

► The Sidewoofers Line Array

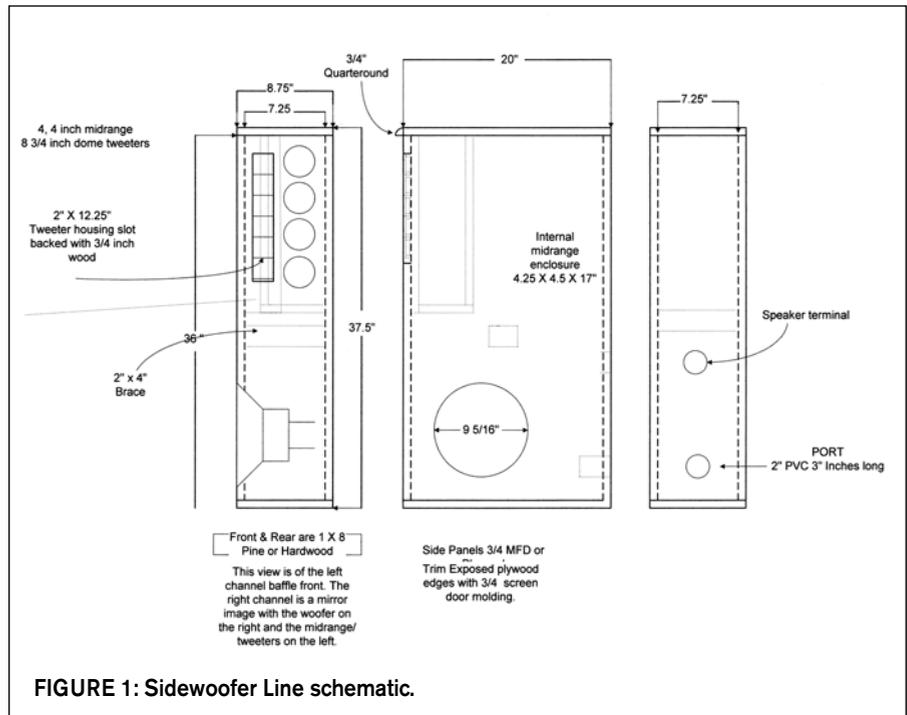
By Ken Bird

This small line array includes a woofer in a ported enclosure.

Speaker building has undergone a number of fads since its inception in the 1950s. First, there were the bass reflex and horn-loaded enclosures that caused the saws to ring. Next came the sealed enclosure with its low compliance woofers, and then the reflex re-emerged through the application of better science by Thiele and Small, sparking further amateur construction. The 80s and 90s saw interest in the transmission line, and the rebirth of the horn challenged the weavers of MDF. The new millennium, and a paper by James Griffin, Ph.D., brought line arrays out of the public address arena to the forefront of home audio, and their requirement for a large number of drivers has made the raw speaker dealers happy.

I have built all—or variations—of the above over the years and have settled on the line array as my current favorite. I like its low distortion, excellent imaging, and slim profile. In order to achieve their fine imaging performance, line arrays require you to use small drivers of 5" or less. Consequently, unless you perform special equalization of the input signal, they lack those last few octaves of bass that all speaker builders seek. You can acquire those missing octaves by the addition of a subwoofer, or the application of aggressive equalization, but in my case, I did not want a bulky box intruding into my limited space listening area, nor the complication of a dedicated equalizer.

My solution is the "Sidewoofers Line" (Photo 1), which combines some of the



attributes of the line array along with a vented woofer in a narrow slab enclosure, 22.5" deep, 37.5" high, and 8.75" wide. My bride said they resembled tombstones, while another friend suggested they could serve as large bookends. Their observations aside, I will stick with the Sidewoofers Line name for now.

THE SIDEWOOFERS LINE DRIVERS

A number of recent articles in *audioXpress* have described line arrays (*aX* Nov. and Dec. 2005, and Jan. 2008). Two of the published systems built by Bill Fitzmaurice utilized a 3/4" dome tweeter, with a 6k to 20k range and a 4" "full-range" driver. One of the systems, built by Roger Russell, used 20 drivers with no tweeter and a dedicated equalizer. Russell has since launched his own company, IDS, to

PHOTO 1: Finished enclosure less grille.



sell a commercial version of his speaker, with equalizer, for \$18,000. As someone who has never spent over \$300 for any pair of speakers, I wish him well.

The tweeters and midrange drivers used in my system are surplus items offered in limited quantities by Parts Express. The dome tweeters sold for 25 cents, and the 4" "full-range" speakers were 49 cents each. Like many *aX* readers, I stocked up on these low-cost jewels. Unfortunately, most are no longer available, but any driver with specifications similar to the following should work as well as or better than the originals.

Tweeter: $\frac{3}{4}$ " dome power 20W, $z = 4$ or 8Ω , Fs 4200, Fr 6k to 20k, SPL 87
Midrange: power 5W, $z = 8\Omega$, Fs 105, Fr 75-15,000, SPL 86

The tweeters could also be 2" cone types. (In the 1950s, *Bozak* featured an array of vertical cone tweeters that provided fine imaging.) Just make sure the SPL closely matches the SPL of the midrange driver.

You can find suitable surplus speakers at All Electronics, Digi-Key, and Parts Express. I have found that the Parts Express customer service people go out of their way to help. Many of their technical staff read *aX*, and they know what is in stock and what would meet your project requirements.

For the woofer, I chose the fine performing Dayton Model DC 250-8 10", which has a specified F3 of 33Hz in a 1.9ft³ vented enclosure. The Sidewoofer Line is about 2.5ft³ when the internal brace and midrange enclosure are subtracted, giving a F3 of 29Hz with a 3" long 2" PVC pipe port. The crossover, in keeping with my preference for electrical simplicity, is a three-way first-order

design using components I already had in my collection. I used the LDP computer programs developed by David Weems, for both the enclosure alignment and the crossover design.

THE ENCLOSURE

The enclosure is constructed of a combination of $\frac{3}{4}$ " plywood and dimensional lumber. The sides are 20" \times 36" $\frac{3}{4}$ " plywood, but you can also use MDF. My local lumberyard cut a 4' \times 8' sheet of $\frac{3}{4}$ " plywood into four 20" wide slabs, and a neighbor made the finished cuts with a tablesaw. This resulted in a complete "kit" of pre-sawn lumber ready to assemble.

The front and rear panels are constructed of ordinary clear pine 1 \times 8 boards. The top and bottom are $\frac{3}{4}$ " pieces of plywood with edge treatments. OK, I know, conventional wisdom says you never use such low-density lumber in a speaker cabinet, yet I have been doing it for years. It reduces the need for wood cutting and is cost-effective.

You can also use dimensional hardwoods for the top, bottom, front, and rear panels. The caveat is that you must use them only in narrow panel configurations. In this instance, the front panel is braced by a combination of a backboard for the tweeter assembly and the enclosure for the midrange drivers. If the pine scares you, make the entire cabinet of plywood or MDF. During assembly, I used clamps and liberal amounts of Elmer's carpenter glue with 2" finished nails spaced 4" apart. I pre-drilled for the nails, which I countersunk,

and filled the depression with stainable wood putty.

CONSTRUCTION

Start by cutting out the two front panels, keeping in mind you are making "mirror" images of one another. The left panel has the tweeters on the left of the midrange units, and on the right panel they are to the right of the midranges (**Photo 2**). The tweeter mounting required an unorthodox solution, so you should prepare for their mounting prior to cutting out the midrange driver holes. You cannot mount them in the usual fashion due to the configuration of the 2" square mounting plate designed to mount into thin metal or plastic automobile panels.

Instead, surface-mount them into a 2.25" \times 12.25" slot cut in the front panel (**Photo 3**). The slot is backed up with a piece of $\frac{3}{4}$ " pine or plywood into an "L" shape because it will also serve as the platform for the internal midrange enclosure. The tweeters are 5/8" deep, and fit nicely in the slot, becoming almost flush with the front panel. They are held in place with 1" drywall screws with the wiring laid in the $\frac{1}{4}$ " space next to the drivers. I thought about gluing them in place but their mass, and magnetic opposition when placed side-by-side, did not make gluing an easy option. The tweet-

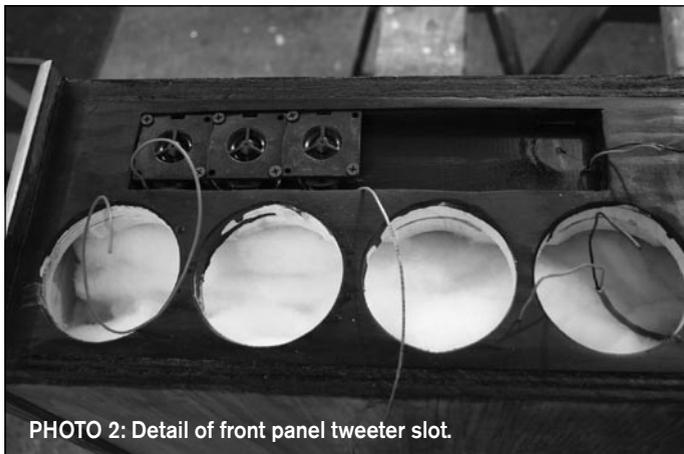


PHOTO 2: Detail of front panel tweeter slot.



PHOTO 3: Installing tweeters in slot.

er feed wires fit into the channel, and a 3/16" hole leads the feed wire into the cabinet.

The close positioning puts the driver centers as close as possible to foster proper line array coupling. Be careful when cutting out the slot, because you will be only 1/2" from the edge of the panel. Use a good-quality jig jaw blade and go slowly. Once the back plate is installed flush with the front panel, the integrity of the panel will be restored.

Using a Jasper Circle Jig, I cut out the midrange holes, after making the tweeter-mounting slot. The speaker I used required a 3 11/16 hole spaced 4" center-to-center. This spacing places the square driver frames right up against each other, providing proper acoustic coupling of the drivers. The tweeters have four mounting holes, but two 1" drywall screws are more than sufficient to hold them in the panel slot.

The midrange drivers have their own isolated enclosure to prevent woofer back wave modulation. This internal baffle is made of 1 x 4 pine using the tweeter slot back plate as a platform. Partially construct the bottom, and one side on the rear of the front panel. The top and other side are formed by the walls of the main enclosure.

Install the panel that forms the wall of the midrange enclosure first, caulking all the joints. Then attach the back of the midrange cabinet and drill a 3/16" hole for the feed wire. Stuff the midrange enclosure with slightly teased polyester fill material (Dacron). The f_s of the drivers was raised to an acceptable 150Hz by the baffle. The woofer hole is 9 15/16" and is mounted slightly off-center toward the front of the enclosure to ensure clearance for the 3" long reflex port and to lessen standing waves in the enclosure.

The rear panel of the main enclosure is cut out 2 7/8" for a round, five-way speaker terminal and a hole for the 3" long 2" PVC pipe reflex vent. The vented enclosure provides a f_3 of 33Hz, and blocking the port raised the f_3 to only 45Hz, which still sounded fine in listening tests.

The side panels are joined to the front and rear panels using clamps, Elmer's carpenter glue, and 2" finishing nails countersunk with a punch and filled with wood putty. The cabinet is internally

braced by a piece of 2" x 2" in the center. When installing the top, put a liberal layer of caulk on the internal baffle pieces that are flush with the top. I nailed the top set nail heads with a punch, filling the holes with wood putty (**Photo 4**).



PHOTO 4: Raw enclosures showing mirror image front panels.

The bottom is applied last, which allows final caulking of the enclosure joints, and then you can caulk the bottom through the woofer hole. Mount the crossover on the bottom panel behind the woofer. I lined the main enclosure on all sides with 1" of polyester quilt padding stapled to the walls, and trimmed the plywood edges of the top and front panel with screen door molding. A piece

of 3.4" quarter round serves as the front panel overhang, under which the grilles are positioned.

FINISHING

You can stain the exposed wood as desired. I painted the back and upper baffle front flat black and fashioned a grille to cover the drivers. I covered the exposed plywood edges with milled 3/4" screen door molding, and the base molding is some scrap door casing I had in the wood box.

The grille frame for the front panel is made of milled 3/4" screen door molding with 45° mitered joints (**Photo 5**). Each joint is reinforced by a corner gusset made from four-ply illustration board. This makes a lightweight frame that, when attached with Velcro, does not resonate with the audio. I first glued together all the frame joints using picture frame clamps, then glued and clamped the corner gussets and I painted the frame flat black and stretched and stapled the grille material over the grille frame. I used a reinforced screen door material that is designed to be pet-claw-proof.

This black plastic coated nylon is open to all audio frequencies, while being rugged enough to protect cone drivers from accidents. It also allows just a hint of the

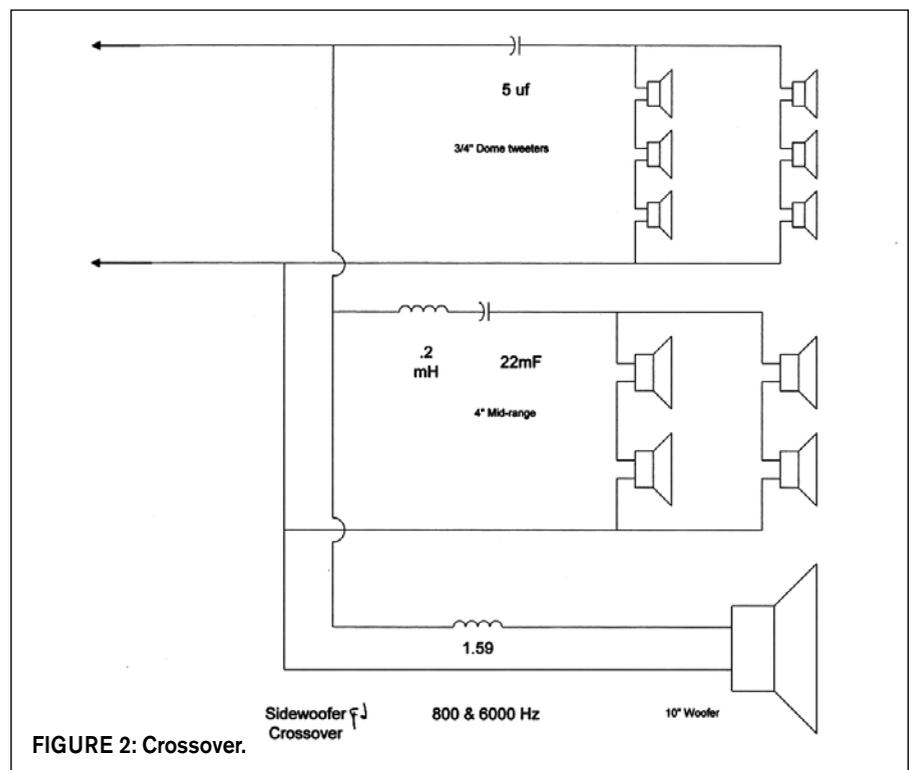


FIGURE 2: Crossover.

drivers to show through for those who want to see as well as hear their audio creations. The frame is attached to the enclosure with matching Velcro "sticky back" strips stapled on the corners of the frame and mating enclosure surface.

For the woofer, you can purchase ready-made round frames from Parts Express, part number 260-426. Or, as I did, lay the woofer face down on the

pet screen material and cut along the edge with a carton knife. Once the woofer is mounted, just glue the grille to the speaker gasket using clear drying "tacky glue" from your local craft store. There is plenty of clearance for the woofers' extreme excursions, and the woofer is protected by the screen material.

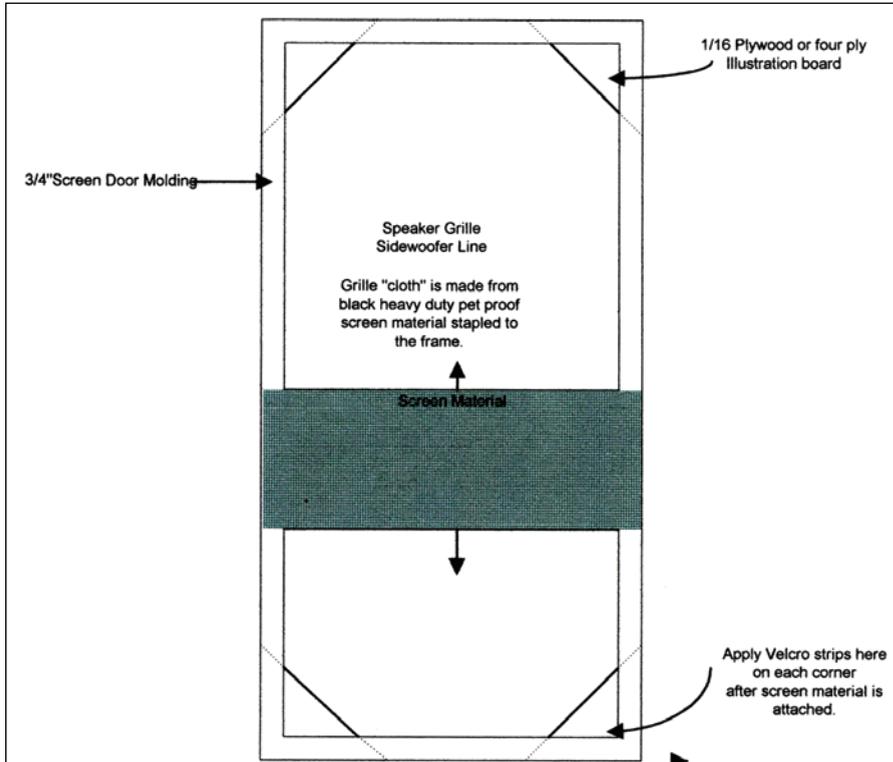


FIGURE 3: Screen material.



PHOTO 5: Front panel speaker grille made from screen door molding and heavy-duty pet screen material.

WIRING THE SIDEWOOFER LINE

I chose to make the low crossover point 800Hz and crossed the tweeters at 6kHz. The 4" midranges perform best in the 200 to 7000Hz range, and, along with the tweeters, they complement the side firing woofer. To make wiring easy, mount the crossover in the bottom behind the woofer (Photo 6).

Wire two of the midrange speakers in series and then parallel them to achieve 8Ω. The tweeters were 4Ω, so I wired three in series and then paralleled them resulting in 6Ω impedance. I soldered all connections and mounted the drivers with 1" drywall screws. I applied a layer of silicone caulk to the underside of the frames of the woofer and midrange units. This ensures a good air seal, and the silicone makes the woofer easy to remove if you must change the driver or tweak the crossover.

TESTING

We are fortunate to have a large walk-in closet with a sloping ceiling, which serves as a fairly good anechoic chamber. It is stuffed with my bride's clothes and a hundred pair of her birkenstocks, all of which nicely absorb sound. (Why does any woman need a hundred pairs of shoes? Answer: For the same reason her



PHOTO 6: Crossover installed in enclosure bottom.

husband has over 200 raw speakers in his shop.) I used a Radio Shack sound level meter, C weighted, and a B&K Model 3001 portable audio generator fed into a solid-state test amp with no equalization controls. Because of the position of the side-mounted woofers, I made measurements from two different positions and then averaged them into the one response chart (Fig. 4).

Subjectively, they reproduce sound with amazing imaging and solid bass. I like classical organ and orchestral music, and, my bride is into heavy metal—both Virgil Fox and Metallica met or exceeded our subjective listening tests. If you want the unique imaging of a line array with some fine low end, this system will meet your requirements. **aX**



PHOTO 7: Finished enclosure with grille.



PHOTO 8: Finished enclosure pair.

REFERENCES

1. Griffin, James, Ph.D., *Design Guidelines For Practical Near Field Line Arrays*. Copies available from Dr. Griffin at jrgriffin@cookeville.com.
2. Russell, Roger, "A Unique Stereo Column System," *audioXpress*, Nov. 2000.
3. Fitzmaurice, Bill, "The Short Line

Array," *audioXpress*, Dec. 2005.

4. Fitzmaurice, Bill, "The CurveArray," *audioXpress*, Jan. 2008.

Surplus Speaker Vendors

Parts Express: parts-express.com
All Electronics: all electronics.com
Digi-Key: digikey.com



PHOTO 9: Closeup of tweeter/midrange array.

Parts List

(All are Parts Express numbers)

4" Midrange: 269-568

3/4" dome tweeter: 269-708

10" Woofer: 295-315999

Speaker terminal: 260-370

10" woofer grille kit: 260-426 (optional, see text)

Crossover parts

2 each 5 μ F at 100V

2 each 22 μ F at 100V

2 each 0.2mH choke

2 each 1.59mH choke

Lumber

4 each 20" \times 36" 3/4" plywood or MDF side panels

4 each 1" \times 8" \times 36" clear pine or hardwood front and rear panels

1 each 1" \times 4" \times 4' pine for midrange baffle

4 each 1" \times 10" \times 18.5" pine or hardwood top and pieces

2 each 2" \times 4" \times 7 1/4" cross brace

2 pieces 2" ID \times 3" long PVC pipe

16' 3/4" screen door molding for trip and speaker grilles

Miscellaneous items

24" of Velcro "stick back" strips, black (craft department at Wal-Mart)

Two yards of 36" wide pet screen (Home Depot or Lowes)

Box of 1" drywall screws

10' #18 wire for internal speaker connections

