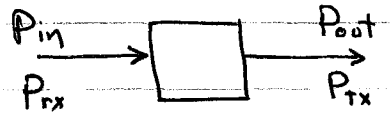
Notes

In general :



$$G = 10\log(P_{out}/P_{in})$$
$$= 10\log(V_{out}/V_{in})^2$$
$$= 20\log(V_{out}/V_{in})$$

If $G > 0$ then it is called "gain". If $G < 0$, it is called loss!

Decibel-milliwatt (dB_m):

$$Power_{dBm} = 10\log\left(\frac{Power\ (in\ mW)}{1\ mW}\right)$$

note that Decibel-watts (dBW)

$$Power_{dBW} = 10\log(Power\ (in\ W)/1\ W)$$

Consider free space loss

$$\frac{P_{out}}{P_{in}} = \frac{P_t}{P_r} = \left(\frac{4\pi d}{\lambda}\right)^2$$

$$\left(\frac{P_t}{P_r}\right)_{dB} = 10\log(P_t/P_r) = 20\log\left(\frac{4\pi d}{\lambda}\right)$$

consider the termal noise in Watts present in a BW of B Hertz

$$N = KTB$$

$$N_{dBW} = 10\log N = 10\log(k) + 10\log(T) + 10\log(B)$$

Note that $K = 1.38 \times 10^{-23}$ J/K and $10\log(k)$ is in dBW

Recall that 1 Watt = 1 J/s.

Remember

$$\frac{E_b}{N_0} = \frac{S/R}{N_0} = \frac{S}{kTR} = \left(\frac{S}{N}\right)\left(\frac{B_T}{R}\right)$$

in decibel

$$10\log\left(\frac{E_b}{N_0}\right) = 10\log\left(\frac{S}{N}\right) + 10\log\left(\frac{B_T}{R}\right)$$

$$= 10\log\left(\frac{S}{N}\right) - 10\log\left(\frac{R}{B_T}\right)$$

Note that E_b/N_0 is unitless and often expressed in dB.

Also, note that

$$\left(E_b/N_0\right)_{dB} = 10\log\left(\frac{E_b}{N_0}\right)$$

note that $\left(\frac{E_b}{N_0}\right)_{dB} \neq \frac{E_b}{N_0}$

$$\left(\frac{R}{B_T}\right)_{dB} = 10\log\left(\frac{R}{B_T}\right)$$

In general,

$$(X)_{dB} = 10\log(X)$$

$X_{dB} \neq X$

For example

$$(6)_{dB} = 10\log(4)$$

$$3\ dB = 10\log 2$$