QC Hi-2 Distortion Measurement S67

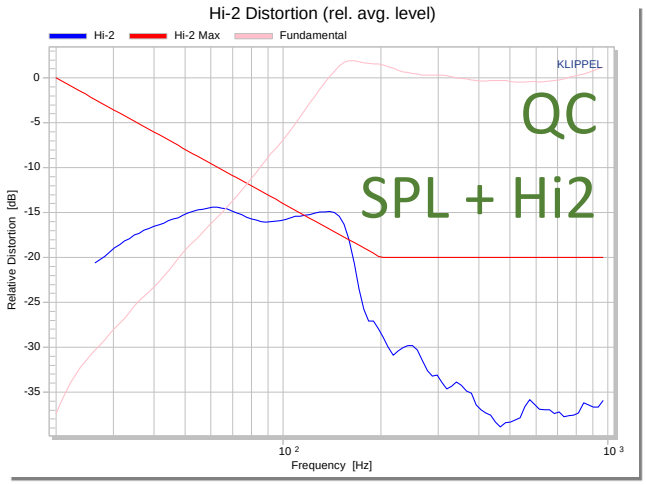
Software Module of the KLIPPEL ANALYZER SYSTEM (Document Revision 1.1)

FEATURES

- Fast Measurement of Hi2 distortion (also called „BLAT“)
- Add-On to SPL task
- Using Sine Chirp
- Standardized limits
- Customizable limits
- Compatible to DIS-Pro

BENEFITS

- Integrated in SPL-task
- Conform to automotive standard
- Sensitive distortion measurement of higher harmonics



DESCRIPTION

Hi-2 distortion (also called „Blat“ distortion since detected defects sound like a “blat” on bass signals) are calculated from higher order harmonic distortion. Such harmonics are weighted in a special way to emphasize defect symptoms of unacceptable speaker behavior. The cause of the distortion was determined to be a rapid increase in suspension stiffness at large cone excursion.

This distortion measure is related to Rub&Buzz symptoms, which also indicates abnormal sound. However, Hi-2 distortion are characterized by lower harmonics than typically Rub&Buzz distortion show.

The SPL-Task uses sine chirps for Hi-2 distortion measurement and can therefore measure this symptom in very short time

Hi-2 distortion may also be measured by the DIS-Pro module using steady state sine tones.

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CONTENT

1 Overview

1.1 Principle

A speaker (DUT) is excited by single frequency tones or a chirp.

The fundamental and the second through tenth harmonics P(k*f) with 2 <= k <= 10 needs to be measured by an acoustic sensor (microphone). Weight the harmonics by 12 dB per octave rising with frequency relative to the level of the fourth harmonic by using the weighting function:

$$w(k) = S^{ld\left(\frac{k}{R}\right)}$$

depending on the order k, using the slope parameter S=4 (12 dB/octave) and the referenced harmonic R=4. The HI-2 distortion is the RMS sum of the weighted harmonic

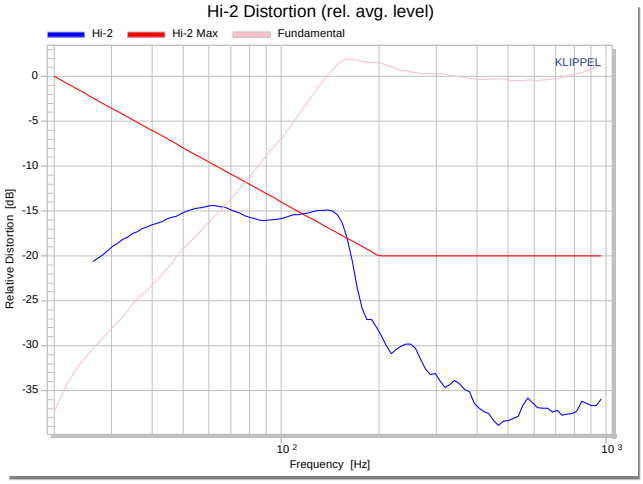
$$L_{HI-2}(f) = 10\,lg\left(\frac{\sum_{k=2}^{K}(w(k)P(kf))^2}{P_{ref}{}^2}\right)$$

The reference amplitude P_{ref} is equal to the mean amplitude of the fundamental component in the pass band of the driver.

For more details, check the paper listed in chapter *References*.

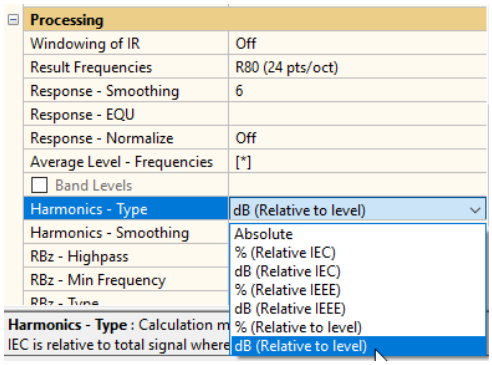
1.2 Results

The Hi-2 distortion depend on frequency and are displayed in the chart “Distortion”



Limits can be applied to this curve.

Note: Hi-2 distortion are defined by the equation given above. They are referenced to the average level in the pass band. It is the responsibility of the user to select a proper setup for the average level and the harmonic distortion mode. This calculation mode must be set to “dB (Relative to level)” for proper Hi-2 calculation:



If there are other modes defined, a warning informs the user that Hi-2 distortion are calculated in a non-dandarid conform way:

	⚠ Task Sound Pressure: Category Measurements: Parameter HI-2: Warning: Non compatible Harmonics Mode. HI-2 Standard requires calculation of Harmonics relative to average level in passband (in dB or percent).

2 Examples

2.1 Example 1

A woofer was excited by a 8V sine chirp resulting in the graph shown in chapter *Results* above. At 150 Hz the pre-defined limit (specified in the paper) was violated by more than 3dB. This indicates a severe symptom which may cause audible distortion. The relationship between Hi-2 and audibility or annoyance is not fully investigated but it was found that the Hi-2 distortion correlate with subjective tests.

In the example above the highest Hi-2 distortion occur around the resonance of the DUT, where the excursion is naturally at its maximum. It is quite typical that high coil excursion generates high distortion since the dominant non-linear mechanisms in electro-dynamic speakers depend on excursion (e.g. stiffness $K_{ms}(x)$).

3 Requirements

3.1 Hardware

Any acoustic measurement based on any Klippel hardware (PA, KA3) or 3 party sound-cards using a microphone

3.2 Software

QC application: QC Standard software + Hi-2 Add-On

R&D application: QC SPL task + Hi-2 Add-On

4 Limitations

4.1 Device Under Test

Electro-dynamic transducer principle. The investigations on Hi-2 distortion were done using automotive speaker, but the symptom is not restricted to those.

4.2 Acoustical

Controlled acoustic environment ensures consistent results. A test enclosure for QC-application is recommend.

Note, noise detection and production noise immunity is available for Hi-2.

5 Setup

5.1 Setup Parameters / Limits

STIMULUS & ACQUISITION: DEFINED BY SPL TASK
NO PARTICULAR SETUP FOR HI-2

Enable Hi-2	Checkbox in section „Measurements“ in SPL task activates the Hi-2 test. Note, that the average level and the Harmonics – Type must be set correctly, see chapter *Results.*
Limits	The following modes are available for the Hi-2 measurement: • Hi-2 Standard (see also reference): below 20Hz: 0 dB from 20 to 200Hz decreasing from 0dB to -20dB Above 200Hz: -20dB • Shift / Absolute / Shift + Absolute (see QC user manual for details)

6 Results

6.1 Results

Measure	Symbol	Unit	QC Limits Applicable
Hi-2(f)	$Hi2(f)$	dBSPL	✓

7 References

7.1 Related Modules	DIS Module PNI Module
7.2 Manuals	QC User Manual
7.3 Publications	Clark, D., "Blat Distortion in Loudspeakers," SAE Technical Paper 950189, 1995, https://doi.org/10.4271/950189.
7.4 Application Notes	AN 7 Measurement of Weighted Harmonic Distortion HI-2 AN46 How to make a test box for QC?

Find explanations for symbols at:
http://www.klippel.de/know-how/literature.html
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