Simulation of Horn Driver Response By Direct Combination of CD Frequency Response and Horn FEA

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Abstract

Today a horn driver developing is still time and cost consuming. In addition compression driver behavior depends by the horn profile. To predict the driver/horn combination behavior, different methods are proposed in the last 15 years for example by G. Behler and M. Makarski [1] [2] or A. Voishvillo [3]. These methods conduct to a complex electrical and acoustical performance of driver/horn combination, using a matrix analysis of the two-port "black box circuit". But to derive the desired matrix elements, different measurements have to be carried out on both electrical and acoustical port.
A new method related to acoustic behavior prediction is presented here, using only one acoustical measurement and FEA. Starting from a real compression driver acoustic response, measured on a Kundt's tube [4] [5] [6] or a Plane Wave Tube [7] and using COMSOL simulated horn, with a simple procedure is possible to predict acoustic absolute response of the driver/horn combination.

Horn design was imported with CAD Import Module in a quarter space 3D model, using pressure acoustic frequency domain simulation.

Case studies have been done and simulations results have been compared with measurements, in order to describe how well a fitted model matches the original data set. In fig. 1, 2, 3, 4 simulated/measured on axis frequency response of different compression driver/horn combinations. A frequency range of 1-20 kHz is selected, in order to reduce computational burden in simulation estimation. This is a common working range for most of commercial compression drivers.

The proposed method is useful to virtualize dB SPL frequency response of the simulated horn with several real compression drivers' response. With compression drivers frequency response database is possible to fast predict dB SPL of each driver with the simulated horn, without physically building horn.

In this case the method was used to determine the right horn profile, with a significant reduction in the number of physical prototypes. Acoustic horn was modeled as a mechanical cross over, adjusting the compression driver frequency response to obtain an extremely flat response.

A new software tool is under construction in order to synthetize the method and it will be available in free download. Anyway with COMSOL Application Builder it might be possible to create an analogous routine.

Reference

[1] G.K. Behler and M. Makarski, “Two-port representation of the connection between horn driver and horn”
111th AES Convention, 2001 Sep 21–24 New York, NY, USA

[2] M. Makarski, “Determining Two-Port Parameters of Horn Drivers using only electrical Measurements”
116th AES Convention, 2004 May 8–11 Berlin, Germany

[3] A. Voishvillo, “Simulation of Horn Driver Response by Combination of Matrix Analysis and FEA”
129th AES Convention, 2010 November 4–7 San Francisco, CA, USA

[4] ISO 10534-1. Acoustics - determination of sound absorption coefficient and impedance in impedance tubes - part 1: Standing-wave method, 1996.

[5] ISO 10534-2. Acoustics - determination of sound absorption coefficient and impedance in impedance tubes - part 2: Transfer-function method, 1996.

[6] ASTM E 1050 – 08 “Standard Test Method for Impedance and Absorption of Acoustical Materials Using A Tube, Two Microphones and A Digital Frequency Analysis System”

[7] AES-1id-2012 “Plane-Wave Tubes - Design and Practice”

Figures used in the abstract

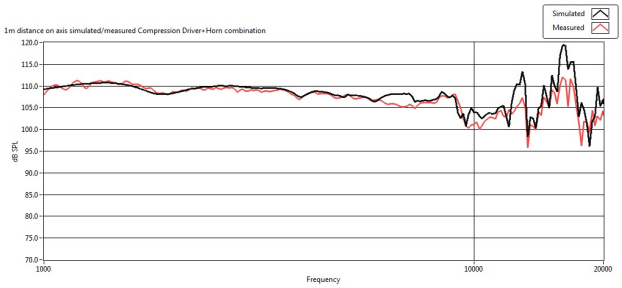

Figure 1: CD1+Horn1

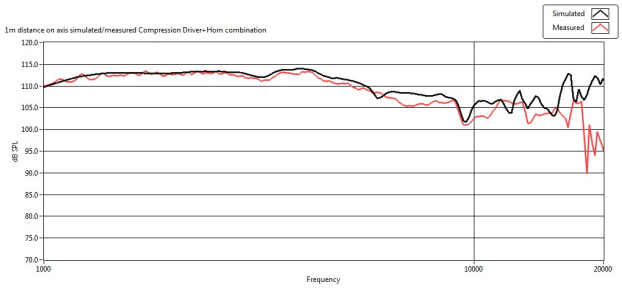

Figure 2: CD2+Horn1

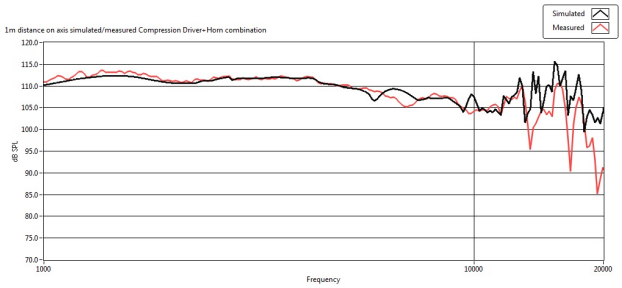

Figure 3: CD3+Horn1

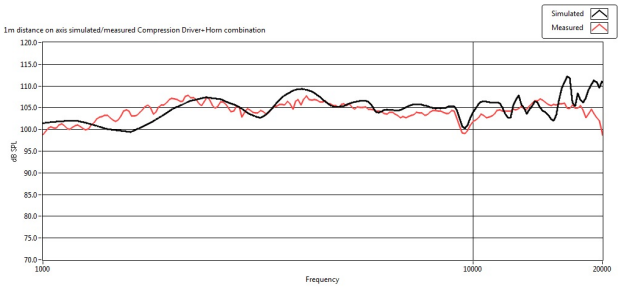

Figure 4: CD2+Horn2