

Directivity of Transducer Array

Guozhu Zhao

Civil Aviation Flight University of China Guanghan Sichuan, China

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Abstract: According to the research of acoustic directivity by using MATLAB software, selection of a relatively larger surface of the transducer and a relatively closer transducer interval will be more preferable for directivity. On the other hand, when the structure of the sound radiating surface of the transducer or array layout is symmetrical, the corresponding directivity pattern will be symmetrical. The two resonance frequencies of a single transducer and a transducer array are measured by an impedance analyzer. And according to the resonant frequency 23kHz, high-power directivity acoustic transducer hardware experiment platform is designed. And this design, which can successfully drive sound transducer array and the drive power is about 10w, can ensure that the ultrasonic signal's amplification will be performed without distortion, while the magnification can reach to 20 times. In order to test transducer' directivity, two methods are designed.

1 INTRODUCTION

By analyzing the electrical characteristics of piezoelectric transducer, it could offer to help for the design of the directional acoustic transducer circuit platform. Directional acoustic transducer system's basic purpose is an audio input signal, using program to process signal, then power amplification, and ultrasonic signals that contain the audio signal are sent into the air, finally, the audio signal is released from the ultrasonic in the air, which realizes its high directional transmission[1]. Because this paper does not involve relevant signal processing, designing hardware circuit platform can provide a solid foundation for the later work of the research. However, the premise is to make sure that the circuit designed could work properly, and the signals of the ultrasound are amplified, essentially without distortion [2, 3, 4].

The section of signal processing is not considered for the moment, and we only consider hardware platform where the transducer emit a directional sound. The following design scheme is adapted, The entire hardware component of the audio directional system[5-6].Among them, the transducer array design and impedance matching circuit design has been completed, the next thing to do is to power amplifier, power source and the

design of filter circuit, its difficulty is class D power amplifier design[7, 8].

The total design scheme of electrical circuit. The section of signal processing is not considered for the moment, and we only consider hardware platform where the transducer emit a directional sound. The following design scheme is adapted, Figure 39 is a total design scheme of the audio directional system signal processing platform. The entire hardware component of the audio directional system is:

(1) power supply module, it provides positive and negative power supplied for power amplifier.

(2)the signal source, it produces high frequency signals, will only provide more than 20kHz of ultrasonic signals, due to the absence of signal processing.

(3)Power amplifier, it can achieve high efficiency of ultrasonic signal, with amplification of low distortion rate.

(4)Filter circuit, it selects the appropriate circuit or component to filter the output of the power amplifier.

(5)Designing transducer array.

(6)Designing impedance matching circuit.

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amplifier, power source and the design of filter circuit, its difficulty is class D power amplifier design.

2 CLASS D POWER AMPLIFIER

To design the power amplifier to enlarge the signal after power transducer, producing mechanical vibration, to the side of launch ultrasonic wave in the air, the power amplifier is to prepare the way for signal processing, therefore it requires small signal distortion rate, higher efficiency magnification at about 20 times. Class C power amplifier, also known as the class B amplifier, is a powerful amplifier with a high distortion rate, and the advantage of C is that the output is high. But due to serious distortion of the characteristics of this kind of power amplifier is not suitable for the Hi-Fi applicable to enlarge, of course, and is not applicable to complex sound signal processing, and is not suitable for directional acoustic signal processing. Class D power amplifiers, also called power amplifiers, are known as digital power amplifiers. Transistor of circuit, once the open directly to the load connected with the power supply, current flows through a transistor, but no voltage in the transistor and voltage load directly to the load, Thus the power consumption is small so that it can achieve the purpose of improving efficiency. When the output transistor is closed, all the power supply voltage on the transistor, and the transistor without conduction, there would be no current, also not consumed power, so the efficiency of the power amplifier in theory should be 100%.

As shown in figure 1 and 2, the advantages of class D power amplifier are high efficiency. The power module is generally integrated into the chip, and it is difficult to design alone. The performance of this type is stable and the size is small, producing less heat. Because of this, without large radiator, the fuselage can significantly reduce the volume and weight, and due to the absence of the distortion, the theoretical distortion is low and the linear effect is better, But the power amplifier is complex, the circuit design is more complex, so the truly successful product is less and the market price is not cheap. Because of the above situation, the class D power amplifier is specially designed, which is used to solve the problems related to the research of high-power directional acoustic transducer.

The D class amplification is called the class D power amplifier, which is 100 percent efficient because the power amplifier controls MOSFET output power. The class D power amplifier design

needs to consider the main problem, including: modulation method, the design of the low-pass LC filter, the selection of the output power MOSFET switch tube, the protection of the output stage, etc.

Choosing a kind of drive circuit with the protective type PWM power amplifier, the circuit is used for under 55 kHz ultrasonic power amplifier. When the supply voltage is ± 12 v, the expected voltage amplification can reach more than 20 times, and the output power is not less than 10W. The signal, after power amplification, constitute a low-pass filter circuit by L1 and C12, which Filter out the unneeded high-frequency signals, and the rest of the ultrasonic signal is the signal for the output of the output-end. When a given frequency is 24kHz, we can obtain the corresponding power amplifier output and input waveform. the magnification of the power amplifier that be found is 20 times. in promoting the nine transducer array when there is no obvious distortion of power amplifier input signal of 1.5 V in input end, and the output voltage is 30 V.

In this project, it is necessary to design the DC power supply, because the power source required by above class D power amplifier is dual power supply. The 220 v alternating current through the transformer T1 output low voltage alternating current. Then, after four diode rectification, you take the zero point in the middle of the transformer T1, and the zero point is exactly the middle of the transformer. The output voltage is -12 V and 12V, and pressure drop is 24V on both ends of the output of power source , and the output current is greater than 500mA. These parameters can satisfy the driver requirements of the class D power amplifier. In subsequent chapters, we will focus on the directionality measurement of the directional acoustic transducer array.

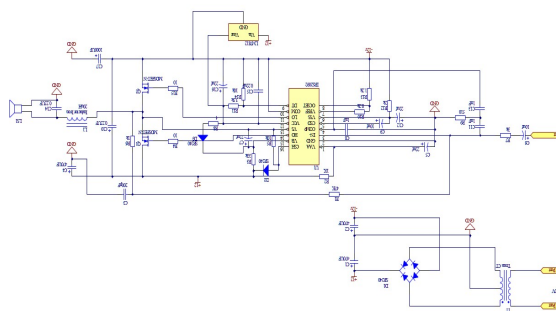


Figure 1. Circuit diagram of class D power amplifier.

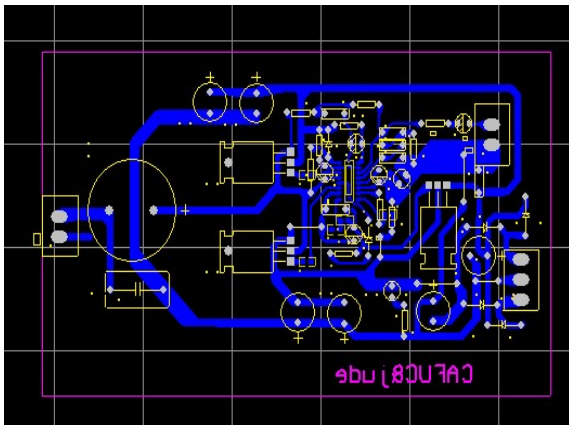


Figure 2. Class D power amplifier PCB diagram.

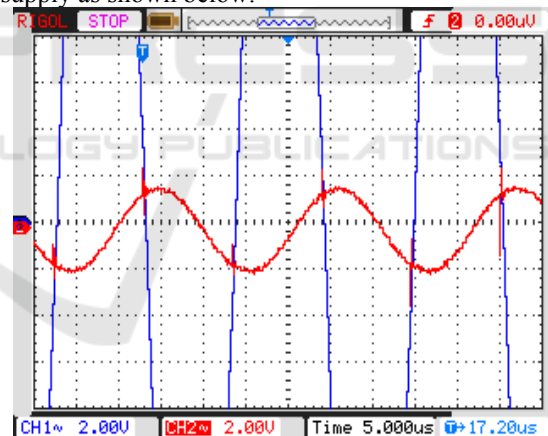
Class D power amplifier design needs to consider the main problem is: modulation method, the selection of the output power switch tube, the output level of protection, LC low-pass filter design and EMI treatment etc. Choosing a kind of power amplifier drive circuit with protective type PWM, It must satisfy four functions of the class D power amplifier, including: PWM modulation, built-in level conversion, grid drive of MOS tube and overcharge protection. In order to use the minimum of peripheral components to design, it adopts chip IRS2092S to produce the vibration mode pulse width modulation, the chip can support the amplifier under 55 KHZ frequency, and the chip can cooperate with a half-bridge power amplification circuit, composed of two MOSFET work. The circuit is used for power amplifier of ultrasonic signal under 55 kHz and audio wave signal. when the supply voltage is 12 v, it is expected to reach 20 times, and Its output power is not less than 10W for the class D power amplifier PCB and class D.

3 FILTER CIRCUIT

The power amplifying signal goes through the low pass filter circuit of L1 and C12 in figure 3, which is connected to the output of the D-type power amplifier. The unneeded signals are filtered out by the filtered circuit, and the rest of the signal is the output of an ultrasonic signal.

When a given frequency is 24 KHZ, the corresponding power amplifier output and input waveform as shown in figure 3, which peaks higher waveform presents output waveform, and wave lower input waveform indicates input waveform. There was no apparent distortion in the array of nine transducers, and when the input of the power

amplifier input is 1.5V, the voltage of the amplifier is 30V, and we can find that the amplification of the amplifier is 20 times. This voltage is the maximum voltage that a transducer can withstand. You can see from the diagram that the blue waveform diagram representing the output is not distorted. That is to say, the design of class D power amplifier can achieve the desired purpose, can amplify the ultrasonic signals, and working condition of LC filter circuit is good, basically can achieve output without distortion, whose magnification can be up to 20 times, and whose frequency response in the range of 20HZ-55kHz. Although there is no signal processing, but from the perspective of signal processing, it is not theoretically distorted by the class D power amplifier, when the signal is transmitted on a carrier with a high frequency signal of 24kHz. For the class D power amplifier designed, the DC power supply that is designed and matched is necessary. Because the class D power amplifier chip drives the MOSFET, The type of power device is used only in N channel, and there is no circuit design of N channel and P channel. To this end, the voltage is high, and the design of the dual power supply can meet this requirement, which designs the power supply as shown below.



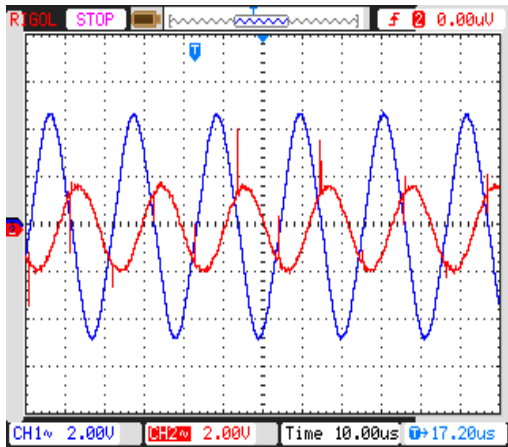


Figure 3 comparison of input and output signals of class D amplifier.

4 POWER MODULE DESIGN

The basic principle of the power supply is that 220 v alternating current through the transformer T1 output low voltage alternating current. Then, after four diode rectification, you take the zero point in the middle of the transformer T1, and the zero point is exactly the middle of the transformer. Finally, pressure drop is 24V on both ends of the output of power source, and the output voltage is -12 V and 12V, and the output current is greater than 500mA, and the output power is not less than 10W. These parameters can satisfy the driver requirements of the class D power amplifier. The D class amplification is called the class D power amplifier, which is 100 percent efficient because the power amplifier controls MOSFET output power. The class D power amplifier design needs to consider the main problem, including: modulation method, the design of the low-pass LC filter, the selection of the output power MOSFET switch tube, the protection of the output stage, etc.

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5 CONCLUSIONS

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