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Design of single phase inverter

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Abstract

In this paper, the SPWM inverter based on STC12C5A60S2 single-chip microcomputer is used. The system can convert the input single-phase AC power supply into DC power, and then convert it into stable 10V AC output. Finally, the frequency adjustable AC output is obtained. The single-chip microcomputer controls two internal hardware PWM modules to generate SPWM pulse signals by natural number table lookup method. The single-phase full bridge inverter circuit is driven by unipolar modulation scheme, and the output is filtered by LC low-pass filter. Finally, stable sine wave alternating current is obtained on the load. The output frequency of sine wave is controlled and regulated by the internal program of single chip microcomputer. LCD can display the input voltage and output current in real time, and output the frequency of sine wave, which greatly improves the security and stability of the system.

Keywords

SPWM; Single phase inverter; STC single chip microcomputer.

1. Introduction

In the continuous development of today's society, energy saving and high efficiency has become a direction pursued by all walks of life. The development of frequency converter is in line with this trend. The improvement of China's economic level has led to the development of modern science and technology. With the development of economy, the electrical industry has been improved in particular. The combination of MCU and inverter has become a new and efficient combination. The development history of frequency converter has been started in foreign countries for a long time, but the development time in China is not long enough. First of all, it appeared in the industrial age, accompanied by the entire industrial process. Domestic inverter is mainly used in AC motor. It is widely considered as the most ideal scheme of AC motor speed regulation. Frequency control technology is more and more widely used in the industry. It is an effective way to increase benefit by making use of the advantages of energy saving and labor saving of variable frequency speed regulating system. Especially in the enterprises with high energy consumption and low output mechanical facilities, the use of frequency conversion speed regulation system will make enterprises get great economic benefits, and it is also the need of the continuous development of national economy. Nowadays, energy conservation and emission reduction are constantly advocated in the world. Using economical and reliable frequency conversion system will greatly reduce the waste of resources.

2. Inverter structure

Frequency converter usually has two kinds of structure, one is direct frequency conversion, the other is indirect frequency converter, this paper studies indirect frequency conversion, mainly by rectifier inverter two parts. The AC-DC-AC frequency conversion circuit consists of two parts. The AC-DC converter is used as the rectifier part. The diode rectifier circuit is not controlled. The DC side is filtered by capacitors and inductors to obtain a flat intermediate DC voltage. The structure of this part is simple and reliable, and its performance meets the needs of the

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experiment. DC to AC inverter, using single-phase bridge inverter circuit, PWM control, output voltage size and frequency can be adjusted by PWM control. Because the intermediate DC link is capacitor filter, the inverter circuit in Fig.1 is voltage type.

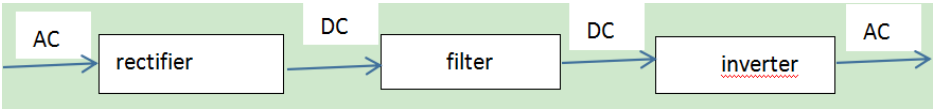

Fig.1 Circuit composition of frequency converter

The commonly used voltage regulation methods of frequency converter are: controlled rectifier voltage regulation, DC chopper voltage regulation, inverter self voltage regulation, single pulse modulation, multi pulse modulation, sine wave pulse width modulation.

SPWM

SPWM wave is generated by the full bridge inverter circuit. The full bridge inverter circuit (Fig. 4) is composed of four transistors controlled by switches. By controlling the on and off of transistors, the alternating voltage is generated on the load to change the working condition of the load.

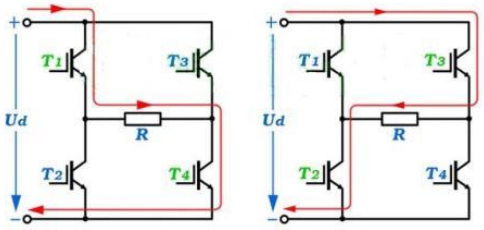

Fig. 2 Working state of full bridge inverter circuit

If we want to output the rectangular wave of SPWM waveform, we must generate a sequence of control signals to control the on and off of transistors in the bridge inverter circuit. The modulation method is often used, in which unipolar modulation or bipolar modulation can be adopted. The following describes the inverter circuit SPWM wave generation principle, the use of unipolar modulation method.

Fig.3 shows the generated SPWM waveform. When SPWM wave is generated by unipolar modulation method, the desired waveform is usually called modulation wave ur, and the modulated signal is called carrier UC. In general, isosceles triangle wave is used as carrier and sine wave is modulation signal. When the two waves meet, the transistor in the circuit is turned on and off, so that the width of the pulse is proportional to the amplitude of the modulation signal.

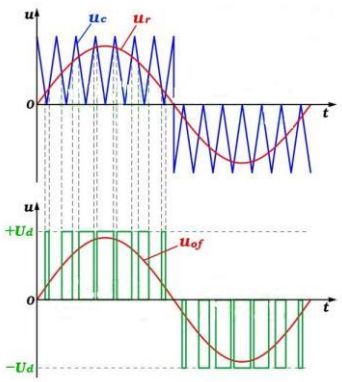

Fig. 3 Generation principle of unipolar SPWM waveform

Therefore, when u_r is in the positive half cycle, T_2 and T_3 are kept off, and the switching transistors T_1 and T_4 are controlled at the intersection of u_r and u_C; when ur is greater than u_C,

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T_1 and T_4 are turned on, and the voltage on R is u_d; when u_r is less than u_c, T_1 and T_4 are turned off, and the voltage on R is 0. When u_c is greater than u_r, T_2 and T_3 are controlled to turn on, and the voltage on R is - u_d. When u_c is less than u_r, T_1 and T_4 are turned off, and the voltage on R is 0. The SPWM waveform which changes according to the sine wave rule will be obtained on R. the red line u_{of} in Fig.3 represents the output equivalent sinusoidal AC voltage.

3. Hardware design

In the hardware design, in order to be simple and convenient, at the same time to achieve the task requirements. The whole circuit should have simple structure and low price, so that the design can meet the requirements of the topic.

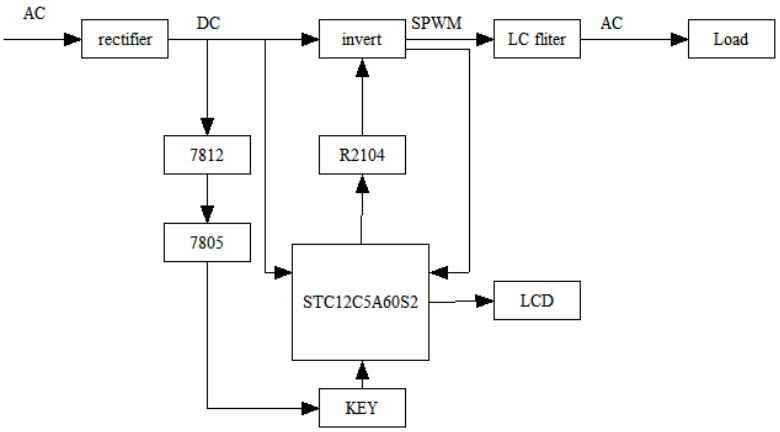

Fig. 4 overall circuit diagram

The hardware circuit of this frequency conversion system includes AC / DC converter, LC filter circuit, DC / AC converter, MCU, display module, IR2104 drive circuit, current detection circuit and some external circuits.

Using STC12C5A60S2 as the main control chip, it is easy to achieve system expansion, and can effectively output two PWM waveforms, it just meets the needs of this design.

3.1. Rectifier circuit

The rectifier circuit is composed of rectifier diodes. As shown in Fig. 5, the voltage of 220 V is converted into 20 V AC by power frequency transformer, and the frequency is 50 Hz. There is transformer isolation in the middle. When the input voltage is in the positive half cycle, D1 and D4 are on, D2 and D3 are cut off. The current flows from the upper secondary end of the transformer through D1 to the load and then to D4. When the input voltage is in the negative half cycle, D2 and D3 are connected, D1 and D4 are cut off, and the current flows from the upper secondary end of the transformer to the load and then to D3.

When the rectifier bridge is used for full wave rectification, two diodes must be on at the same time, which will produce a voltage drop of about 1.4V (single Schottky voltage drop is 0.7V). At the same time, the average output current of the transformer in the circuit is 1.5A. Considering the peak current brought by the filter circuit, three times of margin is selected here, and the rectifier bridge greater than 5A is selected.

3.2. Inverter circuit

As shown in Fig.5 is the schematic diagram of the inverter circuit. From the diagram, we can get that the rectified alternating current is filtered through the capacitor. In the inverter part, four metal oxide semiconductor tubes (MOS transistors) are used to form a single-phase bridge inverter circuit. The output SPWM waveform is filtered by the LC filter composed of inductors and capacitors to obtain a 10V pure sine wave.

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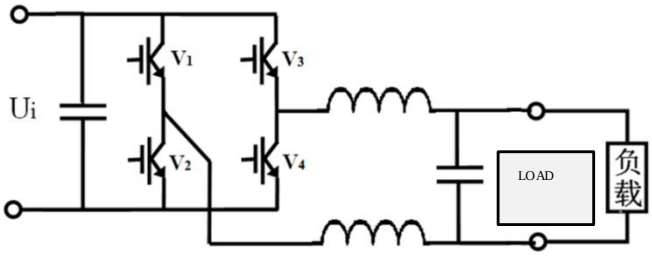

Fig.5 Schematic diagram of main circuit

4. Simulation

The software simulation of the frequency conversion circuit is carried out by using protees software. The function of the software simulation is to simulate the operation of the whole circuit and observe their output waveform. Fig.6 is the simulation diagram。

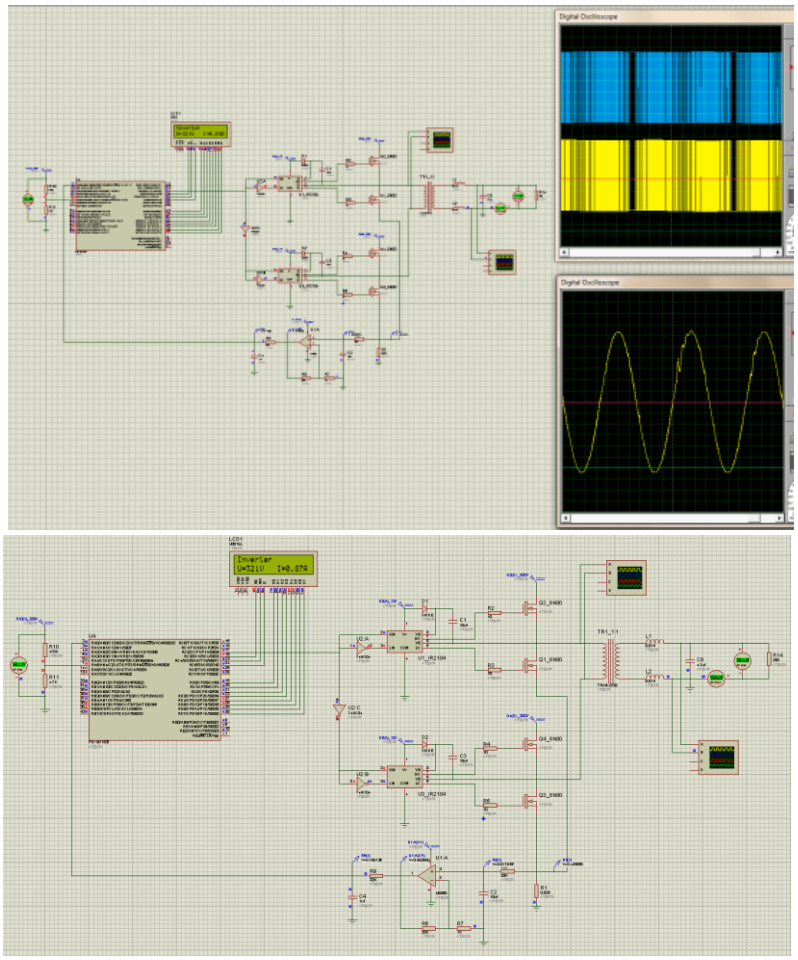

Fig.6 System simulation

5. Conclusion

According to the test results of many times, it can be seen that the inverter outputs 2 ~ 100Hz sine wave current. Moreover, the frequency conversion system is connected with LCD display and buttons, which can manually set the power output voltage and frequency, and display the efficiency of output voltage, current, power and AC voltage in real time. The system has the

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function of over-current protection, which can cut off the AC output when the output current is greater than 4a. The security and stability of the system are improved.

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Project Name: Research on LCL control stability technology of grid connected inverter.

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