2.110 The maximum radar cross section of a resonant linear $\lambda/2$ dipole is approximately $0.86\lambda^2$. For a monostatic system (i.e., transmitter and receiver at the same location), find the received power (in W) if the transmitted power is 120 W, the distance of the dipole from the transmitting and receiving antennas is 120 m, the gain of the transmitting and receiving antennas is 15 dB each, and the frequency of operation is 3 GHz. Assume a polarization loss factor of −1 dB.

Use Radar Range Equation (2-125)

$$\frac{P_r}{P_t} = e_{cdt}\, e_{cdr} [1-|\Gamma_t|^2][1-|\Gamma_r|^2]\, \sigma \frac{D_t D_r}{4\pi} \left(\frac{\lambda}{4\pi R_1 R_2}\right)^2 |\hat{\rho}_w \cdot \hat{\rho}_r|^2$$

Radar Transceiver
$P_t = 120\,W$ ⟵ 120 m ⟶ $\lambda/2$ dipole
$\sigma = 0.86\lambda^2$

$G_t = G_r = 15\,dB_i$

$f = 3\,GHz$

$\rightarrow G_t = G_r = e_{cdt} D_t = e_{cdr} D_r = 10^{15/10} = 31.6228$

$\rightarrow \lambda = c/f = \frac{2.9979 \times 10^8}{3 \times 10^9} = 0.09993\ m$

$\rightarrow \sigma = 0.86\lambda^2 = 0.86(0.09993)^2 = 0.008588\ m^2$

$\rightarrow$ Assume transceiver matched $\Rightarrow |\Gamma_t| = |\Gamma_r| = 0$

$\rightarrow R_1 = R_2 = 120\ m$

$\rightarrow PLF = |\hat{\rho}_w \cdot \hat{\rho}_r|^2 = -1\,dB = 10^{-1/10} = 0.79433$

$$P_r = (120\,W)(1-0)(1-0)\,0.008588 \frac{10^{1.5}\,10^{1.5}}{4\pi} \left(\frac{0.09993}{4\pi\, 120^2}\right)^2 10^{-0.1}$$

$$P_r = 1.98659 \times 10^{-11}\,W = 19.866\,pW$$