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The Brioso Speakers

Lively Two-Way Speakers with Transmission-Line Bass

Photo 1: Cabinet front view (left) and rear view (right)

By
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The Brioso uses a Scan-Speak Revelator midwoofer and a Transducer Labs Alumina ceramic dome tweeter in a floor-standing, mass-loaded transmission-line (ML-TL) enclosure. Paul won first place for this design in the over-$200 category in the 2017 Midwest Audiofest (MWAF) event held by Parts Express.

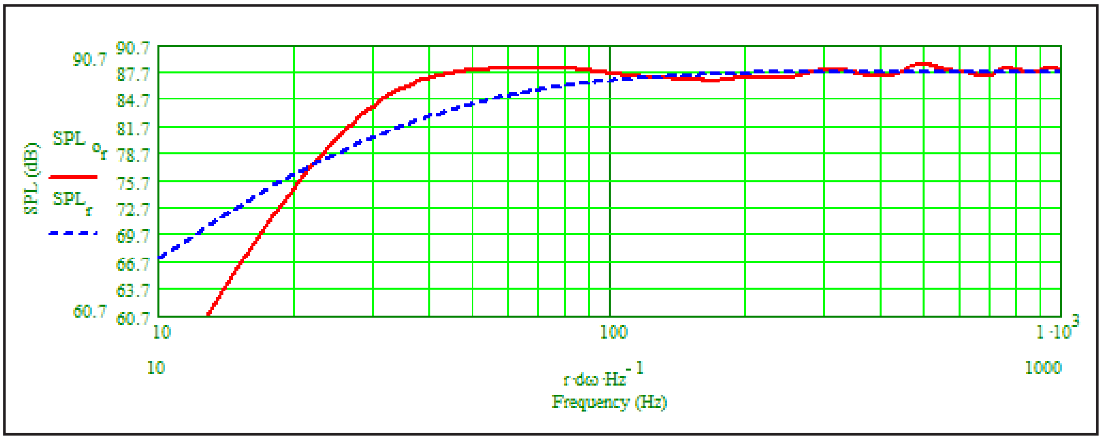

Figure 1: Modeled anechoic bass response for an input of 2.83 V/1 m (red line)

My goal with the Brioso (Italian for lively) was to create a speaker with really high definition by using well-regarded, quality drivers with a transmission-line (TL) design for a bass response in the low-30s. I'm fortunate that cost was not particularly a limitation for me, but to minimize the complexity and keep costs from getting completely out of hand, I chose a two-way design (see **Photo 1**).

The Speakers

For the midwoofer, I originally planned to use a 4-Ω, 7" Scan-Speak Illuminator and a Transducer Labs Beryllium tweeter. After 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 about 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 approximately $200 per cabinet, which ultimately paid for all of the crossover components.

The Design

The 18W/8531G00 is mounted in a single-fold, mass-loaded transmission line (ML-TL) containing about 1.75 ft^3 of volume with a physical line length of 6'. The effective length of the line, however, is almost 6.5' 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°. The quarter-wavelength resonance of the line's effective length tunes the enclosure to approximately 44 Hz. That is not low enough to tune the system to 28 Hz, as is appropriate for this midwoofer's fs and Qts, and achieve an essentially flat system bass response. 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 f3 of 31 Hz and f10 of 23 Hz (see **Figure 1**).

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 one-sixth of the line's length from the end of the line, resulting in the smoothest possible overall response shape, although f3 is a couple of Hertz higher than it would be if the port was closer to the end of the line.

The baffle was tilted back as Dan recommended to aid in reducing diffraction anomalies (along with the three edges of the baffle being chamfered). The bottom 2" 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 the crossover assembly mounted on top of the base assembly (see **Photo 2**). With the cabinet on its base, the tweeter's center is located just over 37" above the floor, a good location relative to the typical ear height range of 35" to 38". I used Martin King's ML-TL Corner worksheet (Revised 8/14/09) to model the transmission line.

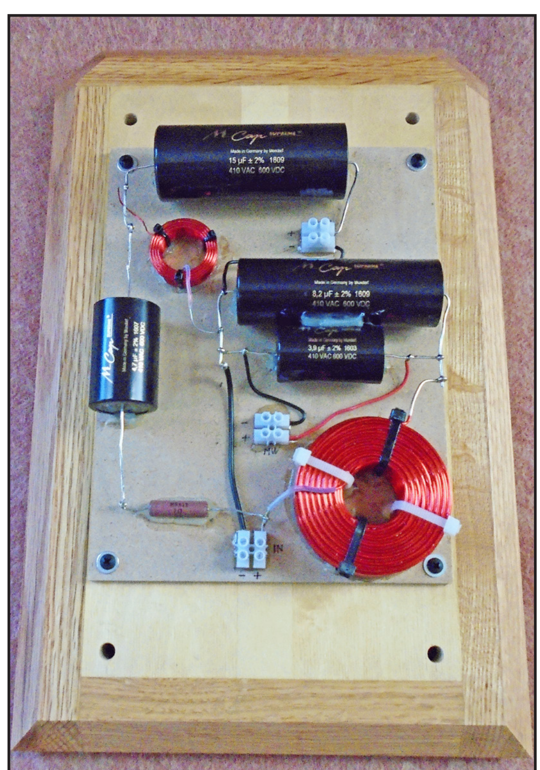

Photo 2: Mounted crossover assembly

The Cabinet

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″ 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 of the divider to end at the bottom of the cabinet. Polyester fiber fills the entire front of the cabinet, which is the first half of the line, and the stuffing density is 0.75 lb/ft^3. I used 1″ thick Dacron batting sourced from Meniscus Audio, but loose polyester "pillow" stuffing performs the same. Loose stuffing, however, has to be weighed, then teased and fluffed during installation, whereas this Dacron batting has an inherent density of 0.75 lb/ft^3. It only needs to be cut to shape and layered in without teasing or compression, and will stay where placed.

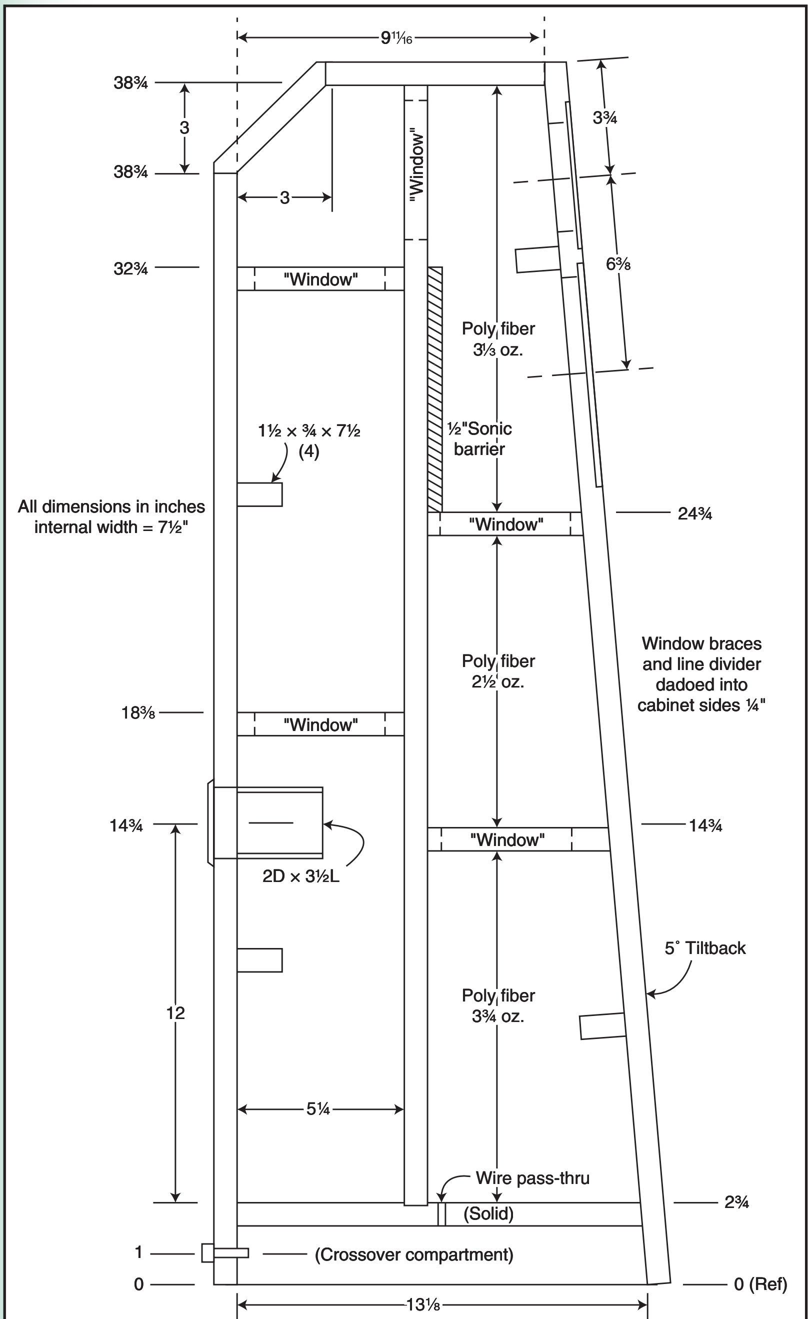

Figure 2: Cabinet side view drawing

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 into 1/4″-deep dadoes in each cabinet's sides, as is the line divider, which is also inset into a similar dado in the top of the solid, horizontal divider above the 2″ cavity at the bottom of the cabinet. There are four additional braces, each 1.5″ 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 (see **Figure 2**).

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 five coats of satin polyurethane to the entire cabinet. The first two coats were applied with a foam brush for thickness, and the last three 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.

I created the baffle by edge-gluing together four pieces of hardwood, three of Jatoba and one of red oak. The baffle was built slightly oversized, 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, I chamfered the edges of its two sides and top, then cut driver through-holes and flange recesses. I made the base assembly from 1.5″ 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.

The Crossover

Dan Neubecker designed the crossover, remarking that it was the easiest design he's ever done, adding that he would describe its sound with one word—"smooth." The corner frequency is approximately 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 Ω between 100 Hz and 250 Hz, plus excellent phase matching and tracking.

Depending on capacitor choices (more on this later) only six components are needed: two inductors and three capacitors with a single resistor for tweeter attenuation. The system's midrange and high-frequency response is very flat up to approximately 11 kHz, and rolls off by about 5 dB at 20 kHz. I built the crossovers per the original design (5-Ω 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 Ω, which starts gradually rolling off the response just above 2 kHz, ending up about 7 dB down at 20 kHz.

Fine Tuning the Sound

Based on my description of the sound, Dan suggested incorporating a 1.5-dB dip in the response centered at 3 kHz, covering an octave on either side

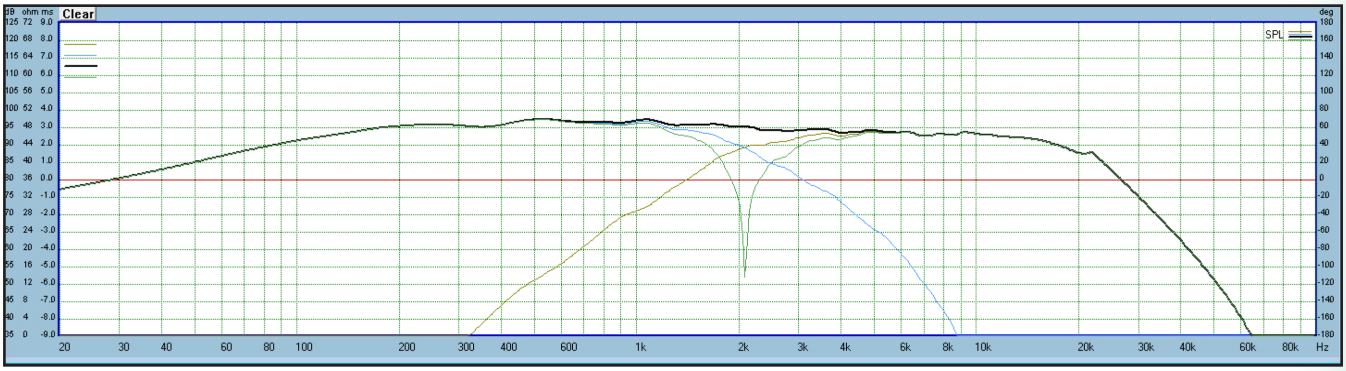

Figure 3: Individual driver's responses, plus system's responses with normal and reversed polarity driver connections via crossover

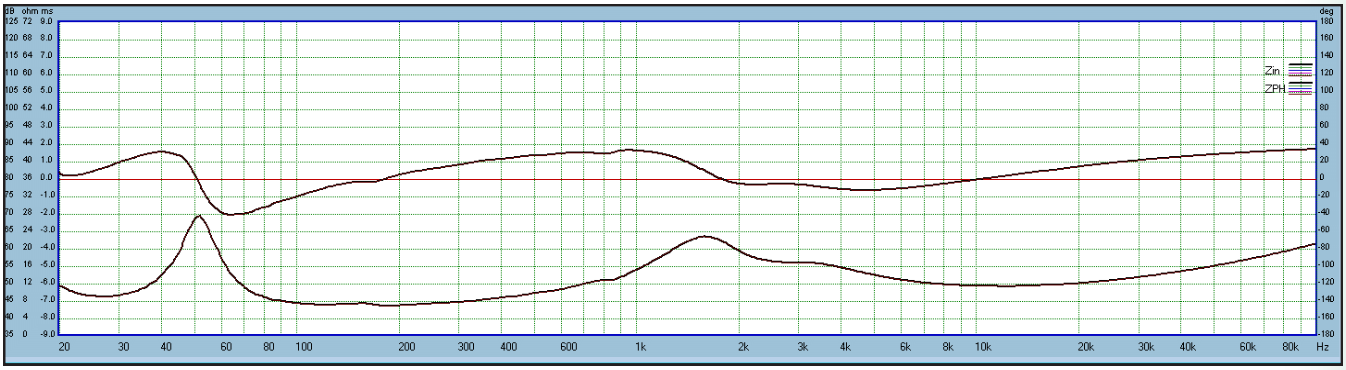

Figure 4: Impedance magnitude and phase characteristics via crossover

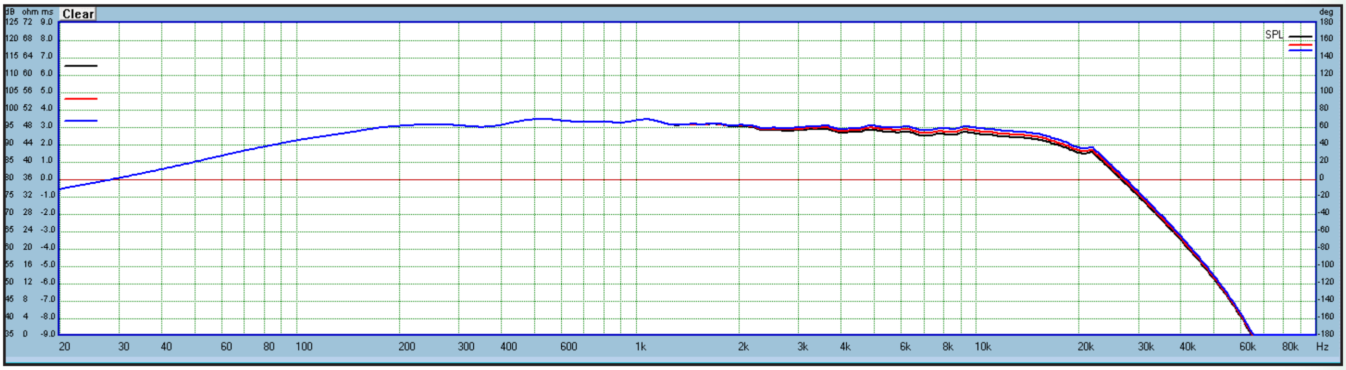

Figure 5: System's upper response versus tweeter's attenuation resistor (R1) value of 5 Ω to 7 Ω

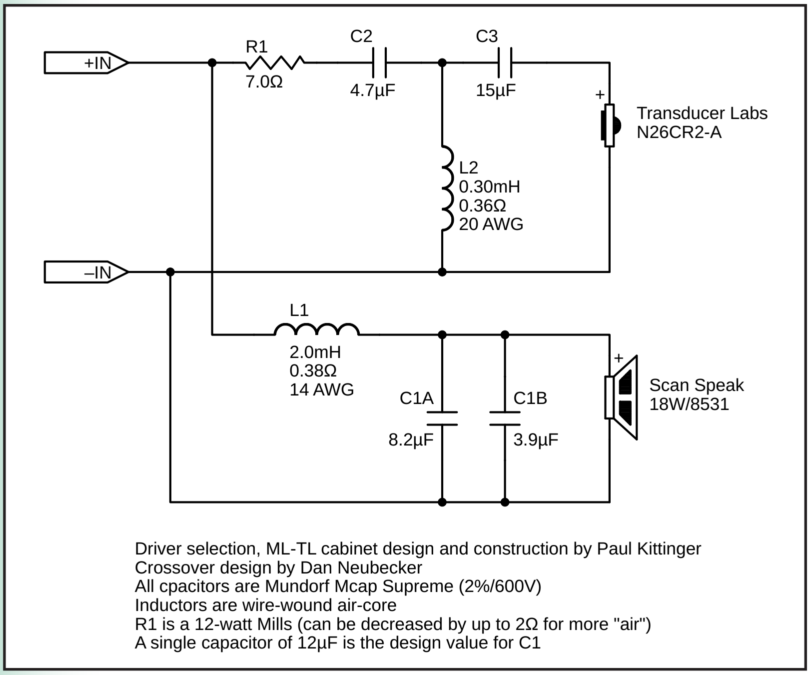

Figure 6: Crossover schematic

of that frequency, with the tweeter resistor at 5 Ω. That was the version attendees heard at InDIYana 2017 and Dan commented that they didn't sound as engaging to him there as when he listened to the single speaker at his home. Frankly, I thought the Briosos sounded better at InDIYana than in my home. After playing lots more music at home 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 (where both 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, I decided to revert to the crossover's original design and tweak the tweeter's attenuation resistor to suit my tastes, ending up at 7 Ω (see **Figures 3–5**).

The Capacitors

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 µf and 15 µf in the tweeter circuit and 12 µf for the woofer. Unfortunately, the Supreme offerings do not include a 12-µf value. So, I paralleled 3.9 µf with 8.2 µf, giving me 12.1 µf and clearly close enough (see **Figure 6** and **Figure 7**). 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 floor-level fireplace hearth diagonally in a corner, flanking the fireplace, with their backs only about 5" away from the wall around the fireplace. As always, I had Dan incorporate 3 to 3.5 dB of BSC since there is some bass reinforcement from the proximity to that wall. The final sensitivity (2.83 V/1 m) ends up at 84 dB to 85 dB, a bit on the low side but pretty typical, but is mostly offset by being a true 8-Ω load and easy to drive. An actual input of 20 W will create an output of 100 dB SPL at 1 m from 40 Hz on up with the midwoofer's excursion not exceeding Xmax+15% above approximately 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 dB to 80 dB at my recliner, which means the speakers are outputting 85 to 90 dB SPL on average at 1 m. This Scan-Speak midwoofer has a maximum mechanical excursion specification of 11 mm peak, so there is an ample amount of additional SPL available for momentary peaks.

Overall Verdict

I am quite pleased with the performance of my Brioso speakers. The T-Lab tweeters are very revealing and provide lots of detail. Recordings that

About the Author

Paul Kittinger is a retired BSEE (since 2003) having worked for 40 years with all but the first couple in the medical device industry. Paul played trumpet and met his future wife in high school orchestra. She instilled an appreciation of symphonic music since she was proficient on violin, viola, and piano. Paul built a couple of speaker systems "way back when" with little knowledge, but became more serious and started gaining knowledge and experience in the late-1990s, with articles about four of his designs published in *Speaker Builder* magazine from 1997 to 2000. Paul prefers and has focused on transmission line (TL) designs, modeled with the accurate software created by Martin King. Not being particularly inclined to design crossovers, he solicited help from others in exchange for TL design help. He loves to design TL cabinets and has done so many times for other DIYers literally around the world, as well as for several commercial entities (Philharmonic Audio, Salk Sound, Ars Harmonia and Rhythm Audio Design). Paul also thoroughly enjoys the woodworking aspects that go along with his hobby that keeps him happily occupied in retirement. He took a pair of speakers to its first DIY speaker event in Sacramento, CA in 2003, has attended the DIY event in Grinnell, IA, several times, and still regularly attends the DIY speaker events of InDIYana and Parts Express' Midwest Audiofest.

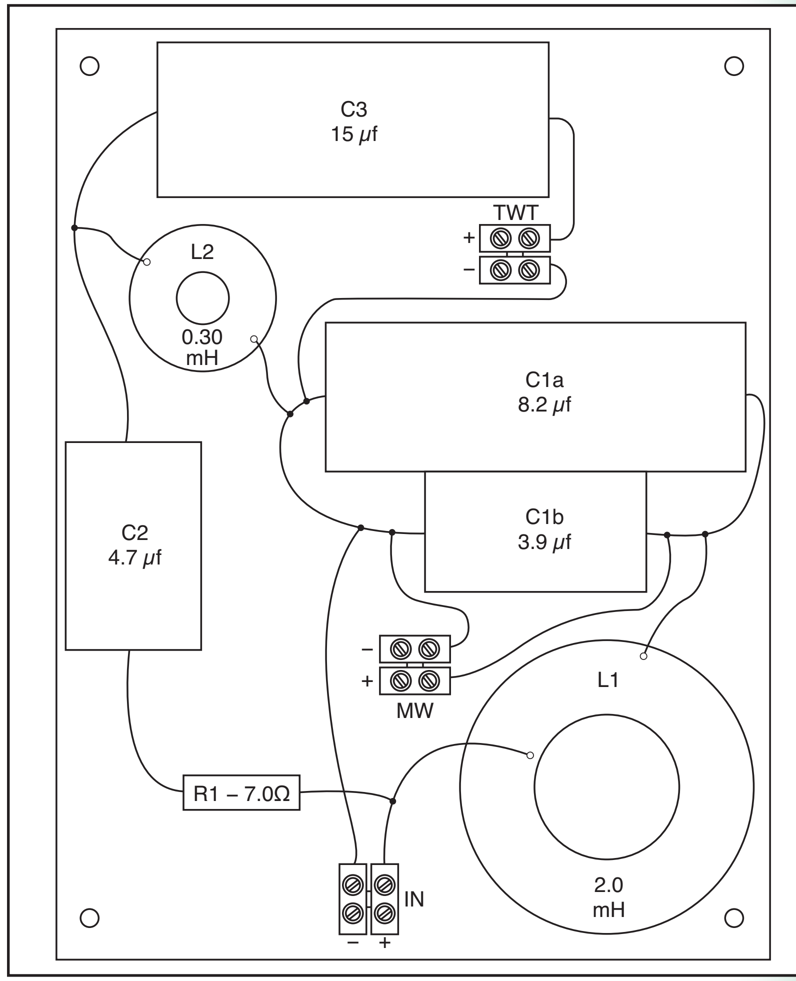

Figure 7: Crossover assembly drawing showing component layout and wiring

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.

As expected, the bass performance from the Scan-Speak Revelators is excellent in depth, definition, and dynamics, plus the midrange sound is detailed and smooth. And, there's so much detail to hear and enjoy. My capacitor choices may have had a positive effect on the outcome and the drivers certainly play a large part in the performance quality, but Dan's crossover design deserves much of the credit. For me, every single penny was well spent.

As a special note, Dan Neubecker has designed at least seven crossovers for speakers I've built—three have taken first place and a couple have taken second place in their respective categories at the Midwest Audiofest (MWAF) since that event's debut. Dan is not only very talented at crossover design, he also is quite inventive and adventurous with his own speaker builds, as well being an excellent woodworker and craftsman. More important, Dan is generous with his help and sage with his advice, as is generally typical in the DIY speaker community. ax