

## Tutorial 5: Decibel, dBm, dBi, dBd

\* decibel is a unit of measurement used to express the ratio of power in logarithmic terms.

$$A = 10 \times \log_{10} (P_o / P_i) \text{ dB.}$$

$P_i$  = Input power

$P_o$  = output power.

2W  $\rightarrow$  [Amplifier]  $\rightarrow$  6W  $\rightarrow$   $A(\text{gain}) = 10 \times \log_{10} (6/2) = 4.77 \text{ dB}$

10mW  $\rightarrow$  [Cable]  $\rightarrow$  8mW  $\rightarrow$   $A(\text{loss}) = 10 \times \log_{10} (8/10) = -0.96 \text{ dB}$

Question\* If you ask why do we use logarithmic values?

Ans: This is because to avoid very big or small numbers.

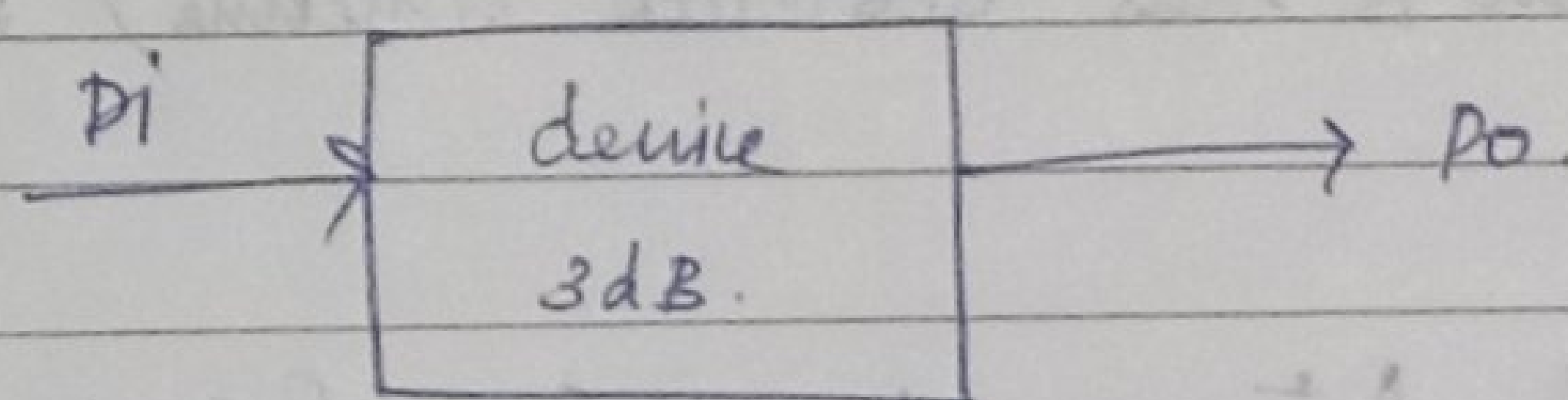
Example 1) The power ratio of 1,000,000 (1 Million) can be expressed by 60dB.

2) The power ratio of 0.000001 can be expressed as -60dB.

3) The power ratio of 1,000,000,000,000,000 is 150dB.

4) The power ratio of 0.0000000000000001 is -150dB.

Decibels (dB)



[The only thing that we know about the device is that it has gain of 3dB only, we don't know i/p power or.]

$$P_i = 1 \text{ mW}, P_o = ? / A = 3 \text{ dB}$$

$$A = 10 \log_{10} (P_o / P_i) \text{ dB}; \quad (P_o / P_i) = 10^{(A/10)}$$



$$P_o/P_i = 10^{(3/10)}$$

$$P_o = 10^{(3/10)} = 1.995 \text{ mW}$$

Decibels (dBm)

\* In this above calculation example, we had the value reference of 1mW.

dB	$P_o/P_i$	Power Ratio ( $P_o/P_i$ )
3	$1.995 \approx 2$	$\times 2$
1	1.259	$\times 1.259$
0	1	$\times 1$
-3	$0.501 \approx 0.5$	$\div 2$
-10	0.1	$\div 10$
-20	0.01	$\div 100$

$$A = 10 \times \log_{10} (P_o/P_i) \text{ dB.}$$

$$P_o/P_i = 10^{(A/10)}$$

Decibel dBi / dBd:

If Manufacturer A has 868MHz antenna, its gain 3dBi

If Manufacturer B has 868MHz antenna, its gain 2.5 dBi

dBi refers to the Antenna gain with respect to an Isotropic Antenna (power radiates in all directions)

dBd refers to the Antenna gain with respect to an reference dipole Antenna.

$$\text{dBi} = \text{dBd} + 2.15$$