Single Phase Z Source Half Bridge Inverter

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***Abstract*—The novel Single phase Z source half bridge inverter is presented as applying Z network in the half bridge inverter.The inverter can convert dc to ac.The proposed converter can solve limited voltage and shoot through problem.By using the Z network voltage source converter in the main circuit can be used as current source and vice versa.The proposed converter can solve the midpoint balance of the input capacitors.By using the Z source half bridge inverter it can improve the voltage as compared to the conventional half bridge inverter.The z network can overcome the disadvantage of voltage source inverter and the current source inverter.The Z network can be applied to dc-dc,dc-ac,ac-ac and ac-dc.The Z source half bridge inverter is working in the duty ratio of 1.2.It is a special case and it can act as buck boost converter by interchanging the duties of the switches. The proposed inverter is increases the efficiency. Total harmonics distortion in conventional half bridge inverter and the single phase z source half bridge inverter is 7.03% and 0.88% respectively.The proposed converter is simulated using MATLAB/Simulink.**

Keywords-Half Bridge Inverter,MATLAB/Simulink,THD,Z network

I. INTRODUCTION

Inverter is used to convert dc to ac.In single phase half-bridge converters have their switches in series,[1] as shown in Fig. 1. Here shoot-through can occur which means that when a strong current flowing through the switches in the same leg makes them break down. Also, the ac output voltage is less than the dc voltage, which is called as the limited voltage problem, since, in practice, ac output voltage is sometimes required to be higher than the dc voltage. Still, an unbalanced midpoint ofinput capacitors in conventional half-bridge converters leads to large ripples.Thismaking the system unstable.

In order to overcome the disadvantages of voltage source inverter(VSI) and the current source inverter(CSI),Z network is proposed [2].It can act as buck boost converter,voltage source inverter in the main circuit can be interchanged to current source and vice versa.

The recently developed new inverter is Z-source inverter. It can produce any preferred output ac voltage, even better than the line voltage, irrespective of the input voltage, improves the reliability of the inverter greatly because the shoot-through states that might be caused by EMI noise can no longer destroy the inverter, and reduce the in-rush current and harmonics in the current owing to the Z-source network. Furthermore it can solve the unbalanced midpoint voltage problem.

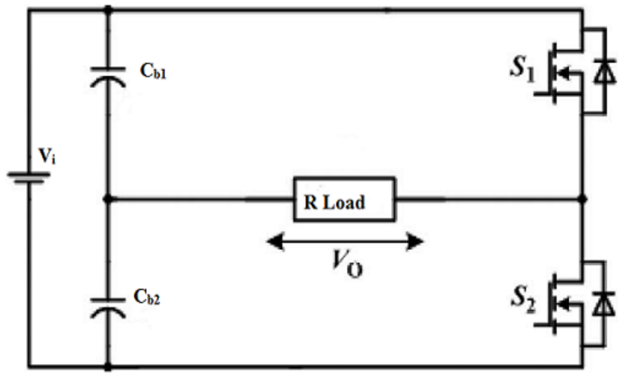

Fig.1 Conventional Half Bridge Inverter

II. EQUIVALENT CIRCUIT

Fig.2. Consisting of single phase z source half bridge inverter [3].The diode *D* is used to prevent the current from flowing backto the source. The inductors is used in the Z-networkis to eliminate strong current, when the switches are inthe shoot-through state.

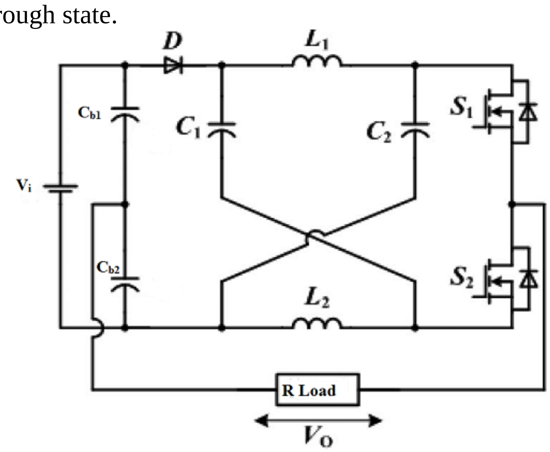

Fig.2 Proposed Inverter

The following conditions are assumed for simplicity
1) Entire components in the circuit are ideal
2) The dead time in the driving pulses is ignored
3) $C1 = C2$ and $L1 = L2$ in the Z-network
4) $C1$, $C2$, $Cb1$, and $Cb2$ has large value
5) The freewheeling diodes present in the switches are ignored.

III. MODES OF OPERATIONS

Duties of the switch $S_1$and S_2 by d_1 and d_2.

Case; $d_1+d_2>1$
There are three modes ofoperations.The switching period T.
T_0 as the beginning of one period.
T_1 as mode of transition instant from mode1 to mode2.
$T_1=T_0+\{d_2+d_1-1\}T$
T_2 as the mode of transition instant from mode2 to mode3
$T_2=T_1+\{1-d_2\}T$
T_3 as the end of the period.
$T_3=T$

Mode1;T€[T_0,T_1]

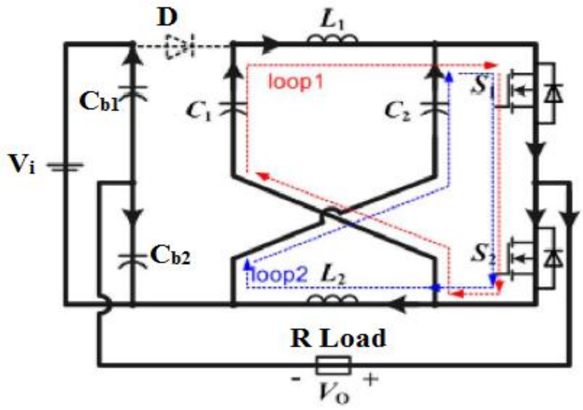

Fig.3 Equivalent Circuit For S_1ON And S_2ON

From Fig.3,In the loop1 C_1 discharges the energy to the L_1, then I_{L1} increases $V_{c1}=V_{L1}$ (1)[3].
the loop2 C_2discharges the energy to the L_2,then I_{L2}increase, then $V_{c2}=V_{L2}$ (2)

The voltage across the diode V_D is negative because the anode voltage is less than the cathode voltage.

$V_D=-\{V_{c1}+V_{c2}-V_i\}$

The energy of C_2 is delivered to R load and C_{b2} through theloop C_2-R-C_{m2}.Therefore, C_{b2} charges and C_{b1} discharges.

Output voltage,$V_0=V_{c2}-V_{cb2}$(3)

Mode2;T€[T_1,T_2]
As shown in Fig.4 $S_1$is ON,S_2 is OFF. In the loop1 V_{in} and L_1 discharges the energy to the C_2.
$V_{c2}=V_i-V_{L1}$(4)
The energy of C_2 is delivered to the load R and C_{b2}through the loopC_2-R-C_{b2}. Therefore,C_{b2} charges and C_{b1}discharges.
Output voltage,
$V_0=V_{c2}-V_{cb2}$

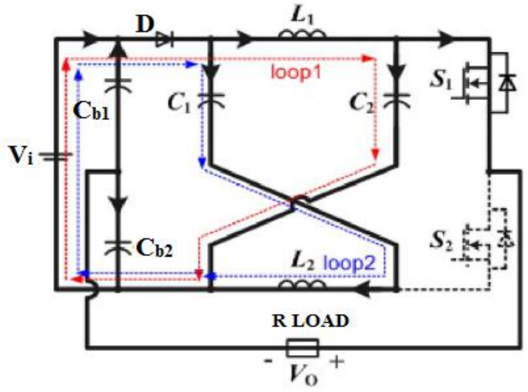

Fig.4Equivalent Circuit for S_1ON And S_2OFF

Mode3;T€[T_2,T_3]

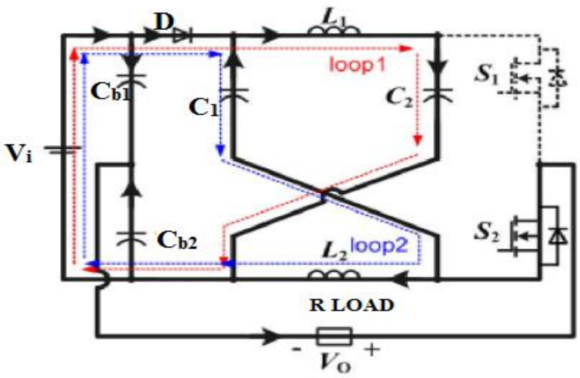

Fig.5 Equivalent Circuit For S_1 OFF And S_2 ON

Fig.5 consist of S_1 is OFF,$S_2$is ON. In the loop1 V_i and L_1discharges the energy to C_2.$V_{c2}=V_i-V_{L1}$

In loop2 V_i and L_2 discharges the energy to the C_1.The energy of L_2 and C_{b2}delivered to load R.So C_{b1} charges and C_{b2} is discharges.

From the loop V_{in}-D_1-C_1-R-C_{m2},the output voltage is
$V_0=V_i-V_{c1}-V_{cb2}$ (5)
$V_{c1}=V_{c2}=\{2-d_1-d_2\}V_i /\{3-2\{d_1+d_2\}\}$ (7)
$V_{cb2}=\{2V_{c2}-V_i\}d_1-V_{c2}+V_i$ (8)

When d_1=0.5 the proposed converter act as the single phase inverter but it exceed the output voltage (V_{in}/2 and –V_{in}/2)than the conventional one[3].

IV. Simulation Result

TABLE1.Simulation parameters and values

Parameters	Values
V_i	40V
X_c%	0.00048
X_L%	0.699
R	10Ω
L_1,L_2	100µH
C_1,C_2,C_{b1},C_{b2}	470µF

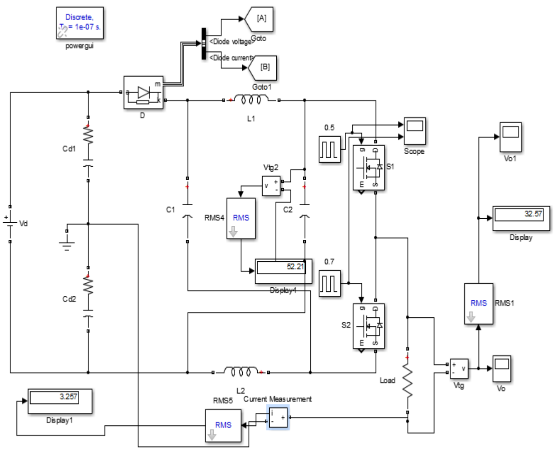

Fig.6 SimulationFor S_1=0.5 and S_2=0.7

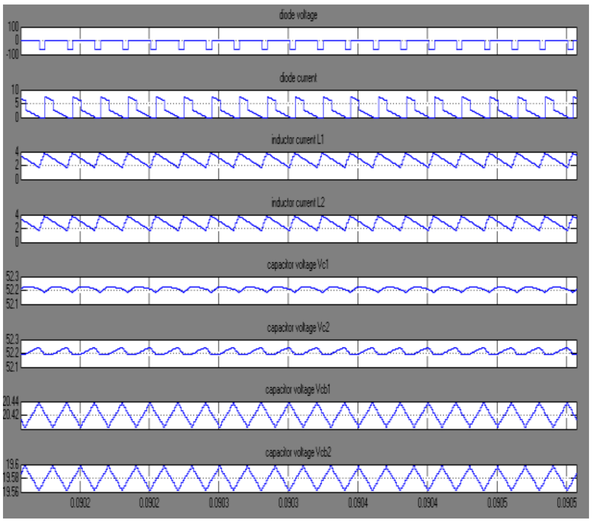

Fig.7 Simulation Results

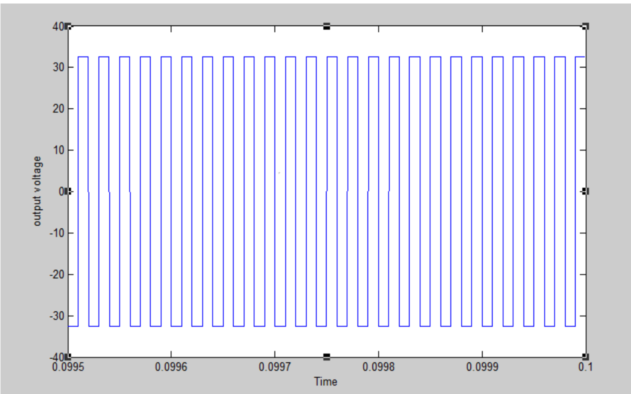

Fig.8 Simulated Output Voltage Waveform

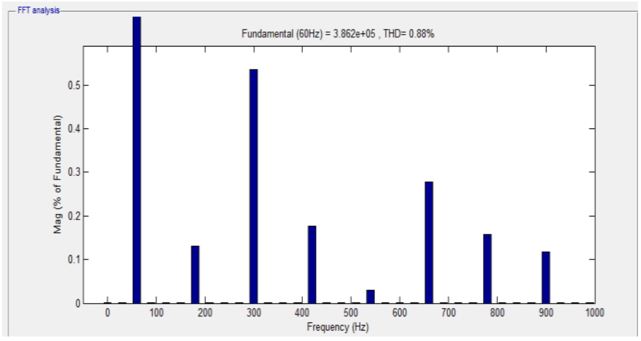

Fig.9 Frequency Domain Response Of Inverter

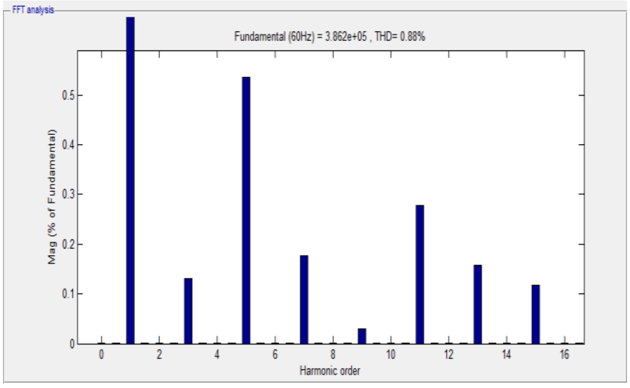

Fig.10 Harmonics Order Analysis Of Inverter

CONCLUSION

The proposed single phase Z source half bridge inverter is improved the output voltage than the conventional one.The voltage across C_{b1} and C_{b2} are $V_{cb1}=V_{cb2}$=20V .So midpoint voltages are balanced. The proposed converter is simulated using MATLAB/Simulink.Total harmonics distortion in conventional half bridge inverter and the single phase z source half bridge inverter inverter is 7.03% and 0.88% respectively.

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