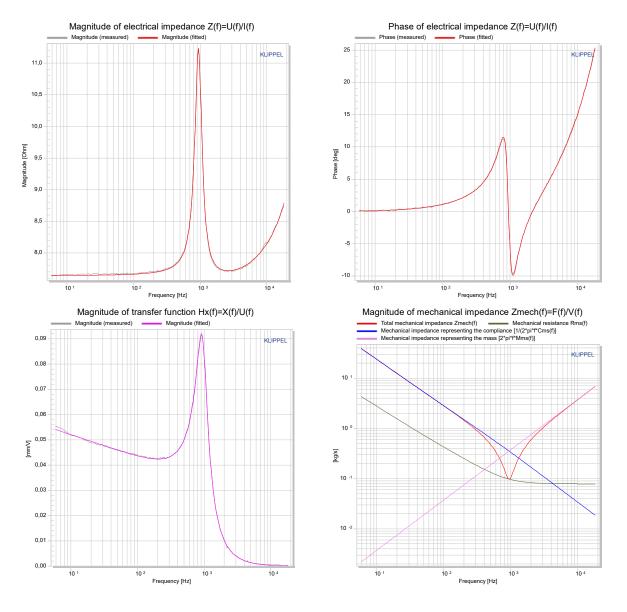
Extended Creep Modeling



Application Note to the KLIPPEL ANALYZER SYSTEM (Document Revision 1.1)

This application note gives an outline how to deploy the Extended Creep Modeling (ECM) tool to estimate linear transducer parameters with a more sophisticated model for the creep of the suspension. The tool offers an improved fitting algorithm and two additional models for the creep of the suspension. This application note shows how to perform a parameter-identification and explains the new models as well as the associated result windows.



CONTENT

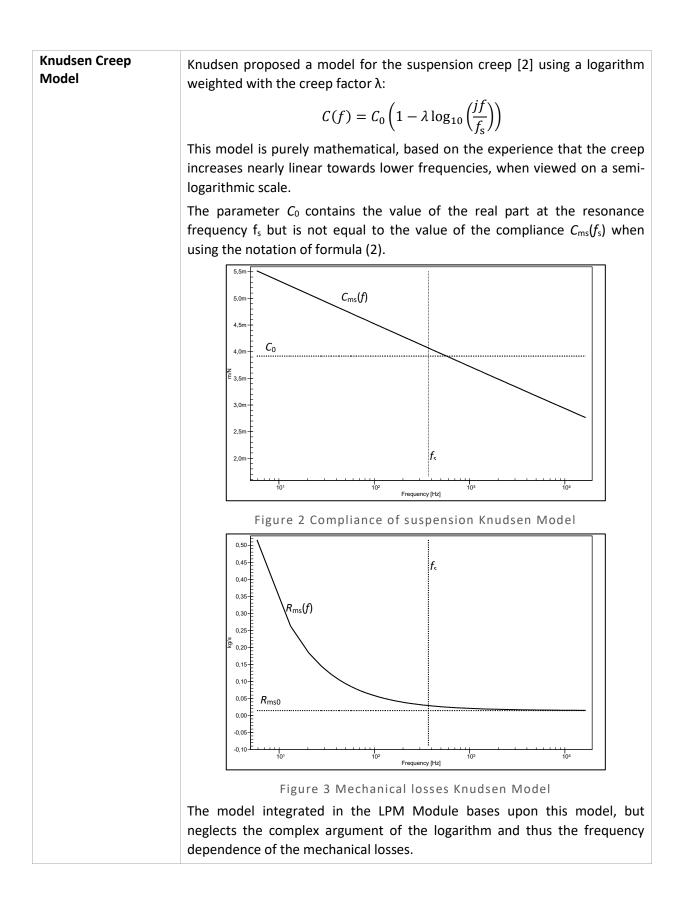
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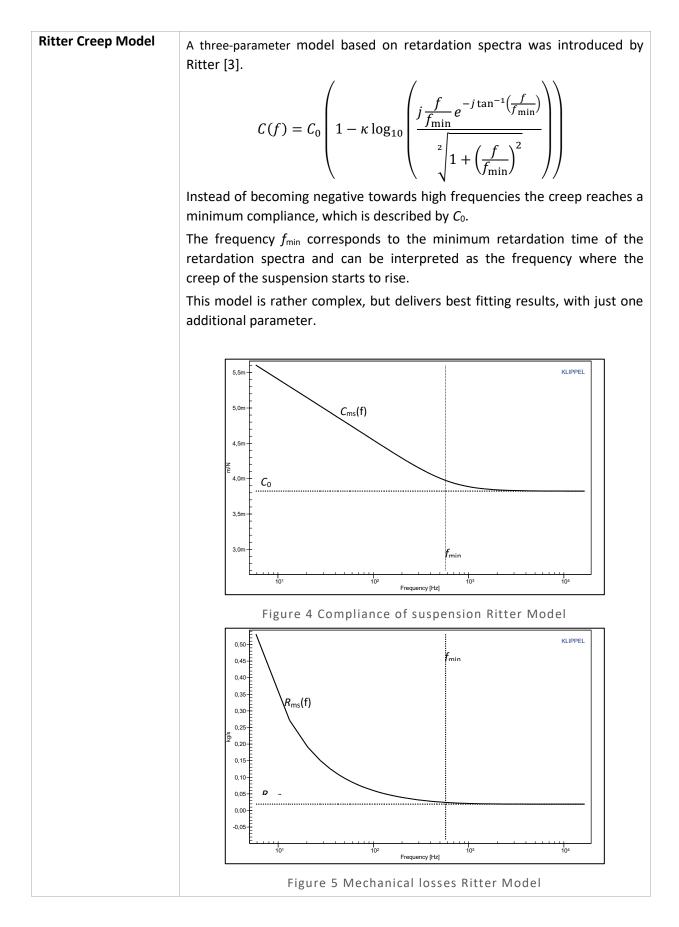
Background 1

Introduction	The traditional Thiele Small Loudspeaker Model considers the compliance of the suspension (C_{ms}) and the mechanical losses (R_{ms}) constant parameters. Taking the creep effect of the suspension into account, these parameters become frequency dependent. The current Klippel LPM module (version 210) offers a creep model with a frequency dependent compliance increasing towards lower frequencies, but still constant losses:
	$C_{\rm ms} = C_{\rm ms}(f_{\rm s}) \left[1 - \lambda \log_{10} \left(\frac{f}{f_{\rm s}} \right) \right] $ (1)
	This simple model delivers good results for speakers with low creep effect, but yields fitting results of limited accuracy for speakers with a high creep effect. The main improvement of this script is the introduction of two extended creep models, for modeling high creep effect.
Complex Compliance	Both new models consider the compliance $C(f)$ to be complex. Thus interpreting the compliance as a spring is not expressive expression.
	interpreting the compliance as a spring is not appropriate anymore. Splitting the complex impedance of the compliance Z_c into its real and imaginary part makes it possible to consider it to be a series connection of a spring and a dashpot:
	$Z_{\rm C} = \frac{1}{j2\pi f C(f)} = \frac{1}{j2\pi f C_{\rm ms}(f)} + R_{C_{\rm ms}}(f) $ (2)
	with
	$C_{\rm ms}(f) = \frac{{\rm abs}^2\{\mathcal{C}(f)\}}{\Re\{\mathcal{C}(f)\}} \tag{3}$
	and
	$R_{\rm Cms}(f) = \frac{-\Im\{C(f)\}}{2\pi f * abs^2\{C(f)\}} $ (4)
	The dashpot modeling the frequency dependent losses of the suspension $R_{C_{\rm ms}}(f)$ can be added to the constant losses $R_{\rm ms0}$, which results into the total mechanical losses $R_{\rm ms}(f)$. Thus the equivalent circuit of the transducer will remain the same, just considering the losses and the compliance to be frequency dependent.
	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$
	Figure 1 Equivalent electrical circuit used as linear transducer model





AN49



2 Application

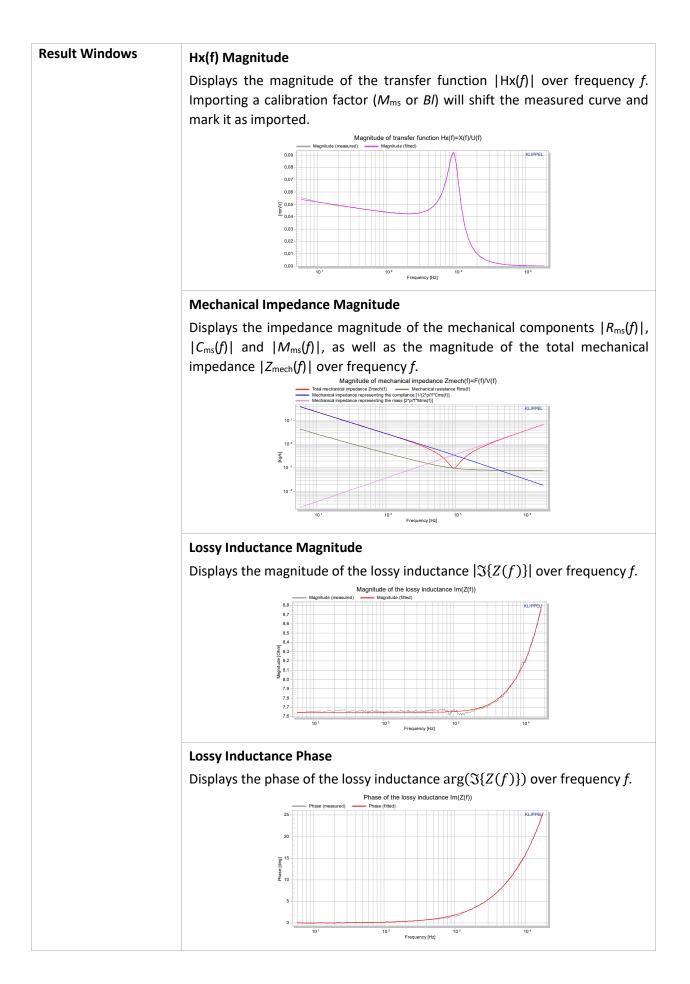
Requirements	Running the tool requir	es dB-Lab 210.6xx, as	well as the LPM Module.		
		uding the electrical i	sured LPM data to estimate the impedance $(Z(f) = U(f)/I(f))$ of the transducer.		
Setup	To use the <i>Extended Creep Modeling</i> , create a new object and select the <i>Extended Creep Modeling AN49</i> template. Conduct the <i>LPM T/S parameter</i> as usual to gain the source data for. Please [8] for further information.				
	Before running the <i>Extended Creep Modeling</i> , open the properties page and set the input parameters. See the next section for further information.				
		ransducer Diagnostics\1 Example - 4	Micro-Speaker in sealed e ×		
			Paste		
		select Operation Name 1a LPM T/S parameter Signal Hx(f)	Clear		
	Calibrate I Model				
	Measurem Inductanc Creep Mo	e Model LR2			
	Press to choo	e an LPM operation			
			OK Help Close		
Input Parameters			rements, hence a joined air volume eters of the creep model.		
	Select Operation LPM Operation Name	Operation used dialogue or directly	for post-processing, set via by name.		
	Import Re		resistance at DC, importing this the fitting of all parameters		
	Calibrate H _x (f) with Force Factor (BI) ¹	Calibrates the abs transfer function	solute value of the measured		
	Calibrate H _x (f) with Mass (Mms) ¹	•	ension, calibrates the absolute red transfer function		
	Measurement		and exported parameters. See D for further information abou		

 $^{^{\}rm 1}$ Importing one of this calibration factors will lead into shifting the measured Hx curve in the result window



Input Parameters	Inductance Model	Inductance model used for the post processing. Available values:
		 none: considers the inductance to be a constant parameter Le: LR2: shunted inductor model Leach: two parameter model by Leach Wright: four parameter model by Wright Thorborg: five parameter model by Thorborg see [4]
	Creep Model	Models the creep effect of the transducer at low frequencies. Available models:
		 none: compliance is real and constant Log: simple, real logarithmic creep model
		 Knudsen: complex logarithmic creep model by Knudsen Ritter: complex creep model by Ritter
Result Windows		· · ·
	There are no difference	e of electrical impedance <i>Z</i> (<i>f</i>) over the frequency <i>f</i> . es compared to the illustration in the LPM module.
	Electrical Impedance P	
		he electrical impedance $\arg(Z(f))$ over the frequency f . es compared to the illustration In the LPM module.
	Phase 25 20 15 15 5 5 -10 -5 -10 -10 -10 -10	Phase of electrical impedance Z(f)=U(f)/I(f) (meaured) Phase (fited)







Result Windows	Mechanical Comp	oliance		
		-	e mechanical compliance $ C_{ms}(f) $ over the	
	frequency f. Lin	ear value <i>C</i> r	$_{ns0}$ and cutoff frequency f_{min} are marked,	
	depending on the	used model.		
			Mechanical Compliance Cms(f)	
	0.7	Compliance Cms(f)		
	0.6- 0.5-			
	0.3- ق ^{0.4-}	Cins0 = 0.47 mm/N		
	0,2-	-		
	0,1-			
		10 '	10 ² 10 ³ 10 ⁴ Frequency [Hz]	
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	Table Linear Para	meters		
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3 More Information

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