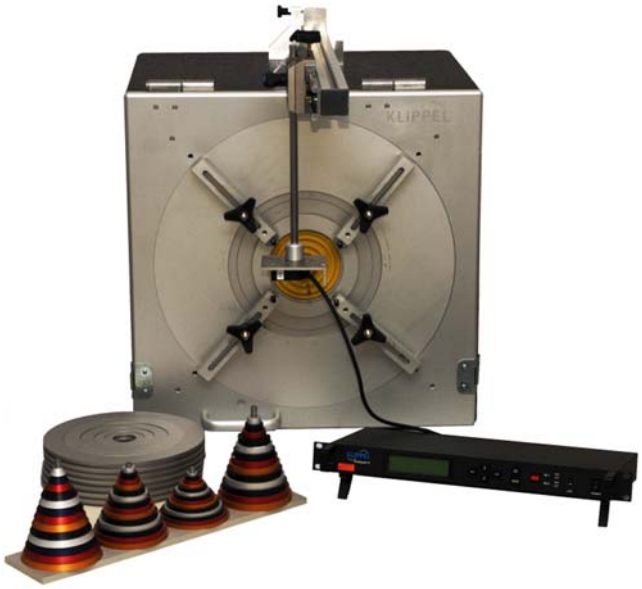
# Suspension Part Measurement Pro C2

Specification to the KLIPPEL ANALYZER SYSTEM

| FEATURES | APPLICATION |
|---|---|
| • Linear and nonlinear stiffness $K_{ms}(x)$<br>• Spiders, surround, cones<br>• Passive radiators (drones)<br>• Size from 1 – 8 inch<br>• Nondestructive, dynamic method<br>• Fast, robust, simple handling | • Specification of suspension parts<br>• Analysis of cause of distortion<br>• Defining mechanical limits<br>• Quality control in manufacturing<br>• Optimal driver design in R&D |




The nonlinear stiffness K(x) and the reciprocal compliance C(x) of suspension parts (spider, surrounds, cones) and passive radiators (drones) are measured versus displacement x over the full range of operation. A dynamic, nondestructive technique is developed which measures the parts under similar condition as operated in the loudspeaker. This guarantees highest precision of the results as well as simple handling and short measurement time. Suspension parts are fixed in the measurement bench by using a set of clamping parts (rings, cones, cups) fitting to any size of circular geometries up to 222 mm diameter. The working bench excites pneumatically the suspension to vibration at the resonance frequency related to the stiffness and the mass of the suspension and inner clamping parts. The nonlinear stiffness is calculated by the measured displacement (one-signal-method) by using modules of the KLIPPEL Analyzer System [1]. The measured parameter is required to specify the large signal properties of the suspension parts and to detect asymmetrical and symmetrical variations, which are the cause for instable vibration behavior and nonlinear distortion.

Additionally, the SPM Pro software includes the SPM Lite software, which calculates linear mechanical parameters of suspension parts and passive radiators (resonance frequency, Q-factor, stiffness, moving mass, mechanical resistance), accurately from the small signal displacement and sound pressure response.

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| Article Number: | 2500-102 (incl. 2500-103) |

**CONTENT:**



# 1 Accessories for SPM Pro

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| **SPM Pro Bench** (Art. #:2500-101) | The measurement bench consists of the clamping platform mounted on a sealed enclosure of 95-liter volume and a linear, long throw 18” driver which excites the suspension pneumatically. The clamping platform holds the high-polished center rod for guiding the inner clamping parts (slide, cup, cone and nuts), the fixture for clamping the outer rim by using rings and the laser stand. The clamping platform can easily be folded up in a horizontal position for charging but is used in a vertical position during measurement. The set contains the cable for connecting the measurement bench to Klippel measurement hardware.  |
| **SPM Pro Software incl. SPM Lite Software** (Art. #: 2500-102 incl. 2500-103) | A special Suspension Part Measurement Software for measuring the nonlinear stiffness using the one-signal method 0<br><br>Additionally, a special CAL Script is provided to calculate linear suspension parameters accurately from the small signal response using the two-signal method 0. |
| **Ring Set** (Art. #: 2500-302) | Multiple sets of clamping rings allow the attachment of almost all suspension parts with a circular geometry between 2 and app. 9 inch. After measuring the outer diameter and the width of the rim, the lower ring set and the upper clamping ring can be easily identified by using a table and nomenclature. The rings are made of 10 mm aluminum. Subsets of rings (to cover only selected sizes) or special forms (elliptic sizes) are available on request.  |

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| **Cup & Cone Set (metal)**<br>(Art. #: 2500-111) | The cone is used for clamping the inner rim of the suspension part nondestructively. Multiple cones are organized in a set with a simple nomenclature to cover from 14 - 111 mm diameters. Single cones are available on request.<br><br>The counterpart of the cone is the cup which clamps the inner rim. The cups are manufactured in multiple sets to give the user full flexibility over all sizes of suspension parts. Cup Set row A, row B and row C are included in the set. Special cups can be manufactured based on customer's specification.<br><br>  |

## 2 Additional Components required

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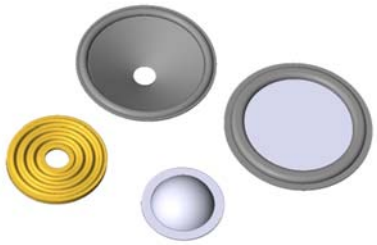
| **Measurement Platform** | The Distortion Analyzer 1 or 2, or the Klippel Analyzer 3 may be used as the hardware to control the laser head and to perform the measurement.<br><br>**Note:** If you are using a Klippel Analyzer 3, an additional license dongle will be provided.<br><br>  |
| **Sensor** | A displacement laser, which is usually available as standard equipment of the KLIPPEL R&D System measures the displacement of suspension at the required precision. Due to high displacements, the sensors have to have a large linear working range. Recommended types are:<br>• ANR 1282 plus Controller ANR5132 (discontinued)<br>• LK-H082 plus Controller LK-G5001P<br><br>  |
| **Software** | The Suspension part measurement also uses software modules of the KLIPPEL R&D System such as the frame software *dB-Lab* and the Transfer Function Module *TRF* |
| **Amplifier** | A power amplifier is required for performing the measurement. The amplifier should provide more than 200 W output power at 4 Ohm. |
| **Microphone (opt.)** | A quarter inch microphone is required for the linear suspension parameter measurement (SPM Lite) only to measure the sound pressure in the test bench. |
| **Computer** | A personal computer (not available from KLIPPEL) is required for performing the measurement. |

# 3 Objects

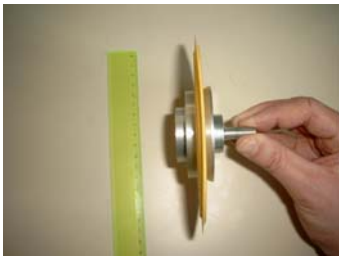


Suspension parts (spiders, suspensions, cone with suspensions) and passive radiators of circular geometries with a diameter up to 222 mm can be measured by using the small clamping set (rings, cups, cones). For particular objects with more complicated curvatures, unusual sizes or extremely small rims special clamping parts can be manufactured on customer's request. KLIPPEL may provide service based on detailed drawings.
Although the suspension is pneumatically excited, the technique used can cope with significant air porosity of the suspension.

# 4 Measurement Procedure

**Centre Clamping**

The measurement usually takes 5-10 minutes by performing the following steps:



1) Measure the inner and outer diameter
2) Look at the tables to find the optimal clamping parts using the nomenclature
3) Clamp the inner rim by using the slide, cone, cup and two nuts.

**Outer Clamping**

1) Bring the clamping platform into horizontal position for easy handling
2) Insert the set of lower rings into the clamping platform
3) Put the slide with the clamped suspension on the guiding rod
4) Fix the upper ring to clamp the outer rim
5) Bring the clamping platform into vertical position

**Measurement**

1) Fold down the laser rack and adjust the laser head
2) Start the measurement which takes a few seconds
3) Calculate the nonlinear stiffness
4) Print your report by using your customized template

# 5 Results


The figure shows the measured stiffness curve K(x) versus displacement. For a positive displacement x=+11 mm the stiffness is approximately 30 times higher than at the rest position x=0. Please note the distinct asymmetry of the curve. The stiffness at negative displacement x=-11 mm is only 16 % of the stiffness at positive displacement x=+11 mm. Under dynamic operation, an ac-signal is partially rectified and a negative dc-component is generated.

The dashed blue curve shows the mean stiffness of the suspension in the working range (-17 mm to 11 mm). This value depends on the amplitude and corresponds with the effective resonance frequency found in the large signal measurement.

# 6 Look up tables for small clamping set:

| Color | Number of the cone | Cone diameter $D_C$ (mm) | Name of the cup | Cup diameter $D_U$ (mm) |
|---|---|---|---|---|
| silver | 1 | 11 | A1 | 13,9 |
| | | | B1 | 16,8 |
| | | | C1 | 19,7 |
| blue | 2 | 18 | A2 | 20,9 |
| | | | B2 | 23,8 |
| | | | C2 | 26,7 |
| red | 3 | 25 | A3 | 27,9 |
| | | | B3 | 30,8 |
| | | | C3 | 33,7 |
| gold | 4 | 32 | A4 | 34,9 |
| | | | B4 | 37,8 |
| | | | C4 | 40,7 |
| black | 5 | 39 | A5 | 41,9 |
| | | | B5 | 44,8 |
| | | | C5 | 47,7 |
| silver | 6 | 46 | A6 | 48,9 |
| | | | B6 | 51,8 |
| | | | C6 | 54,7 |
| blue | 7 | 53 | A7 | 55,9 |
| | | | B7 | 58,8 |
| | | | C7 | 61,7 |
| red | 8 | 60 | A8 | 62,9 |
| | | | B8 | 65,8 |
| | | | C8 | 68,7 |
| gold | 9 | 67 | A9 | 69,9 |
| | | | B9 | 72,8 |
| | | | C9 | 75,7 |
| black | 10 | 74 | A10 | 76,9 |
| | | | B10 | 79,8 |
| | | | C10 | 82,7 |
| silver | 11 | 81 | A11 | 83,9 |
| | | | B11 | 86,8 |
| | | | C11 | 89,7 |
| blue | 12 | 88 | A12 | 90,9 |
| | | | B12 | 93,8 |
| | | | C12 | 96,7 |

| Name of the ring | $D_R$ (mm) |
|---|---|
| A1 | 30 |
| B1 | 33 |
| C1 | 36 |
| D1 | 39 |
| E1 | 42 |
| F1 | 45 |
| G1 | 48 |
| H1 | 51 |
| A2 | 54 |
| B2 | 57 |
| C2 | 61 |
| D2 | 65 |
| E2 | 69 |
| F2 | 73 |
| G2 | 77 |
| H2 | 81 |
| A3 | 85 |
| B3 | 89 |
| C3 | 93 |
| D3 | 98 |
| E3 | 103 |
| F3 | 108 |
| G3 | 113 |
| H3 | 118 |
| A4 | 124 |
| B4 | 130 |
| C4 | 136 |
| D4 | 142 |
| E4 | 148 |
| F4 | 154 |
| G4 | 160 |
| H4 | 166 |
| A5 | 173 |
| B5 | 180 |
| C5 | 187 |
| D5 | 194 |

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|---|---|---|---|---|
| red | 13 | 95 | A13 | 97,9 |
| | | | B13 | 100,8 |
| | | | C13 | 103,7 |
| gold | 14 | 102 | A14 | 104,9 |
| | | | B14 | 107,8 |
| | | | C14 | 110,7 |

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| E5 | 201 |
| F5 | 208 |
| G5 | 215 |
| H5 | 222 |

# 7 SPM Pro Bench Specification

| | Minimum | Typical | Maximum |
|---|---|---|---|
| Height in mm | | 570 | |
| Width in mm | | 570 | |
| Depth in mm | | 470 | |

# 9 References

W. Klippel, "Dynamical Measurement of Loudspeaker Suspension Parts", Convention Paper, 117th AES Convention, October 2004, San Francisco

C7 – Suspension Part Measurement Lite, product specification

# 10 Patents

| | |
|---|---|
| **GERMANY** | 102007005070 |
| **USA** | 8,078,433 |
| **CHINA** | ZL200810092055.4 |
| **JAPAN** | 5364271 |

Find explanations for symbols at:

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

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