

9.23 A 3 GHz line-of-sight microwave communication link consists of two lossless parabolic dish antennas, each 1 m in diameter. If the receive antenna requires 1 nW of receive power for good reception and the distance between the antennas is 40 km, how much power should be transmitted?

Solution: At $f = 3 \text{ GHz}$, $\lambda = c/f = (3 \times 10^8 \text{ m/s}) / (3 \times 10^9 \text{ Hz}) = 0.10 \text{ m}$. Solving the Friis transmission formula (Eq. (9.75)) for the transmitted power:

$$P_t = P_{\text{rec}} \frac{\lambda^2 R^2}{\xi_t \xi_r A_t A_r}$$

$$= 10^{-9} \frac{(0.100 \text{ m})^2 (40 \times 10^3 \text{ m})^2}{1 \times 1 \times \left(\frac{\pi}{4} (1 \text{ m})^2\right) \left(\frac{\pi}{4} (1 \text{ m})^2\right)} = 25.9 \times 10^{-3} \text{ W} = 25.9 \text{ mW}.$$
