Dc Side Low Frequency Harmonic Elimination of Quasi Z Source Inverter

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Abstract- *In the existing inverter topologies quasi Z source inverters are the best solution for PV applications. When the quasi z source inverters are used for delivering power to the grid, the second harmonic fluctuating power will be present at the dc side of the inverter. Huge capacitor banks are required to eliminate the ripple, resulting bulky quasi Z source network. In this paper a new filter integrated method is introduced to eliminate the ripple at the dc side. Considerably the quasi z source impedance will be reduced. The operation principle, control mechanism of the filter, design procedures are explained. The simulation results verify the improved results using a filter integrated quasi z source*

Keywords—*Quasi Z Source Inverter, Second Harmonic Fluctuating Power*

I. INTRODUCTION

The quasi z source inveters are similar to the traditional z source inverters. The arrangement of imedances in quasi z source network is different from the z source inverter. The existing quasi z source(qZSI) is shown in figure 1. qZSI can deal with wide range of PV load voltage and current fluctuations.

When quasi z source inverters are used for delivering power to the load there will be second harmonic fluctuating harmonic power (2ω) power which will be flowing through the dc side of the inverter. The 2ω power will deteriorate the efficiency of the input source.

For eliminating the ripple we need large capacitance and inductance[7],[11]]-[13]. But large inductors and capacitors increase the size of the system. So the reliability of the system decreases and also the cost.

In conventional quasi z source inverters there is no way to reduce the dc link capacitance value without using extra circuits. We need multiple inverter stages to reduce the ripples

II. SINGLE PHASE QZSI INVERTER AND SECOND ORDER HARMONIC FLUCTUATING POWER

Figure 1 shows the existing quasi z source inverter[1]. It is same to that of the conventional single-phase H-bridge inverter system[1]. The voltage and current at the output side of the inverter is given by

$u_s=\sqrt{2}\,V_0 \sin\omega t$ [1]

$i_s=\sqrt{2}\,I_0 \sin\omega t$ [2]

where ω is the fundamental angular frequency, ψ is the phase angle difference between output voltage and current, and the output power is

$P_0=V_0I_0\cos\psi- V_0I_0\cos(2\omega t-\psi)$ [3]

The equation 3 shows that the second order harmonic power exist at the dc side and ac side of the inverter. The dc link voltage is given by

$V_{PN}=V_{PN}+\sin\omega t$ [4]

where V_{PN} is the average value of dc link peak voltage and $v_{ac(t)}$ is the 2ω voltage ripple which is given by $0.5\varepsilon V_{PN}\cos(2\omega t-\delta)$.ε is the ratio of 2ω voltage ripple to the average value of dc link peak voltage.The modulation index is Msinωt.so the output voltage of the H bridge inverter [1] is given by

$u_s=M[V_{PN}+v_{ac(t)}] \sin\omega t$ [5]

We require ε < 5% [1] so the inverter output can be approximated as

$u_s=MV_{PN} \sin\omega t$ [6]

with $MV_{PN}=\sqrt{2}V_0$ the input power of the H bridge inverter is [12]

$Pin=(1-D)V_{PN}i_{PN}$ [7]

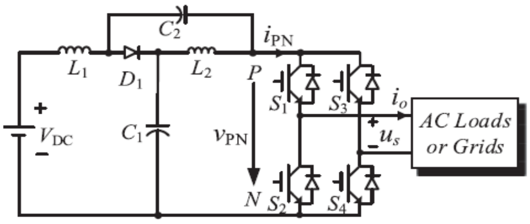

Fig. 1 Existing Quasi z source inverter

As $P_0 = P_{IN}$

$V_{PN}I_{PN}(1-D) = V_0I_0\cos\psi$ [8]

$(1-D)[V_{PN}\, i_{ac(t)}+I_{PN}\, v_{ac(t)}] = -V_0I_0 \cos(2\omega t-\psi)$ [9]

The 2ω power is considered while calculating the power in the equation[9].

III. PROPOSED TOPOLOGY

The new topology has one more half-bridge leg, denoted as 3 as shown in figure 2.An AC capacitor C_3 is connected between the outputs of phase legs 3 and 2.A small inductor L_3 is in series with the capacitor C_3 to smooth the high-frequency current ripple. A second-order LC filter is formed using L_3

and C_3.The 2ω pulsating power of the single-phase AC load is directly transferred to the AC capacitor C_3 through the inductor L_3 and the phase legs 3 and 2. As a result, the capacitor voltage and the inductor current in dc side will no longer have the 2ω ripple. Without 2ω ripple power, we no longer need large impedance, because small qZS capacitance and inductance are enough to take care of high-frequency ripple, so as to small volume and weight of passive components. Also, the constant capacitor voltage will ensure a constant battery current when the battery is connected in parallel to the qZS capacitor C_1 or C_2 in the energy-stored qZSI system, which will benefit the battery with a long lifetime[1].

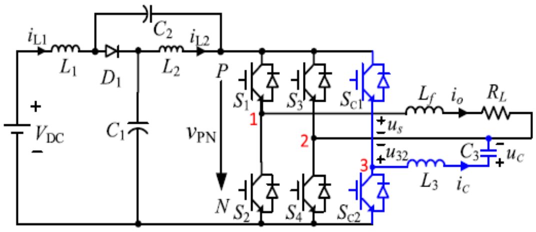

Fig. 2 Proposed System

IV. CONTROL OF ACTIVE FILTER

Control of the active filter is independent from the output voltage control of an H-bridge inverter. For the H-bridge inverter with qZS network, there are numerous control methods that are applicable [5], [8], [1]. The purpose of an active filter is to absorb the 2ω power ripple from the output side of the H-bridge by switching the third phase leg switches S_{C1} and S_{C2} as shown in fig 2. The control of active filter should focus to buffer load 2ω power in the LC active filter branch. The modulation index $M_{32}$is controlled to make the power amplitude of active filter to track the amplitude of 2ω ripple component in the load power[1].Fig 3 shows the control diagram for single phase quasi z source inverter[1].The switching pulses for the four switches in the single phase quasi z source inverter is generated by comparing two sinusoidal signals. Fig 4 shows the control circuit for the filter.The control pulses for the two switches are generated by taking account of the two powers,ie power across the load and power across the filter.

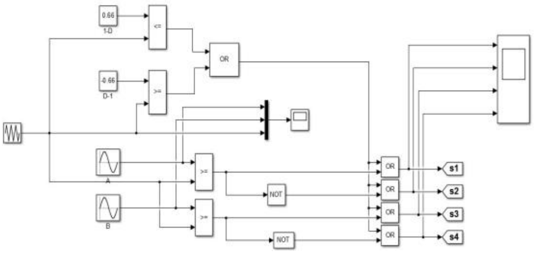

Fig 3 Control Diagram Of Single Phase Quasi Z Source inverter

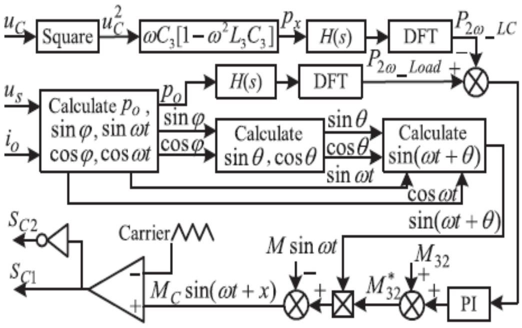

Fig. 4 Control Diagram Of Active Filter[1]

The comparison of two systems shows that the existing single phase qZSI topology requires large inductance and capacitance, which definitely degrades power density, efficiency, and reliability. Furthermore, the system still has 2ω ripple of capacitor voltage and inductor current. For application to the energy-stored single-phase qZSI, larger capacitance is inevitable for the existing topology to further reduce 2ω ripple of capacitor voltage(for lower battery 2ω current).However, the proposed active-filter-integrated single-phase qZSI entirely eliminates the 2ω ripple of voltage and current in the dc side and needs small qZS inductance and capacitance to limit switching current ripple and switching voltage ripple, respectively. The active filter requires small inductor and capacitor to buffer the 2ω power ripple. When the proposed topology is applied to the energy-stored counterpart, the battery current will be constant, which benefits the battery's lifetime[1]. The simulation results of quasi z source inverter without filter is shown in fig .5with filter is in fig .6 which shows that the ripple is eliminated at the dc side.

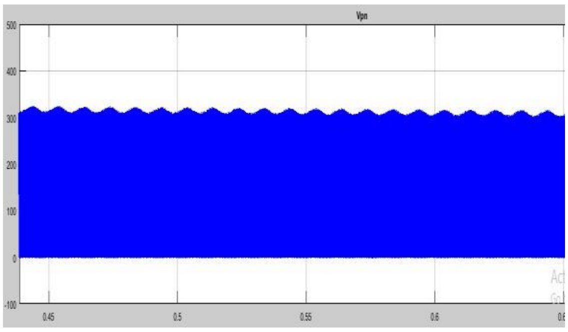

Fig. 5 Quasi Z Source Inverter Dc Link Voltage Without Filter

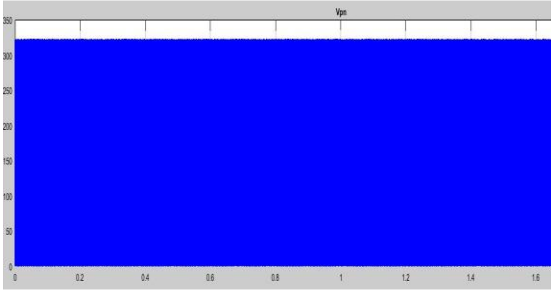

Fig. 6 Quasi Z Source Inverter Dc Link Voltage With Filter

V. CONCLUSIONS

Quasi z source inverter is suitable for the residential PV applications. But when they are used for delivering power to the grid there may be second harmonic fluctuating power at the dc side of the inverter. The proposed active filter integrated inverter reduces the second harmonic fluctuating power. The size of the inductor and capacitor in the inverter is reduced. System efficiency and reliability is increased.

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