Electrical Engineering Experiment

Study on Bipolar Junction Transistors Amplifiers

1. Abstract (In this part, the principle and significance of the experiment should be briefly explained, within 120 words.)

【Significance】

The problem of static working point stability not only determines whether the amplifier will produce nonlinear distortion, but also affects the dynamic performance of the amplifier. In practical application, the change of ambient temperature will cause the instability of the static working point and affect the normal operation of the amplifier circuit.

【Principle】

Because the transistor is made of semiconductor material, like diode, temperature has a great influence on the characteristics of transistor. The influence can not be ignored. It increases with the increase of temperature

In BJT amplifier circuit static working point stability analysis, we to shoot the stability of the amplifier circuit static working point as the main line, through the Multisim simulation found the problem, and then analysis the reason, and then through the study of the improvement to solve the problem of circuit, and is verified by Multisim simulation experiment, which will solve how to stabilize the process of static working point.

2. Experimental Process (Record the steps of simulation and experiment.)

【Progress of experiment】

(1) Use Multism software to construct basic amplifying circuits, measure and record V_{CEQ} and input/output waveforms, as well as amplifying effects.

(2) Multism software is used to construct partial voltage amplifier, introduce dc negative feedback, measure and record V_{CEQ} and input/output waveforms, and amplify effects.

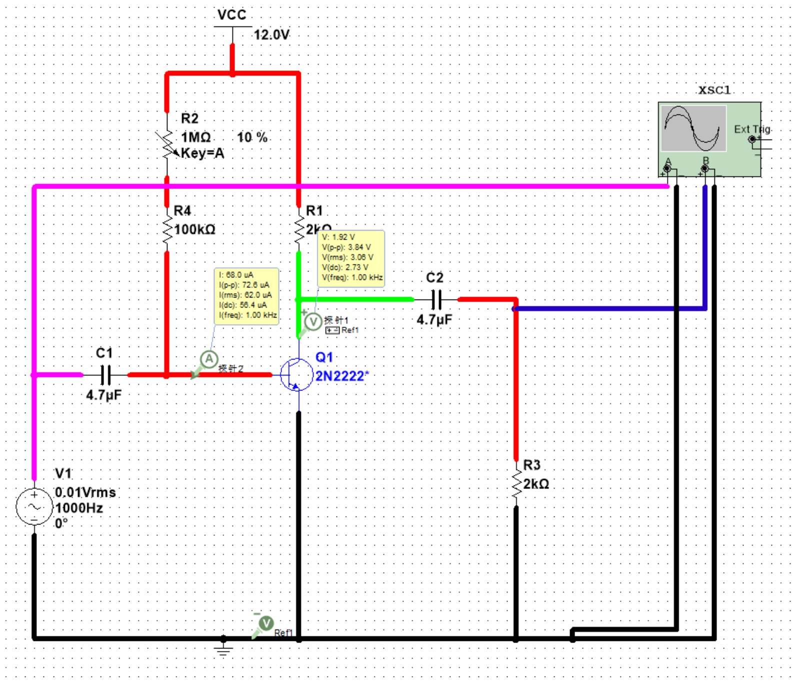
(3) Multism software is used to construct partial pressure biased large circuits, introduce temperature compensation, measure and record V_{CEQ} and input/output waveforms, and amplify effects.

(4) Multism software is used to construct r emitter bias amplifier circuit, measure and record V_{CEQ} and input/output waveforms, as well as amplifying effects.

(5) The stability and amplification gain of static working point under different circuits are compared and analyzed.

【Results of experiment】

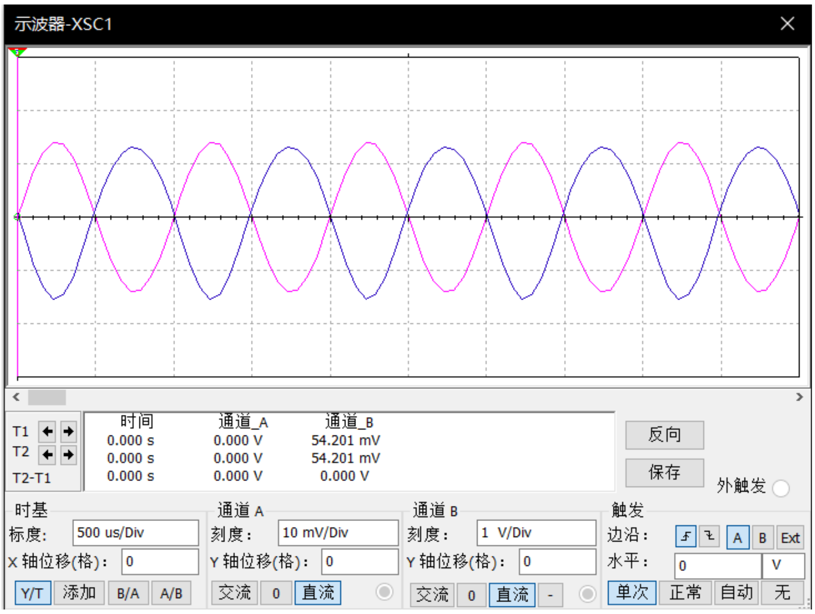
(1) Basic amplifying circuits



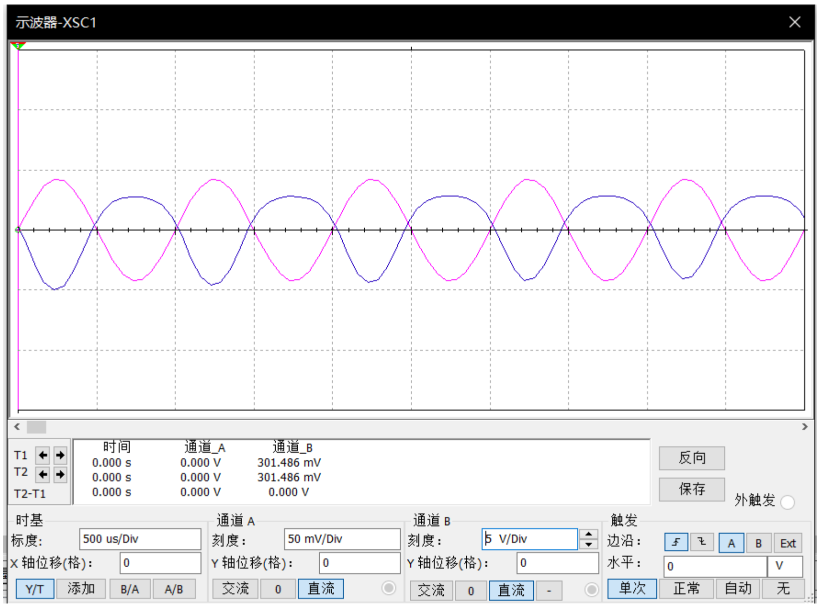
Picture 1 Basic amplifier circuit

Table 1 Data of basic amplifier circuit

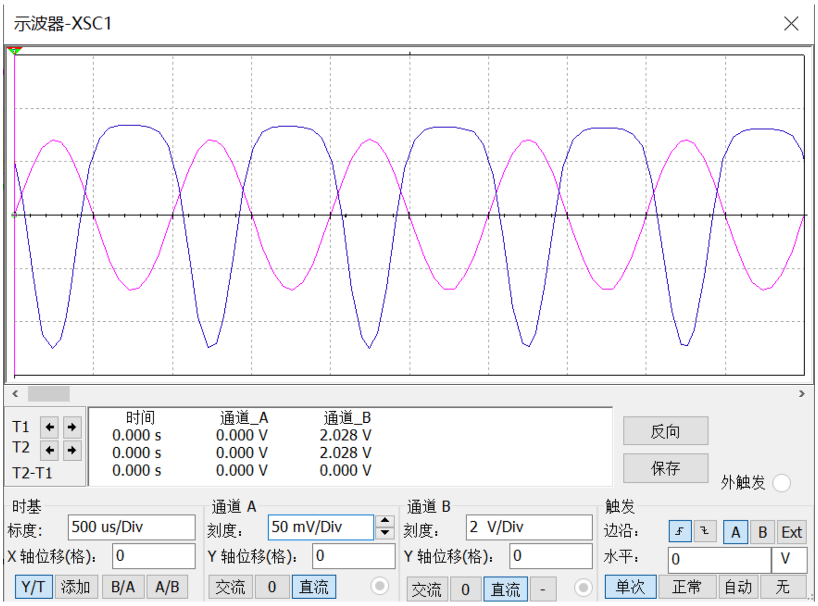
Temperature	V_{CEQ}(V)	Inputoutput waveform
27°C	5.42	Full waveform
17°C	5.69	Distortion at the bottom
37°C	5.15	Bidirectional distortion



Picture 2 Input and output waveform of basic amplifier in 27°C

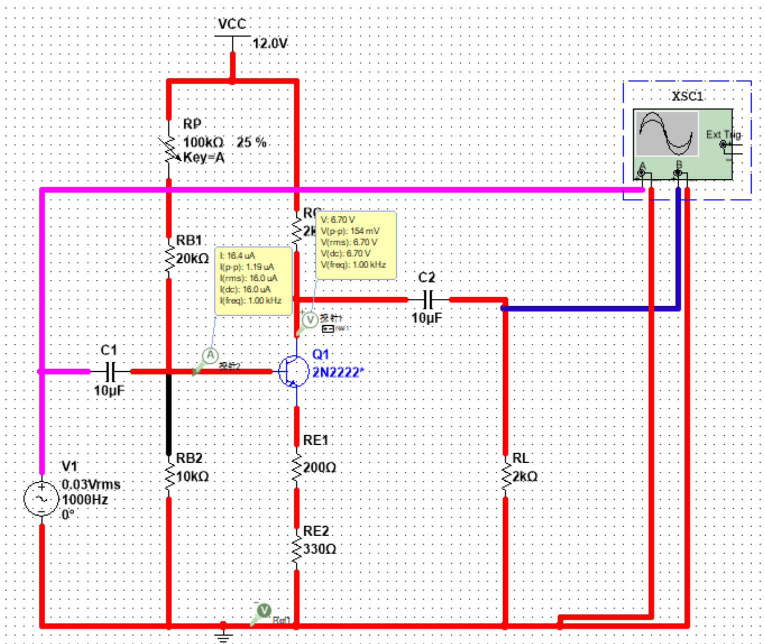


Picture 3 Input and output waveform of basic amplifier in 17°C



Picture 4 Input and output waveform of basic amplifier in 37°C

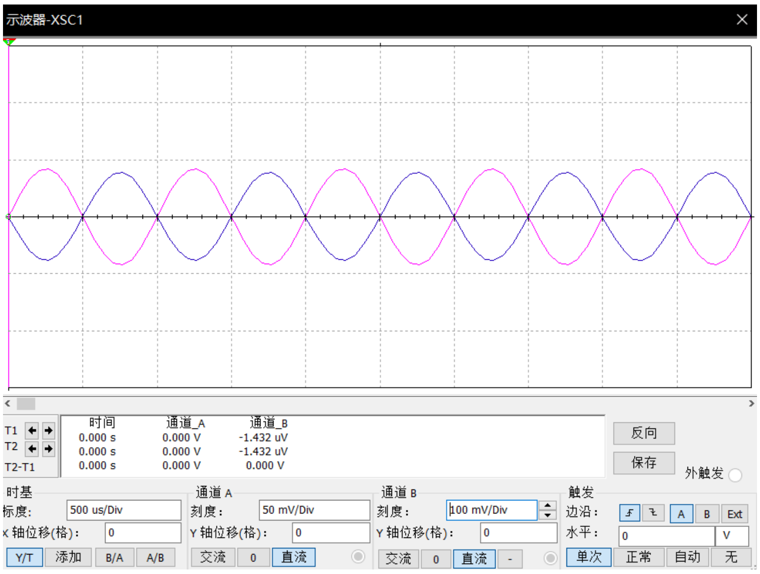
(2) Partial voltage amplifier with DC negative feedback



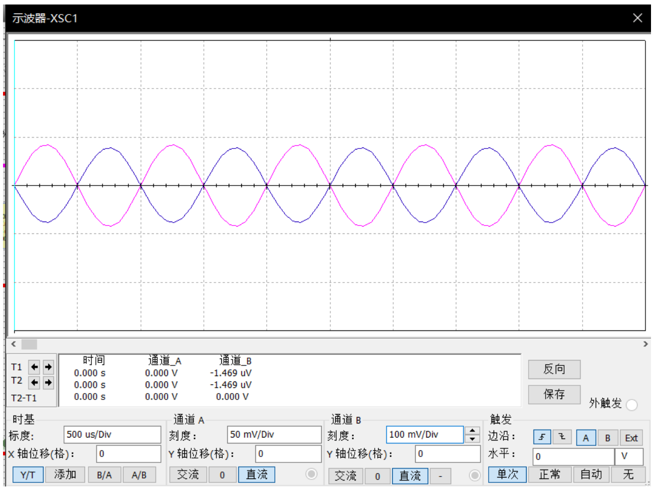
Picture 5 Partial voltage amplifier with DC negative feedback

Table 2 Data of partial voltage amplifier with DC negative feedback

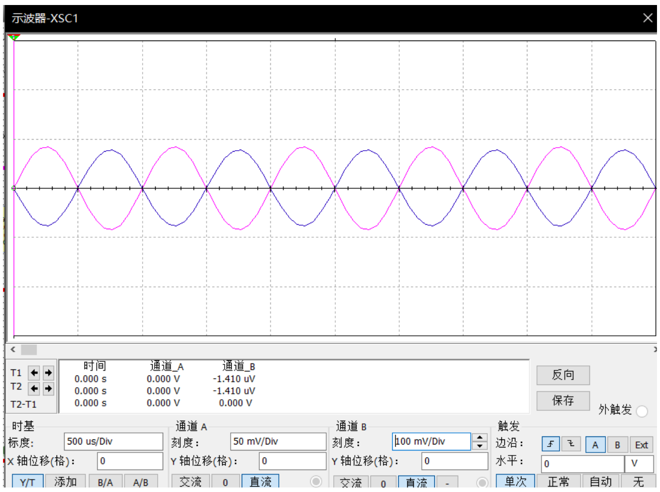
Temperature	V_{CEQ}(V)	Inputoutput waveform
27°C	12	Full waveform
17°C	12	Full waveform
37°C	12	Full waveform



Picture 6 Input and output waveform of partial voltage amplifier with DC negative feedback in 27°C

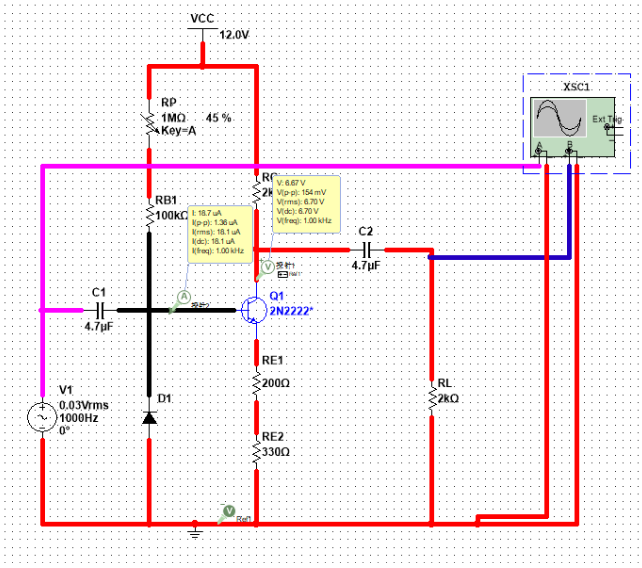


Picture 7 Input and output waveform of partial voltage amplifier with DC negative feedback in 17°C



Picture 8 Input and output waveform of partial voltage amplifier with DC negative feedback in 37°C

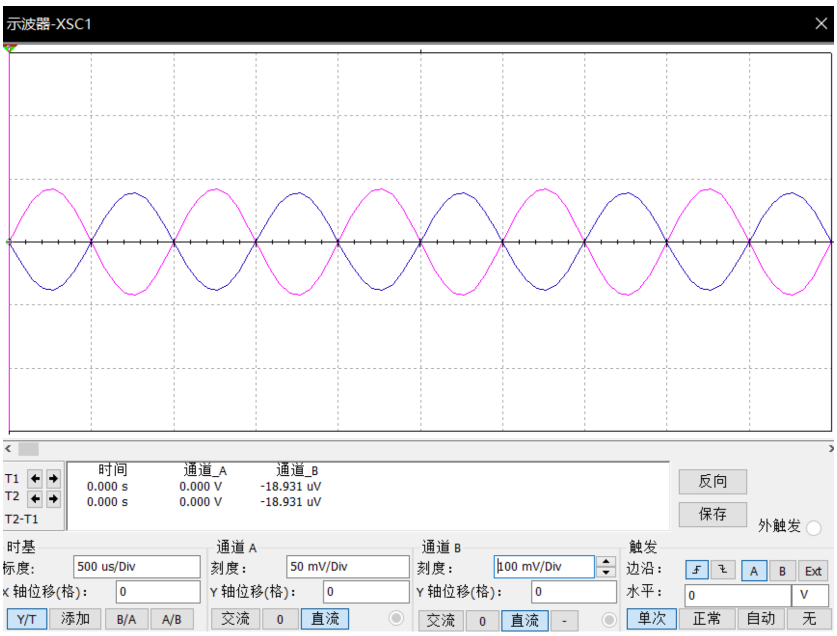
(3) Partial voltage amplifier with temperature compensation



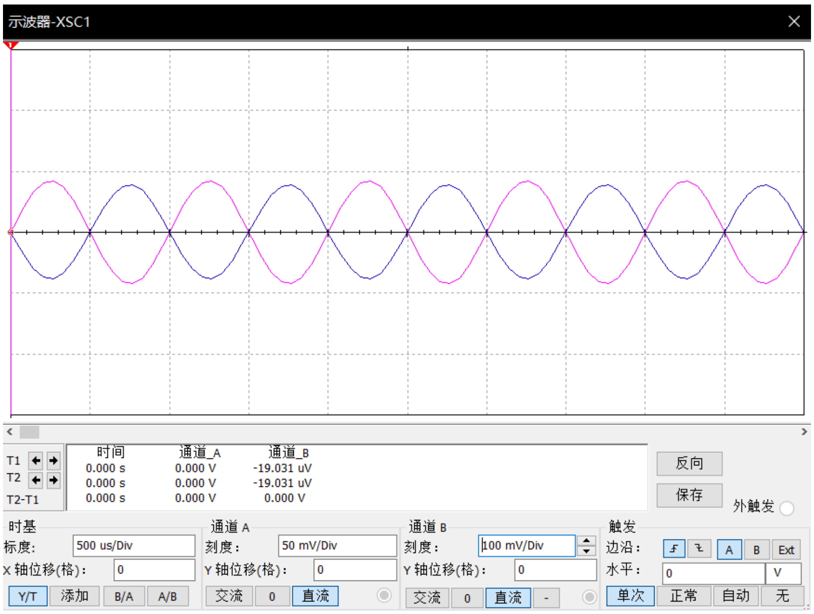
Picture 9 Partial voltage amplifier with temperature compensation

Table 3 Data of partial voltage amplifier with temperature compensation

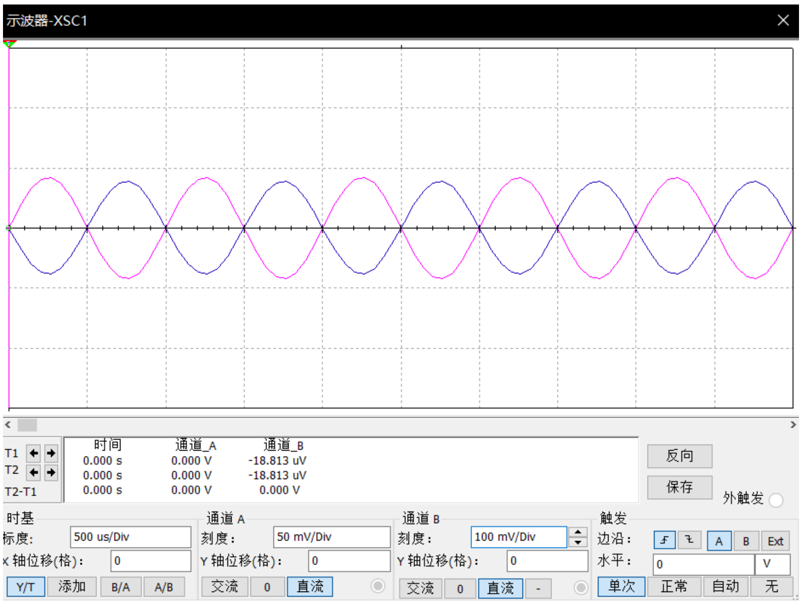
Temperature	V_{CEQ}(V)	Inputoutput waveform
27°C	6.5	Full waveform
17°C	6.7	Full waveform
37°C	6.3	Full waveform



Picture 10 Input and output waveform of partial voltage amplifier with temperature compensation in 27°C

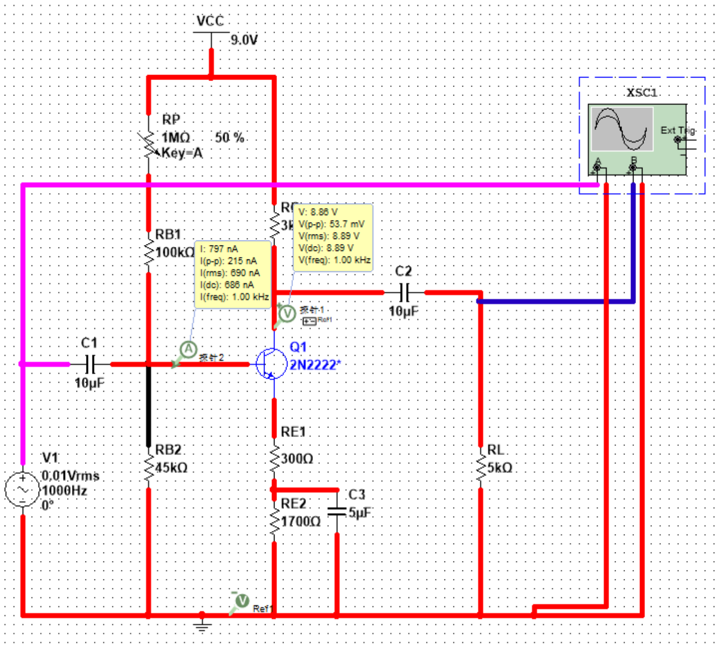


Picture 11 Input and output waveform of partial voltage amplifier with temperature compensation in 17°C



Picture 12 Input and output waveform of partial voltage amplifier with temperature compensation in 37°C

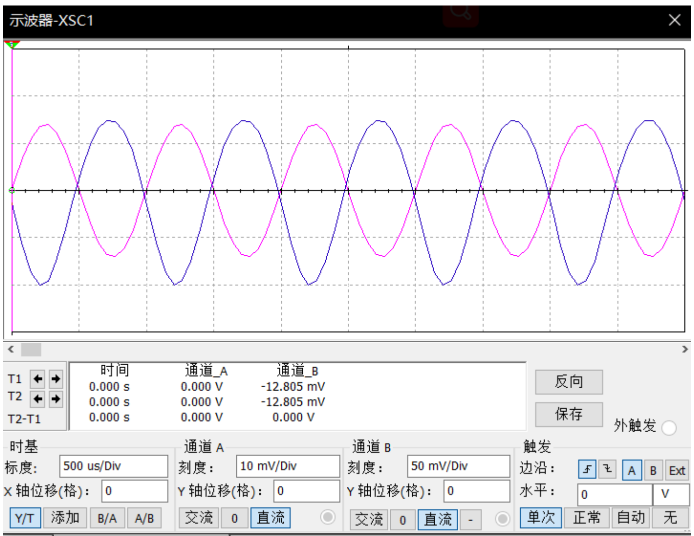
(4) Emitter bias amplifier circuit



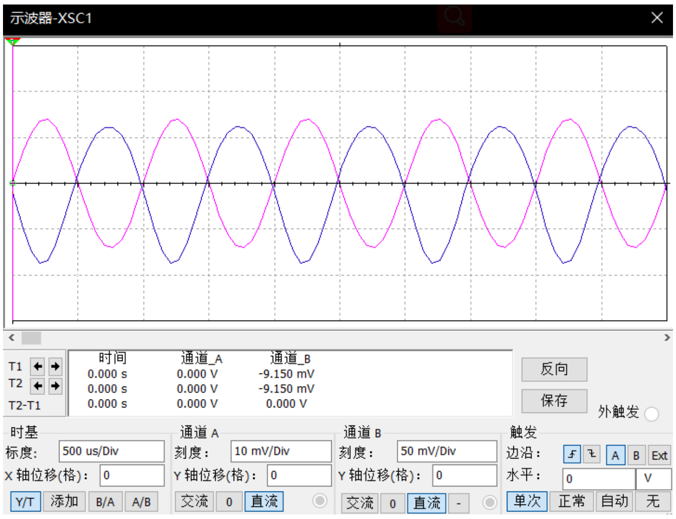
Picture 13 Partial voltage amplifier with temperature compensation

Table 4 Data of emitter bias amplifier circuit

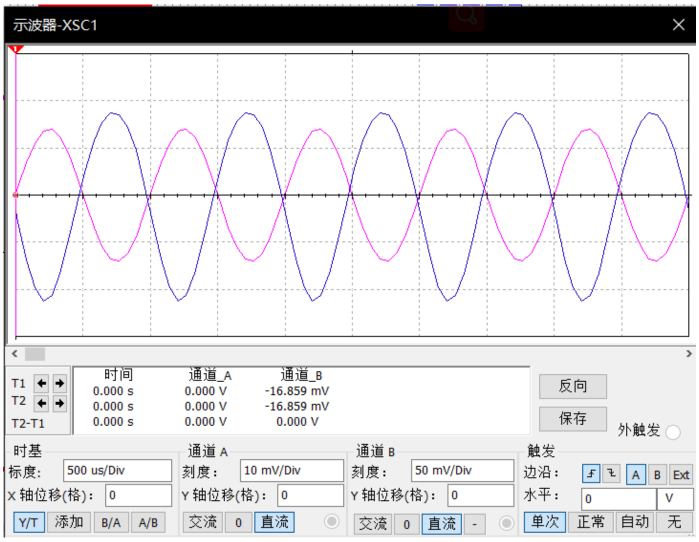
Temperature	V_{CEQ}(V)	Inputoutput waveform
27°C	12	Full waveform
17°C	12	Full waveform
37°C	12	Full waveform



Picture 14 Input and output waveform of emitter bias amplifier circuit in 27°C



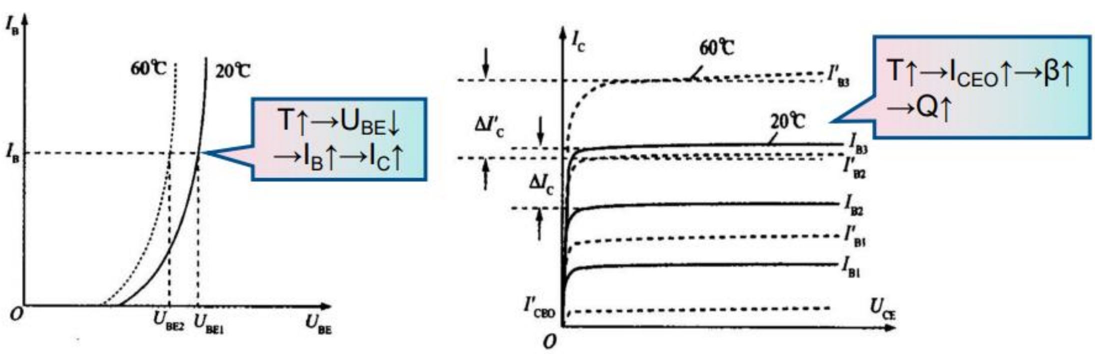
Picture 15 Input and output waveform of emitter bias amplifier circuit in 17°C



Picture 16 Input and output waveform of emitter bias amplifier circuit in 37°C

3. Experimental Discussion

(1) Analysi



温度对三极管输入输出特性的影响

Picture 17 Influence of temperature on input and output characteristics of triode

As is shown in the graph, the effect of temperature on U_{BE}, I_{CBO} and β is reflected in the collector current I_C. The I_C increases with the increase of temperature. On the output characteristic curve, the distance between curves varies with

(2) How's the temperature stability of different circuit?

For basic amplifying circuits, the difference of V_{CEQ} in 17℃ and 37℃ are 5.69-5.42=0.27V and 5.42-5.15=0.27V, so it has very low stability;

For partial voltage amplifier with DC negative feedback, $V_{CEQ} = 12V$ and the waveform keep stable in different temperature, because $U_{BE} \approx \frac{R_{b1}}{R_{b1}+R_{b2}} \cdot V_{CC}$, $I_{EQ} \approx \frac{U_{EQ}-U_{BEQ}}{R_e} \cdot V_{CC}$.

For partial voltage amplifier with temperature compensation, V_{CEQ} is around 6.7V and the waveform keep stable in different temperature, because the temperature sensitive device can directly affect the input loop when the temperature changes

For emitter bias amplifier, $V_{CEQ} = 12V$ and the waveform keep stable in different temperature.

(3) How's the voltage gain of different circuit?

According to the pictures of oscilloscope:

For basic amplifying circuits, the voltage gain is around 100 times;

For partial voltage amplifier with DC negative feedback the voltage gain is around 2 times 2;

For partial voltage amplifier with temperature compensation the voltage gain is around 2 times;

For emitter bias amplifier the voltage gain is more than 5 times.

(4) What is the direct relationship between voltage gain and temperature stability?

Using the working temperature regulation function of Multisim, the circuit is scanned at the temperature of 27 ℃,17℃ and 37℃ respectively, and the difference of output waveform at different temperatures is analyzed.

It can be seen that the partial voltage emitter bias circuit sacrifices the voltage gain at the expense of temperature stability.

(5) Why emitter bias amplifier's temperature stability and voltage gain are both good?

Capacitor C_3 has the function of isolating DC and transmitting AC, which does not affect DC, but also has a by-pass effect on AC signal on resistance R_2, so that the AC amplification capacity of amplifier circuit will not be reduced due to the presence of R_2.