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Inverter air-conditioner Power System using Nonlinear Capacitance

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Abstract - By having the proposed circuit using a smaller one with a small reactor, the output voltage is boosted-up and improves the input of the current waveform. Therefore, we are able to follow the harmonics guidelines. Greater power and efficiency is obtained from the proposed circuit. This also reduces some switching loss and holds the over -shooting by using the inverter of eliminated dead -time HPWM which is a non-linear impedance of the circuit to make up the diodes, the capacitance, and the reactor. We compared the conventional PWM inverter and proposed HPWM inverter.

1. Introduction

Recently, it imposes legal controls on the quantity of harmonic current. Various methods have been studied to help rectify this problem. Among those, an excellent waveform reform measure was developed by using a self-commutation device at a several hundred watt class low power rectifier. However, as the result of this technique as an inverter controlled air-conditioner is typical of direct current power, it is applied to a single phase middle-capacity rectifier and thus avoids the problems that are associated with efficiency, viability, rapidity and electro-magnetic noise. Due to these problems, a rectifier that is satisfied with the guidelines of harmonics, is developed by using a diode and passive device. However, those rectifiers have some degree of insufficiency with respect to general- purpose. In this paper, the aim is to replace the conventional huge capacitor, which used power factor correction circuit, with a small capacitor. When joined with a reactor, it can improve the input current waveform and reduce rising output voltage. We will propose a number of circuits to the power factor correction circuit. Also, we will represent the experimental result that it is satisfied with the regulation of harmonics, and projected within the parameter of those characteristics.

2. Consist system of inverter air-conditioning

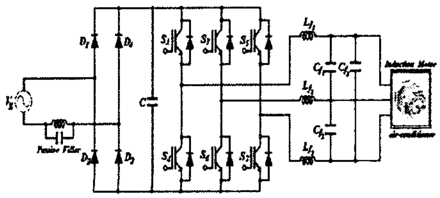


Fig. 1 Conventional air-conditioner power system

Figure 1 represents a Conventional air-conditioner power system which is usually used in air-conditioners, and its input current and voltage waveform is shown in Figure 2.

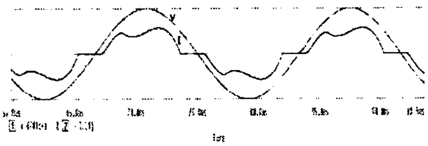


Fig. 2 Input voltage and current waveform of general air-conditioner power system

In this paper, we propose a non-linear capacitance circuit configured with three diodes (D_{11}, D_{12}, D_{13}) and two capacitors (C_{r1}, C_{r2}) as shown in Figure 3. In Figure 3, during the current i as flow (a), capacitance *is* $C/2$ to make a series circuit, during the current flow as (b), capacitance is $2C$ to make a parallel circuit. At this time, both ends of the voltage circuit are each done at v, $v/2$.

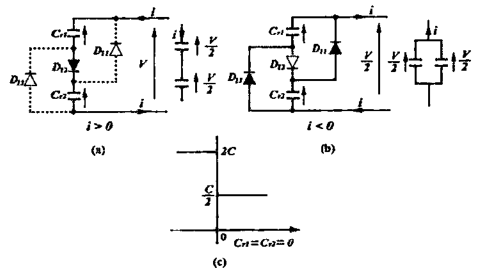


Fig. 3 The Base Principles of proposed nonlinear capacitance

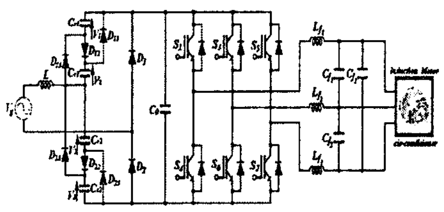
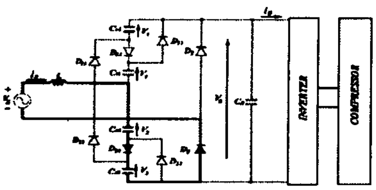


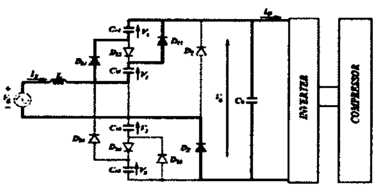
Fig. 4 Proposed rectifier circuit for air-conditioner

By the operation of this circuit, one is able to correct the input current harmonics on rectifier circuits for air-conditioners as shown in Figure 4.

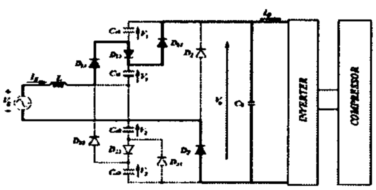
The operation modes of the proposed rectifier circuits are classified into four modes in Figure 5, during a positive half period of the input voltage v_s.



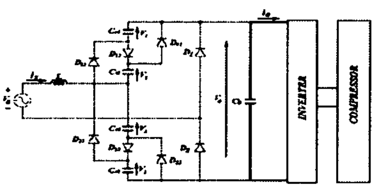
(a) Mode I



(b) Mode II



(c) Mode III



(d) Mode IV

Fig. 5 Operating modes of proposed circuit

3. Simulation and experimental results

Table 1 uses the parameters of the proposed circuit in the simulation and the experiment.

Figure 6 show the input current and the voltage waveform of the proposed rectifier circuit by computer simulation. Compared with waveforms of conventional circuits in Figure 2, the proposed circuit has higher power factor than conventional circuits.

Table 1. Parameters of proposed circuit

Input Source Voltage v_s		220(V), 60(Hz)
Input Reactor L		6.6(mH)
DC smooth Capacitor $C0$		4400(uF)
Capacitor $Cr1$, $Cr2$		157(uF)
Carrier Frequency fc		2160(Hz)
Modulation Ratio M		0.9
Output Filter Reactor Lf		3(mH)
Output Filter Capacitor Cf		10(uF)
Motor	Load Reactor	88.37(mH)
	Load Resistor	8.2(Ω)
IGBT(1MBH40-60)		Vce = 600(V)
		Ic = 40(A)
		Toff = 640(ns)
		20(kHz)

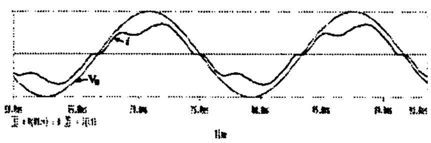
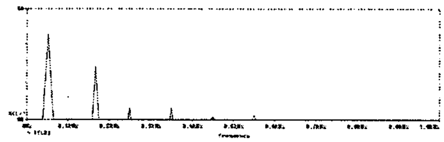
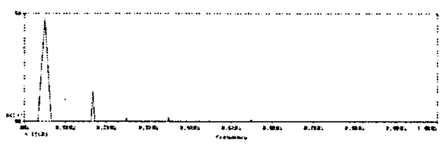


Fig. 6 Input voltage and current waveform of proposed source system

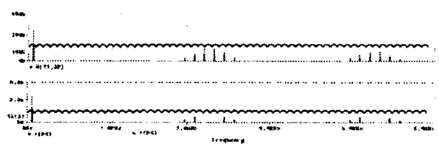


(a)

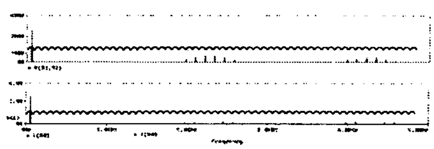


(b)

Fig. 7 Frequency spectrum for input current
(a) General power system
(b) Proposed power system



(a)



(b)

Fig. 8 Frequency spectrum of output voltage and current
(a) Conventional PWM inverter
(b) Proposed HPWM inverter

Figure 7 shows frequency spectrums for input currents of (a) conventional circuits in Figure 1 and (b) proposed circuits in Figure 4 by computer simulation. Figure 8 shows frequency spectrums for output voltage and current of (a) conventional circuits in Figure 1 and (b) proposed circuits in Figure 4 by computer simulation. Comparing (a) and (b), we learn that the proposed circuit has low harmonics components. In this paper, simulation waveforms of output voltage and circuit as shown in Figure 9.

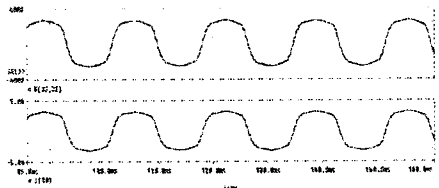


Fig. 9 simulation waveforms of output voltage and circuit

Figure 10 is represents the relationship of phases between the waveform of input voltage and current. Here, the input has a slight unit power factor.

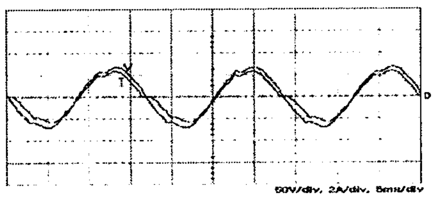


Fig. 10 Experimental waveform of input voltage and current

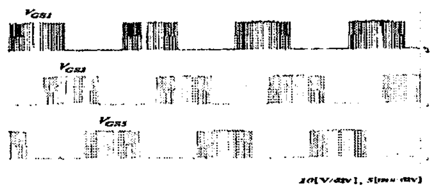


Fig. 11 HPWM inverter control signals

In the inverter control signal, we operate sine-wave modulation signals of a modulation ratio of 0.9, and a triangle-wave carrier signal frequency of 2,160[Hz], as Figure 11 shows HPWM control signals. Figure 12 represents waveforms of output voltage and currents including a low-pass filter. Also, the output has a slight unit power factor.

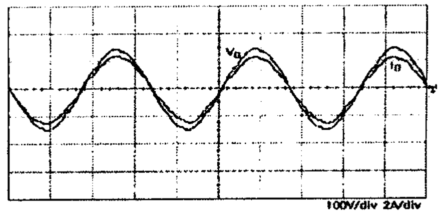


Fig. 12 Experimental waveform of output voltage and current (Low pass filter)

5. Conclusion

In a conventional power factor correction circuit, a conventional huge capacitor was replaced using a power factor correction circuit, with a small capacitor. In use with a reactor, the input current waveform decreased the rising output voltage. These results show the following results. By using a passive device, this can be very practical economically; the circuits have a very simple configuration, and do not emit electro-magnetic noise, because they do not use a switching method. We used two parameters of characteristics based on the circuit parameters. Harmonics of the power equipment is suitable in the guidelines for harmonics. Maximum efficiency was approximate at about 98[%] and the power factor was 97[%]. The results of these tests were proved through the use of computer simulation and experimentation.

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