

Class A CC Amplifier Power Efficiency

Total average Power:

$$\left| \bar{P}_{Tot} = 2V_{CC} \cdot (\bar{I}_{CQ} + I_C \sin^2(\omega t)) = V_{CC} \cdot \bar{I}_{CQ} \right|$$

$$\text{where } \bar{I}_{CQ} = \frac{V_{CC} - V_{BE}}{\pi R_E}$$

$$\therefore \left\| \bar{P}_{Tot} = \frac{2V_{CC}(V_{CC} - V_{BE})}{\pi R_E} \right\|$$

Average load Power (Max)

$$\left| \bar{P}_{LMAX} = V_{LMAX}^2 \frac{1}{2R_L} \sin^2(\omega t) = \frac{V_{LMAX}^2}{2R_L} \right|$$

$$\text{where } V_{LMAX} = \bar{I}_{CQ} \frac{\pi R_E R_L}{(\pi R_E + \pi R_L)} = \frac{(V_{CC} - V_{BE}) R_L}{(\pi R_E + \pi R_L)}$$

$$\therefore \left\| \bar{P}_{LMAX} = \frac{(V_{CC} - V_{BE})^2 R_L}{2(\pi R_E + \pi R_L)^2} \right\|$$

Power Efficiency:

$$\left| \eta_{Max} = \frac{\bar{P}_{LMAX}}{\bar{P}_{Tot}} = \frac{(V_{CC} - V_{BE})^2 R_L \pi R_E}{4(\pi R_E + \pi R_L)^2 V_{CC} (V_{CC} - V_{BE})} \right|$$

$$\therefore \left\| \eta_{Max} = \frac{(V_{CC} - V_{BE}) R_L \pi R_E}{4 V_{CC} (\pi R_E + \pi R_L)^2} \right\|$$

For max efficiency: $R_E = R_L$

$$\therefore \left| \eta_{Max} = \frac{(V_{CC} - V_{BE})}{16 V_{CC}} \right|$$

Class A/B CC Amplifier Power Efficiency

Total average Power:

$$\overline{P_{Tot\max}} = V_{CC} \cdot \frac{V_{L\max}}{T_L} \overline{\sin(\omega t)} = V_{CC} \frac{V_{L\max}}{T_L} \frac{2}{\pi}$$

Half-wave only

where $V_{L\max} \approx V_{CC} - V_{BE}$

$$\therefore \left| \overline{P_{Tot\max}} = \frac{V_{CC}(V_{CC} - V_{BE})}{T_L} \frac{2}{\pi} \right|$$

Average load Power: (Max)

$$\overline{P_L} = V_{L\max}^2 \frac{1}{T_L} \overline{\sin^2(\omega t)} = \frac{V_{L\max}^2}{2T_L}$$

$$\left| \overline{P_{L\max}} = \frac{(V_{CC} - V_{BE})^2}{2T_L} \right|$$

Power Efficiency:

$$\left| \eta_{\max} = \frac{\overline{P_{L\max}}}{\overline{P_{Tot\max}}} = \frac{(V_{CC} - V_{BE})^2 T_L \cdot \pi}{2T_L V_{CC}(V_{CC} - V_{BE}) \cdot 2} \right|$$

$$\therefore \left| \eta_{\max} = \frac{(V_{CC} - V_{BE})}{V_{CC}} \frac{\pi}{4} \right|$$

$$\therefore \left| \frac{\eta_{\max\text{ A/B}}}{\eta_{\max\text{ A}}} = \frac{\pi}{4} \right|$$