순시 무효전력 이론 기반의 능동전력필터 기능을 가지는 삼상 지-소스 정류기

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Three-Phase Six switch Z-source rectifier with active power filtering capability based on instantaneous reactive power theory

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ABSTRACT

Shunt active power filter is a complete current source which can provide an effective and adjustable solution for elimination of harmonic currents in power system. Its performance depends on strategy employed in reference current generation, control technique and topology of converter used in the design.[1-2]. In this paper Three Phase Six switch Z-source rectifier with active power filtering capability based on instantaneous reactive power theory is described. Thanking to the theory power factor and THD value are significantly improved. Experiment results and conclusions are presented.

1. INTRODUCTION

Harmonics, which are caused by the use of nonlinear loads (AC and DC type motors, SMPS and etc.) are object to be eliminated. Because the presence of harmonics in the system results in several affects, such as heating losses and torque pulsation in transformers and motors, low power factor, poor utilization of distribution wiring and plant.[3]. Filtering the source current from undesired harmonics is most important parameter of any power electronics device. The active power filters (APF) are developed to overcome these problems by using a power electronics devices and a lot of switching methods.

The aim of this work is to introduce Three Phase Six switch Z-source rectifier with active power filtering capability based on instantaneous reactive power theory which is capable for cancelling current harmonics. The topology of the APF is implemented by using TMS302F28335 DSP system

2. THE PROPOSED METHOD

2.1 Three-phase Shunt Active Power Filter Topology

The shunt active power filter (SAPF) is most desired active power filter type. In this paper Three Phase Six Switch Z-source Rectifier was selected as SAPF. The Rectifier is capable to produce reference currents which are opposite to harmonics and can delete its. Thus, input currents are cleared from undesired harmonics and getting became sinusoidal waveform and in phase with the input phase voltages. Fig.1 shows the SAPF. The SAPF is connected parallel to the nonlinear load. Producing the currents which are capable to delete the harmonics is performed according to KCL

$$i_{line} = i_{nonlinear} + i_{zfilter} \qquad (1)$$

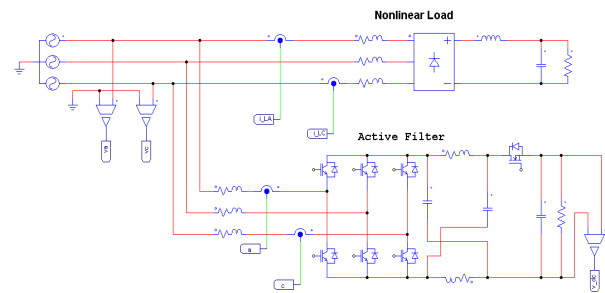Generated currents are injected into the line and thus, harmonic components will be canceled.

Fig1. Three Phase Six Switch Z-source Rectifier with APF capability.

2.2 Instantaneous Reactive Power Theory

The theory (also known as P-Q theory) was firstly introduced in Japan.[4]. Operating principle is based on to find out and to select reactive power contents from source power using Clark transformation.[5]. The selected reactive power will be changed to reference currents which are used to drive SAPF. The generated reference currents are opposite to harmonics flowing in power system and after injecting the reference currents harmonics will be deleted. In Fig2.the algorithm is briefly described. .
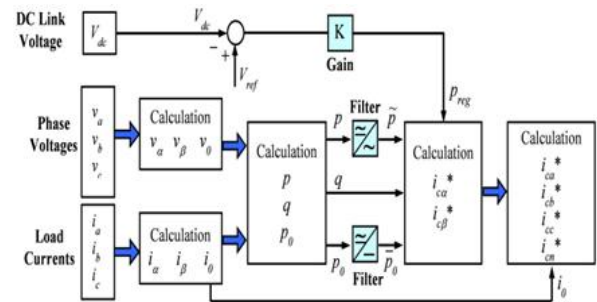

Fig2. Instantaneous Reactive Power theory

3. EXPERIMENT AND RESULTS

There are parameters of the circuit in Table 1 and also experiment results in Fig.3. As it's seen from the picture, source current became sinusoidal waveform and in phase with input voltage. Also, T.H.D value is improved. Output DC voltage can be regulated in according to next formula

$$V_{dc} = \frac{2*(1-2D_0)*V_{in}}{M} \qquad (2)$$

where V_{in} is peak value of input AC voltage,

D_0 is shoot-through value,

M is modulation index.

Table 1 Per unit values of the system parameters

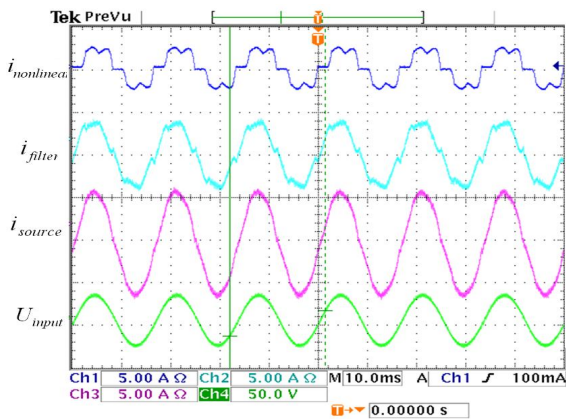| Line to line rms value of input voltage	43 V	Switching frequency	15 kHz
Nonlinear Load inductors	1.5mH	Nonlinear Load	20Ω
Active Filter inductors	1.5mH	Active Filter Load	100Ω
Capacitors		1000 μF	

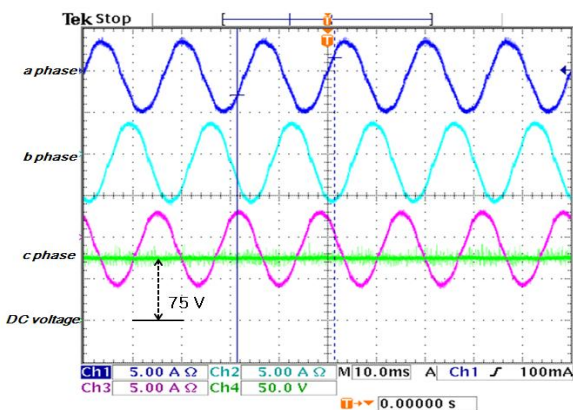Fig 3.Nonlinear load current, filter current, source current and input AC voltage

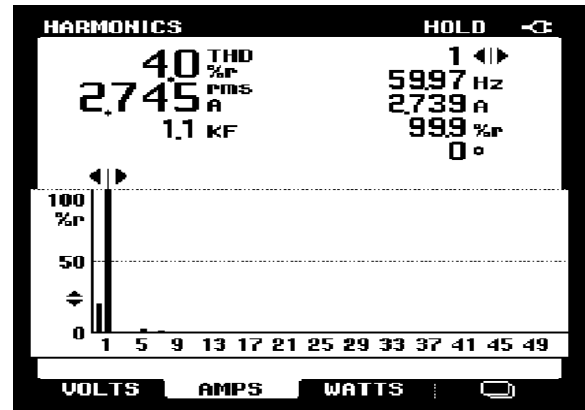Fig 4 . Input currents and output voltage.

Fig5. T.H.D value of the rectifier

4. CONCLUSION

Goal of this paper is to demonstrate active power filtering capability of the Three-Phase Six switch Z-source rectifier by using P-Q method. As it is seen from the results, the goal is achieved. T.H.D value of the rectifier is suitable with IEEE standards.

Reference

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