MSPM Pro C11

Micro Suspension Part Measurement

Module of the KLIPPEL ANALYZER SYSTEM (Document Revision 1.9)

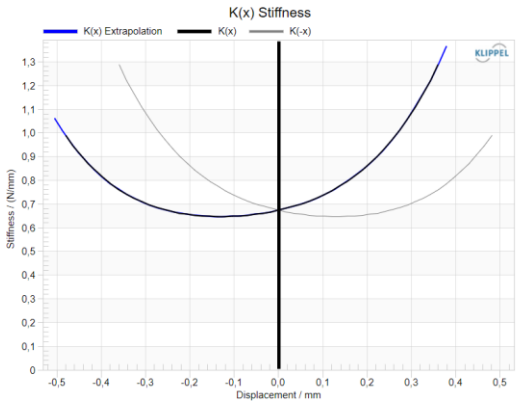
FEATURES

- Measurement of nonlinear stiffness $K(x)$
- Small diaphragms (diameter < 7 cm)
- Measurement of bare membranes without attaching a voice coil
- Suspension Parts of:

  micro-speakers, headphones, tweeters, microphones

BENEFITS

- Automatic measurement
- Nondestructive, dynamic method
- Specification of suspension parts
- Optimal driver design in R&D
- Testing before driver assembly



DESCRIPTION

The *MSPM Pro Micro Suspension Part Measurement* software module and hardware accessory for the KLIPPEL R&D System is designed for the measurement of the large signal stiffness of small suspension parts (micro-speakers, headphones, tweeters, microphones).

The membrane is excited passively by the sound pressure in a small pressure chamber. The nonlinear behavior of the stiffness is measured by monitoring the distortion in the displacement of the membrane.

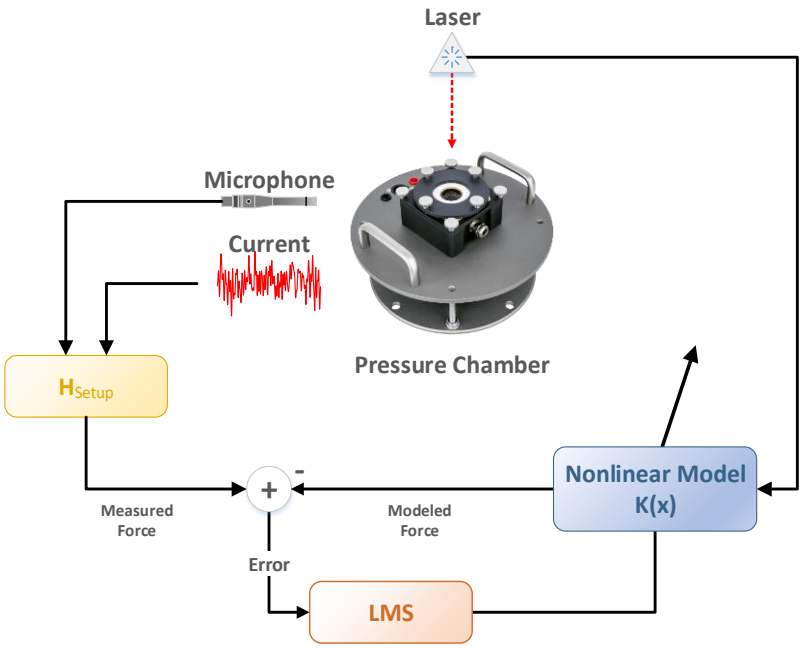
Article number	#2500-602

CONTENT

1 Overview

1.1 Principle

Measurement Principle



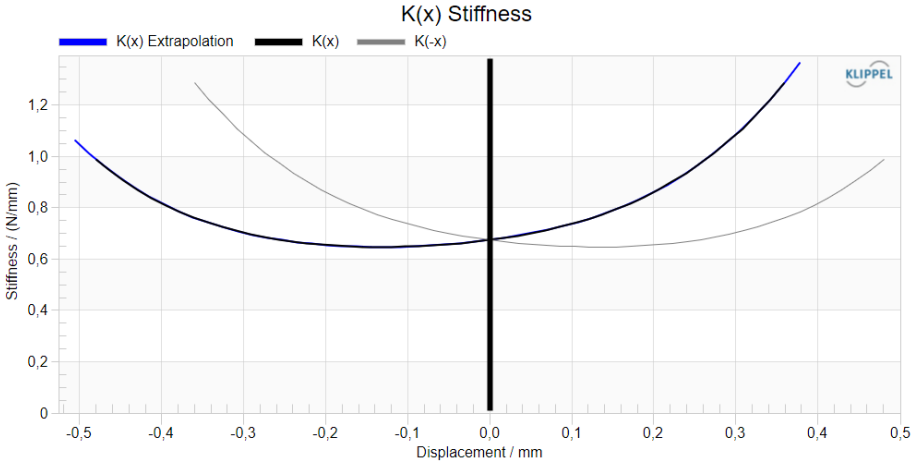
The *MSPM Pro Micro Suspension Part Measurement* identifies the nonlinear stiffness characteristic of small membranes. The device under test (DUT) is glued onto a DUT carrier plate, which is mounted in the *MSPM Bench*.

During the measurement, the membrane is excited by sound pressure in the small pressure chamber. Sound pressure *p* inside the pressure chamber, current *i* of the driving speaker, as well as the displacement *x* of the membrane is captured during the measurement. Using this information, the nonlinear stiffness behavior can be determined by using a fitting algorithm.

1.2 Results

***K*(*x*) over Displacement**

The nonlinear stiffness of the membrane *K*(*x*) is displayed as a curve. In addition, coefficients describing the corresponding regular power series can be exported and used in the *SIM Simulation* or *SIM-AUR Simulation / Auralization* module.



2 Requirements

2.1 Hardware

MSPM Bench (Art. #2500-604)	MSPM Bench comprises a small pressure chamber with a flexible clamping mechanism for micro suspension parts.	
Laser Stand	The MSPM Bench is designed to work with one of the following laser positioning devices • 3D Scanner (Scanning Vibrometer System SCN) (Item # 2510-004) • LST Bench (Item # 2500-310) + Translation Stage (Item # 2300-001) • Pro Driver Stand (Item # 2211-100) + Translation Stage (Item # 2300-001)	
Analyzer	Both the *Klippel Analyzer 3* and the *Distortion Analyzer* are supported to perform MSPM measurements. Both, the *ALS* (internal map) or LSX (for external amp) configuration of the KA3 are suitable.	
Laser Displacement sensor	A high-precision laser displacement sensor is required. It is recommended to use Keyence LK-H052 Laser sensor (Item # 2103-200).	
Microphone	A 1/4" microphone is required for sound pressure measurement in the pressure chamber. The recommended microphone is the MIC 40PP-10-S1 (Item # 2400-360).	
Amplifier	A power amplifier is required for performing the measurement. For operation with *KA3*, the internal Amp Card is recommended. For external amplifiers, refer to the Amplifier Requirements of the KLIPPEL Analyzer System.	
Computer	A personal computer is required for performing the measurement. Please refer to the general PC requirements of the KLIPPEL Analyzer System.	

2.2 Software

dB-Lab	The KLIPPEL dB-Lab R&D software from version 210.128 is required to run the MSPM Pro.
LPM Module	The MSPM Pro control and post-processing module is based on meaurements performed with the *Linear Parameter Measurement* (*LPM*) module for multitone measurements with the KLIPPEL Analyzer devices.
MSPM Lite (optional)	It is recommended to first determine the linear mechanical parameters using the *MSPM Lite Micro Suspension Part Measurement* module.

3 Limitations

3.1 Device Under Test

Parameter	Min	Typ	Max	Unit
Dimension	DUT Dimensions can be found in *A12 MSPM Bench*			
Resonance frequency	100		2500	Hz
Cone Breakup Frequency[1]	600			Hz

3.2 Sensors

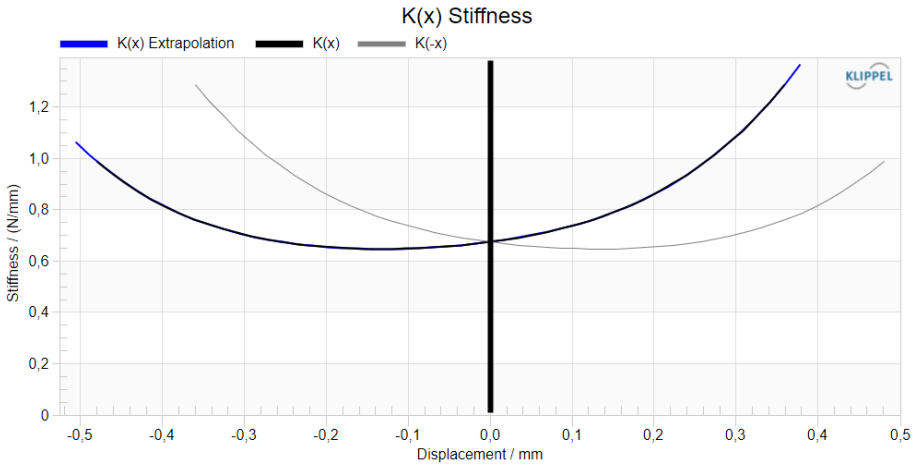
Laser	Laser limitations can be found in *A2 Laser Displacement Sensor*
Microphone	Microphone limits can be found in *A4 Microphones*

4 Outputs

4.1 Result Curves

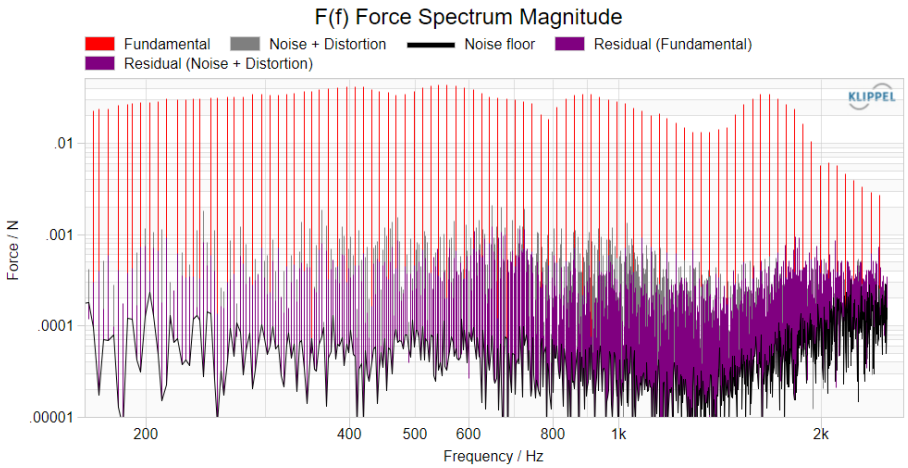
K(x) over Displacement

This curve shows the identified nonlinear stiffness *K*(*x*) of the suspension part.

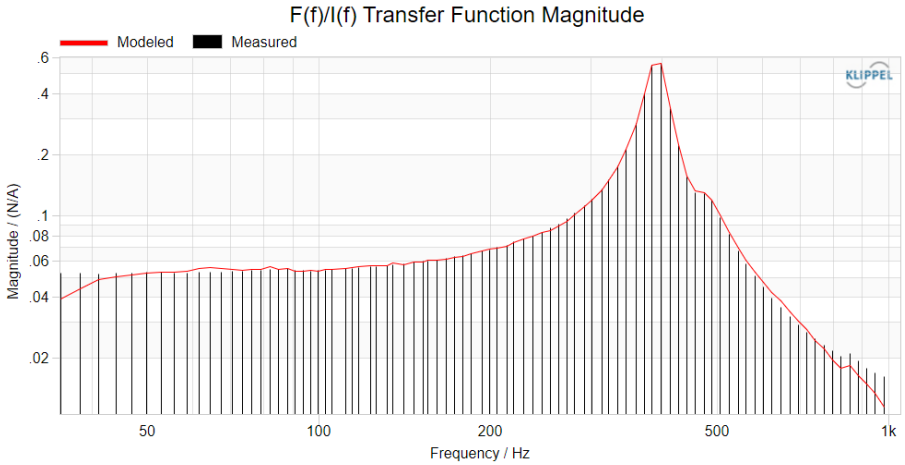
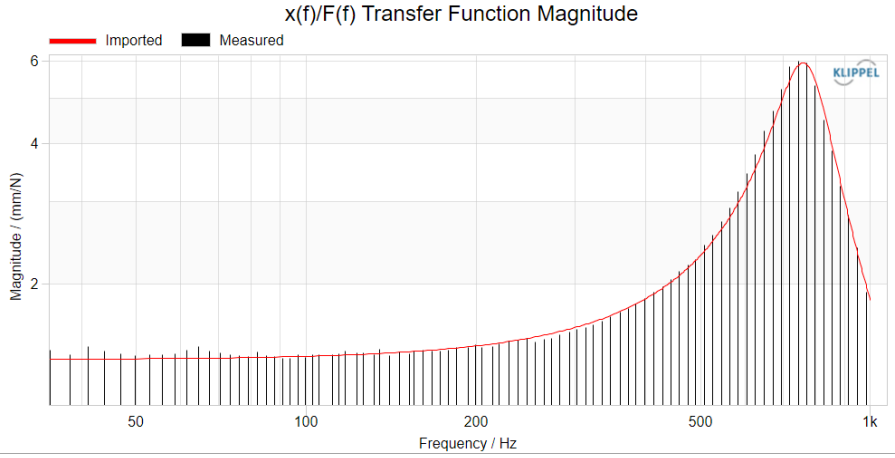


F(f) Force Spectrum Magnitude

This diagnostics window shows the forces *F* in frequency domain. The residual components are the base for derived fitting errors can be used to check fitting quality fitting of both linear and nonlinear parameters.



[1] Negligible partial vibrations below the stated frequency

F(f)/I(f) Transfer Function Magnitude	This diagnostics window shows the transfer function between current and force of the test bench. 
X(f)/F(f) Transfer Function Magnitude	This window shows the imported (MSPM Lite) and measured transfer function between force and displacement of the DUT. 

4.2 Result Parameters

Parameter	Unit	Description
k_1 … k_4	N/mm	Power series coefficients describing the nonlinear stiffness
$K(x=0)$	N/mm	Mechanical stiffness at rest position
R	kg/s	Mechanical resistance
m	g	Moving mass
E_{lin}	%	Linear error in force relative to stimulus signal F_{Stim}
Model Performance	dB	Performance of the nonlinear model
d_K	%	Ratio of the distortion in measured displacement
E_{Setup}	%	Error in measured transfer function

5 MSPM Bench Specification

5.1 Specification for 1.0 and above

5.1.1 Maximum/Minimum Ratings	Min	Max	Unit
Driver nominal impedance	8		Ω
Input voltage (continuous, < 40 s)		12	V
Input voltage (short term, < 5 s)		19	V

Driver used: 18 Sound 6ND410

6 References

6.1 Related Modules	• MSPM Lite – Micro Suspension Part Measurement Pro • SPM Lite/Pro – Suspension Part Measurement • QC LST – Linear Suspension Test
6.2 Manuals	• MSPM Manual
6.3 Specifications	• A12 MSPM Bench

Find explanations for symbols at:

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

Last updated: December 23, 2021

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

KLIPPEL MODULE OVERVIEW FOR MOVING PARTS MEASUREMENT

	SPM Lite	SPM Pro	MSPM Lite	MSPM Pro	QC LST Lite	QC LST Pro
R&D System	✓		✓		✓[5]	
QC System	-		-		*QC Basic* or *Standard*	
Base Module	TRF		TRF	LPM	-	
Analyzer Hardware	Distortion Analyzer 2 Klippel Analyzer 3 [5]		Distortion Analyzer 2 Klippel Analyzer 3 [5]		Klippel Analyzer 3 [5] QC Production Analyzer	
Test Bench	SPM or LST	SPM	MSPM[6]		LST, MSPM[6] or SPM[7]	
Laser Sensor (Default) (Measurement Range)	IL-030 (+/- 12.5 mm)	LK-H082 (+/- 18 mm)	LK-H052 (+/- 10 mm)		IL-065 (LK-H052[8]) (+/- 10 mm)	
Laser Sensors (Alternative) (Measurement Range)	LK-H022 LK-H052 LK-H082 LK-H152 LK-G32	LK-H052 (+/- 10 mm) LK-H152 (+/- 40 mm)	LK-H022 (+/- 3 mm) LK-H082 (+/- 18 mm) LK-G32 (+/- 5 mm)		LK-H022 LK-H052 LK-H082 LK-H152 LK-G32	
Microphone	✓	-	✓		Opt.	✓
Linear Parameters f_0, Q, k, c, m, r	✓	- (only k_{eff})	✓ (only effective)		✓ (*m* import, no *r*)	✓ (*m* & *k* relative, no *r*)
Nonlinear Parameters $K(x)$, $C(x)$	-	✓	-	✓	-	
Mass Import	✓	-	✓		✓	
Added Mass	✓	-	✓	-	-	
DUT Ø in mm	30 – 222[1] (490[2])	30 – 222[1]	< 70		30 – 222[1] (490[2]) <70[8]	
Frequency Range in Hz	1 – 100[4] (200[3])	1 – 100	100 - 2500		1 – 100[4] (200[3]) 100 – 2500[8]	

1) *Standard Ring Set*
2) *SPM Bench (with custom ring)*
3) *LST Bench*
4) *SPM Bench*
5) *Min. dB-Lab Release 210*
6) *MSPM Bench requires additional equipment for laser positioning (SCN Vibrometer, LST-Bench or Pro-Stand)*
7) *For DUTs with Ø >= 222 mm / <= 490 mm, customized clamping rings required*
8) *MSPM Bench*