TRF Voltage Stepping (STEP) S71

PRE-RELEASE

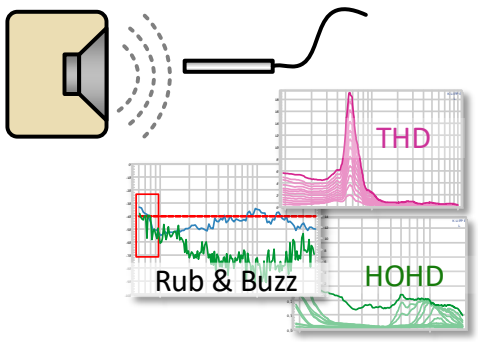
Software Module of the KLIPPEL ANALYZER SYSTEM (Document Revision 1.3)

PRELIMINARY SPECIFICATION

This specification is preliminary and is subject to change.

FEATURES

- Incremental voltage stepping of any TRF applications
- Automatic generation of TRF Batches
- Root cause analysis of Rub & Buzz and other defects
- Equivalent Input Harmonic Distortion (EIHD)
- Limit check for rating U_{max} and SPL_{max} according to IEC 60268-21



DESCRIPTION

The Transfer Function Pro (TRF Pro) measurement is providing a sensitive analysis of impulsive distortion such as clicks and rub & buzz effects. However, these irregular distortions appear at a certain input level and require successive measurements by an advanced user.

The **TRF Voltage Stepping (STEP)** tool simplifies this measurement procedure. The module automatically increases the input voltage until a symptom is detected. This can be for example an impulsive distortion threshold (Rub & Buzz) or a certain level of the regular harmonic distortion to rate U_{max} and SPL_{max} according to IEC 60268-21.

Article number	1000-912 (incl. in TRF Pro with dB-Lab 212)

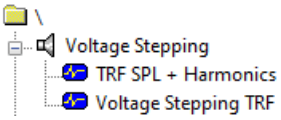
CONTENT

1 Overview

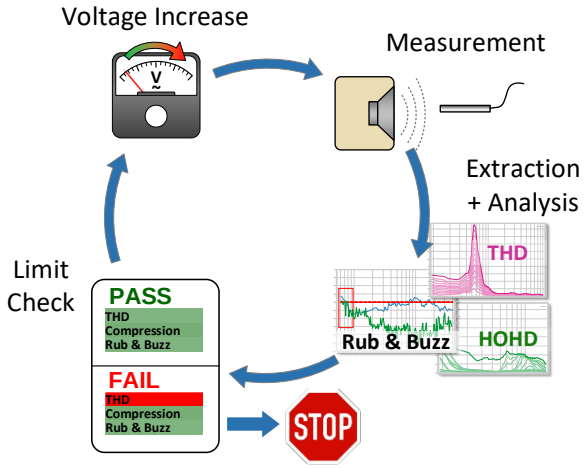
1.1 Principle

How it works?

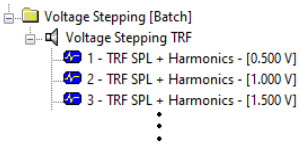
The TRF Voltage Stepping module is a tool to create an automatic test sequence with a systematic voltage increment. The basis of the performed measurement can be any Transfer Function Measurement (TRF) operation with arbitrary settings (e.g., signal routing, smoothing, harmonic and impulsive distortion analysis etc.)



During the measurement the TRF Voltage Stepping module is creating a batch of operation and increments the RMS input voltage of the measurement stimulus automatically. In addition, selected results such as harmonic distortion (THD, HOHD) are extracted from each measurement. Optionally, these results can be checked against limits to stop the measurement batch at a certain level e.g., when a defined level of THD is exceeded or a distinct rub & buzz is detected.



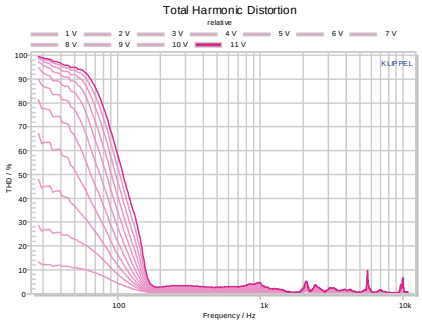
Once the measurement loop is finished, the TRF Voltage Stepping module is summarizing the extracted curves and all individual TRF measurements are stored in the database. Thus, critical measurements can be analyzed in detail.



1.2 Results

Harmonic Distortion

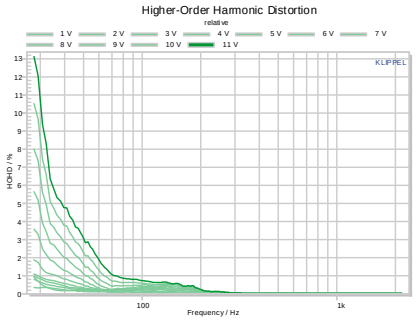
Total Harmonic Distortion - *THD*(*f*,*U*)



The graph shows the relative Total Harmonic Distortion of all individual measurements calculated from the RMS values $\tilde{p}^2{}_{nf}(f)$ of the n-th harmonic component according to IEC60268-21.

$$THD(f,U) = \frac{\sqrt{\sum_{n=2}^{N} \tilde{p}^2{}_{nf}(f,U)}}{\tilde{p}^2{}_{\mathrm{ref}}(f,U)}$$

Higher Order Harmonic Distortion - *HOHD*(*f*,*U*)



The graph shows the relative Higher Order Harmonic Distortion of all individual measurements calculated from selected higher order harmonic (N_l to N) components according to IEC60268-21.

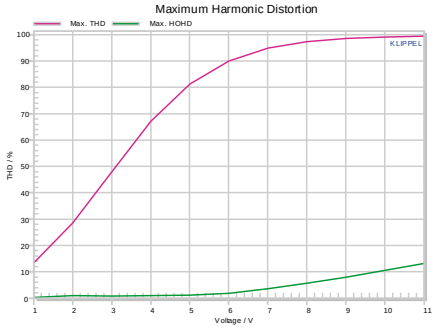
$$HOHD(f,U) = \frac{\sqrt{\sum_{n=N_l}^{N} \tilde{p}^2{}_{nf}(f,U)}}{\tilde{p}^2{}_{\mathrm{ref}}(f,U)}$$

The sound pressure reference $\tilde{p}^2{}_{\mathrm{ref}}(f,U)$ of *THD* and *HOHD* can be either

- Fundamental + *THD*
- Fundamental
- Mean sound pressure level

in a specified frequency band.

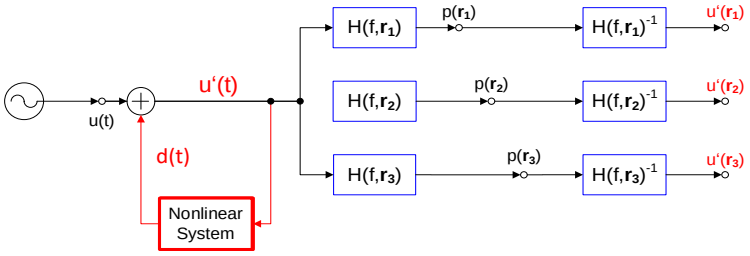
The maximum values of the harmonic distortion *THD*$_{max}$(*U*) and *HOHD*$_{max}$(*U*) are visualized as well.



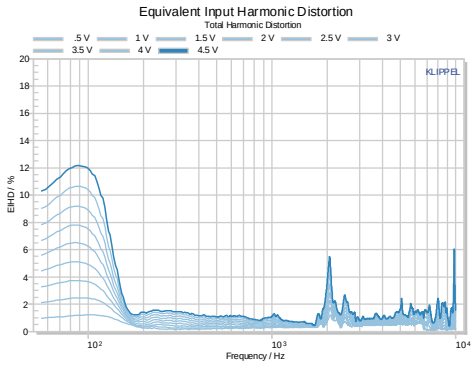
Equivalent Input Harmonic Distortion

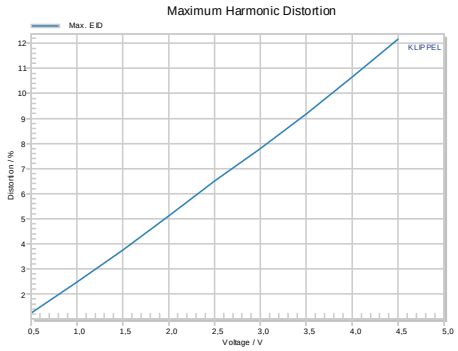
Harmonic distortions of loudspeakers are usually measured using a microphone at a certain position in the sound field. Thus, the harmonic distortions are shaped by the fundamental frequency response at this point. Measurements at different positions may give totally different results.

By filtering the sound pressure by the inverse fundamental frequency response, the influence of the radiation can be removed and all distortion can be transformed back to the input of the system. These so-called Equivalent Input Harmonic Distortion (EIHD) are very useful for comparing different measurements.



The Equivalent Input Harmonic Distortion are displayed vs. frequency and the maximum value is plotted in the specified range vs. voltage.



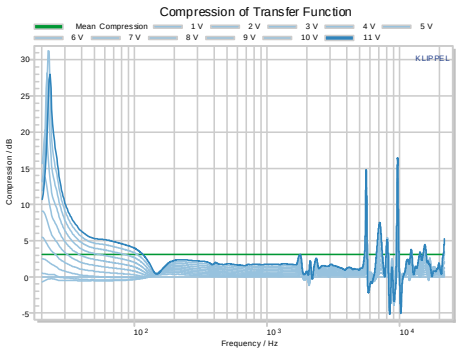


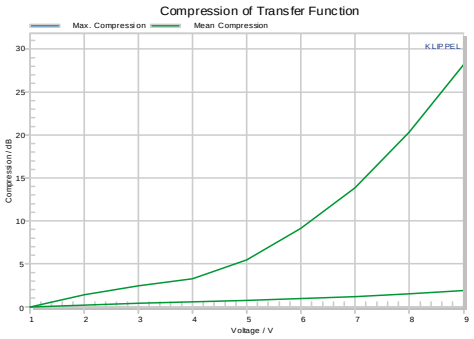
Compression

According to IEC60268-21 the time varying compression of the magnitude of the transfer function *C*(*f*,*U*) is calculated by the level difference of the transfer function $H(f,U)$ compared to the linear transfer function $H_{\mathrm{lin}}(f,U_{\mathrm{lin}})$ at a certain reference voltage U_{lin}.

$$C(f,U) = 20 \cdot \log(|H_{\mathrm{lin}}(f,U_{\mathrm{lin}})|) - 20 \cdot \log(|H(f,U)|)$$

The TRF Voltage Stepping summarizes the compression vs. frequency as well as the deviation of maximum and mean compression vs. input voltage.



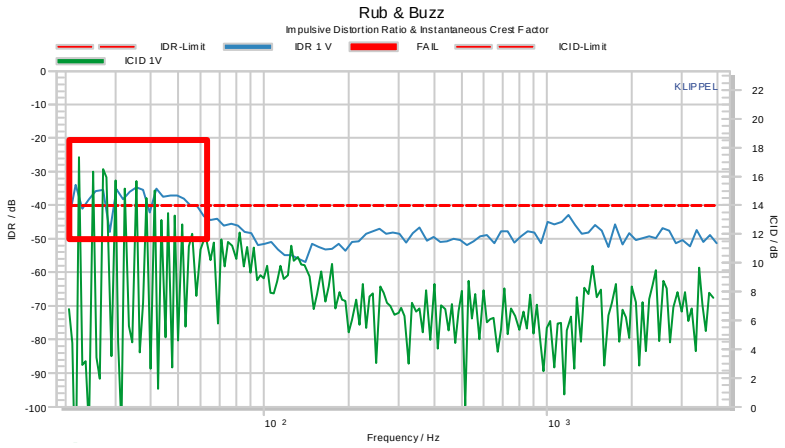


Impulsive Distortion, Rub & Buzz

Loudspeaker defects like voice coil rubbing, hard limiting of the voice coil former, loose particles etc. are producing irregular signal distortion which are audible and have a high impact on the sound quality. These distortion are very impulsive and need to be detected in time domain.

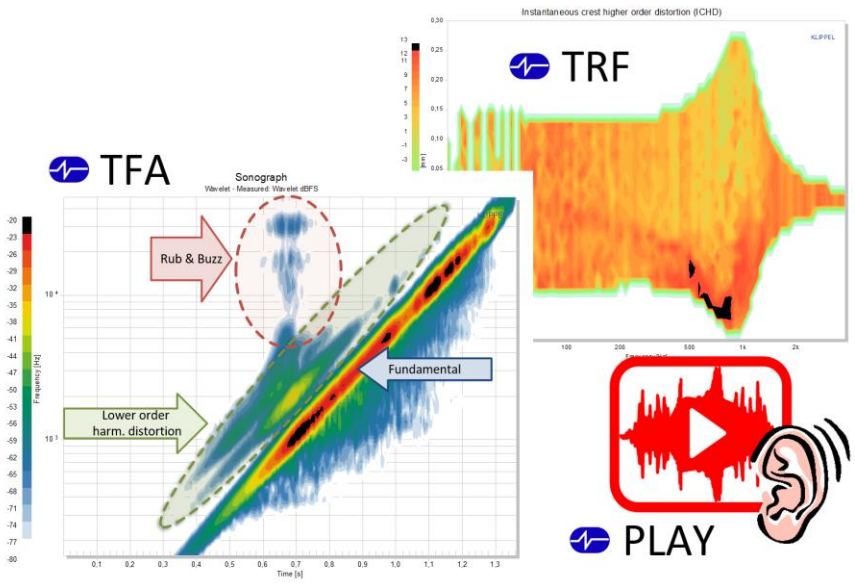
The Voltage Stepping module provides and automatic check of impulsive distortion by combining the peak value and the instantaneous crest of the higher order distortion components. This combination gives a robust Rub & Buzz check and detects if the signal components produce impulsive and audible distortion.

The Rub & Buzz graph contains the Instantaneous Crest Factor of the Impulsive Distortion *ICID* and the Impulsive Distortion Ratio *IDR* according to IEC 60268-21.



Rub & Buzz – Root Cause Analysis

In addition to the integrated graphs, the TRF Voltage Stepping module can link and create additional operations automatically for a detailed root cause analysis of the rub & buzz defects. Crit-ical measurements can be investigated using a Time Frequency Analysis (TFA) or can be ana-lyzed perceptively with the Audio Player (PLAY).



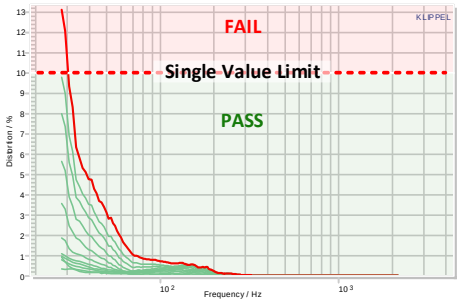
1.3 Limit Check

Single Value Limit

The simplest option to define a limit is a single value. For Example:

```
THD-Limit = 10 %
```

In that case the result curve is checked against this limit over the full frequency range. If the curve exceeds this limit at any point, the verdict is “fail”.



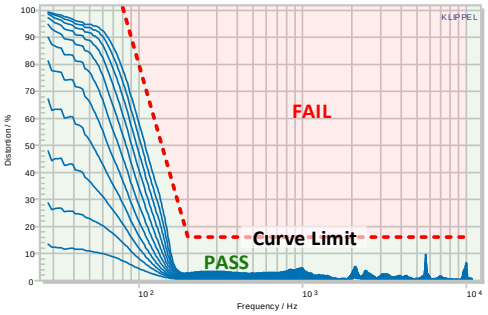
Curve Limit

A limit can also be defined as a curve of frequency - value pairs. For Example:

```
Freq. [Hz]    THD-Limit [%]

100           80
200           15
10000         15
```

If the curve exceeds the limit curve in the defined range, the verdict is “fail”.



Combined Rub & Buzz

To ensure a robust check of impulsive distortion, the Rub & Buzz Limit combines both *IDR* and *ICID*. The verdict is “fail”, when both *ICID* and *IDR* are above the critical threshold in the same frequency band. That means there is a distortion that is both impulsive and loud enough to be audible at the same time.

The Rub & Buzz Limit can be defined either as single values:

```
IDR [dB]      CID [dB]

-40           12
```

or as a curve:

```
Freq.[Hz]     IDR[dB]     CID[dB]

50            -40         14
200           -40         12
1000          -40         12
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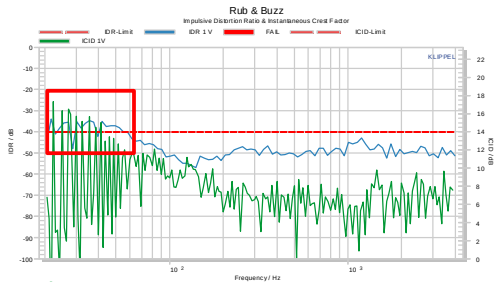

2 Requirements

2.1 Hardware

Klippel Analyzer	 KLIPPEL Analyzer 3 (KA3) or Distortion Ana-lyzer (DA2) are used as the hardware plat-form to perform the measurements.	H1, H3
Microphone	A free field microphone with omnidirectional directivity characteristic over the desired measurement bandwidth is required.	A4
Amplifier	*[optional] Required for the measurement of passive speaker or transducer. (e.g., KA3 Amp-Card or external amplifier)*	
Laser Displacement Sensor	*[optional] Recommended for rub & buzz measurements.* *The root cause of the rub & buzz defect can be analyzed by mapping the dis-placement and microphone signal together to see at which voice coil position the defect is happening.*	A2

2.2 Software

dB-Lab	Project Management Software of the KLIPPEL R&D SYSTEM: Requires at least version 212	
TRF (Pro)	Measurement of Transfer function, Fundamental + Harmonic Distortion, Impul-sive Distortion and Rub & Buzz	S7, S8
TFA	[optional] Time Frequency Analysis: Recommended for Rub & Buzz analysis.	S61
PLAY	Audio Player: Free tool included in dB-Lab Software	

3 Setup

3.1 Setup Parameter Limits

Parameter	Symbol	Min.	Typ.	Max.	Unit
STIMULUS & ACQUISITION					
The measurement is performed with the Transfer Function Measurement (TRF) module. For details see [1] and [2]					
VOLTAGE STEPPING					
Measurement Operation	Name of the Transfer Function Measurement (TRF) operation				
Start Voltage	U_{start}	> 0	-	≤ U_{stop}	V
Voltage increment	U_{step}	> 0	-	-	V
End Voltage	U_{stop}	≤ U_{start}	-	-	V
LIMIT DEFINITION					
Total Harmonic Distortion Limit	THD_{lim}	0	10	100	%
Equivalent Input Distortion Limit	$EIHD_{lim}$	0	10	100	%
Maximum Compression Limit	$C_{max,\,lim}$	0	3	-	dB
Mean Compression Limit	$C_{mean,\,lim}$	0	3	-	dB
Rub &Buzz Limit - Crest	$ICID_{lim}$	> 0	12	-	dB
Rub &Buzz Limit - Peak	IDR_{lim}	-	-40	0	dB

4 Results

4.1 Results

Measure	Symbol	Unit	Limit Check
Total Harmonic Distortion	*THD*	% or dB	Single Value/ Curve Limit
Higher Order Harmonic Distortion	*HOHD*	% or dB	Single Value/ Curve Limit
Impulsive Distortion Ratio	*IDR*	dB	Rub & Buzz Limit
Crest Factor of Impulsive Distortion	*ICID*	dB	Rub & Buzz Limit
Compression of Transfer Function	C	dB	Single Value/ Curve Limit
Mean Compression	C_{mean}	dB	Single Value Limit
Equivalent Input Harmonic Distortion	*EIHD*	% or dB	Single Value/ Curve Limit

5 References

5.1 Related Modules

[1] S7 Transfer Function (TRF)
[2] S8 Transfer Function Pro (TRF-Pro)
[3] S61 Time Frequency Analysis (TFA)
[4] Audio Player (PLAY) - [Free utilities]

5.2 Standards

[5] IEC 60268-21: “Sound system equipment – Part21: Acoustical (output-based) measurements”, 2018, International Electrotechnical Commission

Find explanations for symbols at:
http://www.klippel.de/know-how/literature.html
Last updated: March 19, 2024
Designs and specifications are subject to change without notice due to modifications or improvements.