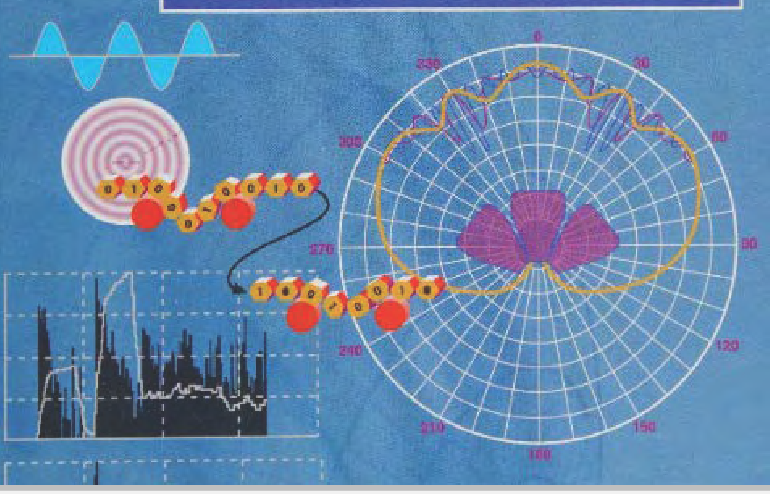
HANDBOOK FOR SOUND ENGINEERS

THIRD EDITION

Glen M. Ballou, Editor



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Chapter 1

Fundamentals of Audio and Acoustics

by Pat Brown

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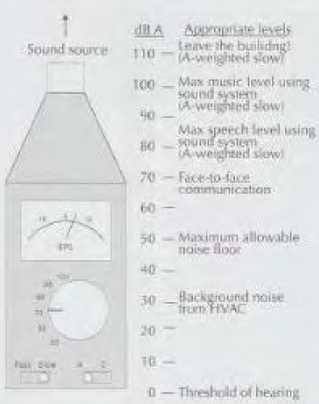


Figure 1-7. Sound levels of interest to system designers and operators. Courtesy Syn-Aud-Con.

appropriate ballistics and weighting to emulate human hearing. Figure 1-7 shows some typical sound pressure levels that are of interest to audio practitioners.

1.4 Frequency

Sound people are in the wave business. A wave is produced when a medium is disturbed. The medium can be air, water, steel, the earth, etc. The disturbance produces a fluctuation in the ambient state of the medium that propagates as a wave that radiates outward from the source of the disturbance. If one second is used as a reference time span, the number of fluctuations above and below the ambient condition per second is the *frequency* of the event, and is expressed in cycles per second, or Hertz. Humans can hear frequencies as low 20 Hz and as high as 20,000 Hz (20 kHz). In an audio circuit the usual quantity of interest is the electrical voltage. In an acoustical circuit it is the air pressure.

As stated in the decibel section, humans are sensitive to the proportional changes in power, voltage, pressure, and distance. This is also true for frequency. If we start at the lowest audible frequency of 20 Hz and increase it by a 2 to 1 ratio, the result is 40 Hz, an interval of one octave. Doubling 40 Hz yields 80 Hz. This is also a one-octave span, yet it contains twice the frequencies than the previous octave. Each successive frequency doubling yields another octave, and each higher octave will have twice the spectral content of one below it. This makes the logarithmic scale suitable for displaying frequency. Figures 1-8 and 1-9 show a logarithmic frequency scale and some useful divisions. The perceived midpoint of the spectrum for a human listener is about 1 kHz.

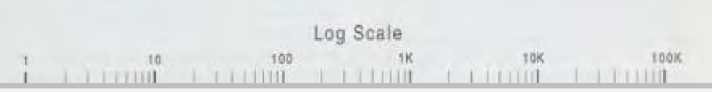
Some key frequency ratios exist:

- 10 to 1 ratio – decade
- 2 to 1 ratio – octave

The spectral response of a system describes the frequencies that can pass through that system. This must always be stated with an appropriate tolerance, such as ±3 dB. This range of frequencies is the *bandwidth* of the system. All system components have a finite bandwidth. Sound systems are usually bandwidth limited to for reasons of stability and loudspeaker protection. A spectrum analyzer can be used to observe the spectral response of a system or system component.

1.5 Wavelength

If the frequency f of a vibration is known, the time period T for one cycle of vibration can be found by the simple relationship



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