17

COMMON EMITTER AMPLIFIER

INTRODUCTION

One of the most commonly used small-signal amplifiers is the common emitter configuration. In this experiment you will be testing a single-stage common emitter amplifier. You will be measuring voltage gain for both an unswamped and a swamped configuration, measuring amplifier phase shift, and observing the amplifier response to loading.

In the troubleshooting section, you will insert amplifier faults and observe the failed amplifier AC and DC circuit values.

REFERENCE

Principles of Electronic Devices and Circuits - Chapter 5, Sections 5.3 and 5.4

OBJECTIVES

In this experiment you will:

✓ Learn how to determine voltage through circuit measurements

✓ Gain understanding of the effects of loading on amplifier gain

✓ Be able to relate amplifier AC and DC voltages to component failures

EQUIPMENT AND MATERIALS

DC power supply
Digital multimeter
Dual-trace oscilloscope
Function generator
NPN transistor, 2N3904 or equivalent
Circuit protoboard
Resistors: 1 kΩ, 2.2 kΩ, 3.9 kΩ [2], 10 kΩ, 47 kΩ
Capacitors: 1 μF [2], 470 μF

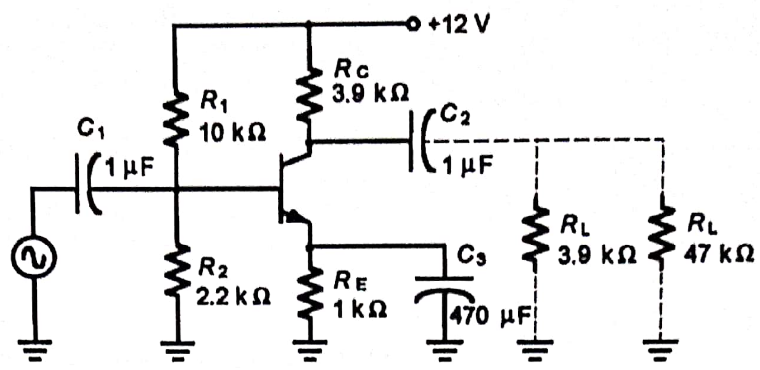


Figure 17.1

1. Build the circuit of Figure 17.1, without connecting a load resistance at this time.

2. Connect the DC power supply set to 12 V. *Do not connect the audio function generator* at this time. Measure and record the following DC voltages:

   V_B = 2.146 v V_E = 1.472V

   V_C = 6.297 v V_{CE} = 4.825 v

   Is the amplifier operating at or close to the load line midpoint?

   it is close to load line midpoint

3. Connect the function generator, and set it to provide a signal of 20 $mV_{p\text{-}p}$ at the base of the transistor.

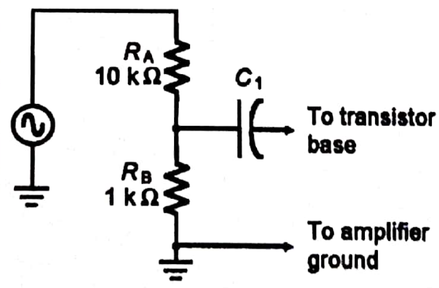


Figure 17.2

If you have difficulty obtaining a low enough output from your function generator in step 3, add the voltage divider network of Figure 17.2 to your circuit.

Do not rely on the divider value to determine the amplifier input signal. Measure the signal at the base of the transistor and adjust the function generator to obtain the required value.

4. Set the oscilloscope coupling to AC and connect the scope to the transistor collector. Adjust the function generator to obtain the maximum output signal possible without clipping. Observe the shape of this output waveform. Reduce the input signal to obtain an output signal of approximately 4 $V_{p\text{-}p}$. (The exact value is not critical.)

5. Set the oscilloscope coupling to DC. Measure and sketch the combined AC and DC signals at the base (V_B), emitter (V_E), and collector (V_C) in Graph 17.1. Record the positive and negative peak values obtained at the collector in the waveform sketch.

6. Using your dual trace oscilloscope, connect channel 1 to the transistor base and channel 2 to the collector. Set the scope coupling to AC. Set the scope to trigger from channel 2. What is the phase angle between the input and output of the amplifier?

   Phase angle = 180

7. Adjust the function generator to provide a 20 $mV_{p\text{-}p}$ input signal to the
   transistor base. Using your oscilloscope, measure and record V_{in} and V_{out} of the amplifier. Calculate and record the value of unloaded voltage gain.

   V_{in} = 20 mV V_{out} = 3.91 V A_V = 195.5

8. Turn off the circuit power and connect the 3.9-kΩ load. Measure the input signal and output across the load. Record these values. Calculate the amplifier loaded voltage gain.

   V_{in} = 20 mV V_{out} = 2.03 V A_{VL} = 101.5

9. Turn off the circuit and replace the 3.9-kΩ load with 47-kΩ measurements of step 8 to determine the loaded voltage gain.

   A_{VL} = 182

10. Turn off the circuit power. Modify your circuit to the swamped amplifier of Figure 17.3. Apply the circuit power. Set the function generator to apply a 20 $mV_{p\text{-}p}$, 1 kHz input signal, using your oscilloscope. Measure and record the amplifier input and output signal values. Then calculate the amplifier loaded voltage gain.

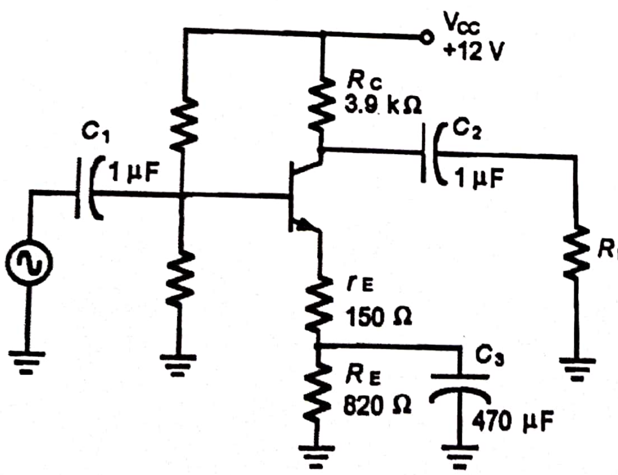


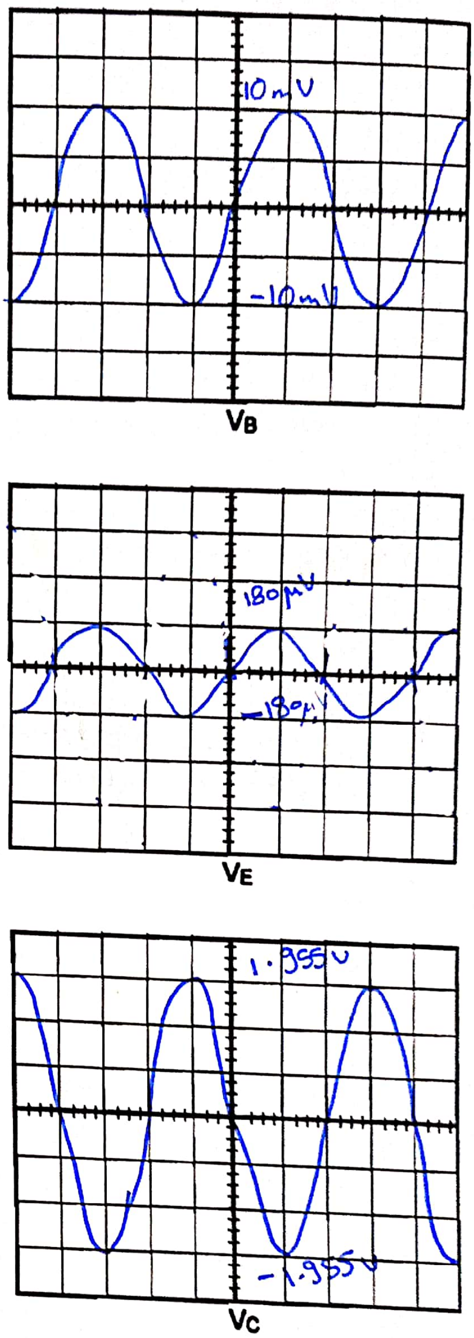
Figure 17.3

R_L = 3.9 kΩ

V_{in} = 20 mV

V_{out} = 229 mV

A_{VL} = 11.45



Graph 17.1

11. While monitoring the output signal at the load, increase the input signal to the point just short of clipping. Observe this waveform. You should observe a clean and undistorted waveform. Contrast this waveform to that obtained in step 4.

Step 11 completes your measurements. You may disconnect your circuit.

SECTION II TROUBLESHOOTING

Fault 1 - Emitter bypass capacitor open

1. Capacitors have three failure modes: They can open, short, or leak. You will now explore what happens to the V_{out} when the Emitter bypass capacitor opens.

2. Apply 12 VDC and the AC signal of 1 kHz at 20 $mV_{p\text{-}p}$ to the amplifier circuit. While monitoring the V_{out} carefully, remove one end of the emitter bypass capacitor and record the V_{out} below. Also observe and record gain differences.

   With emitter bypass capacitor:

   V_{out} = 3.92 v A_V = 196

   Without emitter bypass capacitor:

   V_{out} = 75.7 mV A_V = 3.785

Fault 2 - Transistor shorted

1. The transistor in the CE amplifier has two main failure modes: The transistor can open or short from emitter to collector. You will explore the shorted failure mode here.

2. Turn off the circuit power. Place a shorting wire from the emitter to the collector of the transistor. Apply circuit power. Monitor the output signal and record the voltages below.

   V_{out} 740 nV V_E 2.449 v

   V_C 2.449 v V_{RC} 9.551 v

DISCUSSION

Section I

1. In Procedure step 6, you measured the phase shift between the signal input on the base to the signal output on the collector. Describe, using the functional operation of the transistor, the reason for the phase shift you measured. because when calculation of A_v in the output the voltage = $-I_c (R_c // R_L)$ the negative sign is the reason

2. In Procedure step 4, using the oscilloscope with AC coupling, the average value of the amplifier signal was 0 V. That is because the positive peak value was equal in magnitude and opposite in polarity to the negative peak value.

   A. In Procedure step 5, the average value of the output signal was not zero. Calculate the average value from the data of Figure 17.3.

   V_{avg} = 0.672 V

   B. What is the circuit parameter value represented by the average value V_{avg} of part A? Explain why you obtained the collector waveform values recorded in Figure 17.3.

3. In Procedure step 5, you measured the AC signal on the emitter of the transistor, which should have been essentially 0 VAC. Explain why this value should have been obtained.

Section II

1. In Fault 1 you discovered that the emitter bypass capacitor can greatly affect the gain of the amplifier. What operational measurement would you make to determine if the capacitor was open? Why?

2. In Fault 2 you found that sometimes the AC signal may disappear completely. You must then rely on DC voltage measurements for trouleshooting. Which of the DC voltages checked do you think was the most obvious for showing a shorted transistor? Why?

Quick Check

1. What would be the gain of the amplifier in Figure 17.1 if the value of R_C were changed to 5 kΩ? (Assume no change in quiescent operating point.) 246

2. What should be the normal AC voltage read at the emitter of the transistor amplifier of Figure 17.1? 335 μV (Peak to peak)

3. If the amplifier of Figure 17.1 were exactly midpoint biased (V_{CZ} = 6 V), what would be the maximum undistorted peak output voltage swing?

   (a) 4 V (b) 5 V
   (c) 6 V (d) 10 V

4. If capacitor C_3 in Figure 17.1 shorted, the transistor would likely be "ON". Switch

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MULTISTAGE AMPLIFIERS

INTRODUCTION

Many times the gain required from an amplifier cannot be obtained by only one amplifier stage. Therefore, several amplifier stages are cascaded together so that the individual gain of each amplifier is multiplied to get an overall gain.

In this experiment you will build a two-stage cascaded amplifier, make measurements, and draw conclusions based on those measurements.

The troubleshooting section will examine the effects of capacitor failures on the multistage amplifier. You will install faults and make circuit measurements to be able to relate measured values to component failures.

REFERENCE

Principles of Electronic Devices and Circuits - Chapter 5, Section 5.9

OBJECTIVES

In this experiment, you will:

✓ Add to your knowledge of multistage amplifiers

✓ Be able to relate measured values to circuit failures

EQUIPMENT AND MATERIALS

DC power supply
Digital multimeter
Dual-trace oscilloscope
Function generator
Circuit protoboard
NPN transistor [2], 2N3904 or equivalent
Resistors: 82 Ω, 180 Ω, 330 Ω, 1 kΩ, 3.3 kΩ, 3.9 kΩ, 4.7 kΩ, 5.6 kΩ, 33 kΩ, 56 kΩ
Capacitors: 1μF [3], 47 μF [2]

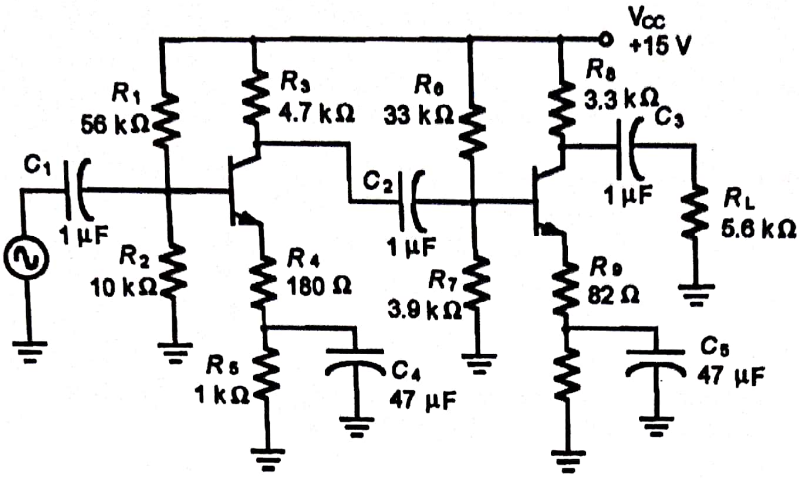

Figure 21.1

1. Construct the two-stage amplifier of Figure 21.1.
2. Apply DC power. Do not connect the function generator at this time.

   Measure the DC voltages at the base, collector, and emitter of the first and second stages of the amplifier. Record your values in Table 21.1.

	DC Values			AC Values				
	V_B	V_E	V_C	V_b	V_c	V_e	V_{out}	V_{CE}
Stage 1	2.2V	1.53V	8.95v	20 mV	176 mV	17.9mV	176mV	7.423V
Stage 2	1.54 V	856 mV	8.18V	176mV	3.76 v	150 mV	3.76v	7.317V

Table 21.1

3. Connect the function generator to provide an input to your amplifier at C_1. Set the generator to 20 $mV_{p\text{-}p}$ at 1 kHz.

   Note: If your function generator will not adjust to a sufficiently low signal, connect the input voltage divider network of Figure 21.2 to your circuit.

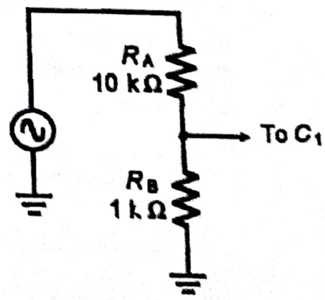

Figure 21.2

4. Using the oscilloscope, measure the peak-to-peak AC signal at the base, emitter and collector of each amplifier stage, and measure the amplifier output across the load resistor. Record your measured values in Table 21.1.
5. From your measured data, calculate the loaded voltage gain of each stage and record below.

   A_{VL} (Stage 1) = 8.8 A_{VL} (Stage 2) = 21.36

6. Calculate the overall voltage gain of the amplifier by taking the product of the individual stage gains from step 5.

7. From the data of Table 21.1, calculate the overall gain of the amplifier.

A_{VT} = 188

This result should be the same as the value calculated in step 6. The total gain of a multistage amplifier is the product of the individual stage gains.

8. Connect your oscilloscope to measure the phase shift from input to output of the amplifier. Connect one channel of the scope to the input signal at C_1, and the other channel to the output at the load resistor. Measure and record the amplifier phase shift.

Phase shift = 0

For stable 'scope triggering in step 8, set the 'scope to trigger on the channel connected to the amplifier output.

This completes the first section measurements. If you are proceeding to the troubleshooting, leave your circuit connected.

SECTION II TROUBLESHOOTING

Troubleshooting amplifiers is very similar to troubleshooting the single stage amplifier. There are some differences, however. One major difference is the coupling capacitors. Like a leaky or shorted bypass capacitor, coupling capacitors alter the signal characteristics. Also, since they isolate the V_c of the first stage from the V_b of the second stage, network bias is affected. Another difference of the amplifier from the single-stage is that the subsequent stages act as the load for the previous stage. Therefore, any problem in later stages affects the operation of the previous stages. This experiment, then, focuses on these two major differences by examining failures of the coupling capacitors.

Fault 1 - C_2 open

1. Turn off circuit power. Open C_2 by disconnecting one end from the capacitor at Q_1. Reapply circuit power and the AC signal of 20 $mV_{p\text{-}p}$ at 1 kHz. Measure and record in Table 21.2 the AC and DC voltages at the collector of Q_1 and the base of Q_2.

2. Reconnect C_2 and measure V_c of Q_1 and V_b of Q_2. Do you observe any differences in the signal?

Fault 2 - C_2 shorted

Turn off circuit power. Remove capacitor C_2 and replace it with a jumper wire (connecting the collector of Q_1 to the base of Q_2). Reapply circuit power and the input signal. This simulates a leaky or shorted capacitor. Measure and record the appropriate data in Table 21.2. Also record the DC levels.

Q_1

	DC Values			AC Values		
Fault	V_B	V_E	V_C	V_b	V_c	V_e
C2 open	2.2	1.53	8.95	20 m	462m	17.8m
C2 shorted	2.19	1.52	2.74	20 m	9.23m	17.9m

Table 21.2

Q_2

	DC Values			AC Values		
Fault	V_B	V_E	V_C	V_b	V_c	V_e
C2 open	1.54	856m	8.18	0	0	0
C2 shorted	2.74	2.02	2.08	9.23 m	5.77m	7.52m

DISCUSSION

Section I

1. Calculate the unloaded voltage gain of the amplifier first stage. How does it compare to your measured value? $A_V = \frac{462m}{20m} = 23.1$

2. The overall gain you measured for your multistage amplifier could be approximated by a single-stage unswamped amplifier. What reasons would you give for using the multistage amplifier? What reasons would you give for using the multistage amplifier as a better choice?
Because using an unswamped amplifier will make its gain unstable $A_V = \frac{R_C'}{r_e'}$ but using a swamped amplifier decreases the gain that's why we use multistage

Section II

1. What effect did an open coupling capacitor have on the circuit? Also, explain how and why the signal changed when C_2 was reinserted into the network. it made the input of the second stage $= 0$ but it increased the gain of the first stage

2. Explain what effect a leaky coupling capacitor would have on the operation of the multistage amplifier. it can change the DC baising for the 2 stages

3. Explain the measurements you observed when C_2 was shorted. What, for example, happened to the gain of the amplifier, or to the output signal waveshape? the gain decreases because second stage enters Saturation

Quick Check

1. The term h_{fe} refers to _____.

(a) Av
(b) beta
(c) impedance
(d) slew rate

2. C_2 is used to couple the first stage to the second stage.

True False

3. An open emitter bypass capacitor _____ the gain of an amplifier?

(a) increases
(b) decreases
(c) has no effect on

4. A multistage amplifier increases signal strength in small steps.

True False

5. In a multistage amplifier, faults in one stage can affect the operation of other stages.

True False

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CLASS A POWER AMPLIFIERS

INTRODUCTION

As its name notes, the emphasis of the power amplifier is power gain. It is most often found in the final stages of multistage amplifiers. Some important features of the class A amplifier are the current drain, maximum power dissipation by the transistor, the stage efficiency and full power output (maximum unclipped signal the amplifier can deliver).

In this experiment you will calculate and measure power output and efficiency of a class A Power amplifier.

The troubleshooting section of this experiment will simulate two amplifier faults and you will, through measurements made, be able to relate failures to circuit measured values.

REFERENCE

Principles of Electronic Devices and Circuits - Chapter 6, Section 6.3

OBJECTIVES

In this experiment you will:

✓ Determine by measurement the efficiency of a class A power amplifier

✓ Understand the effect of a swamping resistor on the signal linearity of a large signal amplifier

✓ Simulate faults and be able to determine their effect on amplifier parameters

EQUIPMENT AND MATERIALS

DC power supply
Digital multimeter
Dual-trace oscilloscope
Function generator
NPN transistor, 2N3904 or equivalent
Resistors: 220 Ω, 820 Ω, 1 kΩ, 3.3 kΩ [2], 6.8 kΩ, 33 kΩ
Capacitors: 1 µF [2], 470 µF

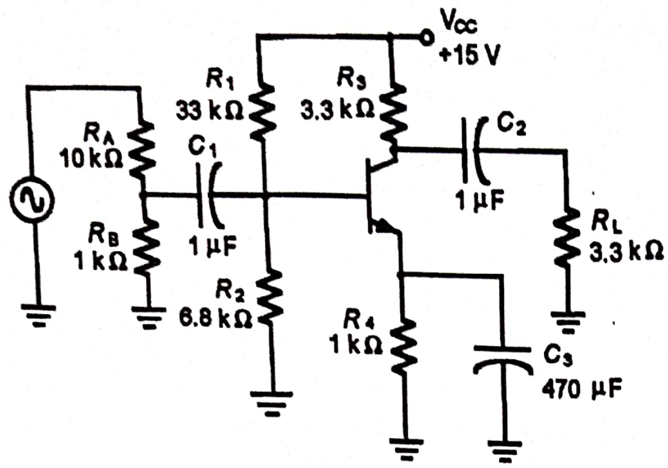


Figure 22.1

1. Construct the circuit in Figure 22.1
2. Apply DC power and with no signal applied, measure and record in Table 22.1 the values of I_{CQ}, V_{CEQ}, and the total current drawn by the amplifier (I_{CC}).
3. Connect the function generator and adjust for a signal of 20 $mV_{p\text{-}p}$ at 1 kHz at the base of the transistor.

   Using the oscilloscope, observe the load voltage while increasing the AC input signal. Continue to increase the input signal until clipping is observed. Take note of the nonlinear distortion of the signal, in fact the signal begins to squash and elongate before clipping in reached. This is due to the changes in r'_e.

NOTE: Although, at the power levels of your circuit you won't do any damage, it is usually not desirable to operate an amplifier in saturation clipping for long intervals.

4. Reduce the input signal until the output signal is at its maximum value without clipping.
5. Measure and record in Table 22.1 the peak-to-peak output voltage ($V_{p\text{-}p}$).
6. Calculate and record in Table 22.1 the DC power supplied to the amplifier (P_{DC}).
7. Calculate and record in Table 22.1 the total power delivered to the load (P_L).
8. Calculate and record in Table 22.1 the efficiency of the amplifier.

Equation for step 6:

$$P_{DC} = V_{CC} \cdot I_{CC}$$

Equations for step 7:

$$V_{Lp} = \frac{V_{Lp\text{-}p}}{2}$$

$$V_{LRMS} = 0.707 V_{Lp}$$

$$P_L = \frac{V_{LRMS}^2}{R_L}$$

Equation for step 8:

$$\text{Efficiency} = \frac{P_L}{P_{DC}} \times 100\%$$

I_{CQ} =	1.81 mA
V_{CEQ} =	7.221 V
$V_{p\text{-}p}$ =	6.06 V
I_{sat} =	3.46 mA
P_{DQ} =	13.07 mW
P_L =	1.44 mW
P_{DC} =	27.15 mW
Eff =	5.2 %

Table 22.1

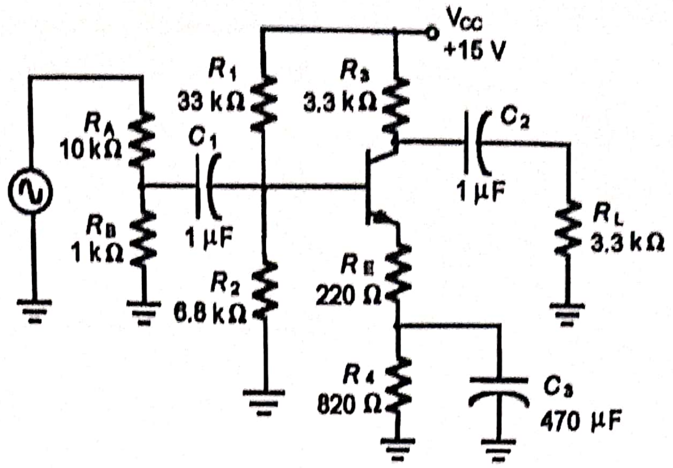


Figure 22.2

9. Turn off the circuit power. Change the emitter circuit to add a swamping resistor as shown in Figure 22.2. Reapply circuit power and the AC signal input.

10. Connect the oscilloscope to monitor the amplifier output. Adjust the input signal amplitude until the output just starts to clip. Compare the signal waveshape to that observed in step 3. Does it appear to be less distorted?

This completes the measurements of this section.

SECTION II TROUBLESHOOTING

Fault 1 - Output capacitor C_2 is shorted

1. Starting with the circuit of Figure 22.1, place a jumper wire to short the output capacitor, C_2.

   Apply circuit power, measure and record the following DC voltages:

   V_C = 4.53 V V_{CE} = 2.717 V V_{RL} = 4.53 V

   Apply an AC input signal of 20 $mV_{p\text{-}p}$ at 1 kHz. Measure and record the peak-to-peak voltages.

   V_C = 4.08 V V_{RL} = 4.08 V

2. Turn off circuit power. Remove the jumper shorting capacitor C_2.

Fault 2 - Emitter bypass capacitor C_3 is shorted

1. With circuit power off, connect a jumper wire to short C_3 Apply DC power, measure and record the following DC voltages:

   V_B = 712 mV V_C = 87.7 mV V_E = 0

2. Apply an input signal of 20 $mv_{p\text{-}p}$ at 1 kHz. Measure the record the following peak-to-peak AC voltages:

   V_C = 20.5 mV V_{RL} = 20.5 mV

Observe the waveshape of the output signal at the collector and load. Does this waveshape imply anything about the state of the transistor? transistor is a switch "on". at cut off

3. Turn off the power and disconnect your circuit.

DISCUSSION

Section I

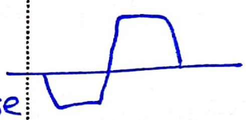
1. What effect did including a swamping resistor have on your measurements. Explain the effect. with swamping resistor the output power is higher

2. The amplifier efficiency you calculated in step 8 should have been much less than the ideal class A efficiency of 25 percent. With reference to your text, can you identify measured circuit parameters that contributed to the low efficiency? R_L

Section II

1. What happens to the signal at the load when the bypass capacitor shorts. Why does this occur? decreased (same as input)

2. What does nonlinear distortion look like and explain why it occurs in a class A amplifier it is because of clipping because transistor entered cutoff



3. What one measurement could you make to be certain to identify a shorted output capacitor? Explain why this measurement would be certain.

output DC voltage because if there is a capacitor the $V_{DC} = 0$ if it is shorted it will be equal to V_C

Quick Check

1. The class A amplifier is highly efficient.

True False

2. The maximum, theoretical, efficiency of a class A amplifier is _____.

(a) 50% (b) 25%
(c) 75% (d) 33.3%

3. Overdriving an amplifier is a good idea.

True False

4. Distortion is caused by changes in _____.

(a) r'_e (b) R_E
(c) R_L (d) r_c

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CLASS B PUSH-PULL AMPLIFIERS

INTRODUCTION

In this experiment you will construct a voltage divider biased and a diode (current mirror) biased class B push-pull amplifier. This will allow you to observe crossover distortion and its elimination by the diode biased amplifier. You will also demonstrate that changing class B bias to class AB eliminates crossover distortion. You will also determine the efficiency of your class B amplifier.

Simulated fault measurements will be made in Section II of the experiment. You will fault a portion of the circuit and make measurements to see the effects of the fault.

REFERENCE

Principles of Electronic Devices and Circuits - Chapter 6, Sections 6.4 and 6.5

OBJECTIVES

In this experiment you will:

✓ Observe crossover distortion

✓ Demonstrate the AC and DC operating characteristics of the class B complementary symmetry amplifier

✓ Demonstrate class B amplifier faults

EQUIPMENT AND MATERIALS

DC power supply
Oscilloscope
Digital multimeter
Function generator
Circuit protoboard

Diode [2], 1N914 or equivalent
NPN transistor, 2N3904
PNP transistor, 2N3906
Resistors: 220 Ω, 1 kΩ [2], 1.8 kΩ [2]
Potentiometer: 1-kΩ ten-turn trimpot
Capacitors: 1 μF [2], 100 μF

SECTION I FUNCTIONAL EXPERIMENT

Crossover Distortion

1. Construct the circuit in Figure 23.1.

2. Adjust the potentiometer (R_2) for a total resistance of 50 Ω or less between the bases of Q_1 and Q_2.

3. Connect a milliamp meter to measure the collector current of Q_1.

4. Connect the DC power supply to your circuit and set it for 12 V.

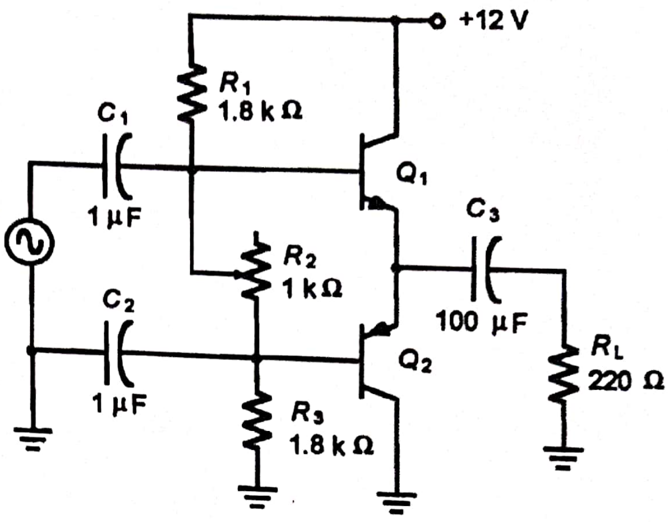


Figure 23.1

CAUTION
Step 5 below must be performed carefully to avoid exceeding the current limit of Q_1 and Q_2.

5. Slowly adjust the potentiometer (R_2) while observing the milliammeter. Adjust R_2 to obtain a current value of 0.25 mA. The exact value is not critical and can be in the range of 0.1 to 0.25 mA. Following the adjustment of R_2, record your current meter reading.

   I_{CEQ} = 0.18 mA (0.1 to 0.25 mA)

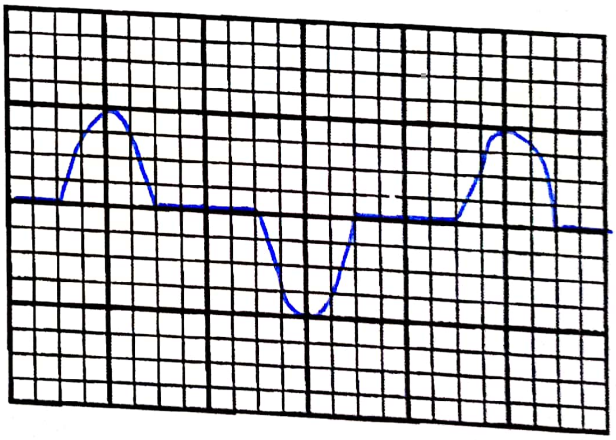
6. Turn the DC power supply off and disconnect the current meter.

7. Reapply 12 VDC. Use your digital voltmeter; measure and record the V_{CEQ} of each transistor.

   Q_1 V_{CEQ} = 5.998

   Q_2 V_{CEQ} = 6.004

8. Connect the function generator to your circuit and set the generator to provide a 1-kHz sine wave at 2 $V_{p\text{-}p}$.

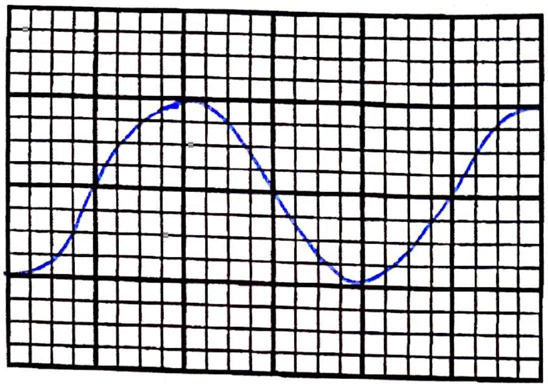


Graph 23.1

9. Using the oscilloscope, observe the signal across the load resistor. The signal you observe should have crossover distortion.

10. Draw the signal in Graph 23.1.

The following procedure step allows you to provide Class AB biasing of your voltage divider biased circuit and observe the elimination of crossover distortion.



Graph 23.1

11. Repeat Procedure steps 3 through 10, except in step 5 adjust the collector current to 5 mA, and plot your signal in Graph 23.2. Do the adjustment carefully; follow the procedure exactly. You will be increasing the transistor forward bias, and too big an increase can put the transistor into full conduction with no limit on the collector current.

This completes the first part of the experiment. Disconnect all power and disassemble the circuit.

Crossover distortion is caused by need for the input signal to increase to the point where the Class B biased transistor will turn on and start conduction. Increasing the bias to a point where the transistor is barely in conduction (Class AB) allows the transistor to follow the input signal without the delay that appears as crossover distortion. This is not easily accomplished with voltage divider biased transistors because of the difficulty in selecting resistor sizes and the danger of thermal runaway.

The Diode Biased Amplifier

1. Connect the circuit in Figure 23.2.
2. Calculate and measure the DC level at the emitter junction of Q_1 and Q_2 (point A). Record your data in Table 23.1.
3. Calculate the remaining parameters shown in Table 23.1 and enter the results in the *Calculated* column.

Reminder: I_{CC} is equal to the sum of the current mirror bias network (I_D) plus the amplifier transistor collector current (I_{CEQ}):

$$I_{CC} = I_D + I_{CEQ}$$

Since your circuit may not be operating at maximum power to the load, use an estimated load voltage value of 9 $V_{P\text{-}P}$ to calculate load power.

4. When your calculations are complete, make the I_{CC} measurement before connecting the function generator to your circuit.
5. Connect the function generator to your circuit and set the generator to provide a 1-kHz signal at 2 $V_{P\text{-}P}$.

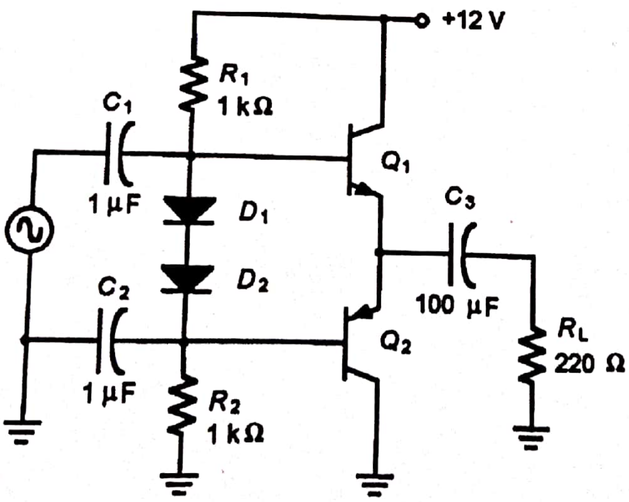


Figure 23.2

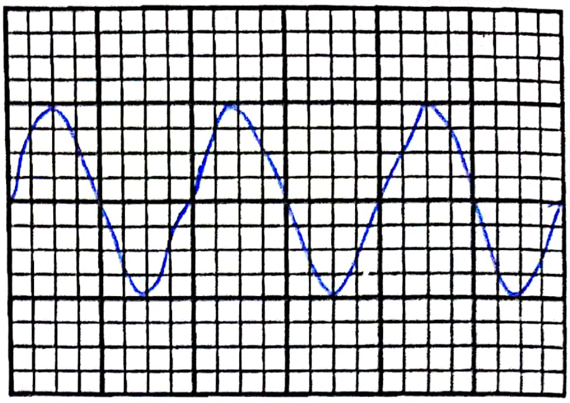
	Calculated	Measured
Q_1 V_{CEQ}		5.999 v
Q_2 V_{CEQ}		6.001 v
I_{CEQ}		8.85m
P_L		81.7 mW
I_{CC}		13.85m
P_{DC}		106.2 mW
Eff		76.9%

Table 23.1

6. Connect the oscilloscope to measure the output voltage across the load. While observing the scope display, adjust the function generator output amplitude to obtain the maximum undistorted (no clipping) load voltage.

7. Measure the output voltage across the load and sketch the load signal waveform in Graph 23.3.

8. Turn off the generator and power supply. Complete the power calculations for the output load power, the circuit DC power, and the amplifier efficiency from your measured values. Enter the results in Table 23.1.



Graph 23.2

You may leave the circuit connected if you are proceeding to the troubleshooting section.

SECTION II TROUBLESHOOTING

Fault 1 - D_1 shorted

Place a jumper wire across D_1. Measure the DC levels and signals at the base of Q_1 and Q_2, and the output junction before the coupling capacitor. Are the DC levels normal?

$V_{BQ_1} = 6.36v$

$V_{BQ_2} = 5.64v$

$V_{oDC} = 6.02v$

Fault 2 - Injected fault

Have your instructor or lab partner inject a problem into the circuit. Try covering the fault with a piece of tape to hide the fault, and make your conclusions based on your measurements only.

DISCUSSION

Section I

1. Explain the term *push-pull*. How does this term describe the class B amplifier?

2. Describe crossover distortion. What does it look like and how can it be eliminated? It is eliminated by baising

3. Considering the measured efficiency of your amplifier versus the theoretical maximum value, what things would you suggest to increase your amplifier efficiency? we need to increase output power by decreasing Load

Section II

1. Describe the procedure you used to troubleshoot the fault that your instructor or partner injected into the circuit.

2. If the base to emitter junction of Q_1 opened, what signal would you expect to observe at the output?

half of the signal will be clipped (positive half)

Quick Check

1. The maximum efficiency of a class B amplifier is approximately ______.

   (a) 50% (b) 63.3%
   (c) 25% (d) 78.5%

2. A class B amplifier is normally biased above cutoff to eliminate crossover distortion.

   True False

3. The class B amplifier consists of two transistors each conducting for 270 degrees of the input signal.

   True False

4. Provided the transistors are biased equally, the DC level at the collector emitter junction of a class B amplifier is _____.

   (a) half the value of V_{CC} (b) 10% of V_{EE}
   (c) 0.7 V above ground (d) 10% below V_{CC}

5. An abnormal voltage reading at the emitter junctions (point A) indicates ______.

   (a) an open biasing resistor (b) an open coupling capacitor
   (c) a shorted or saturated transistor (d) an excessive load