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Implementation of Fan6982 Single Phase Apfc with Analog Controller

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ABSTRACT: Active power factor orrection technique can improve the input power factor and reduce the harmonic component of the input current. In small power applications, the single-phase active power factor correction circuit of high frequency switching (APFC), reduction of the boost inductance decreases the boost inductor and filter capacitor volume, reducing the net side current ripple, improve efficiency. On the basis of describing the principle of single-phase single-stage boost APFC double closed loop control, a new duty cycle compensation method is proposed, which is based on the FAN6982 simulation and the single phase APFC of the rated output power 500W is achieved. The results show that the effect of current ripple rejection is obvious, and the input current is consistent with the input voltage phase.

Keywords: Active power factor correction, Analog controller, Double-loop Control, FAN6982，Duty ratio compensation

I. INTRODUCTION

In single phase power grid,With the rapid development of power electronic technology, more and more power electronic equipments are put into the power grid,Especially, the switching power supply and AC / DC frequency conversion circuit using rectifier bridge and electrolytic capacitor as the front circuit are widely used,Serious harmonic pollution has been caused to the power grid,In order to improve the input power factor of the switching power supply and reduce the harmonic of the input current, APFC technology is widely used in various electronic devices to meet the limits of harmonic current in the IEC61000-3-2 D class standards[1].APFC power circuit adopts Boost converter, and the control strategy includes voltage and current double closed loop control, single cycle control, output voltage follow and so on.According to whether the inductor current is continuous, it is divided into inductor current continuous operation mode (CCM) and inductor current discontinuous operation mode (DCM)[2].A new zero crossing distortion compensation method is proposed in this paper.The advantages of the single-phase active power factor corrector are to reduce ripple current, reduce component loss in the power grid and improve the efficiency of equipment.At present, single-phase small power APFC analog control chip has many kinds, such as L4981, FAN9672 and so on. This article uses Fairchild's FAN6982 analog control chip, its switching frequency is high, the circuit design is simple, the price is relatively cheap.

Based on the description of single stage Boost APFC principle, using Matlab/Simulink simulation, and proposes a new distortion compensation method, analysis and design of FAN6982 circuit realization of active power factor correction.

1. Single phase APFC circuit and principle

1.1 power circuit

The single-phase APFC power circuit is a step-up single-phase AC-DC circuit, and the system structure is shown in figure 1.Figure: S1 for IGBT; L1 for step-up inductance; Rs for shunt resistance; FRD1 for reverse fast recovery diode; power diode D1, D2, D3 and D4 constitute rectifier circuit.

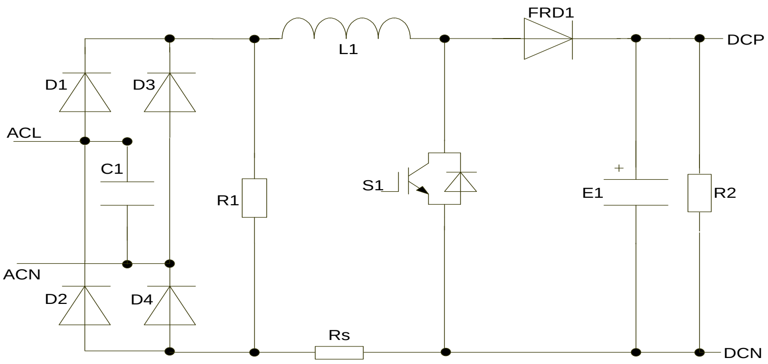

Figure 1 single phase APFC power circuit

1.2 double closed loop control principle

FAN6982 control circuit adopts voltage outer loop, current inner loop and double closed loop control, and works in CCM mode.As shown in Figure 2, the output DC voltage of the resistor divider to the voltage error compensator after sampling, and the reference voltage multiplied by the reference current as current loop, the same to the input end of the reference current to the current error compensator. Another input of the current loop is the actual inductance current waveform, which is sent to the reverse input of the current error compensator, and its output is connected to the PWM comparator to form a trigger signal to control the PWM space.

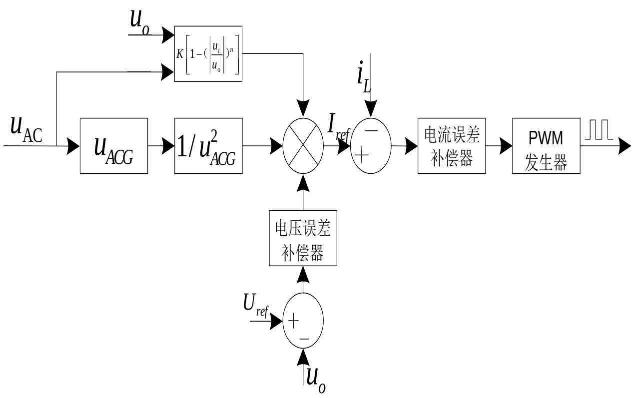

Figure 2 principle of double closed loop control

1.3 duty cycle compensation method

There are many kinds of compensation methods for control circuit duty cycle, such as voltage external loop constant compensation, or current loop constant compensation.This article is based on reading literature [3] [4],a new compensation method is designed:Voltage loop dynamic compensation,The power input voltage is u_i ,Output DC voltage is u_0 ,the voltage dynamic compensation value is as follows:

$$\Delta u = K\left[1-(\left|\frac{u_i}{u_o}\right|)^n\right] \quad (1)$$

$$\Delta u = K\left[1-(\left|\frac{u_i}{u_o}\right|)\right]^n \quad (2)$$

Type 1, type 2 can represent the dynamic compensation value of voltage loop. In design, the K value is selected according to the requirement, and the K value is generally smaller.In design, the index n is in principle desirable for positive numbers, such as 1, 1.2, 10, and so on, with a general value of 1 or 2.

The method of dynamic compensation of voltage loop is analyzed. Take a power frequency cycle, the ratio of the input voltage to the output voltage is sinusoidal. According to formula (1) and (2), the voltage dynamic compensation value is an inverted sine. At zero point, more compensation, less compensation at peak. The signal wave of PWM is shown in figure 3.

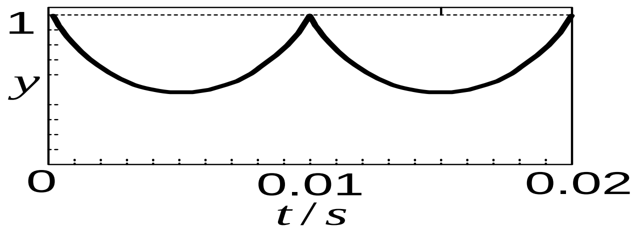

Figure 3 zero crossing compensation for PWM signal wave

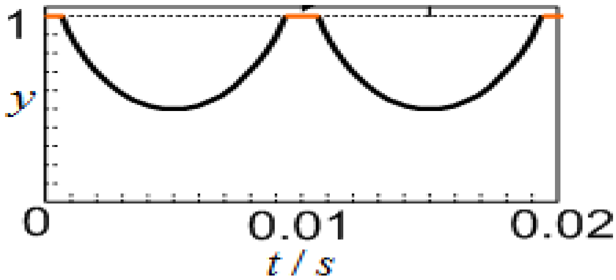

Figure 4 shows a zero offset PWM signal wave

II. SIMULATION ANALYSIS AND EXPERIMENTAL RESULTS

2.1simulation Analysis

According to the internal functional diagram of the FAN6982, using Matlab/Simulink to design the simulation circuit as shown in Figure 4, the control circuit includes a current loop and an outer voltage loop, the basic principle of double closed loop control is the inductor current to follow the rectifier voltage waveform, so as to achieve the objective of power factor correction.The current loop and voltage loop through a multiplier associated multiplier input has two parts: (1) a half sine wave signal given AC sine wave voltage of the rectifier obtained; (2) the DC bus voltage output sampling the output signal value with a given value by one order inertial loop by limiting the festival[5].The output of the multiplier is also a AC half sine wave signal, DC bus voltage regulation of the amplitude, the multiplier output current loop as the reference value, its output voltage and input current detection by PI regulator is obtained after the drive signal of the PWM and IGBT control power off.

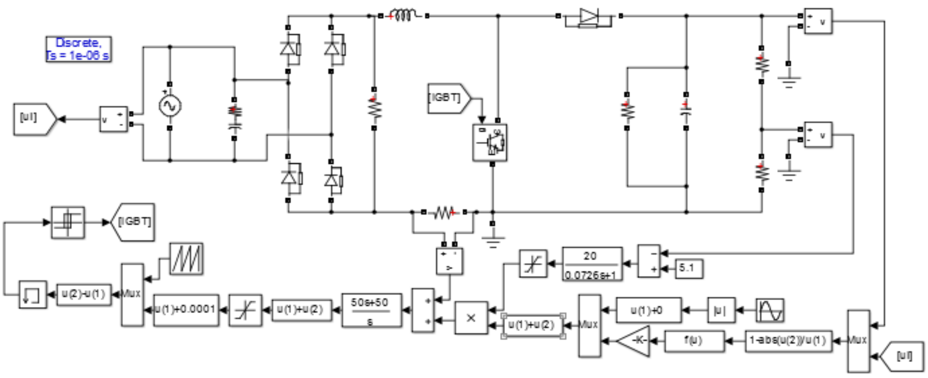

Figure 5 simulation circuit based on Simulink

The simulation parameters are as follows: the single-phase AC input voltage is 220V, the average output voltage is expected to be 385V, and the output power is 500W. 380μH boost inductor, switch frequency 60kHz, K=0.0262, n=1.

Fig. 6 is the input voltage and current simulation waveform, in which the voltage waveform is 1/20[6] of the actual voltage value, and the input current waveform can be observed to track the voltage waveform better. Using tools Powegui, FFT, Analysis analysis, the input current harmonic distortion THD=5.42%, can be PF=0.99. The simulation results show that the power factor correction is effective and the ripple suppression effect is obvious.

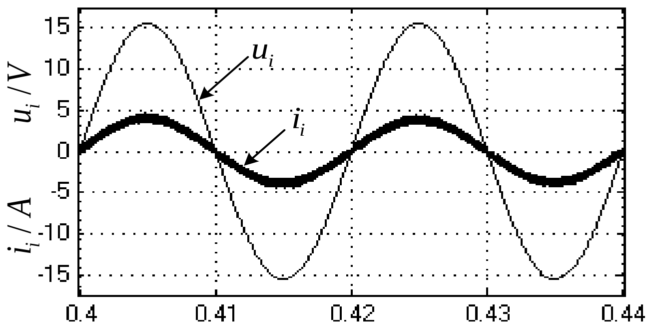

Figure 6 APFC input voltage and input current simulation waveform

2.2experimental analysis

The single-phase APFC is realized based on FAN6982, and the circuit board is shown in figure 8. Rated AC input voltage 220V, input voltage range 85~264V, power frequency 50Hz. No-load output voltage 388V, rated output power 500W.IGBT switching frequency 60kHz.[7]The boost inductor value of 100μH, filter capacitor value is 680μF, IGBT type FCH041N60F, reverse fast recovery diode model FFP08H60S.Tested under rated load, the current effective value is 2.31A, input power $p_i = 508w$, output power Po=489W, efficiency η=96.25%, power factor PF=0.99, THD=10.74%, and the experimental waveform is shown in figure 9.

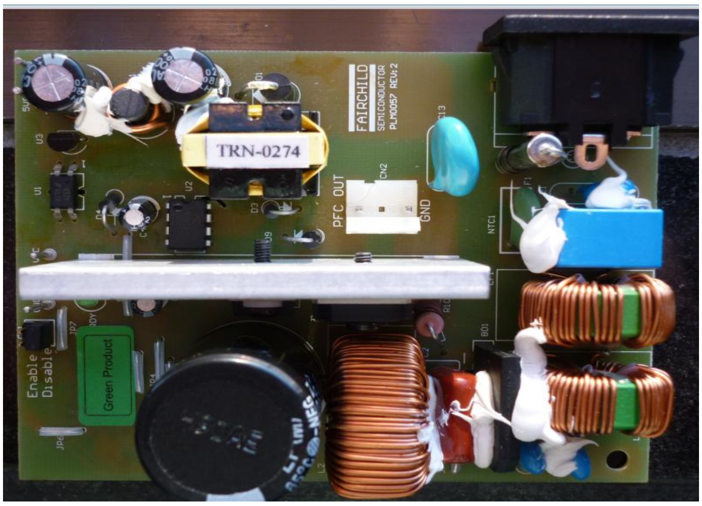

Figure 7 single phase APFC circuit board based on FAN6982

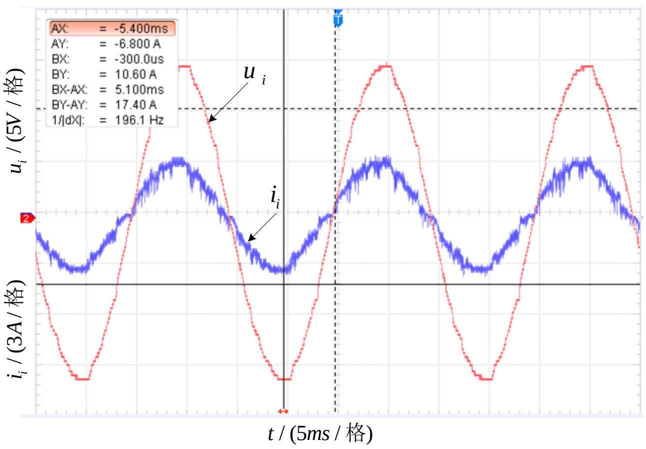

Figure 8 experimental waveforms of input voltage and input current at rated power

III. CONCLUSION

In this paper, a single-phase single-stage PFC device based on FAN6982 is analyzed and implemented. The principle of voltage and current double closed loop control is adopted, and the method of detecting inductance current with series shunt resistance is adopted. The experimental results show that the single-phase single-stage APFC can meet the requirements of small power applications, and can obviously improve the ripple of input current, and the efficiency can reach more than 96%.

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