Section 4: Power Amplifiers 1 (Class A, AB & B)

Purpose

In the next two sections you'll learn about the use of transistors as power amplifiers. Most of your learning has centred on the use of the transistor as a voltage amplifier but you should have no difficulty following the next logical step to an understanding of its use as a power amplifier. In this section you will learn the about class A,AB and B amplifiers and their applications. You'll also carry out fault-finding tests on these classes of amplifier.

Objectives

At the end of this section you should be able to:

- Describe the difference between class A, AB and B power amplifiers and an application of each class
- Describe the relationship between conduction angle and amplifier efficiency
- Diagnose and repair faults in each class of amplifier

Review questions for Section 4

The following review questions will help you revise what you have learned in Section 4.

1. What is the purpose of the output coupling capacitor in a complementary class AB power amplifier using a single supply voltage?

2. Describe the shape of the output waveform of an amplifier that is heavily over-driven by a sinewave input signal.

3. What is the theoretical maximum efficiency of a class A transformer-coupled power amplifier?

4. What is the meaning of the term *conduction angle* as it applies to a power amplifier?

5. Which amplifier has the greater conduction angle - class A or class AB?

6. Why are junction diodes used as part of the output stage bias chain of a class AB complementary-symmetry amplifier?

7. Why are true class B audio amplifiers rarely used?

8. With no input signal, what is the quiescent current of a class B amplifier?

9. Two amplifiers, one class A and the other class AB, both deliver 25 watts into 8 ohm loads from sinewave input signals. Which of the two amplifiers will have the greater temperature rise after switching on? Give a reason for your answer.

10. A single-ended power amplifier is designed to have mid-point quiescent bias. What class of operation will it be in?

11. Describe the basic differences between a complementary-symmetry amplifier and a quasi complementary-symmetry amplifier.

12. What is the advantage of using Darlington pairs in a power amplifier?

13. Give two advantages of using a split-rail supply in a class AB complementary amplifier.

14. Using a simple sketch, describe how DC feedback in an amplifier can be used to stabilise the output stage's quiescent current against temperature rise.

15. Why must class AB and class B audio amplifiers always be used in a push-pull arrangement?

16. A transformer-coupled class A amplifier requires a collector load impedance of 400 ohms and drives a 16 ohm speaker. What is the turns ratio of the output transformer?

The next four questions refer to the circuit shown in Figure 4.1

17. Given an open-loop gain of 12, calculate:
    a) the closed-loop gain of the amplifier
    b) the expected theoretical power output

18. What is the quiescent current of this amplifier?

19. What would be the effect on the output waveform if diode D_1 shorted?

20. Describe the changes in AC and DC conditions if resistor R_1 went open circuited.

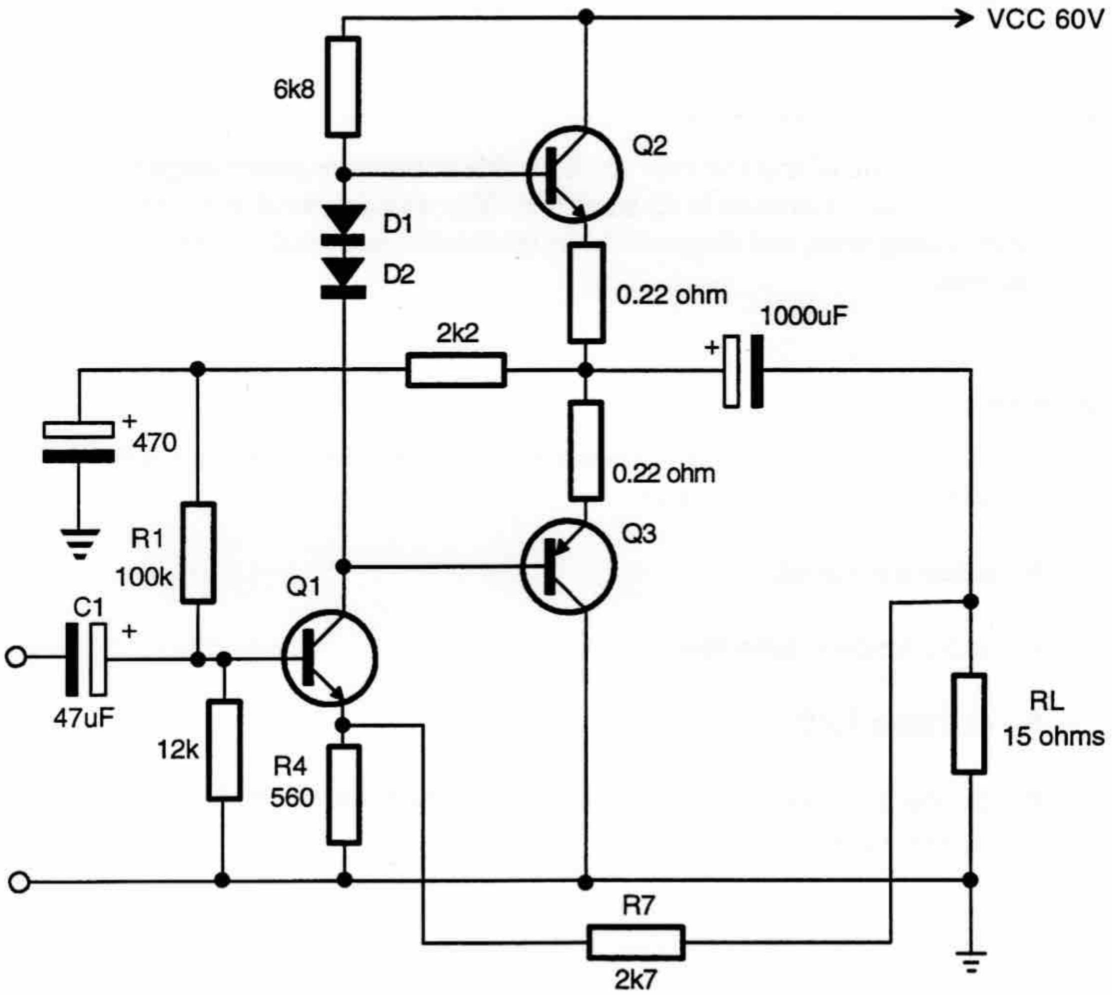

Figure 4.1

Skill practice for Section 4

Topic

Power output and distortion measurements in a complementary-symmetry power amplifier.

Fault finding an audio power amplifier.

About this assignment

- In this exercise you'll carry out dynamic tests on a class AB complementary-symmetry power amplifier.

- You'll diagnose a range of fault conditions in the amplifier and suggest how to correct them.

The outcomes of this assignment

On completion of this exercise you'll be able to measure power output, sensitivity and distortion in an amplifier. You will also be able to carry out fault-finding tests, and diagnose faults by measurement and observation of CRO patterns.

Equipment

- class AB complementary-symmetry power amplifier panel with fault selection switches or equivalent

- schematic circuit

- audio function generator

- dual trace CRO

- dummy load resistors, value and power rating to suit amplifier (4, 8 or 16 ohm)

Step 1

- Examine the amplifier panel you're about to use and note where the input, output and power supply connections are to be made. If fault switches are fitted, make sure they are all *off*.

Step 2

- Connect the dummy load resistor, audio millivoltmeter and channel 2 of the CRO to the amplifier output terminals. Set the millivoltmeter to its highest voltage range.

- Set up the audio function generator to produce a 1kHz sine wave and turn its output level to zero.

- Connect the audio function generator and channel 1 of your CRO to the amplifier input terminals.

- If you're using a split rail power supply, set up the required voltages on the supply *before* connecting it to amplifier. After setting the voltages correctly, turn off the supply, connect it to the amplifier supply rail(s) and don't forget to earth the centre tap! Turn the power back on.

Step 3

- Increase the audio generator output level to 20mV and adjust the CRO until a stable trace is obtained on channel 2.

- You will now need to determine the maximum undistorted power output of your amplifier. A figure may already be provided, in which case you could make sure the amplifier meets specifications. If no figure is available, calculate what order of output power should be expected, using the equation:

$$P_{out} = \frac{(V_{CC})^2}{8R_L}$$

where R_L is the load resistance in ohms.

P_{OUT} =

- Increase the input signal level until the output displayed on the CRO just starts to clip on the peaks. Reduce the input level until the output is a clean sinewave. **Make sure the audio millivoltmeter is not off scale, adjusting its range if necessary!**

Read the *rms* load voltage (V_L) on the millivoltmeter and calculate the power output using:

$$P_{out} = \frac{V_L^2}{R_L}$$

$P_{OUT} =$

■ Compare your calculated and measured values. Are they within 10% of each other? If so, tick the box below.

✔ ☐

■ If the readings are not similar, can you suggest reasons for the difference?

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Step 4

■ Distortion is usually measured at the maximum rated power output of the amplifier under test.

■ While your amplifier is still delivering maximum power into the load resistor, connect the distortion meter across the load and calibrate it at this output level.

Remember!

Continuous power into the dummy load resistor makes it very hot!

■ Measure the distortion using the procedure for your particular meter. If you're not sure, ask your teacher to show you how to take the reading, and then do it again yourself.

Dist = %

Step 5

■ Reduce the power output to half the maximum value and repeat the distortion measurement, remembering to re-calibrate the distortion meter at the new output level.

Dist = %

- Is there any significant difference in distortion at the lower output level? If so, why?

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Step 6

- Leave your amplifier operating as in Step 5.

- Using your DVM, take voltage measurements at the marked test points and record your results in the "Normal" column of Table 1.

Table 1

	Normal	Fault 1	Fault 2	Fault 3	Fault 4	Fault 5
TP1						
TP2						
TP3						
TP4						
TP5						
TP6						
TP7						
TP8						
TP9						
TP10						

Step 7

Turn on fault switch (1) and note the effect (if any) on the output signal. Take a new set of voltage readings and record your results in Table 1 under the column headed "Fault 1". Compare the new voltage readings with the original values and, referring to the CRO display if applicable, determine the cause of the fault and enter your diagnosis in Table 2. Return fault switch (1) to the off position.

In any fault-finding operation, you should be asking three questions at each step:

1. "What is the reading or observation at this point?"
2. "What *should* be the reading or observation at this point?"
3. "What has changed to cause this new reading or observation?"

Be logical and methodical in analysing each possibility.

Step 8

Repeat Step 7 for each fault switch in turn, recording the readings in the appropriate Table 1 column. Don't forget to turn each switch off after use.

Table 2

Reason for fault #1	
Reason for fault #2	
Reason for fault #3	
Reason for fault #4	
Reason for fault #5	