Overview Tutorials

Monday + Tuesday (15:00 – 17:00)

General Timetable

	Monday, 13.03.2017	Tuesday, 14.03.2017	Wednesday, 15.03.2017
Sound Quality of Audio Systems	9:00 -10:30	9:00 -10:30	9:00 -10:30
Break	10:30 - 10:45	10:30 - 10:45	10:30 - 10:45
Sound Quality of Audio Systems	10:45 - 12:00	10:45 - 12:00	10:45 - 12:00
Lunch	12:00 - 13:00	12:00 - 13:00	12:00 - 13:00
Sound Quality of Audio Systems	13:00 - 14:30	13:00 - 14:30	13:00 - 14:30
Break	14:30 - 14:45	14:30 - 14:45	14:30 - 14:45
Sound Quality of Audio Systems			14:45 – 16:00
Tutorials	15:00 - 17:00	15:00 - 17:00	No Tutorials offered on Wednesday
	1) Loudspeaker Control – Theory and practical applications Part 1	1) Loudspeaker Control – Theory and practical applications Part 2	
	or	or	
	2) How to measure Thiele/Small-Parameters accurately	3) How to cope with Rocking Modes / High-Mode Vibration Analysis	
	or	or	
	4) How to measure distortion and other symptoms	5) Measuring stiffness and material parameters of loudspeaker components	
	or	or	
	6) Nonlinearities of loudspeakers and its components	7) Holographic Measurement of 3D Sound Pressure Output	
	or	or	
	8) A case history of application of state-of-the-art Klippel QC systems at the end of production lines for automotive loudspeakers	9) Auralization of Loudspeaker Defects and Distortion	

1) Loudspeaker Control – Theory and practical applications

Digital Signal Processing offers new degrees of freedom to cope with the challenges in loudspeaker design:

- Maximal sound pressure output achieving defined sound quality
- Reliable protection from mechanical and thermal damage
- Minimal physical resources (size, weight, volume, cost …)

This tutorial gives an introduction into adaptive loudspeaker control and how it can be used to equalize, stabilize, linearize and protect transducers.

Topics addressed in this tutorial:

- Speaker Modelling – basis for protection and control
- Active protection – driving to mechanical and thermal limits
- Mirror filter – compensating nonlinear distortion actively

- Active Stabilization – ensuring optimal voice coil rest position
- Adaptive Control – on-line monitoring with music
- Implementation – hardware vs. software
- Green speaker – new freedom for passive transducer design

2) How to measure Thiele/Small-Parameters accurately

The Thiele/Small-Parameters are the basic parameters to model the transducer behavior using lumped parameters. They comprise the electrical and mechanical components of the loudspeaker and lay the foundation to predict and evaluate the loudspeaker behavior for small excitation signals.
Using the Klippel LPM Module, these parameters can be measured in a robust and intuitive way. The tutorial aims to present an overview of different measurement techniques, showing pitfalls and examining reasons for errors and warnings during the measurement process.

Topics addressed in this workshop:

- What do Thiele/Small Parameters represent?
- How to measure Thiele/Small Parameters
    - Added Mass
    - Laser
    - Performing measurements in Vacuum
- How to set up a correct measurement setup
- How to interpret warnings and errors and improve the measurement result

3) How to cope with Rocking Modes / High-Mode Vibration Analysis

How to cope with Rocking Modes
Rocking modes are a critical problem in small loudspeakers like headphones, micro speakers and other drivers causing Rub&Buzz and reducing the acoustic output. The causes of rocking modes are imbalances of the mass, stiffness and Bl distributions that can be arbitrarily produced in the production process. An innovative measurement technique allows for determining the causes. In this tutorial, the practical aspects of an optimal measurement, a set of common case studies and the remedies are discussed in detail.

- Optimal Laser setting
- Root cause analysis
- Remedies for rocking modes

High-mode Vibration analysis
The loudspeaker cone transforms the mechanical vibration to the acoustic field, dramatically affecting the performance and sound quality of loudspeaker drivers. Beyond the piston mode, the cone vibrates as a modal structure, producing peaks and dips in the frequency response. To cultivate and design the higher order modes with desired characteristics, an optimized modal analysis technique is required. This tutorial explains how to do experimental modal analysis, which the basis for the identification of the effective material parameters of FE models.

- Modal analysis for loudspeakers
- Easy interpretation of mechanical vibration

4) How to measure distortion and other symptoms

At high amplitudes, electrodynamic loudspeakers produce nonlinear distortion in the sound pressure output, affecting the acoustical performance. Assessing the quality of loudspeakers requires a variety of measurements. In this tutorial, the different measurements will be performed live and the optimal measurement stimuli for each particular symptom, like harmonic, intermodulation, multitoned distortion, etc., will be discussed.

Topics addressed in this tutorial:

- Harmonic and intermodulation measurement

- Ultra-fast measurement with sweep
- Multi- tone measurement
- DC measurement
- Compression measurement
- Burst measurements (CEA2010)
- Detection of MAXIMUM SPL output

5) Measuring stiffness and material parameters of loudspeaker components

One of the first steps in loudspeaker design is selection, design, prototyping and verification of speaker components. Since they are playing a key part in the quality and cost/performance ratio of the final product, insight into those properties is crucial even before mounting a first prototype.

Material parameters, such as E-modulus and loss factor, as well as the stiffness of finished suspension parts, are the basis for designing cones using finite element models. Klippel provides measurement techniques to measure the displacement of components while they are pneumatically excited. They are touchless, nondestructive, robust, can be applied to all materials, and yet are easy to handle.

Topics addressed in this tutorial:

- How to measure component parameters using pneumatic excitation
- How does the air load affect the measurement
- How to communicate with the soft part provider
- How to determine meaningful material parameter for FEA

6) Nonlinearities of loudspeakers and its components

The force factors Bl(x), inductance L_e(x,i), stiffness K_{ms}(x) and mechanical resistance R_{ms}(v) are the main nonlinear parameters in loudspeaker systems. Upon a critical value of stimulus (large signal domain), they can generate signal distortion (THD, IMD), limit the maximal output (SPL) and also may cause unstable behavior (DC displacement).
So identifying those nonlinearities is very important for both speaker design and the end of line testing, for which Klippel provides different measurement techniques which will be introduced in this tutorial.

Topics addressed in this tutorial:

- Dynamically measured Nonlinear Parameters with Klippel RnD & QC System
- Measurements at loudspeaker components before assembly
- Suspension Parts Nonlinearities
- B-Field Nonlinearity
- Relation between the different techniques and methods

7) Holographic Measurement of 3D Sound Pressure Output

Directivity of audio devices is traditionally measured in the far field in an anechoic chamber. Because of physical limitations of the measurement rooms, the results are often unsatisfying. For low frequencies (f<100Hz), the damping of the room is insufficient. For large speakers, the room is too small. For high frequencies (>10kHz), the phase is inaccurate at larger distances.

An alternative method is the measurement in the near field in combination with holographic wave expansion based on special solutions of the wave equation (Spherical Harmonics, Hankel functions).

The tutorial introduces the holographic measurement process from the data acquisition to visualization. Also, the particularities of special measurement application (like speaker arrays, transducer mounted in a baffle) and usage of correction curve to perform fast measurements in every environment will be discussed.

Topics addressed in this tutorial:

- How to measure directivity in a normal room using a holographic approach
- What are the results of the holographic measurement and how can they be simplified?
- Directivity of line array and sound bar: What are the particularities?
- How to measure the directivity of transducer mounted in a baffle.
- How to use a correction curve to perform calibrated measurements in every environment

8) A case history of application of state-of-the-art Klippel QC systems at the end of production lines for automotive loudspeakers

This Tutorial will be presented by Prof. Angelo Farina – University of Parma

The adoption of a fully-automated QC system goes towards the objective test requirements typical of an industrial environment, but it posed a number of problems, related on automatizing the handling and electrical connection of the DUT, on setting up the limits of acceptability, and on managing the enormous amount of data generated.

Due to the availability of this system, customers have started to require limits in production on parameters that generally were measured only during development phase. So it was necessary to perform an extensive research project to understand the causes of potential deviations from specs. The project required to fully understand the electromechanical behavior of "failed" loudspeakers, for tracing back the causes of the deviations to anomalies in the components or in the assembly line. For this, it was also necessary to set up diagnostic systems including scanning laser Doppler vibrometry, FEM modal analysis, tests in the anechoic room and inside the EOL boxes with microphone arrays, and also the creation of a powerful tool to analyze a very big amount of data.

In the end it resulted that, even after finding and fixing all the causes of anomalies, some part of the problem was coming from “impractical” contractual specifications of the acceptability limits. So it appeared natural to use all the knowledge obtained in this two-years research project in a document, which has the form of a guideline, to be used by customers, manufacturers and third parties when setting up the specifications for a new contract and when tuning the QC systems.

These guidelines have been submitted as a draft to AES, and the AES Technical Committee on Automotive Audio agreed to proceed in the refinement of these guidelines, which will be released as an official AES guideline. So this tutorial is also an invitation to cooperate with the AES TC for improving the current draft and finalizing it quickly.

Topics addressed in this tutorial:

- QC at EOL: technical challenges
- Contractual specifications between manufacturer and customer
- Big Data statistical analysis
- AES guidelines for EOL QC test of loudspeakers for automotive applications

9) Auralization of Loudspeaker Defects and Distortion

During the design of a loudspeaker or audio system, several design choices have to be made influencing the final sound quality and the costs for development and production. Often, these choices are made in dialogs between engineering and the departments of management and marketing using objective and subjective evaluation methods.
KLIPPEL offers a set of tools that combines physical measurements with perceptual techniques (auralization, systematic listening tests) to assess the audibility of signal distortion and the impact on sound quality.

Topics addressed in this tutorial:

- Introduction on different auralization methods
- Practical examples using the DIF-AUR module
    - Auralizing defect symptom of a failed unit (QC rejected)
    - Compare small and large signal domain responses
- Introduction/preview of our new “*Live Audio Analyzer*”