Problem 9.14 A 10 kilowatt transmitter amplitude modulates a carrier with a tone $m(t) = \sin(2000\pi t)$, using 50 percent modulation. Propagation losses between the transmitter and the receiver attenuate the signal by 90 dB. The receiver has a front-end noise N_0 = -113 dBW/Hz and includes a bandpass filter $B_T = 2W = 10$ kHz. What is the post-detection signal-to-noise ratio, assuming the receiver uses an envelope detector?

Solution

If the output of a 10 kW transmitter is attenuated by 90 dB through propagation, then the received signal level R is

$$\begin{aligned} R &= 10^4 \times 10^{-90/10} \\ &= 10^{-5} \text{ watts} \end{aligned} \tag{1}$$

For an amplitude modulated signal, this received power corresponds to

$$R = \frac{A_c^2}{2}\left(1 + k_a^2 P\right) \tag{2}$$

From Eq. (9.30), the post-detection SNR of an AM receiver using envelope detection is

$$\mathrm{SNR}_{\mathrm{post}}^{\mathrm{AM}} = \frac{A_C{}^2 k_a{}^2 P}{2N_0 W}$$

Substituting for k_a, P, and $A_c^2/2$ (obtained from Eq. (2)), we find

$$\begin{aligned} \mathrm{SNR}_{\mathrm{post}}^{\mathrm{AM}} &= \frac{R}{1 + k_a^2 P}\frac{k_a^2 P}{N_0 W} \\ &= \frac{10^{-5}}{1 + 0.25 \times 0.5} \times \frac{0.25 \times 0.5}{(5 \times 10^{-12})(5 \times 10^3)} \\ &= 44.4 \end{aligned}$$

where $k_a = 0.5$ and $P = 0.5$.

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