A New Single-Phase Switched-Coupled-Inductor DC–AC Inverter for Photovoltaic Systems

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Abstract:

This paper displays another single-stage switched coupled- inductor dc– air conditioning inverter highlighting higher voltage pick up than the current single-stage qZ-source and semi-Z-source inverters. Like the single-stage qZ-source and semi-Z-source inverters, the proposed inverter additionally has regular grounds between the dc information and air conditioning yield voltages, which is valuable particularly for photovoltaic inverter frameworks. The inverter volume and most extreme current streaming can be diminished fundamentally through the coupling everything being equal. A hypothetical examination of the proposed inverter is depicted and a 280-W trial model is worked to confirm the execution of the inverter.

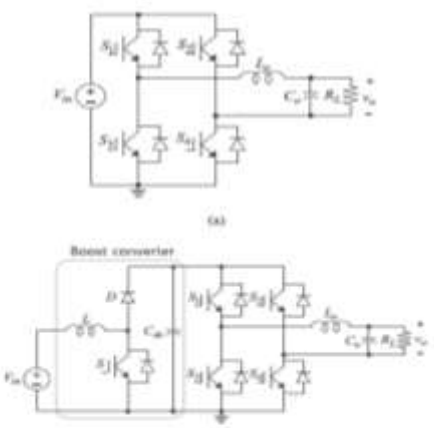
Keywords: Common ground, dc–ac inverter, high voltage gain, qZ-source inverter, single-phase inverter, switched-coupled-inductor (SCL), Z-source inverter.

I. INTRODUCTION

NOWADAYS, there's an growing call for for low-price unmarried-section dc–ac inverters in lots of applications inclusive of photovoltaic (PV), fuel cellular, and Battery powered structures. The traditional techniques complete-bridge (FB) inverter called greenback inverter in this paper. In this circuit, the inverter output voltage (vo) cannot be greater than input voltage (Vin). When the enter voltage is low, a boost dc–dc converter is inserted between Vin and the inverter bridge. However, the two topologies have distinct enter and output grounds. This may additionally bring about big leakage cutting-edge in applications which includes transformer-less grid-tied PV inverter, a good way to purpose safety and electromagnetic interference trouble. In order to conquer the hazards of the conventional inverters, a big wide variety of single-degree inverters are proposed . In addition, the Z-supply inverter topologies overcome the restrictions stated earlier. Indicates the present day-fed (CF) single-phase qZ-supply inverter , and is the semi-qZ-source inverter,

Fig. 1. Conventional single-phase inverters. (a) FB inverter. (b) FB inverter with dc–dc boost converter

The progressed version had both the inverters have the equal voltage advantage as shown below and require most effective lively switches to reap the same maximum voltage advantage as the FB inverter



$v_o \; V_{in} = 2D - 1D$. (1)

In (1), D is defined because the duty ratio of switch S2 . The two topologies percentage not unusual grounds between Vin and vo , consequently they are able to minimize the feasible floor leakage modern-day trouble correctly whilst they may be used for PV inverter. However, as depicted, their manageable most voltage gain is restricted to 1, this means that that they may be now not suitable for applications wherein enter voltage is low. In order to conquer the limitations while retaining the doubly floor features, a three-switch 3-country single-phase Z-source inverter (TSTS-ZSI) became delivered in the raise-primarily based TSTS-ZSI and greenback-boostbased TSTS-ZSI, respectively. The inverters could have better voltage benefit than 1, and they include three switches, 3 capacitors, and 3 inductors.

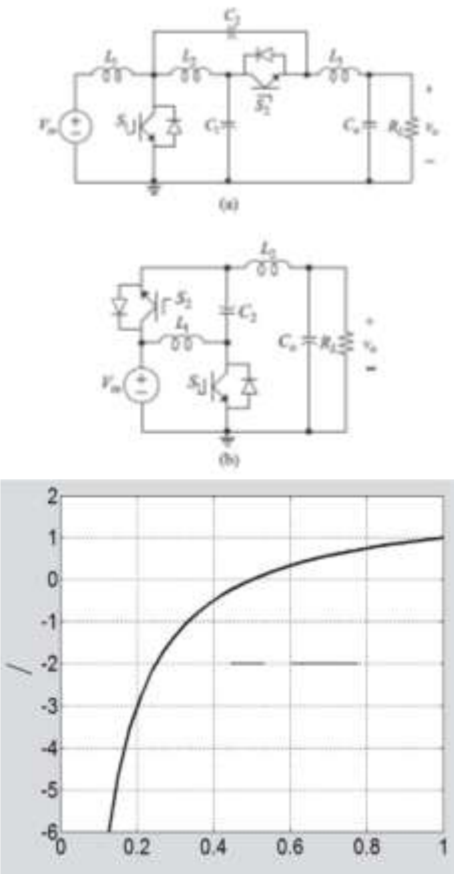


Fig. 2. Single-phase qZ-source inverters. (a) Single-phase CF-qZ-source inverter. (b) Semi-qZ-source inverter. (c) Voltage gain.

Although better voltage gain is acquired, the three inductors (L1, L2 , and L3) within the TSTS-ZSI make the circuit a chunk bulky and heavy. In addition, the transfer indicators of the inverter are all unique and relatively complex. In this paper, a unmarried-section switched-coupled-inductor dc– ac inverter is proposed. Similar to the TSTS-ZSIs, the proposed inverter can obtain higher voltage benefit than the circuits and keeps equal ground between Vin and vo. The proposed inverter also calls for 3 lively switches, but all of the inductors inside the circuit can be coupled together, as a way to lead to more compact and price effective answer than the TSTS-ZSI. In addition, the transfer sign generation is pretty simpler than the TSTS-ZSI. A 280-W prototype inverter is built and its performances are confirmed via test.

II. OPERATION PRINCIPLE OF THE PROPOSED DC–AC INVERTER

The proposed inverter and it takes comparable shape with the single-phase CF-qZ-inverter .Compared with, the proposed inverter has an extra switch (Sx), capacitor (Cx), and inductor (L2) coupled with inductor L1 . The inductors L1 and L2 are coupled with 1 : n turns ratio and all of the inductors within the proposed topology can be coupled altogether as can be mentioned. The brought 1 : n coupled inductor contributes to the increase of voltage gain.

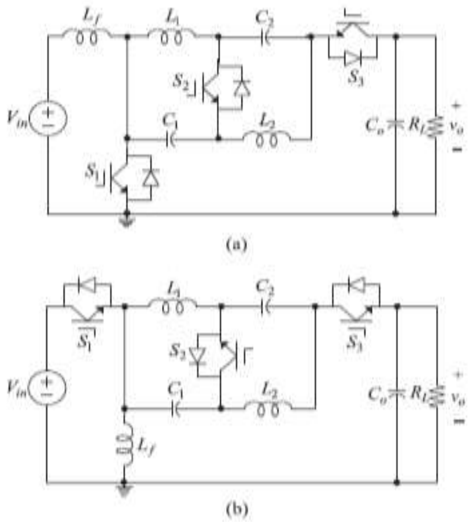
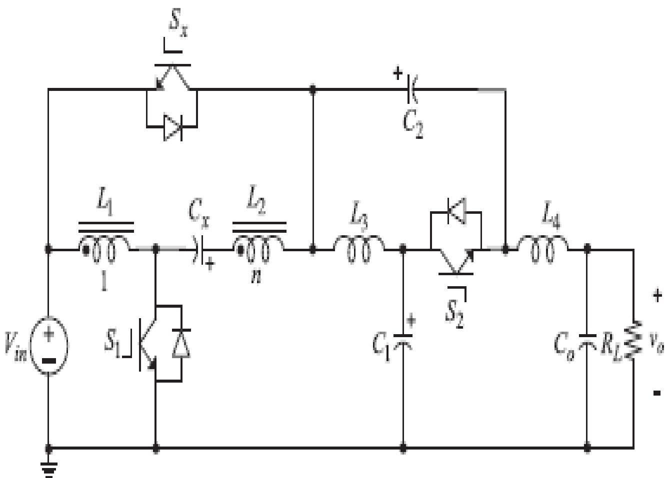


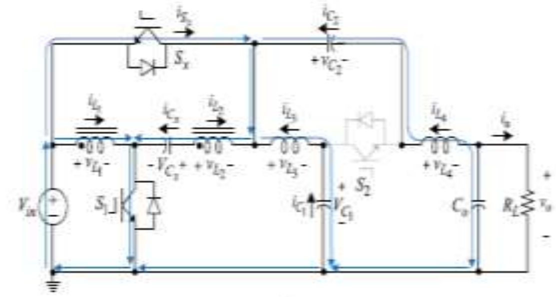
Fig.3. Three-switch TSTS-ZSI . (a) Boost-based TSTS-ZSI.
(b) Buck-boost-based TSTS-ZSI.



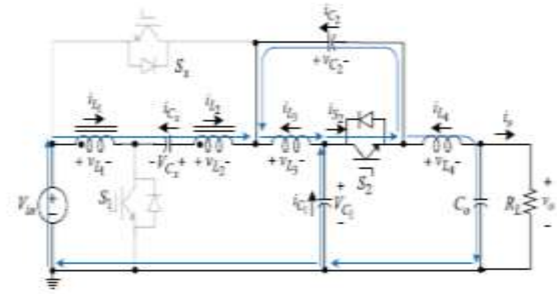
Although the leakage inductance of the coupled inductor may additionally induce a voltage spike throughout transfer S1, this is not a major problem due to the fact any such voltage spike and the voltage of S1 are low. It will likely be located that the voltage stress of S1 is always 1/2 of S2 or Sx if leakage inductance is not taken into consideration. Therefore, so long as the voltage overshoot caused by the leakage inductance isn't always so high, the voltage stress of S1 could be less than that of S2 and there isn't an awful lot trouble in choosing switching tool for S1 . On the other hand, the leakage inductance is beneficial in restricting the modern passing through Cx . Switches S1 and S2 are complementary as inside the unmarried-phase qZ-supply inverter and the switch Sx is synchronized with S1 .

A. Mode Analysis of the Proposed Inverter

The working principle operation of the proposed inverter and there are two operational modes during one switching cycle. In mode 1, switches $S1$ and Sx are turned-ON, and $S2$ is turned-OFF. In mode 2, switches $S1$ and Sx are turned-OFF, and $S2$ is turned-ON. Followings are the detailed mode analysis of the proposed inverter. In mode 1, the capacitor Cx is charged to $(n + 1)V\text{in}$. Since the Cx is being charged and discharged during one switching.



(a)



Mode analysis of the proposed inverter. (a) Mode 1: $S1$ and Sx are ON, and $S2$ is OFF. (b) Mode 2: $S1$ and Sx are OFF, and $S2$ is ON.

Period, its voltage has ripple and the ripple voltage depends on the output power [18]–[20]. Therefore, when the voltage difference between $(n + 1)V\text{in}$ and Cx is high, relatively high surge (charging) current will flow through $V\text{in} - Dx$ (Sx) $- L2 - Cx - S1$ and the switching devices in this path (Sx and $S1$) can be damaged. In order to limit the high surge current, a current limiting inductor is necessary. In this paper, the leakage inductance generated by the coupling of $L1$ and $L2$ serves as the current limiting inductor. From Fig. 5(a), the voltage and current relations in mode 1 are derived as $VCx = V\text{in} + vL2 = (n + 1)V\text{in}$ (2)

$vL1 = V\text{in}$

$vL3 = V\text{in} - VC1$

$vL4 = V\text{in} - vC2 - vo$

$iC1 = iL3$

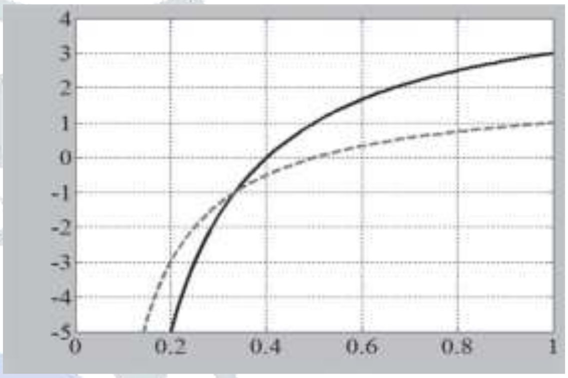
$iC2 = iL4$

$iCx = i\text{in} - iL1 + iL3 + iL4$

. (4)

In mode 2, capacitor Cx is discharged by the inductor current, $iL1$. From Fig. 5(b), the voltage and current relations in mode 2 are derived as follows:

$(1 + n)vL1 = V\text{in} + VCx - vC2 - VC1$ $vL3 = vC2$ $vL4 = VC1 - vo$



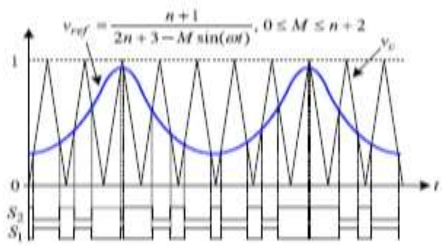


Fig 7. Gate signal generation of the proposed inverter.

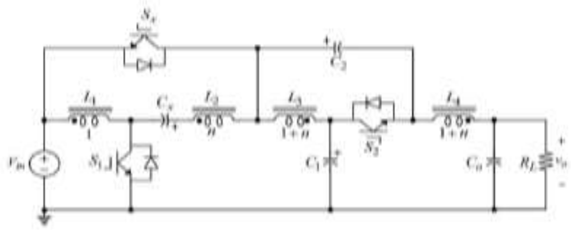


Fig.4:Circuit topology of the proposed inverter when all inductors are coupled into one core

CONCLUSION

In this paper, the single-phase switched coupled inductor dc–ac inverter turned into supplied. It has an operation principle similar to that of a single-section qZ-source inverter. With the addition of additives Sx , Cx , and the coupled inductor, voltage advantage of the proposed inverter may be extended to extra than 2. The magnetic integration of all inductors decreases the converter volume notably and the proposed inverter has pretty simple gate signal technology. Moreover, similar to the single-phase qZ source inverter and the TSTS-ZSI, the proposed inverter shares commonplace grounds among the dc enter and the ac output voltage. A 280-W prototype inverter emerge as built and tested to verify operation of the proposed inverter.

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