Decibel

1/10th of a “Bel” (not commonly used)
A decibel is 10 times the base-10 logarithm of the ratio of the two power levels.
A Logarithm of a number is the exponent to which a base (commonly 10) must be raised to equal that number.
For a power level of 2:1: Log (base 10) of (2/1) = 10 to the 0.30102999566 power or (approx) 3db
For a power level of 10:1: Log_{10} (10/1) = 10 to the 1^{st} power or 1 Bel or (exactly) 10 db

Merits

The use of the decibel has a number of merits:

- The decibel's logarithmic nature means that a very large range of ratios can be represented by a convenient number, in a similar manner to scientific notation. This allows one to clearly visualize huge changes of some quantity. (See Bode Plot and half logarithm graph.)
- The mathematical properties of logarithms mean that the overall decibel gain of a multi-component system (such as consecutive amplifiers) can be calculated simply by summing the decibel gains of the individual components, rather than needing to multiply amplification factors. Essentially this is because log(A × B × C × ...) = log(A) + log(B) + log(C) + ...
- The human perception of the intensity of, for example, sound or light, is more nearly proportional to the logarithm of intensity than to the intensity itself, per the Weber–Fechner law, so the dB scale can be useful to describe perceptual levels or level differences.

Uses

Acoustics

Main article: Sound pressure

The decibel is commonly used in acoustics to quantify sound levels relative to a 0 dB reference which has been defined as a sound pressure level of .0002 microbar, or 20 micropascals.[16] The reference level is set at the typical threshold of perception of an average human and there are common comparisons used to illustrate different levels of sound pressure. As with other decibel figures, normally the ratio expressed is a power ratio (rather than a pressure ratio).

The human ear has a large dynamic range in audio perception. The ratio of the sound intensity that causes permanent damage during short exposure to the quietest sound that the ear can hear is greater than or equal to 1 trillion.[17] Such large measurement ranges are conveniently expressed in logarithmic units: the base-10 logarithm of one trillion (10^{12}) is 12, which is expressed as an audio level of 120 dB.

Electronics

In electronics, the decibel is often used to express power or amplitude ratios (gains), in preference to arithmetic ratios or percentages. One advantage is that the total decibel gain of a series of components (such as amplifiers and attenuators) can be calculated simply by summing the decibel gains of the individual components. Similarly, in telecommunications, decibels denote signal gain or loss from a transmitter to a receiver through some medium (free space, waveguide, coax, fiber optics, etc.) using a link budget.

The decibel unit can also be combined with a suffix to create an absolute unit of electric power. For example, it can be combined with "m" for "milliwatt" to produce the "dBm". Zero dBm equals one milliwatt, and 1 dBm is one decibel greater (about 1.259 mW).

In professional audio, a popular unit is the dBu (see below for all the units). The "u" stands for "unloaded", and was probably chosen to be similar to lowercase "v", as dBv was the older name for the same thing. It was changed to avoid confusion with dBV. This unit (dBu) is an RMS measurement of voltage which uses as its reference 0.775 V_{RMS}. Chosen for historical reasons, it is the voltage level which delivers 1 mW of power in a 600 ohm resistor, which used to be the standard reference impedance in telephone audio circuits.

Suffixes and reference levels

Suffixes are commonly attached to the basic dB unit in order to indicate the reference level against which the decibel measurement is taken. For example, dBm indicates power measurement relative to 1 milliwatt.

Acoustics

Probably the most common usage of "decibels" in reference to sound loudness is dB SPL, sound pressure level referenced to the nominal threshold of human hearing:[26]

dB(SPL)

> dB (sound pressure level) – for sound in air and other gases, relative to 20 micropascals (μPa) = 2×10^{-5} Pa, the quietest sound a human can hear. This is roughly the sound of a mosquito flying 3 meters away. This is often abbreviated to just "dB", which gives some the erroneous notion that "dB" is an absolute unit by itself. For sound in water and other liquids, a reference pressure of 1 μPa is used.[27]

One Pascal is equal to 94 dB(SPL). This level is used to specify microphone sensitivity. For example, a typical microphone may put out 20 mV at one pascal. For other sound pressure levels, the output voltage can be computed from this basis, except that noise and distortion will affect the extreme levels.

Antenna measurements

dBi

> dB(isotropic) – the forward gain of an antenna compared with the hypothetical isotropic antenna, which uniformly distributes energy in all directions. Linear polarization of the EM field is assumed unless noted otherwise.

dBd

> dB(dipole) – the forward gain of an antenna compared with a half-wave dipole antenna. 0 dBd = 2.15 dBi

dBiC

> dB(isotropic circular) – the forward gain of an antenna compared to a circularly polarized isotropic antenna. There is no fixed conversion rule between dBiC and dBi, as it depends on the receiving antenna and the field polarization.

dBq

> dB(quarterwave) – the forward gain of an antenna compared to a quarter wavelength whip. Rarely used, except in some marketing material. 0 dBq = −0.85 dBi