Experiment 5: Common – Emitter Amplifier

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Aim

1. Handle electronic instruments properly.
   Include： DC power supply, oscilloscope, function generator, AC millivoltmeter, digital multimeter.
2. Learn to adjust the quiescent point of an amplifier, and know test method of its characteristic parameters .
3. Strengthen amplifier theory involved, and study to design and adjust an amplifier.

Principle and method

Function: signal (voltage or current) amplifier. Here, Ui →Uo
Characteristic: common emitter (input and output)
Testing method
First, adjust circuit to proper quiescent point
Then with no output wave distortion, test dynamic values of input and output

Experiment circuits

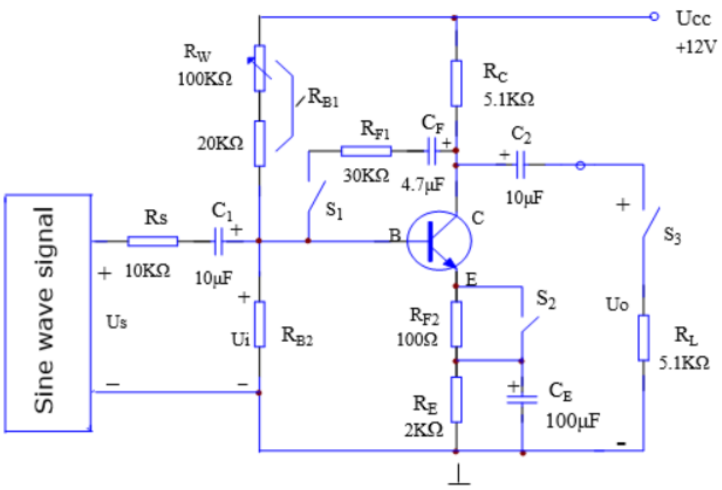


Diagram2 Common – Emitter Amplifier Circuit Diagram

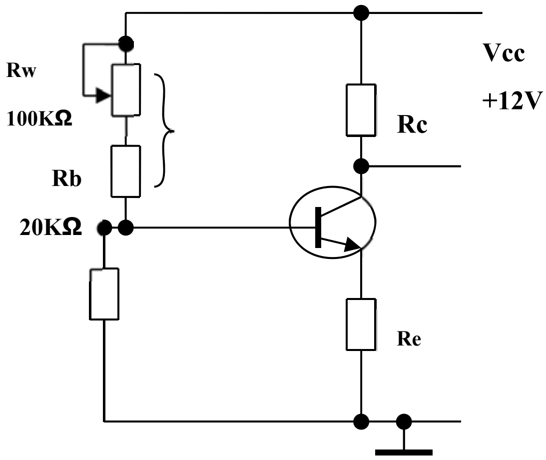


Diagram2. Direct current pass of common

Instruments

DC power supply, oscilloscope, function generator, AC millivoltmeter, digital multimeter.

Tasks

1. Power off the DC supply.
2. Construct common emitter amplifier circuit according to Diagram2. (based on Diagram1.)
3. Power on DC power supply.
4. Power on function generator, setting up an input signal of sine wave , and f= 1kHz , Ui=8mv.

(1) Turn the amplitude knob while measuring Ui with voltmeter.

(2) Use attenuation buttons.

5. Connect the two channels of oscilloscope to Ui and Uo, and watch the waves of input and output.
6. Measure Us, Uo, URL under the circumstance : no distortion of output wave. （teacher checking） Then fill in Table 2.
7. Switch on S1 to add voltage negative feedback, repeat above measurements and calculation.
8. Based on step7, measure A and ro when Rs=0, in order to compare them with those values when Rs ≠ 0.
9. Study the relationship between output wave and the quiescent point.

Adjust to get 3 different distortion waves （teacher checking）, record waves and corresponding work point , telling distortion type. Fill them in table 3.

10. Add current negative feedback, measure dynamic parameters, and compare them with above results, explaining feedback functions.

Data collation and analysis

Task 1~3: adjust circuit to proper quiescent point

β=141.2

U_e	U_b	U_c	$U_{be}=U_b-U_e$	$U_{ce}=U_c-U_e$
2.035V	2.661V	6.686V	0.626V	4.025V

Ue is about 2V, so I_E = 1mA.

Task 4~6 : test dynamic values of input and output

Rs=10kΩ R_L=5.1kΩ

U_i(mv)	U_s(mv)	U_o(v)	U_{RL}(v)	$Av=-U_o/U_i$	$r_i=R_sU_i/(U_s-U_i)$ (Ω)	$r_o=(U_o/U_{RL}-1)R_L$ (Ω)	$A_s=-U_o/U_s$
8.08	30.42	1.397	0.699	-171	3617	5093	-46

Task 7

U_i(mv)	U_s(v)	U_o(v)	U_{RL}(v)	$Av=-U_o/U_i$	$r_i=R_sU_i/(U_s-U_i)$ (Ω)	$r_o=(U_o/U_{RL}-1)R_L$ (Ω)	$A_s=-U_o/U_s$
8.013	0.255	0.716	0.670	-89	324	350	-2.8

When S1 turn to ON, voltage parallel negative feedback is added.

From this set of data, we can summarize that negative feedback will reduce Av. But at the same time, voltage connection method will reduce r_o, and parallel connection will reduce r_i. So, this kind of negative feedback has great load capacity.

Task8 Rs=0

U_i(mv)	U_s(mv)	U_o(v)	U_{RL}(v)	$Av=-U_o/U_i$	$r_i=R_sU_i/(U_s-U_i)$ (Ω)	$r_o=(U_o/U_{RL}-1)R_L$ (Ω)	$A_s=-U_o/U_s$

8.054	8.054	1.118	0.674	-139		3360	-139

If an amplifying circuit has low ri, the change of the upper circuit will significantly influence dynamic values of this circuit. For instance, with the same Ui, the Uo in task 8 is obviously bigger than Uo in task 7.

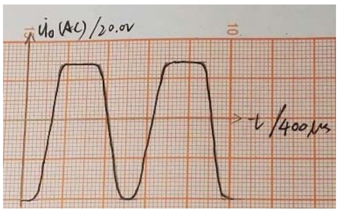
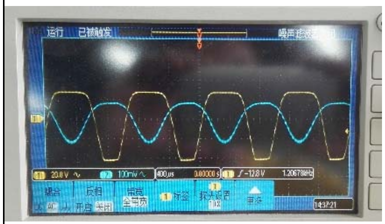
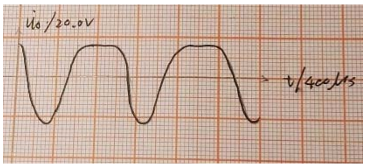
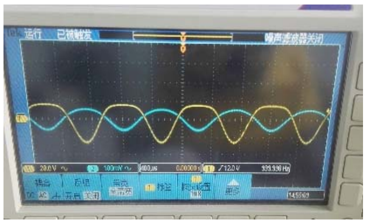
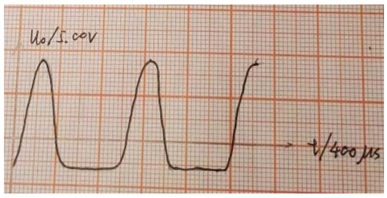
Task10

U_i(mv)	U_s(mv)	U_o(v)	U_{RL}(v)	$Av=-U_o/U_i$	$r_i=R_sU_i/(U_s-U_i)$ (Ω)	$r_o=(U_o/U_{RL}-1)R_L$ (Ω)	$A_s=-U_o/U_s$
8.040	16.347	0.267	0.135	-33	9678	4987	-16

In this circuit, the series current negative feedback is added. According to circuit theory, series current negative feedback could increase ri and increase ro. But from my data, ro is smaller, this means when measure values of ro, some mistakes have been made.

Task 9:

Distortion / Types	Normal	Cut-off	Saturation
U_b (v)	2.074 (this might be wrong)	1.832	3.833
U_c (v)	6.577	8.751	3.662
U_e (v)	2.073	1.242	3.193
$U_{be}=U_b-U_e$ (v)	0.001	0.590	0.640
$U_{ce}=U_c-U_e$ (v)	4.504	7.509	0.469

Waves	 	 	 
reasons	Quiescent point didn’t change, but Vrms of Ui is too large, so the top and the bottom of Uo has cut-off and saturation distortion. In theory, Ube is around 0.7V, so after comparing with other classmates, I think I measure Ub wrongly.	When quiescent point is too low, a part of signal fall into the cut-off area. In order to show waveform clearly, I turn up Vrms. And because common emitter amplifier will plus 180° phase to Uo, the top of waveform is flat.	When quiescent point is too high, a part of signal go up into the saturation area. So the bottom of waveform is flat.

Summary and problem discussion

Feedback can change many parameter of circuit, we should choose proper feedback to meet different aims. And after every measurement, I should check the data according to theory. If the circuit has many test point, measurement should be cautious and careful, in case get a wrong data because of misoperation.