Complex Room Compensation Sxx

Software/Module/… of the KLIPPEL ANALYZER SYSTEM (Document Revision 1.0)

PRELIMINARY SPECIFICATION – NOT FOR RELEASE
This specification is preliminary and is subject to change.

FEATURES • Room Compensation Curve for non-anechoic measurements. • Generation of a compensation function $H_c(f)$ that can be used for similar loudspeakers at low frequencies. **BENEFITS** • Fast loudspeaker measurements with high accuracy, performed in a non-anechoic environment (workshop, office …). • Accurate far field data under simulated free field conditions. • Applicable to nonlinear distortion (THD, IMD, rub & buzz). • Single point measurement.	(Insert Image)

DESCRIPTION

Good anechoic rooms are very rare and thus, performing accurate measurements of a Device is a challenging task. Since most measurement room range from correct to very bad, generating a Complex Room Compensation function is a good solution to perform fast and accurate measurement in such conditions.

Article number	

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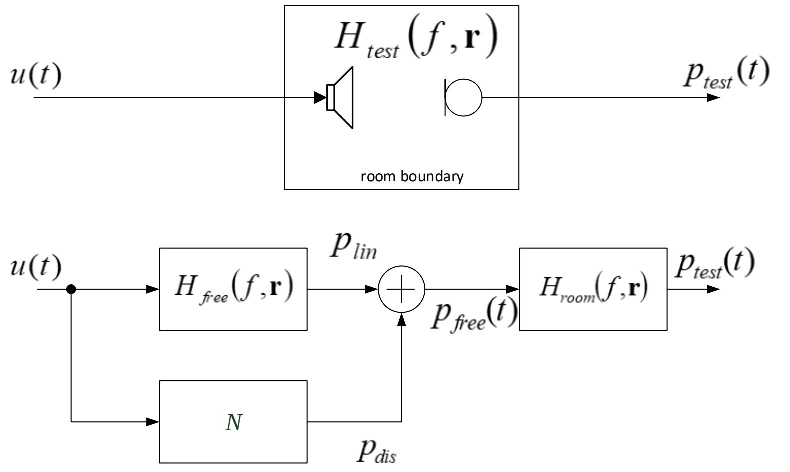
1 Principle



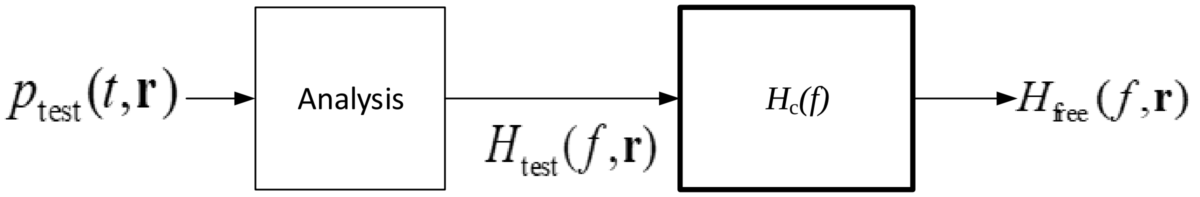
On this flowchart, $p_{test}(t)$ represents the sound pressure under real test environment and $p_{free}(t)$ the sound pressure measured at the same distance and angle under free field condition.

The impact of the room can be described by a linear transfer function $H_{rom}(f,\mathbf{r})$.

The loudspeaker under test can be modelled by a linear subsystem $H_{free}(f,\mathbf{r})$ and a nonlinear subsystem connected in parallel N.

p_{dis} represents the nonlinear distortion, that are negligible in the small signal domain but come comparable in magnitude with the linear output signal p_{lin} at higher amplitudes; resulting in the room response $H_{room}(f,\mathbf{r})$ affecting not only the amplitude and phase of the fundamental component but also shaping all harmonic and intermodulation distortion generated by these inherent loudspeaker nonlinearities.

The Complex Room compensation module aims to ease off the room response $H_{room}(f,\mathbf{r})$ from the measured transfer function $H_{test}(f,\mathbf{r})$ by applying a post-filter on the measurement, as shown in the flowchart bellow.



2 Requirements

2.1 Hardware

KLIPPEL ANALYZER		The Klippel Analyzer 3 is the hardware platform for the R&D modules that performs the data acquisition and real time processing. [1]	H3
MICROPHONE		Free field microphone with omnidirectional directivity characteristic over the measurement bandwidth.	A4
AMPLIFIER (OPTIONAL)		Amplifier with a flat frequency response over the desired measurement bandwidth	

2.2 Software

TRF MODULE (S7)	The Transfer function (TRF) is a dedicated PC software module for measurement of the transfer behavior of a loudspeaker. [2]
COMPLEX ROOM COMPENSATION MODULE	[4]
NFS VISUALIZATION MODULE	[5]

3 Example

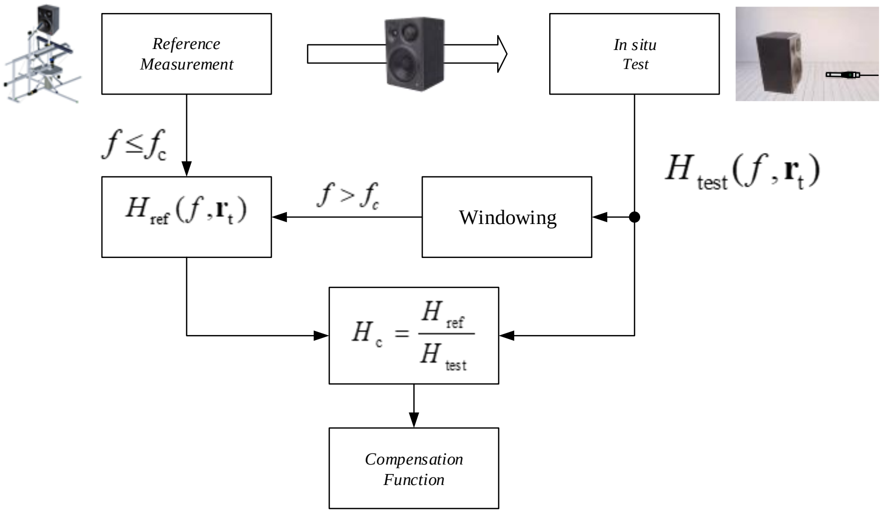
3.1 Introduction

Target

In the following the measurement of a 2-way vented studio monitor will be performed in a workshop, and corrected thanks to the Complex Room Compensation module.
The following topics will be addressed:

- How to generate the reference curve?
- How to measure in a workshop?
- How to compensate the measurement results?

Principle



The flowchart above presents the principle of the following example.

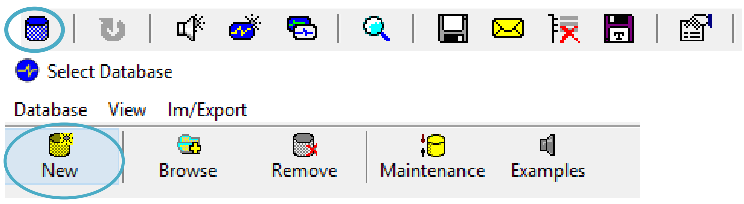
First, the reference measurement is performed in free field conditions (using the NFS or in anechoic room for example), generating the reference transfer function $H_{\mathrm{ref}}(f, \mathbf{r}_t)$.

Then the in-situ measurement is performed in non-anechoic conditions, generating the in-situ transfer function $H_{\mathrm{test}}(f, \mathbf{r}_t)$.

From these measures, the compensation function $H_{\mathrm{c}} = \frac{H_{\mathrm{ref}}}{H_{\mathrm{test}}}$ is calculated. This function represents the influence the influence of the room reflections on the measurement at all frequencies.

Finally, the compensation function H_{c} is applied to the sound pressure signal measured under non-anechoic conditions.

3.2 Start dB-Lab and create a new database for the measurement

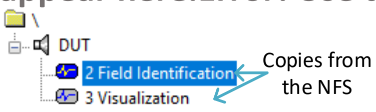


Click “select database” and create a new database.

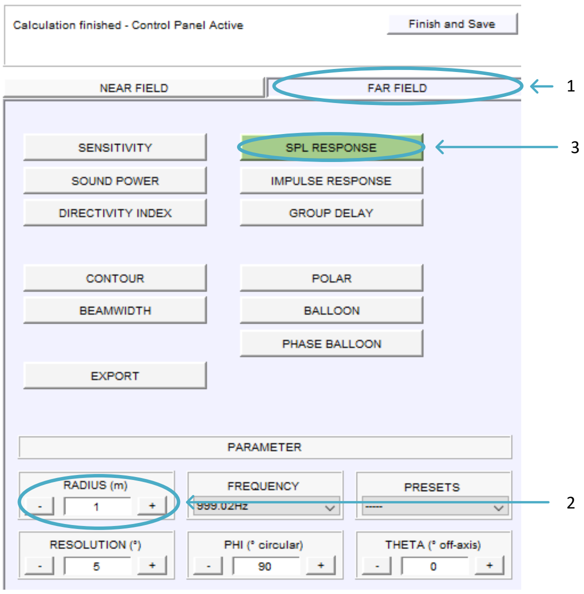
3.3 Create the reference curve

In this example, the reference curve has been generated thanks to a coarse NFS scan with a 300 points grid. Other options are available for the generation of a reference curve such as a measurement on axis performed in an anechoic room, or a measurement on axis performed in free field conditions (performed outside).

To ensure an accurate correction, the input voltage and frequency range must be the same for the reference and in-situ measurements.



Paste the NFS field identification and the NFS visualization operations of the reference measurement in the database of the in-situ measurement.



Run the NFS visualization.

1- In the control panel, select “Far-Field”.

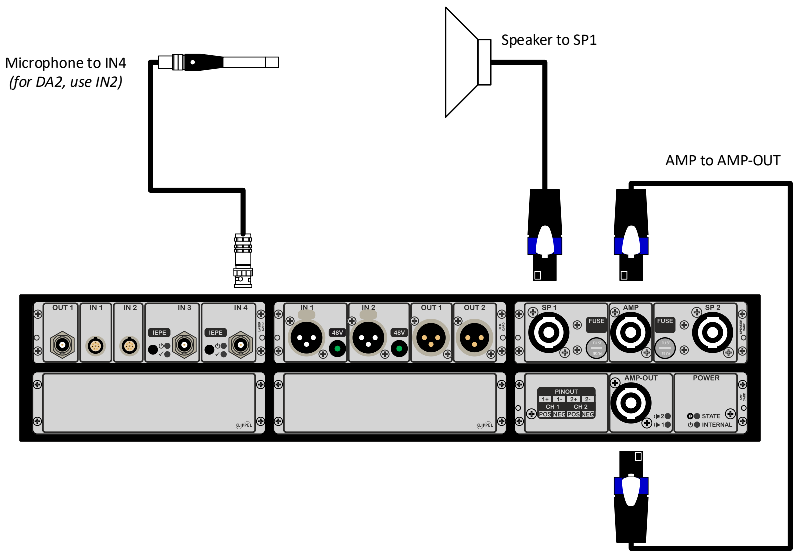
2 - Set a radius of 1m.

3 - Generate the SPL response by clicking the corresponding button.

For more details about the NFS, please refer to the NFS manual available at [5]

3.4 Perform the in-situ measurement

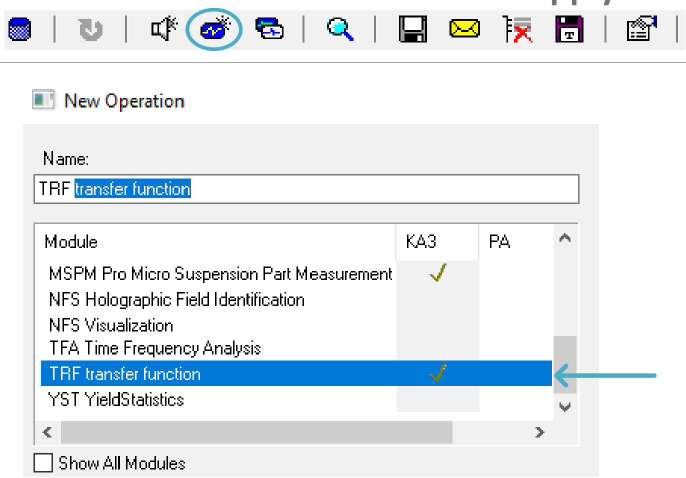
1) Connect the hardware



2) Measurement setup

Setup the DUT and the microphone for a single point measurement: in this example, place the microphone 1 m On-Axis in front of the DUT.

3) Create the TRF operation



Open the "new operation" dialog, select "TRF transfer function (default)".

4) Open the "property page".

5) Configure stimulus

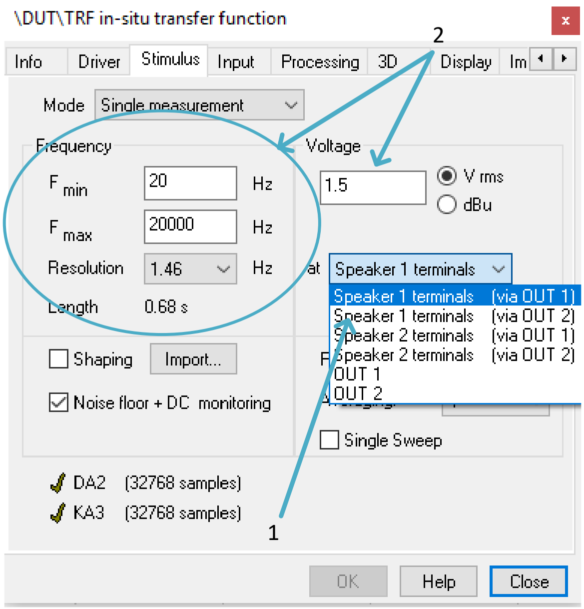
1 -Select the "***Stimulus***" tab and define:

- "***Speaker 1 terminals (via OUT1)***"

2 - Configure Parameters:

- Frequency Range (***f_{min}, f_{max}***)
- Frequency Resolution
- Input Voltage

⚠ These parameter must be the same as the ones used for the reference curve.

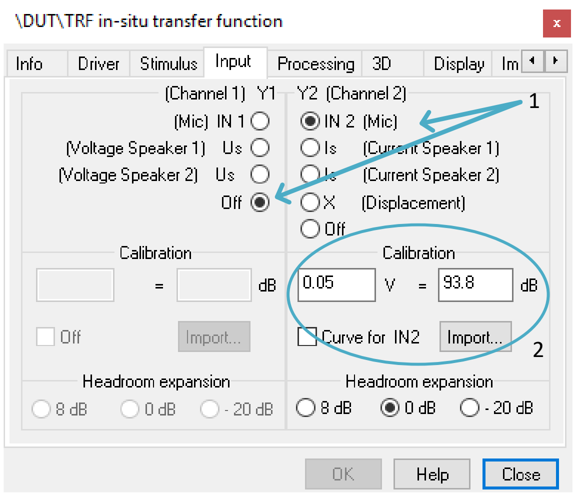


6) Define Channels

1- Select the "***Input***" tab and define:

- ***Channel 1 – Off***
- ***Channel 2 - IN 2 (Mic)***

2- Insert the **calibration** of the mic.



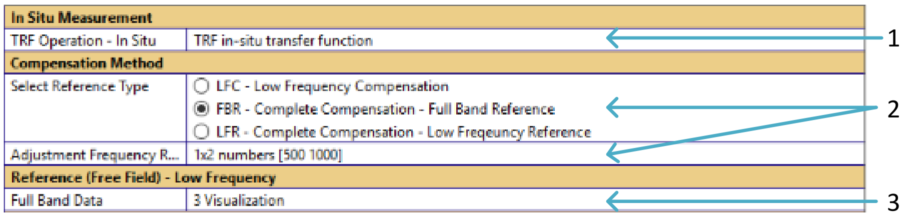
7) Run the operation

3.5 Setup the Complex Room Compensation

1) Open the “new operation” dialog, and select “Complex Room Compensation”.

2) Open the “property page”.

3) Configuration of the in-situ and reference measurements



In Situ Measurement	
TRF Operation - In Situ	TRF in-situ transfer function
Compensation Method	
Select Reference Type	LFC - Low Frequency Compensation FBR - Complete Compensation - Full Band Reference LFR - Complete Compensation - Low Freqeuncy Reference
Adjustment Frequency R...	1x2 numbers [500 1000]
Reference (Free Field) - Low Frequency	
Full Band Data	3 Visualization

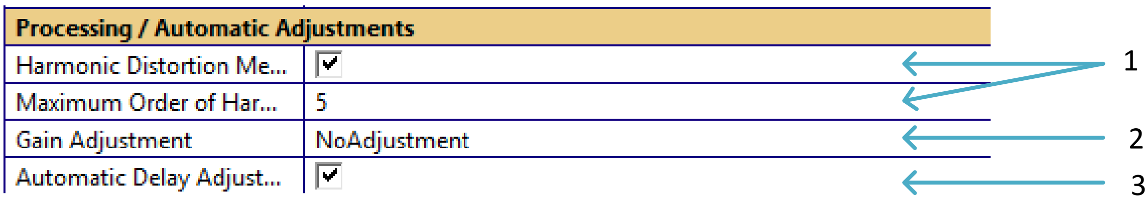
1 - In the “in-situ measurement” section, use the selection list to select the previously measured in-situ TRF.

2 - In the “Compensation Method” section, select the reference type and the cross-frequency range

Please refer to the Complex Room Compensation manual for further details about these parameters, available at [4]

3 – In the “reference (free field) – Low Frequency” section, select the NFS visualization created before.

4) Configuration of the processing/Automatic Adjustments



Processing / Automatic Adjustments	
Harmonic Distortion Me...	☑
Maximum Order of Har...	5
Gain Adjustment	NoAdjustment
Automatic Delay Adjust...	☑

1 – Set the “Harmonic Distortion Measurement” parameter and set the Maximum Order of Harmonics (if applicable)

2 – Set the “Gain Adjustment” parameter.

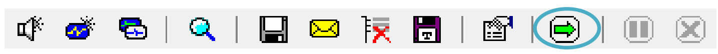
If “NoAdjustment” is selected, the gain of both the in-situ measurement and the reference measurement should be the same.

If “Automatic” is selected, the module will automatically adjust the gain of the reference curve to match the in-situ measurement.

If the measurement was performed in half-space, select “HalfSpace”.

3 – Check that “Automatic Delay Adjustment” is selected. This will compensate the delays between the in-situ and reference measurement, ensuring that there is no phase shift between them.

5) Run the operation

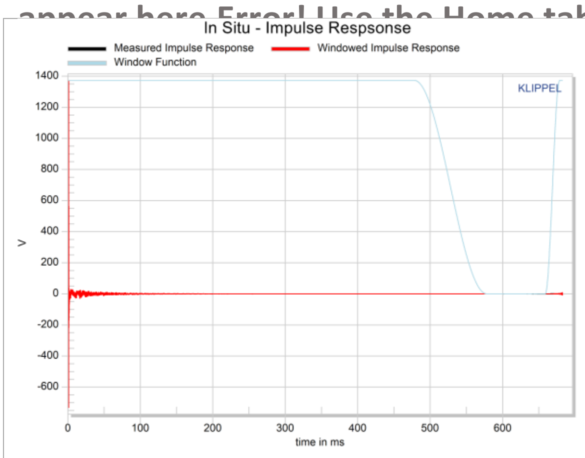


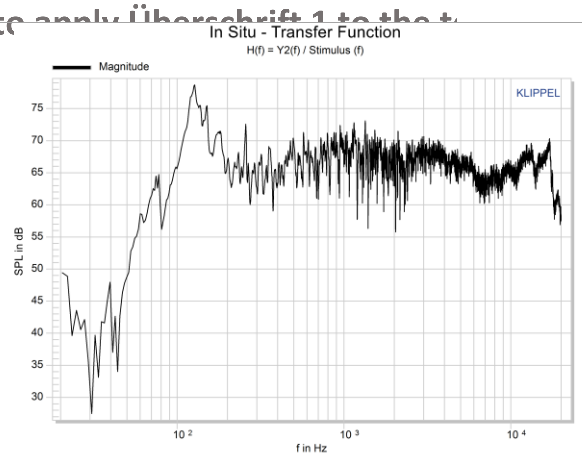
3.6 Results

1) Double click on the “Complex Room Compensation” operation to show the results.

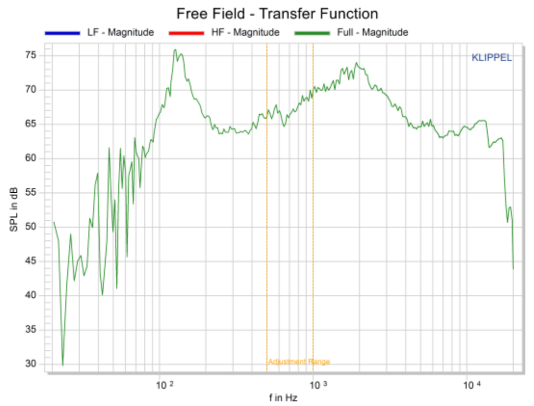
1 - The in-situ impulse response window presents the impulse response and the window used to determine the High Frequency data.

2- The in-situ transfer function presents the measured transfer function.

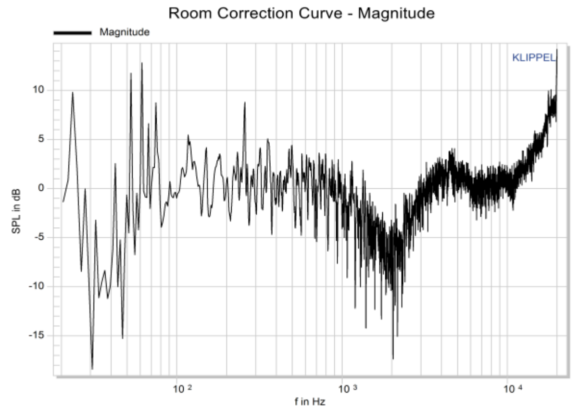




3 – The free-Field transfer function window presents the Low and High frequency data separately, the result of the merging, and the cross-frequency band.



4 – The Correction Curve window presents the calculated correction curve.

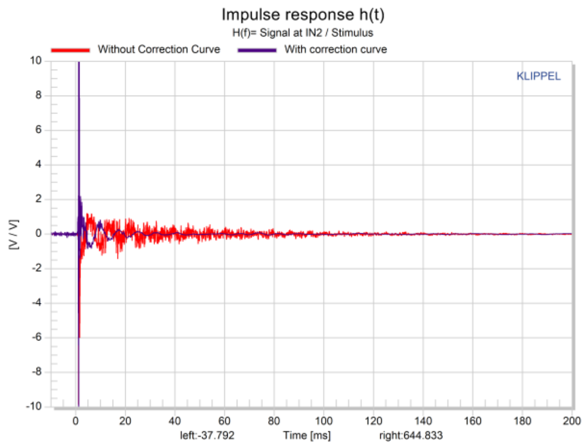


2) Open the “TRF Transfer Function (with correction curve)” operation

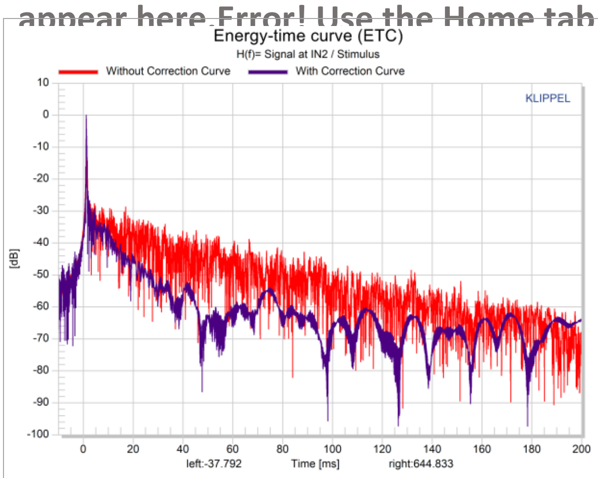
In this operation, the in-situ transfer function measured previously has been corrected by the Room Correction Curve. Comparing the results with the in-situ transfer function evidences how the Correction works.

The Room Correction Curve can be used to perform all kind of different measurement on the DUT, given that its position in the room and the microphone’s position does not change, for example:

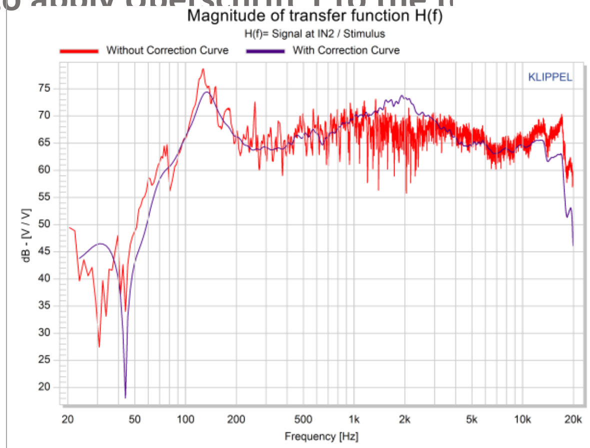
- The stimulus can be changed for other TRF measurements.
- Any kind of acoustic measurement can be performed and corrected such as the TBM, DIS, ..



1 – On the Impulse Response, it can be observed that all effects from the room have been removed: the early reflections are eased off, and the corrected Impulse Response is much shorter than the one measured in-situ. The ringing of the Impulses has been reduced.



2 – On the Energy-Time Curve, similar results than with the Impulse Response can be found. The ringing is reduced, and the room's effects are removed.



3 – Comparing the magnitude of the transfer functions evidences how the Complex Room Compensation can generate a more accurate measurement. All room artifacts are effectively removed from the transfer function.

4 References

4.1 Related Modules	[1] *Klippel Analyzer 3,* Specifications H3, 2017 Klippel GmbH, www.klippel.de [2] *Transfer function (TRF)*, Specification S7, 2016 Klippel GmbH, www.klippel.de
4.2 Manuals	[3] User Manual *TRF Transfer function*, included in dB-Lab Software installation [4] User Manual *Complex Room Compensation*, included in dB-Lab Software installation [5] User Manual *NFS Near Field Scanner*, included in dB-Lab software installation
4.3 Publications	[6] W. Klippel, C. Bellmann: *Fast Loudspeaker Measurement in Non-Anechoic environment*, AES 2017 - 143th Convention, Audio Engineering Society

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