MSPM Lite – Micro Suspension Part Measurement C10

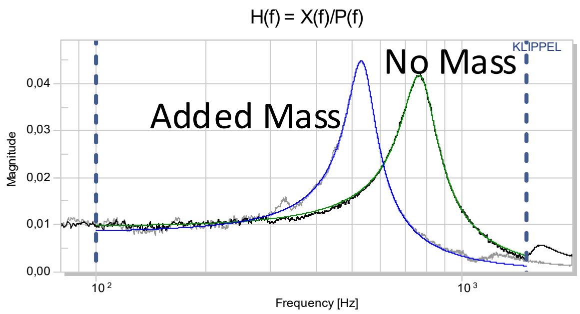
Specification to the KLIPPEL ANALYZER SYSTEM (Document Revision 1.2)

FEATURES

- Linear Parameter Measurement: Stiffness K, Moving Mass m, Mechanical Resistance R
- Resonance Frequency & Q-Factor
- Measurement of bare membrane without attaching to a voice coil

APPLICATIONS

- Micro-speakers, headphones
- Tweeters, microphones
- Specification of suspension parts
- Optimal driver design in R&D



Name	Value	Description
f_{reso}	797.8Hz	Resonance Frequency
Q	5.968	Quality Factor
m	.021 g	Moving Mass
C	1.924 mm/N	Mechanical Compliance
K	.520 N/mm	Stiffness
R	.017 kg/s	Mechanical Resistance

DESCRIPTION

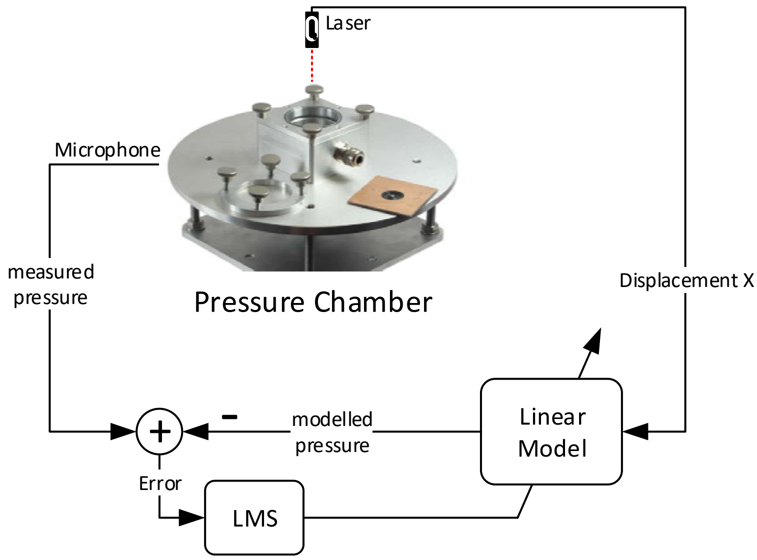
The MSPM Lite (Micro Suspension Part Measurement) software module and hardware accessory for the KLIPPEL R&D System is designed for the measurement of the small signal parameters of small suspension parts (Micro-speakers, headphones, tweeters, microphones).

The membrane is excited passively by the sound pressure in a pressure chamber and the linear parameters: resonance frequency, Q-factor, stiffness, moving mass and mechanical resistance are determined dynamically by a simultaneous measurement of displacement and sound pressure.

Article number	#2500-603

CONTENT

1 Principle

The membrane of the DUT is excited by the sound pressure in a small pressure chamber. The sound pressure inside the pressure chamber is measured with a microphone and the displacement of the DUT is measured with a Laser sensor. Then the transfer function from sound pressure to displacement is calculated. This transfer function is modelled with a spring mass system and fitted to the measured transfer function, deriving the resonance frequency and the quality factor. The linear parameters are determined by the measurement of the resonance shift when adding a known mass *(Added Mass Method)* or by calculating it from the known moving mass of the DUT.	
Signal Flow	

2 Components of the MSPM Lite

2.1 MSPM Lite

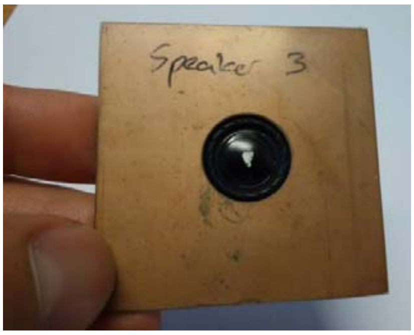
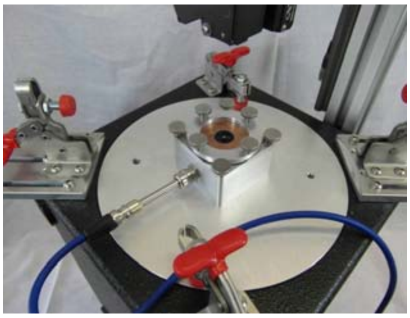
MSPM Lite Software	The Micro Suspension Part Measurement Software. Measurement of linear suspension part parameters.

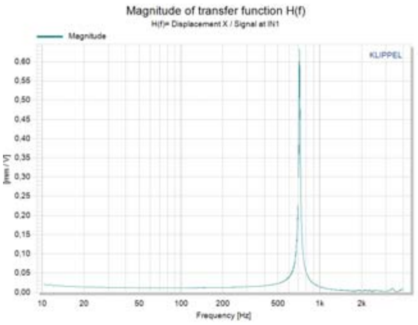
2.2 Additional Components required

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

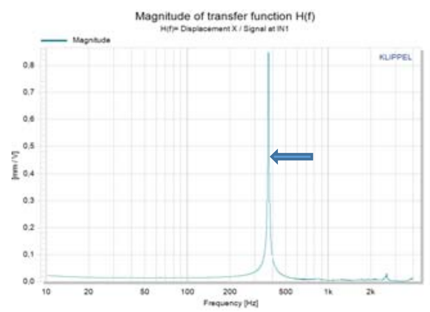
dB-Lab (>210.124)	Project Management Software of the KLIPPEL ANALYZER SYSTEM
TRF-Module	Software Module for Transfer Function Measurements with the Distortion Analyzer 1 or 2, or the Klippel Analyzer 3.
Laser Stand	The MSPM Bench is designed to work with one of the following laser positioning devices • 3D Scanner (Scanning Vibrometer System SCN) (Art. #:2510-001) • LST Bench (Art. #: 2500-310) + Translation Stage • Pro Driver Stand (Art. #:2211-002) + Translation Stage
Laser Displacement sensor	A high precision laser displacement sensor is required. It is recommended to use: • Keyence LK-H052 Laser sensor (Art. #:2102-080)
Microphone	A 1/4" microphone is required for sound pressure measurement in the pressure chamber. Recommended Product: • MIC 40PP-S1 (Art.: #2400-007)
Amplifier	A power amplifier is required for performing the measurement.
Computer	A personal computer is required for performing the measurement.

3 Measurement Procedure

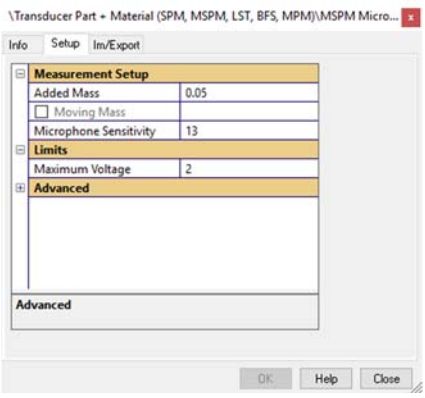
<table>
<tr>
<td>Prepare the measurement object</td>
<td>
</td>
<td>Before the measurement the membrane needs to be glued into a stiff plate with dimensions of 60 mm by 60 mm. (e.g. PCB Material)
Although the used technique can cope with significant air porosity of the membrane the area between plate 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>
<tr>
<td>Measurement of sound pressure and displacement</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Perform the main measurements</td>
<td>

Typical transfer function between displacement and sound pressure</td>
<td>Perform one or more TRF measurements with the TRF Module</td>
</tr>
</table>

<table>
<tr><td>Use added mass (optional)</td><td>

Resonance shift due to the added mass</td><td>Add some mass to the membrane and perform one or more TRF measurements.

If you know the moving mass of the DUT this step is not required.</td></tr>
<tr><td>Prepare the data extraction</td><td>
</td><td>Set correct names for the operations so that the MSPM Lite Module can identify them for extraction.</td></tr>
<tr><td>Set the input parameters</td><td>
</td><td>Set either the added mass or the known moving mass of the DUT.</td></tr>
<tr><td>Calculate Results</td><td><table>
<tr><th>Name</th><th>Value</th><th>Unit</th><th>Description</th></tr>
<tr><td>f_{reso}</td><td>896.39</td><td>Hz</td><td>Resonance Frequency</td></tr>
<tr><td>Q</td><td>3.74</td><td>-</td><td>Quality Factor</td></tr>
<tr><td>m</td><td>0.0176</td><td>g</td><td>Moving Mass</td></tr>
<tr><td>C</td><td>1.7872</td><td>mm/N</td><td>Mechanical Compliance</td></tr>
<tr><td>K</td><td>0.5595</td><td>N/mm</td><td>Stiffness</td></tr>
<tr><td>R</td><td>0.0265</td><td>kg/s</td><td>Mechanical Resistance</td></tr>
</table></td><td>The data is extracted automatically from former measurements and the results are displayed and available for export.</td></tr>
</table>

4 Inputs

4.1 Input Parameters

4.1.1 Basic Settings

Added mass	[g]	Not required if the moving mass is known
Moving mass	[g]	Use added mass if the moving mass is not known
f_{low}	[Hz]	Minimum frequency for parameter fitting
f_{high}	[Hz]	Maximum frequency for parameter fitting

4.2 Input Curves

Automatically extracted from the TRF operations

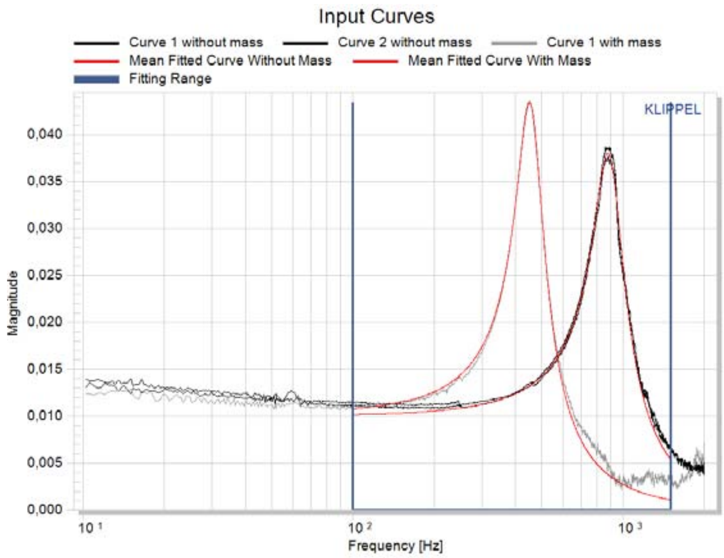
4.2.1 TRF without added mass

$H(f)_{no\ mass}$		$H_{X/P}(f) = \frac{displacement}{sound\ pressure}$ Magnitude of the transfer function between displacement and sound pressure without added mass
$H(f)_{mass}$		$H_{X/P}(f) = \frac{displacement}{sound\ pressure}$ Magnitude of the transfer function between displacement and sound pressure with added mass

5 Outputs

5.1 Result Curves

Input Curves



The *Input Curves* window shows the measured $H_{X/P}$ curves at multiple measurement points, with and without mass. The mean fitted curves are displayed and can be checked for proper fitting at the resonance peak.

5.2 Result Parameters

f_{reso}	[Hz]	Resonance frequency
Q		Quality factor
m	[g]	Moving mass
C	[mm/N]	Mechanical Compliance
K	[N/mm]	Stiffness
R	[kg/s]	Mechanical Resistance

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

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