Satellite Communications (Data & Formula Sheet)
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$$EIRP = P_t G_t \qquad F = \frac{EIRP}{4\pi R^2} = \frac{P_t G_t}{4\pi R^2} \ \text{W/m}^2$$

k = Boltzmann's constant = $1.38\text{x}10^{-23}$ J/K(-228.6 dBW/HzK)

$$P_r = F \text{ x } A_r = \frac{P_t G_t A_r}{4\pi R^2} \qquad A_e = A_{phy} \text{ x } \eta \qquad Gain = \frac{4\pi A_e}{\lambda^2} \qquad L_p = \left(\frac{4\pi R}{\lambda}\right)^2$$

$$Gain = \frac{4\pi A_e}{\lambda^2} = \frac{4\pi A_{phy}}{\lambda^2} \times \eta \qquad \theta_{3dB} \cong \frac{75\lambda}{D} \text{ degrees} \qquad \boxed{P_r = \frac{P_t G_t G_r}{L_p L_a L_{ta} L_{ra} L_{pol} L_{other} L_r}}$$

$$N = kT_s B \ \text{(dBW)} \qquad \boxed{T[K] = T[^0C] + 273} \qquad \boxed{T[K] = (T[^0F] - 32)\frac{5}{9} + 273}$$

$$T_s = T_{transmitted} + T_{antenna} + T_{LNA} + T_{lineloss} + T_{RX} \qquad T_{no} = T_p(1\text{-}G)$$

$$F_N = \frac{[S/N]_{in}}{[S/N]_{out}} = \frac{N_{out}}{kT_0 B_N G} \qquad T_d = T_0(F_n - 1)$$

$$B = 2(\Delta_f + f_{\text{mod}}) \qquad \frac{C}{N} = \left(\frac{P_t G_t G_r}{kT_s B_n}\right)\left(\frac{\lambda}{4\pi R}\right)^2 = \left(\frac{P_t G_t}{kB_n}\right)\left(\frac{\lambda}{4\pi R}\right)^2\left(\frac{G_r}{T_s}\right)$$

$$v_{FM}(t) = v(t) = A\cos\left[\omega_c t + \left(\frac{\Delta\omega}{\omega_{\text{mod}}}\right)\sin(\omega_{\text{mod}} t)\right] \qquad \left(\frac{C}{N}\right)_{total} = \left[\left(\frac{C}{N}\right)_1^{-1} + \left(\frac{C}{N}\right)_2^{-1} + \ldots + \left(\frac{C}{N}\right)_n^{-1}\right]^{-1}$$

$$erfc(y) = \frac{2}{\sqrt{\pi}}\int_y^{\infty} e^{-z^2} dz \qquad BER_{total} = BER_1 + BER_2 + \ldots + BER_n$$

$$\left(\frac{S}{N}\right)_{Out} = \left(\frac{C}{N}\right)_{Overall} + 10\cdot\log_{10}\frac{BW_{FM}}{f_{\max}} + 20\cdot\log_{10}\frac{\Delta f_{Peak}}{f_{\max}} + 1.8 + P \ \text{(dB)}$$

$$P_{eBPSK} = P_{eQPSK} = Q\left[\sqrt{\frac{2E_b}{N_0}}\right] \qquad BER = \frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{N_o}}\right)$$

$$BER \approx \frac{0.2821}{\sqrt{\frac{E_b}{N_o}}} e^{-\frac{E_b}{N_o}}$$