

The Crimson Bass Monsters

Full-Size 2-way Transmission Line with active DSP, Morel H8.1 Woofer and SB Acoustics Ceramic-Aluminum Tweeter



I have always loved the challenge and elegance of 2-way systems. The goal of this system was to elicit truly authoritative bass from a 9" bass driver; to enjoy the warm radiant effortless sound of a full-size Transmission Line; to achieve extraordinary definition in the top octaves, along with creamy uncolored midrange. And finally to put them in a beautiful "race car red" cabinet.

I built my first transmission line system in 1985 when I was in high school. I used the classic Dynaudio 22W75 and Dynaudio D28 horn tweeter. Considering I was only 16

years old, that system was pretty darn good. They had superb power handling, decent bass and beautiful midrange. The crossover was very simple and the blend from woofer to tweeter was admirable.

But there were still a lot of things I didn't understand about TLs. There was no realistic way for someone like me to model TLs on a computer back then. First of all the software didn't exist; secondly, truly accurate mathematical models didn't exist either; and even if I had both of those things, I still would have had to lay my hands on a computer.

One of the worst things you can do with a Transmission Line is make the line cross section too small, and that was one of my rookie mistakes. The 22W75 was a high Q woofer. I figured that made it perfect for a TL, because of the damping of the back wave. I didn't understand that what I was really achieving with a high-Q and too-narrow enclosure was *anemic* bass.

I also was under the mistaken impression at the time that the job of a TL was to dampen the bass, when in fact it is to minimize cone excursion at resonance and *amplify* bass.

That's why bass below 40Hz was anemic in my 1985 system... but it was pretty decent at 50Hz and above. Every single one of my friends who came over and listened to *The Rhythm of the Heat* by Peter Gabriel was blown away. So... not bad for a 16-year-old with a \$150 budget.

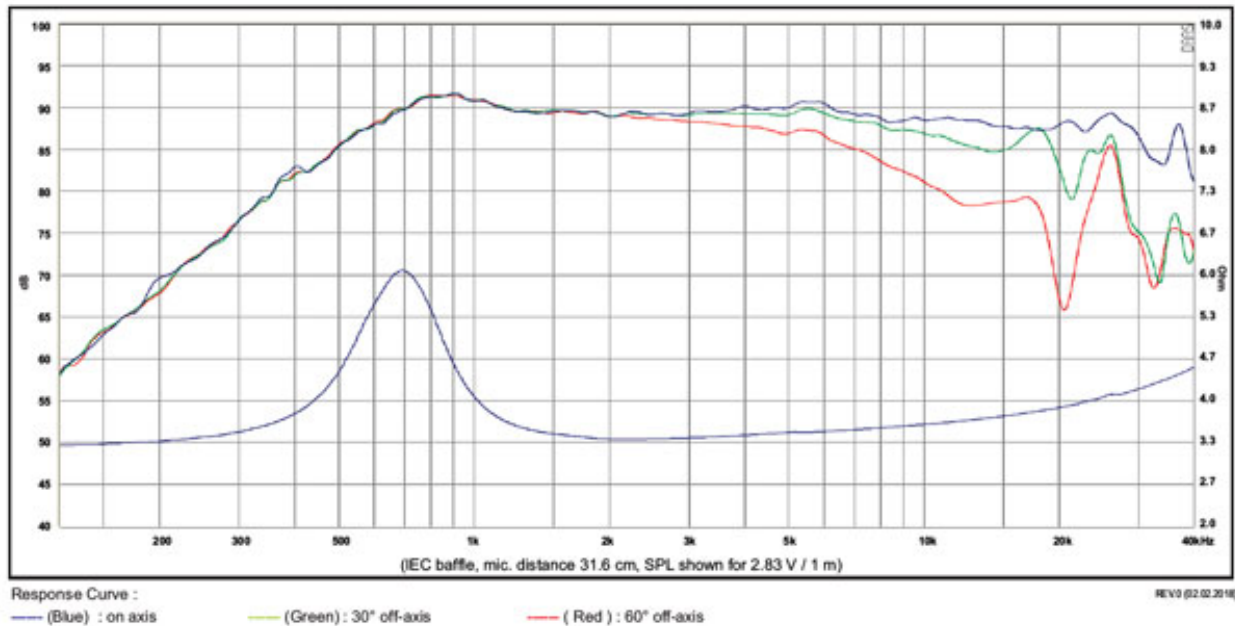
I quickly figured out that the Morel 9" woofers were virtually clones of the Dynaudios, less expensive and easier to obtain. I've always been partial to Morel drivers – virtually indestructible classic designs with very fine sound. I then made numerous iterations of that design and sold many systems to friends. A couple years later I sold them through an audio dealer for a time.

Fast forward to modern times and armed with good computer models I wanted to take a second run at this design. I chose the Morel H8.1 woofer:

<https://www.parts-express.com/pedocs/specs/297-066-morel-h81-specifications.pdf>

Which has a strong magnet and low Q of 0.29 (which increases the leverage of the TL) and matched it to the SB Acoustics SB26CDC-C000-4 Aluminum-Ceramic Dome Tweeter:

<https://www.madisoundspeakerstore.com/tweeters/sb-acoustics-sb26cdc-c000-4-alum-ceram-dome-tweeter/>



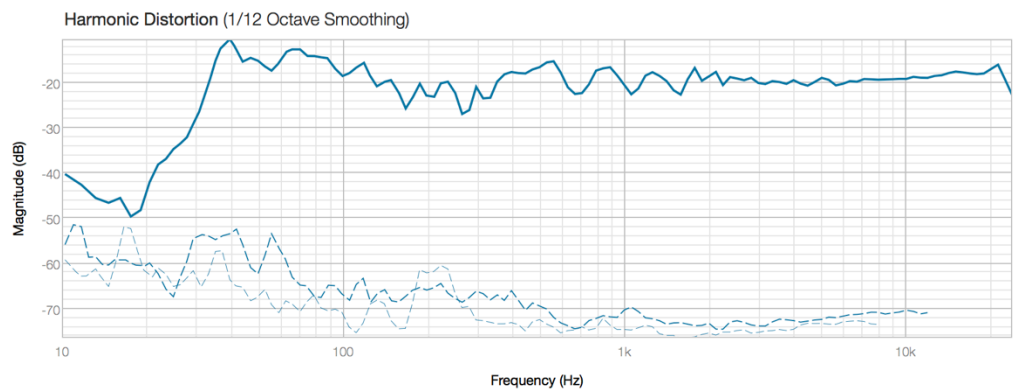
This tweeter is without doubt one of the best tweeters I've tried. It has better off-axis response than most 1" domes, on-axis response to almost 40KHz and a very precise, highly detailed sound that, while somewhat analytical, only slightly exhibits the hard sound that is typical of metal dome tweeters. As you can see the dome breakup is very well controlled. This is a very high quality "Danish tweeter."

In the back of the speaker, in the bass port, I mounted a 1" polycarbonate dome tweeter to add high-end back fill. The SB tweeter is connected directly to the amp, but the rear tweeter adds a 4.7uF capacitor in series. The woofer is connected directly to the amp with no passive crossover components.

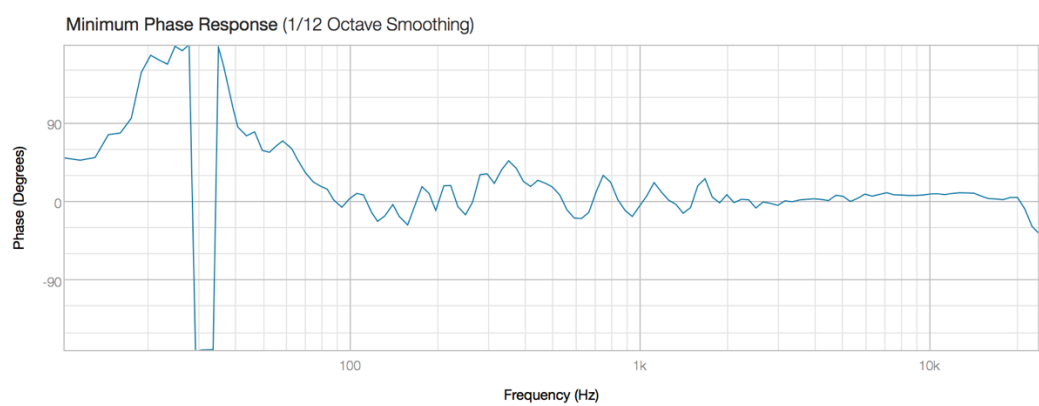
I chose a MiniDSP 2x4HD digital crossover. I like this unit because it has analog, USB and fiber inputs; and has both IIR and FIR signal processing. I used both IIR and FIR on the tweeters to achieve linear phase.

These measurements were taken in my room with no attempt to approximate "anechoic response." They include room and floor reflections. Microphone distance is about 1 meter.

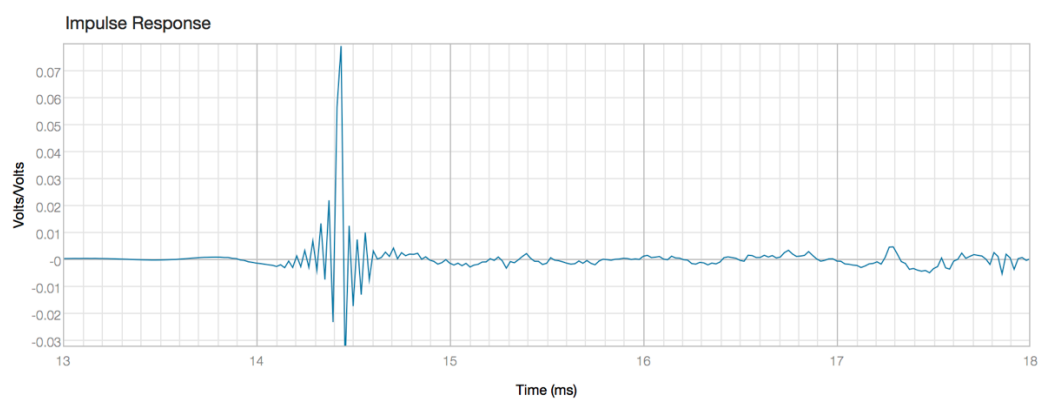
Frequency Response and Distortion:



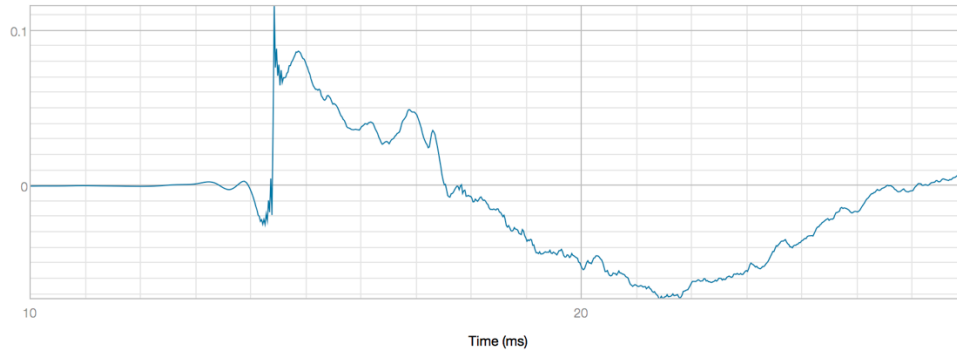
Phase Response:



Impulse Response:



Step Response:



Linear phase and clean impulses translate into superb imaging, depth and incredible detail. These speakers excel at percussion. You have no difficulty hearing fine details like whether drumsticks have wood or plastic tips. Ghost notes on a snare drum give you the full sound of the shell and the wires.

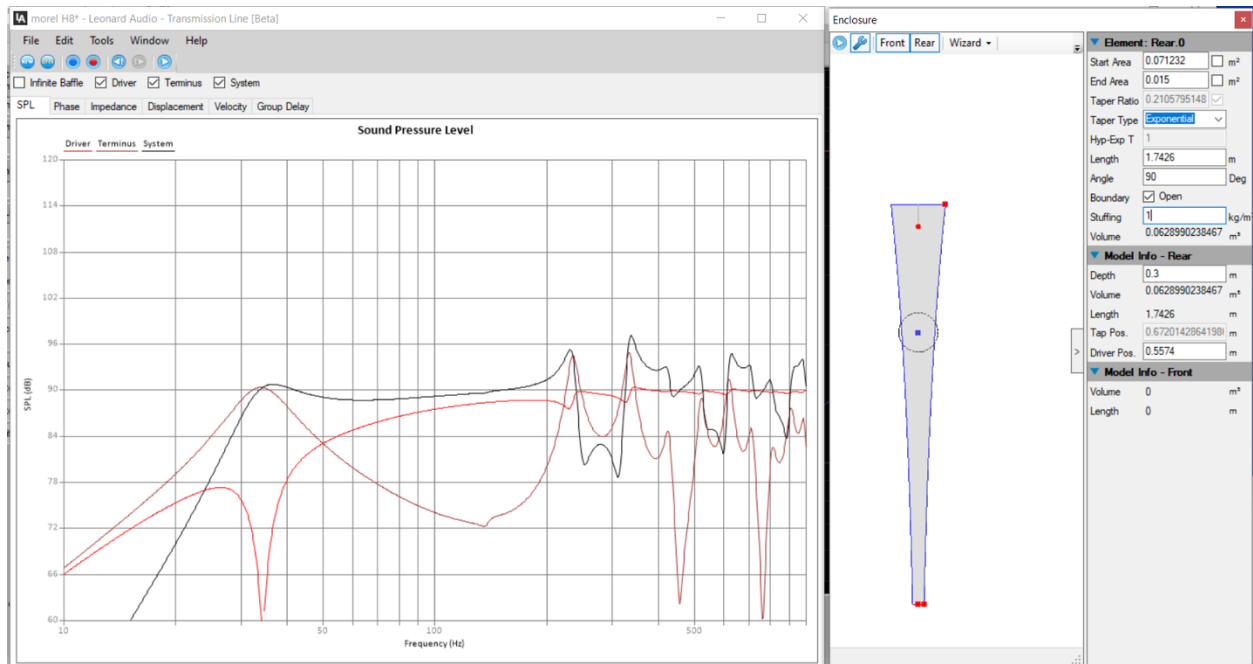
As you can see in the step response, there is some ringing at low frequencies. This is inevitable unless you build a highly damped system with a very gradual rolloff. (A popular myth is that a transmission line is non-resonant. It's not. It's a calculated and controlled resonance.)

When people say TLs "sound non-resonant" what they really mean is they don't sound *boxy*. Sealed and ported speakers almost always sound boxy, and I think a transmission line actually adds a more complex radiation pattern and time signature which to the human ear sounds more like real musical instruments and less artificial.

I wrote a Transmission Line modeling paper in college for one of my Electrical Engineering classes. It's online here:

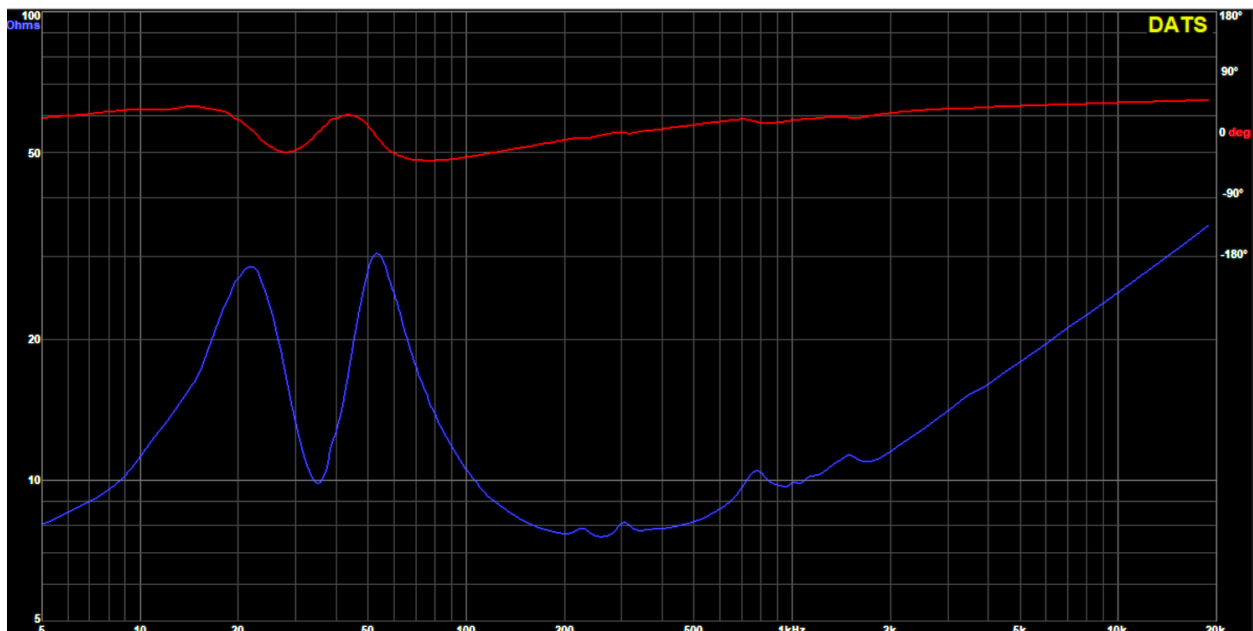
<https://www.perrymarshall.com/articles/industrial/transmission-line/>

An overdamped system will sound anemic, and what I wanted was open, plump, rich, unconstructed bass. You will get that from a woofer with high BL product (=strong magnet) and a spacious transmission line. Below is the computer model of the TL design:



As you can see from the impedance plot below, the predicted resonance of 35Hz matches the measured resonance of 36Hz.

The box only has stuffing below the woofer (in the first ¼ of the line basically) – no stuffing anywhere else. I find that stuffing makes TLs sound congested. The computer model also predicts a peak just above 200Hz which I did have to compensate for with the DSP filter and which also shows up in the impedance curve.

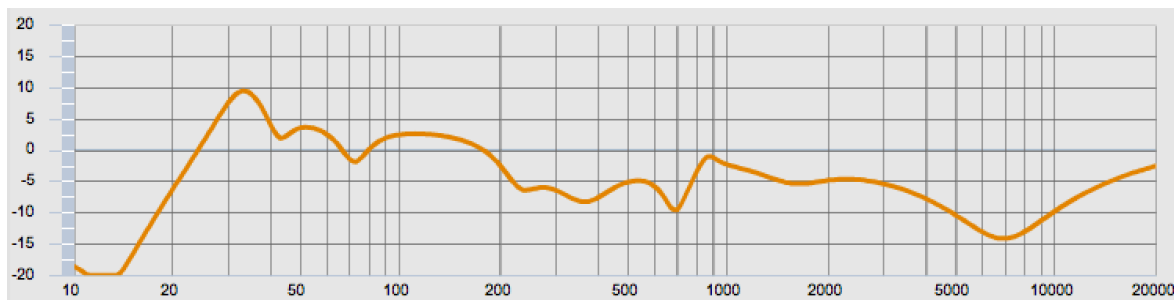


The crossover frequency is 1700Hz; the woofer rolls off naturally there. I also had to compensate for some irregularities in the woofer's response between 500Hz and 1000Hz. In the impedance curve you can see a resonance at 800Hz for example and that is a cone breakup mode.

As a former speaker designer (I worked at Jensen for 3 years in the 1990s) I figured I could fix the breakup modes around 800Hz with "edge treat" which is putting a bead of glue around the lip of the surround. This often does the trick but not in this case. It just moved the resonances around. The H8.1 is really designed to be a bass unit so its tradeoffs favor bass over midrange. However I compensated with DSP and the midrange turned out excellent.

These don't play as loud as dedicated 12" or 15" subwoofers, but make no mistake, these can still shake the house. I didn't call them the Crimson Bass Monsters for no reason. Response is 30Hz – 40KHz with extremely high resolution, outstanding imaging, and a very warm "comfort food" sound in the bottom octaves.

Because of the size of the TL, the driver has a lot of leverage and produces excellent output without a lot of excursion.



Above: The DSP curve that I ended up with for the woofers. The rapid roll-off below 30Hz reduces wasted cone excursion. The dips at 43Hz and 73Hz compensate for bass modes peculiar to my room. You can download my MiniDSP files at <https://tinyurl.com/crimsondsp>. These will ONLY work with the MiniDSP 2x4HD.

Joseph Budka (3dsignchicago@gmail.com) cut all the pieces on a CNC machine for me. He is based in Chicago. I imagine he could re-run the design for you if you wish to get in touch with him. Logan Steele (logansteele183@gmail.com) who is an automotive body repair specialist, painted these cabinets bright red. He is also based in Chicago. I was extremely happy with them – they look like they were made from the body of a race car.

Sensitivity is around 89dB for 1 watt. Suitable for amps up to 200W / channel.

Cabinet Plans on next page.

