

Reference Series Microbes

Design Overview and Goals

The Reference Series Microbes are a 2-way design with the following goals:

- High-quality sound, but not necessarily budget-minded
- Bookshelf speaker for use in a small listening environment (bedroom in this case) to be driven by a 2-channel amp
- Subwoofer not necessarily required
- Child-proof tweeter domes (i.e., no soft or exposed metal domes!)

Component Selection

Dayton's RS drivers were just released from Parts Express when I started this design and they were all the rage; however, the RS tweeter was still an unreleased mystery. While I was feverously searching for a tweeter that would suitably match with the RS125 and not suffer the wrath of a youngster's fingers, Roman Bednarek released his Microbe design (<http://www.rjbaudio.com>), which ironically was very similar to my own in-progress design. The tweeter however would not do... Roman had used a Tang Band T25-1166S soft-dome tweeter which would be short work for my 1-year old. Fortunately, a few weeks later the RS28 tweeters were released and they had a protective metal mesh grill (even more fortunate was that I won Noid's first DIY raffle for a pair of these babies! – <http://www.palmbayaudio.com/raffle.html>).

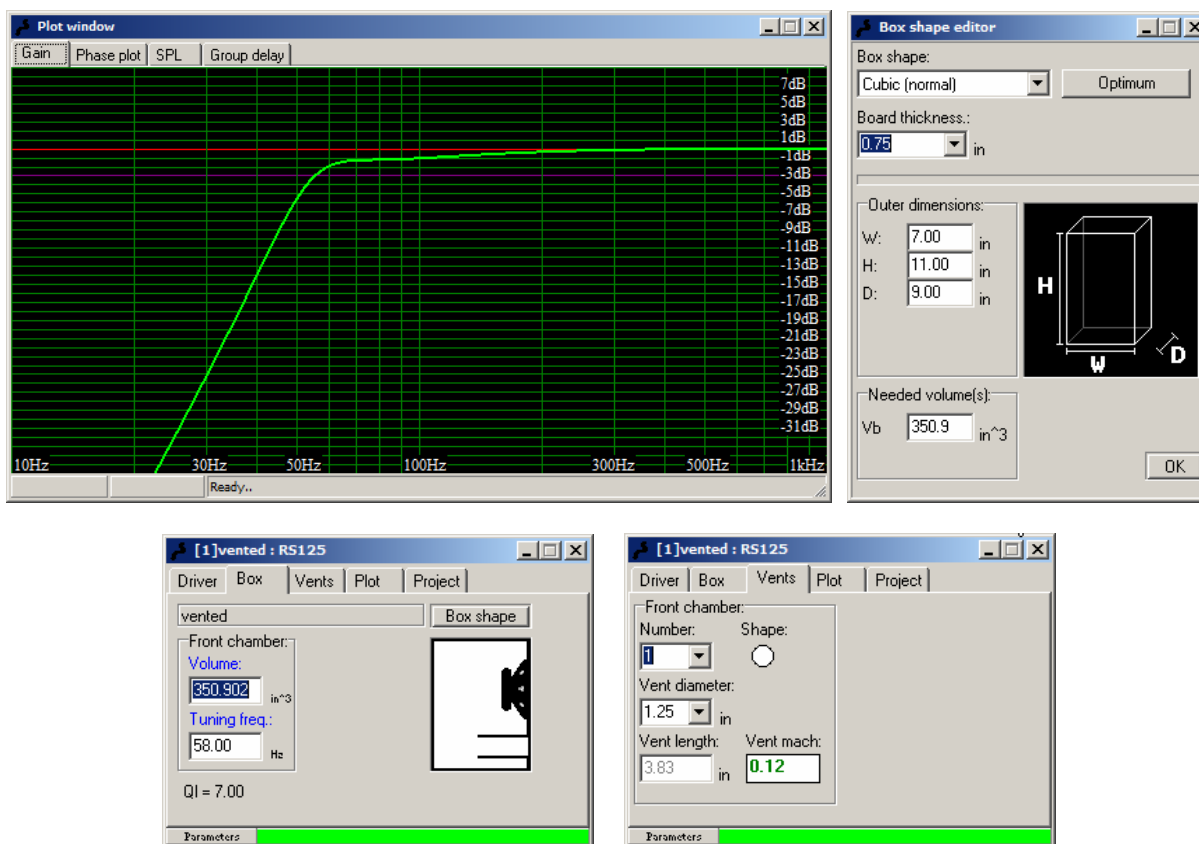
Box Design

The box was primarily designed around the RS125 with the intent of tuning as low as possible yet minimizing the box size. I toyed with several different dimensions and ended up with this configuration (all figures in inches or cubic inches):

Box Construction	W	H	D	Volume		
				in3	ft3	liters
Exterior Dimensions	7.000	11.000	9.000	693.000	0.401	11.355
Thickness Side 1	0.750	0.750	0.750			
Thickness Side 2	0.750	0.750	0.750			
Interior Dimensions	5.500	9.500	7.500	391.875	0.227	6.421
Component Volume	#	Diameter	Length	in3	ft3	liters
Driver	1.000	3.500	2.750	19.242	0.011	0.315
Amp	0.000	0.000	0.000	0.000	0.000	0.000
Tweeter	1.000	3.000	1.500	5.301	0.003	0.087
Port Tube	1.000	1.625	3.850	6.429	0.004	0.105
Crossover (estimate)				10.000	0.006	0.164
Component Volume Subtotal				40.973	0.024	0.671
Braces - Straight	W	H	D	in3	ft3	liters
Brace 1	0.000	0.000	0.000	0.000	0.000	0.000
Brace 2	0.000	0.000	0.000	0.000	0.000	0.000
Brace Volume Subtotal				0.000	0.000	0.000
Net Box Volume				350.902	0.203	5.750

Net box volume after subtracting the various internal components provided 350.90 cubic inches of space (0.203 cubic feet or 5.75 liters), which tuned the box to 58hz with a 3.85" port tube.

WinISD Calculations

**Cutting the MDF**

To make two boxes, cut four of each of the following:

Baffles: 7.00" x 11.00"

Sides: 11.00" x 7.50"

Top/Bottom: 7.50" x 5.50"

Front Baffle Cutouts**RS125S**

- Center Location: Center of the baffle and 3.50" from the bottom of the baffle
- Outer Diameter: 4 15/16"
- Outer Depth: 3/8"
- Inner Diameter: 3 7/8"

RS28AS-4

Note: The tweeters are offset, so the 2 front baffles will be different.

- Center Baffle 1 Location: 2.75" from the left, and 3.00" from the top of the baffle
- Center Baffle 2 Location: 2.75" from the right and 3.00" from the top of the baffle
- Outer Diameter: 4 1/8"
- Outer Depth: 3/8"
- Inner Diameter: 3 3/8"

Rear Baffle Cutouts**Port Hole**

- Center Location: Center of the baffle and 3.50" from the top of the baffle

- Diameter: 1 5/8"

Binding Posts

- Location: Center of the baffle and 2.00" from the bottom of the baffle, 0.75" between the posts
- Diameter: 1/4"

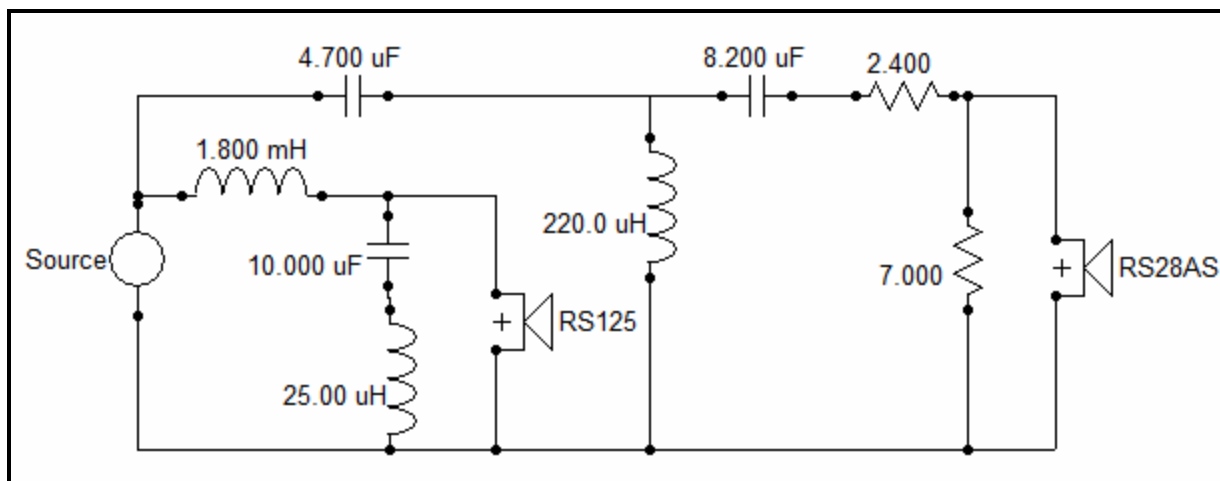
No real tricks were used in box construction except that no nails, brads, or screws were used, only Gorilla glue. The two side pieces were glued to the rear baffle, clamped, and allowed to dry for 24 hours. Then the top and bottom pieces were glued (hammered more like since it was a tight fit) into place and allowed to dry for another 24 hours. After this, the entire box was sanded with 100 and 150 grit paper to make it entirely smooth at the connections, especially the front opening.

A Dremel tool was used with a 1/2" sanding bit to cut the space for the terminals for both the driver and tweeter. This worked really well since the 1/2" allowed for just enough clearance and the Dremel provides excellent control when working with this bit.

I wanted to allow the front baffle to be easily removable, so I used small hex bolts and seated inserts in the corners of the box to attach it to the baffle.

Crossover

The crossover design is entirely the work of Roman Bednarek. He had previously created his Microbes using a RS125 and a Tang Band tweeter, but then later revised the crossover to use the RS28AS instead. Fortunately, he does great work since he had only modeled the crossover and never actually built it.



Tweaks

I incorporated some minor tweaks into the project. I like to believe that they contributed to the overall sound quality, but one will never know!

Silver Wire and Silver Solder

Meniscus Audio sells 14ga silver-coated copper wire with a Teflon jacket for a very reasonable price (\$0.49/ft/lead). Since these speakers are so small, only a couple feet are required for the whole project. I purchased 5' of red and 5' of black for the crossovers and connecting components and had leftovers.

Silver solder is also available from Meniscus which contains 4% silver. It is also very reasonable at \$0.25/ft. I purchased a buck's worth and that was plenty for the whole project.

Truck-bed liner

I am not sure where I came up with this one, but I had some of this stuff laying around after coating the underside of my SUV, so I decided to slap some inside of all six sides of the box. I even coated the outside of the port tube after it was glued in place.

My thought was that it would help dampen vibrations and diffuse the sound inside the box because of its uneven texture.

As an added bonus, it does completely seal the seams and prevent moisture expansion of the MDF.

0.5" Round-over

This is no secret to those who have worked with the RS line of drivers before. These have such large magnets and shielding cups that they cover some of the airflow between the cone and box chamber. Use a 1/2" round-over bit on the inside perimeter of the front baffle to help with relieve this.

Results

When first playing them, the speakers sounded tight, which is probably normal for the RS drivers. After a few hours of breaking in, the sound really opened up. I was surprised by the large amount of detailed sound produced.

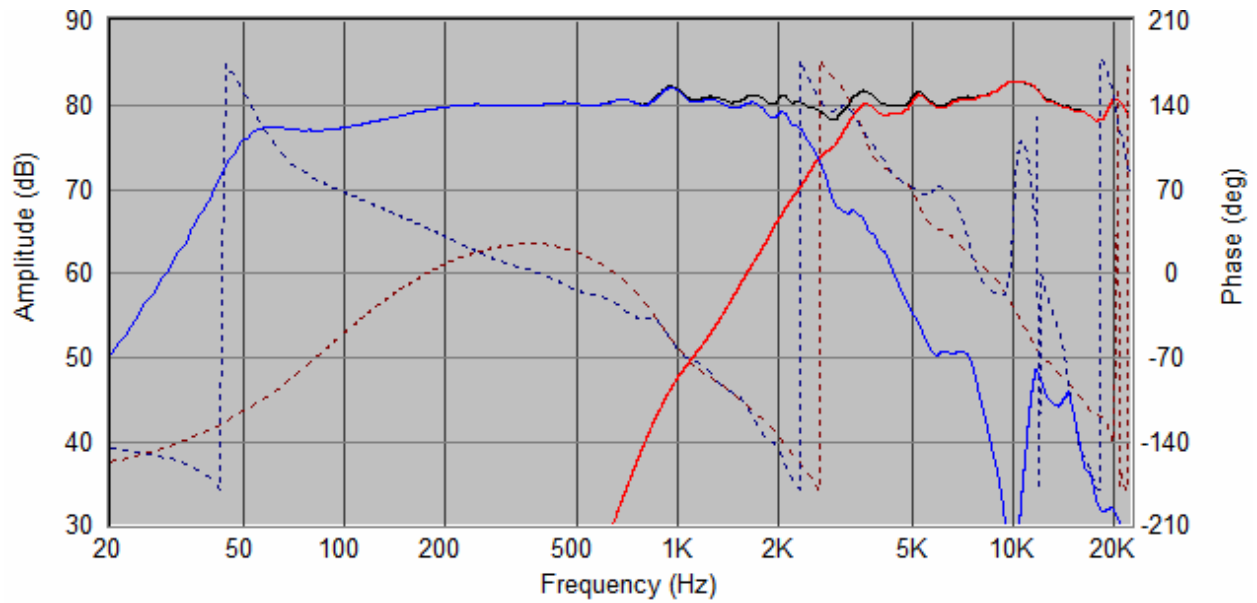
Everyone who has heard them cannot believe the sound quality, especially the bass, produced from such small cabinets. At the 2005 Dayton DIY the reactions were overwhelmingly positive and they were one of the show's favorites, especially for a small cabinet design.

All the design goals stated above have been met!

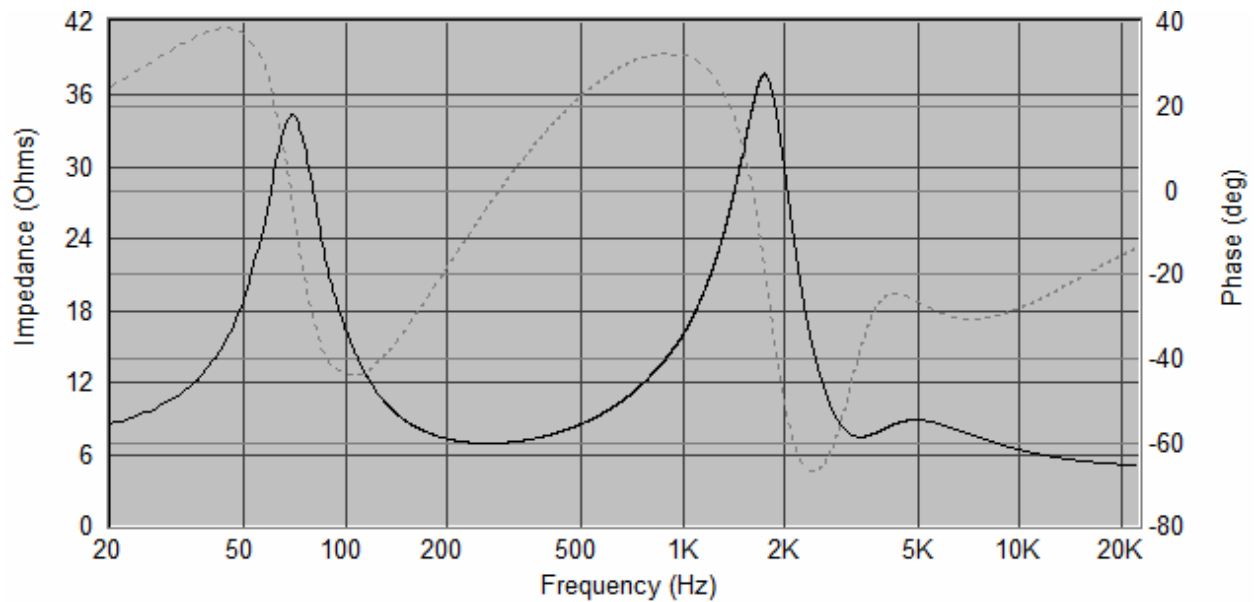


Predicted Frequency Response and Impedance Graphs

Frequency Response



Impedance



Materials List

Materials costs are as of 10/21/2005.

Description	PE Part #	Cost Each	Quantity	Total Cost
Box Construction				
0.75" MDF 4' x 8' sheet	-	\$8.00	1	\$8.00
Gorilla Glue	-	\$5.00	Small bottle	\$5.00
8" section of Schedule 80 grey 1.25" PVC (Lowe's)	-	\$2.00	1	\$2.00
Speaker Components				
RS125S 5" Drivers	295-360	\$21.85	2	\$43.70
RS28AS-4 shielded tweeters	275-135	\$49.50	2	\$99.00
Hardware				
#8 x 32 x 1" Button Head Machine Screws with Threaded Inserts (Meniscus Audio)	-	\$0.30	28	\$8.40
Dayton BPA-38 Binding posts	091-1245 (gold) 091-1246 (nickel) 091-1247 (satin nickel)	\$6.88	2	\$13.76
Tweaks				
Truck-bed liner	-	\$8.00	1	\$8.00
Lynk Single Lead Silver Coated Copper with Teflon Jacket Wire 14ga (Red) (Meniscus Audio)	-	\$0.49	5'	\$2.45
Lynk Single Lead Silver Coated Copper with Teflon Jacket Wire 14ga (Black) (Meniscus Audio)	-	\$0.49	5'	\$2.45
Crossover				
Dayton 8.2uF – 250v Poly Cap	027-426	\$2.48	2	\$4.96
Dayton 10uF – 250v Poly Cap	027-428	\$2.84	2	\$5.68
Dayton 4.7uF – 250v Poly Cap	027-422	\$1.70	2	\$3.40
Dayton 2.4 ohm 10w non-inductive resistor	004-2.4	\$1.25	2	\$2.50
Dayton 7 ohm 10w non-inductive resistor	004-7	\$1.25	2	\$2.50
Jantzen 1.80mH 18 GA Air Core Inductor	255-264	\$5.73	2	\$11.46
Jantzen 0.22mH 18 GA Air Core Inductor	255-212	\$2.53	2	\$5.06
Jantzen 0.025mH 18 GA Air Core Inductor	255-198	\$1.60	2	\$3.20

Total Cost = \$231.52

Note: Total cost does not include shipping/tax charges and materials for finishing the cabinets (e.g., paint, vinyl, or veneer, etc.).