Diamond Series

Final Testing Report

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2012

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Speaker Testing Process

My initial design called for a crossover between the tweeter and mid range at 2000 Hz, and a half crossover between the mid and low range at 570 Hz. When testing I began by testing the frequencies of the drivers themselves, and then the response of the drivers and the system with a 2.5 way crossover at 2000 Hz and 570 Hz. This initial test showed that I had some issues with frequency summation at 4000 Hz with this particular crossover, and also a problematic bump at about 15,000 Hz from the tweeter.

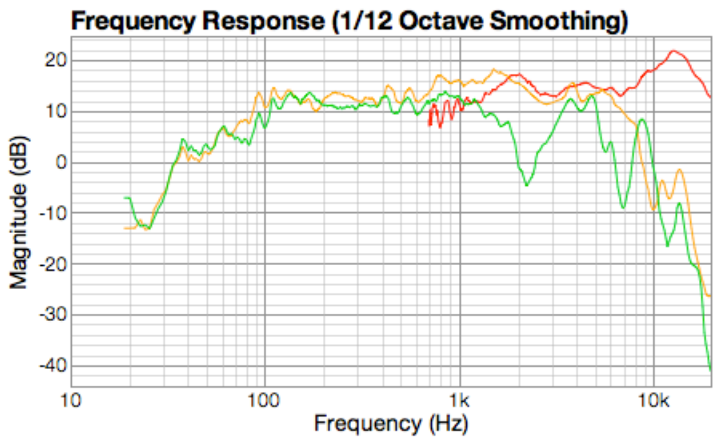

Figure 1: Drivers Only (Red-Tweeter, Yellow-Mid, Green-Low)

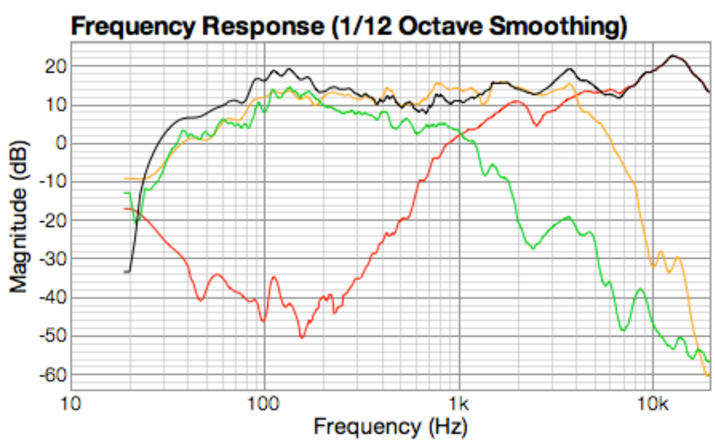

Figure 2: Frequency Response 2000, 570 Hz 2.5 Crossover
(Black-Full System, Red-Tweeter, Yellow-Mid, Green-Low)

In an effort to smooth out the bump around I moved the tweeter's crossover point to 1000 Hz and the mid crossover point to 1500 Hz. As Figure 3 shows, this smoothed the bump at 4000 Hz greatly, but still left the problem of my tweeter's bump around 15,000 Hz. To try and fix this I added a 3 dB high shelf filter to the tweeter above 7000 Hz. This resulted in a much smoother high end, as shown in Figure 4. Even though the highs have leveled out, they were still 3 to 4 dB above the mid range, so I added a pad to the tweeter to try and level the highs with the mid range. As can be seen in Figure 5, adding a pad to my tweeter evened out my high end with my mids, but it also accentuated the bump at 1,500 Hz.

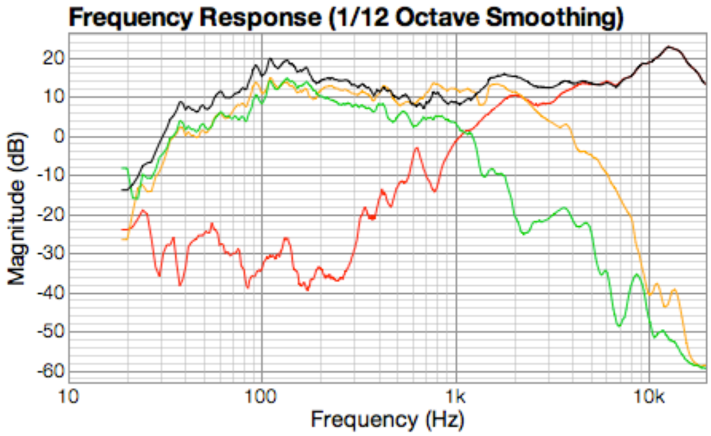

Figure 3: Frequency Response T@1000, M@1500, L@570 Hz 2.5 Crossover
(Black-Full System, Red-Tweeter, Yellow-Mid, Green-Low)

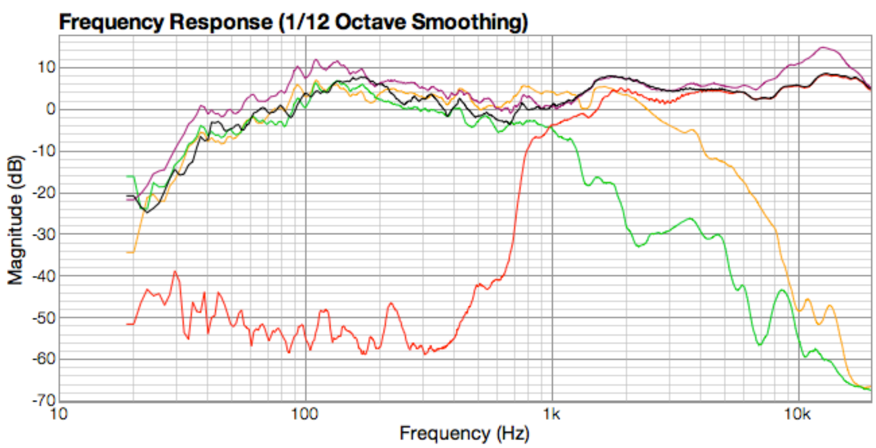

Figure 4: Frequency Response T@1200, M@1500, L@570 Hz 2.5 Crossover
3dB High Shelf Filter above 7000 Hz
(Magenta-Previous Response, Black-Full System, Red-Tweeter, Yellow-Mid, Green-Low)

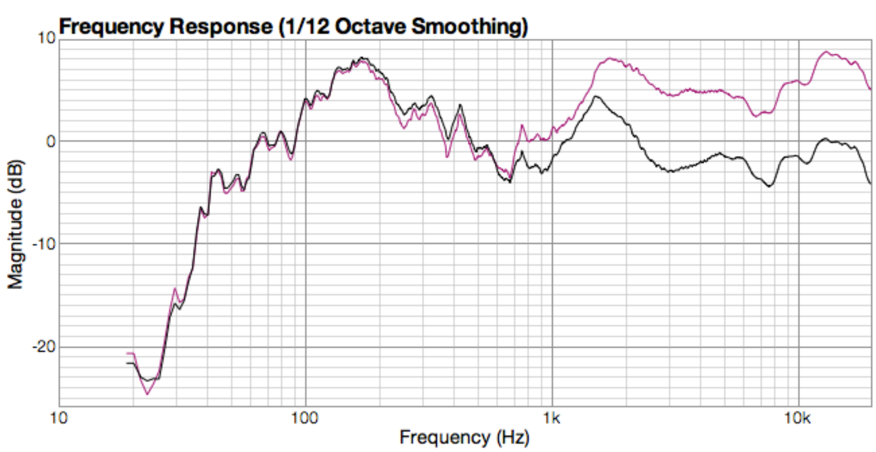

Figure 5: Frequency Response 8dB Tweeter Pad
(Magenta-Previous Response, Black-Full System)

Since this bump is around the crossover point, I experimented with different crossover calculations for the tweeter and mid drivers. This helped smooth out the bump at 1,500 Hz, but left a bump in the tweeter again so I took another 2dB off with the high shelf filter. A tweeter crossover calculated at 2200 Hz and mid at 700 Hz, with an extra 2 dB off with the high shelf filter is much smoother than the previous crossover calculations.

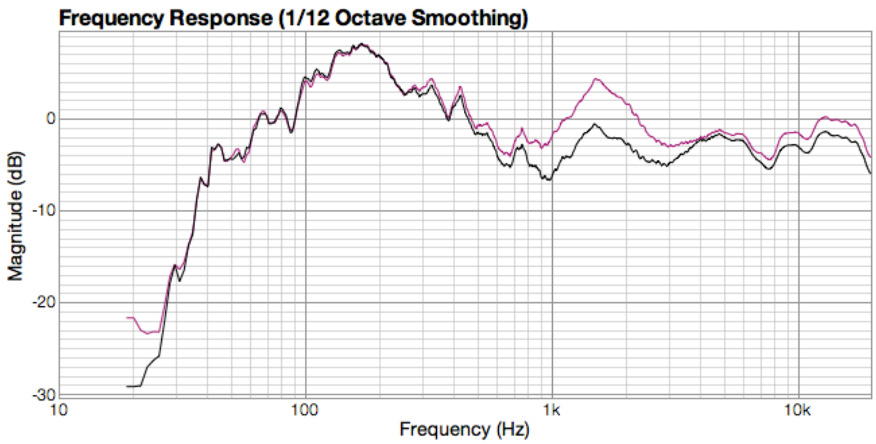

Figure 6: Frequency Response T@2200, M@700, L@570 Hz
5dB High Shelf Filter above 7000 Hz
(Magenta-Previous Response, Black-Full System)

Once my frequency response was relatively level at the crossover point and in the high end, I turned my attention to tuning my ports. I began with ports that were far longer than calculations called for just to make sure that I had room to work with. I measured the port response with these long ports (~18 in), and also with a much shorter port (~9 in), and found that the shorter port produced 2 dB more low end than the long ports. During this process, I also began to add dampening material. It can clearly be seen in Figure 7 that the dampening material lowered some of the mid range noise, as well as extra high frequency noise.

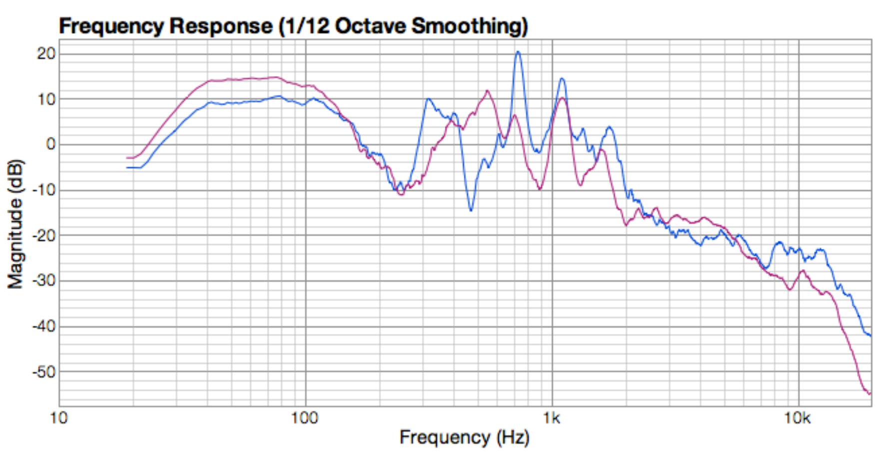

Figure 7: Frequency Response Ports
(Magenta-9 in. Port w/ Dampening, Blue-18 in. Port w/o Dampening)

Once the dampening material was in, and both ports were tuned, the low-end bump around 200 Hz seen in Figures 2-5 was smoothed out.

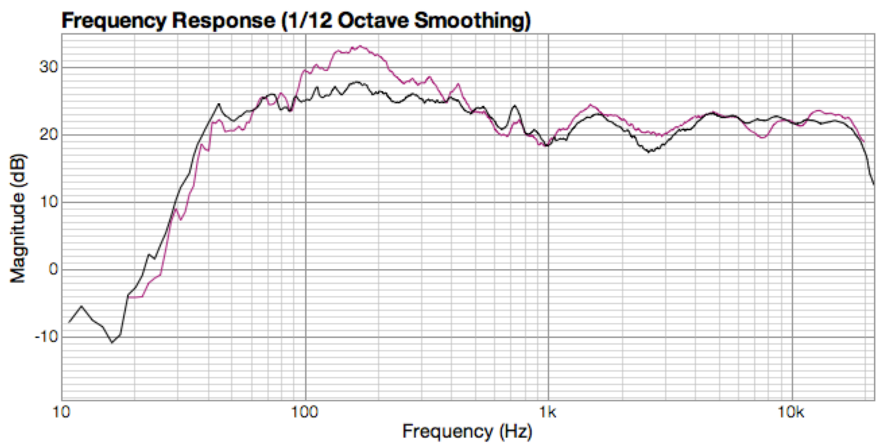

Figure 8: Frequency Response With Ports and Dampening
(Magenta-Previous Response, Black-Full System)

With the new smoothness of the low end, I could see that I had taken too much of the high frequencies off. To finalize my crossover, I eased up on the tweeter pad to bring up the high end, but left the high shelf filter to smooth the natural bump in the tweeter. After a few more crossover changes between the tweeter and the mid range, as well as the mid and low range, I achieved a fairly smooth frequency with at +/- 3 dB variation through out until the f_3 at about 50 Hz.

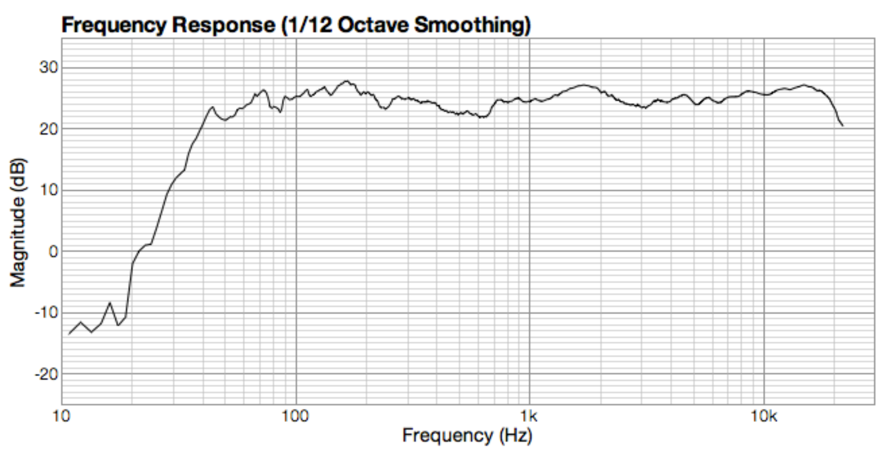

Figure 9: Frequency Response T@900, M@900, L@350, Pad -2dB

Once I had finished my crossover, and most of my measurements, the tweeter I was testing with blew out and I had to finish my tests with a different tweeter. This tweeter had a little bit different frequency response than the previous one, and required about 2 dB more subtraction with the high shelf filter in my crossover.

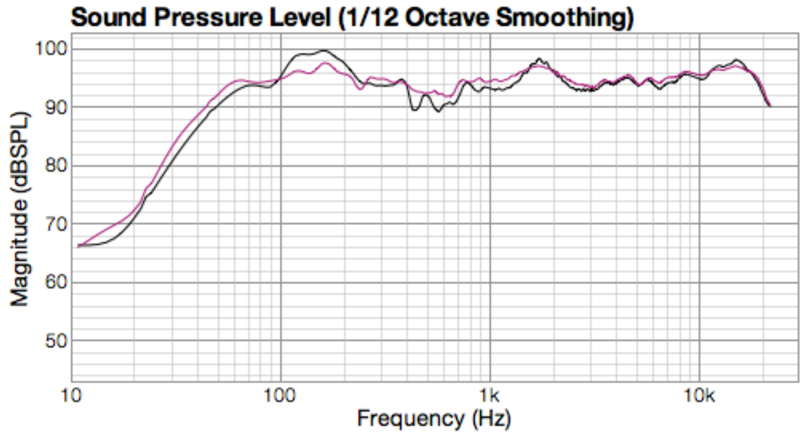

Figure 10: Final Frequency Response T@900, M@900, L@350, Pad -2dB
7dB High Shelf Filter above 7000 Hz
(Magenta-Previous Response, Black-Full System)

Overall Loudspeaker Performance

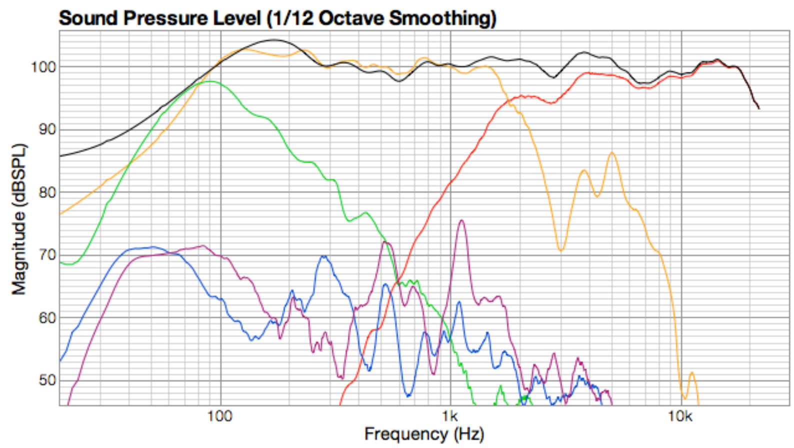

Figure 11: Frequency Response
(Black-Full System, Red-Tweeter, Yellow-Mid,
Green-Low, Magenta-Top Port, Blue-Bottom Port)

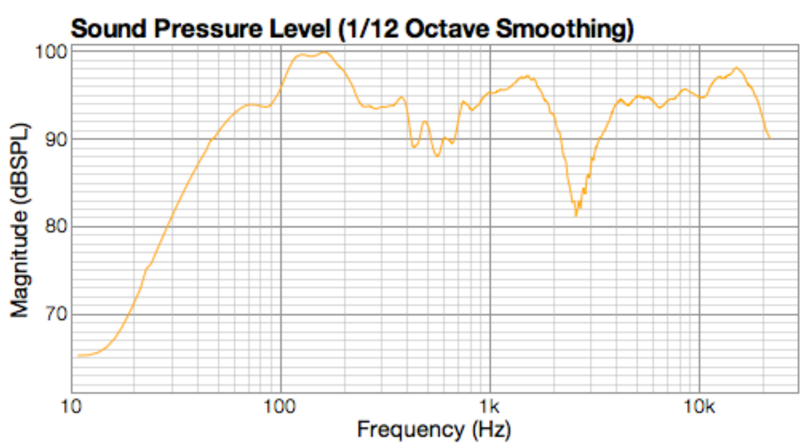

Figure 12: Reverse Tweeter Polarity Frequency Response

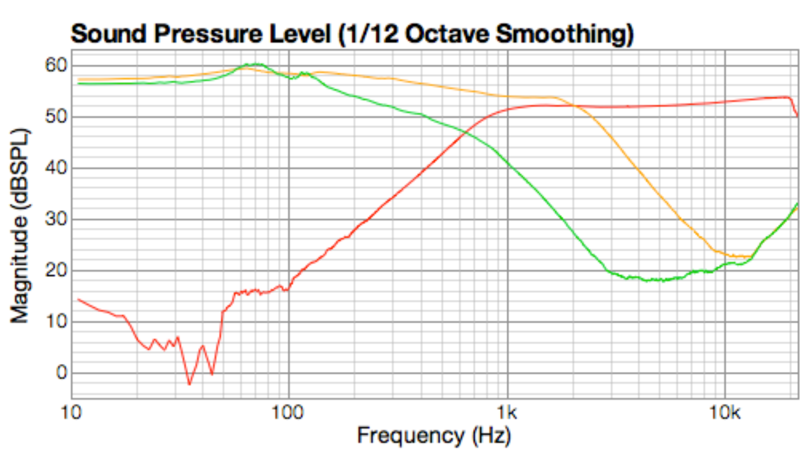

Figure 13: Electrical Crossover Response (Red-Tweeter, Yellow-Mid, Green-Low)

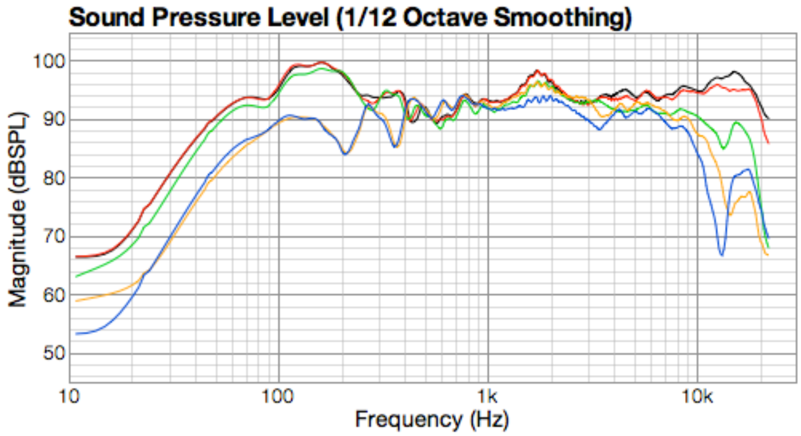

Figure 14: Horizontal Off Axis Response of System
(Black-0°, Red-15°, Green-30°, Yellow-45°, Blue-60°)

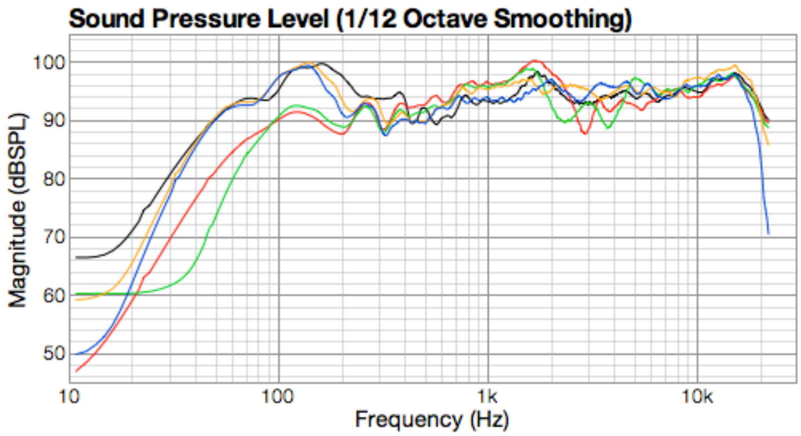

Figure 15: Vertical Off Axis Response of System
(Black-0°, Red-15°, Green-30°, Yellow-45°, Blue-60°)

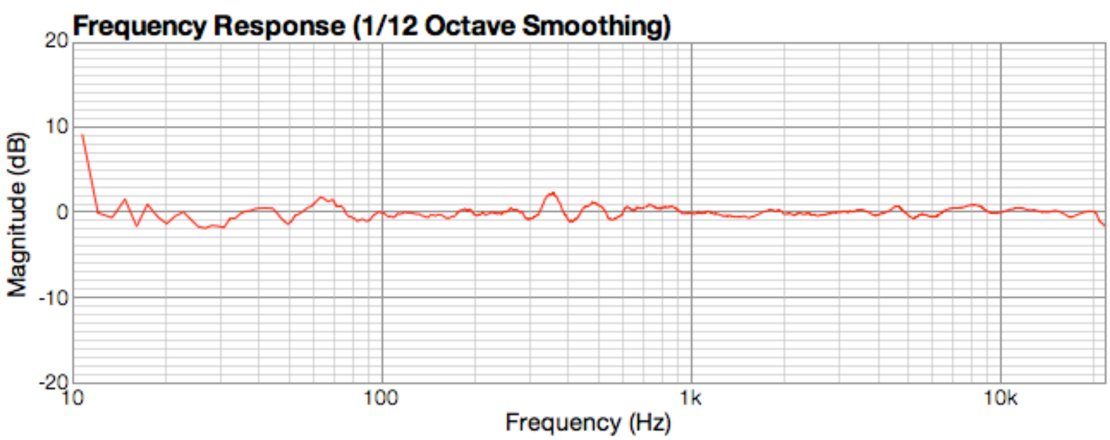

Figure 16: Difference Between Left and Right Speakers

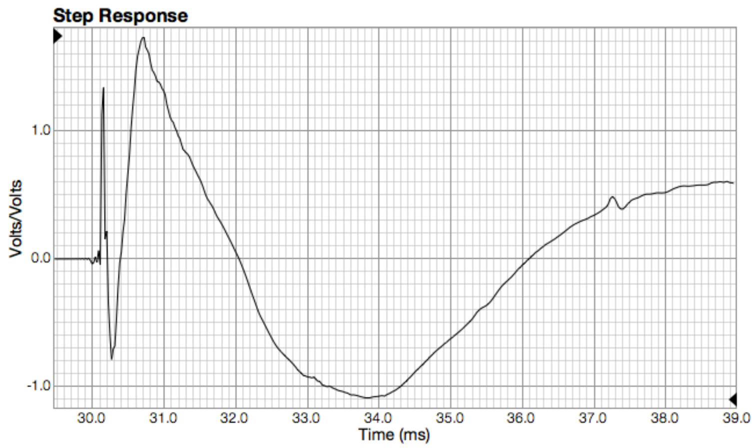

Figure 17: Full System Step Response

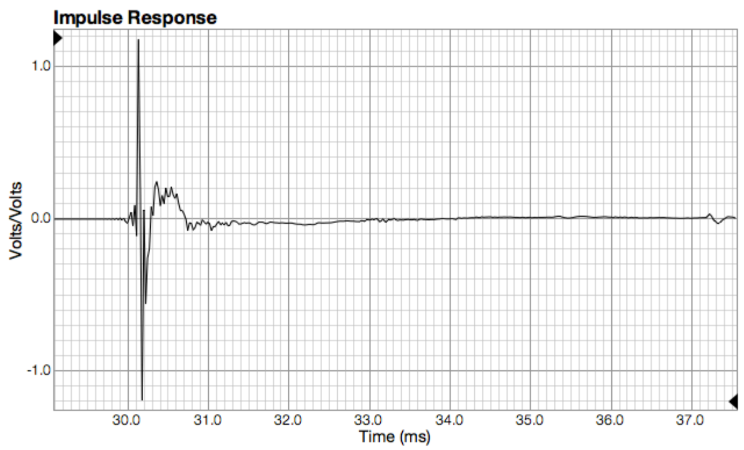

Figure 18: Full System Impulse Response

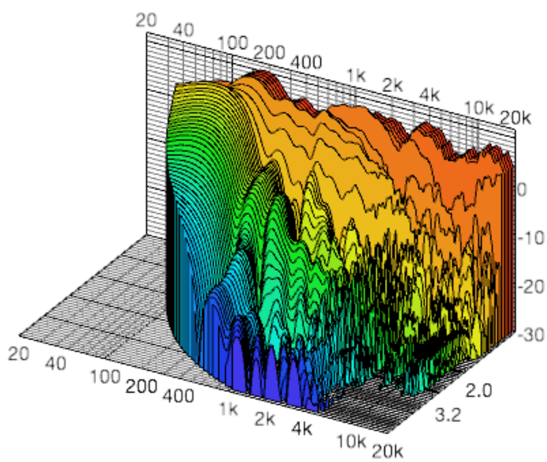

Figure 19: Full System Energy Decay

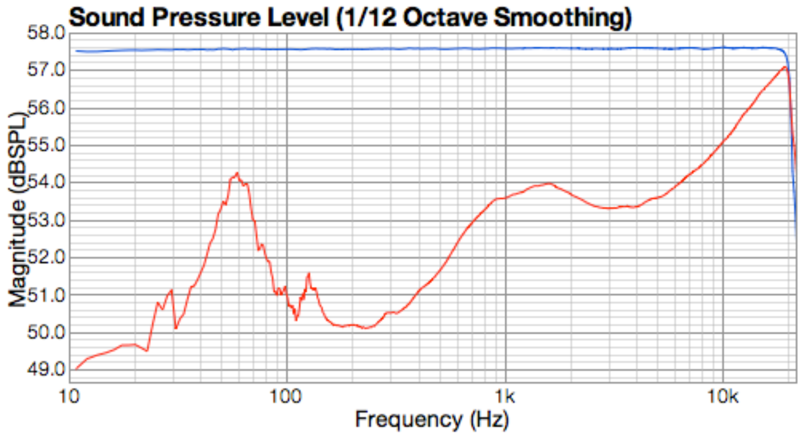

Figure 20: Full System Impedance (Red-System, Blue-8 ohm resistor)

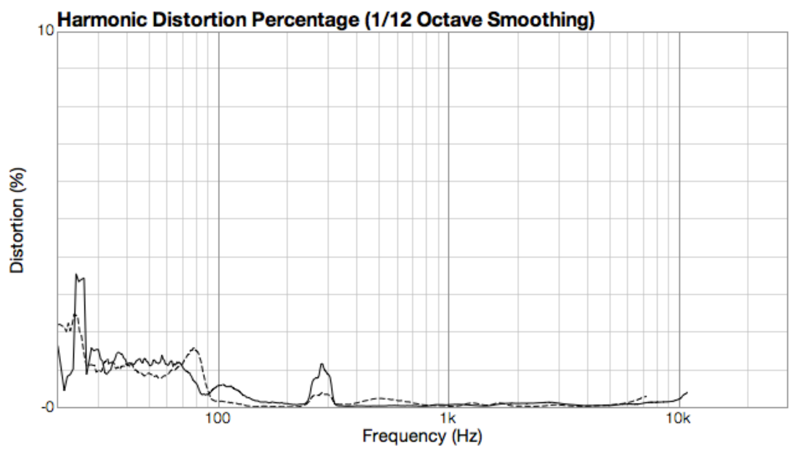

Figure 21: Full System Harmonic Distortion Percentage

Tweeter Performance

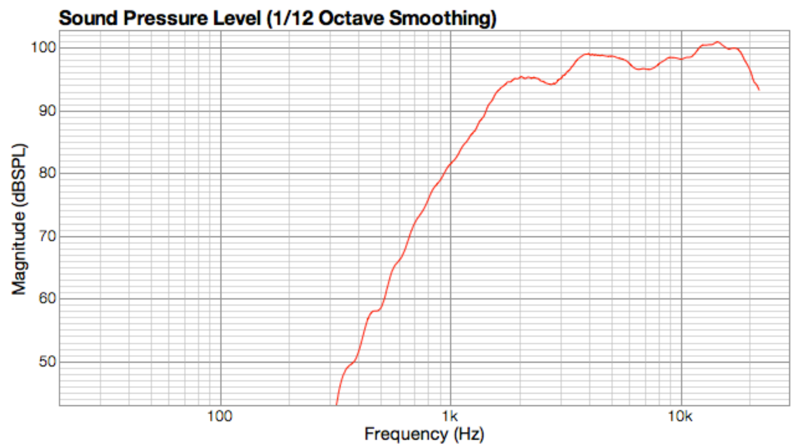

Figure 22: Tweeter Frequency Response

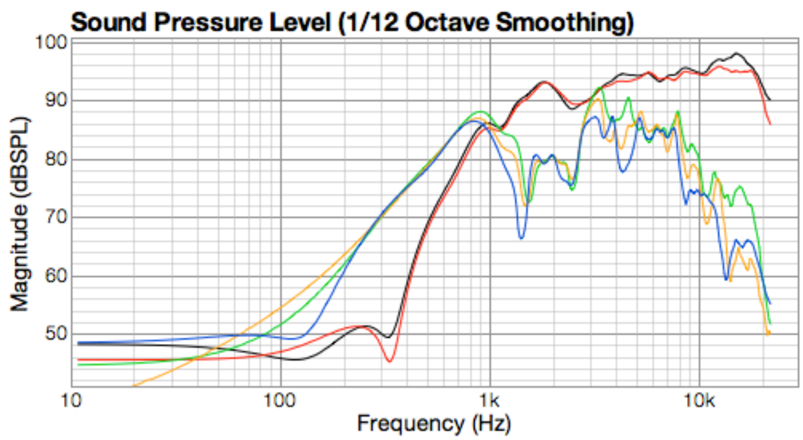

Figure 23: Horizontal Off Axis Response of Tweeter
(Black-0°, Red-15°, Green-30°, Yellow-45°, Blue-60°)

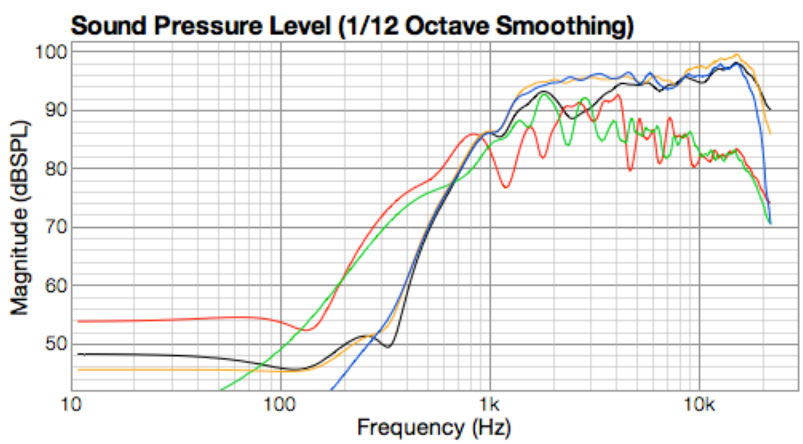

Figure 24: Vertical Off Axis Response of Tweeter
(Black-0°, Red-15°, Green-30°, Yellow-45°, Blue-60°)

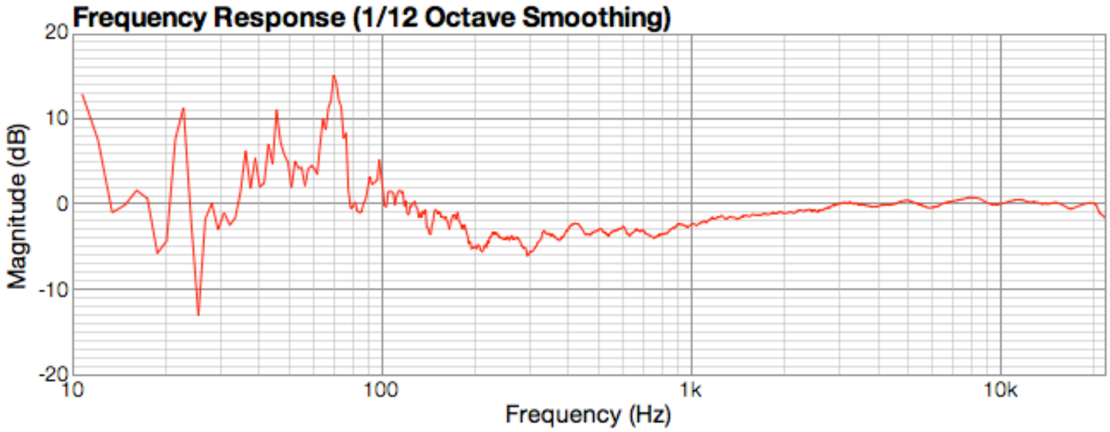

Figure 25: Difference Between Left and Right Tweeters

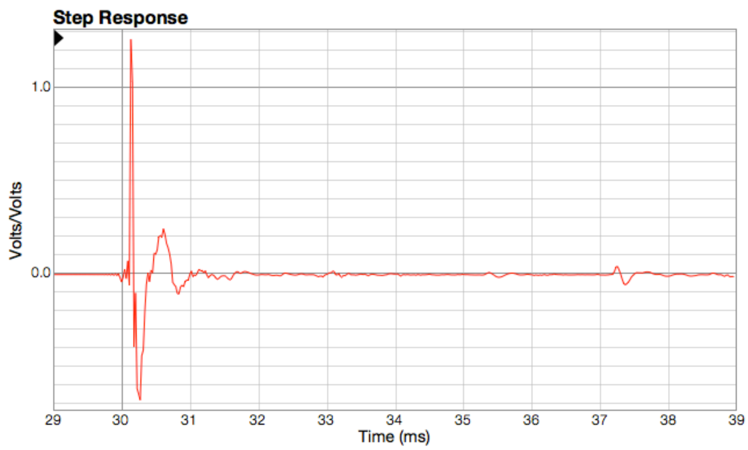

Figure 26: Tweeter Step Response

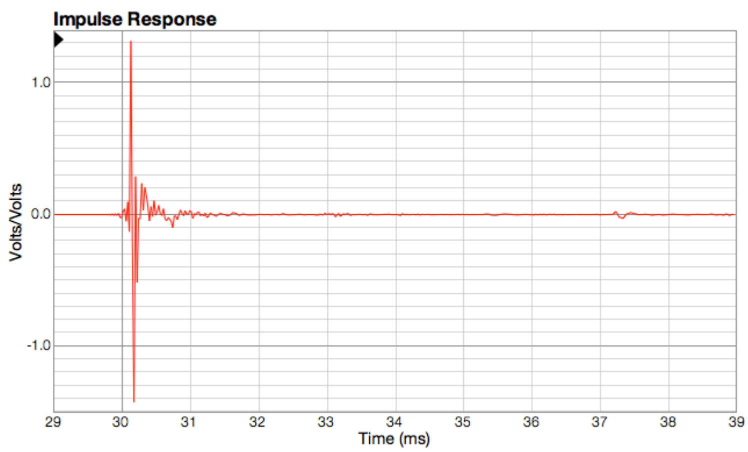

Figure 27: Tweeter Impulse Response

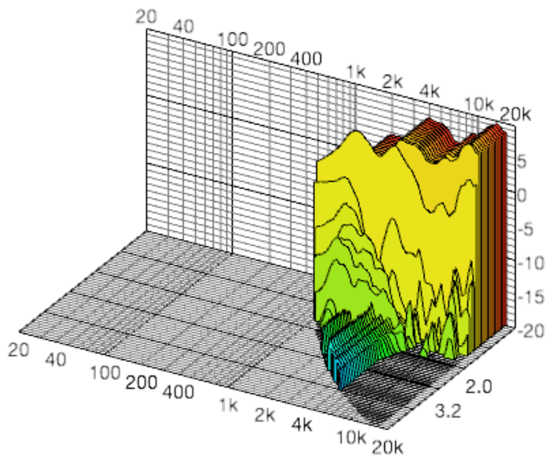

Figure 28: Tweeter Energy Decay

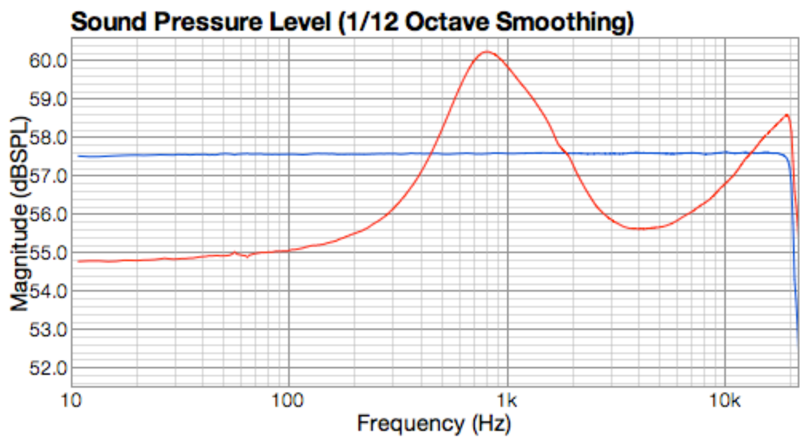

Figure 29: Tweeter Impedance (Red-Tweeter, Blue-8 ohm resistor)

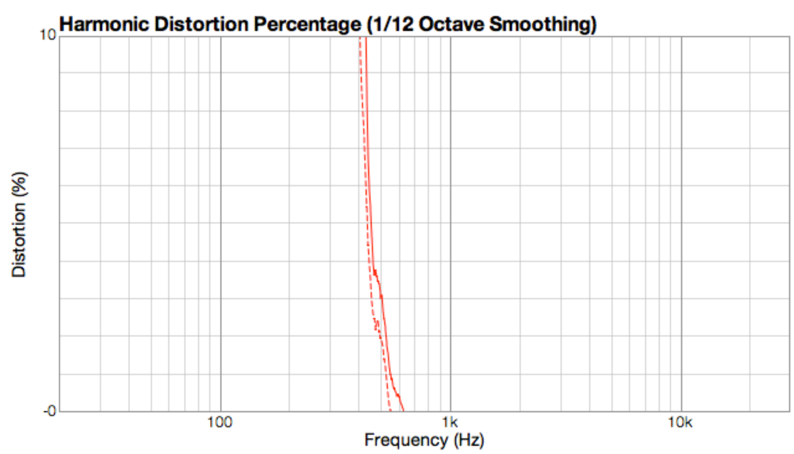

Figure 30: Tweeter Harmonic Distortion Percentage

Mid Woofer Performance

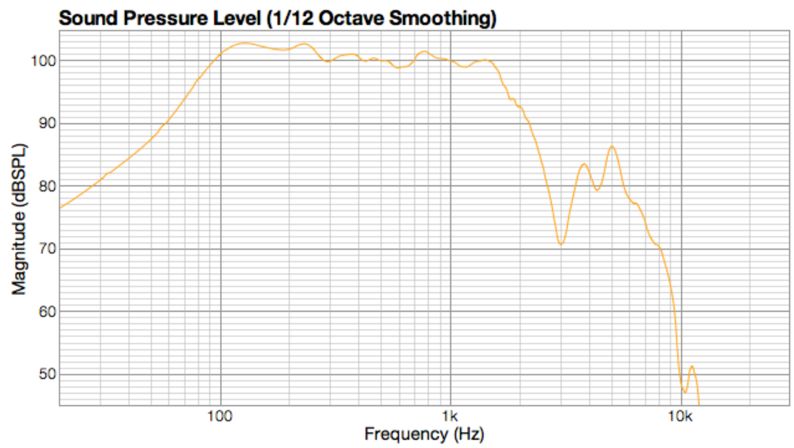

Figure 31: Mid Woofer Frequency Response

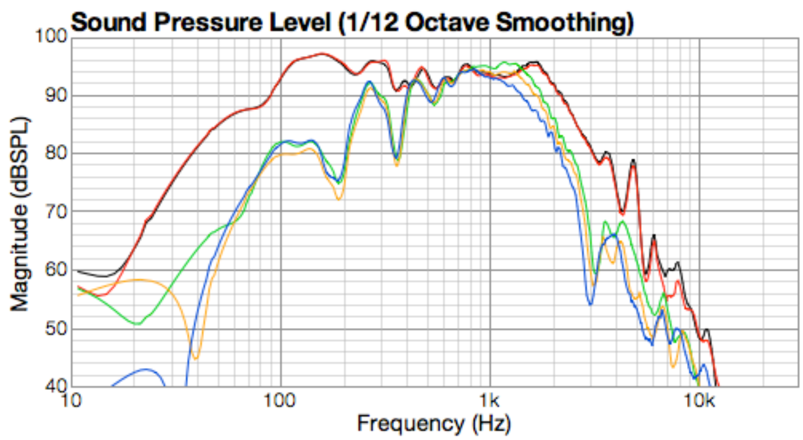

Figure 32: Horizontal Off Axis Response of Mid Woofer
(Black-0°, Red-15°, Green-30°, Yellow-45°, Blue-60°)

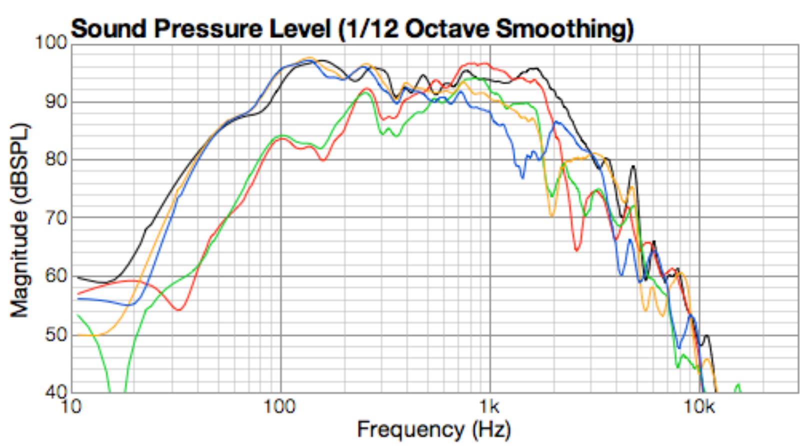

Figure 33: Vertical Off Axis Response of Mid Woofer
(Black-0°, Red-15°, Green-30°, Yellow-45°, Blue-60°)

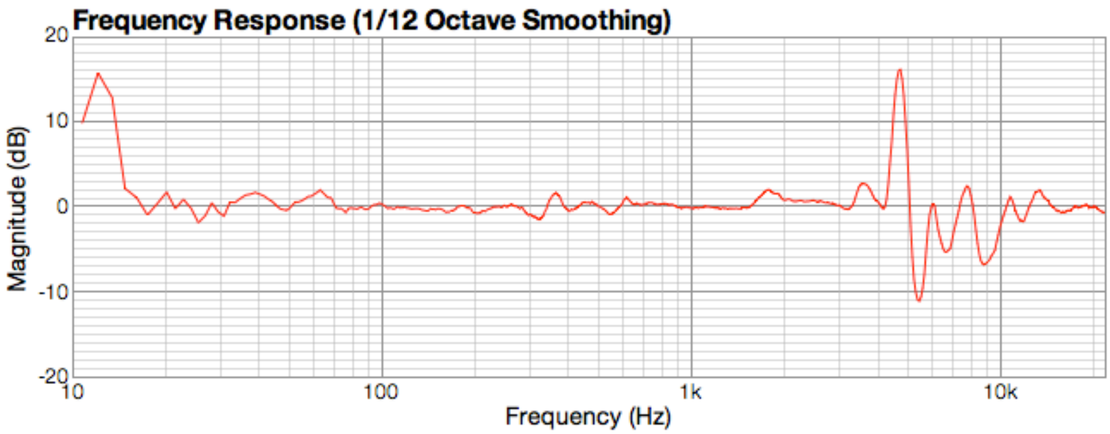

Figure 34: Difference Between Left and Right Mid Woofer

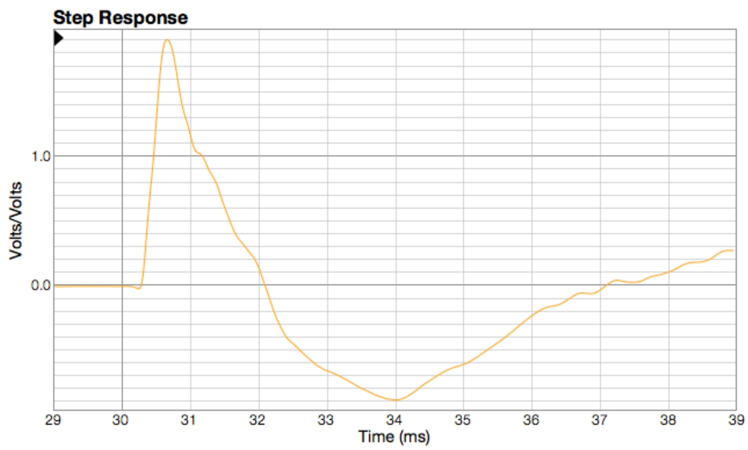

Figure 35: Mid Woofer Step Response

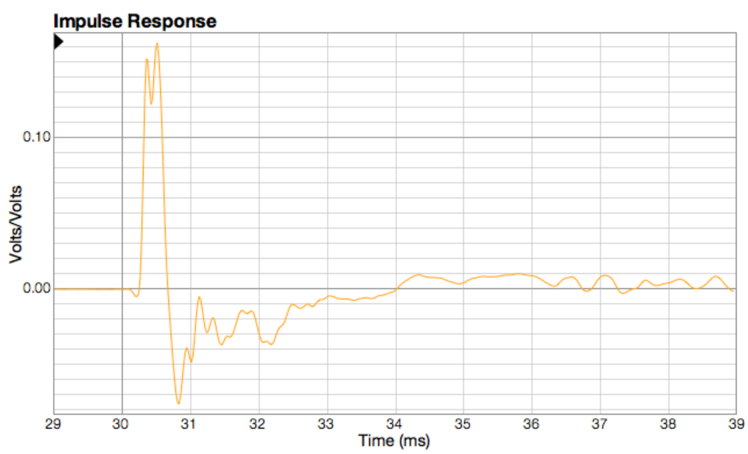

Figure 36: Mid Woofer Impulse Response

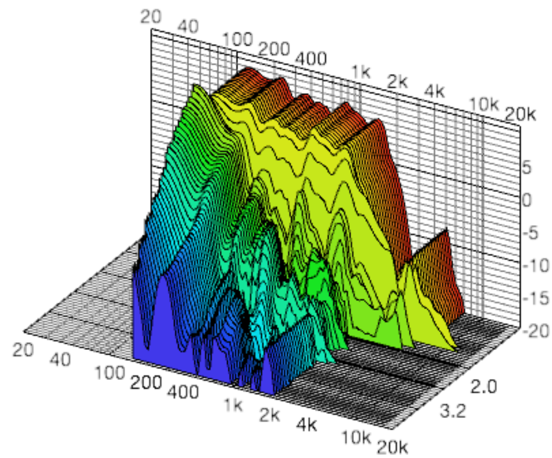

Figure 37: Mid Woofer Energy Decay

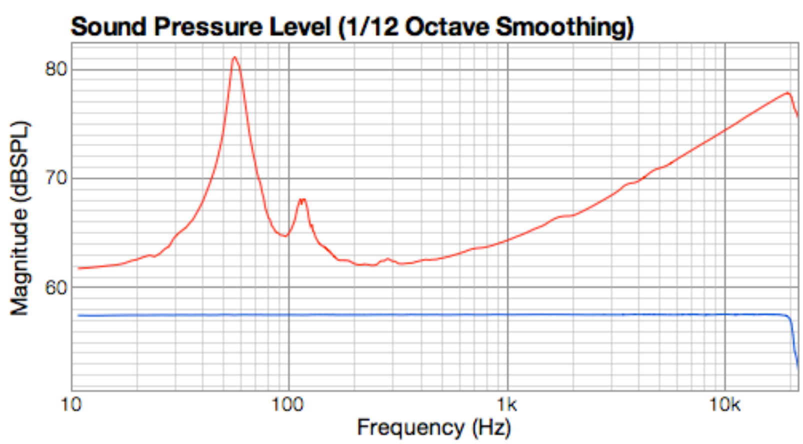

Figure 38: Mid Woofer Impedance (Red-Mid Woofer, Blue-8 ohm resistor)

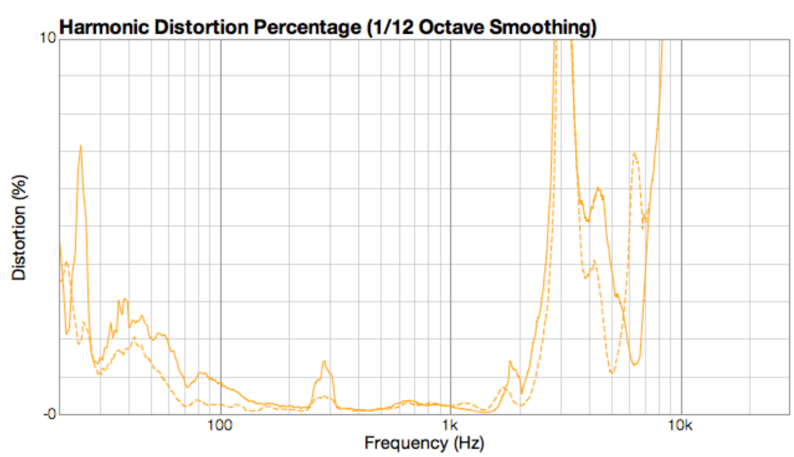

Figure 39: Mid Woofer Harmonic Distortion Percentage

.5 Woofer Performance

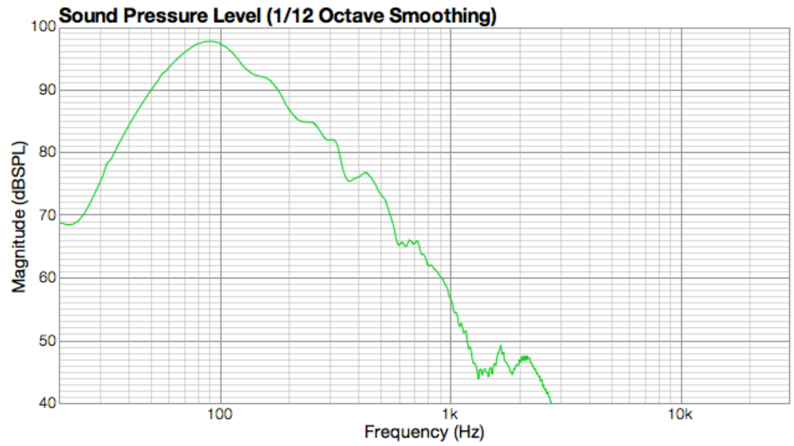

Figure 40: .5 Woofer Frequency Response

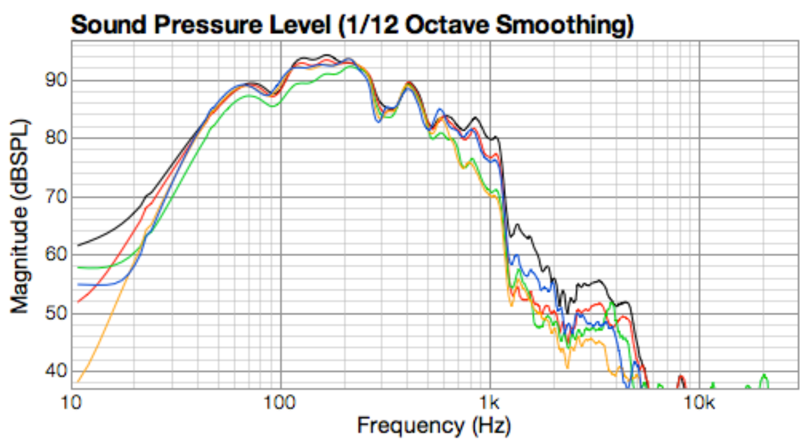

Figure 41: Horizontal Off Axis Response of .5 Woofer (Black-0°, Red-15°, Green-30°, Yellow-45°, Blue-60°)

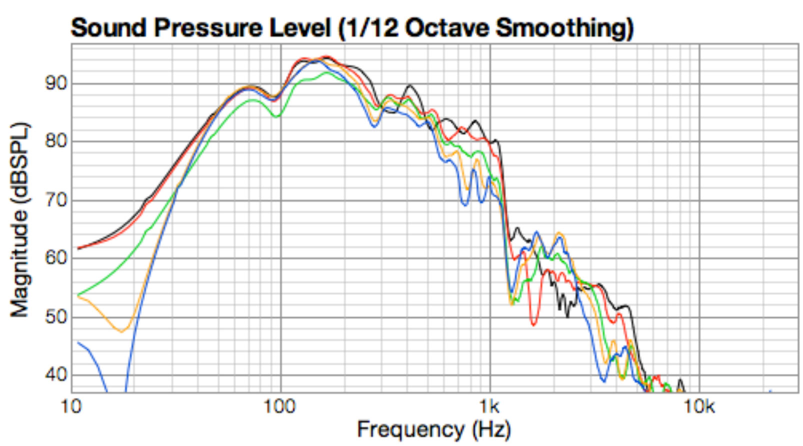

Figure 42: Vertical Off Axis Response of .5 Woofer (Black-0°, Red-15°, Green-30°, Yellow-45°, Blue-60°)

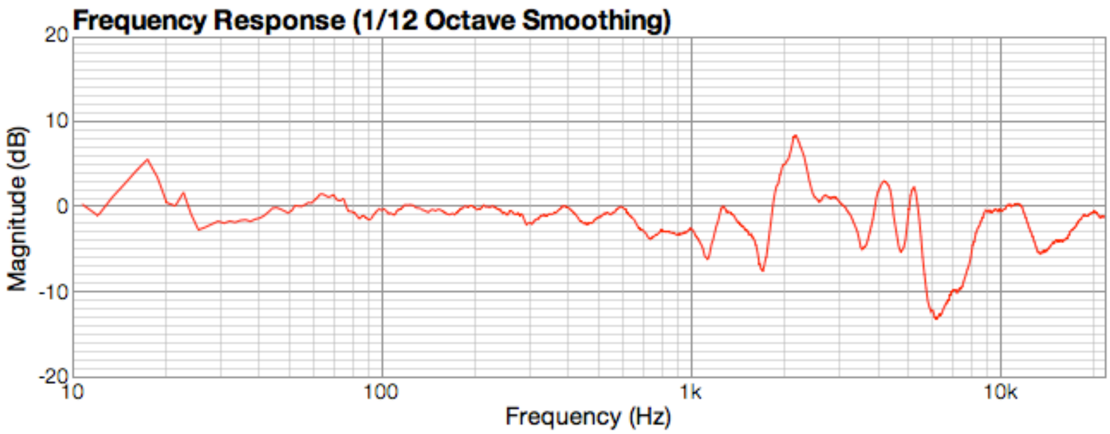

Figure 43: Difference Between Left and Right .5 Woofer

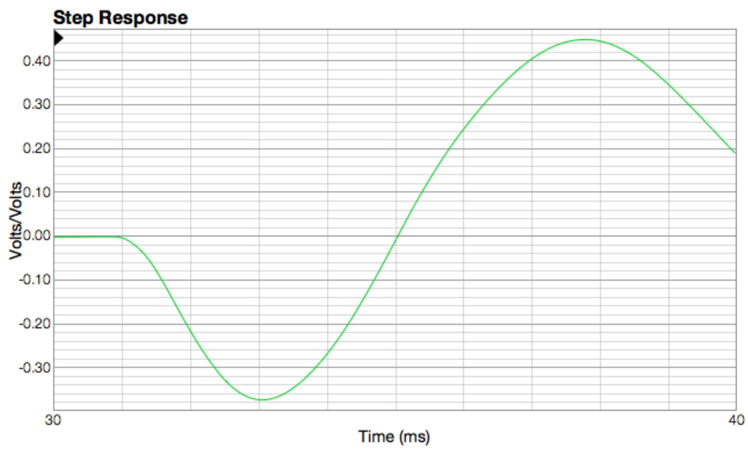

Figure 44: .5 Woofer Step Response

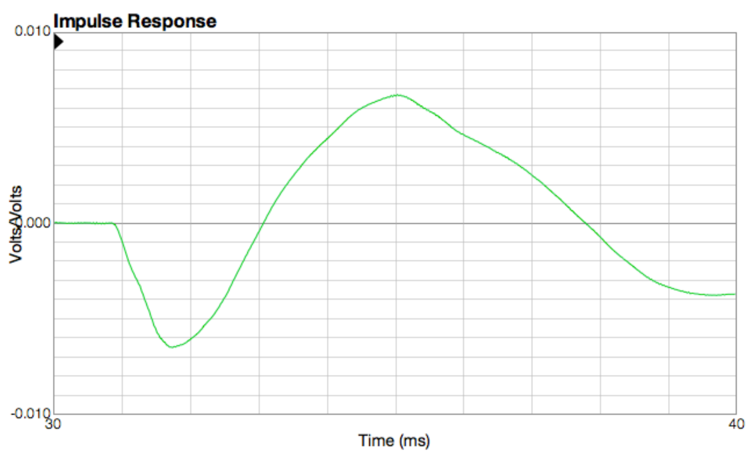

Figure 45: .5 Woofer Impulse Response

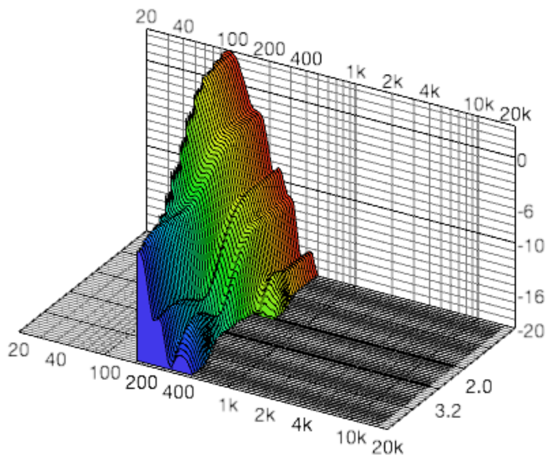

Figure 46: .5 Woofer Energy Decay

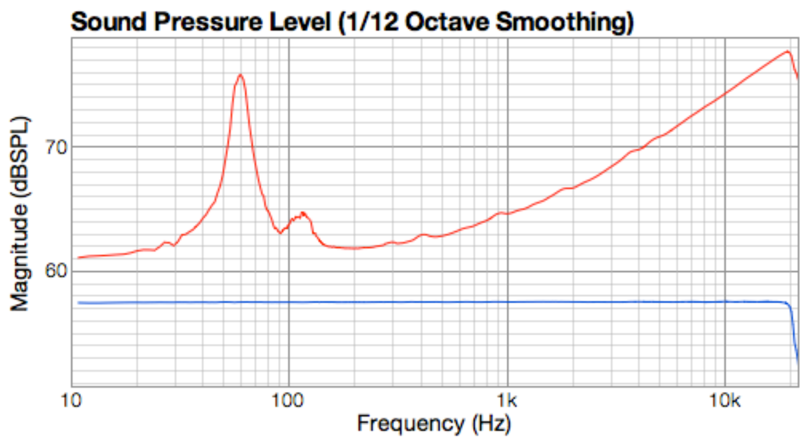

Figure 47: .5 Woofer Impedance (Red-Low Woofer, Blue-8 ohm resistor)

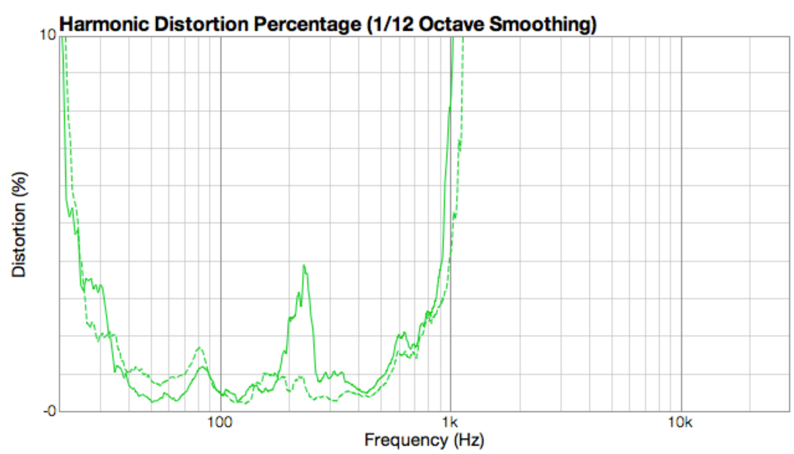

Figure 48: .5 Woofer Harmonic Distortion Percentage