1430
TRANSISTORS
EXPERIMENT 10,
THE COMMON-COLLECTOR
AMPLIFIER

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OBJECTIVES

1. To measure the current, voltage, and power gains of the CC amplifier

2. To measure the input impedance of the CC amplifier

CC = Common Collector
INTRODUCTION

• The following slide shows a basic common-collector amplifier.
  • Note that the input signal is applied to the base, and the output signal is taken off at the emitter, leaving the collector, which is at AC ground, as the “common”.
BASIC COMMON-COLLECTOR AMP
We will use a larger value of emitter resistance than we did for the common-base and common-emitter amplifiers, because we want the base current to be the same as it was for those amplifiers which had collector resistors.
REQUIRED PARTS

1  8200Ω, ½ W resistors (grey-red-red)
3  10kΩ, ½ W resistors (brown-black-orange)
3  10μF electrolytic capacitors
1  MPSA-20 (NPN) silicon transistor
PROCEDURE

1. Construct the circuit in the following diagram.

2. Turn the trainer on and adjust the positive power supply to 15 V.
   a) Adjust the FREQUENCY control so the output is 1 kHz
CC PICTORIAL DIAGRAM FOR EXP. 10
3. Measure the voltages on the emitter and base, and compare them to the ones shown on the previous diagram.

4. Adjust the 1 kΩ potentiometer \( (R_1) \) so the output is 0.5 V rms.

5. Measure the voltage going into the amplifier \( (V_i) \).
   
a) Record the voltage measurement
6. Use the formula $A_v = \frac{V_o}{V_i}$ to calculate the voltage gain.
   a) Record the voltage gain calculation

7. Modify the constructed circuit to match the circuit on the following slide.
   a) Adjust the 100 kΩ Pot (R6) fully counterclockwise (thus making it 0 Ω)
EXPERIMENT 10 MODIFICATION CIRCUIT
EXP. 10 MODIFICATION CKT. PICTORIAL
b) Adjust the 1 kΩ pot (R₁) so the output is 0.2 V rms.

1. Then readjust the 100 kΩ pot (R₆) so the output is 0.1 V rms.

2. Turn off the trainer, and measure the resistance between terminals 1 and 2 of the 100 kΩ pot (R₆).

1. Record this resistance value
8. Use the formula $I_0 = \frac{V_0}{R_L}$, and the values of $V_0$ (0.5 V) and $R_L$ (10 k $\Omega$) to calculate the output current.
   
   a) Record your current calculation
   
   b) Using the formula $I_i = \frac{V_i}{Z_i}$, and the values of $V_i$ (step 5) and $Z_i$ (step 7) that you recorded earlier to calculate the input current.

   1. Record the input current calculation
9. Use the formula $A_p = A_v A_i$ to calculate the current gain of the amplifier.
   a) Record the power gain calculation
5. 0.55 V
6. 0.91...\(A_v = \frac{V_o}{V_i} = 0.05 \text{ V} / 0.55 \text{ V} = 0.91\)
7. 3520 \( \Phi \)
8. 0.02 mA; 0.16 mA; 0.125 mA
   \(I_o = \frac{V_o}{R_L} = 0.20 \text{ V} / 10^4 \Phi = 0.02 \text{ mA} = 20 \\mu\text{A}\)
   \(I_i = \frac{V_i}{Z_i} = 0.55 \text{ V} / 3520 \Phi = 0.16 \text{ mA} = 160 \\mu\text{A}\)
   \(A_l = \frac{I_o}{I_i} = 0.02 \text{ mA} / 0.16 \text{ mA} = 0.125\)
9. 0.114...\(A_p = A_vA_l = 0.91 \times 0.125 = 0.114\)
FINAL DISCUSSION

• We were able to measure the input voltage directly since the voltage gain of the common-collector (CC) amp is always less than 1.

• The input impedance was about equal to the parallel resistance of the biasing resistors.
• This indicated the transistor itself had little effect on the input impedance.

• We could not measure the output impedance, because loading the transistor with the right impedance would distort the signal, and the meter would not accurately indicate the true effective value of the signal.
The actual output impedance of the CC amp is less than 100 Ω. This makes CC amps useful in matching high-impedance signal sources to low-impedance loads.

The current gain of this amplifier was low, since we used a 10 kΩ load resistance.

The low output impedance of the amp indicates that it could have driven a smaller load resistance.
• Though, we used a 10 kΩ load resistance for purposes of comparison with the other amplifiers discussed in this lesson

• The power gain of the common-collector amplifier can often be significant; however, in this case, the amplifier was not very well matched to the load
SUMMARY OF LESSON 1430

- For those of you who have completed all the experiments: Use the data from your experiments to fill out the data table on the following slide.
- Then compare your results with the data table which follows the next slide to see how your results compare with CIE’s results.
<table>
<thead>
<tr>
<th></th>
<th>Voltage Gain</th>
<th>Current Gain</th>
<th>Power Gain</th>
<th>Input Z</th>
<th>Output Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Base</td>
<td></td>
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<td></td>
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<tr>
<td>Common Emitter (Bypassed)</td>
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<tr>
<td>Common Emitter (Unbypassed)</td>
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<td></td>
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<tr>
<td>Common Collector</td>
<td></td>
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</tbody>
</table>

1430 Data table for Experiments 7-10
<table>
<thead>
<tr>
<th>Configuration</th>
<th>Voltage Gain</th>
<th>Current Gain</th>
<th>Power Gain</th>
<th>Input Z</th>
<th>Output Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Base</td>
<td>13.3</td>
<td>0.40</td>
<td>5.33</td>
<td>292 Ω</td>
<td>5000 Ω</td>
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<tr>
<td>Common Emitter (Bypassed)</td>
<td>111</td>
<td>8.8</td>
<td>694</td>
<td>1100 Ω</td>
<td>5000 Ω</td>
</tr>
<tr>
<td>Common Emitter (Unbypassed)</td>
<td>3.0</td>
<td>0.39</td>
<td>1.17</td>
<td>1300 Ω</td>
<td>5000 Ω</td>
</tr>
<tr>
<td>Common Collector</td>
<td>0.91</td>
<td>.125</td>
<td>.114</td>
<td>3520 Ω</td>
<td>&lt; 100 Ω</td>
</tr>
</tbody>
</table>

1430 Data table for Experiments 7-10
• Your results should be fairly close to ours; although variations from one transistor to another will always make a difference.

• The common-base configuration is characterized by high voltage gain, a current gain which is always less than 1, high power gain, low input impedance; and high output impedance
The bypassed common-emitter amplifier has high voltage gain, moderate current gain and high power gain.

- The input impedance is about equal to the parallel AC impedance of the two base-bias resistors.
- The output impedance is high.
• The unbypassed common-emitter amplifier has low voltage, current and power gains.
  • The input impedance was slightly higher than the bypassed amplifier, but was still roughly equal to the parallel AC impedance of the base-bias resistors
  • The output impedance was about the same as the unbiased amplifier
• The common-collector amplifier always has a voltage gain of less than one. The current gain should always be high.
• Although it was not high in our experiment because we used a 10 KΩ load resistance.
- The input impedance is about equal to the parallel AC impedance of the base bias resistors, and is generally higher than the common-base and common-emitter amplifiers.
- The output impedance is always very low.
QUESTIONS?
RESOURCES
