**Authors:**
R. Garziera (*), A. Farina (*), S. Carra (**), L. Chiesi (*)

**Affiliations:**
(*) University of Parma, Industrial Engineering Department, Via Usberti 181/A, 43124 Parma, Italy
(**) Center of Excellence for Research and Innovation Technology (CERIT) – INAIL – Research, Certification and Verification Area, c/o University of Parma, Industrial Engineering Department, Via Usberti 181/A, 43124 Parma, Italy

**Relevant Conference Topic(s):** Laser Doppler Vibrometry, NDT, Modal Analysis

**Presenting Author:** Prof. Ing. Angelo Farina, University of Parma, Industrial Engineering Department, Parma, Italy
**Email:** farina@unipr.it;
**Phone**:+39-0521-905854

**Contribution Title:**
Use of advanced signal processing methods for measuring vibrations of loudspeaker membranes with a Laser Doppler Vibrometer.

**Key words:**: Laser Vibrometer, loudspeaker, exponential sine sweep, modal analysis

**Abstract**:
Vibration measurements above the breakup frequency have been performed on two models of loudspeakers (a woofer and a mid-range) by using a single-point Polytech Laser Doppler Vibrometer (sensor head OFV-505 and controller OFV-5000), realizing complete modal analyses.
The activity started in order to discover why several loudspeaker samples were identified as "failed for frequency response problems" during the manufacturing quality control. One of the possible cause of failure has been identified in anomalous modal response of the cone above the breakup frequency, due to geometrical imperfections or asymmetric stiffness of suspensions.
A computer-controlled XY scanner, over which the laser head was mounted, has been completely designed and built, in order to automatize acquisitions on a grid of points covering membrane, dust cap and surround of the loudspeakers. A Roland USB2 sound card was employed for generating the test signal and acquiring the velocity signal from the laser. The system is totally controlled by means of Matlab scripts.
After experimenting with various methods, the Exponential Sine Sweep (ESS) method was chosen, as it provides higher signal/noise ratio with respect to more traditional excitation signals, even where the optical reflectivity of the surface is small (black paper cone and rubber surround). Additional improvement of the signal quality has been obtained by forcing autofocus of the laser after each change of position and by applying white matte paint on the surface.
A further advantage of the ESS method was the capability to separate the linear system's response from the not linear effects.
The study has shown that Doppler Vibrometers, connected with state-of-the-art audio measurement systems, can be considered an optimal instrument to characterize the dynamical behaviour of bodies under forced vibrations, even when initial measurement conditions (for example reflectivity) are not optimal.