PA Loudspeaker System Design Using Multiphysics Simulation

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Abstract

This paper intent is to describe how to utilize COMSOL Multiphysics® software for the design of a PA system loudspeaker for the optimization of geometries and crossover topology with the idea of controlling sound directivity over a wide spectrum including minimizing side lobes due to the often overseen time/phase signal interaction between woofer and tweeter. Often in the design there's a focus on the on-axis frequency response, and for ceiling PA system speakers it is often the least utilized listening position. The use of simulation helps the analysis of the spatial response over right in the computer, while the traditional process of prototyping and measurements on multiple points necessary for the polar response/balloon/DI/or frequency vs angle plots is extremely time-consuming.

The process of iterating shapes of the tweeter's waveguide and woofer's flange, including also a variation of transducers location, was done in the computer model. Both tweeter and woofer had lumped circuit equivalent that modeled the behavior of the diaphragm seen from the electrical side, including components of the filters; the analysis of the behavior of the crossover was immediate from the results of the simulation.

Results at time of prototype were close to simulation's result and with the use of this tool over 30 design were analyzed in a matter of a few months with the advantage of shorter delivery times and reduced resource's cost for the preparation and measurements of prototypes.
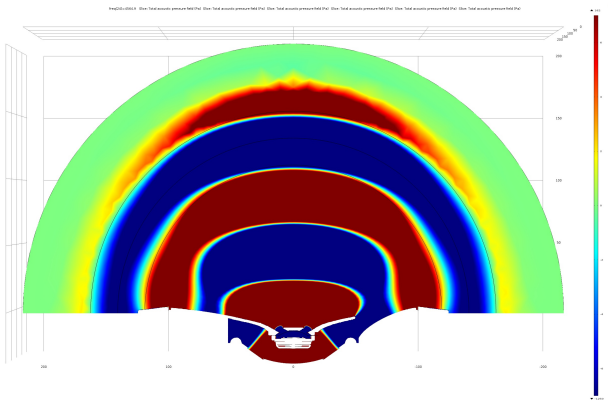
Figures used in the abstract

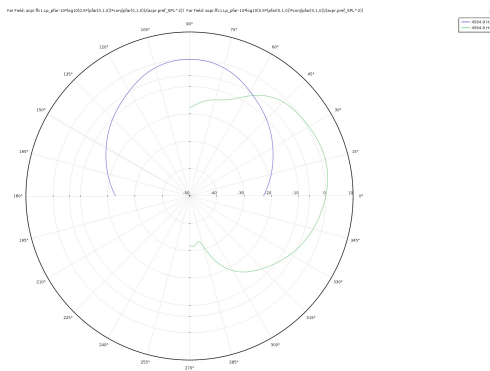**Figure 1**: Pressure Waves generated by the tweeter

Figure 2: Normalized Horizontal and Vertical Polar Response

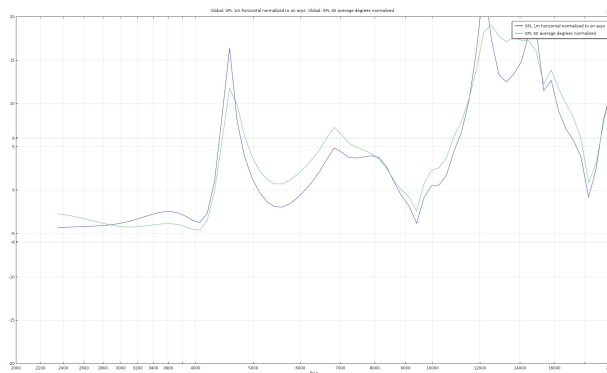**Figure 3**: On axis normalized frequency response at a 60 degrees angle

Figure 4: Simulated tweeter response with corresponding 60 degrees off axis response