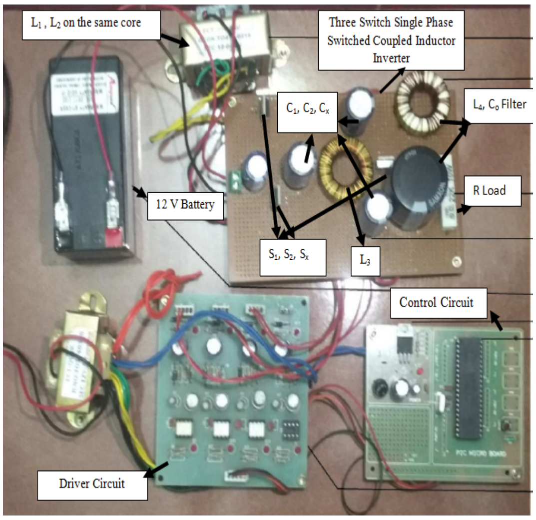

Fig. 9. Experimental hardware prototype

3. CONCLUSION

A three – switch single phase switched coupled inductor inverter's performance in terms of voltage gain, modulation index and voltage THD is presented as part of this article. From the simulation results it is inferred that voltage gain greater than 3 can be achieved for the presented circuit in comparison with a conventional VSI and a boost converter included VSI. It is also understood that with a higher value of modulation index, M= 5, the voltage THD is a slightly reduced percentile and voltage gain is at a higher. A hardware prototype is also developed to validate the simulation results.

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