MSPM Pro – Micro Speaker Suspension Part Measurement C11

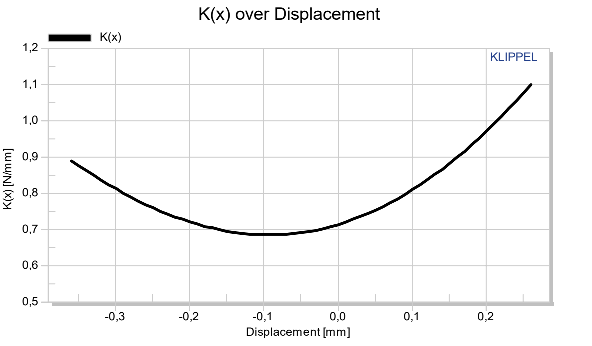
Specification to the KLIPPEL ANALYZER SYSTEM (Document Revision 1.2)

FEATURES

- Measurement of nonlinear stiffness K(x)
- Small diaphragms (diameter < 4 cm)
- Measurement of bare membranes without attaching a voice coil
- Nondestructive, dynamic method

APPLICATIONS

- Suspension Parts of:
  micro-speakers, headphones, tweeters, microphones
- Specification of suspension parts
- Optimal driver design in R&D



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.

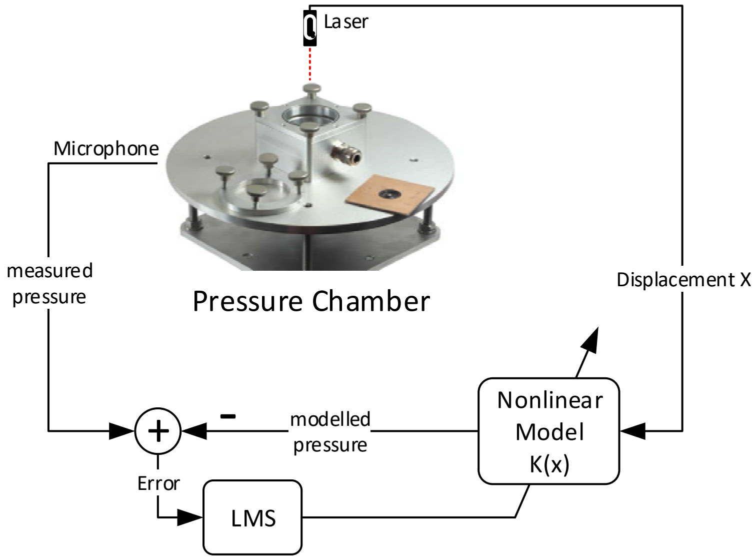
Article number	#2500-602

CONTENT

1 Principle

The membrane of the DUT is excited by the sound pressure of a small pressure chamber. The displacement of the DUT is measured with a laser sensor and the driving force F_{Stim} is anticipated by the measurement of the current of the driving speaker, and knowing the transfer function H_{setup} from current to force.
The algorithm fits the nonlinear model, by minimizing the error between the anticipated force F_{Stim} and the modelled force F_{Model}

Signal Flow



2 Components of the MSPM Pro

2.1 MSPM Pro

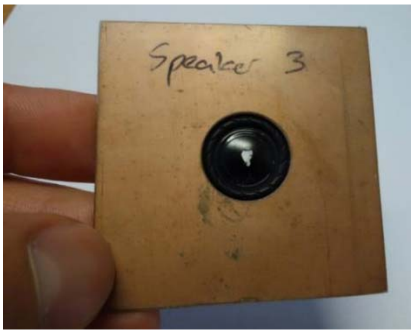
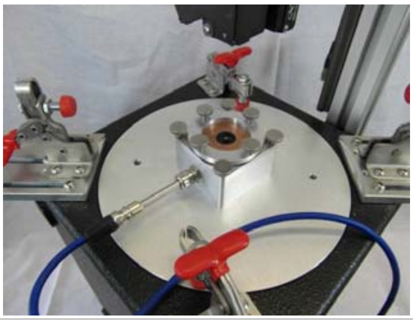
MSPM Pro Software	Micro Suspension Part Measurement Software for the measurement of nonlinear suspension part parameters
MSPM Lite Software	Micro Suspension Part Measurement Software for the measurement of linear suspension part parameters

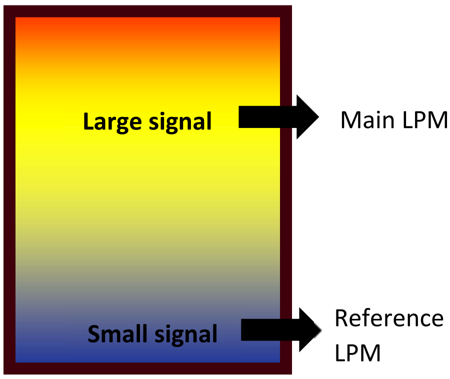
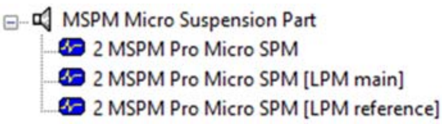
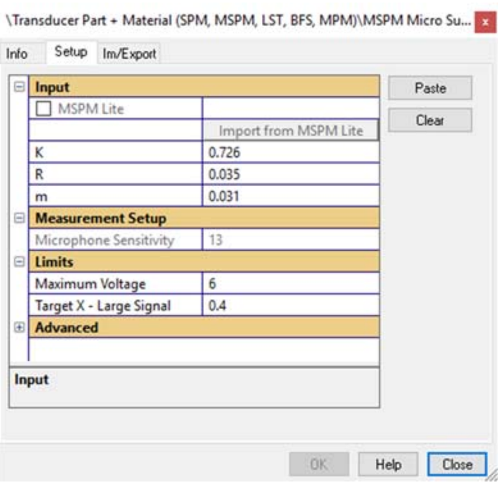
2.2 Additional Components required

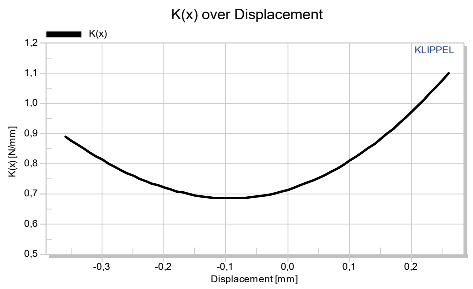
MSPM Bench (Art. #2500-601)	MSPM Bench comprises a small pressure chamber with a flexible clamping mechanism for micro suspension parts.	

<table>
<tr><td>Measurement Device</td><td>The Distortion Analyzer 1 or 2, or the Klippel Analyzer 3 are used as hardware to control the laser head and to perform the measurement.</td><td></td></tr>
<tr><td>dB-Lab (>210.124)</td><td colspan="2">Project Management Software of the KLIPPEL R&D SYSTEM.</td></tr>
<tr><td>LPM-Module</td><td colspan="2">Software Module for multitone measurements with the KLIPPEL Analyzer devices.</td></tr>
<tr><td>TRF-Module</td><td colspan="2">Software Module for Transfer Function Measurements with the KLIPPEL Analyzer devices.</td></tr>
<tr><td>Laser Stand</td><td colspan="2">The MSPM Bench is designed to work with one of the following laser positioning devices
3D Scanner (Scanning Vibrometer System SCN) (Art. #:2510-001)
LST Bench (Art. #: …) + Translation Stage
Pro Driver Stand (Art. #:2211-080) + Translation Stage (Art. #:2300-001)</td></tr>
<tr><td>Laser Displacement sensor</td><td colspan="2">A high precision laser displacement sensor is required. It is recommended to use:
Keyence LK-H052 Laser sensor (Art. #:2102-002)</td></tr>
<tr><td>Microphone</td><td colspan="2">A 1/4" microphone is required for sound pressure measurement in the pressure chamber. Recommended Product:
MIC 40PP-S1 (Art. #:2400-007)</td></tr>
<tr><td>Amplifier</td><td colspan="2">A power amplifier is required for performing the measurement.</td></tr>
<tr><td>Computer</td><td colspan="2">A personal computer is required for performing the measurement.</td></tr>
</table>

3 Measurement Procedure

<table>
<tr><td>Prepare the measurement Object</td><td></td><td>Before the measurement the membrane needs to be glued into a stiff plate with dimensions of 55 mm by 55 mm. (e.g. PCB Material).
Although the used technique can cope with significant air porosity of the membrane the area between plate and membrane should be as sealed as possible due to the pneumatic excitation and the necessary high sound pressures.</td></tr>
<tr><td>Prepare the measurement setup</td><td></td><td>Mount the plate with the DUT
Adjust the laser</td></tr>
</table>

Measurement of sound pressure and displacement		For the calculations the sound pressure inside the enclosure and the displacement of the DUT are needed. The LST Box is a possible stand for the measurement setup and the laser
Perform the Measurements	 	Use the LPM – Module to get the needed curves for the calculations. For the MSPM-Pro, 2 LPM operations are needed
Prepare the data extraction	 	Set correct names for the operations so that the CAL Module can identify them for extraction
Set the input parameters	 	Check the initialized parameter values and adjust them if needed

Run the MSPM Pro Module		Data is extracted automatically from former measurements and the results are shown.

4 Inputs

4.1 Input Parameters MAT-Module

Basic Settings

K	*[N/mm]*	Linear Stiffness, Optional if the MSPM Lite is used
R	*[kg/s]*	Linear mech. Losses, Optional if the MSPM Lite is used
m	*[g]*	Moving mass, Optional if the MSPM Lite is used

4.1.1 Advanced Settings

f_{max}	[Hz]	Upper limit of the fitting bandwidth
f_{min}	[Hz]	Lower limit of the fitting bandwidth. Cuts out low frequency disturbances like leakages of the membrane (default: automatic detection)
Model Order		Order of the nonlinear Model. Possible Values: 2, 4

4.2 Input Curves MAT-Module

4.2.1 Reference LPM

I(t)	[A]	Current at driving speaker terminals (extracted from LPM measurement)
U(t)	[V]	Voltage at driving speaker terminals (extracted from LPM measurement)
X(t)	[mm]	Displacement of the DUT (extracted from LPM measurement)
p(t)	[mV]	Sound pressure in the pressure chamber (extracted from LPM measurement)

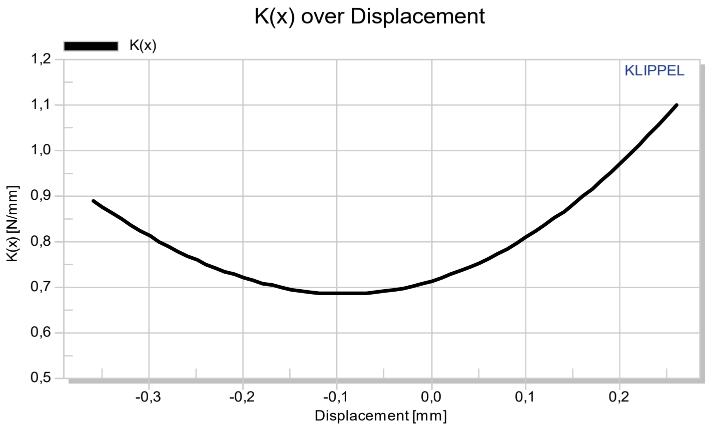
4.2.2 Main LPM

I(t)	[A]	Current at driving speaker terminals (extracted from LPM measurement)
U(t)	[V]	Voltage at driving speaker terminals (extracted from LPM measurement)
X(t)	[mm]	Displacement of the DUT (extracted from LPM measurement)
Displacement noise (f)	[mm]	Noise floor measured by the laser (extracted from LPM measurement)

5 Outputs

5.1 Result Curves

K(x) over Displacement



This curve shows the estimated K (x).
---- K (x) up to 90 % of the reached displacement
---- K (x) extrapolation up to 100 % of the reached displacement

5.2 Result Parameters

K (X=0)	[N/mm]	Mechanical stiffness at rest position
R	[kg/s]	Mechanical resistance
m	[g]	Moving mass
E_F	[%]	Residual error in force
E_{Model}	[%]	Residual nonlinear error
E_{Setup}	[%]	Error between the imported and measured transfer function of the DUT

A low fitting error (E_F) shows high accuracy of the parameter identification (it should be smaller than 10%). Additionally the setup error should be low to assure that the stimulating force is determined correctly.

6 Limits

Parameter	**Min**	**Typ**	**Max**	**Unit**
DUT[1]				
Resonance frequency	100		2500	Hz
Cone Breakup Frequency[2]	600			Hz

Find explanations for symbols at:
http://www.klippel.de/know-how/literature.html
Last updated: June 21, 2017

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[1] Find DUT Dimensions in *A12 MSPM Bench* Specification
[2] Negligible partial vibrations below the stated frequency