

# ECE 2305: dB, dBm, and dBW

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D-term

# Decibels

A decibel is convenient way of quantifying a ratio. For example, we often quantify “signal-to-noise ratio” (SNR) in decibels as

$$\text{SNR}_{\text{dB}} = 10 \log_{10} \left( \frac{\text{signal power}}{\text{noise power}} \right)$$

The ratio should be dimensionless, so it is important to make sure the units of signal power and noise power are the same.

As an example, if the signal power is 20 mW and the noise power is 10  $\mu$ W, we can compute the SNR to be

$$\text{SNR}_{\text{dB}} = 10 \log_{10} \left( \frac{20 \text{ mW}}{0.010 \text{ mW}} \right) = 33.01 \text{ dB}$$

We can also easily convert from  $\text{SNR}_{\text{dB}}$  to the actual power ratio with

$$\frac{\text{signal power}}{\text{noise power}} = 10^{\text{SNR}_{\text{dB}}/10}.$$

## Decibels with respect to 1 Watt

Sometimes, rather than specifying a signal power directly, we specify it in decibels with respect to a 1 Watt signal. The notation for this is **dBW** and is given as

$$P_{\text{dBW}} = 10 \log_{10} \left( \frac{\text{signal power (Watts)}}{1 \text{ Watt}} \right)$$

Note the ratio is dimensionless, as it should be.

Given  $P_{\text{dBW}}$ , we can calculate the actual signal power in Watts as

$$\text{signal power (Watts)} = 10^{P_{\text{dBW}}/10}.$$

## Decibels with respect to 1 mW

In communication systems, one Watt is often much larger than any of the actual powers in the system (by several orders of magnitude). It is often more convenient in communication systems to describe the power in decibels with respect to a 1 mW signal. The notation for this is **dBm** and is given as

$$P_{\text{dBm}} = 10 \log_{10} \left( \frac{\text{signal power (mW)}}{1 \text{ mW}} \right)$$

Note again that the ratio is dimensionless.

Given  $P_{\text{dBm}}$ , we can calculate the actual signal power in mW as

$$\text{signal power (mW)} = 10^{P_{\text{dBm}}/10}.$$

# Equivalent Scales

The power of a signal can be represented in W, mW, dBW, and dBm. This scale shows how these quantities are all interchangeable, as long as you are careful to specify your units.

