

# Maximum level and distortion measurements for loudspeakers with multitone signals

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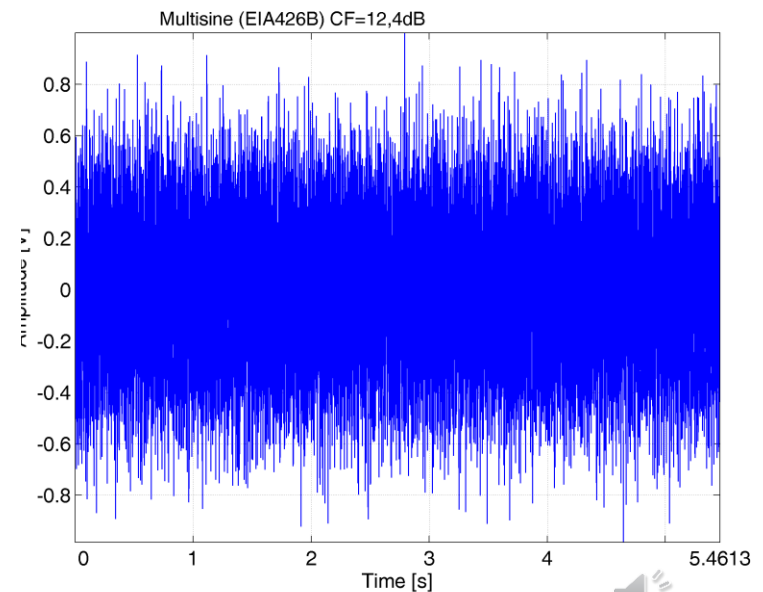
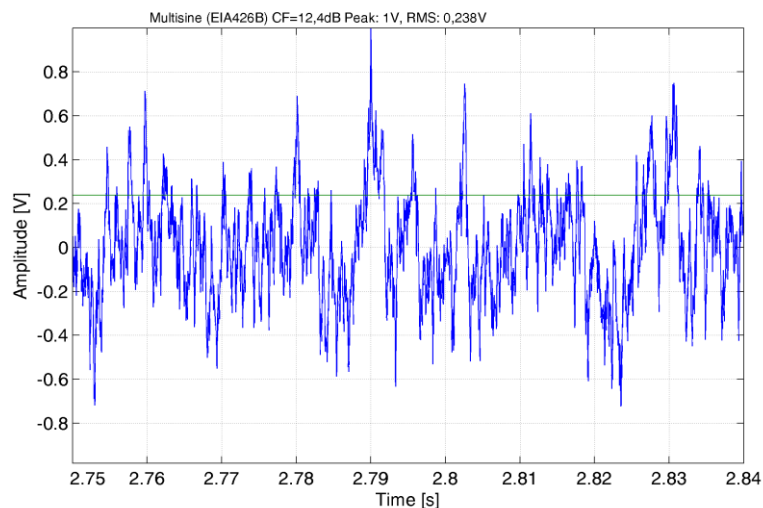
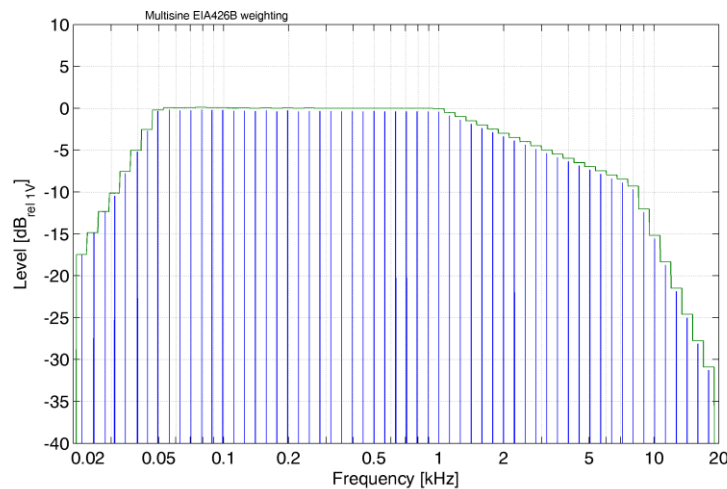
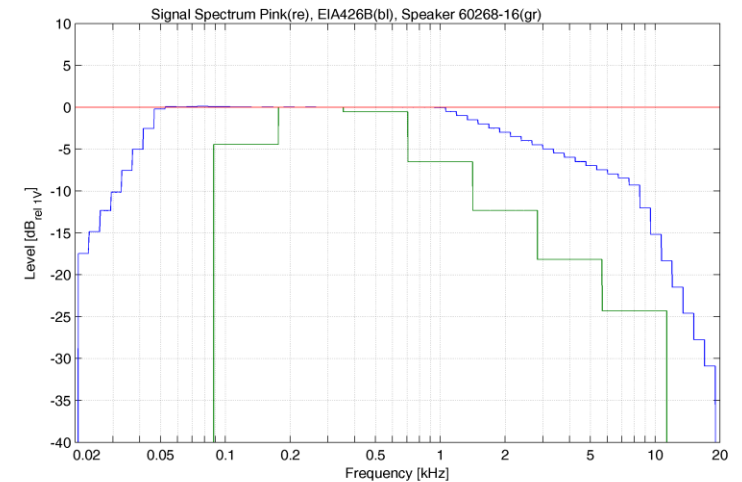
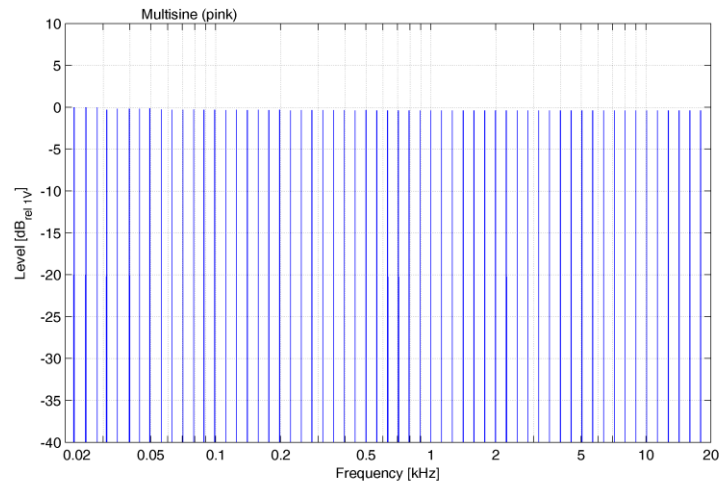
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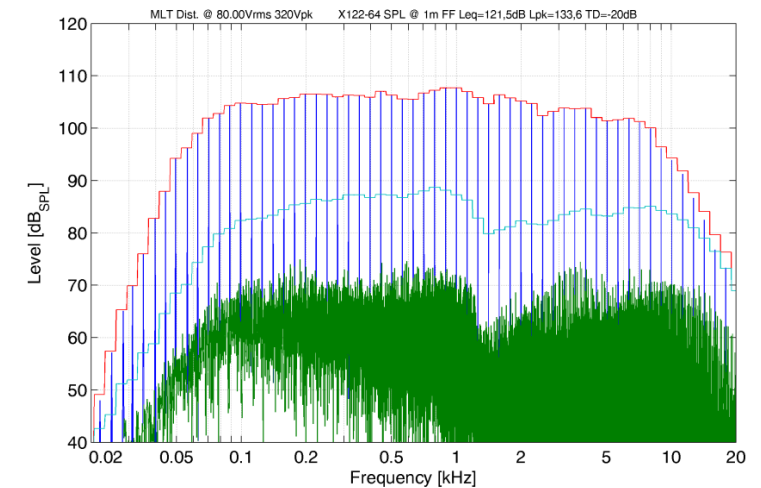
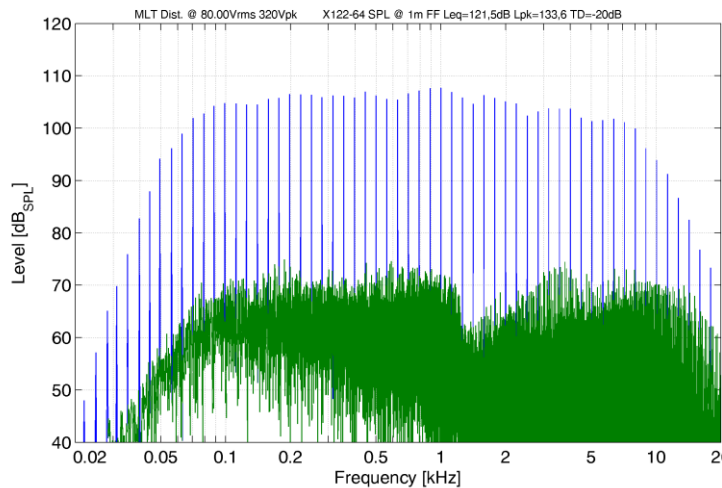
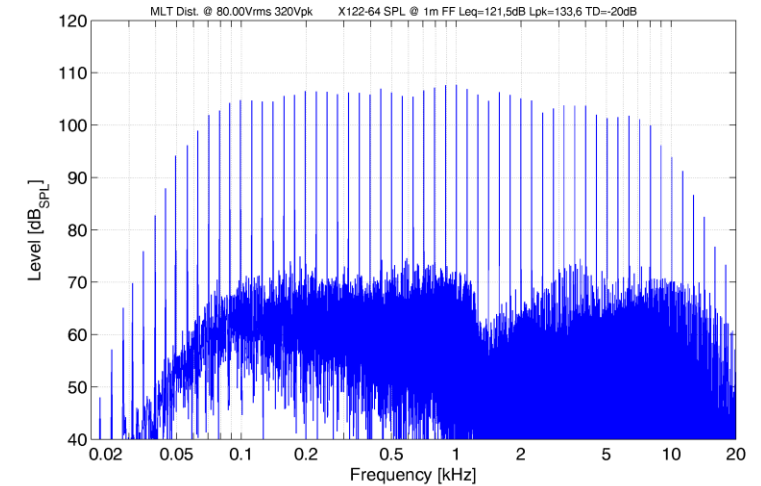
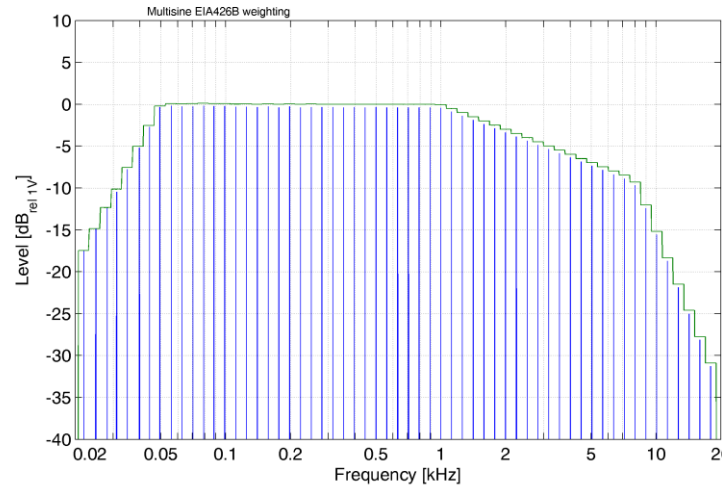
# Multitone test signal

- 60 sinusoidal signals (1/6 Oct.)
- With random phase
- Spectral weighting possible  
e.g. EIA-426B Music, 60268-16  
Speech, Pink, Bandpass Filter, ...
- Time signal with a crest factor of 4  
corresponding to 12 dB  
( $CF = \text{peak value to effective value}$ )



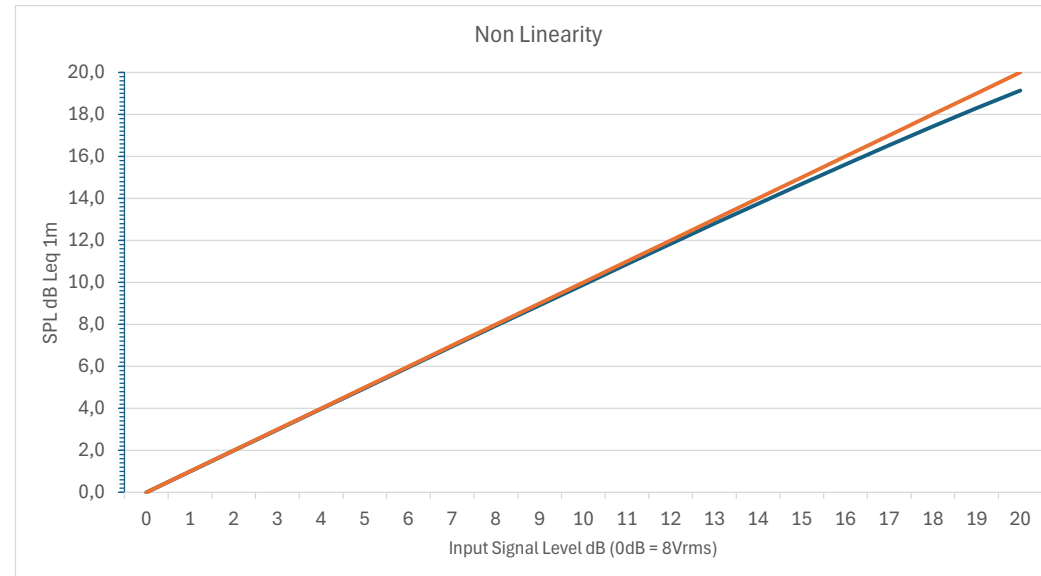
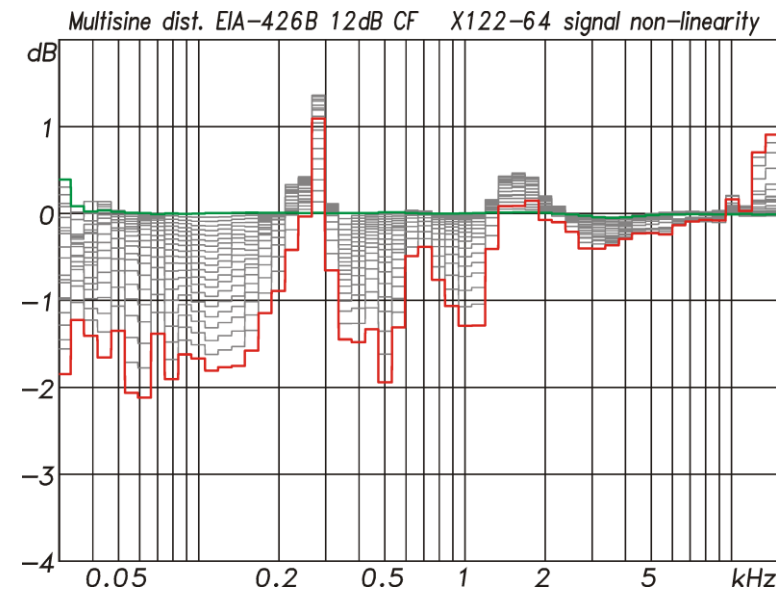
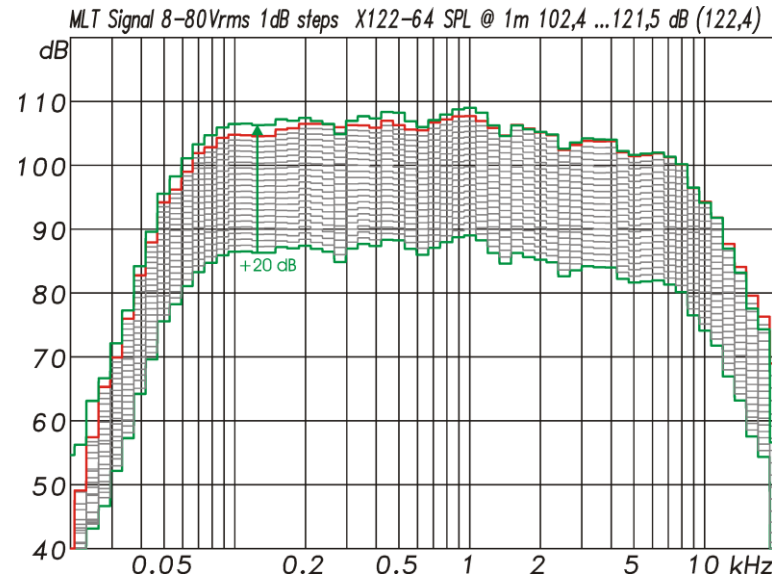
# Evaluation TD

- Simple evaluation of the distortions via subtraction of the spectral lines of the measurement signal from the excitation signal
- Recording of THD and IMD = TD (Total Distortions)  
Limit value of 10% (-20 dB)
- Evaluation of the SPL as  $L_{eq}$  average level and as  $L_{pk}$  peak level
- $L_{eq}$  SPL acoustic  $\leftrightarrow V_{rms}$  electrical
- $L_{pk}$  SPL acoustic  $\leftrightarrow V_{pk}$  electrical



# Evaluation of non-linearity

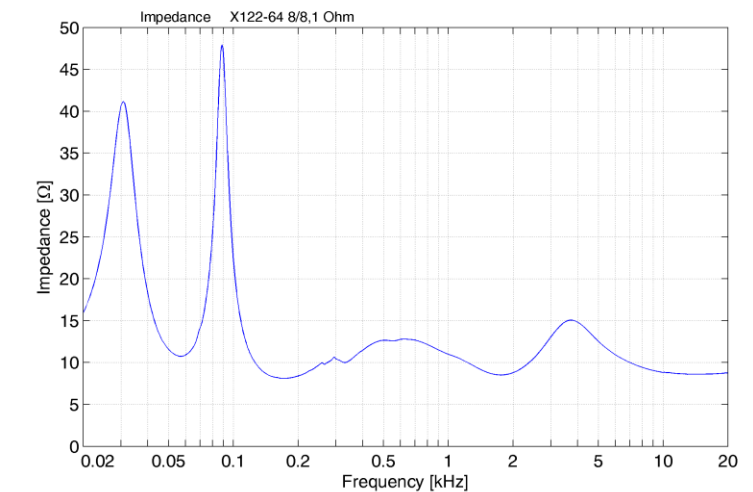
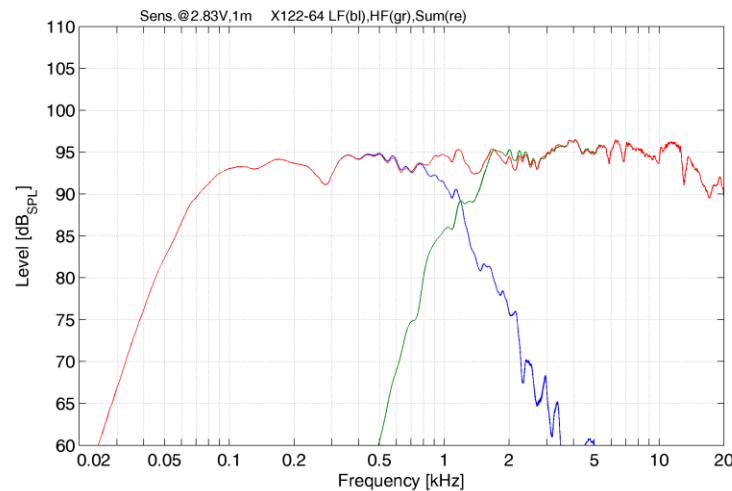
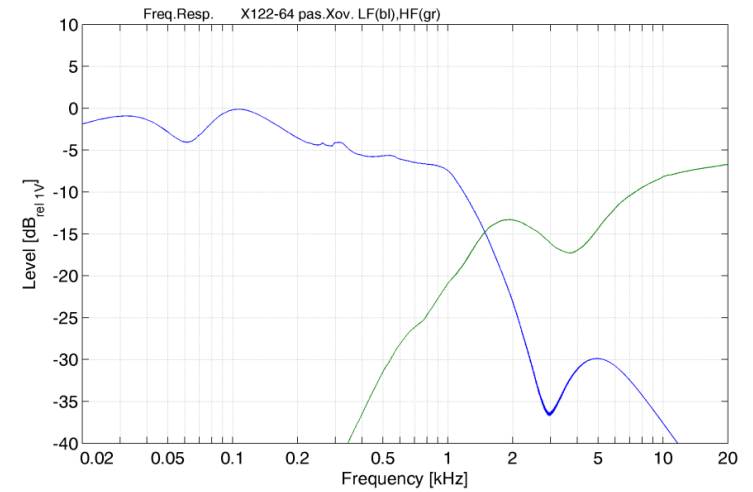
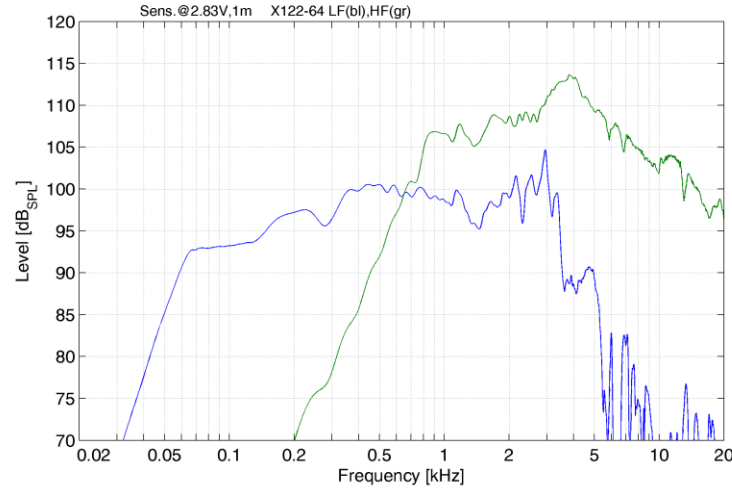
- Deviation from the linear behaviour of the loudspeaker with increasing level
- Limit values:  
max. 2 dB over max. 2 Oct.  
or  
max. 3 dB in a third ( $\frac{1}{3}$  Oct.)
- Distortions can also lead to level increases
- Shifts in the TS parameters at high levels can lead to changes in the frequency response of woofers.



SPL Leq [dB]	
Measurement	Calculated
102,4	102,4
103,4	103,4
104,3	104,4
105,3	105,4
106,3	106,4
107,3	107,4
108,3	108,4
109,3	109,4
110,3	110,4
111,3	111,4
112,2	112,4
113,2	113,4
114,2	114,4
115,2	115,4
116,1	116,4
117,0	117,4
118,0	118,4
118,9	119,4
119,8	120,4
120,7	121,4
121,5	122,4

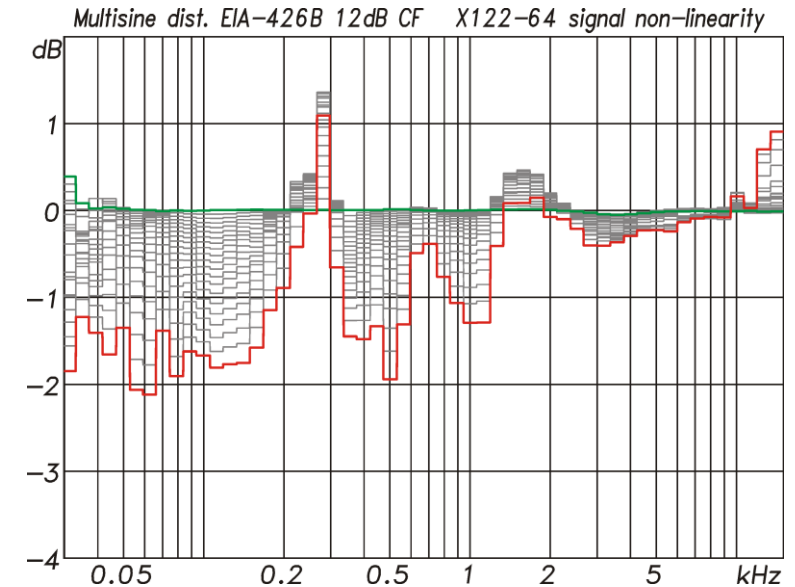
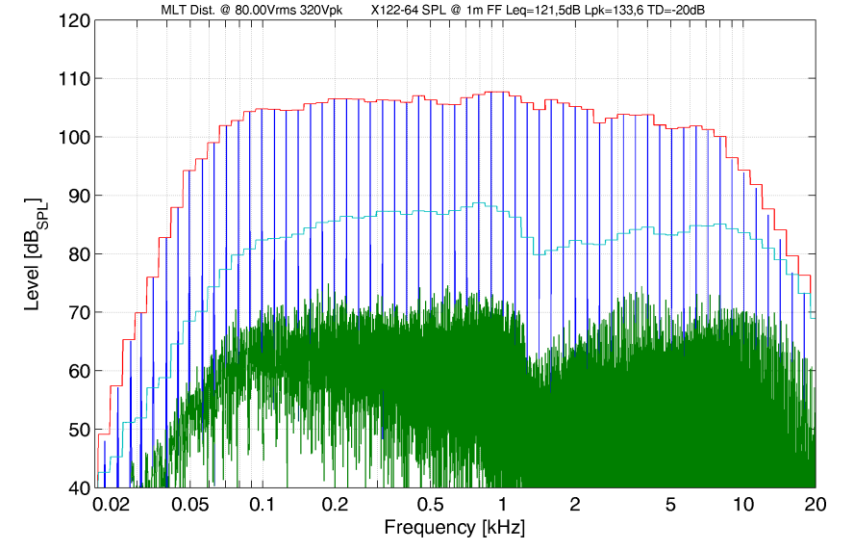
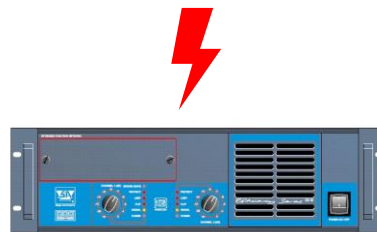
# Test object X122-64

- Passive 2-way PA speaker
- 12" LF-driver 8 Ω      400 W (AES 2h)  
                                  800 W (Program)
- 1" HF-driver 8 Ω        50 W (AES 2h)  
                                  100 W (Program)
- X-Over at 1.2 kHz
- Measuring distance 4 m (anechoic chamber)



# Evaluation X122-64

- Three criteria :
  - max. -20 dB (10%) TD (Total Distortions)
  - max. 2 dB non-linearity broadband
  - max. 3 dB non-linearity narrowband
- Limit first reached by 10% TD
- SPL values related to 1 m in free field and full room :
  - Average level  $L_{eq} = 121.5$  dB
  - Peak level  $L_{pk} = 133.6$  dB
- Input voltage :
  - Effective value  $80 V_{rms}$
  - Peak value  $320 V_{pk}$
  - Stage Accompany ES40 BTL Mode



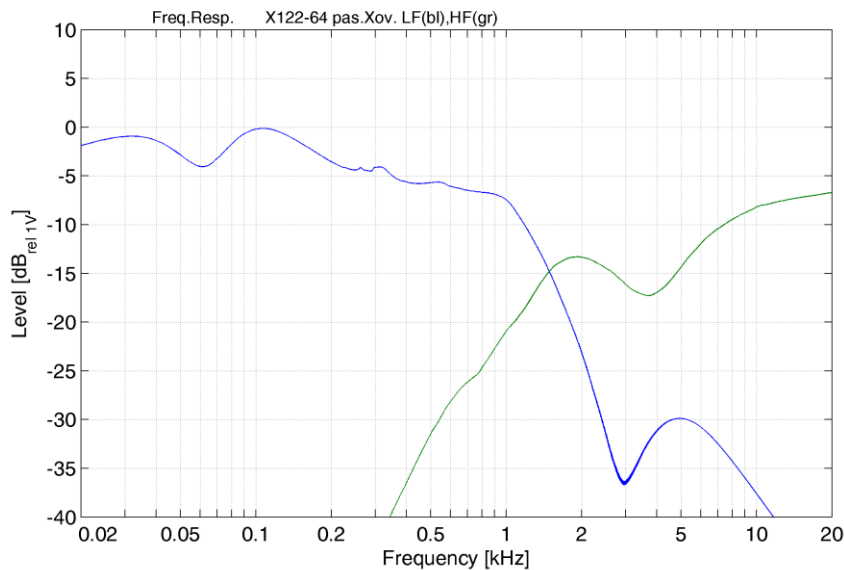
# Simulation comparison

- EASE GLL file :

- 12" LF-driver 8 Ω  
max. voltage 49.8 V ↔ 400 W @ 6.2 Ω\*
- 01" HF-driver 8 Ω  
max. voltage 19.5 V ↔ 50 W @ 7.6 Ω\*

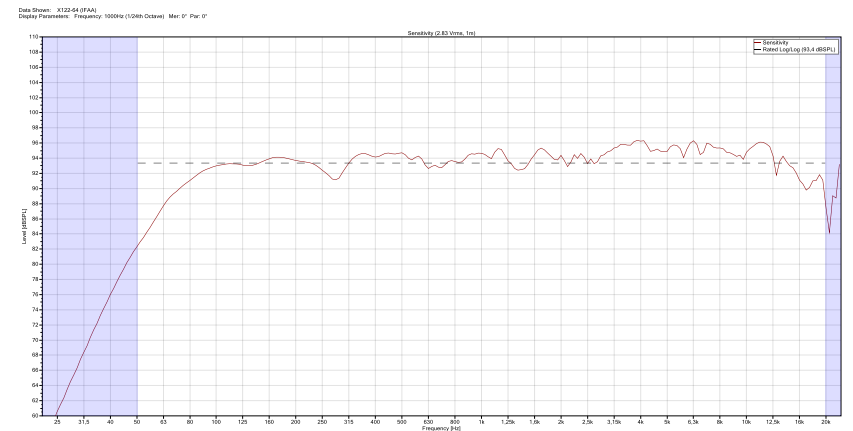
\* Impedance minimum

- Note level reduction due to filter function



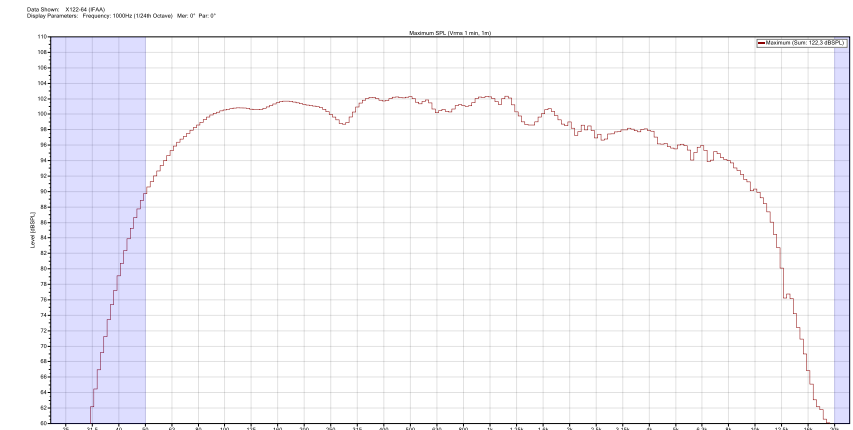
- Sensitivity:

- 2.83V/1m : 93.4 dB
- 8V/1m : 102.4 dB



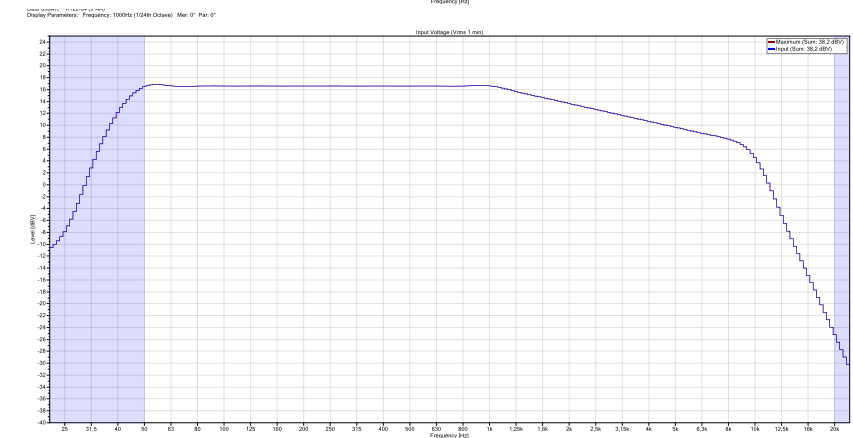
- Max. SPL  $L_{eq}$  @ 1m FF:

- 122.3 dB (GLL value)
- 121.5 dB (measured value)



- Max. Input Voltage:

- 81.3  $V_{rms}$  ↔ 38.2 dBV  
corresponds to 12 dB CF
- 325.2  $V_{pk}$  ?



# Music noise measurement

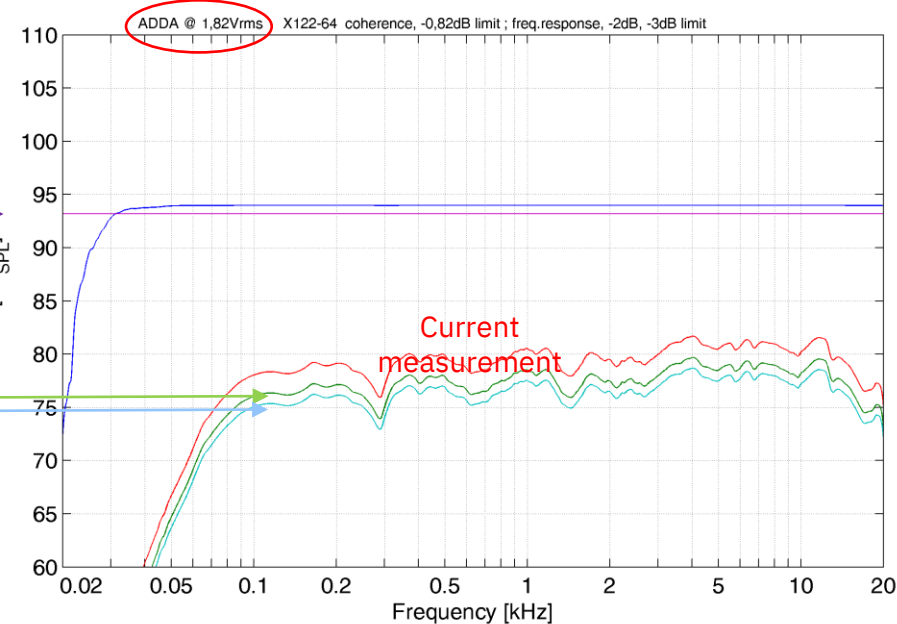
## Stop criteria :

- Signal coherence as a measure for the linear dependence of two time signals  
Requirement:  $\gamma^2 \geq 91\%$  (-0.82dB)
- Deviation in frequency response < 2dB over two octaves or more
- Deviation in frequency response < 3dB at any point

Coherence limit

Reference -2 dB

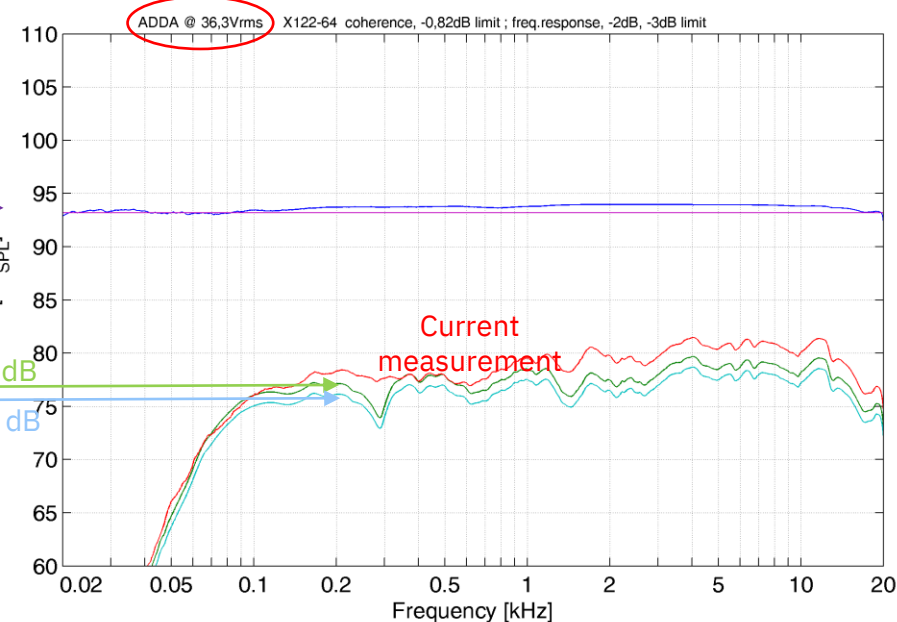
Reference -3 dB



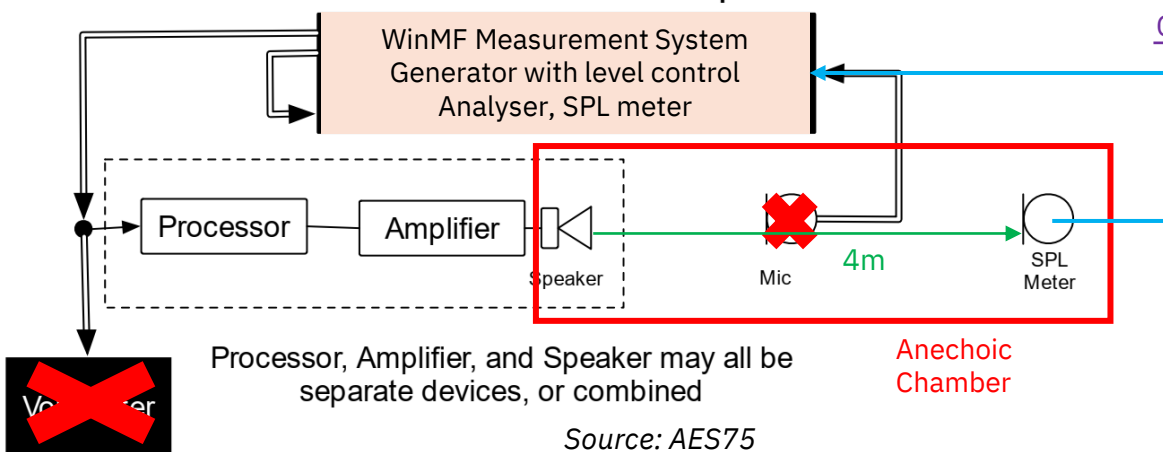
Coherence limit

Reference -2 dB

Reference -3 dB



## Practical Test Example



# Music noise measurement

- Speaker Input Voltage :  
 $1.82 \dots 36.3 \text{ V}_{\text{rms}}$   
 Range: 26 dB  
 $15 \dots 277 \text{ V}_{\text{pk}}$   
 Range: 25.3 dB

- SPL @ 1 m FF :  
 $L_{\text{eq}} 89.0 \dots 114.2 \text{ dB}$   
 Range: 25.2 dB  
 $L_{\text{pk}} 104.8 \dots 129.9 \text{ dB}$   
 Range: 25.1 dB

