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Design of Communication FM Transmitter

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Abstract: In this paper, a set of wireless FM transmitter system is designed. When the audio signal with peak value of 200mV and frequency of 2KHz is input, the transmission signal with resonant frequency of about 46Mhz and power amplification of 40-50 will be obtained. After scheme comparison, the wireless FM transmitter with VCO as frequency modulation device and AB high-frequency power amplifier as high-frequency power amplifier is finally determined, the designed circuit is verified by simulation software.

1. Introduction

Signal transmission is an important part of communication system. Due to its nonlinear characteristics, different transmission systems will have different degrees of impact on the original signal [1]. The signal will go through two parts: frequency modulation circuit and high-frequency power amplification circuit, from the original signal to the modulated signal [2]. Different systems have their own advantages and disadvantages due to their own characteristics, so how to design an appropriate wireless FM transmitter system is of great significance.

2. Overall Design

At the beginning of this design, it is planned to use PLL, mixer, frequency multiplier and high-frequency power amplifier in the frequency modulation module. However, considering the complexity of the system and the compatibility of the parameters of each module in the actual test, the overall design is adjusted. The audio signal is input to the voltage controlled oscillator to realize frequency modulation, and then the signal is transmitted to the high-frequency power amplifier, and then transmitted to the transmitter through the antenna switch. The carrier frequency is about 45-46mhz. The system block diagram of FM transmitter is shown in Figure 1:

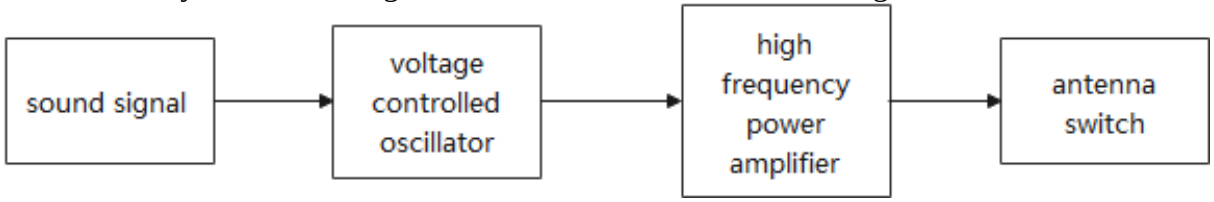

Fig.1 Overall Design of FM Transmitter

3. Scheme Description of Wireless FM Transmission System

3.1 Comparison and Selection of Frequency Modulation Circuit Schemes

Scheme 1: varactor direct frequency modulation. Compared with ordinary diodes, when reverse voltage is applied, the junction capacitance of PN junction will change with the change of reverse voltage. Using the characteristics of the varactor, connect the varactor to the oscillation circuit, and the capacitance in the circuit will change with the change of the modulation signal voltage, resulting in the change of the oscillation frequency, so as to achieve the purpose of frequency modulation [3].

Scheme 2: VCO frequency modulation. Voltage controlled oscillator (VCO) is an oscillation circuit, whose output frequency has a functional relationship with the input control voltage. When the low-frequency modulation signal enters the voltage-controlled oscillator, the output frequency f is at the free oscillation frequency f_0 changes up and down with the change of modulation signal, so as to realize the frequency modulation function [4].

VCO has good frequency stability, high control sensitivity and wide frequency modulation range. Therefore, VCO is selected here to realize the frequency modulation function.

3.2 The Determination of the Number of Network Layers

Input amplitude of audio signal:$U_\Omega = 200mV$,frequency:$f_\Omega = 2KHz$;

The voltage-controlled oscillator is actually measured: carrier frequency$f_c = 46KHz$, Maximum frequency offset$\Delta f_m = 100\text{KHz}$.

Bandwidth is in (1), (2):

$$m_f = \frac{\Delta f_m}{f_\Omega} = 50 \qquad (1)$$

$$BW = 2(m_f + 1)f_\Omega = 204KHz \qquad (2)$$

3.3 Matlab Simulation Results of VCO

The frequency modulation module of VCO is made by using Simulink in MATLAB, as shown in Figure 2.

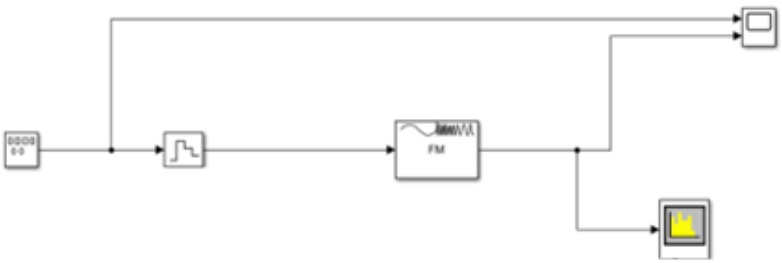

Fig.2 Simulation Diagram of Fm Module in Matlab

After using the data obtained in 2.2 to set the initial value for each module, measure the waveform of audio signal and adjusted signal on the oscilloscope and find that it is consistent with the principle and index, as shown in Figure 3.

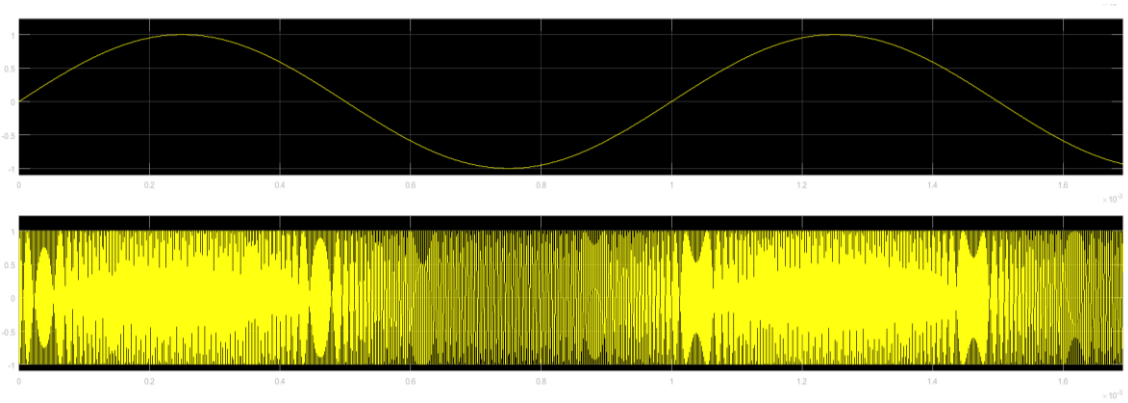

Fig.3 Simulation Result

The oscillation frequency is 46.5MHz. The pressure control sensitivity is calculated according to formula (3):

$$s = \frac{\Delta f}{\Delta U} = \frac{364KHz}{V} \tag{3}$$

4. Circuit Scheme Description of High Frequency Power Amplifier

4.1 Comparison and Selection of Circuit Schemes of High Frequency Power Amplifier

For different power amplifiers, according to their current conduction angle θ, its scope can be divided into class A, class AB, class C, etc. Current conduction angle of power amplifier θ the smaller the, the higher the efficiency of the amplifier η Higher [2]

Table.1. Comparison of Power Amplifier

Type	Current conduction angle	Efficiency η
Class A power amplifier	θ=±180o	25%
Class AB power amplifier	90 °≤θ≤180 °	50%
Class C power amplifier	θ≤90 o	80%

The selection of high frequency power amplifier shall meet the requirements that the power gain of the final stage power amplifier should not be too high, otherwise the circuit performance is unstable and easy to generate self-excitation. Compared with Class A and class C power amplifiers, class AB power amplifiers have less distortion and better sound quality. Therefore, class AB power amplifier is selected to realize the function of power amplifier. [5]

4.2 Calculation of Related Parameters of High Frequency Power Amplifier

For high frequency power amplifier:
Input:$R_i = 39K\Omega; U_i = 8V;$
Output:$R_o = 50\Omega; U_O = 2.5V;$
Input power P_i Output power P_o and power gain A_p The calculation is as follows: (4),(5),(6).

$$P_i = \frac{U_i^2}{R_i} = 2.6mW \tag{4}$$

$$P_o = \frac{U_o^2}{R_p} = 125mW \tag{5}$$

$$A_p = \frac{P_o}{P_i} = 48.1 \qquad (6)$$

4.3 Matlab Simulation Results of High Frequency Power Amplifier

The frequency modulation module of VCO is made by using Simulink in MATLAB, as shown in Figure 4

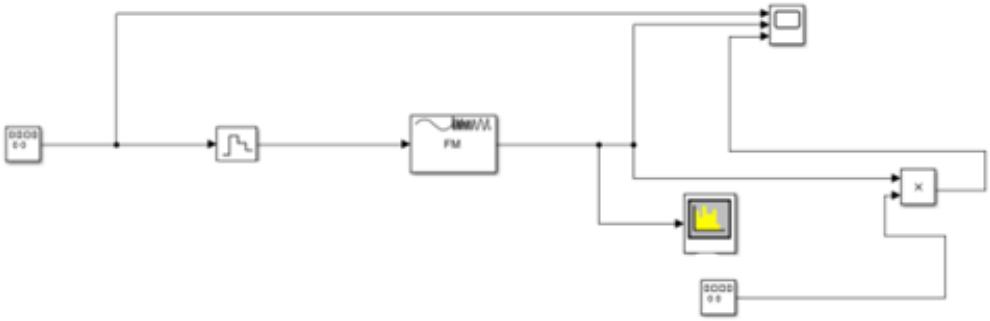

Fig.4 Simulation Diagram of High Frequency Power Amplifier in Matlab

Use the index designed in 4.2 to set the initial value for each module and measure $P_i = 2.68mW, P_o = 130mW, A_p = 48.5$, which shows that the simulation results are roughly consistent with the design indexes. See Table 2 for specific test results:

Table.2. Test Results of High Frequency Power Amplifier Module

Input voltage / V	7.41	7.6	7.83	7.92	8.05	8.21	8.3
Output voltage / V	1.80	1.95	2.05	2.26	2.45	2.61	2.78
Input power / MW	2.29	2.41	2.55	2.61	2.70	2.81	2.87
Output power / MW	64.80	76.05	84.05	102.152	120.05	136.242	154.568
Power gain	28.32	31.60	32.90	39.08	44.46	48.51	53.84

5. Results

This paper designs a wireless transmission system. The wireless FM transmitter consists of two modules: voltage-controlled oscillator and class AB high-frequency power amplifier, which are used to modulate the audio signal and output the signal received by the antenna. The wireless FM transmitter can generate a center frequency of 46.3mhz, the maximum frequency offset is 75khz, the bandwidth is greater than 150kHz, and the transmission power is not less than 0.1W.

6. Conclusions

This paper takes FM transmitter as the core, which is not only an understanding and test of the frame structure diagram and principle of FM process and high-frequency power amplifier, but also a training of design ability and independent innovation ability. This paper only designs the FM transmitter system from a shallow level, without considering more complex situations, so it still needs to be improved continuously. However, the design is only in the preliminary stage, and there are still many deficiencies that need to be improved.

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