Adding Coherent and Incoherent Amplitude and Level

German version : http://www.sengpielaudio.com/AdditionVonAmplitudenUndPegeln.pdf

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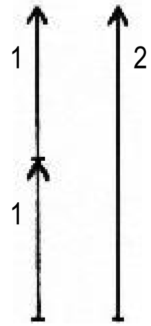
Tutorium

Amplitude addition

Amplitude = maximum, absolute signal value

1. Addition of equal **coherent** amplitude, such as derived by the the center signal of the two tape tracks L plus R: Amplitude 1 (L) + amplitude 1 (R) = total amplitude 2 (L+R):

Vector diagram:



The total amplitude is the sum of the two coherent vectors

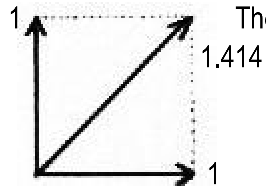
The two vectors must stand in a line.

The total sum is here 1 + 1 = 2

This is only true for correlated (coherent) signals.

2. Addition of two **incoherent** signals of equal amplitude, such as the two tracks of a trumpet and a trombone:

Vector diagram:



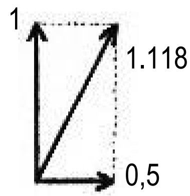
The total amplitude of 1.414 is a diagonal.

The vectors for incoherent uncorrelated signals stand at right angles to each other

Calculation of the diagonal = $\sqrt{(1^2 + 1^2)}$ (Pythagoras)

3. Addition of two **incoherent** signals of **unequal** amplitudes, such as at full amplitude and at half amplitude.

Vector diagram:



The total amplitude of 1.118 is a diagonal.

The vectors for non-coherent uncorrelated signals stand at right angles to each other.

Calculation of the diagonal = $\sqrt{(1^2 + 0{,}5^2)}$ (Pythagoras)

Level addition

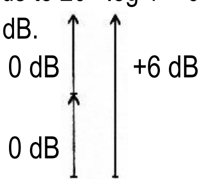
Using the same examples shown above, but now converted to decibels.

Remember: **dB values of individual signals can never be directly added!**

1. Adding **coherent**, equal levels. **It is vector-like "addition".**

The singular amplitude 1 corresponds to 20 · log 1 = 0 dB. Adding two, correlated amplitude values: 1 + 1 = 2

This corresponds to 20 · log 2 = +6 dB.



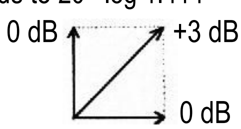
The result is calculated from the amplitude value of 2.

Decibel addition: 0 dB + 0 dB = +6 dB

⇒ log. addition of correlated signals.

2. Addition of **incoherent** (non-coherent) **equal levels**:

The singular amplitude 1 corresponds to 20 · log 1 = 0 dB. Adding two, uncorrelated equal amplitude values: $\sqrt{(1^2 + 1^2)}$ = 1.414 This corresponds to 20 · log 1.414 = +3 dB.



The result is calculated from the amplitude value of 1.414.

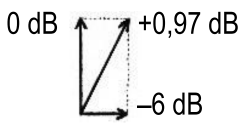
Decibel addition: 0 dB + 0 dB = +3 dB

⇒ log. addition for uncorrelated signals.

3. Addition of two **incoherent unequal levels**:

The singular amplitude 1 corresponds to 20 · log 1 = 0 dB. The amplitude of 0.5 corresponds to 20 · log 0,5 = –6 dB. Adding two, uncorrelated unequal amplitude values: The combined amplitudes are $\sqrt{(1^2 + 0{,}5^2)}$ = 1.118

This corresponds to 20 · log 1,118 = +0,97 dB.



The result is +1 dB calculated from the amplitude value of 1.118

Decibel addition: 0 dB + (–6 dB) = +1 dB

⇒ log. addition for uncorrelated signals.

Note: The vectors of incoherent signals stand at right angles (90°) to each other - they are independent.

Adding dB values should always start with calculating amplitude values. Then coherent signals can be directly added. Incoherent signals should be added using the type of "diagonal calculation" noted above.

Decibel "levels" cannot be simply added together, as can amplitude values. This is because the **addition** of decibel values requires the log-based **multiplication** of numbers.