Nonlinear Residual Analyzer (NRL) S74

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

PRELIMINARY SPECIFICATION – PRODUCT IS STILL AWAITING FORMAL RELEASE

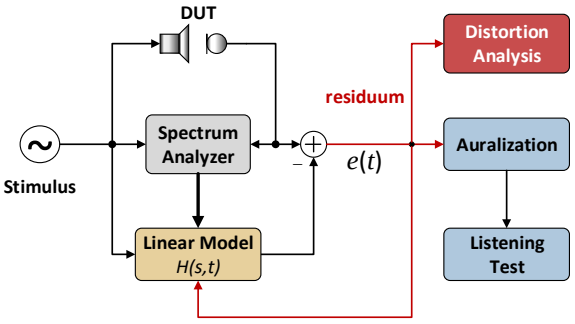
This specification is preliminary and is subject to change.

FEATURES

- Spectrum analyzer with an arbitrary stimulus (e.g. music)
- Signal monitoring and analysis
- Monitoring of time-variant and time-invariant linear transfer function
- Distortion separation (Nonlinear, Rub & Buzz)
- Listen to isolated distortion
- Amplitude compression

BENEFITS

- Combine measurement and listening
- Applicable to all audio systems
- Loudspeaker diagnostics
- Visualization and auralization of distortions
- Root cause analysis of loudspeaker defects



DESCRIPTION

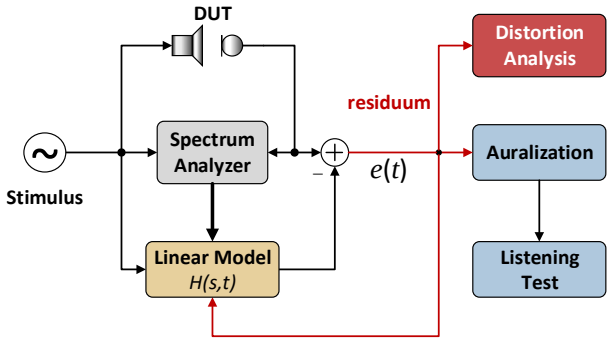
The Nonlinear Residual Analyzer (NRL) is a tool dedicated to analyzing audio signals or generic signal sources and determining their linear transfer function. The distortion to the determined linear relationship between two signals can be separated and analyzed. The distortion may also be listened to or amplified and added back to the measured signal to intuitively understand the effect of distortions introduced in loudspeaker systems.

Article number	

CONTENT

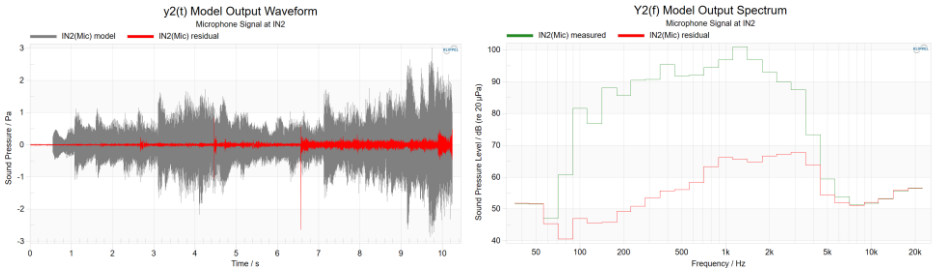
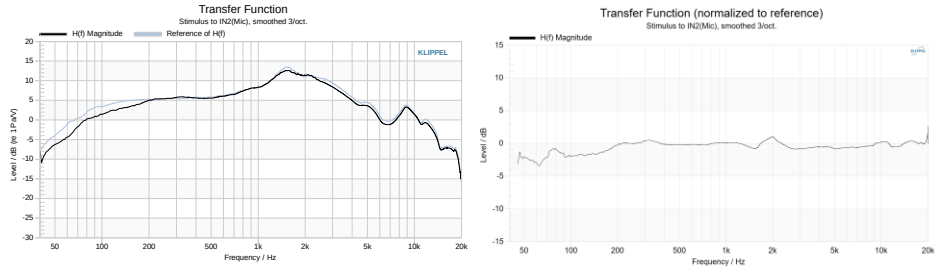
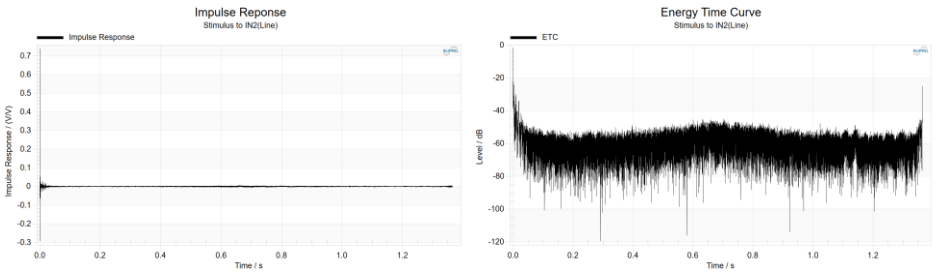
1 Overview

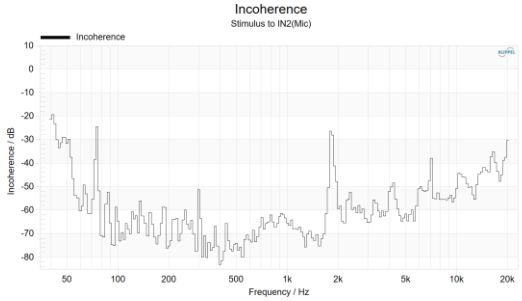
1.1 Principle



The Nonlinear Residual Analyzer is a tool dedicated to measuring active or passive audio systems with music, speech or any other test signal. Based on the monitored signals, the NRL determines the linear transfer function of the device under test adaptively and separates the linear response from distortion components (e.g. non-linear or Rub&Buzz). This combination of modern measurement and listening techniques (auralization) helps to understand and evaluate the sound quality of your audio product.

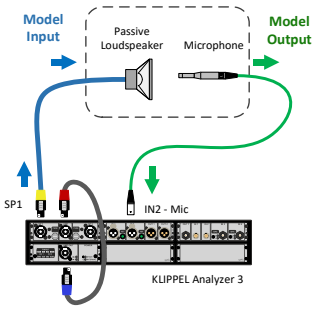
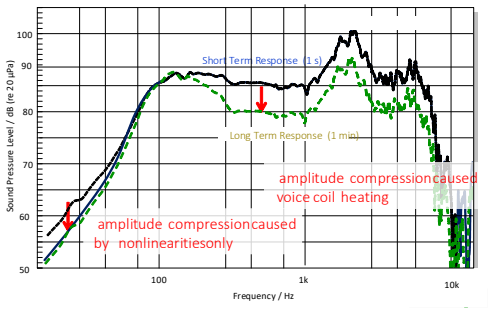
2 Results

Signal Characteristics	The waveforms of the measured, modelled and residual signal and the corresponding spectra are visualized. In addition, derived signal characteristics like peak value, rms value and envelope of the signal can be analysed. 
System Analysis	The NRL's modelling algorithm is identifying the linear transfer function of the system. This can be analysed absolutely or relative to a reference transfer function. This can be used to measure for example the effect of DSP or to monitor compression.  The NRL is also showing the corresponding time representation of the linear system (impulse response, energy time curve). 

Distortion Analysis	For audio system testing, incoherence is a very universal tool to evaluate non-linear signal distortion (e.g. Harmonics, IMD) generated by the DUT for any broadband test signal. 
Auralization	The modelled and the residual signal can be exported as wave files to be auralized by any 3rd party audio player. The level of the residual signal can be amplified or reduced to analyse the audibility of distortion and defects and to produce material for listening tests.

3 Applications

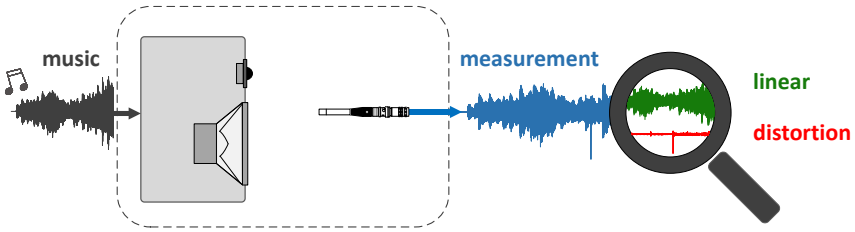
3.1 Transfer Function Learning

Identification and Monitoring	The NRL can be operated as a spectrum analyzer and beyond that, the transfer function between two signals is identified adaptively. That means, if the transfer function changes during the test, the modeling adjusts itself. This can be used to determine the long-term properties of loudspeaker systems.   Applications include the investigation of heating effects, the drift of transfer function and durability tests.

3.2 Distortion Analysis

Distortion separation and Auralization

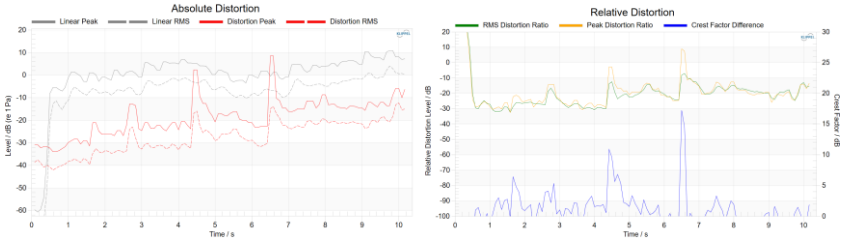
In addition to the transfer function, the NRL will separate a residual signal from a measurement based on a linear modelled signal.



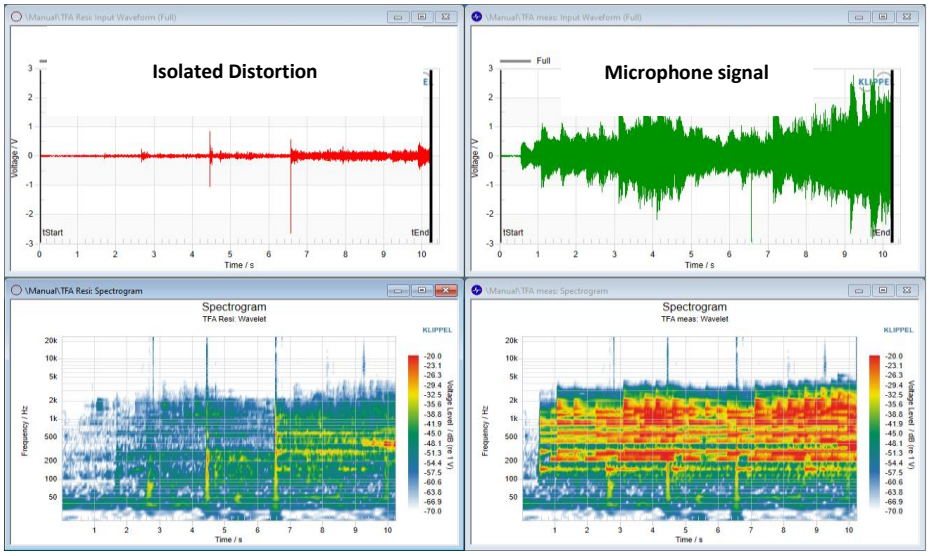
This residuum will contain all the nonlinear effects of the provided DUT and can be listened to. The residuum can also be amplified and added back to the linear modelled signal. Listening to this will provide an intuitive picture of how different nonlinear effects influence sound quality.

Defect Root-cause Analysis

The calculated residual signal can be further analyzed to identify different sources of distortions. Typical distortions include low-order distortions (harmonics, intermodulation) as well as impulsive distortions such as rub and buzz. The NRL has specific measures to quantify the amount of distortion.



In addition, the isolated distortion signal and linear signal are provided for further analysis e.g. with the TFA Time-Frequency Analysis



4 Requirements

4.1 Hardware

KLIPPEL Analyzer 3 (KA3)	Measurements with the Nonlinear Residual Analyzer are based on the KA3 platform. The schematic below shows a typical setup with Laser-Card, XLR-Card and Speaker-Card 
Microphone	A microphone sensor to analyze the acoustical output of the audio systems.
External Player [optional]	The NRL can be operated with an external player that produces the stimulus (e.g. broad-band noise or music)

4.2 Software

dB-Lab (>212.500)	Frame Software of the KLIPPEL R&D System

5 Limitations

5.1 Software

Real-time Processing	A continuous real-time mode is currently not supported yet. The NRL performs a block-based measurement with small recording gaps. The maximum recording time is currently 10 seconds.
Auralization Time	Only the latest captured block of max. 10s can be exported and auralized.
Measurement Signals	2 signals can be monitored at the same time.

6 Setup

6.1 Setup Parameter Limits

Parameter	Symbol	Min.	Typ.	Max.	Unit
MEASUREMENT MODES					
Measurement Mode	• Single measurement • Continuous Loop				
STIMULUS					
Stimulus	The stimulus can be generated by KA3 or played by an external player. External Source: Any signal (e.g. music) Internal Playback: White Noise, Pink Noise or Wav-File				
Sample Rate	f_A		48		kHz

Measurement Signal	The NRL can measure 2 signals simultaneously. The following signal are available: Stimulus(f) (only for internal stimulus) • IN1(f) Line/Mic • IN2(f) Line/Mic • U(f) Voltage • I(f) Current • X(f) Displacement				
Recording Block Length	T_{Rec}	1	3	10	s
PROCESSING & DISPLAY					
Learning Rate	μ	0	0.5	1	
Spectral Resolution	Δf	1	12		Point per oct.
Smoothing Bandwidth		1	12		Point per oct.
AURALIZATION					
Auralization Gain	S_{AUR}	-40	0	40	dB
Wave Export	The following signal can be exported as wav-files: • Linear Signal • Residuum * Gain • Linear Signal + Residuum * Gain				

Find explanations for symbols at:

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

Last updated: January 18, 2023

Designs and specifications are subject to change without notice due to modifications or improvements.