Advanced Loudspeaker Calculator – an Example of COMSOL Apps Utilization

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INTRODUCTION: Developing a new loudspeaker design requires not only knowledge and experience in the field, but also an access to verified and efficient tools. Engineers at HARMAN have developed a COMSOL® Application to serve at the early stages of the design process. The Application has been created in a close collaboration with the end users, i.e. transducer engineers.

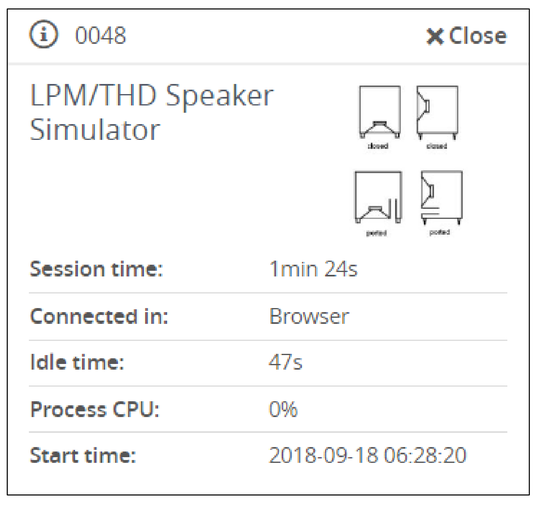

Figure 1. LPM/THD Application

COMPUTATIONAL METHOD: Simulations are based on a linear Lumped Parameter Model[1] (LPM) and a non linear LPM where the speaker is described with a set of electro-magnetic and mechanical parameters[2]. The linear LPM allows to simulate speakers in free field, closed and vented enclosures. The user can predict the Total Harmonic Distortion (THD) and the membrane DC-Shift. Linear LPM is solved with COMSOL® Analytic Functions. Non linear simulations are performed with Infinite Impulse Response filters in MATLAB®.

Speaker 1	*Speaker #1*	
Voltage	1.568	V
Re	2.46	ohm
Bl	5.871	N/A
Diam	163.9	mm
Sd	0.0804	m²
Mms	66.55	g
Cms	0.444	mm/N
Rms	1.367	kg/s
Enclosure Vol	3	l
Vent length	32	cm
Vent diameter	8	cm
Resistance R2*	1.79	ohm
Inductance L2*	0.664	mH

Figure 2. Linear speaker input

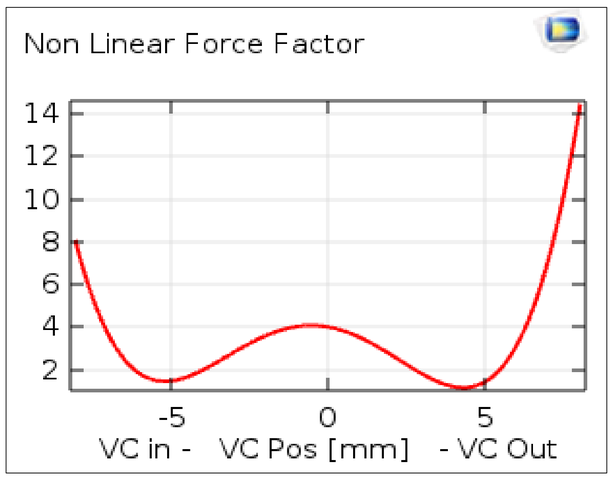

Figure 3. Non Linear LPM parameters (Motor)

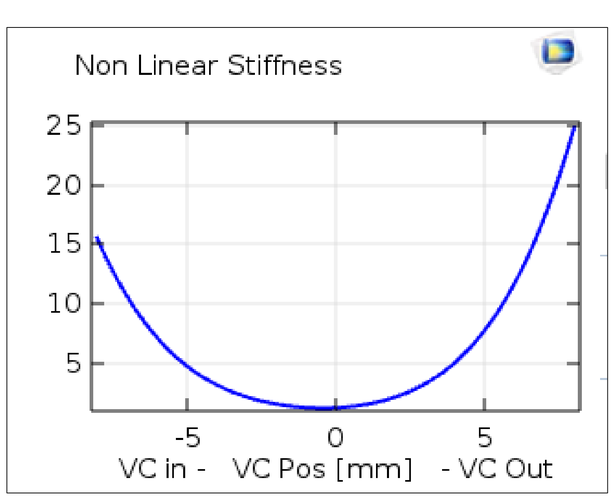

Figure 4. Non Linear LPM parameters (Suspension)

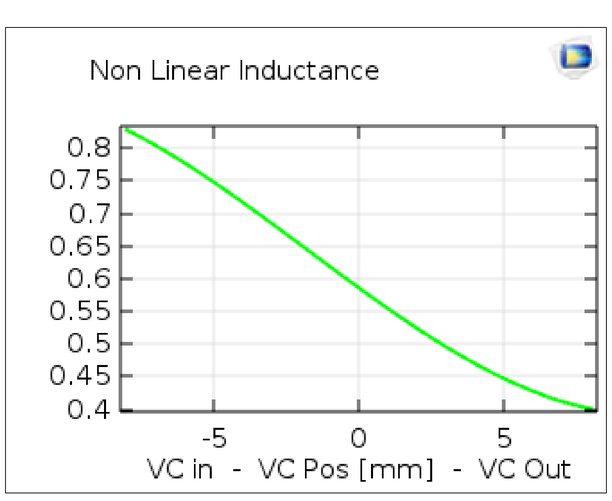

Figure 5. Non Linear LPM parameters (Motor)

RESULTS:

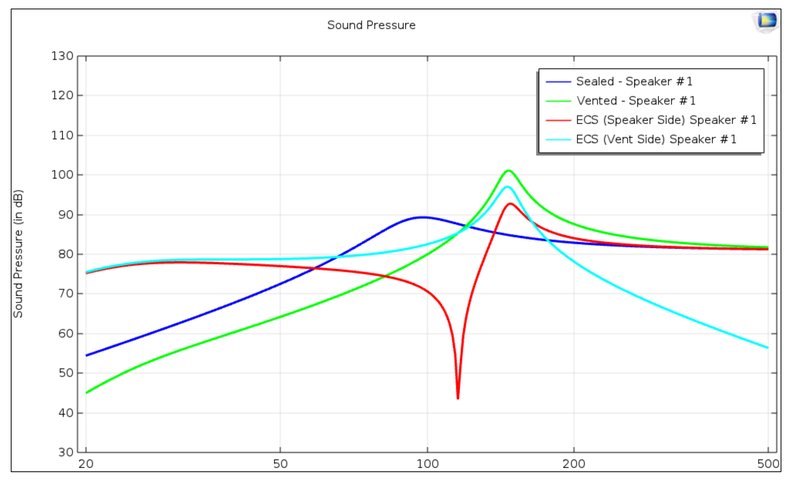

Figure 6. SPL simulation

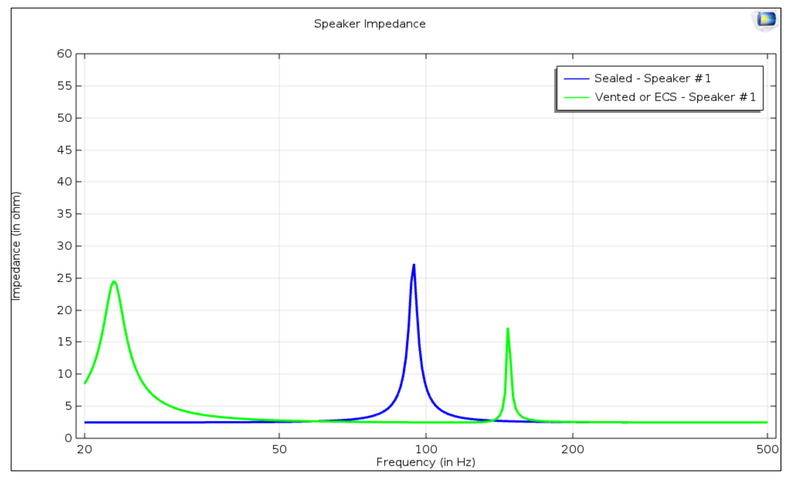

Figure 7. Impedance simulation

Non linear simulation results were compared with measurement data delivered by a professional loudspeaker measurement[3].

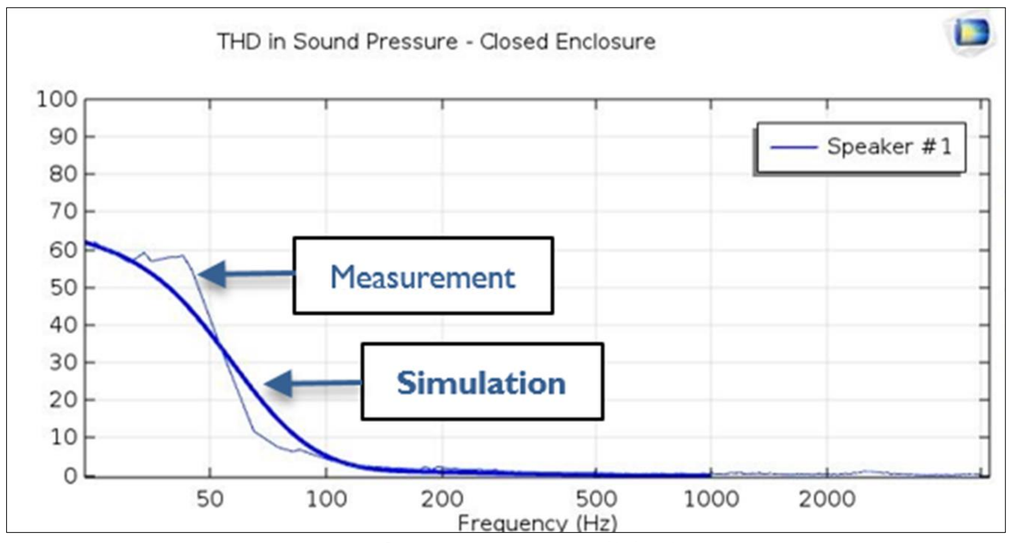

Figure 8. THD validation

The user can generate a fully automatic and standardized report where all speaker parameters and simulation results are saved. The goal is to instantaneously build a simulation report which is used in any customer meetings or shared amongst HARMAN R&D centers worldwide.

CONCLUSION: the LPM/THD Apps is a very fast and accurate tool to predict the performances of subwoofers, woofers and midranges. Application is currently on a COMSOL® Application Server and is accessible globally to all transducer engineers at HARMAN.

REFERENCES:

1. J. Vanderkooy, P.M.Boers, M.Aarts, “Direct-Radiator Loudspeaker System with High Bl”, Paper presented at AES 114th Convention, 22-25 March 2003, Amsterdam, Netherlands
2. W. Klippel, Prediction of Speaker Performance at High Amplitudes, 111th AES Convention (2001)
3. W. Klippel, - Measurement of large parameters of electrodynamic speaker, 107th AES Convention (1999)