Metric Prefix

A metric prefix is a unit prefix that precedes a basic unit of measure to indicate a multiple or fraction of the unit.

In the previous section, we saw that Mhz means a million Hertz. Here's a list of the most common ones:

Name	Symbol	Base 10	Decimal
Tera	T	10^{12}	1 000 000 000 000
Giga	G	10^{9}	1 000 000 000
Mega	M	10^{6}	1 000 000
Kilo	k	10^{3}	1 000
hecto	h	10^{2}	100
deca	da	10^{1}	10
		10^{0}	1
deci	d	10^{-1}	0.1
centi	c	10^{-2}	0.01
milli	m	10^{-3}	0.001
micro	μ	10^{-6}	0.000 001
nano	n	10^{-9}	0.000 000 001
pico	p	10^{-12}	0.000 000 000 001

The decibel

A decibel (dB) is a way of saying how many times bigger (or smaller) something is compared to something else. For example, let's use the faintest sound that the human ear can detect as the basis. A normal conversation would be a million times louder, and a jack hammer would be a hundred billion times louder. To represent these vast differences in numbers, we use a logarithmic scale based on powers of 10.

Here's the idea. Start with representing numbers by their exponents instead:

Number	Base 10	Exponent
1	10^{0}	0
10	10^{1}	1
100	10^{2}	2
1000	10^{3}	3
10 000	10^{4}	4
100 000	10^{5}	5
1 000 000	10^{6}	6

For now, let's call the exponent a "bel" (not decibel yet).

- Instead of saying that a sound is **1000** times louder, we could say that it's **3 bels** louder, and
- instead of saying that it's **10,000** times louder, we could say that it's **4 bels** louder.

But what if it's 5000 times louder?

- Since 5000 is between 1000 and 10,000, it might be tempting to say that it would 3.5 bels louder (midway between 3 and 4), but let's check to see if it works: $10^{3.5}$ = 3162, which is between 1000 and 10,000, but not 5000.
- By trial and error, you might get pretty close: $10^{3.7}$ = 5011... so **5000** times louder is roughly **3.7 bels**.
- But a faster way of finding the exponent of a base 10 number is to use the Log button on your calculator: $\log(5000) \approx 3.699$ [1)]

But in the same way that *milli* means a thousandth, and *centi* means a hundredth (think millimetre and centimetre), a *deci* means a tenth. So 1 bel contains 10 decibels (like 1 metre contains 10 decimetres, 100 centimetres, or 1000 millimetres).

So another way of saying 3.7 bels is to say 37 decibels, or 37 dB. So here's our table again with a few common "in between" numbers:

Number	Base 10	Exponent (bels)	decibels (dB)
1	10^0	0	0
2	$10^{0.3}$	0.3	3
4	$10^{0.6}$	0.6	6
10	10^1	1	10
100	10^2	2	20
1000	10^3	3	30
10 000	10^4	4	40
100 000	10^5	5	50
1 000 000	10^6	6	60

In addition to being more convenient to represent big numbers, decibels also allow us to multiply big (or small) numbers more easily by adding the dB instead. For example, take 100 x 1000 = 100,000. Notice how the exponents add here: 10^2 x 10^3 = 10^5 . So 100 x 1000 is the same as saying 20 dB + 30 dB = 50 dB. That is, adding the dB representation of numbers, is the same as multiplying those numbers. Here's Dave explaining this in more details:
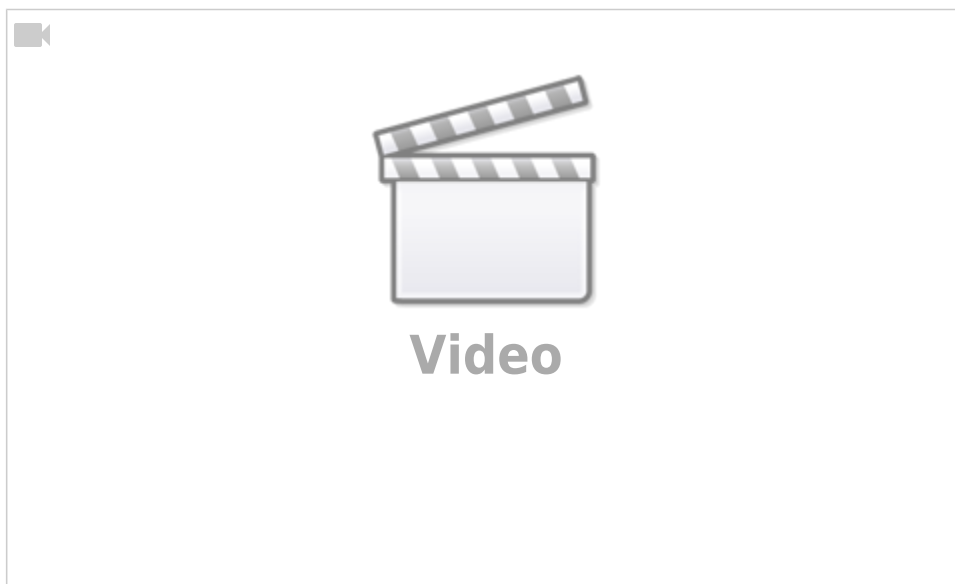
Alternative Formulation

If you like formulas, I suggested that the dB can be defined *implicitly* as:

\$$ \text{ratio} = 10^{\left(\frac{\text{dB}}{10} \right)} \$$

For example, a ratio of 1000 is equivalent to 30 dB because:

\$$ 1000 = 10^{\left(\frac{\text{30}}{10} \right)} \$$

dBm

A related measurement is the dBm. While decibel (dB) is a ratio between two quantities (saying "20 dB" is the same as saying "100 times more"), the dBm is a ratio between one quantity and 1 mW. That is, it's a measures of how much stronger (or weaker) the power of something is compared to 1 milliwatt.

For example, a typical fibre optic light signal to a house for internet has a light level of -15 dBm (or 0.03 mW)

\$$-15 \text{ dBm} = 10^{-1.5} \text{ mW} \approx 0.03 \text{ mW} \$$

[1)]
Depending on your calculator, you might have to type it in this order 5 Log