

Decibels for engineers.

While dB is a very handy way of expressing large numbers, like we often have to deal with in amplifier circuits, unfortunately a lot of engineers fail the ability to juggle with them. So apart from the “official” mathematical way of dealing with dB's, we will now learn a handy way how to use them by only remembering 3 numbers.

Decibel is a number that describes how the ratio is between two voltages or two powers

Voltage dB = $20 * \text{LOG} (A1 / A2)$

Power dB = $10 * \text{LOG} (P1 / P2)$

As we do not always have a scientific calculator at hand there is a trick that helps you handle these memorizing only 3 numbers:

POWER deciBels (small d capital B)

times two = + 3 dB

divided by two = - 3 dB

times four = + 6 dB

divided by four = - 6 dB

times ten = + 10 dB

divided by ten = - 10 dB

other values can be derived from this, like FIVE = TEN divided by TWO = +10 dB – 3 dB = 5 dB

times hundred = TEN times TEN = +10 dB + 10 dB = 20 dB

VOLTAGE deciBels

times two = + 6 dB

divided by two = - 6 dB

times four = + 12 dB

divided by four = - 12 dB

times ten = + 20 dB

divided by ten = - 20 dB

An overview:

dB	Power ratio	Amplitude ratio
100	10 000 000 000	100 000
90	1 000 000 000	31 623
80	100 000 000	10 000
70	10 000 000	3 162
60	1 000 000	1 000
50	100 000	316.2
40	10 000	100
30	1 000	31.62
20	100	10
10	10	3.162
6	$3.981 \approx 4$	$1.995 \approx 2$
3	$1.995 \approx 2$	$1.413 \approx \sqrt{2}$
1	1.259	1.122
0	1	1
-1	0.794	0.891
-3	$0.501 \approx \frac{1}{2}$	$0.708 \approx \sqrt{\frac{1}{2}}$
-6	$0.251 \approx \frac{1}{4}$	$0.501 \approx \frac{1}{2}$
-10	0.1	0.316 2
-20	0.01	0.1
-30	0.001	0.031 62
-40	0.000 1	0.01
-50	0.000 01	0.003 162
-60	0.000 001	0.001
-70	0.000 000 1	0.000 316 2
-80	0.000 000 01	0.000 1
-90	0.000 000 001	0.000 031 62
-100	0.000 000 000 1	0.000 01

An example scale showing power ratios x , amplitude ratios \sqrt{x} , and dB equivalents $10 \log_{10} x$.

(source <https://en.wikipedia.org/wiki/Decibel>)

Exercices:

An antenna is driven by a transmitter power of 1000 Watts. How much is this in dBm ? (dBm is the power output compared to 1 mW)

A microphone amplifier has a voltage gain of 100, How many dB's gain has it ?

The noise floor of a PA system is 1.000.000 below the nominal output power. How much is the signal to noise ratio ?

A system consists of 3 cascaded amplifiers, the first one having 1000 times voltage amplification, the second 500 and the last stage 40. How much is the total gain in dB.

A 100 Watts transmitter is feeding a 6 dB gain antenna using a cable that has 3 dB loss. How much is the effectively radiated power in dBm ?

A satellite van has a dish antenna with 60 dB gain and is driven by a travelling wave tube amplifier that has a maximum output power of 500W via a waveguide that has 3 dB loss. How much is the effectively radiated power in dBW ?

The signal at the output of a low noise microphone amplifier is 1 Vpp. The signal to noise ratio is 80 dB. How much is the noise level at the output and how much is the microphone signal at the input when the amplifier has a 1000 times voltage gain ?

The maximum input power of an amplifier is 0 dBm while the uncompressed gain is 40 dB. How much Watts will the amplifier deliver to the load ?

A cabling system at a cellphone tower consists of a patch cable of 0,3 dB loss, followed by a feed line that has 1,5 dB loss, an antenna splitter that has 3 dB loss and an antenna feed patch line that adds another 0,2 dB of loss.. When the transmitter delivers a power output of 20 dBW, how much power will my Bird Wattmeter indicate at the antenna terminal (in Watts) ?

An active speaker clips at 10V output level over a 4 ohms speaker resistance at an input voltage of 250 mV. How much is the system gain ?