Decibel Chart

Decibels to sound pressure and intensity, adding decibels, distance, A-weighting, noise exposure limits and typical levels

For: Acoustic and audio engineers, health and safety officers, students

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EXACT DEFINITION	FORMULA	REVERSE	WORKED EXAMPLE
$L_p = 20 \cdot \log_{10}(p \div 20\ \mu Pa)$; $L_I = 10 \cdot \log_{10}(I \div 10^{-12}\ W/m^2)$	p (Pa) = 0.000 02 × 10^(dB ÷ 20)	$dB = 20 \cdot \log_{10}(p \div 0.000\ 02\ Pa)$	94 dB SPL = 1.002 Pa (the usual calibrator level)

Pressure uses 4 and intensity 3 significant figures.

Sound pressure level to pressure and intensity

dB SPL	Pressure (Pa)	Intensity (W/m²)	dB SPL	Pressure (Pa)	Intensity (W/m²)
0	2×10^{-5}	1×10^{-12}	**90**	0.6325	0.001
10	6.325×10^{-5}	1×10^{-11}	**94**	1.002	0.00251
20	2×10^{-4}	1×10^{-10}	**100**	2	0.01
30	6.325×10^{-4}	1×10^{-9}	**110**	6.325	0.1
40	0.002	1×10^{-8}	**120**	20	1
50	0.006325	1×10^{-7}	**130**	63.25	10
60	0.02	1×10^{-6}	**140**	200	100
70	0.06325	1×10^{-5}	**194**	100,200	2.51×10^{7}
80	0.2	1×10^{-4}			

Level changes and their meaning

Change	Meaning
+3 dB	Double the sound power or intensity (two equal sources together)
+6 dB	Double the sound pressure; also the change for halving distance from a point source
+10 dB	10 × the intensity; heard as roughly twice as loud
−6 dB per doubling of distance	Point source in a free field (inverse-square law)
1 Np = 8.686 dB	Neper (natural-log level unit) to decibels; 1 B = 10 dB

Adding two sound levels

Add the value to the louder level. Two equal sources make +3 dB; a source 10 dB quieter adds only 0.4 dB.

Difference (dB)	Add to the louder (dB)	Difference (dB)	Add to the louder (dB)
0	3.0	**8**	0.6
1	2.5	**9**	0.5
2	2.1	**10**	0.4
3	1.8	**11**	0.3
4	1.5	**12**	0.3
5	1.2	**13**	0.2
6	1.0	**14**	0.2
7	0.8	**15**	0.1

Distance: change in level from a point source

Free field, inverse-square law: $\Delta L = 20 \cdot \log_{10}(r_1 \div r_2)$. A line source such as a busy road falls 3 dB per doubling instead.

Distance ratio $r_2 \div r_1$	Point source (dB)	Line source (dB)
1	0.0	0.0
1.5	−3.5	−1.8
2	−6.0	−3.0
3	−9.5	−4.8
4	−12.0	−6.0
5	−14.0	−7.0
8	−18.1	−9.0
10	−20.0	−10.0
16	−24.1	−12.0
20	−26.0	−13.0
32	−30.1	−15.1
50	−34.0	−17.0
100	−40.0	−20.0

A-weighting at octave-band centre frequencies (IEC 61672-1)

Frequency (Hz)	A-weighting (dB)	Frequency (Hz)	A-weighting (dB)
31.5	−39.4	**1,000**	0.0
63	−26.2	**2,000**	1.2
125	−16.1	**4,000**	1.0
250	−8.6	**8,000**	−1.1
500	−3.2	**16,000**	−6.6

Noise exposure: permitted time per day

NIOSH recommended limit: 85 dBA for 8 hours, halving every 3 dB. OSHA permissible limit: 90 dBA for 8 hours, halving every 5 dB (hearing conservation from 85 dBA).

Level (dBA)	NIOSH REL	OSHA PEL
85	8 h	16 h
88	4 h	10 h 33 min
90	2 h 31 min	8 h
91	2 h	6 h 58 min
92	1 h 35 min	6 h 4 min
94	1 h	4 h 36 min
95	48 min	4 h
97	30 min	3 h 2 min
100	15 min	2 h
102	9 min 27 s	1 h 31 min
103	7 min 30 s	1 h 19 min
105	4 min 43 s	1 h
110	1 min 29 s	30 min
115	28 s	15 min

Typical sound levels and workplace limits

Source or limit	Level
Threshold of hearing	0 dB
Quiet bedroom at night	≈ 30 dB(A)

Source or limit	Level
Normal conversation at 1 m	≈ 60 dB(A)
UK lower exposure action value (daily)	80 dB(A)
UK upper exposure action value (daily)	85 dB(A)
UK exposure limit value (daily, with hearing protection)	87 dB(A)
Rock concert near speakers	≈ 110 dB(A)
Threshold of pain	≈ 120–130 dB

Sources and method

- **NIST Special Publication 811** — Guide for the Use of the International System of Units (www.nist.gov/pml/special-publication-811)
- **UK Control of Noise at Work Regulations 2005** — Exposure action values 80 / 85 dB(A), limit 87 dB(A)
- **IEC 61672-1:2013** — Electroacoustics, sound level meters: frequency weighting A
- **NIOSH, Criteria for a Recommended Standard: Occupational Noise Exposure (1998)** — REL 85 dBA as an 8-hour TWA with a 3 dB exchange rate
- **OSHA 29 CFR 1910.95** — PEL 90 dBA for 8 hours with a 5 dB exchange rate (Table G-16 and Appendix A)

Pressures, intensities, level sums, distance losses, A-weighting and exposure times are calculated from their defining formulas (IEC 61672-1, NIOSH, OSHA 29 CFR 1910.95); typical levels are approximate. Interactive version, corrections and more charts: **allunitconversions.com/sound-conversion-chart**