

Usually the whole harmonic distortion generated by a speaker is characterized by the Total Harmonic Distortion, which is defined as the harmonic content in terms of the total sound pressure and will automatically be calculated directly within the Klippel TRF module. But in certain cases you might like to evaluate the harmonic content referring to the mean sound pressure in a stated frequency band according to the IEC standard 60268-5 paragraph 24.4 [ 1 ].

This Application Note is a step by step introduction for a fast calculation of this ratio denoted as Characteristic Harmonic Distortion with the appropriate Klippel Template.

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## 1 Definitions

<b>TOTAL HARMONIC DISTORTION (THD)</b>	$p_{THD}(f) = \sqrt{\sum_{i=2}^n p^2(if)}$	A very important characteristic of amplitude nonlinearity is the Total Harmonic Distortion which is defined by the root mean squared value of all harmonic components ( $p(if)$ ) in the analyzed output signal.
<b>MEAN SOUND PRESSURE LEVEL</b>	$p_r = \sqrt{\sum_{i=1}^n \frac{p_i^2}{n}}$ $\overline{L}_p = 20 \log \frac{p_r}{20 \mu Pa} \text{ dB}$	The mean sound pressure level according to IEC standard [ 2 ] as the Root Mean Square of equal logarithmical frequency bands. ( $p_i$ is the sound pressure in a definite 1/k octave band) The mean sound pressure level will be calculated afterwards from the mean sound pressure.
<b>CHARACTERISTIC HARMONIC DISTORTION (CHD)</b>	$d_{CHD}(f) = \frac{p_{THD}(f)}{p_r}$ $L_{CHD} = 20 \log(d_{CHD}) \text{ dB}$	The Characteristic Harmonic Distortion is defined by IEC standard [ 1 ] as the THD referred to the mean sound pressure in a stated frequency band.

## 2 Requirements

<b>START UP</b>	<p>To measure and calculate the Characteristic Harmonic Distortion the following equipment is required:</p> <ul style="list-style-type: none"> <li>• Install the RnD Analysis Software on your computer</li> <li>• Create a new object and select the <i>IEC 60268-5 §20.6 Harmonic Distortion</i> Template to start the analysis</li> <li>• Enter the sensitivity of the microphone in property page <i>Input</i> for the operation <i>1 TRF Measure FUND+THD</i> or use a pistonphone to calibrate the microphone.</li> </ul>
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### 3 Procedure

<b>TRF MEASUREMENT</b>	<p><b>Motivation:</b> We start with a simple sinusoidal sweep measurement to gain the Transfer Function of the Loudspeaker.</p> <p><b>How to do it:</b> Adjust the measurement microphone normal to the driver as preferred and select the <i>1 TRF Measure FUND+THD</i> operation. In <i>Properties</i> → <i>Stimulus</i> set <math>F_{min}</math> to a lower and <math>F_{max}</math> to a higher value than the boundary frequencies of your required bandwidth and modify the voltage if necessary. Run the measurement.</p>
<b>DETERMINATION OF THE CHARACTERISTIC HARMONIC DISTORTION</b>	<p><b>Motivation:</b> The Characteristic Harmonic Distortion can easily be determined by the <i>2 CAL Harmonic Distortion</i> operation in an arbitrary frequency band.</p> <p><b>How to do it:</b> Select the curve “<i>Fundamental</i>” from the window <i>Fundamental + Harmonic distortion components</i> and copy it to the clipboard. Select <i>Fund</i> in <i>Properties</i> → <i>Input</i> of <i>CAL Harmonic Distortion</i> and paste the Fundamental curve from Clipboard.</p> <p>Repeat this Step for the <i>THD</i> curve.</p> <p>Determine your frequency band for averaging the sound pressure level by defining the upper and lower bounds <math>f_{max}</math> and <math>f_{min}</math> as required. We recommend selecting a band which is inside the bounds of the THD curve. You might increase your resolution of your stimulus in the TRF property page to earn a wider bandwidth of the THD curve.</p> <p>Specify your required format of the result curve, which is provided in percent (%) or in decibel (‘dB’).</p>
<b>RESULTS</b>	<p>After running the script a result curve and the result variables window will appear showing following results.</p> <p>The window “<i>Result Curve 1</i>” shows the characteristic harmonic distortion curve in the chosen unit (% or dB) while the “<i>Result Variables</i>” window displays the <b>Mean SPL</b> according to IEC standard [ 2 ] in the frequency band between <math>f_{min}</math> and <math>f_{max}</math>. These bounds usually resemble your entered parameters, but might deviate if they exceeded the bounds of the fundamental curve.</p> <p>A warning will be returned if they exceed the bounds of the THD curve.</p>

### 4 More Information

<b>APPLICATION NOTE</b>	AN34 – IEC 60268-5 Mean SPL in a stated frequency band
<b>STANDARDS</b>	<p>[ 1 ] IEC 60268 Sound System Equipment – Part 5 Loudspeakers, 24.4 Characteristic harmonic distortion</p> <p>[ 2 ] IEC 60268 Sound System Equipment – Part 5 Loudspeakers, 20.6 Mean sound-pressure level in a stated frequency band</p>

Find explanations for symbols at:

<http://www.klippel.de/know-how/literature.html>

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