Transmisión, ganancia, pérdida y uso de dB

1) a) Pérdidas físicas:

Conector inicial → 2dB
4 empalmes por fusión → 0,3 dB + 0,2 dB + 0,15 dB + 0,2 dB = 0,85 dB
1 empalme por conector al medio → 4 dB
⇒ 6,85 dB

Pérdidas por distancia:

$0{,}35\ dB/Km \cdot 21\ Km = 7{,}35\ dB$

- Pérdida total: $6{,}85\ dB + 7{,}35\ dB = \boxed{14{,}2\ dB}$

b) $P_e = 4\ mW$, $P_s = ?$

- Se agrega un conector al final ⇒ $P(dB) = 14{,}2\ dB + 2dB = 16{,}2\ dB$ ⇒ $G(dB) = -16{,}2\ dB$
- $G(dB) = 10 \log (P_s/P_e)$

$-16{,}2dB/10 = \log (P_s/P_e)$

$10^{-1{,}62\ dB} = P_s/P_e \Rightarrow P_s = P_e \cdot 10^{-1{,}62dB} = (4mW)\,10^{-1{,}62dB} = 0{,}096\ mW = \boxed{96\ \mu W}$

2) 500 Km de fibra óptica, $P_e = 2mW$, $G = -31{,}5\ dB$

- 25 Km ____ 1 empalme

500 Km ____ ? empalmes ⇒ 20 empalmes

- Pérdidas físicas:

19 empalmes · 0,2 dB/empalme = 3,8 dB
2 conectores (entrada y salida): 1,1 dB = 2,2 dB
⇒ 6 dB

- Pérdidas por distancia:

500 Km · 0,1 dB/Km = 50 dB

$G_{total}(dB) = -56\ dB$

- $G(dB) = 10 \log (P_s/P_e) \Rightarrow P_s = P_e\, 10^{G/10} = (2mW)\, 10^{-56dB/10} = 5 \times 10^{-6}\ mW$

- $dBmW = 10 \log P_s = 10 \cdot \log (5 \times 10^{-6}\ mW) = -53\ dBmW$

$-53\ dBmW < -31{,}5\ dB$ ⇒ No es factible

③ a) Pérdidas:

$$\left.\begin{array}{l} 2 \text{ empalmes} \cdot 3 dB/\text{empalme} = 6 dB \\ 40 Km \cdot 0,1 dB/Km = 4 dB \end{array}\right\} \Rightarrow P(dB) = 10 dB$$

- $P_e = 2 mW \Rightarrow P_{tx} = 10 \cdot \log P_e = 10 \log(2 mW) = 3 dB$
- $P_{rx} = P_{tx} - P = 3 dB - 10 dB = -7 dB$
- $P_s = 0,18 mW \Rightarrow S_{rx} = 10 \log P_s = 10 \log(0,18 mW) = -7,44 dB$

- Factibilidad técnica:

$P_{rx} \geq S_{rx} \Rightarrow -7 dB \geq -7,44 dB \Rightarrow$ Si es factible

b) Realizando un empalme adicional $\rightarrow P(dB) = 10 dB + 3 dB = 13 dB$

- $P_{rx} = P_{tx} - P = 3 dB - 13 dB = -10 dB$
- Factibilidad técina:

$P_{rx} < S_{rx} \Rightarrow$ No es factible

④ $A = 0,49 dB/Km$, $P_s = 19,8 W$, longitud $= 34700 m = 34,7 Km$

- Pérdida:

$0,49 dB/Km \cdot 34,7 Km = 17 dB \Rightarrow G(dB) = -17 dB$

- Potencia inicial:

$$P_e = \frac{P_s}{10^{G/10}} = \frac{19,8 W}{10^{-17dB/10}} = 992,3 W$$

$$P_e(dBW) = 10 \log(992,3 W) = \boxed{30 dBW}$$

⑤ $T = 25°C$, $B = 10 MHz$, $K = 1,38 \times 10^{-23} J/K$

- $T(°K) = 25°C + 273 = 298 °K$

- $P_N(dBm) = 10 \log(k \cdot T \cdot B \cdot 10^3) = 10 \log\left[(1,38 \times 10^{-23} J/\cancel{K})(298 \cancel{K})(10 MHz)(10^3)\right] =$

$= 10 \log\left[(1,38 \times 10^{-23} W/\cancel{Hz})(298)(10^7 \cancel{Hz})(10^3)\right] = \boxed{-103,85 dBm}$

Práctica Nº 3

⑥ $T = 17°C$, $k = 1{,}38 \times 10^{-23}$ J/K

• $°K = °C + 273 \Rightarrow T = 17°C + 273 = 290° K$

• $N_0 (W/Hz) = k \cdot T = (1{,}38 \times 10^{-23}\ J/K)(290\ K) = \boxed{4 \times 10^{-21}\ W/Hz}$

• $N_0 (dBW/Hz) = 10 \log N_{0(W/Hz)} = 10 \log (4 \times 10^{-21}\ W/Hz) = \boxed{-204\ dBW/Hz}$

⑦

$V_s = 2V$ —— [3 dB] —— $P_{N_s} = -50$ dBm

$R = 93 \Omega$

$(S/N)_e = \dfrac{P_{se}}{P_{Ne}} = ?$

• $P_{s_e} = \dfrac{V_s^2}{R} = \dfrac{(2V)^2}{93 \Omega} = 0{,}043\ W = 43\ mW$

• $G(dB) = P_s - P_e = P_{N_s} - P_{Ne} \Rightarrow P_{Ne} = P_{N_s} - G = -50\ dBm - 3\ dB = -53\ dBm$

• $P(dBm) = 10 \log P_{Ne} \Rightarrow P_{Ne} = 10^{P(dBm)/10} = 10^{-53\ dBm/10} = 5{,}01 \times 10^{-6}\ mW$

• $(S/N)_e = \dfrac{P_{se}}{P_{Ne}} = \dfrac{43\ mW}{5{,}01 \times 10^{-6}\ mW} = \boxed{8.581.747{,}07}$

⑧ $(S/N)_s = ?$

• $P_{N_s}(dBm) = 10 \log P_{Ns(mW)} \Rightarrow P_{N_s}(mW) = 10^{P_{N_s}(dBm)/10} = 10^{-50\ dBm/10} = 10^{-5}\ mW$

• $G(dB) = 10 \log (P_{ss}/P_{se}) \Rightarrow P_{ss} = P_{se} \cdot 10^{G(dB)/10} = (43\ mW)\, 10^{3dB/10} = 85{,}8\ mW$

• $(S/N)_s = \dfrac{P_{ss}}{P_{Ns}} = \dfrac{85{,}8\ \cancel{mW}}{10^{-5}\ \cancel{mW}} = 8.580.000$

• $(S/N)_{s(dB)} = 10 \log (S/N)_s = 10 \log (8.580.000) = \boxed{69{,}33\ dB}$

⑨ Si $(S/N)_s$ se deteriora un 40 %:

- $(S/N)_s = (S/N)_s - (40\%)(S/N)_s = 0{,}6\,(S/N)_s = (0{,}6)(8.580.000) = 5.148.000$

- $(S/N)_e = 8.581.747{,}01$

- $F = \dfrac{(S/N)_e}{(S/N)_s} = 1{,}67$

- Indice de ruido:

$N(dB) = 10 \log F = 10 \log(1{,}67) = \boxed{2{,}2\ dB}$

⑩ $N_o = -300\ dBW/Hz$, $K = 1{,}38 \times 10^{-23}\ J/K$

- $N_o(dB_m) = 10 \log (kT \cdot 10^3)$

$N_o/10 = \log(10^3 kT)$

$10^{N_o/10} = 10^3 kT \Rightarrow T = \dfrac{10^{N_o/10}}{10^3 K}$

- $T = \dfrac{10^{(-300\ dBW/Hz)/10}}{(10^3)(1{,}38 \times 10^{-23}\ J/K)} = \dfrac{10^{-30}\ \cancel{W/Hz}}{1{,}38 \times 10^{-20}\ \cancel{J/K}} = 7{,}25 \times 10^{-11}\ °K$

- $°K = °C + 273 \Rightarrow °C = °K - 273$

- $T(°C) = 7{,}25 \times 10^{-11}\ °K - 273 = \boxed{-273\ °C}$

⑪ Pérdidas:

$$\left.\begin{array}{l}\text{Pérdida de acoplamiento y conector: } 10\ dB \\ \text{Pérdida por distancia: } 0{,}5\ dB/Km \cdot 10\ Km = 5\ dB \\ \text{Pérdida de empalmes: } 4 \text{ empalmes} \cdot 0{,}2\ dB = 0{,}8\ dB \\ \text{Pérdida de conector de salida: } 2\ dB\end{array}\right\} P(dB) = 17{,}8\ dB$$

$P_e = 1\ mW$ y $P_s = 1\ \mu W$

• $G(dB) = -17{,}8\ dB \Rightarrow P_s = ?$

• $G(dB) = 10 \log (P_s/P_e)$

$10^{G(dB)/10} = P_s/P_e \Rightarrow P_s = P_e \cdot 10^{G(dB)/10} = (1\ mW)\, 10^{(-17{,}8\ dB)/10} = 0{,}0166\ mW$

• $P_s = 0{,}0166\ mW = 16{,}6\ \mu W > 1\ \mu W \Rightarrow$ Si, el sistema funcionará

12 $G(dB) = 5\ dB$, $N = 3\ dB$, $V_{se} = 10\ dBmV$, $V_{Ne} = 50\ dB\mu V$, $V_{Ni} = ?$

• $F = \dfrac{\dfrac{P_{se}}{P_{Ne}}}{\dfrac{P_{ss}}{P_{Ns}+P_{Ni}}} = \dfrac{\dfrac{V_{se}^2}{V_{Ne}^2}}{\dfrac{V_{ss}^2}{(V_{Ns}+V_{Ni})^2}}$

• $N(dB) = 10 \log F \Rightarrow F = 10^{N(dB)/10} = 10^{3dB/10} = 1{,}995$

• $V_{se}(dBmV) = 20 \log V_{se} \Rightarrow V_{se} = 10^{V_{se}(dBmV)/20} = 10^{10\ dBmV/20} = 3{,}162\ mV$

• $V_{Ne}(dB\mu V) = 20 \log V_{Ne} \Rightarrow V_{Ne} = 10^{V_{Ne}(dB\mu V)/20} = 10^{50 dB\mu V/20} = 316{,}22\ \mu V = 0{,}3162\ mV$

• $V_{ss}(dBmV) = V_{se} + G = 10\ dBmV + 5\ dB = 15\ dBmV \Rightarrow V_{ss} = 10^{15\ dBmV/20} = 5{,}623\ mV$

• $V_{Ns}(dB\mu V) = V_{Ne} + G = 50\ dB\mu V + 5\ dB = 55\ dB\mu V \Rightarrow V_{Ns} = 10^{55 dB\mu V/20} = 562{,}34\ \mu V = 0{,}5623\ mV$

• $F = \dfrac{\dfrac{V_{se}^2}{V_{Ne}^2}}{\dfrac{V_{ss}^2}{(V_{Ns}+V_{Ni})^2}} \Rightarrow \dfrac{V_{ss}^2}{(V_{Ns}+V_{Ni})^2} = \dfrac{(V_{se}^2/V_{Ne}^2)}{F} \Rightarrow (V_{Ns}+V_{Ni})^2 = \dfrac{F V_{ss}^2}{(V_{se}^2/V_{Ne}^2)} \Rightarrow$

$\Rightarrow V_{Ni} = \sqrt{\dfrac{F V_{ss}^2}{(V_{se}^2/V_{Ne}^2)}} - V_{Ns} = \sqrt{\dfrac{(1{,}995)(5{,}623\ mV)^2}{(3{,}162\ mV)^2/(0{,}3162\ mV)^2}} - 0{,}5623\ mV = 0{,}2319\ mV$

• $V_{Ni}(dBmV) = 20 \log V_{Ni} = 20 \log (0{,}2319\ mV) = \boxed{-12{,}69\ dBmV}$