Fostex FE-167E Full Range Driver in a Bigger is Better Enclosure
By Martin J. King, 02/17/09

Introduction :

The “Bigger Is Better”, often abbreviated BIB, full range driver speaker design has been around for many years. The first place I saw the design documented was on the Single Driver Web Site in an article[1] by the late Terry Cain. The speaker built by Terry Cain used a Radio Shack 40-1354 driver mounted in a single fold TQWT that exhausted at the top of the cabinet towards the ceiling. The top firing exhaust was significantly different from more traditional TQWT designs which tended to exhaust at the floor.

The BIB enclosure has attracted a lot of builders over the years as the process of enclosure design has become more scientific through the use of computer based simulations. The BIB design efforts of Scott Lindgren and Greg Monfort (and probably a few others that I have missed) have been pulled together by Jeff Feith on his ZillaSpeak web site[2]. Shown on the dedicated BIB pages of ZillaSpeak are calculate SPL response curves for many BIB designs using a wide assortment of full range drivers. If you have a favorite full range driver, odds are good that the geometry for a BIB design has already been worked out and can be found on these web pages.

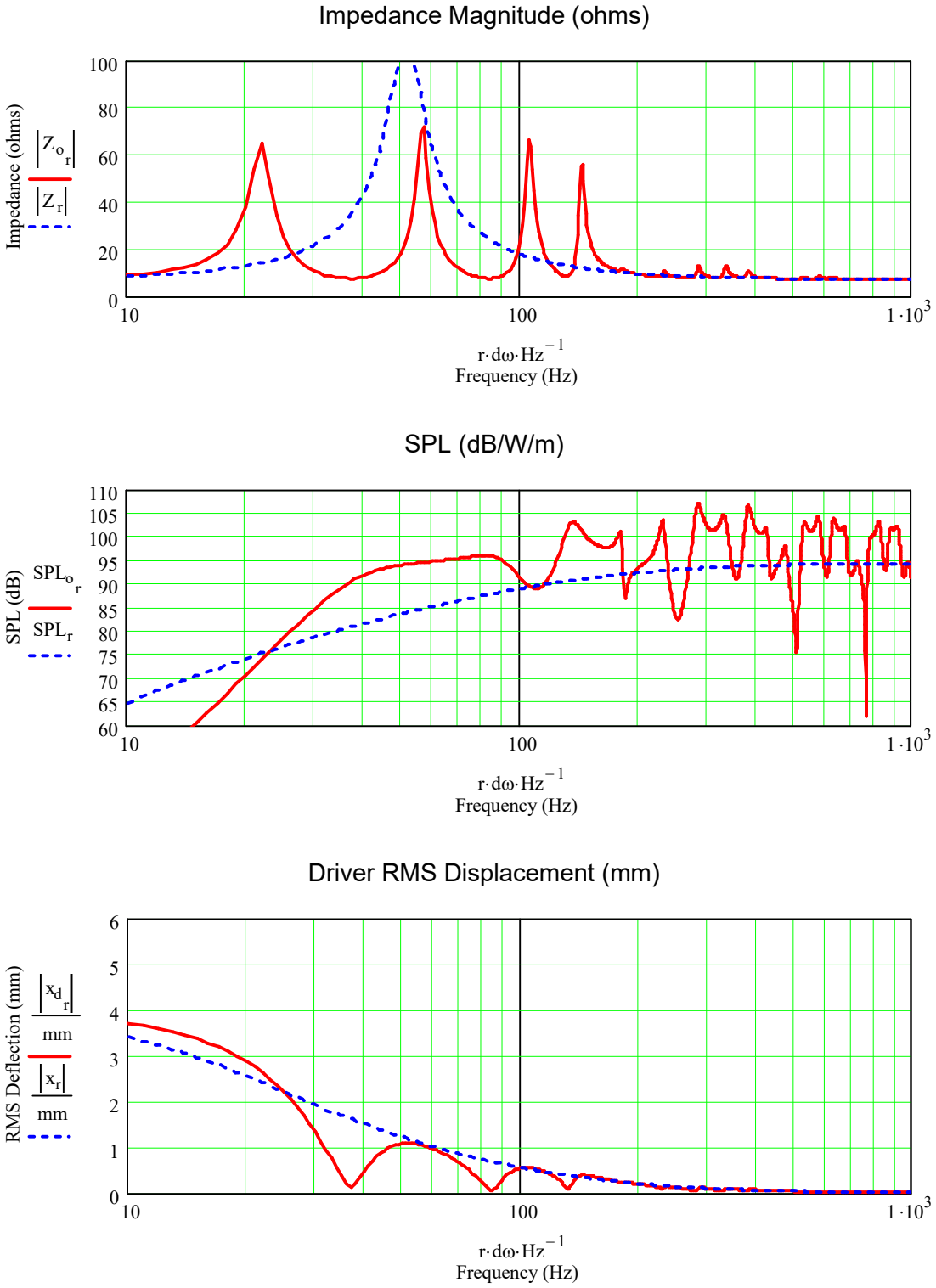
The calculated response plots on the ZillaSpeak web site are an approximation that includes a number of simplifying assumptions. In general the SPL curves exhibit a pretty ragged response and yet the feedback about the speakers’ performance, when placed correctly in a typical listening room, is extremely positive. Clearly the designers and builders have a vision of how these simplified SPL response curves translate into excellent real world acoustic performance. The intent of this write up is to take one of the calculated SPL curves, from the ZillaSpeak web site, and explore a more accurate calculation method of in-room SPL response to try and produce a more realistic estimate of how the BIB actually performs.

Discussion :

The design I decided to study is for the Fostex FE-167E full range driver. The box characteristics specified for this driver are a length of 136 inches, a driver offset from the closed end of 27.5 inches, and a mouth opening of 87.75 in^2. A calculated SPL response plot is shown on ZillaSpeak which has been replicated and is included in Figure 1 along with the electrical impedance and RMS driver deflection plots. Comparing the calculated SPL plot on ZillaSpeak with the SPL plot in Figure 1 confirms that the starting point for this analysis matches the intent of the designer.

When studying the SPL response shown in Figure 1, a number of simplifying assumptions should be kept in mind. The SPL response is calculated as if the driver and the mouth of the BIB enclosure are coincident and mounted on an infinite baffle. There is no attempt to account for the relative locations of the driver and mouth, the mouth exhausting at the top of the enclosure towards the ceiling, the front baffle size and shape, or any interactions with room boundaries. While this sounds like a fairly crude approach to modeling a speaker design, it is entirely consistent with almost all other Thiele/Small parameter based speaker modeling programs widely used to design sealed and ported enclosures. This simplified modeling approach does work and a large number of high performance DIY and commercial speaker systems have been designed using this analysis method.

Figure 1 : Simplified Model Calculated Results



The first step towards improving the SPL predictions for the BIB design is to consider the external enclosure geometry in the calculation of the SPL response. The simplified model already accounts for the geometry of the internal air volume and the location of the driver along the length. So the output from the driver and the mouth are calculated correctly but their relative spatial locations are not accounted for in the analysis.

Figure 2 shows the geometry model used for the improved calculations. The driver is depicted as a circular cluster of small red circular sources and the mouth is depicted as a rectangular cluster of small blue circular sources. Notice that the integrated response of the driver sources fires forward and the mouth sources fire upward. In addition the external edges of the enclosure are shown as dark black lines. Some of these external edges will act as diffraction sources that generate the baffle step response and associated ripple above the transition from a 4π sound field to a 2π sound field.

Figure 3 shows the next step towards improving the accuracy of the calculated SPL response. In the three plots in Figure 3, the BIB enclosure is shown relative to a room corner that is located at the origin of the 3D coordinate system. The XZ (side wall), YZ (rear wall), and XY (floor) planes and an eight foot ceiling represent room boundaries that generate reflections. The red circles shown in Figure 3 denote driver and mouth sources while the blue circles denote edge diffraction sources. The lower plot in Figure 3 shows the view from the ceiling which depicts how close the BIB enclosure is placed to the room corner. The corner loading reinforces the low bass output from the speaker but at the same time produces nulls higher in frequency as reflected sound arrives 180 degrees out of phase with direct sound.

The calculated SPL response for this improved modeling method is shown in Figure 4 along with the impedance and RMS driver deflection. Comparing the impedance plots presented in Figures 1 and 4, it should be obvious that I have also added stuffing to the BIB enclosure to help tame the internal standing waves. The resulting calculated SPL response is much improved and based on the 95 dB bass output would probably not require a baffle step correction filter. However, there is a broad shallow depression extending from 70 Hz to 500 Hz that probably could be improved by changes to this particular BIB geometry or modified room placement.

Conclusions :

The BIB speaker enclosure design has proven to be a viable option for full range drivers that can produce excellent in room performance if positioned close to a corner. The design can produce sufficient bass output thus eliminating the need for a baffle step correction filter. While this is not in any way a revelation to the many builders of the BIB design, it now can be predicted and confirmed analytically which in turn may lead to further improvements in BIB enclosure design concepts.

References :

1. http://fullrangedriver.com/singledriver/DIYTQ8.html

2. http://www.zillaspeak.com/bib.asp

Figure 2 : Basic BIB Geometry

Circular Driver and TL Terminus Simple Source Pattern with Baffle Edge Outline

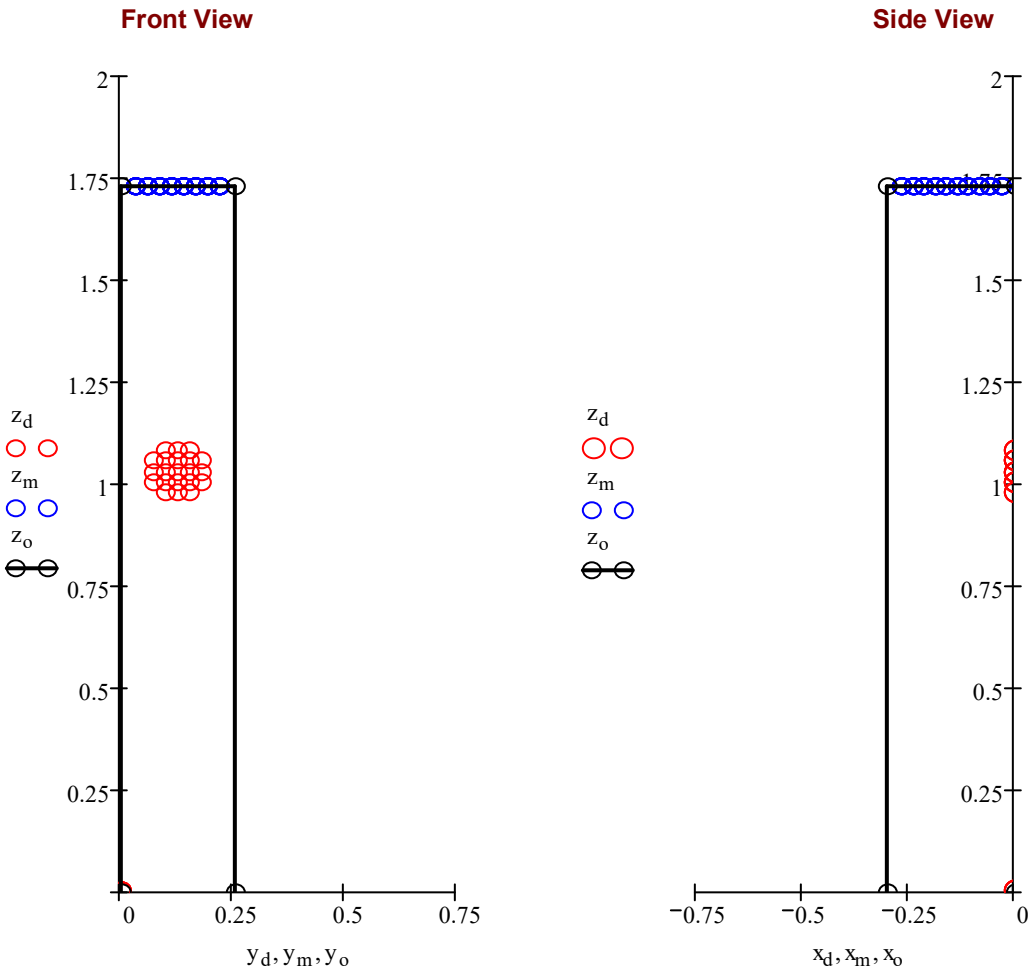
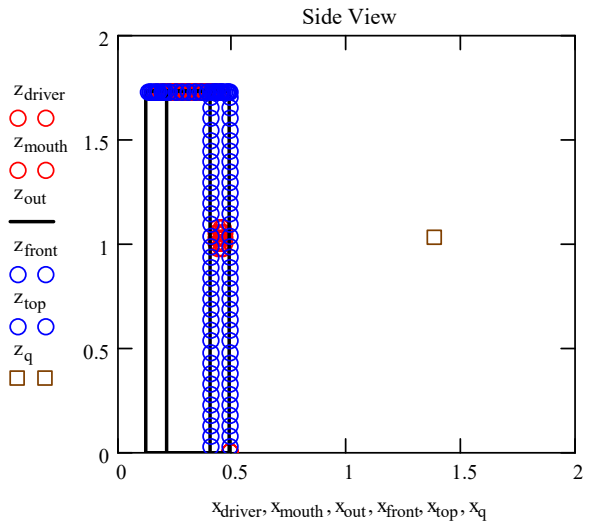
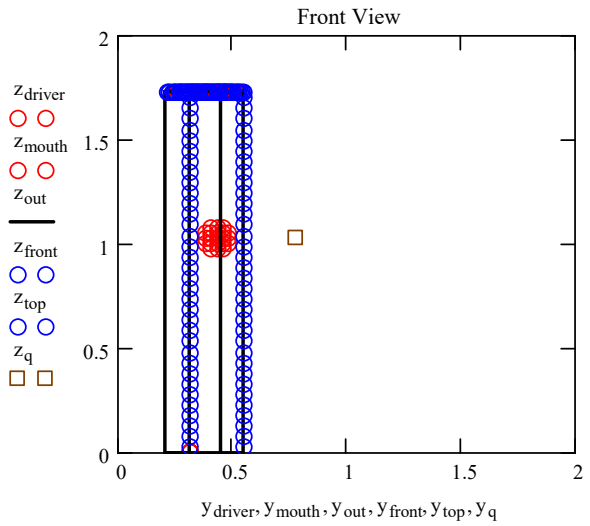


Figure 3 : BIB Enclosure and Corner Geometry





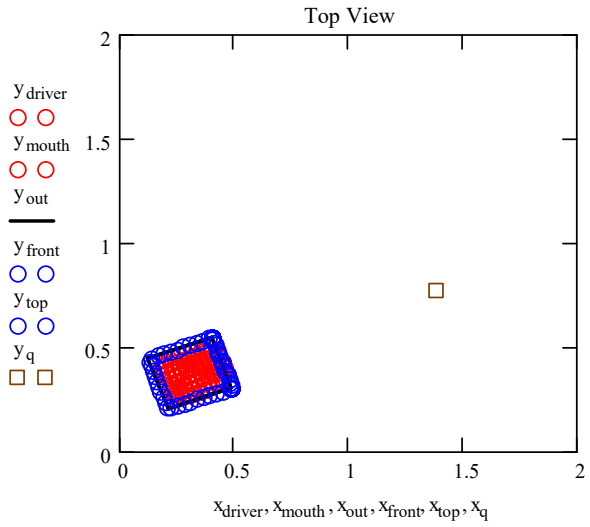
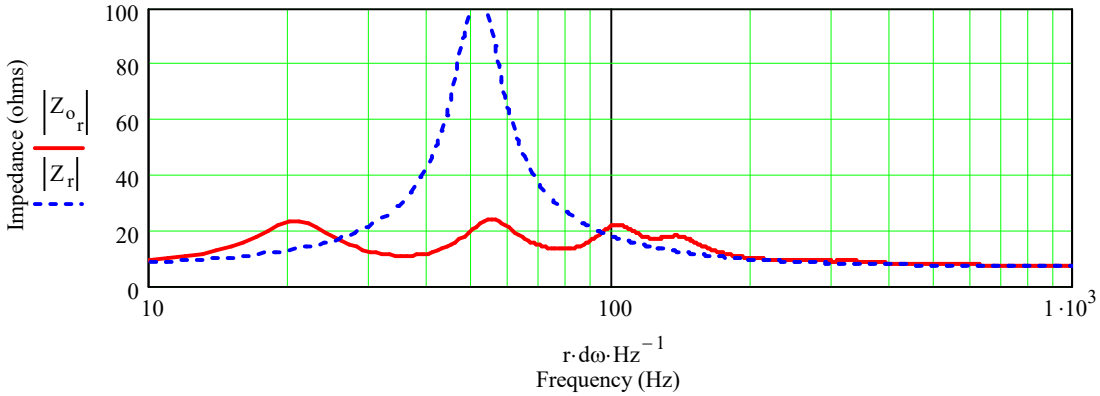
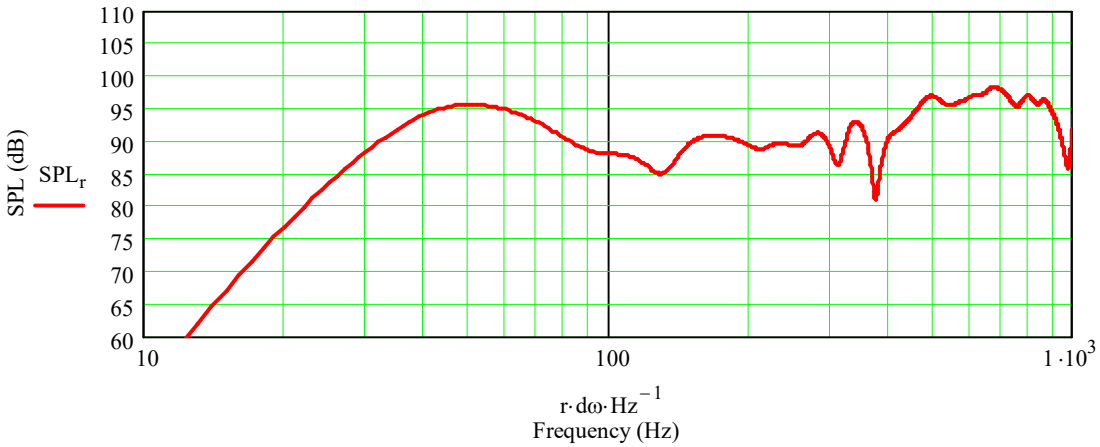


Figure 4 : Final Model Calculated Results

Impedance Magnitude (ohms)



SPL (dB/W/m)



Driver RMS Displacement (mm)