The University of New Mexico

School of Engineering

Electrical and Computer Engineering Department

ECE 535 Satellite Communications

Student Name: Alex Hostick

Student SN: 2O1

Module # 12-2: 12.15, 12.19, 12.21, 12.23, 12.25

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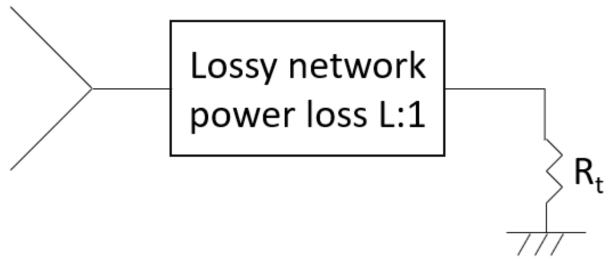
Prof. Tarief Elshafiey

12.15 An amplifier having a noise temperature of 200 K has a 4-dB attenuator connected at its input. Calculate the effective noise temperature referred to the attenuator input.



$T_{NW,i} = T_x(L-1)$

$T = 200K; \quad L = 4dB$

$T_S = T_O(L-1) + \frac{T_e}{\frac{1}{L}} = T_O(L-1) + LT_e$

$L = 10^{4/10} = 2.511$

$T_S = 290 * (2.511 - 1) + (2.511 * 200) = 438.19 + 502.2 = 940.39K$

12.19 Explain what is meant by carrier-to-noise ratio. At the input to a receiver the received carrier power is 400 pW and the system noise temperature is 450 K. Calculate the carrier-to-noise density ratio in dBHz. Given that the bandwidth is 36 MHz, calculate the carrier-to-noise ratio in decibels.

Definition: Carrier-to-noise ratio is a measurement of the performance of a satellite link to the received input. Link budgets are typically concerned with solving this ratio (C/N).

$CW_{Rx} = 400x10^{-12}W; T1 = 450K; BW = 36MHz; k = 1.38x10^{-23}J/K$

(a) Carrier-to-Noise Density Ratio in dBHz

$P_{RxdB} = 10\log(CW_{Rx}) = -93.98dBW$

$$\frac{C}{N0} = \frac{P_{RxdB}}{k * T1} = \frac{-93.98dBW}{(1.38x10^{-23}J/K) * 450K} = 6.44x10^{10} = 10\log(6.44x10^{10}) = 108.1dB$$

(b) Calculate Carrier-to-Noise Ratio in Decibels at 36MHz Bandwidth

$$CN0dBHz = \frac{C}{N_0}dBHz - dBHz = 108.1dB - 10\log(36MHz) = 108.1dB - 75.56dbHz = 32.5dBHz$$

12.21 In a satellite link the propagation loss is 200 dB. Margins and other losses account for another 3 dB. The receiver [G/T] is 11 dB, and the [EIRP] is 45 dBW. Calculate the received [C/N] for a system bandwidth of 36 MHz.

$$L_{Prop} = 200dB;\quad L_a = 2 = 3dB;\; G_r = 11dB;\quad EIRP = 45dBW$$

(a) Calculate the received [C/N] for a system BW of 36MHz

Boltzmann's constant (J/K dB) for temp = 228.6 decilogs

C/N0 = EIRP + k + G_r - L_{Prop} – L_a = 81.6dB

[C/N0] = C/N0 – BW = 81.6dB – 10log(36MHz) = 6 dB

12.23 Explain what is meant by saturation flux density. The power received by a 1.8-m parabolic antenna at 14 GHz is 250 pW. Calculate the power flux density (a) in W/m2 and (b) in dBW/m2 at the antenna.

Definition: Saturation flux density (Ψ_s) is required at the receiving antenna to produce saturation of the TWTA (traveling-wave tube amplifier). It is the maximum flux that a material can support before it becomes saturated. Antennas can hold a calculated amount of magnetic field before saturating.

$$D = 1.8m, f = 14GHz, P_R = 250pW$$

(a) Power flux density in W/m^2

$$A_{ett} = \eta_I A_0$$

$$A_0 = \pi \frac{d^2}{4}$$

$$\eta_I = 0.55$$

$$P_R = \Psi_M A_{ett} \xrightarrow{yields} \Psi_M = \frac{P_R}{A_{ett}}$$

$$A_{ett} = \eta_I A_0 = 0.55 * \left(\frac{\pi * (1.8)^2}{4}\right) = 1.399$$

$$\Psi_M = \frac{250}{1.399} = 178.6\, pw/m^2$$

(b) Power flux in dBW/m^2

$[\Psi_M] = 10\log(\Psi_M)$ = 10log(178.6x10^{-12}) = -97.5 dBW/m^2

12.25 A satellite transponder requires a saturation flux density of -110 dBW/m2, operating at a frequency of 14 GHz. Calculate the earth station [EIRP] required if total losses amount to 200 dB.

$[EIRP] = [\Psi_M] + [A_0] + [FSL]$

$$A_0 = 10\log\left(\frac{\lambda^2}{4\pi}\right)$$

$$A_0 = 10\log\left(\frac{(c/f)^2}{4\pi}\right) = -44.38$$

EIRP = (-110dBW/m^2) + (-44.38dB) + 200dB = 45.6dBW