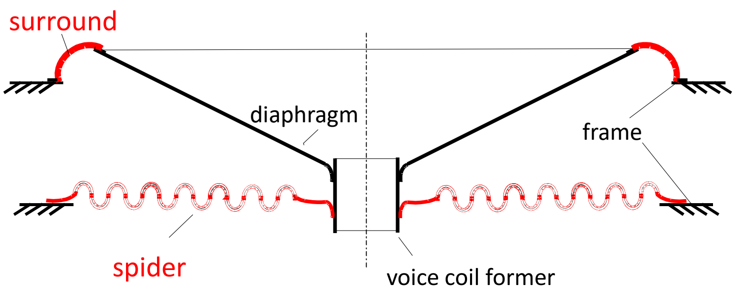
Spider and surround separation AN2

Application Note for the KLIPPEL ANALYZER SYSTEM

Document Revision 1.1

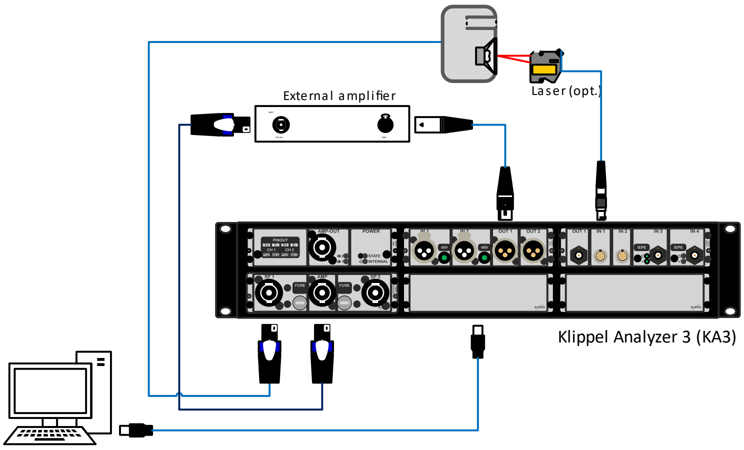
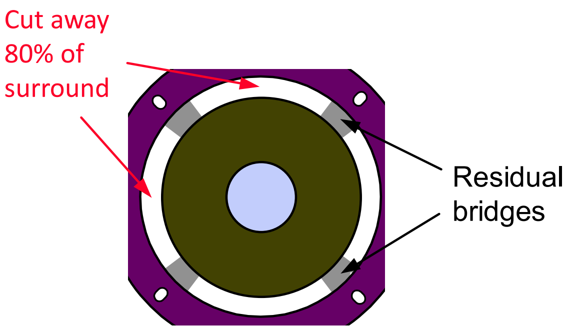
DESCRIPTION

Using the Large Signal Identification module of the Klippel Analyzer System, the nonlinear characteristic of the mechanical stiffness of the transducer can be measured. This parameter represents the total mechanical stiffness of the suspension system (spider and surround). In this application note, a procedure is described that demonstrates how the total stiffness can be separated into its individual contributing components. Although this procedure is destructive, the valuable information obtained enables the designer to improve the overall linearity of the suspension system by specifically addressing the stiffness properties of each component. Two examples are examined that employ post-processing to calculate the surround characteristic. These examples represent typical cases for diagnosing and optimizing suspension designs.



CONTENT

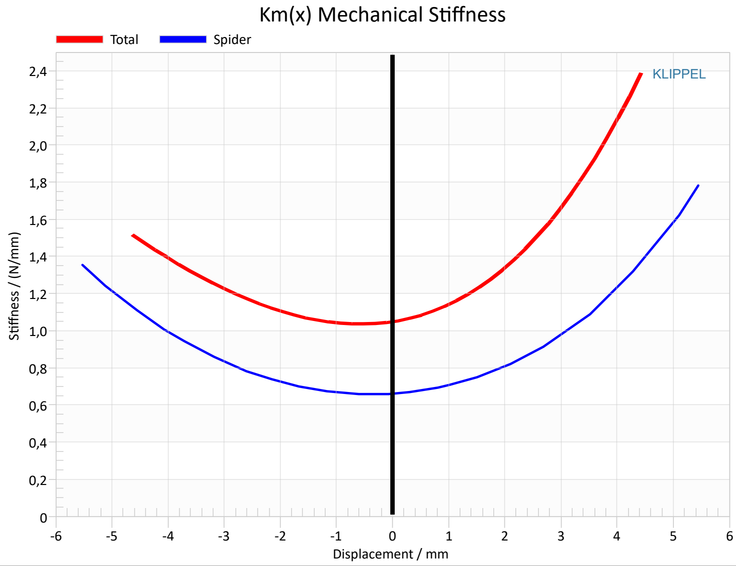
1 Measurement of nonlinear suspension

Requirements	• Klippel Analyzer (KA3) + PC • External amplifier or internal AMP-Card of KA3 • Laser sensor • dB-Lab software • Fast Large Signal Identification (FLSI) or Large Signal Identification (LSI3) • Programmable Post Processing (PPP)
Setup	• Connect external power amplifier or use internal AMP-Card of KA3 • Mount DUT and connect terminals with speaker output of KA3 • Connect laser with laser input of KA3 and adjust beam to diaphragm of the speaker 
Preparation	Create a new measurement object template “Separate Suspension - AN2” provided in the dB-Lab object templates. Adjust the setup parameters according to the requirements of your selected DUT (more information in FLSI manual or LSI3 manual).
Measurement	1. Operate DUT in free air and start large signal operation for total suspension 2. After the measurement has been completed, disconnect the DUT and carefully cut away approximately 80-90% of the surround. It is sufficient to leave four residual bridges. The exact number and width of these bridges will depend on the suspension’s ability to keep the diaphragm properly centered. This may be challenging if the surround contributes significantly to the overall stiffness of the suspension. Therefore, it is advisable to proceed in several stages when cutting. Begin by removing about 50% and then increase the removed portion in increments of 10-15%, carefully checking proper suspension operation at each step until 80-90% of the surround has been removed. 3. Start large signal measurement operation for spider only 4. Open result window “Km(x) Mechanical Stiffness” for both operations and compare curves 

2 Postprocessing and interpretation

<table>
<tr>
<td>Stiffness

$K_m(x)$ of suspension and spider only</td>
<td>The total stiffness is reduced by the surround cutting process. If the stiffness curve of the spider closely matches the total stiffness curve, this indicates that the spider is the dominant contributor to the system's stiffness. This can be an acceptable design, provided that the spider's stiffness characteristic does not exhibit any asymmetries. In some cases, this observation alone is sufficient to identify the spider as the root cause of the problem. If this is confirmed, the designer should focus on improving the spider design accordingly.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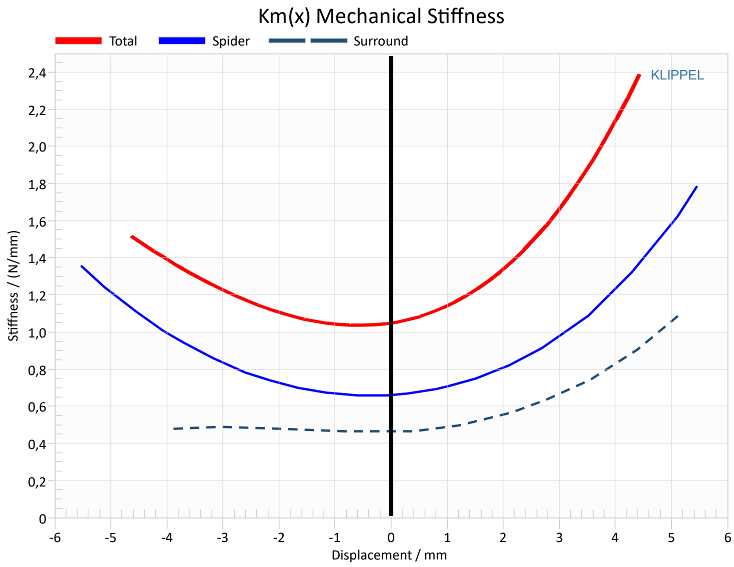
<tr>
<td>Stiffness of surround calculation</td>
<td>The contribution from the surround may be determined by subtracting the spider stiffness from the total stiffness. To determine the stiffness of the surround in dB-Lab, perform the following steps:
1) Select PPP operation, open property page "Input" and change the "Cut Ratio" according to your measurement
2) Using the template, the stiffness curves from the two LSI measurements are automatically imported into the PPP operation. The curve assignments can be adjusted at the property page "Input", for example if the LSI operations have been renamed.
3) Run the PPP operation



The graph compares all three stiffness curves, which allows a detailed investigation of the separated contributions towards the total stiffness.
Note: The remaining surround material will partially influence the spider stiffness characteristic. However, in most cases, the surround is softer than the spider resulting in a minor influence.</td>
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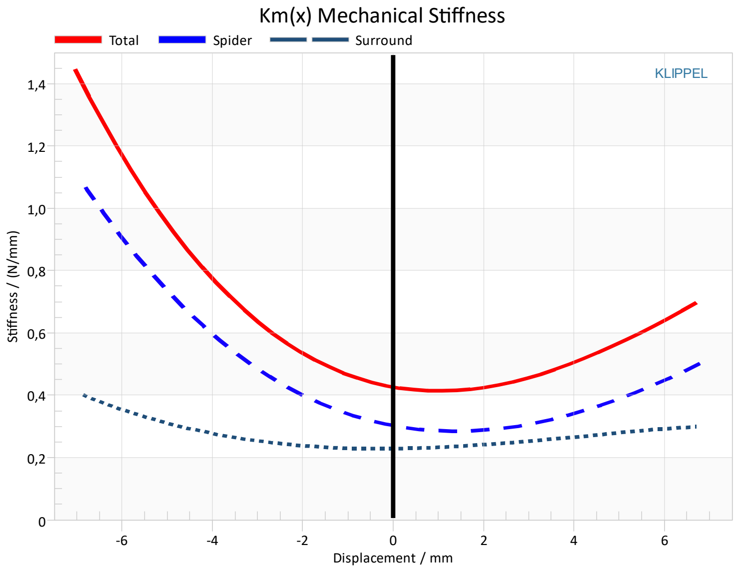
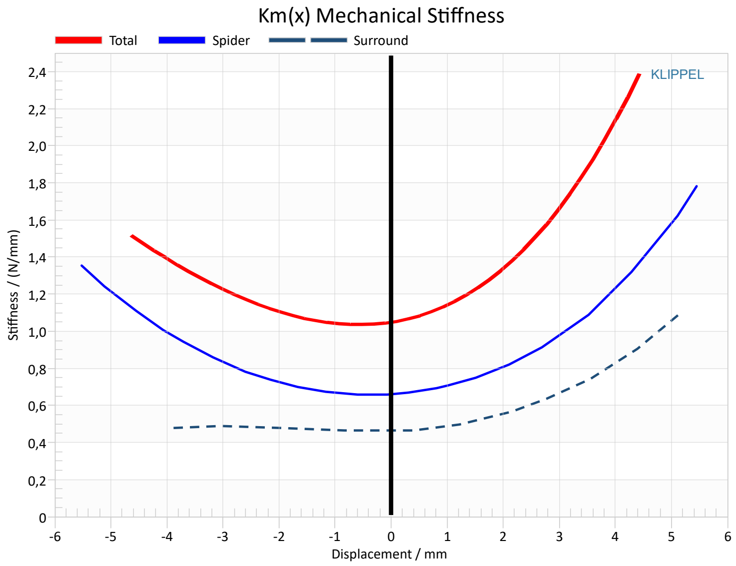
3 Examples

Dominant spider asymmetry	In this example, the surround shows a very flat compliance characteristic and is considerably softer than the spider. As a result, the asymmetry of the total suspension stiffness is dominated by the spider, while the surround has only a minor influence. When the driver is operated in the large-signal domain, the spider material reaches its point of lowest stiffness at approximately 1 mm outward from the rest position. This effect can be reduced by using a spider with a different geometry. 
Dominant surround asymmetry	In this example, the asymmetry in the total stiffness is mainly caused by the mechanical limiting of the surround during positive displacements. The excessive stress on the surround at positive displacements may cause permanent damage to the surround material. This problem is fixable by adjusting the rest position of the surround with respect to the spider. This can be achieved by positioning the diaphragm further down on the voice coil former, closer to the spider. For further details on improving suspension linearity, refer to application note [AN3 Adjusting the mechanical suspension]. 

4 More Information

Application Notes	Adjusting the mechanical suspension, Application Note AN3
Related Specification	Fast Large Signal Identification (FLSI), Specification FLSI Linear Parameter Measurement, Specification LPM Large Signal Identification (LSI3), Specification LSI3 Klippel Analyzer 3 (KA3), Specification H3 Laser displacement sensor, Specification A2
Manuals	User Manual Fast Large Signal Identification User Manual Large Signal Identification User Manual Linear Parameter Measurement
Paper	Klippel, Wolfgang. "Diagnosis and remedy of nonlinearities in electrodynamical transducers." *Audio Engineering Society Convention 109*. Audio Engineering Society, 2000.

Find explanations for symbols at:
http://www.klippel.de/know-how/literature.html
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