



During the last Consumer Electronics Show, I met with Usher Audio and congratulated them on the recent success of their high-end line of finished systems. All the audio magazines and forums had nothing but great things to say about their designs. After seeing them myself, I was impressed by the craftsmanship, sound quality and value of their systems. The discussion quickly turned to ideas on how to increase sales on raw drivers to the DIY market. One idea was to have a famous designer create several speaker kits using Usher drivers.

Due to the existing relationship between Usher Audio and the world-renowned designer Dr. Joseph D'Appolito, Joe was the obvious choice to create the Usher speaker kits. Before Parts Express could develop a kit (custom crossover board, pre-cut baffle, instruction manual, etc.), a prototype of the design needed to be built. For all our hardcore DIY customers, below is a "preview" of the first design by Mr. D'Appolito and the steps I went through to build the prototype. Enjoy! Stay tuned, more designs to come!

1 Design Goals

To kick off the Usher kit line, we asked Joe to design a classic two-way bookshelf system. The design needed to be relatively inexpensive, easy to build and have performance that rivals systems costing hundreds of dollars more.

2 Driver Selection

Choosing the drivers for our two-way bookshelf speaker was probably the easiest part of designing this system. Joe quickly selected the Usher 9930 tweeter and the legendary 8945A woofer.

Usher 9930: This tweeter uses a specially coated textile dome that offers a flat frequency response and a very open and detailed sound quality. A tuned rear chamber and a lightweight ferro-fluid in the gap provide a well-dampened, low resonance point, making for an easy crossover design.

Usher 8945A: The 8945A woofer is one of Usher's most popular drivers which features their low distortion motor system and a carbon fiber/paper blended cone. This driver provides powerful bass without a harsh midrange, making it one of the best all around woofers for traditional two-way speaker systems.

3 Enclosure Design

Although the classic QB3 alignment for the Usher 8945A woofer would use a much smaller box and produce an F3 of about 50 Hz, Joe chose an alignment leaning toward the extended bass-shelf response that allows a much lower F3. The Dayton 0.75 cubic foot two-way cabinet with its classic "high-end" looks was an ideal choice for his design.

Even though the Xmax for the Usher 8945A is listed at 6mm, Klippel analysis shows this woofer can throw +/- 10mm symmetrically at the 70% BL point. In layman's terms, this driver can move a lot of air before it starts distorting. To help reduce power compression, Joe chose the 2" flared port tube by Precision Port. The enclosure tuning frequency is 36.7 Hz.

4 Enclosure Construction & Assembly

Using the Dayton 0.75 cubic foot two-way cabinet made building my prototype easy. With the unique "B-Rex" baffle removal system, recessing and cutting the driver holes was a snap. I chose the cherry cabinet (#302-732) because I like the

USHER 701 SPEAKER SYSTEM

Written By: Karl B. Keyes, Director of Marketing, Parts Express



\$499

For a limited time, you can save over \$160 when you purchase all the components to build this great speaker system. See parts-express.com for details!

finish and it will go with the rest of my furniture. I just love this job! In keeping with the "high-end" theme, I decided to use our new brushed aluminum bi-amp plates with the premium binding posts. I went with the black anodized plate (#091-612), satin nickel binding posts (#091-624) and the satin nickel jumpers (#091-654) because it looks cool.

For construction tips using the Dayton line of cabinets and detailed information regarding crossover assembly, see this article posted on the website.

After removing the cabinets from their shipping cartons, unscrew the screws holding each blank baffle and separate them from the cabinet. With the baffles removed we can now lay out the driver placement and make our cuts. The tweeter and woofer will be centered (left to right) on the baffle. The spacing between the tweeter and woofer is critical due to the crossover frequency so please adhere to the measurements below. The center of the tweeter opening is 4-1/2" from the top of the baffle. The center of the woofer opening is 6" below the center of the tweeter. Mark both locations and drill a small 1/8" hole. Using a Jasper circle jig and plunge router, cut the woofer mortise (recess) to a depth of 1/4" on a 6-15/16" diameter. Then cut the woofer through-hole to a diameter of 6-1/4". Next, cut the tweeter mortise to a depth of 1/8" on a 4-1/8" diameter. Then cut the tweeter through-hole to a diameter of 2-15/16". You will need to "notch" out the hole to allow room for the terminals. Repeat these steps with the second baffle.

The next step is to mount the port tube to the back of the cabinet. The port tube should be located directly behind the tweeter. This location positions the interior flare directly in the center of the internal brace opening guaranteeing minimal obstruction of the port. The port will be centered (left to right) and the center of the port through-hole will be 4-1/2" down from the top of the cabinet (just like the tweeter on the front baffle). Mark the location and drill a 1/8" hole. Again, using the circle jig and router, cut the port mortise to a depth of 1/8" on a 5-1/4" diameter. Next, cut the port through-hole to a 4" diameter. Cut the 2" ID tube that connects the two flares to a length of 1-1/4". The total length of the assembled port tube will be 6-1/4". Due to the fact the interior flare is a larger diameter (4-1/4") versus the port through-hole (4"), the port tube should be assembled

Look for These Products

Woofer - #296-600



Tweeter - #276-604



Cabinet - #302-732



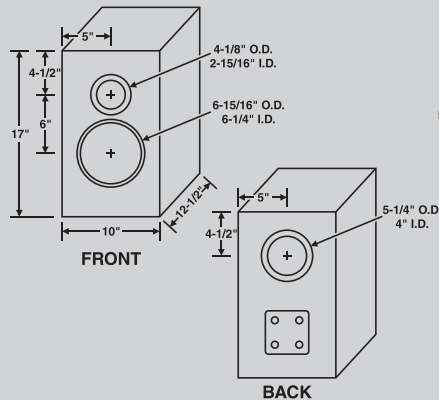
*Turn to page 18 for more information on items featured in this article.

USHER 701 SPEAKER SYSTEM

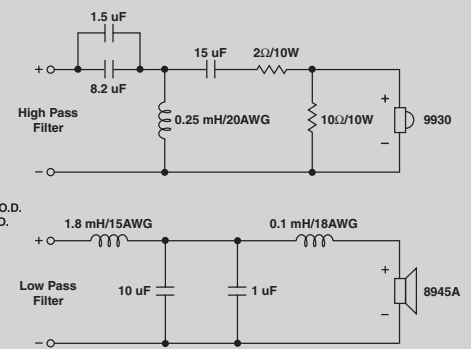
Parts List

Part #	Description	Qty.
260-516	Acoustic foam 1-1/2" 24"x18" UL94	2
255-428	Jantzen 1.80 mH 15 ga air core inductor	2
255-026	Jantzen .25 mH 20 ga air core inductor	2
260-840	#6 x 3/4" decorative head wood screws	20
004-2	Dayton DNR-2.0 2 ohm 10W non-inductive resistor	2
004-10	Dayton DNR-10 10 ohm 10W non-inductive resistor	2
091-612	Dayton DBPP-BK double binding post plate black anodized	2
091-654	Dayton PJMP-SN dual binding post jumper satin nickel	2
091-624	Dayton BPP-SN premium binding post pair satin nickel	2
268-348	Precision port 2" flared port tube kit	2
027-242	Dayton PMPC-8.2 8.2uF-250V precision audio capacitor	2
027-244	Dayton PMPC-10 10uF-250V precision audio capacitor	2
027-210	Dayton PMPC-1.0 1.0uF-250V precision audio capacitor	2
027-212	Dayton PMPC-1.5 1.5uF-250V precision audio capacitor	2
302-732	Dayton TWC-0.75CH .75 cu ft two-way cabinet cherry finish	2
296-600	Usher 8945A 7" woofer	2
276-604	Usher 9930 1" textile dome tweeter	2

Overall Dimensions



Crossover Schematic



Listeners' Comments

Mike: Everyone says their premium loudspeaker sounds like a studio monitor, but these compact 2-ways possess accuracy, detail, and transparency that must be heard to be believed. Caution: Some of your music tracks may not be good enough for these speakers!

Mike V: Clinical is the word that comes to my mind when listening to these. The bass seemed articulate and effortless. The buttery midrange was forward, but not overbearing. Lastly, the highs brought out every last ounce of air that was on the recording. Like slightly aged whiskey, though with just a touch of bite.

Brian: Detailed and accurate with impressive bass performance. "High end" look with sound quality to match.

inside the cabinet. First install the (larger) outer flare into the cabinet back wall. The outer port flare is a press fit design and should fit snug in the hole. Place a small amount of RTV sealant around the mounting flange before installing in the cabinet. Attach the 2" ID tube to the interior flare using an ABS adhesive. From the front of the cabinet attach this assembly to the outer flare through the opening in the internal brace using the same ABS adhesive. Repeat these steps with the second cabinet.

I really like our new brushed aluminum bi-amp plates. They have a beveled edge and look great even when surface mounted. All you need to do is drill four 5/8" diameter holes for your wires and to clear the binding post's mounting nuts. You can use the plate as a template for the hole locations. The Dayton cabinets come with two pre-drilled 1/4" holes on 3/4" centers. I filled these holes with RTV sealant, drilled my four new holes and then covered everything up with the bi-amp plate. I then mounted the assembled crossover boards (see crossover design below) in the cabinet using Gorilla glue (#340-004). I placed the woofer crossover to the rear and bottom of the cabinet due to it having the heaviest inductor. I glued the tweeter crossover to the rear and side of the cabinet next to the woofer crossover. The input leads were then soldered to the binding posts observing correct polarity using the top set for the tweeter. Remember to install the jumpers if you are not planning on bi-amping the system.

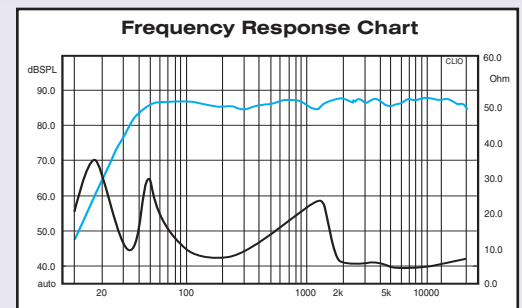
The cabinet should be fully lined using our 1-1/2" acoustic foam (#260-516). If done correctly one sheet is enough for each cabinet. 3M's Super 77 (#340-255) is the perfect adhesive for attaching the foam to the cabinet walls.

It is now time to attach the front baffle to the cabinet. Apply a very small amount of Gorilla glue (#340-004) to the rabbet edge of the cabinet and install the baffle. Do not use too much, because polyurethane glue expands and if you are not careful you may get it on the cabinet finish. Secure the baffle in place using the four screws located on the outer corners.

When connecting the drivers be sure to observe proper polarity and connect the crossover to the driver for which it was intended. During mounting, make sure you use the gaskets supplied with the drivers to ensure an airtight seal to the cabinet. The Usher drivers have very small mounting holes so I used #6x3/4" decorative head wood screws (#360-840). They give a more professional finished look to the system.

5 Crossover Design

The crossover point occurs at 2 kHz. As I mentioned earlier, this is possible thanks to the Usher 9930's very low resonance. The tweeter is also slightly padded to smoothly match it to the woofer's output. The minimum system impedance of 4.6 ohms occurs at 7.7 kHz with the worst phase angle of -58° occurring at 1.73 kHz, making this an easy load for any good amplifier. On both the high pass and low pass circuits, new 1% precision



Dayton capacitors were used in parallel to get the critical values necessary to optimize the crossover. Also, to help facilitate easy placement inside the cabinet, both the high pass and low pass circuits were constructed using separate boards. This also makes it easier when using the bi-amp terminal plate.

6 Comments & Conclusions

The system's on axis frequency response is flat within +/- 1.7 dB from 100 Hz to 20 kHz, which is excellent by anyone's standards. Sensitivity averaged in the two octaves around 1 kHz (500 Hz-2 kHz) is 86.5 dB (2.83V/1m), relative to that level, the low frequency -3 dB point is 41 Hz—pretty good for a small 2-way design.

During my listening session, I found the system to have a smooth non-fatiguing sound with "studio monitor" type accuracy. The detailed imaging creates a very wide and open sound stage. Listening to the jazz masterpiece "Kind of Blue" by Miles Davis with John Coltrane on tenor sax was awesome! This system is relatively inexpensive, easy to assemble and is perfect for any audiophile, young or old. I think Joe summed it up perfectly when he said, "I'm quite satisfied with the results!"

When Parts Express offers the Usher speaker kits in the future, they will include pre-cut baffles, custom crossover boards and all the components necessary to build these great sounding systems!



About the Designer

Dr. Joseph D'Appolito is a world-renown authority in audio and acoustics, specializing in loudspeaker system design. Dr. D'Appolito holds BEE, SMEE, EE and Ph.D. degrees from RPI, MIT and the University of Massachusetts. As a member of the Audio Engineering Society, Dr. D'Appolito has published over 30 journal and conference papers. His most popular and influential brain child, however, has to be the MTM loudspeaker configuration, commonly known as the "D'Appolito Configuration," which is now used by dozens of manufacturers throughout the world.



Construction tips: Over the years, I've had the pleasure of building many systems using the Dayton cabinets. Listed here are just a few tips that may help make building your speaker project a more enjoyable experience.

1. Minimize the number of times you handle the cabinet during construction. I try to keep the protective "pearl" wrap on the cabinets as long as possible through the construction process and store them in the shipping carton until needed.

2. When working on the cabinets, I like to cover my work surface with a soft cloth or carpet. I use our cabinet carpet (#260-765). It doesn't have the "stiff backing" commonly found on carpet; it's soft and inexpensive.

3. Before making any cuts to the baffle or cabinet I recommend putting masking tape over the surface being cut. I prefer using the "blue" painters masking tape due to its low adhesive properties. The masking tape will protect the surface from scratches caused by the circle jig and help minimize "chip out" from the router bit. The masking tape will also make it easier to see your pencil marks showing hole locations.

4. When mortising or recessing drivers, make your recess a hair deeper than the thickness of the faceplate or mounting frame. This will allow room for gaskets or sealing caulk. When cutting your mortise or holes, it is better to make several shallow cuts than one deep cut. Again, this will help reduce "chip out" and burning up the router bit. After you cut your mortise and mounting hole, take a wide black permanent marker and lightly go over the cut so you do not see a "tan MDF" ring around your drivers.

5. Pre-drill all screw mounting holes. This helps keep the wood veneer/MDF from splitting and the screwdriver from slipping.

6. Last but certainly not least, I remember what my high school wood shop teacher used to say, "Measure twice and cut once".