넓은 직류 출력전압 제어영역을 갖는 Z-소스 Four-Switch 3상 PWM 정류기

쭈샤*, 정영국**, 임영철*
전남대학교*, 대불대학교**

Z-Source Four-Switch Three-Phase PWM Rectifier with Wide DC Output Voltage Control Region

Zhu Sha*, Young Gook Jung**, Young Cheol Lim*
Chonnam National University*, Daebul University**

ABSTRACT

In this paper, we proposed the Z source four switch three phase rectifier. As we know, the conventional Four Switch Three Phase Rectifier(FSTPR) has advantages of the lower cost and less complex switching control. However, The conventional FSTPR can only either perform buck or boost operation, it can only attain the buck boost operation by adding another DC DC converter. In addition, besides its narrow output voltage region, distortion of the input current is serious either. Thus, we proposed the Z source FSTPR which has buck boost function and better input current waveform by applying the Z impedance network to the conventional FSTPR. The validity of the proposed system was confirmed by experiments.

1.Introduction

Nowadays, voltage source rectifiers have been found many in the industries with deferent topologies. Generally speaking, among the three phase rectifiers, the six switch ones can satisfy most applications [1]. However, topologies with reduced switches are being considered more for its smaller volume and simple switching control. Then the conventional FSTPR was proposed to achieve that goal [2]. In this rectifier, one phase's leg is split into two capacitors and to the middle of them one phase load is connected. Nonetheless, the conventional FSTPR has limitation as that it can only boost or buck voltage and it brings distortion to the input current.

In order to solve the problems referred above, we proposed the Z Source Four Switch Three Phase Rectifier which applies the Z source impedance network to the convention FSTPR [3]. In this paper, by the experiment results it was shown that the proposed rectifier has excellent performance in the wide output voltage variation, correction of input current's distortion, and power factor control.

2. The proposed Z-source FSTPR system

2.1 Circuit of conventional FSTPR

The circuit structure of the traditional FSTPR is shown in Fig.1 where one phase's leg is split into two capacitors and the switches are reduced by a third, so its control is easier and cost is reduced.

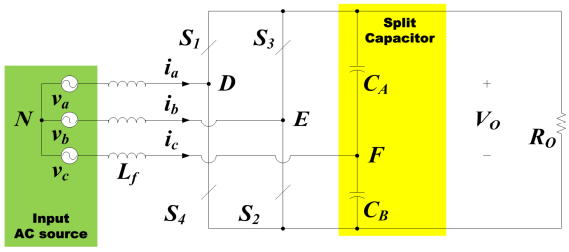


Fig. 1 Configuration of the conventional FSTPR

2.2 Circuit of the proposed Z-source FSTPR

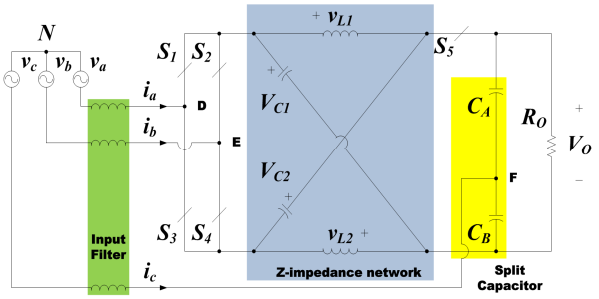


Fig. 2 Configuration of the proposed Z source FSTPR

3. Experimental results

We used a DSP to conduct the experiments, and the parameters of experiments are shown in Table 1.
Fig.2 shows the circuit of the proposed Z source FSTPR. Z impedance network is coupled between the front two legs and the leg split into two capacitors.

Table 1 the system parameters

		Conventional FSTPR	Z source FSTPR
Input AC voltage (v_a, v_b, v_c)		30Vpeak	30Vpeak
Input inductor		1 5mH	1.5mH
Split capacitor in the third leg (C_A, C_B)			3,300uF
Z impedance network	Inductor(L_1, L_2)		2mH
	Capacitor(C_1, C_2)		1,000uF
Capacitor of output DC link		1,000uF	1,000uF

the Fig.3 shows the output DC voltage and three phase input current waveform of the conventional FSTPR when M=1. In other words, 107V is the minimum voltage that the conventional FSTPR can reach, and in the figure it can be seen that the distortion and unbalance of the three phase input current is very serious which is harmful to the system.

However, by using the proposed Z source FSTPR the output DC voltage can be reduced to 58.5V and the distortion of input current waveform shown in Fig. 4(a) is highly modified. In addition, the Fig. 4(b) shows excellent control of factor power that the input voltage and current are almost with same phase angle.

4. Conclusion

In this paper, we proposed the Z source Four Switch Three Phase Rectifier(FSTPR) which can break many disadvantages of conventional FSTPR. And in order to verify the proposed system's feasibility we implemented experiments on both of the conventional FSTPR and Z source FSTPR. After comparison and analysis of the experimental results. it's proved that the proposed Z source FSTPR with buck function has wider output voltage variation compared to conventional one, the unbalance and distortion of the input current is highly corrected in the proposed system, and the proposed rectifier has very excellent performance in the power factor control.

Reference

[1] N.G. Hingorani, "Power Electronics in Electric Utilities : Role of Power Electronics in Future Power System", Proceedings of the IEEE, Vol. 76, No. 4, pp. 481 482, 1988, April.

[2] Curtis F. Gerald, Applied Numerical Analysis: Second Edition, Addison Wesley Publishing Company, Inc. pp. 1 14, 1978.

[3] F. Z. Peng, "Z Source Inverter," IEEE Trans Ind. Applicat., Vol.39, No.2, pp. 504 510, March/April 2003.

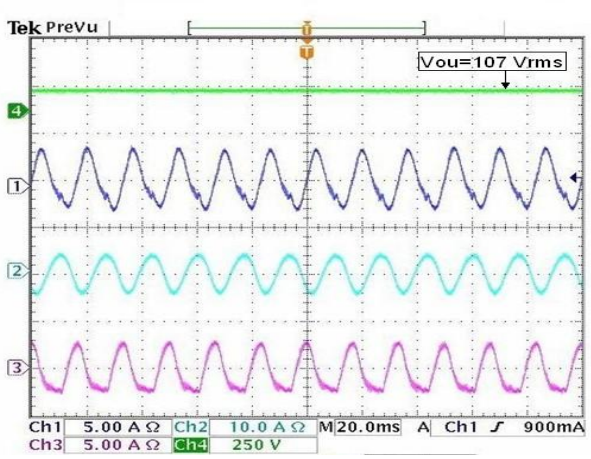
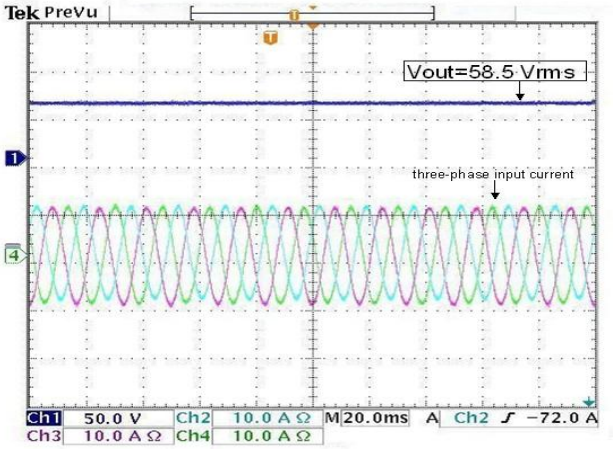
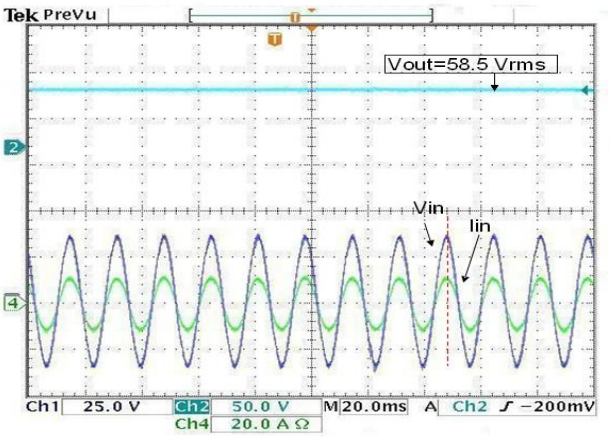


Fig. 3 Minimum output DC voltage(Top) and three phase input current waveforms of the conventional FSTPR (under M=1)



(a) Waveform of the output DC voltage(Top) and three phase input current waveforms



(b) Power factor control

Fig. 4 The proposed Z source FSTPR(under M=0.8, D=0.12)