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Characterization of nonlinear port parameters in loudspeaker modeling

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ABSTRACT

The outputs from ports used in common vented box loudspeakers are not linear with input level. With the goal of developing accurate modelling of vented boxes, a new method for estimation of nonlinear port parameters is shown. Acoustic mass and acoustic resistance parameters change with pressure in the enclosure and velocity in the port. Along with all nonlinear speaker parameters required for modeling, a practical way to characterize the changing acoustic mass and acoustic resistance is presented and tested with measurements. Using the new method, nonlinear port parameters are extracted for multiple box and port types.

1 Introduction

This work extends the vented box model by incorporating dynamic acoustic resistance (R_a) and acoustic mass (M_a) parameters. The R_a and M_a parameters are functions of the volume velocity in the port. For the adaptive parameter estimation method to work, we approximate the R_a and M_a functions as being dependent on input voltage level. The volume velocity in the port is also a state variable and its calculation depends on the current estimate of R_a and M_a , whereas input voltage level is a known and easily tracked value. Evaluating this method based on the normalized mean squared error between measured and modeled displacement we found that excellent vented box model predictions can be made.

2 Background

Many excellent background papers exist in the literature which study vented boxes and port characteristics. Roosen, et. al. [1], Backman [2, 3, 4], Vanderkooy [5, 6], Salvatti, et. al. [7] have characterized aspects of the port, including differences in port geometry. Klippel [8] has presented a succinct state space equation for modeling vented boxes. These papers and the equations in [8] are limited to characterizing fixed level input signals rather than incorporating dynamic acoustic resistance (R_a) and acoustic mass (M_a) terms. Therefore, there is still a need for a practical vented box model that can be used to model a full vented box system with any type of input signal.

Linear And Nonlinear Loudspeaker Characterization

Xiaolong Qi



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