EEC133 Midterm Formula Sheet

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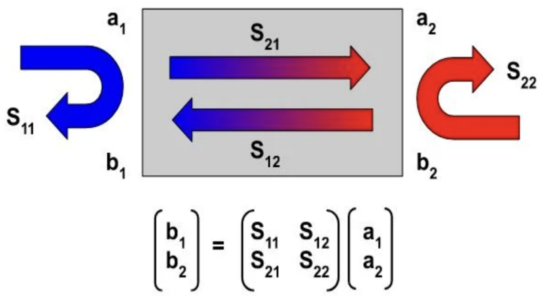

Figure 1: S Parameter

db to dbm

$$P(\text{dBm}) = 10 \times \log(P(w)) + 30$$

Steradian:

$$A = r^2\Omega$$

where A is the surface area patch, r is the radius, and Ω is the solid angle.

Half Power Beamwidth:

$$\theta_2 - \theta_1$$

where θ_2, θ_1 are the angles where the normalized radiation intensity is $\frac{1}{2}$.

Directivity:

$$D_0 = \frac{4\pi}{\Omega_p} = \frac{4\pi}{\int_{sphere} F(\theta, \phi) d\Omega}$$

where Ω_p is the pattern solid angle.

$$\frac{A_e}{D_0} = \frac{\lambda^2}{4\pi}$$

where A_e is the effective area of the antenna, D_0 is the directivity of the antenna, and λ is the wavelength of the wave transmitted by the antenna.

Gain

$$G_0 = e \times D_0$$

where e is the efficiency of the antenna.

Poynting Vector

$$\vec{S}_{av} = \hat{z}\frac{|\widetilde{E}|^2}{2\eta}$$

Power Radiated from the Antenna

$$|\vec{S}_{avg}| = \frac{e_t P_t}{4\pi r^2} D_t$$

Friss Transmission Equation:

$$\frac{P_{rec}}{P_t} = e_t e_r \left(\frac{\lambda}{4\pi R}\right)^2 D_t D_r$$
$$= \left(\frac{\lambda}{4\pi R}\right)^2 G_t G_r$$
$$= \frac{e_r e_t A_t A_r}{\lambda^2 R^2}$$

where subscript t denotes the transmitter's parameter, r denotes the receiver's parameter, and R is the distance between two antennas.

Vector Potential

$$\vec{H} = \frac{1}{\mu_0}\nabla \times \vec{A}$$

Retarded Potential

$$\widetilde{A}(\vec{r}) = \int \frac{\mu_0 \widetilde{J}(\vec{r}) e^{-jkr}}{4\pi R} dV'$$

Hertzian Dipole Antenna: $l < \frac{\lambda}{50}$
Far Field ($r >> \lambda$)

$$\widetilde{E}_{ff,\theta} = j\eta_0 \frac{Ikl}{4\pi r} e^{-jkr}\sin(\theta)$$
$$\widetilde{H}_{ff,\phi} = \frac{\widetilde{E}_{ff,\theta}}{\eta_0}$$
$$D(\theta,\phi) = 1.5\sin^2(\theta)$$
$$F(\theta,\phi) = \sin^2(\theta)$$
$$P_{rad} = 40\pi^2 I_0^2 \left(\frac{l}{\lambda}\right)^2$$
$$R_{rad} = 80\pi^2 \left(\frac{l}{\lambda}\right)^2$$

Small dipole Antenna: $l < \frac{\lambda}{10}$
Fields are 1/2 those form the Hertzian Dipole.

$$P_{rad} = 10\pi^2 I_0^2 \left(\frac{l}{\lambda}\right)^2$$
$$R_{rad} = 20\pi^2 \left(\frac{l}{\lambda}\right)^2$$

Small Loop Antenna: $a << \frac{\lambda}{2\pi}$
Far Fields ($r >> \lambda$)

$$\widetilde{H}_{ff,\theta} = \frac{Ik^2(\pi a^2)}{4\pi r} e^{-jkr}\sin(\theta)$$
$$\widetilde{E}_{ff,\phi} = -\widetilde{H}_\theta \eta_0$$

$$D(\theta,\phi) = 1.5\sin^2(\theta)$$
$$R_{rad} = 320\pi^6 \left(\frac{a}{\lambda}\right)^4 N^2$$

Choosing Capacitor to be in parallel with loop antenna to cancel antenna's input reactance

$$j\omega C - j\frac{X_A}{R_A^2 + X_A^2} = 0$$

where X_A is the input reactance and R_A is the input resistance of the antenna