Application For Simulating Acoustic Response Of Condenser Microphone Cartridges

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Abstract

Electret condenser microphones are one of the most used transducers for a variety of applications. The engineer designing these cartridges must take into consideration many factors to create a design that meets its specifications. Most parts of the design have multiple constraints across electrical, mechanical, and acoustical disciplines and it can be difficult to create a design from scratch or optimize for a specific acoustical response. Prototyping transducers can often be costly and time consuming, while simulation can reduce the number of prototyping iterations needed to validate a design. An FEM simulation with representative geometry has many advantages over a traditional lumped element equivalent circuit simulation of a transducer. The simulator allows dimensions and parameters to be input directly, creating the model instead of having to dissect a design, create an equivalent circuit and take those inputs into equations to determine equivalent circuit component values. COMSOL's Application Builder also allows for creation of a GUI that will allow even novice users to use the tool effectively regardless of their experience in developing COMSOL models.
This application allows for the electrical, mechanical, and acoustical aspects of a design to output a frequency response, polar response, cartridge capacitance and static diaphragm deflection distance. The cartridge geometry is created by entering dimensions for ports, cavities, and the housing of the cartridge and electrical, mechanical, and acoustical parameters, such as polarizing voltage, diaphragm resonance frequency, and acoustical resistance, are entered as well. The user can select the acoustic source used in the model including the frequency range, distance, and angle(s) of incidence. The application will display the simulated acoustic response as well as the capacitance and static diaphragm deflection and allows the user to save the response data as a .txt file or to create a report using COMSOL's report generator that saves all the details of the simulation.
The model for a Brüel & Kjær 4134 Condenser Microphone from COMSOL's Application Library (Application ID: 12375) was used as a reference in the development. Unlike the initial model, the simulated cartridge can have a polar response that is bi-directional or uni directional as the surrounding air is included in the geometry. This allows for differences in sources and port to port propagation delays to be simulated to be and diffraction around the cartridge geometry to be considered. For an engineer new to transducer design or an experienced engineer trying to dig into the details, this tool provides numerous features to ease in simulation of condenser microphone cartridges.

Reference

COMSOL, “The Brüel & Kjær 4134 Condenser Microphone,” https://www.comsol.com/model/the-br-252-el-kj-230-r-4134-condenser-microphone-12375
Accessed June 2024

Figures used in the abstract

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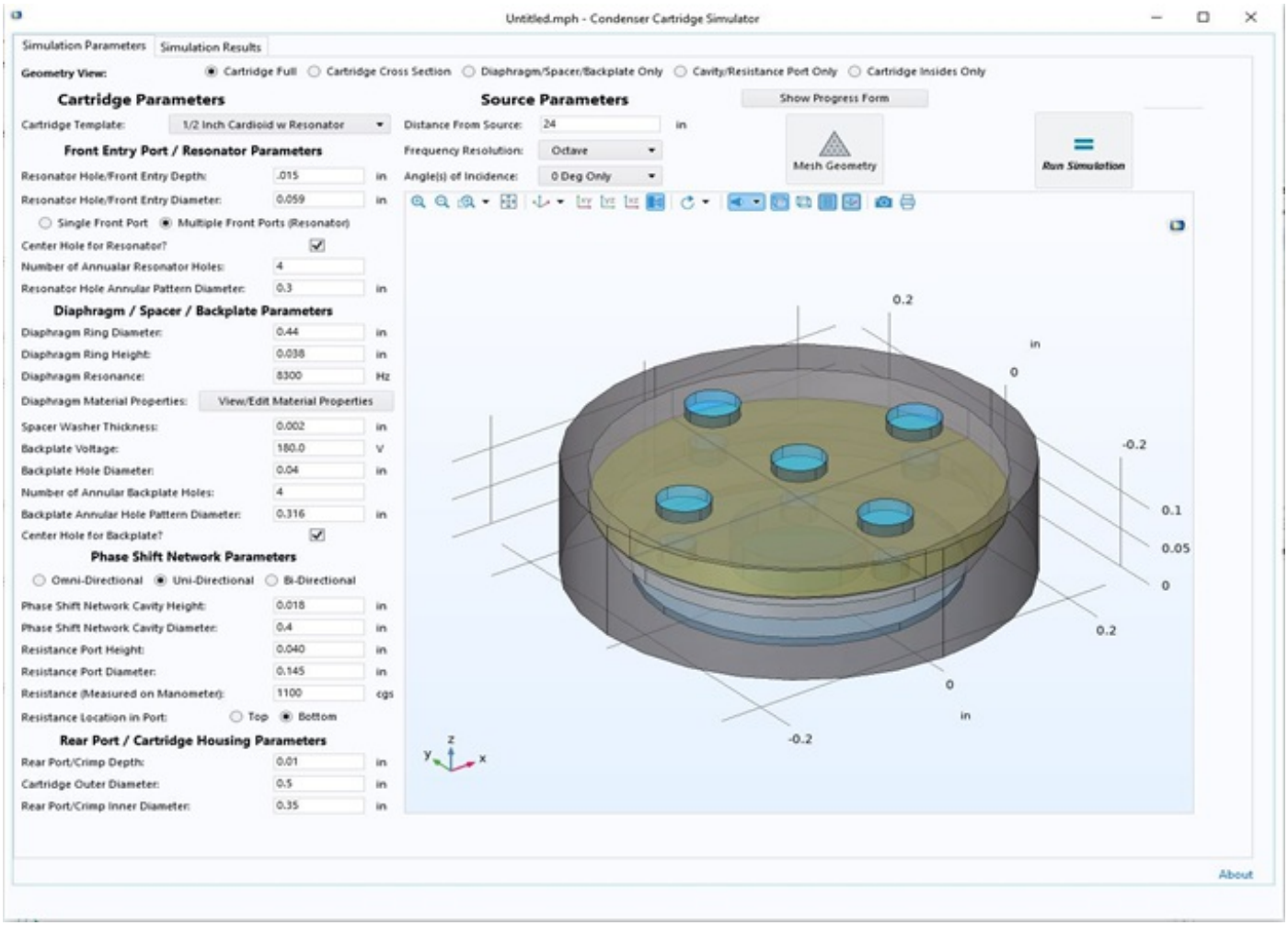

Figure 1 : Main screen of the application showing the assignable parameters for the simulation and a window to view the created geometry

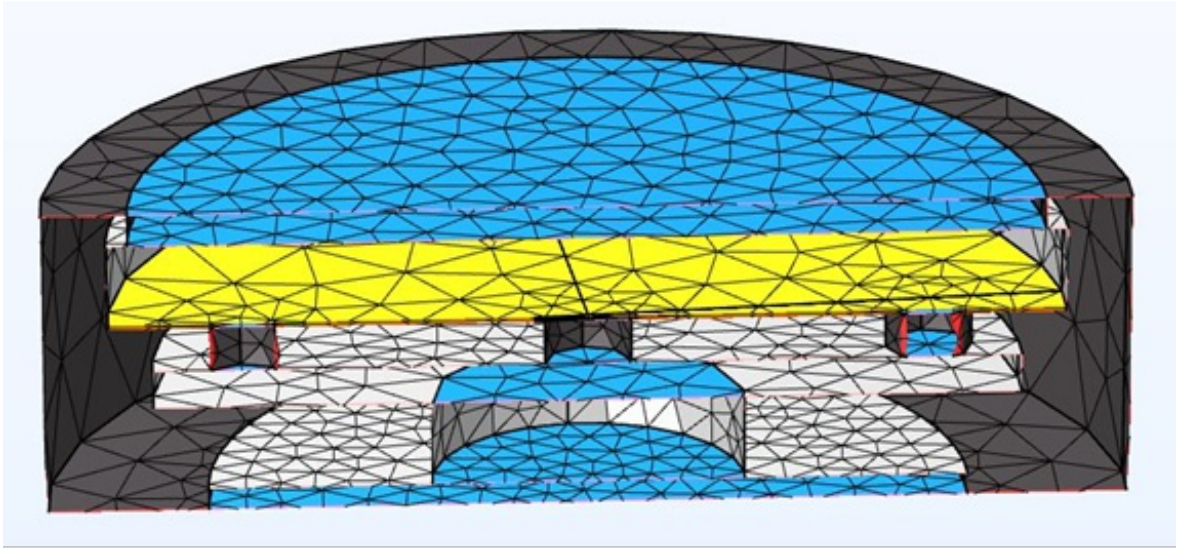

Figure 2 : Cross section view of the mesh on a created microphone cartridge geometry

Figure 3 : Output from a simulation showing the absolute frequency response of the simulated microphone cartridge with a source at 2 ft on-axis and off-axis rotated 90 degrees and 180 degrees.