CONSIDERATIONS ABOUT SOUND

Loudness

The loudness of a sound perceived by the human ear at a certain location depends on several factors, such as: distance from the source, frequency of the sound, strength of the source, ear sensitivity, conditions of the air etc.

Sound pressure level versus distance

In a free progressive spherical sound wave the sound pressure drops by 6 dB each time the measuring distance is doubled. This condition only exists a number of wavelengths away from the source and if the source radiates spherical waves.

ΔSPL = 20.log (r1 / r2)

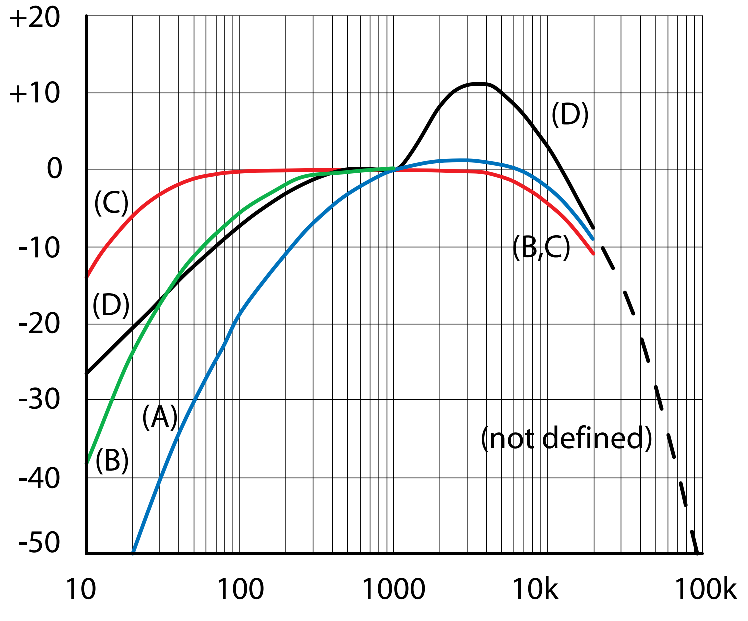
with: r1 = distance at which the SPL is given
r2 = distance at which you want to know the SPL

example: 105 dB(A) @2m =>@ 1m?
=>ΔSPL=20 log (2/1)= + 6
=> result: 111 dB(A) @ 1m

Weighting curve

The human ear is more sensitive to frequencies between 2000 and 5000 Hz. This is why the operating frequency of alerting piezo buzzers is essentially chosen for this range. The human ear has a logarithmically response to sound pressure, of which the unity is expressed in decibels (dB). The sound pressure level is measured with an audiometer; an instrument developed in order to give an objective indication to sound pressure. The frequency response of this instrument is corrected by a weighing curve to match the characteristics of the human ear. The type of the weighing curve is indicated by the symbol (A) that gives the indication dB(A).

A-weighting curve

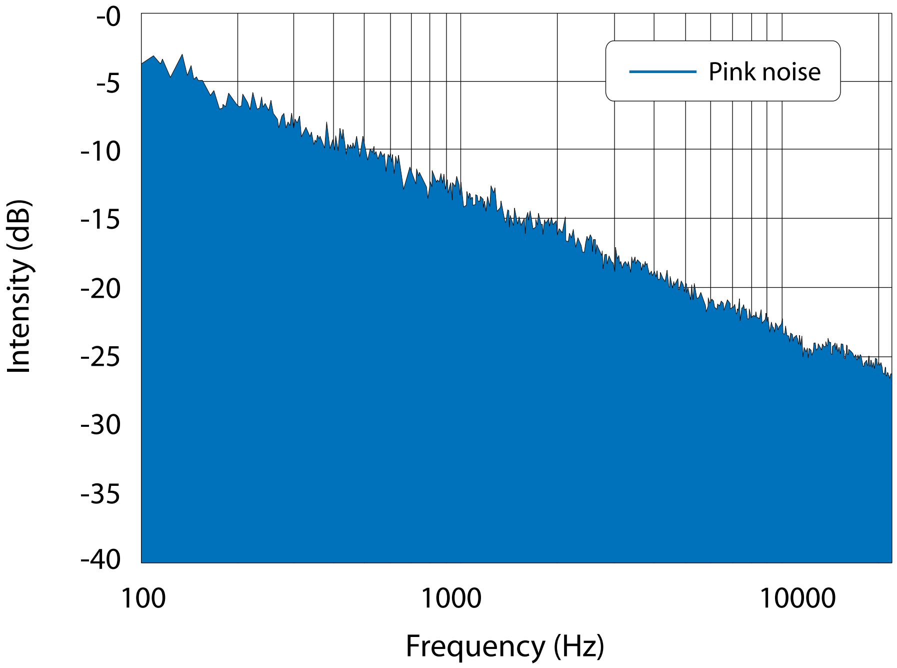


A-weighting(blue), B(yellow), C(red), and D-weighting(black)

Pink noise

Pink noise or 1/f noise is a signal with a frequency spectrum such that the power spectral density is inversely proportional to the frequency. In pink noise, each octave carries an equal amount of noise power. There is equal energy in all octaves (or similar log bundles).

- In terms of power at a constant bandwith, 1/f noise falls off at 3 dB per octave.
- Pink noise has a tendency to occur in natural physical systems.
- White noise is equal energy per hertz.



Sound character

The character of a sound is determined by the harmonic content, the amplitude relation between the harmonics for a steady signal when the signal varies the rate of attack and decay, and the presence of resonance.

Pulsating sounds

The human ear is particularly sensitive to changes in condition. Switching on and off a sound makes it more attention-getting than a continuous sound of the same frequency. Shifting the frequency in a rapid rate produces a similar effect.

Pulsating frequency

When a pulsed sound source is placed in a reverberant room, reflections tend to fill up the pauses between the pulses. In a large, highly reverberant room, longer pauses are necessary to produce the desired effect: a slow pulsing sound source should be used.

HARMONIC

In acoustics a harmonic of a wave is a component frequency of the signal that is an integer multiple of the fundamental frequency.

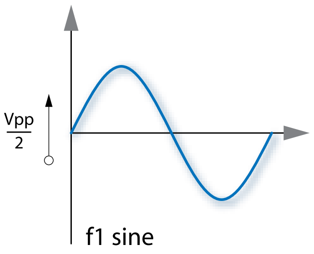
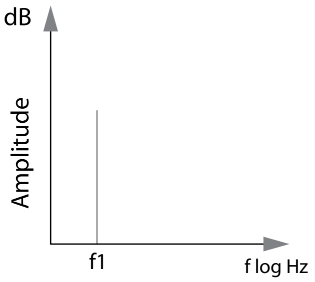
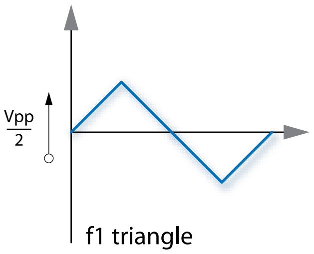
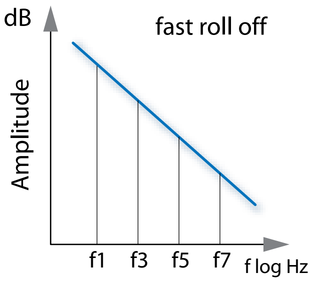
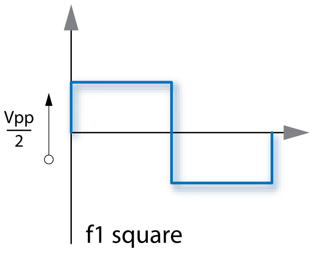
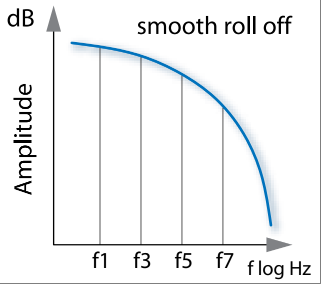
n = 1	n = 2	n = 3	n = 4	...
f1	f2	f3	f4	...
300Hz	600Hz	900Hz	1200Hz	...

FOURIER

To analyse a certain sound or function it can be decomposed in basic pieces.
Mathematical a Fourier series can be used to decompose a periodic function or signal into a sum of simple oscillating functions, namely sines and cosines.

The use of a fourier analyse of a signal into sine waves with a certain amplitude gives the opportunity to study the amplification response of different vibrating systems.

Overview of basic mathematical signals and the corresponding fourier series:

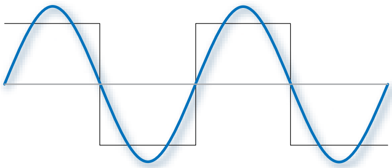
Signal	Time domain	Fourier domain	Frequency domain (log scale)
sine wave		$f_{1\_sine} = \frac{V_{pp}}{2}\cdot f_{1\sin}$ $\sin(\omega_0 t)$	
triangle wave		$f_{1\_triangle} = \frac{V_{pp}}{2}\cdot\frac{8}{\pi^2}\cdot\left(\frac{1}{1^2}f_{1\sin} + \overset{\pi\ phase\ change}{(-)}\frac{1}{3^2}f_{3\sin} + \frac{1}{5^2}f_{5\sin} + \overset{\pi\ phase\ change}{(-)}\frac{1}{7^2}f_{7\sin} + \dots\right)$ $\sum_{\substack{n=1\\n=odd}}^{N}\left(-1/n^2\right)\cdot\sin(n\omega_0 t)$	
square wave		$f_{1\_square} = \frac{V_{pp}}{2}\cdot\frac{4}{\pi}\cdot\left(f_{1\sin} + \frac{1}{3}f_{3\sin} + \frac{1}{5}f_{5\sin} + \frac{1}{7}f_{7\sin} + \dots\right)$ $\sum_{\substack{n=1\\n=odd}}^{N}\left(1/n\right)\cdot\sin(n\omega_0 t)$	

f1: ground frequency (first harmonic) Vpp= voltage peak to peak
f2: second harmonic
f3: thirth harmonic
fn: "n" th harmonic

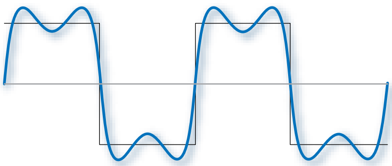
HARMONIC CONTENT OF A SQUARE WAVE

If a square wave is analysed with his fourier series into a sum of sine waves it is notable that it contains a lot of harmonics with a high amplitude.

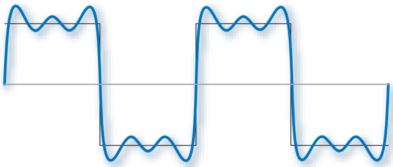
Or otherwise, a pure square wave can be build as the sum of many f(2n-1) odd harmonics.



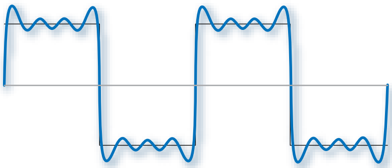
f1



f1 + f3



f1 + f3 + f5



f1 + f3 + f5 + f7

RMS AND AVERAGE POWER

The average power gives an idea of the power consumption of a device over a certain time period. It can be easily found by multiplying the RMS-voltage and RMS-current .

$$\boxed{P_{average} = V_{RMS} \cdot I_{RMS}}$$

RMS is a mathematical function that reduces a complex function to a single value. It is the "square Root of the Mean of the Square of the function". Mean is the same as average.

$$x_{rms} = \sqrt{\frac{1}{n}\sum_{i=1}^{n} x_i^2} = \sqrt{\frac{x_1^2 + x_2^2 + \ldots + x_n^2}{n}}$$

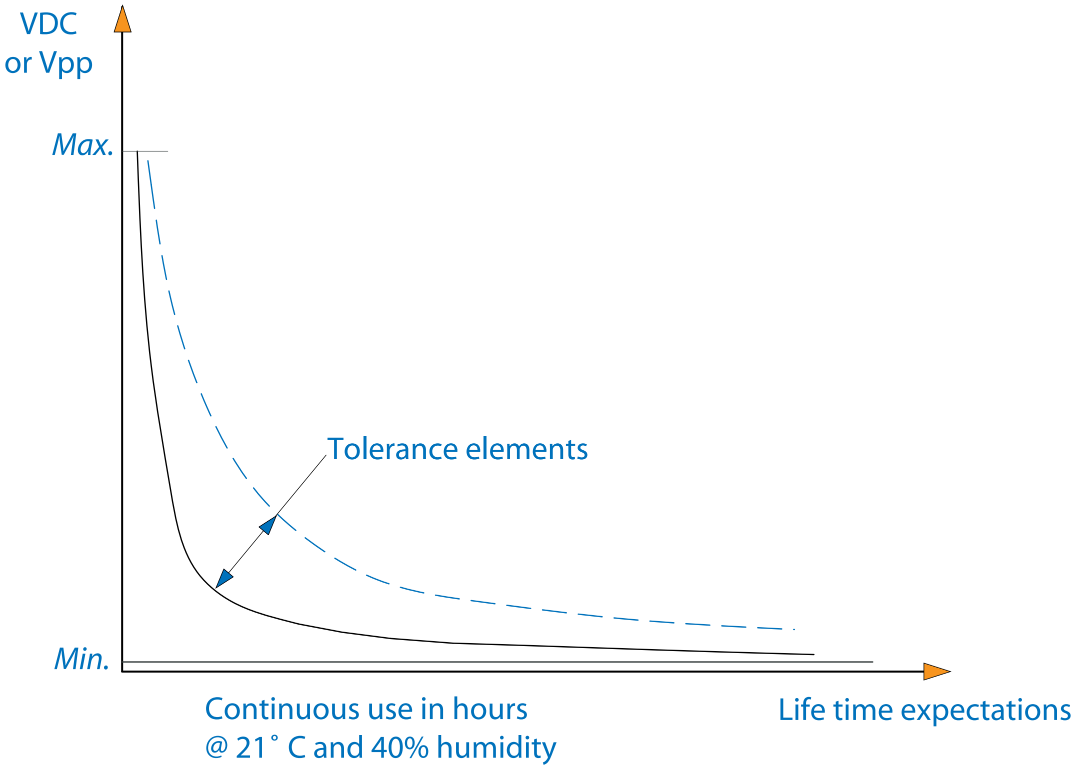
EXPECTED LIFE TIME

The lifetime of our audible components depends on many different factors and is impossible to determine exactly. We therefore publish the expected minimum lifetime measured under specific circumstances and environmental conditions.

If customers need lifetime expectations under other circumstances, we request them to ask for our instructions before performing their own lifetime tests in order to save time and exclude wrong conclusions.

Claims will only be examined and taken into account on condition that guidelines and instructions below have been strictly applied.

Working voltage or drive signal versus expected life time:



The relationship between working voltage and expected life time is one of the prime factors on which life time depends. The curve follows an asymptotic function, strongly depending on tolerance elements published by the suppliers of several basic materials and working environmental conditions.

The expected life time of our different series is defined as follows:

- T ambient: 21˚C; humidity: 40%; free air
- Voltage : see below
- Mounted as described in our catalogue

Standard series:

- mounted on panel
- working @ 12 Vdc in continuous use
- life expectations: min. 2000 hours
- The SXLC515C, SXLI515C1, SXLW515C and SXLP515C series have a minimum life time of 9 hours

SMA series:

- mounted on PCB
- working @ 12 Vdc in continuous use; L-version working @ 6 Vdc
- life expectations: min. 100 hours
- The SMA-21LV (PIN/SMD) working @ 3 Vdc in continuous use: min. 24 hours
- All tests are made @ 20˚C

SMAT series

- mounted on PCB
- working @12 Vpp in continuous use at resonance frequency, tested on maximum sound pressure (eg. SMAT-21 @ 3.75 kHz).
- life expectations: min. 1000 hours

SMAC series

- mounted on PCB
- working @12 Vdc in continuous use.
- life expectations: min. 1000 hours

Remarks:

- Please contact our customer service for information and our recommendations before making life time tests at voltages exceeding the above-mentioned levels per series.
- Sonitron reserve the right to make modifications without pre-announcement to their materials, raw materials, specifications, configurations and prices.
- Applications in this catalogue are indicative and it is the responsibility of the customer to make the necessary tests with our products in order to meet the required specifications.
- If you need further information concerning product selection, performances, life time expectations and environmental situations, please contact us.
- The use of Sonitron products, as critical components in life support systems, is not authorised without the explicit written approval by Sonitron.
- If our Products are used as a critical component (final alarms in life support system), we recommend a model especially adapted to the customers' special test requirements.