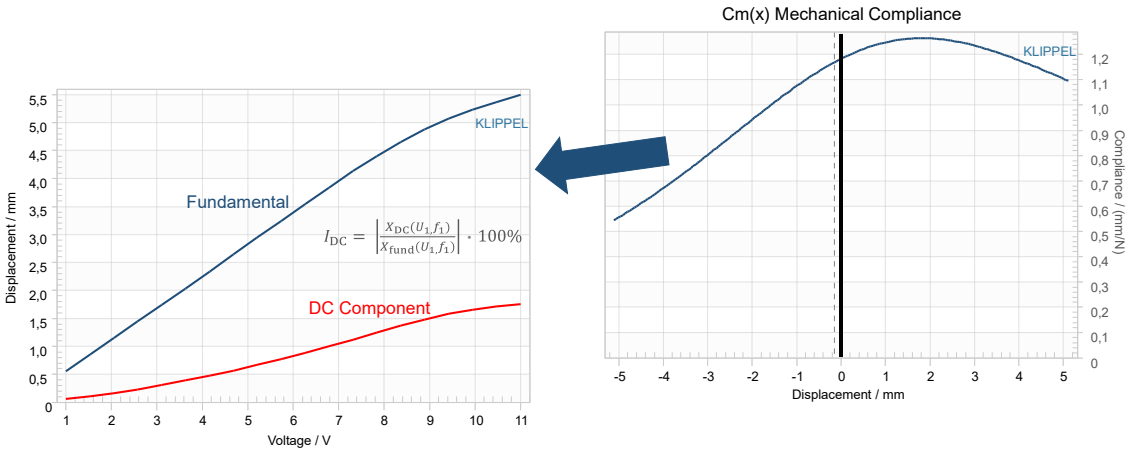
Checking for compliance asymmetry AN15

Application Note to the KLIPPEL R&D system (Document Revision 1.2)

DESCRIPTION

A mechanical suspension having an asymmetrical compliance characteristic will partly rectify the signal and will produce a DC component in voice coil displacement. This DC part may move the coil away from the optimal rest position of the coil in the magnetic field and deteriorate the performance of the speaker. Using the 3D Distortion Measurement (DIS) of the Klippel Analyzer System, a simple test can be performed for checking the asymmetry of the suspension. Different ways for improving the suspension are discussed.



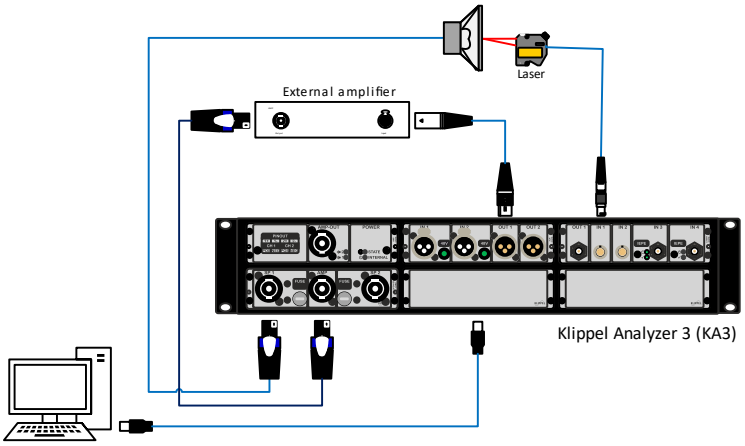
CONTENTS:

1 Compliance asymmetry

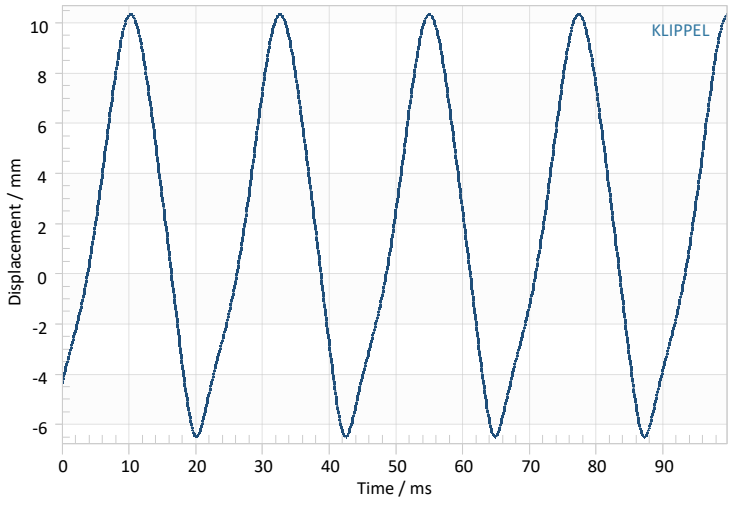
Effect	Any asymmetry in the nonlinear characteristic of the electrical and mechanical parameters produces a high magnitude of second-order distortion and a DC component of the displacement. The DC component produced by the nonlinear compliance of the suspension will always move the coil into a direction where the total effective compliance is maximal (softest point). If the driver exhibits a symmetrical compliance $C_{ms}(x)$ characteristic, it has a stabilizing effect for the driver by keeping the coil at the rest position. However, if the maximum of the curve $C_{ms}(x)$ is not at the rest position of the coil or if the curve is asymmetrical at higher amplitudes, a DC component is generated. This deteriorates the performance of a good motor having a symmetrical force factor characteristic $Bl(x)$ and the maximum at the optimal rest position.
Critical frequency	A critical excitation tone for a driver with asymmetries in the compliance is the resonance frequency. Here the AC part of the displacement is high and the rectification of the displacement results in significant second-order harmonic distortion as well as the generation of a DC component. In addition, the input current is minimal at the resonance. Nonlinearities such as inductance $L(x)$ and force factor $Bl(x)$ cannot produce a significant DC component. That's why the measurement with fixed frequency at resonance and variable amplitude is a good check for the symmetry of the suspension.
Critical ratio	The ratio between DC displacement and magnitude of fundamental displacement is a critical measure for the stability of the driver. $$I_{DC} = \left\| \frac{X_{DC}(U_1, f_1)}{X_{fund}(U_1, f_1)} \right\| \cdot 100\%$$ A value of $I_{DC} < 10$ % indicates that the driver is sufficiently stable.
Remedy	There are several ways to improve the symmetry of compliance: • Measurement of the large signal parameters in connection with a FEM program for modeling mechanical structures reveals the constructional cause of the asymmetry • Comparing the results of the measurements with complete and partly removed surround shows the defective part which should be replaced and optimized (see AN2 Spider and Surround Separation)

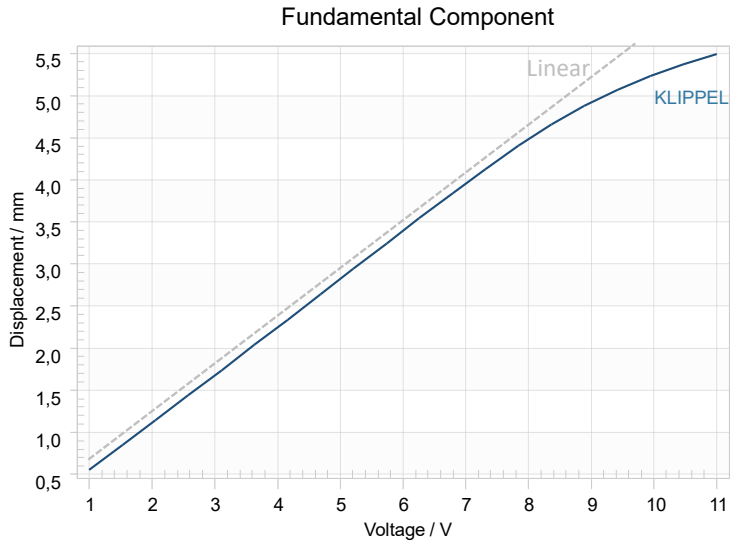
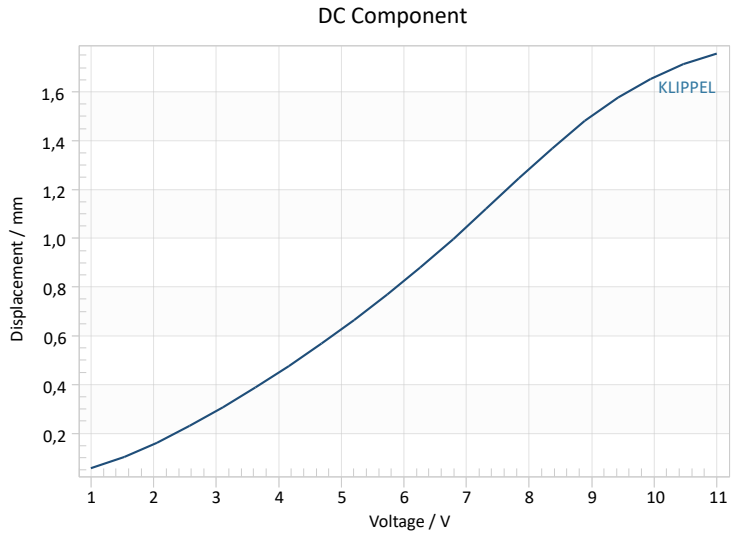
2 Measurement

Requirements	• Klippel Analyzer (KA3 or DA2) + PC • Laser sensor • dB-Lab Software • DIS software module Note: The resonance frequency of the driver must be known for the DIS measurement. For this purpose, the Linear Parameter Measurement (LPM) or Fast Large Signal Identification (FLSI) of the Klippel Analyzer System can be used.
Setup	• Connect external power amplifier or use internal AMP-Card of KA3 • Mount DUT to the driver stand and connect terminals with speaker output of Klippel Analyzer • Connect laser with laser input of Klippel Analyzer and adjust beam to diaphragm of the speaker Note: A dot of white ink shall be used to increase the signal to noise ratio of the measured displacement signal.

	
Preparation	Create a new operation based on the operation template “DIS Compliance Asymmetry AN15” provided in the dB-Lab operation template.
DIS measurement	1. Open the property page “Stimulus” of the DIS operation, make sure the stimulus level is appropriate for your DUT 2. Set the stimulus frequency to resonance frequency 3. Start the measurement 4. Open the windows “Fundamental” and “DC Component”. Check the results and calculate the critical ratio I_{DC} Note: If the measurement is paused and the warning “Excessive distortion in the displacement signal” is shown, stop the measurement and reduce the stimulus voltage at the property page “Stimulus”. Otherwise, if the total harmonic distortion in displacement is much less than 10 %, then you may increase the voltage and restart the measurement.

3 Example

Waveform	The result window “y2(t) Input Waveform” displays the displacement versus time of the last measured point. In this example, a positive DC component is generated moving the coil about 2 mm to positive directions. This offset shifts the voice coil out of the symmetrical magnetic field and will produce second-order intermodulation of any high frequency tone in the pass band of the driver. y2(t) Waveform 

Fundamental displacement	The result window “Fundamental” shows the displacement versus amplitude U_1. At lower amplitudes there is an almost linear relationship between input and output amplitude. At the voltage U_1 = 8 V the suspension starts to limit the peak displacement. 
DC component	The result window “DC Component” shows the DC Displacement generated dynamically versus voltage. The DC component grows up with input voltage, moving the coil more and more to the compliance maximum. At U1 = 11 V rms, the critical ratio I_{DC} is about 32 % which is a critical value for compliance asymmetries. By increasing the input voltage further, the DC displacement would be reduced, where the suspension would limit the positive and negative excursion symmetrically. 

4 More Information

Application Notes	Separating Spider and Surround, Application Note AN 2 Dynamic Generation of DC Displacement, Application Note AN 13 Motor Stability, Application Note AN 14
Related Specification	3D Distortion Measurement (DIS), Specification DIS Klippel Analyzer 3 (KA3), Specification H3 Laser displacement sensor, Specification A2 Linear Parameter Measurement (LPM), Specification S2 Fast Large Signal Identification (FLSI), Specification S75
Manuals	User Manual 3D Distortion Measurement

Find explanations for symbols at:

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

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