Four switch three-phase Z-source rectifier with reduced capacitor values

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ABSTRACT

This paper describes Four Switch Three-Phase Z-Source rectifier with reduced value capacitors. This configuration has some advantages in term of small size of the circuit. The rectifier has buck-boost function by shoot-through state. Also, the rectifier has the advantage of decreasing inrush current in start-up and transient states. In order to reduce harmonics PWM modulation technique with a variable index has been suggested. Four Switch Three-Phase Z-Source rectifier with reduced value capacitors can output stable DC. Principles and dynamics of the system are discussed in detail.

1. INTRODUCTION

Capacitor is important element in the power electronics devices. Many characteristics of any circuit are depend on value or place of capacitors. Generally, capacitors are used for eliminating or reducing harmonics, to store energy and also in some circuits to delete undesired high frequency signals. Three-phase four switch rectifiers, due to their high efficiency and desired current quality are widely used in industry.

In this paper, three phase four switch Z-source rectifier based on reduced value capacitors topology is presented. This z-network allows the z-source rectifier to buck or boost its output voltage. The four switch topology have a smaller size than previous models. This configuration also simplifies the hardware structure and increases the rectifier reliability.[1]

2. THE PROPOSED RECTIFIER

2.1 Three phase four switch Z-source rectifier

The main objective of any three-phase rectifier is to generate three-phase sinusoidal input currents in phase with the input voltages and also DC voltage in output. Fig.1 shows the four switch three-phase Z-source rectifier. Phase b of the three-phase AC source is connected to the midpoint of a split capacitor and the Z-impedance network is coupled between the front other two phase leg's end and the second leg. When both the upper and lower devices of any one phase leg, or any two phase legs are shortened-through, the z-source rectifier has one extra zero state. This Z-network allows the Z-source rectifier to buck or boost its output voltage. For four switch and six switch three-phase Z-source rectifier, their switching control and shoot-through time control are basically the same. The DC output voltage of the traditional V-source PWM rectifier can be expressed as ;

$$V_{dc} = \frac{2V_i}{M \cos \phi} \quad (1)$$

Where V_{dc} is output DC voltage , M is modulation index , V_i is input AC voltage value, $\cos\phi$ is power factor. Thus, for 3 phase 4 switch Z-source rectifier

$$V_{dc} = B_b \frac{2V_i}{\cos \phi} \quad (2)$$

where B_b is buck-boost factor .

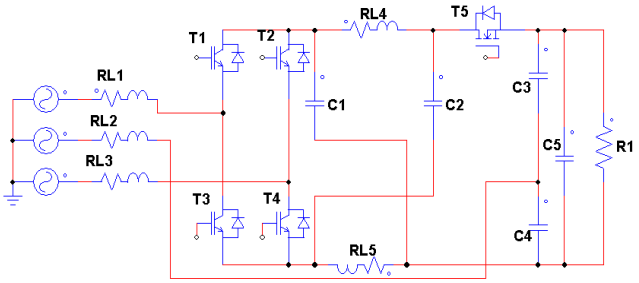

Fig. 1 Three phase four switch Z-source rectifier

2.2 Three phase four-switch Z-source rectifier with reduced value capacitors

The proposed circuit has similar parameters with previous three phase four-switch Z-source rectifiers, only the value of the capacitors of Z-network has been decreased from 1000 uF to 10 uF. It doesn't change and influence any characteristics of the rectifier. It has been proved by simulation. The key parameters, such as output voltage and in-phase synchronism between input voltage and input current have been saved. And also transient period has been decreased thanks to the proposed method.

3. SIMULATION AND DISCUSSION

There are simulation parameters in below:

Peak value of the input AC voltage :	100 V
Input inductance and resistance :	0.2 ohm and 2 mH
Z-source network :	0.2 ohm and 1 mH
Capacitors C1 ,C2 :	10 uF
Split capacitors C3 ,C4 :	3300 uF

Output capacitor C5 :	1000 uF
Output load R1 :	100 ohm
T1 ,T2 ,T3 ,T4 :	IGBT transistor
T5 :	MOSFET transistor

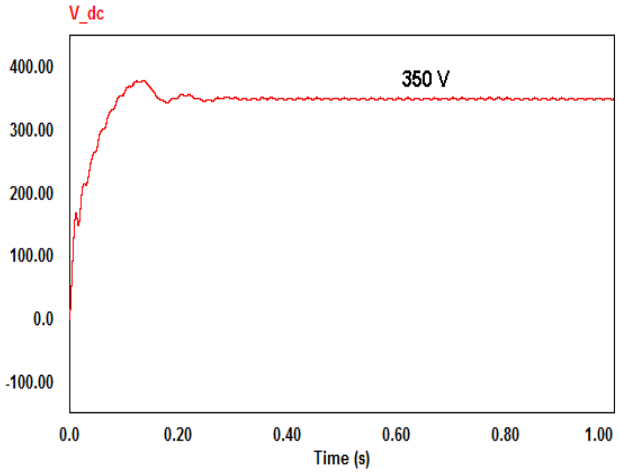

Fig.2 Output DC voltage of the rectifier

Fig.2 shows the output DC voltage, where we can confirm that the rectifier can save its boost capability, even though the value of Z-source's capacitors is decreased .

4. CONCLUSIONS

The goal of this paper is to prove reliability of the three-phase Z-source rectifier when the value of the Z-source capacitor has decreased value. It is shown that the proposed diagram has comparable performance.

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