

Brioso

A transmission line-based "high-end" 2-way

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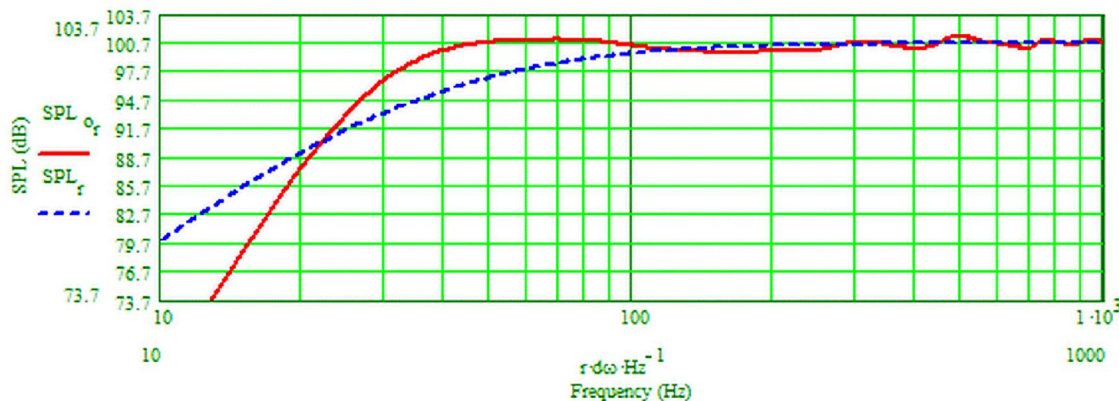


The *Brioso* (Italian for lively) uses a Scan Speak Revelator midwoofer and a Transducer Labs Alumina ceramic dome tweeter in a floor-standing, mass-loaded transmission line enclosure (ML-TL). My goal was to create a speaker with really high definition by using highly-regarded and high-quality drivers, with a transmission line design (of course!) for a bass response in the low-30s. I'm fortunate that cost was not particularly a limitation, but to minimize complexity and keep costs from getting completely out of hand, a 2-way design was chosen.

For the midwoofer I originally planned on using a 4-ohm, 7-inch Scan Speak Illuminator and a Transducer Labs Beryllium tweeter. After discussing these choices with and getting opinions/recommendations relative to cost/performance considerations from several fellow DIYers, especially Dan Neubecker, I decided to use the Scan Speak Revelator 18W/8531G00 along with the Transducer Labs Alumina ceramic tweeter, N26CR2-A. What was "lost" with these choices was ~3 dB in sensitivity, but what was gained was a very amplifier-friendly impedance and a pretty simple crossover, plus a reduction in driver costs of ~\$200 per cabinet, which ultimately paid for all of the required crossover components.

The midwoofer is mounted in a single-fold, ML-TL containing about 1.75 cubic feet of volume with a physical line length of 6 feet. The effective length of the line, however, is almost 6-1/2 feet due to the first half of the line having a mild negative taper (decreasing cross-sectional area), a result of the baffle being tilted back at 5 degrees. The 1/4-wavelength of the line's effective length tunes the enclosure to ~44 Hz. This is not low enough to tune the system to 28 Hz and achieve an essentially flat system bass response, as is appropriate for the midwoofer's f_s and Q_{ts} . The mass-loading port, mounted on the rear panel, completes the system tuning, resulting in a pretty smooth overall bass response shape with a predicted anechoic f_3 of 32 Hz and f_{10} of 23 Hz. The center of the midwoofer is located 37% of the line's length from the line's beginning, a little further than 33%, one of the two optimum positions along a line, but close enough. The port's center is located at 1/6th of the line's length from the end of the line, resulting in the smoothest possible overall response shape, although f_3 is a couple of Hz higher than it would likely be with the port closer to the end of the line. The baffle was tilted back as recommended by Dan Neubecker to aid in reducing diffraction anomalies (along with the three edges of the baffle being chamfered). The bottom 2 inches are separated from the rest of the cabinet by a solid horizontal divider, above which is the TL enclosure, thus creating a pocket at the bottom for housing the crossover assembly (which is mounted on top of the base assembly). With the cabinet on its base, the tweeter's center is located just over 37 inches above the floor, a good location relative to the typical ear height range of 36-38 inches. I used Martin King's ML-TL Corner worksheet, Rev. 8/14/09, to model the transmission line.

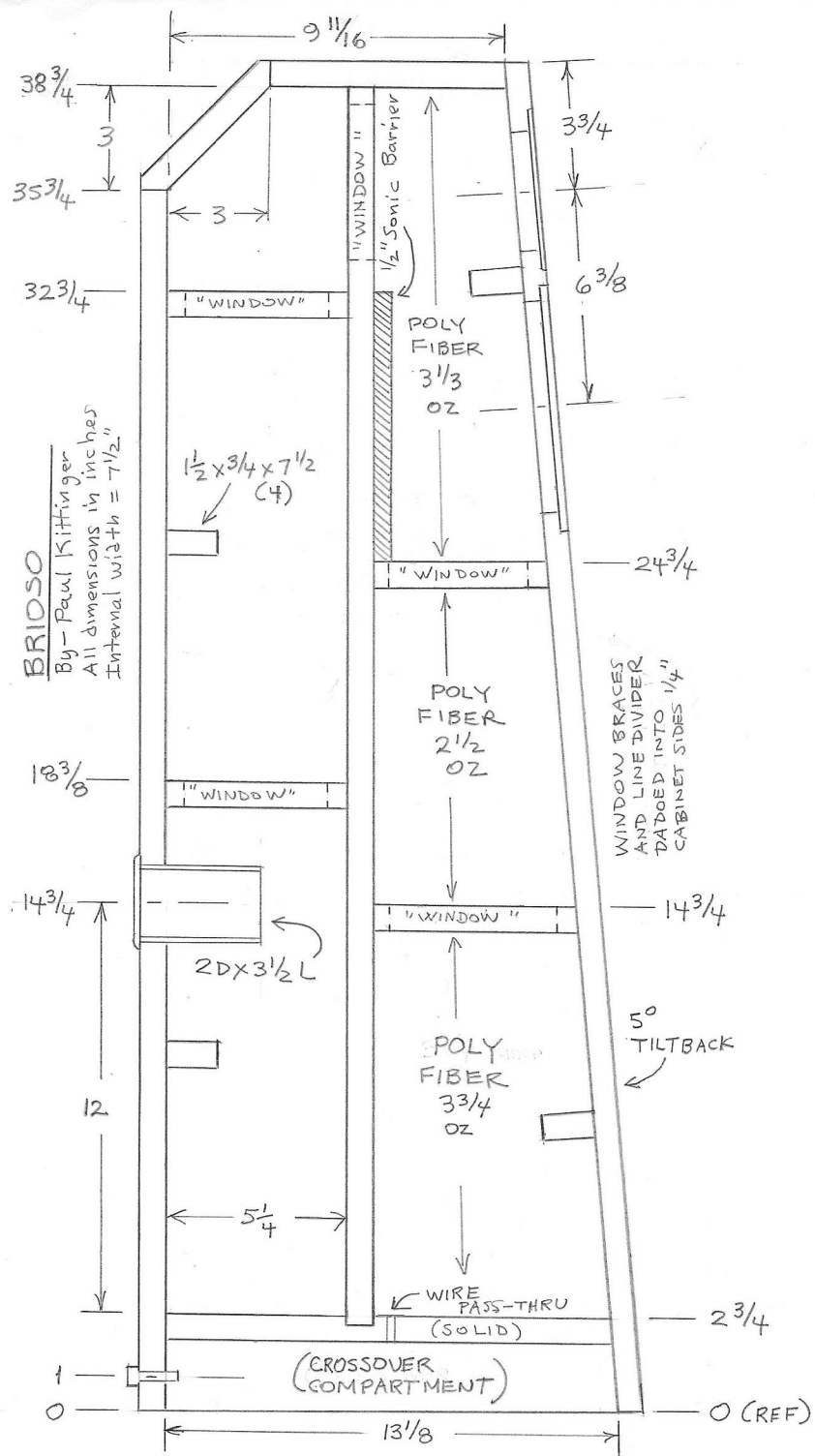
Modeled anechoic system bass response for an input of 22 w/1m (red line):



Other than the baffle, the cabinet is made from 18-mm Baltic Birch Plywood (BBP) that I veneered with Jatoba (Brazilian cherry). The baffle is constructed from solid, 3/4-inch hardwood, red oak down the middle flanked on both sides and above the tweeter by Jatoba. A vertical divider located about halfway back in the cabinet's depth creates the single-fold line, with the line starting in front of the divider at the bottom of the cabinet, going up to the top and making a U-turn, then going down the back to end at the bottom of the cabinet. Polyester fiber fills the whole front of the cabinet, which is the first half of the line, and the stuffing density is 0.75 lb/ft³. I used 1-inch thick Dacron batting, but loose polyester "pillow" stuffing performs the same. Loose stuffing, however, has to be weighed, then teased and fluffed during installation, whereas the Dacron batting has an inherent density of 0.75 lb/ft³, only needing to be cut to shape and layered in without teasing or compression, and will stay where placed. There are four horizontal "window"

braces, two located between the line divider and baffle, and the other two between the line divider and the back panel. The window braces are inset in 1/4-inch deep dados in each cabinet's sides, as is the line divider which is also inset in a similar dado in the top of the solid, horizontal divider above the 2-inch cavity at the bottom of the cabinet. There are 4 additional braces, each 1-1/2 inches wide, spanning the width of the cabinet, with two located on the back and the other two located on the front to create additional attachment areas for the rear panel and baffle. The Jatoba veneer looked much like walnut in its unfinished state, but a single coat of polyurethane brought out the reddish tint hidden in its primarily brown color. The Jatoba hardwood for the baffle, however, wasn't nearly as dark in raw form as was the veneer, but I found that a single coat of red mahogany oil stain, followed by a coat of polyurethane, created a pretty good match. In the end, I applied a total of 5 coats of satin polyurethane to the whole cabinet. The first two coats were applied with a foam brush for thickness, and the last 3 coats were wiped on, with light sanding performed after the brushed-on coats, and smoothing out the wiped-on coats with Norton Super Fine (0000) plastic "steel wool" pads. All of the cabinet, excluding the baffle, was assembled and veneered first. The baffle was created by edge-gluing together four pieces of hardwood, three of Jatoba and one of red oak. The baffle was built slightly over-sized, then clamped to the front edges of the assembled, veneered cabinet and trimmed to an exact match with a router and flush-trimming bit. After removing the trimmed baffle, the edges of its two sides and top were chamfered, then driver through-holes and flange recesses were cut. The base assembly is made from 1-1/2-inch square red oak on all four sides attached to the four edges of a piece of 18-mm BBP that form its top plate where the crossover assembly is attached.

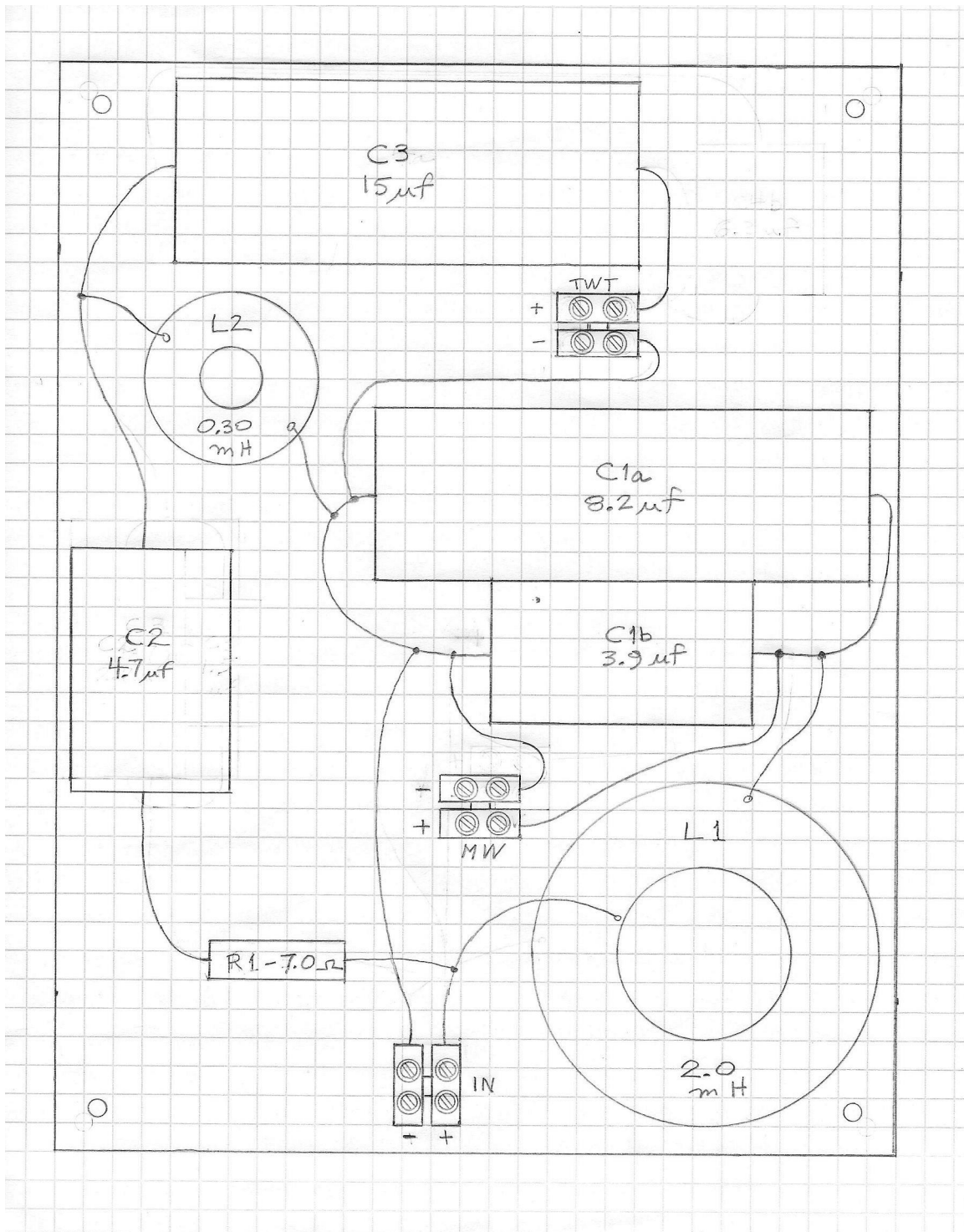




Dan Neubecker designed the crossover and told me it was the easiest design he's ever done, adding that his one-word description of the system's sound was "smooth". The corner frequency is ~2.1 kHz with an LR4 slope on the tweeter and a relaxed LR4 slope on the woofer. It has an amplifier-friendly impedance that drops to a "low" of 7.5 ohms between 100 and 250 Hz, plus excellent phase matching and tracking. Depending on capacitor choices (more on this later) only 6 components are needed; 2 inductors and 3 capacitors with a single resistor at the front of the tweeter's crossover. The system's midrange and high frequency response is very flat up to ~11 kHz, and rolls off by about 5 dB at 20 kHz. I built the crossovers per the original design (5-ohm tweeter resistor) and listened to a variety of music over a couple of weeks. The sound was a bit forward, so I increased the tweeter's resistor to 7 ohms, which starts gradually rolling off the response just above 2 kHz, ending up about 7 dB down at 20 kHz. Based on my description of the sound to Dan, he suggested incorporating a 1.5-dB dip in the response centered at 3 kHz, covering an octave on either side of that frequency, with the tweeter resistor at 5 ohms. That was the version attendees heard at InDIYana 2017 and Dan commented that they didn't sound as engaging to him as when he listened to the single speaker at his home. Frankly, I thought the *Brîsos* sounded better at InDIYana than in my home. After playing lots more music after InDIYana, I eventually determined that the left channel of my preamp was sometimes distorting the music, mostly noticeable on massed violins and some percussion instruments (which are almost always located on the left side of a typical symphony orchestra). I switched to a backup preamp, which resolved this issue. Realizing that all of my listening perceptions had likely been negatively affected by the distortion in the left channel speaker, I decided to revert to the original design and tweak the tweeter's attenuation resistor to suit my tastes, ending up at 7 ohms.

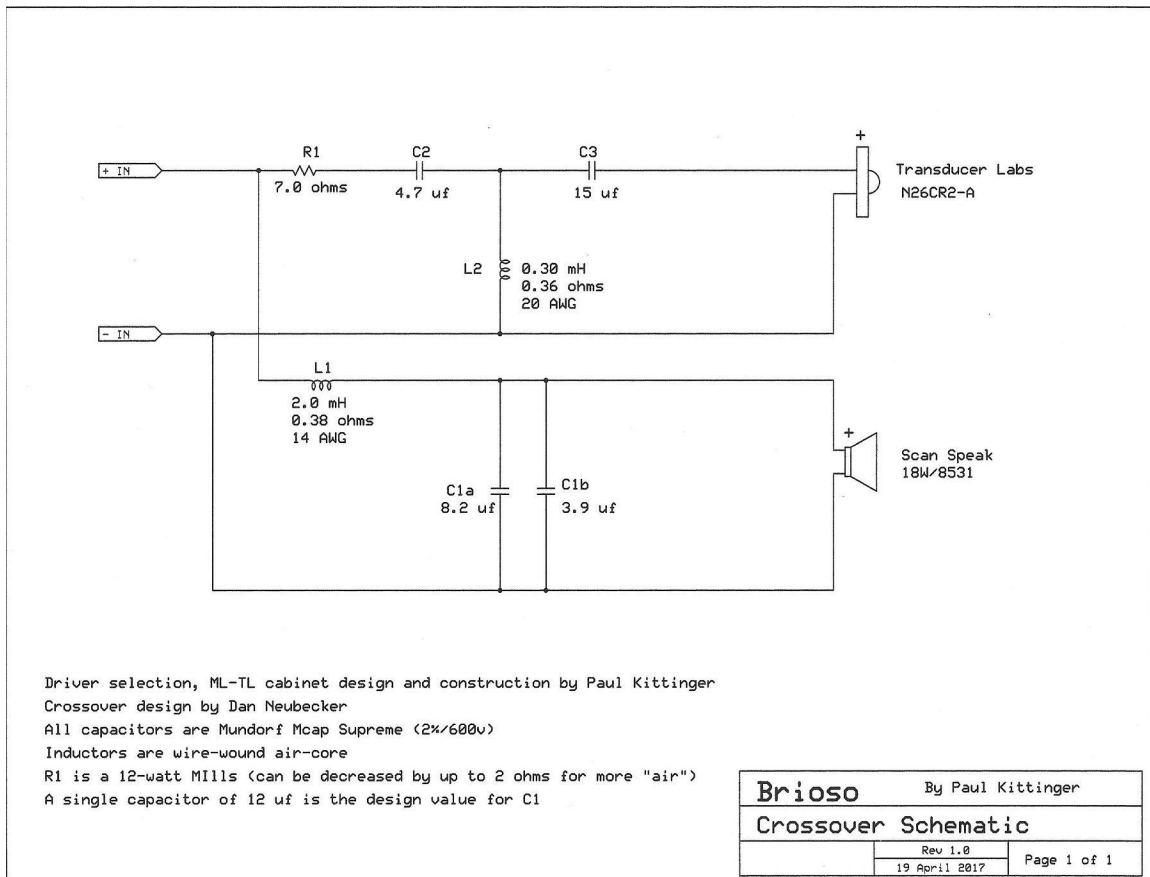
Regarding capacitors, I decided up front I would use premium but not obscenely expensive "boutique" capacitors (with questionable advertised or perceived attributes) in the crossovers, although I doubted my old ears would likely notice any differences. I chose Mundorf Supreme capacitors for the three needed, 4.7 uf and 15 uf in the tweeter circuit and 12 uf for the woofer. Unfortunately, the Supreme offerings do not include a 12-uf value. So, I paralleled 3.9 uf with 8.2 uf, giving me 12.1 uf and clearly close enough. In the end, total costs for capacitors, inductors and resistors came to \$395 for the pair (\$322 in capacitors). Far less expensive polypropylene capacitors are obviously available and it would be up to anyone that might replicate this design to decide what to use. As a note, while my main audio room is the living room part of a "great" room and has some favorable dimensions, angles and ceiling heights, my speakers sit on opposite ends of a fireplace hearth diagonally in a corner, flanking the fireplace, with their backs ~5 inches away from the wall around the fireplace. As always, I had Dan incorporate 3 to 3-1/2 dB of BSC since there is some bass reinforcement from that wall. The final sensitivity (2.83v/1m) ends up at 84-85 dB, a bit on the low side, but is mostly offset by being a true 8-ohm load and easy to drive. An actual input of ~20 watts will create an output of 100 dB SPL at 1 meter from 40 Hz on up with the midwoofer's excursion not exceeding $X_{max}+15\%$ above ~23 Hz. That is actually quite loud, louder than necessary, and translates to about 90 dB SPL in my "sweet spot" recliner. I typically listen at an average SPL of 75-80 dB at my recliner, which means the speakers are outputting 85-90 dB SPL on average at 1 meter. This Scan midwoofer has a maximum mechanical excursion specification of 11 mm Peak, so there is a reasonable amount of additional SPL available for momentary peaks.

Crossover Assembly Drawing

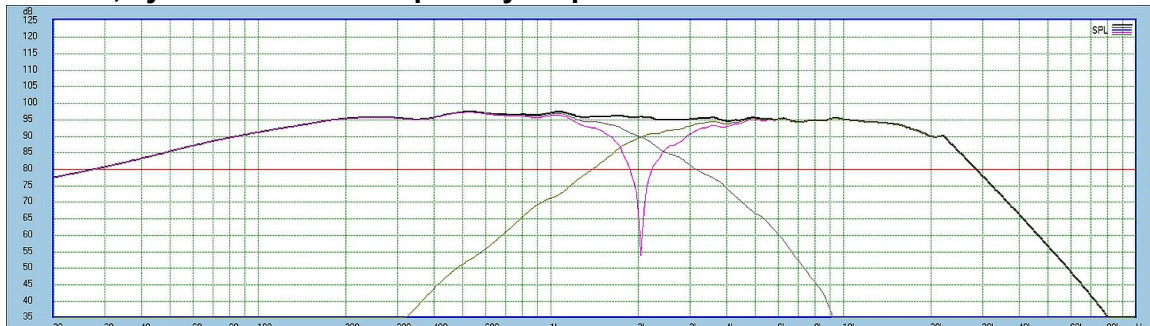


(Actual size of mounting board is 7-1/4" x 9-1/2")

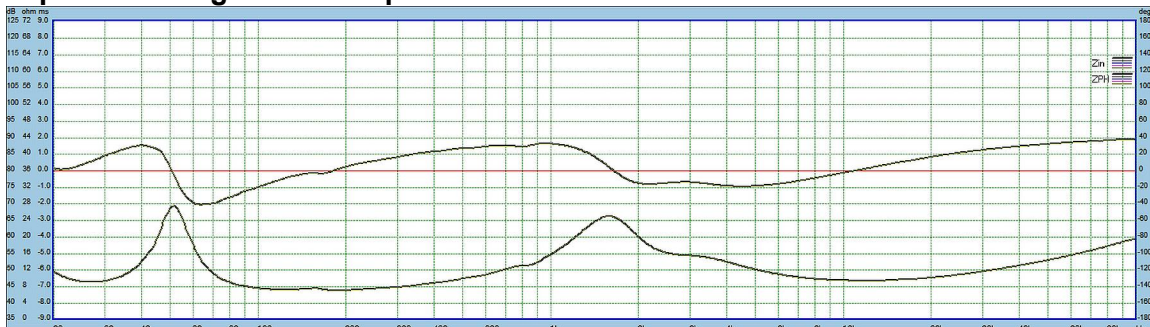
Crossover Schematic



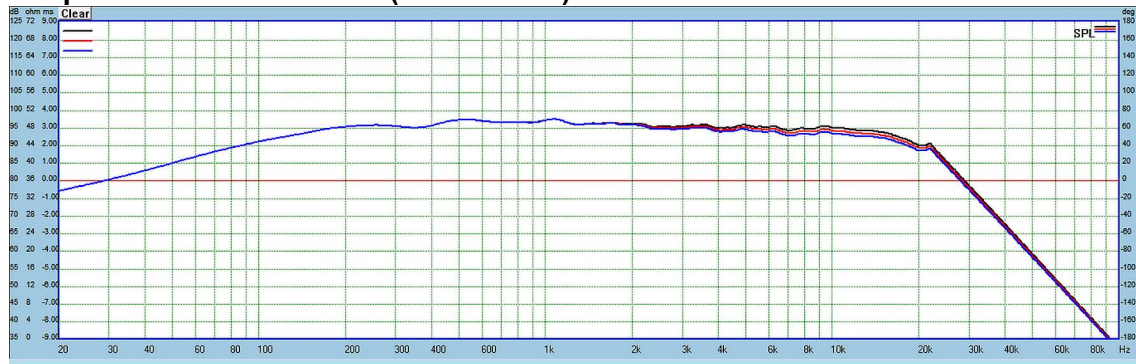
Drivers', system and reverse-polarity responses with crossover



Impedance magnitude and phase



Response versus R1 value (5 to 7 ohms)



I am quite pleased with the performance of my *Brioso* speakers, but there's a caveat. These T-Lab tweeters are very revealing and provide lots of detail. Recordings that have high sonic qualities will sound their very best, but if the recording quality is not good (or there are deficiencies in the audio equipment string!) these tweeters won't sugar coat the music at all. I fully expected the bass performance from the Scan Revelators to be excellent, and it is, in depth, definition and dynamics, plus the midrange sound is detailed and smooth. And, there's so much detail to hear and enjoy. My choice in capacitors may have had a positive effect on the outcome and the drivers certainly play a large part in the performance quality, but I'm pretty sure Dan's crossover design deserves most of the credit. For me, every single penny spent was well spent.

