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Wireless Transceiver System Based on BH1417F Transmitter Module and MC3362P Receiver Module for Mixed Transmission of Digital and Analog Signals

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Abstract

In this paper, a wireless transceiver system based on BH1417F transmitter module and MC3362P receiver module for mixed transmission of digital and analog signals is designed. In this system, the audio signal collected from the signal generator end, the digital signal collected from the digital input and the coding end, are processed by the combining circuit, and the obtained composite signal modulates the high-frequency carrier and transmits it through the antenna; receiving The terminal receives the modulated signal through the antenna, the signal is amplified by the high-frequency small signal amplifying circuit, and then the two signals of the sender are restored by the demodulation circuit, which are displayed by a digital tube and an oscilloscope respectively. This design makes full use of the existing equipment, so that the working center frequency is stable at about 25MHz, the channel bandwidth is less than 25kHZ, and the propagation distance is greater than 1m. The settings can be selected from no less than 3 carrier frequencies, of which the primary oscillator of the receiver is 36.6MHz. The two local oscillators are around 10.25MHz, and the waveform output by the demodulation has no obvious distortion. While receiving the analog signal as usual, it can also receive the high-speed digital information attached to the carrier.

Keywords

Wireless communication system; Modulation; Detection; BH1417F; MC3362P.

1. INTRODUCTION

The purpose of this paper is to design and manufacture a wireless transceiver that performs mixed transmission of digital and analog signals on the same channel. Among them, the digital signal is composed of a group of four numbers from 0 to 9: the analog signal is a voice signal, and the frequency range is 100Hz5kHz. Using wireless transmission, the carrier frequency range is 2030MHz, the channel bandwidth is not more than 25kHz, and the shortest transmission distance between the transceiver equipment is not less than 100cm. The transmitting end of the transceiver completes the digital signal and the analog signal combining processing, modulates and transmits in the same channel. The receiving end of the transceiver completes the receiving and demodulation, and separates the digital signal and the analog signal. The digital signal is displayed by a digital tube, and the analog signal is observed by an oscilloscope.

2. SCHEME DESIGN, COMPARISON AND DEMONSTRATION

2.1. Scheme Comparison and Demonstration

2.1.1 Comparison and selection of transmitter schemes

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Option 1: CC1070 chip single-chip RF transmitter adopts low-voltage power supply, the working voltage is 2.1-3.6V, and the output power is programmable; small size; with a variety of data modulation methods.

Option 2: The BH1417 chip adopts phase-locked loop frequency locking, which is composed of high-frequency oscillator, high-frequency amplifier and phase-locked loop frequency synthesizer. Integrated with the FM transmitter circuit, the transmitter frequency is very stable.

Option 3: The transmission range of BA1404 can reach hundreds of meters, mainly composed of preamplifier, stereo modulator, FM modulator and radio frequency amplifier. It has high integration, simple peripheral circuits, stable and reliable operation.

CC1070 is a monolithic FM transmitter, and it is complicated and unsuitable for a single module to transmit composite signals; BA1404 module is older than BH1417F, and it is difficult to buy in the market. To sum up, the transmitter selection scheme 2.

2.1.2 Receiver Scheme Comparison and Selection

Scheme 1: mc3362p chip includes oscillator, mixer, quadrature detector, meter driving circuit and carrier detection circuit; The center frequency of the demodulated FM signal is 455khz. The signal is divided into two channels, one directly enters the multiplier, and the other enters the multiplier through a phase-shifting network.

Scheme 2: cxa1538m integrated chip is adopted to change the oscillation frequency of FM high-frequency amplification tuning loop by adjusting the value of double adjustable capacitor CV, so as to select the frequency of received signal.

Scheme 3: si473x series radio module is adopted. The module is small, portable, built-in DSP low if architecture, provides three serial control modes, and is fully compatible with I2C bus.

The Si473x series chips need to be connected to the microcontroller module, and the system is more complicated and difficult to maintain; although the CXA1538M is used by many radios, it is prone to errors due to the large number of materials required for the peripheral construction. Therefore, the design of the receiver adopts the scheme one.

2.2. Overall Scheme Design

2.2.1 Transmitter Principle

The digital signal is input from the keyboard, and the analog signal generated by the function generator is superimposed in the combiner circuit through 2FSK frequency selection, limiter circuit, PD phase detector, VOC voltage controlled oscillator and other circuits. The composite signal is converted into a modulated signal through frequency modulation and amplitude modulation successively, and then the frequency is amplified by the power amplifier circuit and transmitted to the free space by the antenna.

2.2.2 Transmitter Principle

The modulated signal is received by the antenna, and digital and analog signals are obtained after pre-amplification, frequency mixing, IF amplification, frequency discrimination and diode envelope detection. The digital tube displays digital signals, and the oscilloscope displays analog signals.

3. CIRCUIT AND PROGRAMMING

3.1. Modulate the Emission Section

3.1.1 Limiting circuit

The function of the limiter circuit is to limit the amplitude of the output signal within a certain range. When the input voltage exceeds or falls below a certain reference value, the output voltage will be limited to a certain level and will no longer change with the input voltage.

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3.1.2 Frequency modulation circuit

The 2FSK signal communication method has strong anti-noise and anti-attenuation performance. There are two production methods. Frequency keying method: After two independent oscillators that generate sinusoidal oscillations pass through an electronic switch controlled by a digital baseband signal, the selected high-frequency oscillation signal is the FSK modulation signal. Direct frequency modulation method: use digital baseband signal to directly control the oscillation frequency of carrier frequency oscillator. Compared with the keying method of frequency modulation, the frequency stability of the signal generated by the direct frequency modulation method is worse than that of the signal generated by the keying method, and there is a transition frequency.

3.1.3 BH1417 phase-locked loop modulation circuit

Frequency modulation is realized by a high-frequency oscillator composed of varactor diodes (VCO), which is composed of the LC circuit outside the 9th pin and the internal circuit, and the oscillation signal is output from the 11th pin through the high-frequency amplifier. At the same time, it is sent to the phase-locked loop circuit for comparison, and the value of the high-frequency oscillator is corrected to ensure that the frequency is stable. The operating frequency of the crystal oscillator is 2MHz, and the passband bandwidth is 4MHz according to formula (2-1). The schematic diagram of the frequency modulation circuit is shown in Figure 1.

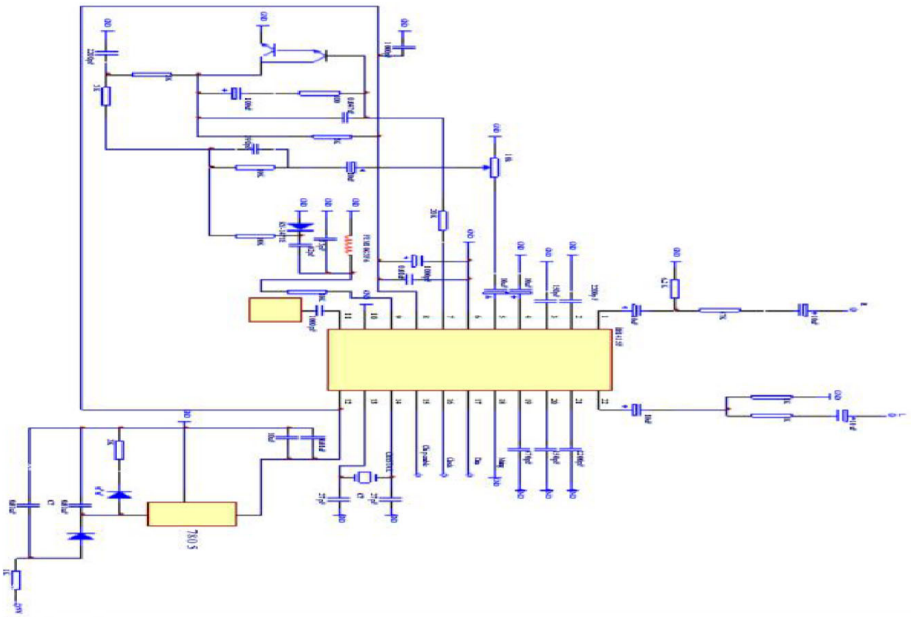

Figure 1. Frequency modulation circuit principle diagram.

3.1.4 Amplitude modulation circuit

The collector amplitude modulation circuit uses the low frequency modulation voltage to control the collector voltage of the transistor. Through the change of the collector voltage, the fundamental component of the collector high frequency current changes with the law of the modulation voltage to realize the analog signal amplitude modulation. In fact, it is a resonant power amplifier whose collector power is controlled by a modulating signal, which is a high-level amplitude modulation.

3.1.5 High frequency power amplifier circuit

The high-frequency power amplifier is used in the final stage of the transmitter. Its function is to amplify the power of the high-frequency modulated wave signal to meet the requirements of the transmission power, and then radiate it into the space through the antenna to ensure that

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the receiver in a certain area can Satisfactory signal levels are received without interfering with adjacent channel communications. The circuit is mainly composed of three parts: transistor, resonant circuit and input circuit. The resonant circuit is the load, which not only ensures that the output voltage is not distorted relative to the input voltage, but also has the function of impedance transformation. The circuit schematic diagram is shown in Figure 2.

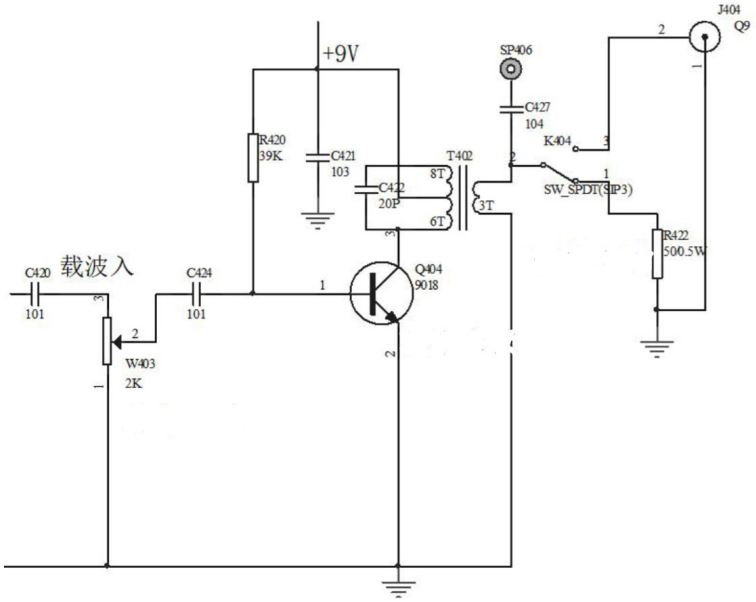

Figure 2. Schematic diagram of high frequency power amplifier circuit.

3.2. Receiving Demodulator Part

3.2.1 High-frequency small-signal amplification circuit

The high-frequency small-signal resonant amplifier is the front-end circuit of the receiving end of the communication machine. It is mainly used for linear amplification of high-frequency small signals or weak signals, so that it can reach a sufficient power level to improve the receiving sensitivity of the receiver. This circuit not only needs to amplify high-frequency signals, but also has a certain frequency selection function to filter out low-frequency interference signals. The circuit schematic is shown in Figure 3.

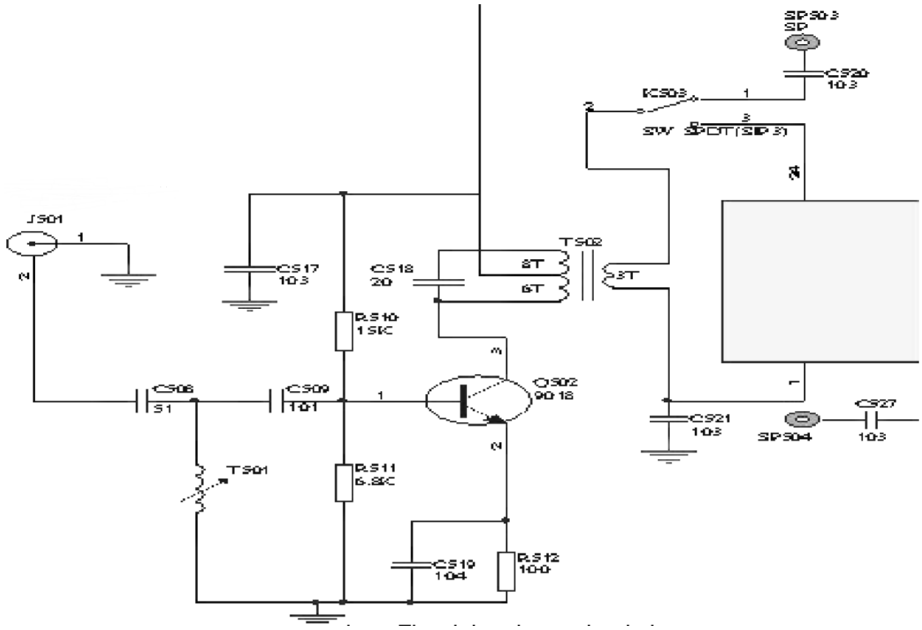

Figure 3. Schematic diagram of high frequency small signal amplifier circuit.

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3.2.2 Frequency demodulation circuit

The frequency demodulation circuit selects the MC3362P low-power narrow-band FM receiver chip, which can realize the functions of frequency mixing and frequency modulation at the same time. The signal output by the mixing frequency is the first intermediate frequency, which is generated by the T voltage-controlled oscillator, and the frequency is selected as 10.7MHz. Then the circuit obtains the second intermediate frequency signal 455kHz after two mixing. During frequency demodulation, the IF signal of 455kHz is coupled to the 7th pin of MC3362 through C526, and then divided into two channels into the multiplier, and the digital signal is recovered. The schematic diagram of the MC3362 circuit is shown in Figure 4.

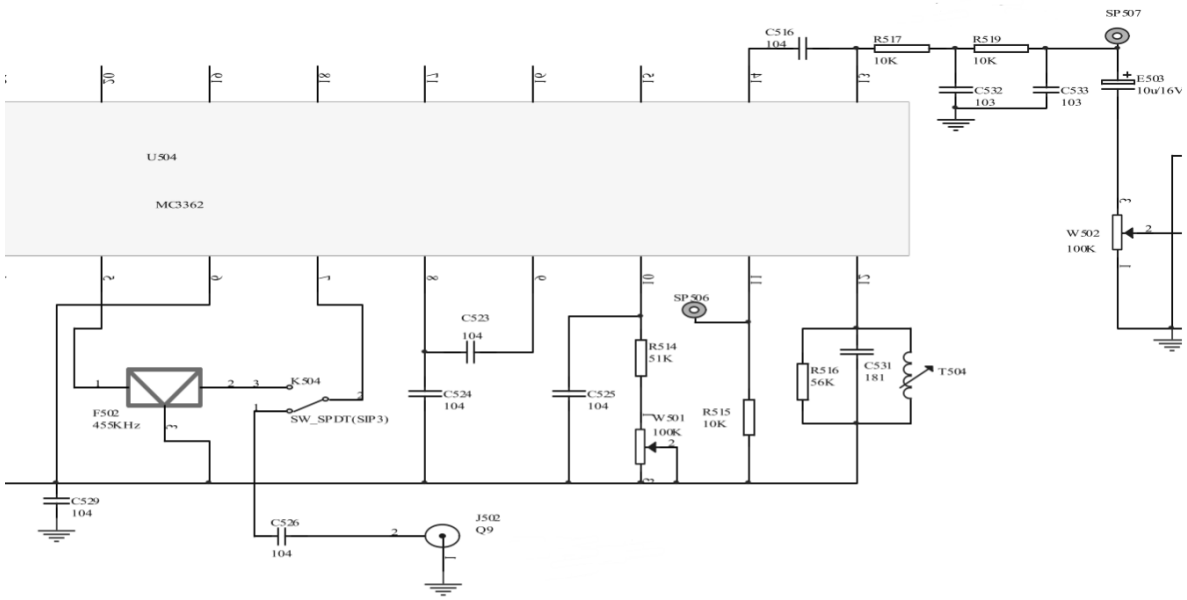

Figure 4. Schematic diagram of the MC3362 chip circuit.

3.2.3 Diode envelope detection

The detection diode has high detection efficiency and good frequency characteristics. Pass the AM signal through the detection diode. Due to the unidirectional conduction characteristics of the detection diode, the negative part of the AM signal is cut off, leaving only the positive part. At this time, for example, take the average value in each signal cycle (low-pass filtering), the obtained wave packet of the amplitude modulation signal is the baseband low frequency signal, which realizes the demodulation function of the analog signal. The circuit schematic is shown in Figure 5.

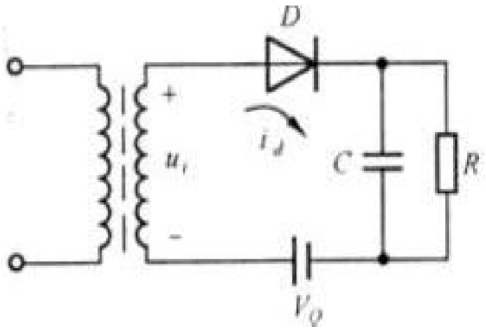

Figure 5. Schematic diagram of diode envelope detection circuit

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3.3. Digital Signal Transmission Program

The hardware part uses two STM32F103C8T6 microcontrollers for the communication transmission of digital signals, and the function is implemented through the USART asynchronous serial communication of the microcontroller. The digital signal input is typed using 4×4 keyboard buttons, which consist of 10 numeric keys from 0-9, a start key, and an end key.

3.3.1 Key setting

First, input a group of 4 numbers from 0 to 9 from the keyboard, press the send key, and the digital signal will be transmitted continuously and cyclically. Press the end key to end the transmission, clear the digital signal at the sending end and display "0000" on the nixie tube, waiting for a new signal to be entered. According to the definition of the pins of STM32F103C8T6 MCU, configure the pins of 10 buttons, and apply the interrupt service routine to realize the corresponding functions.

3.3.2 USART transceiver

When the send button is pressed, the sender will send the digital signal through USART serial communication, and the receiver will receive the data in the same way.

4. CONCLUSION

1. Realize analog signal transmission. The analog signal is a 2kHz voice signal, and the waveform of the analog signal demodulated at the receiving end has no obvious distortion. When only analog signals are transmitted, the digital display on the receiving end is off.

2. The transmission of the digital signal firstly uses a STM32F103C8T6 microcontroller to input and transmit the digital signal through the hardware. The signal enters the communication transmitter through 2FSK frequency selection. After modulation, it is demodulated and restored to the original signal by the receiver. Displayed by digital tube. Hardware transfers use the USART peripheral serial communication.

3. Realize the mixed transmission of digital-analog signal. The audio signal collected from the signal generator end, the digital signal collected from the digital input and coding end, are processed by the combiner circuit, and the composite signal is obtained after modulation. Then the demodulation circuit restores the two signals of the sender, and displays them with a digital tube and an oscilloscope respectively. The digital display is correct, and the analog signal waveform has no obvious distortion.

The frequency of the antenna end is measured by the signal generator without connecting any signal, and the test result is 25.8970621326MHz. Ensure that the peak frequency deviation setting frequency is less than 25KHz (frequency deviation meter), and the antenna length is less than 0.5 meters. According to formula (1-3), three groups of transceivers can be selected and set in no less than 3 carrier frequencies.

Carrier frequency selection; f1=25.8776MHz, f2=25.9746MHz, f3=26.0231MHz.

Corresponding to the local oscillator is respectively: F1 = 36.5776 MHz, F1 = 36.6746 MHz, F1 = 36.7231 MHz.

After testing, all three groups of data can get the correct output signal. This design completes the wireless transceiver system of digital-analog signal mixed transmission. After the analog signal and the digital signal are mixed and transmitted through the combining circuit, they are modulated and sent on the same channel. The receiving end can correctly demodulate the digital signal and the analog signal, the digital display is correct, and the analog signal waveform has no obvious distortion.

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