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 $\frac{DSB A_c^2 P}{2}$ is

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

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

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

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

$$\frac{A_{c}^{2}P}{2} = \frac{AMA_{c}^{2}}{2} \left(1 + k_{a}^{2}P\right)$$
$$\Rightarrow \frac{AMA_{c}^{2}}{2} = \frac{DSBA_{c}^{2}}{2} \frac{P}{1 + k_{a}^{2}P}$$

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

$$\operatorname{SNR}_{\operatorname{post}}^{\operatorname{AM}} = \frac{{}^{DSB}A_{c}{}^{2}P}{2N_{0}W} \left(\frac{k_{a}{}^{2}P}{1+k_{a}{}^{2}P}\right) = \operatorname{SNR}_{\operatorname{post}}^{\operatorname{DSB}}\Delta$$

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 $\Delta = \frac{(.2)^2}{1.04} = .04$ less.

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

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