Líneas de transmisión

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}} \quad \gamma = \begin{cases} \sqrt{-(R + j\omega L)(G + j\omega C)} \\ \beta - j\alpha \end{cases} \qquad \text{Bajas pérdidas} \iff \begin{cases} \omega L \gg R \\ \omega C \gg G \end{cases}$$

$$\rho = \frac{Z_L - Z_0}{Z_L + Z_0} \qquad Z(z) = Z_0 \frac{Z_L \cos(\beta z) + j Z_0 \sin(\beta z)}{Z_0 \cos(\beta z) + j Z_L \sin(\beta z)} \quad \text{ROE} = \frac{1 + |\rho|}{1 - |\rho|} \quad |\rho| = \frac{\text{ROE} - 1}{\text{ROE} + 1}$$

Bajas pérdidas $\Rightarrow$

$$\beta \approx \omega\sqrt{LC} \quad \alpha \approx \frac{\beta}{2}\left(\frac{R}{\omega L} + \frac{G}{\omega C}\right) \qquad \alpha \ll \beta$$

$$Z_0' \approx \sqrt{\frac{L}{C}} \quad Z_0'' \approx \frac{Z_0'}{2}\left(\frac{G}{\omega C} - \frac{R}{\omega L}\right) \qquad Z_0'' \ll Z_0'$$

Definiciones y fórmulas generales

$$U \overset{\text{def}}{=} \langle |\boldsymbol{P}| \rangle r^2 \qquad D \overset{\text{def}}{=} \frac{U(\theta,\phi)}{U_{\text{promedio}}} = \frac{4\pi U(\theta,\phi)}{P_{\text{entregada a la antena}}} = \frac{4\pi}{\lambda^2} A_{\text{ef}}$$

$$\ell_{\text{ef}} = \frac{1}{I_0} \int_{-L/2}^{L/2} I(z)\, dz = -\frac{V}{|\boldsymbol{E}|} \quad G \overset{\text{def}}{=} \frac{4\pi U_{\text{máx}}}{P_{\text{entregada a la antena}}} = \eta D \quad A_{\text{ef}} = \frac{P_{\text{irradiada}}}{\langle |\boldsymbol{P}| \rangle}$$

Dipolo

$$I = I_m \sin\left(\beta\left[\frac{L}{2} - |z|\right]\right) \qquad F(\theta,\phi) = \left(\frac{\cos\left(\frac{\beta L}{2}\cos\theta\right) - \cos\left(\frac{\beta L}{2}\right)}{\sin\theta}\right)^2$$

$Z_{\text{in}} \approx (73 + j43)\ \Omega$ $L = \lambda/2$ $\quad R_{\text{perd}} = \dfrac{L}{2\pi a}\sqrt{\dfrac{\pi c \mu}{\sigma \lambda}}\,(1 - \text{sinc}\ (\beta L)) \qquad \eta = \dfrac{R_{\text{rad}}}{R_{\text{rad}} + R_{\text{perd}}}$

$$U(\theta,\phi) = \frac{I_m^2}{8\pi^2} Z_{00} F(\theta,\phi) \qquad R_{\text{rad}} = \begin{cases} 60\,\Omega \displaystyle\int_0^{\pi} \frac{\left[\cos\left(\frac{\beta L}{2}\cos\theta\right) - \cos\left(\frac{\beta L}{2}\right)\right]^2}{\sin\theta} \\ 73\,\Omega \quad L = \lambda/2 \end{cases} \qquad D = \begin{cases} \dfrac{2\,F(\theta)\rfloor_{\text{máx}}}{\int_0^{\pi} F(\theta)\sin\theta\, d\theta} \\ \dfrac{3}{2} \quad L = \lambda/2 \end{cases}$$

Monopolo

$$D = \begin{cases} 2D_{\text{dipolo}} \\ 3 \quad \text{corto} \\ 4{,}8 \quad L = 2h = \lambda/2 \end{cases} \qquad R_{\text{rad}} = \frac{R_{\text{rad monopolo}}}{2} \qquad R_{\text{perd}} = \frac{h}{2\pi a\sqrt{\lambda}}\sqrt{\frac{\pi c\mu}{\sigma}}\left(1 - \text{sinc}\ \left(\frac{4\pi h}{\lambda}\right)\right)$$

Friis

$$W_R = W_T G_T G_R \left(\frac{\lambda}{4\pi R}\right)^2 |\hat{\boldsymbol{\rho}}_T \cdot \hat{\boldsymbol{\rho}}_R|^2 \left(1 - |\Gamma_T|^2\right)\left(1 - |\Gamma_R|^2\right)$$

$$W_R\,[\,\text{dBm}] = W_T\,[\,\text{dBm}] + G_R\,[\,\text{dB}] + G_T\,[\,\text{dB}] - 20\log R\,[\,\text{km}] - 20\log f\,[\,\text{MHz}] - 32\,\text{dB}$$

Conjuntos

$$\text{AF}(\psi) \overset{\text{def}}{=} \frac{1}{N}\frac{\sin\frac{N\psi}{2}}{\sin\frac{\psi}{2}} \qquad \psi \overset{\text{def}}{=} \beta d\cos\phi + \alpha \qquad \text{HW} \to \alpha = \pm(\beta d + \delta) \quad \delta \approx \frac{\pi}{N}$$

$$\boldsymbol{E}_{\text{tot}} = \boldsymbol{E}_0 N \text{AF}(\psi) \qquad \text{SLL} \overset{\text{def}}{=} \frac{\text{máximo secundario mayor}}{\text{máximo principal}}$$