8.3 POWER OUTPUT CIRCUITS

PUSH-PULL AMPLIFIERS

$V_{BB}$ determines whether the stage will operate in Class-A, B, AB, or C. Typically all audio amplifiers are biased to operate in Class-AB in order to minimize the effects of cross-over distortion at low drive levels and to benefit from the high efficiency of Class-B operation at medium and high volume. In this push-pull amplifier, $Q_A$ will turn on and amplify when $v_{IN}$ is positive; $Q_B$ will turn on and amplify when $v_{IN}$ is negative. The center-tapped transformer, T1 makes sure the transistors get the right polarity to turn on (both require positive voltage on their bases to turn on) but receive alternate halves of $v_{IN}$. The center-tapped transformer, T2 superimposes the amplified halves by combining them with opposite phases, thereby correcting for the phase reversal introduced by T1. $R_L$ receives the amplified halves superimposed with the correct polarity for each, therefore the whole waveform is reproduced on it at amplified levels.

Advantages: (1) No need for large capacitors, (2) No need for complementary devices, (3) Suitable for any type power device, including vacuum tubes, (4) transformer coupling at the input allows matching of amplifier input impedance to the source/driver impedance and (5) transformer coupling at the output allows optimization of power coupling to any load impedance.

Disadvantages: (1) Transformer coupling: heavy, bulky, costly, and limited frequency response.
COMPLEMENTARY SYMMETRY AMPLIFIERS

Figure 8.3 (a) Dual supply DC-coupled Complementary Symmetry Emitter Follower Output Stage
(b) Single Supply AC-coupled Complementary Symmetry Emitter Follower Output Stage

Complementary output stages rely on two complementary and "matched" (i.e. symmetrical) transistors to split and share the task of amplifying an AC signal, positive half by one and the negative half of the signal by its complementary pair. Figure (a) shows a complementary symmetry emitter follower circuit biased with two diodes to operate in class-AB mode. Note the symmetry (anti-symmetry) with respect to a line drawn at the center from the input to the output terminal. Upper half of the circuit responds to the positive half of an input, $v_{IN}$. A positive $v_{IN}$ raises the voltage on the base of the NPN, forcing its emitter to follow and deliver a positive current into the load $R_L$ from the positive $+V_{CC}$ through the NPN. The NPN transistor cannot supply a negative current into $R_L$ and turns off when $v_{IN}$ becomes negative. For the negative half cycle of $v_{IN}$, the PNP half of the circuit takes over and helps to create a reproduction of $v_{IN}$ on $R_L$ by delivering the negative current to $R_L$ from the negative supply $V_{EE} = -V_{CC}$.

This circuit can supply undistorted peak swings to $R_L$ by as much as $(V_{CC} - V_{CESAT})$. For sinusoidal waveforms the ac power delivered to the load can be as high as $\frac{(V_{CC} - V_{CESAT})^2}{2R_L}$.

Figure (b) gives the single supply version of the complementary symmetry circuit. Note that both the input and the output terminals of this circuit are expected to be at $V_{CC}/2$, therefore creating a need to ac-couple the input as well as the output. The coupling capacitor needed at the output may have to be very large if high ac powers are to be delivered while operating from a small $V_{CC}$ voltage power supply.