Q Convert noise figures of 4dB & 4.1dB to eqt noise temp. Use 300K for environmentale temperature

(* here if values in dB then convert into ratio b/c formula is not for dB)

Ans $F = 4dB$

$10 \log F = 4dB$.

$\log F = 0.4$

$F = 2.5118 = 2.512$.

$10 \log F = 4.1 dB$.

$F = 2.57$

$T_e = T[F-1]$

$T_e = 300[2.512-1] = 453.6K$

$T_e = 300[2.57-1] = 471K$.

Q Convert noise fig of 4 & 4.1 into its eqt noise temp use 300K for T_e.

$$T_e = T[F-1]$$

$$T_e = 300[4-1] = 900$$

$$T_e = 300[4.1-1] = 930$$

NOISE DENSITY (N_o)

is the noise power normalised to 1 Hz Bandwidth or noise power present in 1 Hz Bandwidth

$$N_o = \frac{N}{B} = \frac{\text{Total noise power}}{\text{Bandwidth}}$$

$$N_o = \frac{KT_eB}{B} = KT_e$$

$N_0 \rightarrow$ noise density (Watt...

$$1\,Watt/H_z = \frac{1\,Jouls/sec}{1\,cycle/sec} = 1\,Jo...$$

$N \rightarrow$ total Noise power (Watt

$B \rightarrow$ Bandwidth (H_z)

$K \rightarrow$ Boltzman's constant (Joules/...

$T_e \rightarrow$ eqt noise temp (kelvin)

$$N_0(dB\,watt/H_z) = 10\log N - 10\log B$$

$$N_{0(dB)} = 10\log K + 10\log T_e$$

Q For an eqt noise Bandwidth of 10 MH_z & a total noise power of 0.0276 pwatt find noise density & eqt noise tem...

pico (10^{-12})

$$N_0 = \frac{N}{B} = \frac{276 \times 10^{-16}\ W}{10 \times 10^{6}\ Hz}$$

$N_0 = 276 \times 10^{-23}$ Watt / Hz OR Joules/cycle

$N_0 = K T_e$

$$T_e = \frac{N_0}{K} = \frac{276 \times 10^{-23}\ J/cy}{1.38 \times 10^{-23}\ J/K} = 200\ \text{Kelvin/cycle}$$

In dB $\rightarrow N_0 = 10 \log 276 \times 10^{-23} = -205.59$ dBW/Hz

$= -205.6$ dB watts/Hz

$T_e = 23$ dBK.

Carrier to Noise Density $\left[C/N_0 \right]$

It is the avg wideband carrier power to noise density ratio. The wideband carrier power is the combined power of the carrier & its associated sidebands.

The noise density is the thermal noise present in a normalized 1 Hz Bandwidth.

Mathematically C/N_0 can be expressed as function of noise temperature

$$\frac{C}{N_0} = \frac{C}{KT_e}$$

$C \to$ carrier power

$N_0 \to$ noise density

$$\left.\frac{C}{N_0}\right|_{dB} = [C]_{dB} - [K]_{dB} - [T_e]_{dB}$$

Energy of bit to noise density ratio

$$\frac{E_b}{N_0} = \frac{CT_b}{N/B} = \frac{C/F_b}{N/B} = \frac{C}{N} \times \frac{B}{F_b}$$

$$\left[\frac{E_b}{N_0}\right]_{dB} = \left[\frac{C}{N}\right]_{dB} + \left[\frac{B}{F_b}\right]_{dB}$$

$E_b \rightarrow$ energy per bit
$C \rightarrow$ total wideband carrier power
$F_b \rightarrow$ transmission rate (bps)
$N_0 \rightarrow$ Noise density

Conclusion $\rightarrow$ E_b will remain constant as long as total wideband carrier power (C) &

& transmission rate remains unchanged.

N_o will remain constant as long as noise temp remains constant

Thus for a given carrier power, bit rate & noise temp $\left[E_b/N_o\right]$ ratio will remain constant regardless of

→ encoding technique
→ modulation scheme
→ Bandwidth used.

$\left(G/T_e\right)$ Gain to eqt noise temperature ratio

$\left(G/T_e\right)$ is a <u>figure of merit</u> used to represent the quality of sat. or an earth station receiver.

The $\left(G/T_e\right)$ of a R^r is the ratio of receiving antenna gain to eqt noise ~~temp~~ temp (T_e) of the receiver

Mathematically

$$G = A_r \times A_{LNA}$$

Total gain of receiving antenna = (receiver gain)(Low noise amp gain)

$$\frac{G}{T_e} = \frac{A_r \times A_{LNA}}{T_e}$$

$$\left[\frac{G}{T_e}\right]_{dB/kelvin} = [A_r]_{dB} + [A_{LNA}]_{dB} - [T_e]_{dBkelvin}$$

Pg 832 Tomasy

Q 18-12 For an earth station, receiver with an eqt input temp of 200 kelvin A noise bandwidth of 20 MHz, the received antenna gain of 50 dB & carrier freq of 12 GHz find
(a) G/T_e (b) N_o (c) N

Ans $\frac{G}{T_e} = ?$

$G = 50\,dB \quad T_e = 10\log_{10} 200 = 23.010\,dBK$

$$\frac{G}{T_e} = [G]_{dB\,watts} - [T_e]_{dBK}$$

$$G/T_e = 50 - 23 = 26.98\,dB/kelvin$$

(b) $N_0 = \frac{N}{B} = \frac{KT_eB}{B} = KT_e$

$N_0 = (1.38 \times 10^{-23}$ Joules/ Kelvin$) \times (200$ Kelvin$)$

$N_0 = 2.76 \times 10^{-21}$ Joules.

$[N_0]_{dB} = -205.59$ dB Joules.

(c) $N = N_0 \times B = KT_eB$
$= 2.76 \times 10^{-21} \times 20 \times 10^6$

$N = 5.52 \times 10^{-14}$ Watts
$N = -132.58$ dB watts

Q 18-10 / Ag 533 Find carrier to noise density ratio for a R^x w/h −70dBWatt input carrier power, an eqt noise temp of 180K & a bandwidth of 20MHz

$C = -70 \text{dBWatt} = 10^{-7}$

$T_e = 180K \quad B = 20 MHz$

$\frac{C}{N_0} = \frac{10^{-7}}{1.38 \times 10^{-23} \times 180} = 4.025 \times 10^{13}$

$\frac{C}{N_0} = 136.048 dB.$

Q Find energy per bit to noise density ratio w/n the receiver input carrier power is −100dBWatt the receiver input noise temp is 290K & 60Mbps transmission rate is used.

$\frac{E_b}{N_0} = ?$

$P_t = -100 \text{dBWatt}$
$T_e = 290K.$
$F_b = 60 Mbps$

$E_b = [P_t]_{dB} - [F]_{dB}$

$= -100 - 10 \log 60 \times 10^6$

$E_b = -177.78 \text{ dB joules}$

$E_b = 1.66 \times 10^{-18}$ joules/bit

$N_0 = KT_e = 4.002 \times 10^{-21}$ Joules/cycle

$N_0 = -203.977$ dB joules

$\frac{E_b}{N_0} = 414.79 = 26.178 dB$

Q For a satellite transponder with a receiver antenna gain of 12dB a LNA gain of 10dB & an eqt noise temp of 26dB Kelvin find (G/T_e) figure of merit

Ans → $\frac{G}{T_e} = 12dB + 10dB - 26dBK$

$\frac{G}{T_e} = -4dB/Kelvin$

Pg 834 18-23 January

Q An earth station satellite T^r has an HPA with a rated saturated output power of 12,000 W. The backoff ratio of 4dB, the branching loss = 1.5dB the feeder loss = 5dB & the antenna gain = 38dB. Det actual radiated power & EIRP.

Ans $P_r = P_t - L_{bo} - L_{bf}$

$P_r = [10 \log(12000)] - [6]_{dB} - [4]_{dB} - [2]_{dB}$

$P_r = 28.79 \, dBWatts$

$EIRP|_{dB} = P_t|_{dB} + A_t|_{dB}$

$= 10 \log 12000 + 40$
$= 80.79$

Q Find total noise power for a R^r with an I/P B.W of 20MHz & an eqt noise temp of 600K

Ans $BW = 20 \times 10^6$, $T_e = 600K$

$N = KT_eB$

$= 1.38 \times 10^{-23} \times 600 \times 20 \times 10^6$

$N = 1.656 \times 10^{-13} \, Watts$

Total noise power $[N]_{dB} = -127.80 \, dBWatts$

noise density $= \frac{N}{B} = \frac{1.656 \times 10^{-13}}{20 \times 10^{6}}$

$N_0 = 8.28 \times 10^{-21}$

$[N_0]_{dB} = -200.81$ dB watts

Q Pg 112 Q.3.4 Pratt

(i) An Earth Station antenna has dia of 30 mts has an overall efficiency of 68%

$G = \left[\frac{4\pi A_e}{\lambda^2}\right] \eta$

$A_e = \eta A$

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

$\lambda^2 = \frac{c^2}{f^2}$

Given $\eta = 68\% = 0.68$

$d = 30$ mts

$f = 4150$ MHz

$T_e = 79$ Kelvin

$\frac{G}{T_c} = ?$

$G = \left[\frac{4 \times 22}{7} \times A_e\right] \times \frac{1}{\lambda^2} \times 0.68$

$G = \frac{4 \times 22}{7} \times \frac{\pi d^2}{4} \times \frac{f^2}{c^2} \times 0.68$

$G = \frac{\pi^2 d^2 f^2}{c^2} \times 0.68$

$G = \frac{(\pi)^2 \times (30)^2}{0.0228} \times 0.68$

$\boxed{G = 1.156 \times 10^{6}}$

$\boxed{G = 60.62 \text{ dB}}$

$T_e = 79$ Kelvin
$T_e = 18.976$ dB Kelvin

$$\frac{G}{T_e} = [G]_{dB} - [T_e]_{dB}$$

$= 41.65$ dB/Kelvin

Q If heavy rain causes sky to T_{se} so that system noise temp rises to 88K find new $\frac{G}{T_e}$ value.

$$\frac{G}{T_e} = 60.62\,dB - 10\log 88$$

$$\frac{G}{T_e} = 41.17\ dB/\text{Kelvin}$$

$$\frac{G}{T_e} = 41.2\,dB/\text{Kelvin}$$