IEC 60268-5: Characteristic modulation distortion AN37

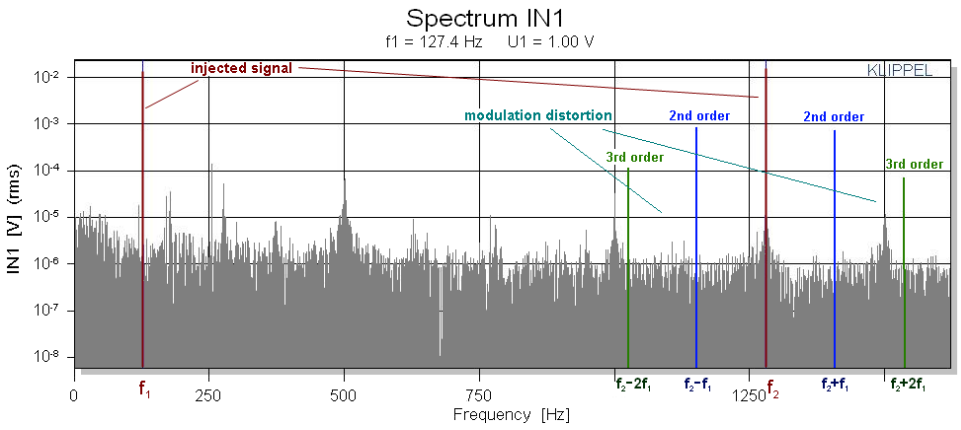
KLIPPEL ANALYZER SYSTEM (Document Revision 1.0)

While exciting a loudspeaker with a multi-tone signal, it produces modulation distortion at combination of the frequencies of the exciting tones. The measurement of intermodulation distortion can be accomplished by the *DIS 3D Distortion*. Chapter 24.6 of IEC 60268-5 [1] proposes to calculate the characteristic modulation distortion which is defined as the modulation distortion of the nth order in terms of the mean sound pressure in stated frequency band.

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

CONTENTS:

1 Definitions

<table>
<tr><td rowspan="2">MODULATION DISTORTION</td><td colspan="2"> 
</td></tr>
<tr><td>$d_n = \frac{P(f_2-(n-1)f_1)+P(f_2+(n-1)f_1)}{P(f_2)}$

$d_n[\%] = d_n \cdot 100\%$

$L_{dn} = 20\log(d_n)\text{dB}$</td><td>Excited with a two-tone signal (f_1 and f_2) the loudspeaker nonlinearities generate modulation distortion components at frequencies $f_2 \pm (n\text{-}1)\ f_1$ of n^{th} order. The modulation distortion of n^{th} order is specified as d_n and shall be expressed in percent or decibels.</td></tr>
<tr><td>MEAN SOUND PRESSURE LEVEL</td><td>$p_r = \sqrt{\sum_{i=1}^{n} \frac{p_i^2}{n}}$</td><td>The mean sound pressure level according to IEC standard [2] is defined as Root Mean Square value of the sound pressure measured in equal logarithmical frequency bands. (p_i is the sound pressure in a defined</td></tr>
</table>

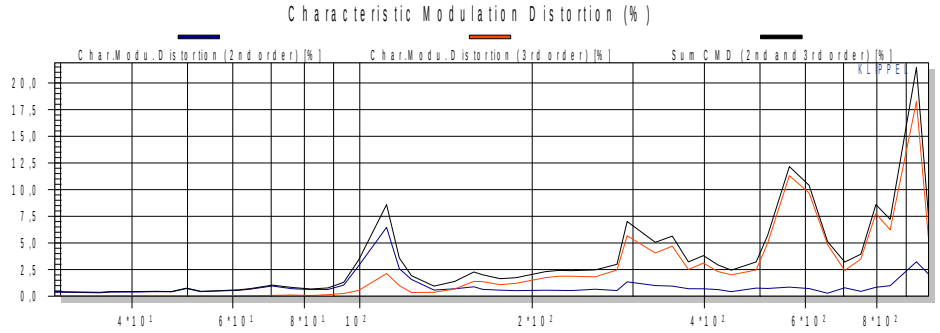
	$\overline{L_p} = 20\log\frac{p_r}{20\,\mu\text{Pa}}\text{dB}$	1/k octave band) The mean sound pressure level will be calculated afterwards from the mean sound pressure.
CHARACTERISTIC MODULATION DISTORTION (CMD)	$d_{CMDn} = \frac{p(f_2-(n-1)f_1)+p(f_2+(n-1)f_1)}{p_r}$ $L_{CMDn} = 20\log(d_{CMDn})\text{dB}$	The Characteristic Modulation Distortion is defined by IEC [1] as the sound pressure due to n^{th} order distortion components in terms of the mean sound pressure in a stated frequency band.

2 Requirements

START UP	To measure and calculate the Characteristic Modulation Distortion the following equipment is required: • Install the RnD Analysis Software on your computer • Create a new object and select the *IEC 60268-5 §24.6 Modulation Distortion* to start the analysis • Enter the sensitivity of the microphone in property page *Input* of the operation *1 DIS Measure FUND+Ld* or use a pistonphone to calibrate the microphone.

3 Procedure

DIS MEASUREMENT	**Motivation:** With the DIS measurement operation it is quite easy to measure the fundamental and the harmonic distortion components. **How to do it:** Adjust the measurement microphone normal to the driver as preferred and select the *1 DIS Measure FUND + Ld* operation. In *Properties* → *Stimulus* select a preferred frequency sweep of *f1* by setting the appropriated parameters as required. Keep in mind that your measurement time will increase by selecting a large number of measurement points. Determine your frequency ratio or set *f2* to a constant value. See the Manual of *DIS 3d Distortion* for more Information. Run the measurement.
DETERMINATION OF THE CHARACTERISTIC MODULATION DISTORTION	**Motivation:** The Characteristic Modulation Distortion can easily be determined by the *2 CAL Modulation Distortion* operation in an arbitrary frequency band. **How to do it:** Select the curve "*Fundamental*" from the window *Fundamental + 2nd and 3rd order harmonic distortion components* and copy it to the clipboard. Select *Fund* in *Properties* → *Input* of the *2 CAL Modulation Distortion* operation and paste the Fundamental curve from Clipboard. Use the same procedure to copy the Curves "*Ld2*" and "*Ld3*" individually from the window "*Modulation distortion*". Determine your frequency band for averaging the sound pressure level by defining the upper and lower bounds f_{max} and f_{min} as required. We recommend selecting a band which is inside the band of you frequency sweep. Specify your required format of the result curve, which is provided in percent ('*%*') or in decibel ('*dB*').

RESULTS	 After running the script a result curve and the result variables window will appear showing following results. If an error occurred it will be displayed in the result variables window as well. The window "Result Curve 1" shows the characteristic modulation distortion of the 2nd and 3rd order and its cumulation (*Sum CMD*) in the chosen unit (% or dB). The "Result Variables" window displays the **Mean SPL** according to IEC standard [2] in the frequency band between $\mathbf{f_{min}}$ and $\mathbf{f_{max}}$. These bounds usually resemble your entered parameters, but might deviate if they exceeded the bounds of the fundamental curve.

4 More Information

APPLICATION NOTE	AN34 – IEC 60268-5: Mean SPL in stated frequency band
STANDARDS	[1] IEC 60268 Sound System Equipment – Part 5 Loudspeakers, 24.6 Characteristic modulation distortion [2] IEC 60268 Sound System Equipment – Part 5 Loudspeakers, 20.6 Mean sound-pressure level in a stated frequency band

Find explanations for symbols at:

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

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