

9.25 A 150 MHz communication link consists of two vertical half-wave dipole antennas separated by 2 km. The antennas are lossless, the signal occupies a bandwidth of 3 MHz, the system noise temperature of the receiver is 900 K, and the desired signal-to-noise ratio is 17 dB. What transmitter power is required?

Solution: From Eq. (9.77), the receiver noise power is

$$P_n = KT_{\text{sys}}B = 1.38 \times 10^{-23} \times 900 \times 3 \times 10^6 = 3.72 \times 10^{-14} \text{ W}.$$

For a signal to noise ratio $S_n = 17 \text{ dB} = 50$, the received power must be at least

$$P_{\text{rec}} = S_n P_n = 50 (3.72 \times 10^{-14} \text{ W}) = 1.86 \times 10^{-12} \text{ W}.$$

Since the two antennas are half-wave dipoles, Eq. (9.47) states $D_t = D_r = 1.64$, and since the antennas are both lossless, $G_t = D_t$ and $G_r = D_r$. Since the operating frequency is $f = 150 \text{ MHz}$, $\lambda = c/f = (3 \times 10^8 \text{ m/s}) / (150 \times 10^6 \text{ Hz}) = 2 \text{ m}$. Solving the Friis transmission formula (Eq. (9.75)) for the transmitted power:

$$P_t = P_{\text{rec}} \frac{(4\pi)^2 R^2}{\lambda^2 G_r G_t} = 1.86 \times 10^{-12} \frac{(4\pi)^2 (2 \times 10^3 \text{ m})^2}{(2 \text{ m})^2 (1.64) (1.64)} = 112.5 \quad (\mu\text{W}).$$
