Problem 9.3. For the same received signal power, compare the post-detection SNRs of DSB-SC with coherent detection and envelope detection with k_a = 0.2 and 0.4. Assume the average message power is P = 1.

Solution

From Eq. (9.23), the post-detection SNR of DSB-SC with received power $\dfrac{{}^{DSB}A_c^{\,2}P}{2}$ is

$$SNR_{post}^{DSB} = \frac{{}^{DSB}A_c^2 P}{2N_0W}$$

From Eq. (9.30), the post-detection SNR of AM with received power $\dfrac{{}^{AM}A_c^2}{2}\left(1+k_a^{\,2}P\right)$ is

$$SNR_{post}^{AM} = \frac{{}^{AM}A_c^2 k_a^2 P}{2N_0W}$$

So, by equating the transmit powers for DSB-Sc and AM, we obtain

$$\frac{{}^{DSB}A_c^2 P}{2} = \frac{{}^{AM}A_c^2}{2}\left(1+k_a^{\,2}P\right)$$

$$\Rightarrow \frac{{}^{AM}A_c^2}{2} = \frac{{}^{DSB}A_c^2}{2} \quad \frac{P}{1+k_a^{\,2}P}$$

Substituting this result into the expression for the post-detection SNR of AM,

$$\mathrm{SNR}_{\mathrm{post}}^{\mathrm{AM}} = \frac{{}^{DSB}A_c^{\,2}P}{2N_0W}\left(\frac{k_a^{\,2}P}{1+k_a^{\,2}P}\right) = \mathrm{SNR}_{\mathrm{post}}^{\mathrm{DSB}}\Delta$$

Where the factor Δ is

$$\Delta = \frac{k_a^{\,2}P}{1+k_a^{\,2}P}$$

With k_a= 0.2 and P= 1, the AM SNR is a factor $\Delta = \dfrac{(.2)^2}{1.04} = .04$ less.

With k_a = 0.4 and P = 1, the AM SNR is a factor $\Delta = \dfrac{(.4)^2}{1+.16} = \dfrac{.16}{1.16} \approx 0.14$ less.