UNIVERSITY OF CALIFORNIA AT BERKELEY
College of Engineering
Department of Electrical Engineering and Computer Sciences

EE105 Lab Experiments

Report 5: Single Stage BJT Amplifiers: Common Collector and Common Base

Solutions

1 Lab Questions — Solutions

3.1.2–4 CB Amplifier Parameters

$\boxed{A_v = 86.3}$

$\boxed{R_{in} = 11.15\ \Omega}$

$\boxed{R_{out} = 925\ \Omega}$

3.1.5 Suppose the source resistance of V_{IN} is 50 Ω. Would the CB amplifier amplify a signal from this source well? Why?

No, it would not. The input impedance of the CB amplifier is way too low for it to be an effective voltage amplifier. A source with an output impedance of 50 Ω would lose most of its input signal to the source resistance.

3.2.2 DC voltage values when biased at maximum output voltage swing:

$\boxed{V_{IN} = 6.350\ \text{V}}$

$\boxed{V_{OUT} = 5.700\ \text{V}}$

$\boxed{\text{Output Voltage Swing} = 11.300\ \text{V}}$

3.2.3 CC amplifier parameters:

$\boxed{A_v = 0.996}$

$\boxed{R_{in} = 23.7\ \text{k}\Omega}$

$\boxed{R_{out} = 16\ \Omega}$

3.2.4 Another name for the CC amplifier is the emitter follower. Based on the gain that you have found, why do you think it has this name?

The gain is unity. Thus, the output voltage "follows" the input voltage.

3.3.3 Is the output of the common collector speaker amplifier louder, quieter, or about the same as when the signal was directly applied using the function generator? Why? (*Hint: The output impedance of the function generator is* 50 Ω.)

The output from the CC should be much louder. Despite its unity gain, it has a much lower output impedance than the signal generator, thus it will be able to deliver more power to the speaker.

2 Post-lab Questions

2.1 Common Collector Amplifier as a Voltage Buffer

1. Even though the common collector amplifier has almost unity gain, why is it still a useful amplifier configuration?

   The common collector is extremely useful because it has a high imput impedance and a very low output impedance. Thus, the CC amplifier serves as a voltage buffer—it isolates the voltage source from the load. In other words, the voltage source cannot feel the power hungry load as the CC amplifier is the one that is actually driving it.

2. What are the advantages or disadvantages of using a larger R_E in our common collector amplifier?

   Possible advantages of a larger R_E include lower power consumption and higher input impedance. The primary disadvantage is a decrease in I_C, resulting in a decrease in g_m and a higher output impedance.

2.2 Common Base Amplifier as a Current Buffer

1. The CB amplifier is rarely used as a voltage or transconductance amplifier; the CE amplifier is typically used instead. Based on the values of the CB and CE amplifier two-port parameters you found during the labs, explain why this is the case.

   The voltage gain and output impedance of the CB amplifier are very similar to those of the CE amplifier. The severe handicap of the CB amplifier is its extremely low input resistance, thus making it not suitable for a voltage input.

2. The CB amplifier is commonly used as a current amplifier. Approximate the current gain of a CB amplifier (*Hint: What is the relationship between the emitter and collector currents of a CB amplifier?*) Draw the two-port model of the CB current amplifier and find A_i.

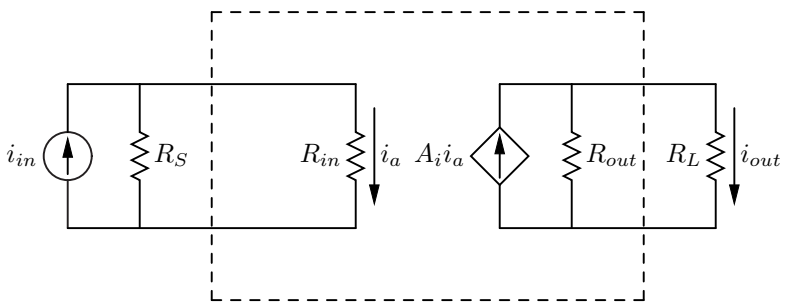

Figure 1: CB current amplifier model

$$A_i = \frac{I_C}{I_E} = \boxed{\frac{\beta}{\beta + 1}} \approx 1$$

3. Suppose that a small signal current of 10 µA peak-to-peak is applied directly to a load resistor of 5 kΩ. Assuming the source resistance is 100 Ω, what is the peak-to-peak current flowing through the load resistor?

$$I_{out} = I_{in} \frac{R_S}{R_S + R_L} = \boxed{1.67\ \mu A}$$

4. Now, assume the small signal current of 10 µA peak-to-peak with source resistance of 100 Ω is applied to the input of the CB amplifier. Assume a 5 kΩ load resistor is also attached to the output of the CB amplifier. Using the two port characteristics found during lab and the approximated current gain, what is the current flowing through the load resistor? Based on this result, why is the CB amplifier used as a current buffer?

$$I_{out} = I_{in} \frac{R_S}{R_S + R_{in}} A_i \frac{R_{out}}{R_{out} + RL} = \boxed{6.20\ \mu A}$$

It is a current buffer because it is able to isolate a current source from a high impedance load. The low input impedance of the CB amplifier will take in most of the input from the current source, while its high output impedance allows more current to flow through the load resistor.