Lab 8 Class B & AB Amplifiers

Name ______________________ Section ______

Purpose:

To demonstrate the dc and ac operating characteristics of the Class B & the Class AB complementary-symmetry amplifier.

Equipment:

- * 1 - dc Power Supply
- * 1 - Digital Multimeter (DMM)
- * 1 - Variable ac Signal Generator
- * 1 - Dual Trace Oscilloscope
- * 2 - 1N4148 Small Signal Diodes
- * 1 - 2N3904 npn Transistors
- * 1 - 2N3906 pnp Transistor
- * 1- 1 kΩ Potentiometer (102)

Resistors

1 -22 Ω   2 - 100 Ω   1 - 2 kΩ   1 - 1.5 kΩ

Capacitors

2 - 10 μF Capacitors   1 - 470 μF Capacitor

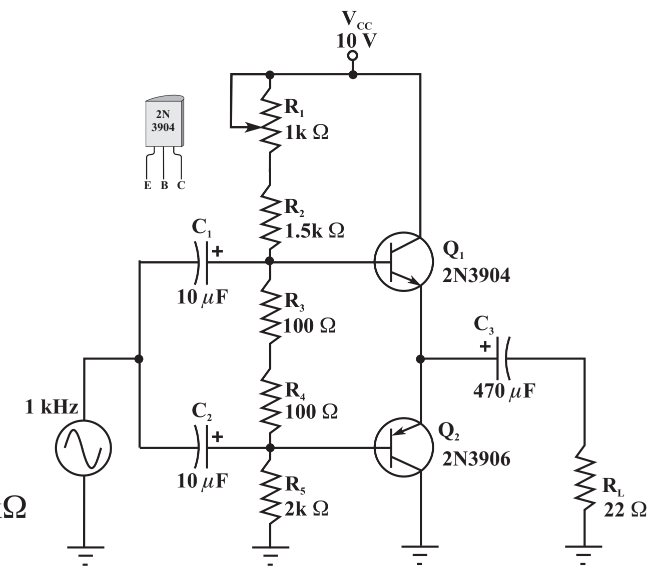

Figure 1

Discussion:

In a Class AB Amplifier, each transistor operates in the active region for slightly more than 180° of the ac cycle. With a single power supply, the ac output compliance is approximately equal to V_{CC}. Class AB amplifiers are often used as the output stage of audio systems because they are much more efficient at delivering load power than the Class A amplifiers. We know from our studies that the theoretical efficiency of the Class B amplifier is 78.5%. This is much greater than the Class A amplifier at 25%.

The difference between the Class B amplifier and the Class AB amplifier is the biassing level. The Class B amplifier is biased into cutoff and this introduces crossover distortion. This distortion occurs during the time that neither transistor is conducting ; and is caused by the transition time required for the transistor to come out of cutoff into the active region of operation. The Class AB amplifier is biased at soft cutoff. This is the point at which the transistor is just beginning to conduct. I_{CQ} is slightly above zero with the Class AB, but the transition time is greatly reduced and this virtually eliminates crossover distortion.

In this lab you will build a Class B amplifier with voltage divider bias, and with diode bias. The voltage divider bias unit will show crossover distortion. It is biased into cutoff and is true Class B. The diode bias unit should be much more stable. We know that there is a real danger of thermal runaway in these amplifiers. The compensating diodes are the usual way to bias these amplifiers. The diodes serve two purposes. The first is that they automatically bias the transistors at soft cutoff (Class AB) and this helps to eliminate crossover distortion. Secondly, they help eliminate thermal runaway by counteracting the thermal runaway effect caused by the emitter diode. Note that these diodes must match the current - voltage characteristics of the emitter diodes.

It should be noted that technical people often do not differentiate between the Class AB and Class B amplifier. Often, both classes are simply referred to as Class B amplifiers.

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Procedure - Do this part in the Lab

1) Using the transistors in your kit, match the transistors for h_{FE} as closely as possible.

2) Set the power supply at 10 V. Set the current limit at approx 100 mA **(if your power supply is so equipped.)**

3) Build the circuit shown in Figure 1. Set R_1 initially to about half rotation.

4) Apply power and adjust R_1 to provide midpoint bias.

5) Set the signal generator to 1 kHz. Turn the amplitude setting to minimum.

6) Connect the oscilloscope to the circuit.

- ***Connect Channel A to the input of the amplifier***
- ***Connect Channel B across the load resistor.***
- ***Adjust the generator to produce a 6 $V_{p\text{-}p}$ input to the amplifier.***
- ***You should observe crossover distortion as shown in Figure 2.***
- ***Carefully draw the input and output signals on the graph shown in Figure 3. Label it properly.***

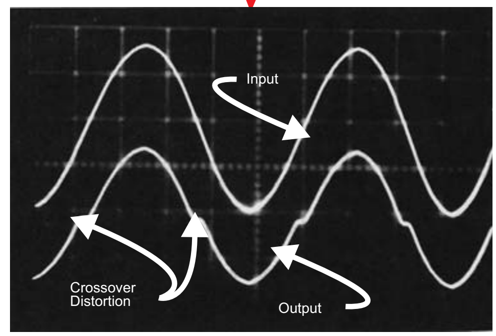

Figure 2

Volts/Div: Channel 1 ______

Volts/Div: Channel 2 ______

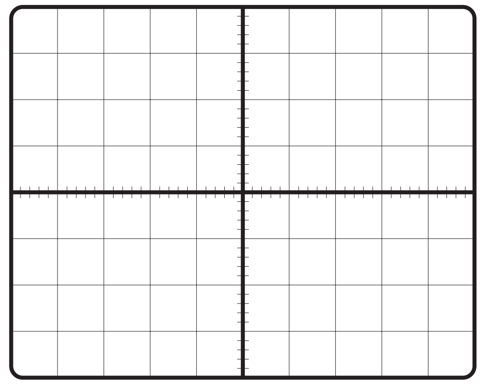

Figure 3 **Input and Output Waveforms of the Class B Amplifier Showing Crossover Distortion.**

The Class AB Amplifier

Disconnect the power and signal generator leads from the circuit and replace the series resistors R_3 and R_4 with the two 1N4148 compensating diodes in series with the transistor base leads as shown in Figure 4.

1) Apply power to the circuit and adjust R_1 to provide midpoint bias.
Measure and record the following:

V_{CEQ1} ______________________

$V_{B(Q1)}$ ______________________

V_{CEQ2} ______________________

$V_{B(Q2)}$ ______________________

2) Apply an input signal to the amplifier. Set the signal generator for a frequency of 1 kHz and 6 Vp-p. Carefully draw the input and output signals on the graph shown in Figure 5. Label it properly.

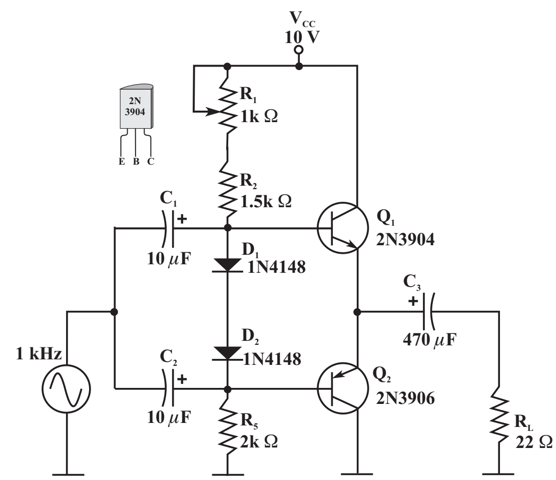

Figure 4 **The Class AB Amplifier**

Volts/Div: Channel 1 ______

Volts/Div: Channel 2 ______

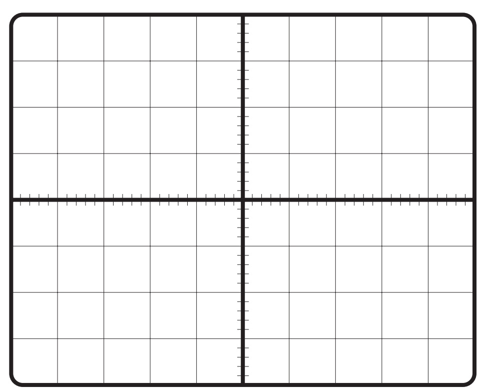

Figure 5 **Input and Output Waveforms of the Class AB Amplifier**

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1) Compare the output signals that you have drawn in Figures 3 and 5.

   The peak-to-peak output voltage of the Class AB amplifier should be larger than the Class B amplifier. Explain why this is so.

2) The Class AB signal should contain very little or no crossover distortion. Explain how the use of compensating diodes achieves this.

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3) Using V_{in} and V_{out}, calculate the measured voltage gain of the Class AB amplifier shown in Figure 4.

4) ***Calculating efficiency using measured values.***

   Insert an ammeter to properly measure I_{CC}. Increase the input signal until the amplifier reaches compliance. Measure I_{CC}.

   I_{CC} ____________

   With the amplifier at compliance, measure the peak-to-peak output voltage.

   $V_{out(max)}$ _________

   Calculate the efficiency of the amplifier

   η = ____________

5) What is the practical application of this circuit?

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