Problem 9.15 The average noise power per unit bandwidth measured at the front end of an AM receiver is 10^{-6} watts per Hz. The modulating signal is sinusoidal, with a carrier power of 80 watts and a sideband power of 10 watts per sideband. The message bandwidth is 4 kHz. Assuming the use of an envelope detector in the receiver, determine the output signal-to-noise ratio of the system. By how many decibels is this system inferior to DSB-SC modulation system?

Solution

For this AM system, the carrier power is 80 watts, that is,

$$\frac{A_C^{\,2}}{2} = 80 \text{ watts} \tag{1}$$

and the total sideband power is 20 watts, that is,

$$\frac{A_C^{\,2}}{2} k_a^{\,2} P = 20 \text{ watts} \tag{2}$$

Comparing Eq.s (1) and (2), we determine that $k_a^2 P = \frac{1}{4}$. Consequently, that post-detection SNR of the AM system is

$$\begin{aligned} SNR_{post}^{AM} &= \frac{A_C^{\,2} k_a^{\,2} P}{2 N_0 W} \\ &= \frac{20}{10^{-6} \times 4000} \\ &= 5000 \\ &\sim 37 dB \end{aligned}$$

For the corresponding DSB system the post detection SNR is given by

$$\begin{aligned} \text{SNR}_{\text{post}}^{\text{DSB}} &= \frac{1 + k_a^2 P}{k_a^2 P} \quad \text{SNR}_{\text{post}}^{\text{AM}} \\ &= \frac{1 + \frac{1}{4}}{\frac{1}{4}} \\ &= 5 \times \text{SNR}_{\text{post}}^{\text{AM}} \\ &\sim 7 dB \text{ higher} \end{aligned}$$