Z-Source Dynamic Harmonic Filter with Four Switches

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4개 스위치를 갖는 Z-소스 동적 고조파 필터

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ABSTRACT

In this paper, four switches three phase Z source dynamic harmonic filter is proposed. It has many advantages, such as reduction of the cost, switching loss and smaller drive circuit. In order to reduction harmonics, new PWM modulation technique with a variable index has been suggested that in comparison with a fixed index type has more capability. The paper presents an application of direct current control(DCC) method in Z source dynamic harmonic filter to reduce the harmonics generated by the non linear load. The experimental results will verify the validity of the proposed method.

1. INTRODUCTION

Harmonics are one of the most parameters power quality. According to the power electronic equipment development, the idea using of dynamic harmonic filter was introduced in 1971 by Sasaki and Machida. In this filter is sampled of the system signals then according to it parallel current of series voltage is injected to system so that decrease harmonics in the system. In this paper, Z source dynamic harmonic filter with four switches is presented. This Z network allows the Z source rectifier to buck or boost its output voltage. The boosting of the capacitor voltage of Z network is possible with the proposed method through valve arm's short circuit even when the voltages on the output side of the rectifier are low. A normal supply of the compensating currents is possible. For harmonics compensation, four switches three phase Z source PWM rectifier is controlled.

2. THE PROPOSED METHOD

2.1 Four Switches Three-Phase Z-Source dynamic harmonic Filter

The four switches three phase Z source dynamic harmonic filter shows in Fig.1. It consist of four power switches in a single three phase full bridge configuration, with anti parallel diodes connected to each switch to provide a mechanism for bi directional flow of compensation current to be either absorbed from or injected into the supply system. The Z source dynamic harmonic filter can output DC voltage and compensate the harmonics.

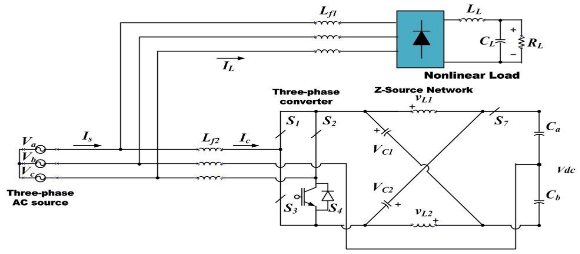

Fig.1 The four switches three-phase Z-source dynamic harmonic filter

The source current(I_S) can be expressed by the nonlinear load current(I_L) and the compensating current(I_C) such as the equation(1).

$$I_S(t) = I_L(t) + I_C(t) \tag{1}$$

According to the related literature[1], we get the equation (2) of the output DC voltage.

$$V_{dc} = \frac{1-D_0}{M}\frac{2V_i}{\cos\psi} = \frac{B}{M}\frac{2V_i}{\cos\psi} \tag{2}$$

Where, D_0 is the duty cycle, M is the modulation index, B is the buck factor. Because one leg of the three phase AC source is connected to the midpoint of a split capacitor, in order to balance is established, V_i which is in the above equation is the peak value of two signals(Va Vb),(Vc Vb).

2.2 The Control Method

Fig.2 shows the DCC(Direct Current Control) method which is to complete SPWM control[2]. The error value of the reference DC voltage and the output DC voltage is through the PI control. This value and the unit voltage are multiplied to get the ideal active grid current. The reference values are obtained by subtracting the grid current. And then the compensation can be realized by the SPWM.

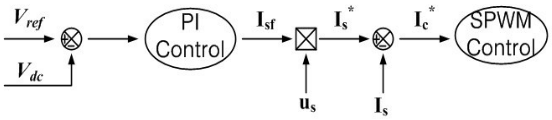

Fig.2 Direct current control(DCC) method

3. SIMULATION AND EXPERIMENT

The simulation and experiment parameters are as follows:

Input voltage : $40V_{peak}/60Hz$

Rectifier : $L_{f2}=3mH$, $C_a=C_b=3,300uF$

Z network : $L_1=L_2=1.5mH$, $C_1=C_2=1000uF$

Nonlinear Load : $L_{f1}=1.5mH$, $L_L=3mH$

$C_L=1000uF$, $R_L=40\Omega$

Switching frequency: 10kHz

Fig 3 shows the simulation currents waveform of four switches three phase Z source dynamic harmonic filter. It has the Z network, the source current can be output normally since the harmonics produced by the nonlinear load is well compensated.The source current becomes a sinwave.

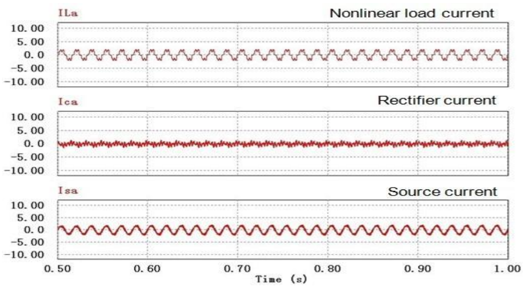

Fig.3 The simulation currents waveform of four switches three-phase Z-source dynamic harmonic filter.

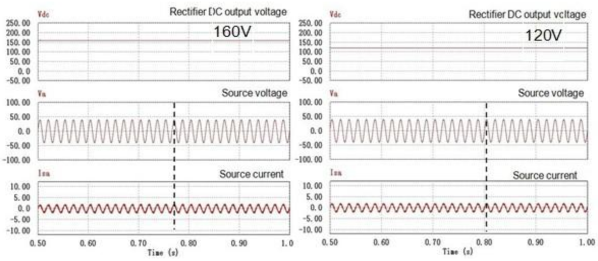

Fig.4 The different rectifier output voltage, the source voltage and current's waveform.

Fig.4 shows the different rectifier output voltage, the source voltage and current. According to relevant knowledge, the minimum output voltage of four switches three phase rectifier is 138V. From the simulation results, we can know that Z network can buck or boost output, and the power factor is nearly unity.

Fig 5 shows the experiment currents waveform. From the figure, we can see that the nonlinear load current exists the harmonics. Though the compensating current from the grid current of four switches three phase rectifier becomes sine waveform. It is the same with the simulation results.

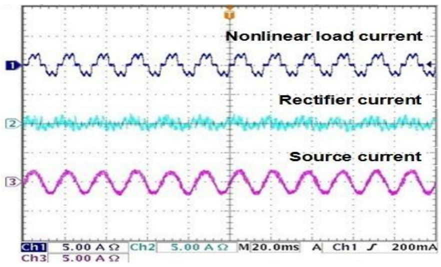

Fig.5 The experiment currents waveform of four switches three-phase Z-source dynamic harmonic filter

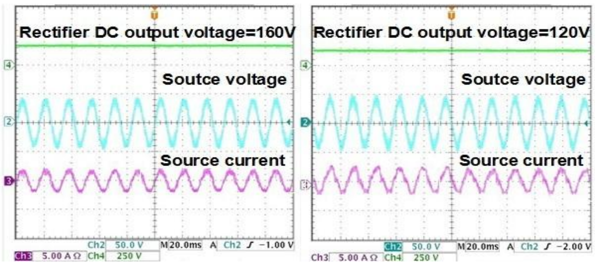

Fig.6 The experiment results of the rectifier output voltage, the source voltage and current.

Fig.6 show the experiment results of different rectifier output voltages, the source voltage and current. They proved boost and buck characteristics of Z network, and are consistent with the simulation results.

4. CONCLUSIONS

The goal of this paper is to eliminate harmonics generated by using four switches three phase Z source rectifier. Through the simulation and experiment, we know that three phase Z source rectifier can buck or boost output voltage. At the same time, the harmonics have also been compensated effectively. Thus, the proposed method has been well verified and is feasible.

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References

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