MMT Multipoint Measurement Tool S59

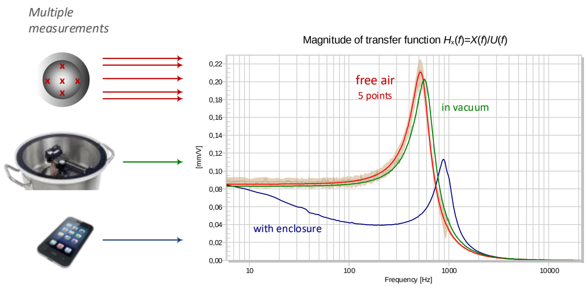
Module of the KLIPPEL ANALYZER SYSTEM (Document Revision 1.0)

FEATURES

- Cope with rocking modes
- Advanced micro-speaker modeling
- Separation of air and enclosure load
- Pure mechanical parameters

BENEFITS

- Automatic post-processing
- Increased accuracy of parameter identification
- Advanced creep models
- Investigate the influence of air and enclosure load



DESCRIPTION

The *MMT Multipoint Measurement Tool* performs post-processing, using the results of multiple *LPM Linear Parameter Measurement* operations. By using this data set, the accuracy of the parameter identification can be increased. To compensate for rocking modes and other irregular vibration, spatial averaging of the voice coil displacement is used.

If additional measurements in vacuum and/or in the final enclosure are performed, pure mechanical parameters of the transducer separated from the acoustical elements can be determined. Using advanced creep models (e.g. Ritter), significant visco-elastic behavior of micro-speaker can be identified.

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CONTENT

1 Overview

1.1 Principle

Measurement Principle	The *Multipoint Measurement Tool* offers acquisition of precise T/S-parameters by evaluating a set of *LPM* taken from one transducer. Measurements taken in air, vacuum and with an attached load (e.g. an enclosure) can be used. Thus, the load as well as the impact of air to the transducer can be calculated, displayed and evaluated. Especially the estimation of the force factor *Bl* with a laser measurement is very prone to resonant modes of the transducer, since the estimation is directly proportional to the displacement of the membrane. Displacement measurements taken on different points of the membrane can be averaged to improve the accuracy of the measured force factor *Bl*, and derived parameters.

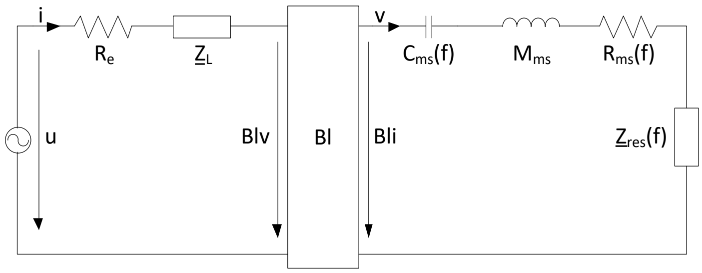

Figure 1: Equivalent electrical circuit for air measurements

Measurement Types	Measuring the speaker in air, the mechanical parameters R_{ms}, C_{ms} and M_{ms} represent both mechanical as well as acoustical qualities. To measure the pure mechanical and electrical parameters, a vacuum measurement neglecting all influences of air can be performed. By attaching a load to a transducer, it will add a mechanical (e.g. adding a panel to a shaker) or an acoustical system (e.g. adding a horn to a compression driver) or a mixture of both. All three kinds of measurements are supported.

1.2 Results

T/S-Parameters	Spatial averaged Thiele/Small-Parameters, to cope with Rocking Modes and other irregular vibration.
Mechanical Compliance (frequency)	Frequency dependent mechanical compliance $C_{ms}(f)$ (in air) or $C_{md}(f)$ (in vacuum, preferred).
Creep Model	The *Multipoint Measurement Tool* offers advanced creep models, which aid to identify significant visco-elastic behavior of micro-speakers.
Load Separation	Mechanical Impedance with separated load (if load data is present), which helps to get an outline of the connected load and the influence on the transducer

2 Requirements

2.1 Hardware

Analyzer	*Klippel Analyzer 3* or the *Distortion Analyzer 2* is the hardware platform for the measurement modules performing the generation, acquisition and digital signal processing in real time.	

Vacuum Measurement Kit [optional]	The *Vacuum Measurement Kit* allows the measurement of electro-acoustical transducers in vacuum. This allows to measure the properties and parameters of the electro-mechanical system without disturbance by effects caused by air.	
Laser Displacement Sensor	A high precision laser displacement sensor is required. It is recommended to use: • Keyence LK-H052 Laser sensor (Art. #:2103-200) • Keyence LK-H082 Laser sensor (Art. #:2103-300)	
Amplifier	A power amplifier is required for performing the measurement.	
Computer	A personal computer is required for performing the measurement.	

2.2 Software

dB-Lab (>210.560)	dB-Lab is the project management software of the KLIPPEL R&D SYSTEM. The current *MMT* version is based on the new framework version and will require at least dB-Lab 210.560.
LPM	The *LPM Linear Parameter Measurement* identifies the electrical and mechanical parameters of the electro-dynamical transducer. Multiple *LPM* measurements are the basis for the *MMT* post-processing.

3 Output

3.1 Result Curves

Z_e(f) Magnitude	Magnitude of the measured / fitted electrical impedance
Z_e(f) Phase	Phase of the measured / fitted electrical impedance
H_x(f) Magnitude	Magnitude of the measured / fitted transfer function $H_x(f) = X(f) / U(f)$
Z_{mech}(f) Magnitude	Magnitude of the measured / fitted mechanical impedance components
Z_{mech}(f) Magnitude (load separation)	Magnitude of the separated driver + air / load. Only available if load separation possible.
Z_{mech}(f) Phase (load separation)	Phase of the separated driver + air / load. Only available if load separation possible.
Mechanical Compliance	Magnitude of the mechanical compliance, depending on the chosen model.

3.2 Result Parameters

Parameter	Unit	Description
R_e	Ω	DC resistance of driver voice coil
L_e	mH	Lumped elements of para-inductance
L_2	mH	
R_2	Ω	
K	-	Parameters of the *Leach* inductance model
N	-	
K_{rm}	-	Parameters of the *Wright* inductance model
E_{rm}	-	
K_{xm}	-	
E_{xm}	-	
R_{es}	Ω	Electrical resistance due to mechanical losses in free air
R_{ed}	Ω	Electrical resistance due to mechanical losses in vacuum
C_{mes}	µF	Electrical capacitance representing moving mass in free air
C_{med}	µF	Electrical capacitance representing moving mass in vacuum
L_{ces}	mH	Electric inductance representing driver compliance in free air
L_{ced}	mH	Electric inductance representing driver compliance in vacuum

Parameter	Unit	Description
f_s	Hz	Driver resonance frequency in free air
f_d	Hz	Driver resonance frequency in vacuum
Q_{tps}	-	Total quality-factor considering all losses in free air
Q_{tpd}	-	Total quality-factor considering all losses in vacuum
Q_{ms}	-	Mechanical quality-factor measured in free air considering R_{ms} only
Q_{md}	-	Mechanical quality-factor measured in vacuum considering R_{md} only
Q_{es}	-	Electrical quality-factor measured in free air considering R_e only
Q_{ed}	-	Electrical quality-factor measured in vacuum considering Re only
Q_{ts}	-	Total quality-factor measured in free air considering R_{ms} and R_e
Q_{td}	-	Total quality-factor measured in vacuum considering R_{md} and R_e only
M_{ms}	g	Mechanical moving mass of driver diaphragm assembly including voice coil and air load
M_{md}	g	Mechanical moving mass of driver diaphragm assembly including voice coil without air load
C_{ms}	mm/N	Mechanical compliance of driver suspension measured in free air
C_{md}	mm/N	Mechanical compliance of driver suspension measured in vacuum
K_{ms}	N/mm	Mechanical stiffness of driver suspension measured in free air
K_{md}	N/mm	Mechanical stiffness of driver suspension measured in vacuum
R_{ms}	kg/s	Mechanical losses of driver in free air
R_{md}	kg/s	Mechanical losses of driver in vacuum
Bl	N/A	Force factor (Bl product)
λ	-	Suspension creep factor
κ	-	Creep factor of the Ritter creep model
f_{min}	Hz	Frequency representing the minimum retardation time of the Ritter creep model

4 References

4.1 Related Modules	LPM
4.2 Manuals	MMT Manual
4.3 Publications	▪ W. Klippel and U. Seidel, “Fast and Accurate Measurement of Linear Transducer Parameters,” presented at the 110th Convention of the Audio Engineering Society, Amsterdam, May 12-15, 2001, preprint 5308 ▪ M.H. Knudsen and J.G. Jensen, “Low-Frequency Loudspeaker Models that Include Suspension Creep,” J. Audio Eng. Soc., vol. 41, pp. 3-18, (Jan./Feb. 1993) ▪ F. Agerkvist and T. Ritter, “Modelling Viscoelasticity of Loudspeaker Suspensions using Retardation Spectra,” presented at the 129th Convention of the Audio Engineering Society, San Francisco, November 4-7, 2010, preprint 8217
4.4 Application Notes	AN50 Multipoint Parameter Fitting and Load Separation

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

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