COMPLEMENTARY SYMMETRY POWER AMPLIFIER

PRACTICAL LABORATORY

OBJECTIVES

While performing this experiment, you will be able to:

1. Measure the quiescent circuit voltages and compare to estimated values.
2. Measure the AC conditions of the circuit.
3. Determine the voltage gain of the output stage.
4. Determine the efficiency of the circuit.
5. Observe the effects of:
   a) the bootstrap capacitor
   b) the forward bias diodes.

REFERENCES

PAYNTER — Chapter 11 & handout notes.
HAZEN — Chapter 7 & handout notes.
FLOYD — Chapter 9 & handout notes.

MATERIALS REQUIRED

1 Amplifier module C.E.T. 13.
1 Mother board.
1 C.R.O. & 2 leads.
1 Function generator & leads
1 DMM.

SUMMARY OF THEORY

(Refer to circuit of figure 1)

Transistor Q_1 is a PNP common emitter pre-amplifier with voltage divider bias provided by R_1, R_2 and R_3. A.C. and D.C. negative feedback are applied to the emitter to reduce distortion and temperature instability.

Transistor Q_2 provides the necessary voltage swing to drive the output stages Q_3 & Q_4 which in turn provide the necessary current to the load resistance R_L. The amplifier uses direct coupling between the transistor stages while A.C. coupling is used at the input and output terminals of the amplifier. The circuit uses 'Boot-strapping' of the collector resistor for Q_2 and also diode biasing for class AB operation of the output stage.

The circuit uses single supply power and therefore the voltage at point 'A' should be near $V_{CC}/2$. Transistors Q_3 & Q_4 are the complementary pair whose voltage gain is less than one. The overall gain of the circuit is fixed at approximately 16 by the negative feedback arrangement. The combination of R_1 and C_1 cause 'decoupling' of the supply rail and therefore minimise the supply ripple from entering the input bias circuit.

PROCEDURE

1. Plug in the power amplifier and set the 'rail' voltage to 18V. Set the switches as follows:
   S1 to ON and
   S2, S3 to OFF.
2. Measure and record the no-signal total D.C. current supplied to the amplifier — remove the link and insert the ammeter for this.

   $I_{t(no\ signal)}$ = _____
3. Measure and record the D.C voltages w.r.t ground at the following points:

   V_B Q_1 = _____ V_E Q_1 = _____

   V_B Q_2 = _____ V_B Q_3 = _____

   V_B Q_4 = _____ V TP 'A' = _____

4. Referring to your measured results state whether the following transistors are forward or reverse biased:

   Q_1 _____ Q_2 _____

   Q_3 _____ Q_4 _____

5. Calculate and record the theoretical maximum output power of the amplifier.

   $P_{O(max)}$ =

6. Connect a function generator to the input of the amplifier. Set the output frequency to 1kHz, sinewave.
7. Monitor the A.C. output voltage across R_L with the CRO. Adjust $v_{(in)}$ to obtain a maximum output voltage (just below clipping) across R_L
8. Record the P-P output voltage across R_L.

   $V_{(out)\ P\text{-}P}$ = _____
9. Calculate the output power from the results of step 8.

   $P_{(out)}$ =
10. Compare the values of $P_{(out)}$ obtained in step 5 and step 9 and explain the reason for any variation.

EXPLANATION

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11. Measure and record $v_{(in)}$ and $v_{(out)}$ of the complementary transistors Q_3 and Q_4.

Q_3 $v_{(in)}$ _____ Q_3 $v_{(out)}$ _____

Q_4 $v_{(in)}$ _____ Q_4 $v_{(out)}$ _____

12. Calculate the A_v of each transistor and comment on the value obtained.

Q_3 A_v _____ Q_4 A_v _____

Comments:

_____

_____

13. Measure the supply current with the amplifier delivering maximum power. Record this value.

$I_{t(full\ power)}$ = _____

14. Why is this value of I_t different from the value measured in step 2?

_____

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_____

15. Calculate the P_{DC} (use I_t of step 13)

P_{DC} =

16. Calculate and record the efficiency of the amplifier.

η =

17. Set the output to 6 $V_{P\text{-}P}$ at 1kHz, and operate switch S3 and observe the result on the CRO. Comment on the result.

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18. Reset S3 to OFF. Operate S1 and observe the result on the CRO. Comment on the result.

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ASSIGNMENT

1. . With reference to figure 1, state the function of:

a) Q_1 _____

b) Q_2 _____

c) D_1 & D_2 _____

d) C_3 _____

e) Q_3 & Q_4 _____

_____

f) C_4 _____

g) R_1 & C_1 _____

TEST

1. A complementary power amplifier requires
a) two out-of-phase input signals.
b) an input transformer.
c) both a.) and b).
d) neither a) nor b).

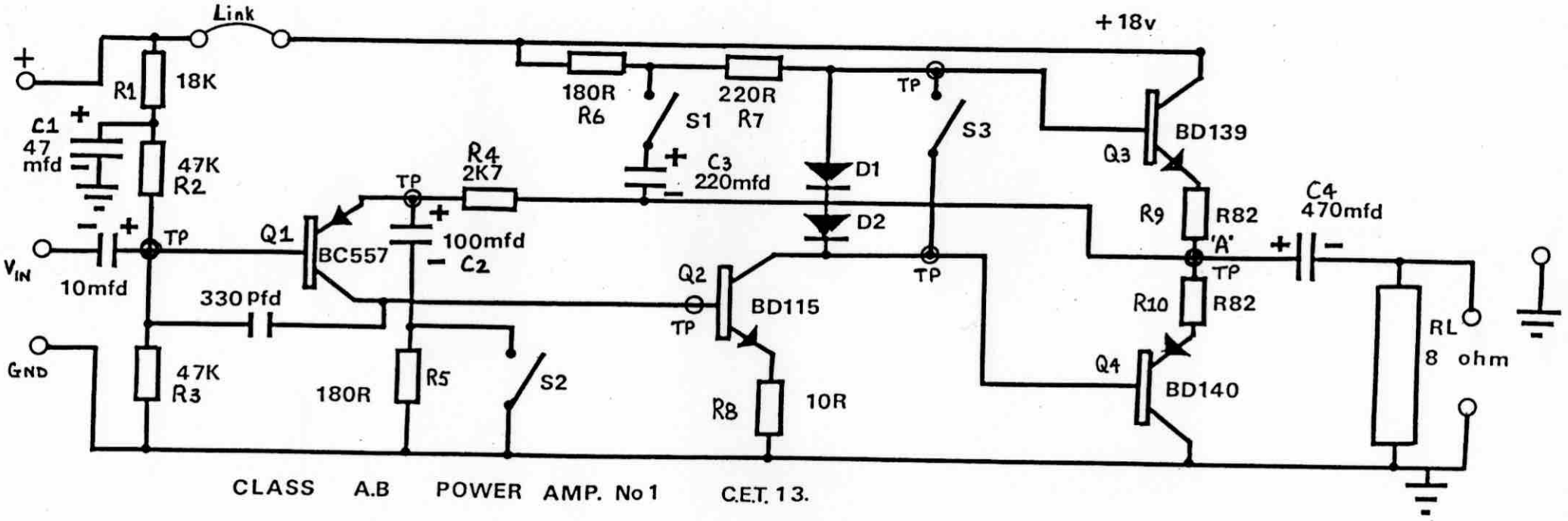
2. A complementary power amplifier has
a) series connected transistors.
b) NPN and PNP transistors.
c) neither a) nor b).
d) both a) and b).

3. Complementary power amplifiers
a) have excessive cross-over distortion.
b) must operate in class B.
c) require output transformers.
d) can produce push-pull operation

4. A complementary power amplifier operating in class AB
a) becomes forward biased with signal.
b) is normally reverse biased.
c} is normally forward biased.
d) has unchanging collector current with signal.

5. The output impedance of a complementary power amplifier
a) is relatively low.
b) is relatively high.
c) depends on the impedance of the output transformer.
d) depends on the impedance of the speaker voice coil.

6. Complementary power amplifiers are useful because
a) they produce a large voltage gain.
b) they eliminate the need for input and output transformers.
c) phase reversal occurs between input and output.
d) all the above.



CLASS A.B POWER AMP. No 1 C.E.T. 13.

$I_{R_1,R_2,R_3} = 160.714285\,7\,\mu A$

$V_{R_1} = 2.8928571\,43\,V$

$V_{R_2} = 7.5535714\,29\,V$

$V_{R_3} = 7.5535714\,29\,V = V_{B_1}$

$V_{E_1} = V_{B_1} + 0.7 \simeq 8.25357142\,9V$

$I_E \simeq 3.05026455\,2\,mA.$

$V_{C_2} \simeq 8.3V$

$V_{B_3} \simeq 9.7V$

$V_{B_4} \simeq 8.3V$

$V_{E_{3,4}} \simeq 9V$

$$P_{O(max)} = \frac{(V_{L\,max.})^2}{R_L}$$