ECE 363
Power and dB

ECE363 staff - February 14, 2000

1 Introduction

Power is a common quantity measured in RF and communications systems. In many measurement contexts, power is measured in decibels referenced from milliwatts (dBm). This handout reviews how to work with dB and power. This handout also reviews the meaning and relationship between quantities like average power (P_{avg}), noise power (N_o), power density ($P_{density}$), etc. Finally, this handout discusses the three ways we measure E_b/N_o in ECE 363.

2 Decibels

To allow us to work in orders of magnitude on a linear scale, we often take the logarithm of quantities and compare them. For example, say we have an amplitude A and an amplitude B such that,

$$A = 1000 \times B \tag{1}$$

In the logarithm domain, we have,

$$10 \cdot log_{10} A = 10 \cdot log_{10}(1000 \times B) \tag{2}$$
$$10 \cdot log_{10} A = 10 \cdot log_{10} 1000 + 10 \cdot log_{10} B \tag{3}$$
$$10 \cdot log_{10} A = 10 \cdot log_{10} B + 30 \tag{4}$$

So, we would say that A is 1000 times greater than B or that A is 30 dB greater than B. Therefore, the unitless 'dB' represents factors on quantities. Because of this, a power cannot be measured in dB; there is no unit involved. The power must be referenced from something else. Common references are dBm (decibels referenced from milliwatts), and dBc (decibels referenced from the power of the carrier), among others.

3 Decibels Referenced from Milliwatts (dBm)

Let us say we have a power $P_a = 5.012$ mW. This is expressed in dBm as,

$$P_a = (10 \cdot log_{10} 5.012) \text{ dBm} \tag{5}$$
$$P_a = +7 \text{ dBm} \tag{6}$$

Now, say we have a power $P_b = 0.05012$ mW. Because $P_b < 1$ mW, we expect it to be negative in dBm,

$$P_b = (10 \cdot log_{10} 0.05012) \text{ dBm} \tag{7}$$
$$P_b = -13 \text{ dBm} \tag{8}$$
$$P_b = (P_a - 20 \text{ dB}) \text{ dBm} \tag{9}$$

Also as expected, P_b is 20 dB lower than P_a.