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consumeR PRODUCTS REVIEWED

Constructing the SEAS Froy Mk. 3

By Edward T. Dell, Jr.

PHOTO 1: Finished Froy Mk. 3 system.

The tiny vented SEAS Froy Mark 3 design turned up on the Madisound website (www.madisound.com) while I was searching for details on THOR[1]. The Froy (*Photo 1*) is a small MTM utilizing the SEAS Excel Millennium technology drivers. The specs looked impressive. The structural drawing (*Fig. 1*) is from SEAS. Its only unusual feature, other than small size, is the ½″ slot port centered in the rear panel which also adds rigidity to the one-square-foot enclosure.

FEATURES

The drivers for each Froy include two W15CY001 mid/woofers and one T 25 CF 002 tweeter. The 5″ mid/woofers use the same type of machined magnesium cones as the larger ones used in the THOR design. SEAS says the rear vent directs any possible port noise away from the listener.

The crossover, set at 2200Hz, includes a Zobel (L2 + C2) in parallel with the paralleled mid/woofers. The crossover schematic is in *Fig. 2a*; the layouts for the crossovers in *Fig. 2b* (low-pass) and *Fig. 2c* (high-pass). The latter two drawings are full-scale and work as templates.

The Froy design was originated by Murray Zeligman, including this latest Mk. 3 iteration. Frequency range is claimed to be 40–25000Hz, with a maximum short-term power of 300W and long-term power of 140W and 4Ω impedance. On special order through a dealer, SEAS can provide magnetically shielded drivers for this design where it might be used as a center channel speaker for a home theater system.

MAKING THE CUTS

Building stock for the Froys is ¾″ MDF (medium-density fiberboard) requiring about a third of a 4 × 8′ sheet. The cutting guide is *Fig. 3*. If you make the four vertical cuts as suggested, then the short cuts form the sides, fronts, backs, tops, and bottoms. The remaining pieces may be cut to form the vent walls.

Adding to the SEAS instructions, I used a ⅜″ roundover bit to shape the inner edges of the two sides of these port walls (*Photo 2*), which may make for a smoother transition into the port and possibly ease some diffraction turbulence. I decided to leave cutting the ½″ slot until after box assembly, since otherwise the MDF is soft and likely to break (*Photo 3*).

You might consider making the panels which form the vent ¼″ longer (4¼ × 6 × ¾″) and cutting two ⅛″ deep × ¾″ wide dadoes in each side wall to make mounting the port walls easier. As an alternative, I mounted the walls using #8 × 1½″ flathead screws (*Photo 4*)—one to each of the three vent mating edges—and sank them ¼″ below the outer surfaces of the box (sides and back). I used a plug cutter in scrap plywood stock to plug the screw heads, sanding the plugs flat after the glue dried. Plywood works better because the MDF plugs break too easily.

As with my THOR project[1], I used biscuits for assembling every joint except the vent walls (*Photo 5*). I used far fewer this time, making doubly certain that the fit of each joint was snug. I labeled each of the parts indicating left and right, inside/outside, back, front, sides, top, and bottom. This is enormously helpful in keeping track of where you are during assembly.

I marked mating edges to simplify assembly, and also to keep track of the biscuit locations. It is a good

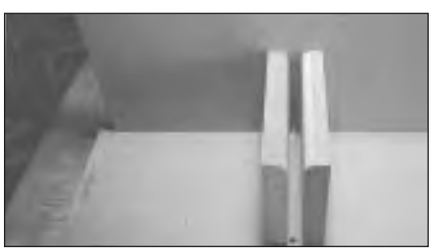

PHOTO 2: The Froy port is unusual located midway between top and bottom of the cabinet. The inner sides of the port walls have been rounded to smooth diffraction in the port. Screws were used to fasten the port walls, and pilot holes are visible for cutting the back opening later with a jig-saw.

PHOTO 3: Opening the rear port after the box is assembled.

PHOTO 4: Countersunk screws hold the port walls in place during assembly.

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idea to mark these with either an "E" for the edge cuts or an "F" for face cuts. The Froy front and back panel biscuit cuts are all face cuts, the sides are all edge cuts, and the top and bottom require two of each—face cuts for the sides and edge cuts for the front and back.

PHOTO 5: Dry assembly of the box before gluing ensures a good fit of joints. Biscuits were used on all joints except the port walls.

PHOTO 6: Threaded brass inserts were used for mounting the drivers.

I used a router to cut both the dadoes for the driver rims, using the Jasper® jig, and carefully made test cuts for both the correct diameters and the respective depths. I find these easier to do in each panel (*Photo 6*), before assembling the box. I used a ¼″ bit for the driver holes with the jig as a guide.

During construction of the Froys, I ordered and received a new DeWalt router which has a dust collection port you can attach to your shop vacuum. Although slightly more difficult to manage with a 1¼″ hose attached, it is virtually dustless during operation, in sharp contrast to the standard unvented router (*Photo 7*).

MOUNTING THE DRIVERS

One of the major problems I encountered in building the THORs was attempting to use brass inserts and #8 machine screws to mount the drivers. The problem is marking the locations for the ¼″ holes for the inserts. The holes in the rims of the drivers can accept a 3⁄16″ bit, but nothing larger. How do you make sure that you drill the necessarily larger ¼″ hole ex-

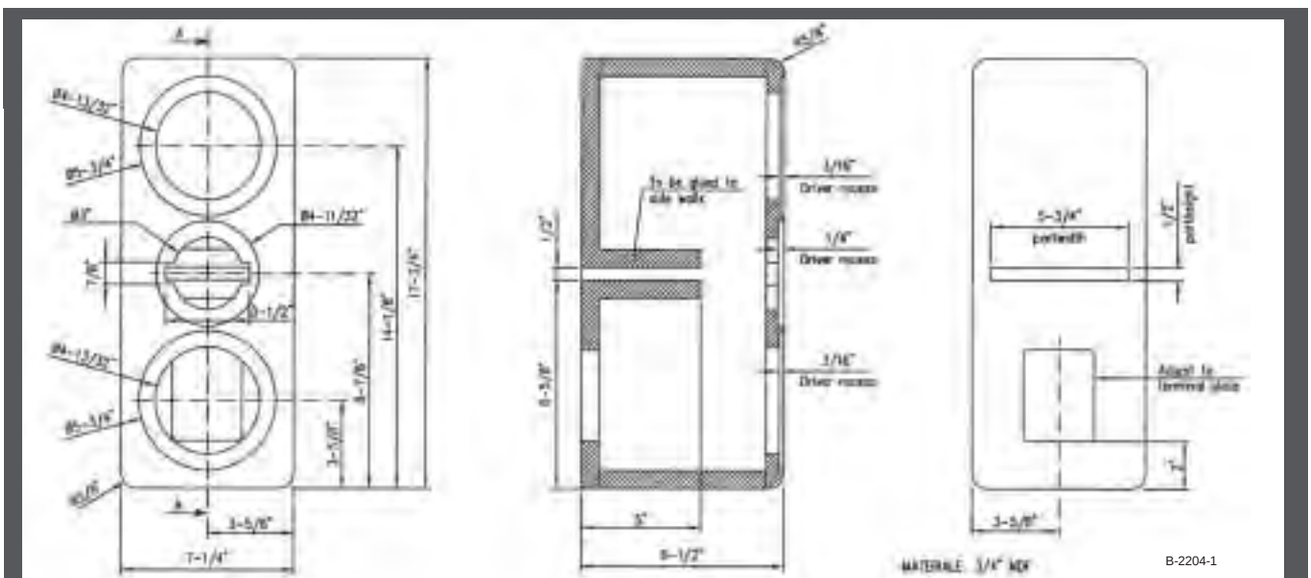

FIGURE 1: The SEAS cabinet drawing. The original was drawn in metric, which accounts for the tight diameters for the driver openings. The outer dimensions for cutting the dadoes are reasonable using the Jasper guide. The inner diameters are not so critical since they must only clear the cast frame of the drivers. Note that the sides of the cabinets fit inside the fronts, backs, tops, and bottoms.

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actly centered on the pilot hole?

Thinking hard about this one day, far from my shop, I found a solution, which popped unbidden into my head. I placed the driver in its dadoed mounting shelf, face downward. I placed the front panel in the drill press and carefully drilled one 3⁄16″ hole, through the mounting flange of the driver as guide. I removed the driver, leaving the bit in the chuck.

Then I lowered the bit into the pilot hole and clamped the panel to the drill press table. I removed the 3⁄16″ bit and installed the ¼″ one, and drilled the mounting hole for the threaded brass insert. I then installed the first brass unit.

Next—and I admit I'm being super fussy about this—I repositioned the driver, face down, and fastened it to the baffle with the first machine screw. I replaced the ¼″ bit with the 3⁄16″ one, and drilled a second pilot hole, again using the driver as a guide, followed by the ¼″ hole. I then installed the second threaded insert, and again remounted the driver, now with two screws.

Next I drilled the remaining four 3⁄16″ pilot holes. I removed the driver and inserted the bit into each pilot hole, clamped the panels to the drill press table, and drilled the remaining ¼″ insert mounting holes, one by one. I followed the same procedure for the tweeters. After installing the threaded inserts, the drivers were all mounted perfectly.

Take care in installing the brass inserts. Be sure to drive them in at 90° to the face of the panels. I found this easiest with a very large screwdriver, strangely enough. The final two or three turns must be done with a narrower-bladed tool, driven slightly below the surface of the stock. Clean up any expanded material with a sharp knife or chisel.

I found a tip in an old copy of *Shop Notes*[2], which suggested using a small three-cornered file to make a relief trench across one side of the insert threads, at right angles. Clamp each insert in your bench vise for this procedure. This apparently helps relieve expansion pressure avoiding bulges around the top of the insert. I discovered this suggestion after installing all my inserts, of course, but it does sound as though it should alleviate the bulges.

ASSEMBLY

I assembled my crossovers on 1⁄8″ hard masonite® bases with copies of the paper templates (*Figs. 2a* and *b*) attached with spray adhesive (*Photo 8*). I drilled holes for

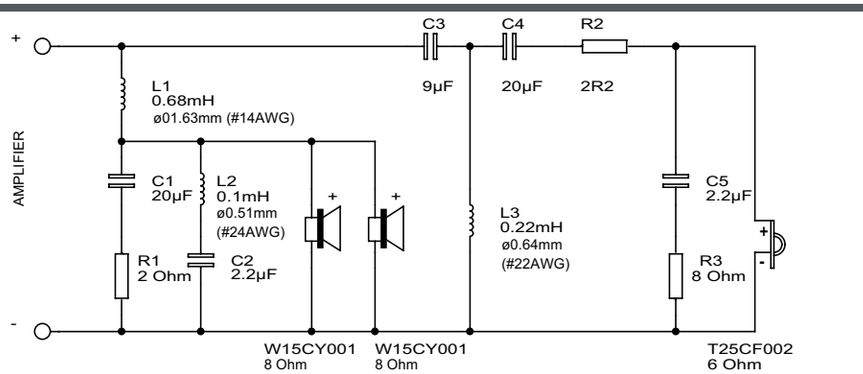

FIGURE 2A: Froy crossover schematic. The coils are all air core; the capacitors are either polypropylene or polyester foil; the resistors are all metallic oxide or non-inductive wire wound.

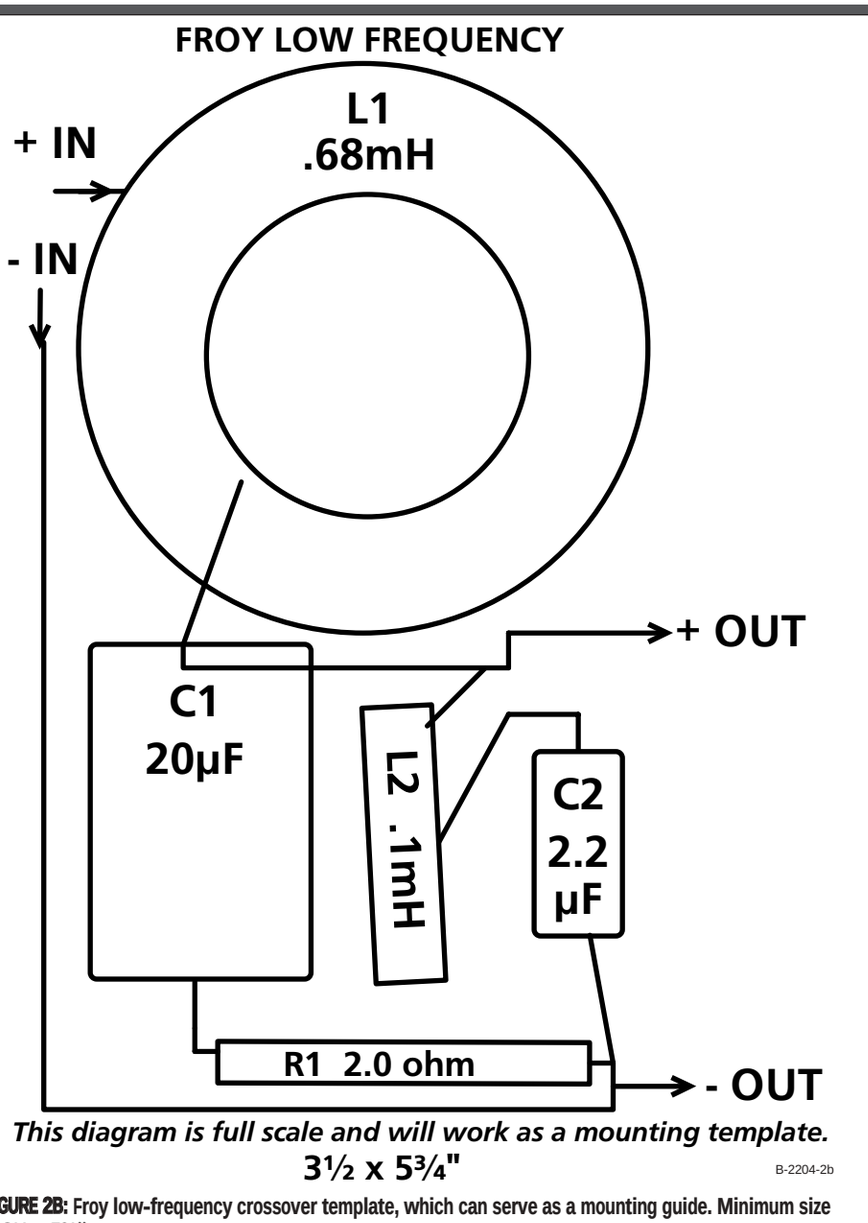

FIGURE 2B: Froy low-frequency crossover template, which can serve as a mounting guide. Minimum size is 3½ × 5¾″.

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the cable ties to mount each component. I used staked terminals for input and output connections. I put the high-pass and low-pass components on separate boards to allow for bi-wire and bi-amp connections.

The input terminal plate with separate HF and LF is rather large, so I turned it sideways at the bottom of the rear panel (*Photo 9*) to leave room to mount the tweeter board. It seemed sensible to mark mounting hole locations for the crossover boards and drill pilot holes for them (two each) inside the rear panel before assembling the box. The LF board fits easily on the rear wall (*Photo 10*) of the upper half of the box.

Gluing the box together should be preceded by a complete, dry assembly. A few of the biscuits may need "encouragement," or the slots re-sawed. Vacuuming the slots ahead of time helps, as well.

Once everything is fitted, if you do as I did, clamp the dry assembled box firmly, fitting the port side pieces in their proper locations. Mark their positions on the sides and back panel, both inside and outside, and use a tool that cuts a pilot hole for the screw and its countersink as well as a recess for a glued plug atop the screw. Attach the vent sides to the back panel first, then to the sides. Remove the screws and disassemble the box.

Using screws to hold the vent walls is also helpful in the first stages of the gluing process. Begin with glue on the back panel and on one vent wall edge, and attach with its pre-drilled screw, making sure the wall is accurately located. Next, attach the sides, then the ends and, finally, the front panel. Clamp the entire assembly. I used 12 clamps (*Photo 11*), cleaning off the glue oozing from each joint with a damp paper towel.

FINISH WORK

After each box has dried overnight, it is time to seal any gaps with plas-

PHOTO 7: All box edges were rounded with a router, ⅝″ bit. The router is a new style DeWalt equipped with a dust port for connection to a vacuum.

PHOTO 9: The opening for the terminal block is opened after box assembly, and mounting screw locations marked for drilling.

PHOTO 11: Gluing uses all 12 of my clamps.

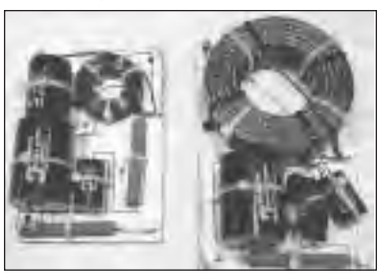

PHOTO 8: The two assembled crossover networks, HF on the left, LF on the right. Components are held in place with cable ties. Stud terminals are press-fit into the ⅛″ Masonite.

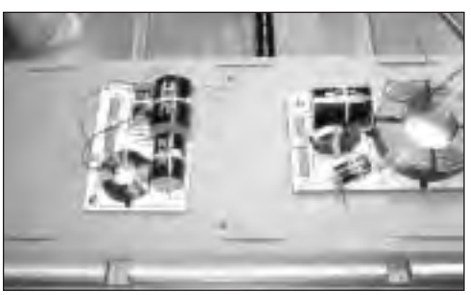

PHOTO 10: Crossovers were pre-mounted on the back panel prior to box assembly, then removed prior to the gluing. This eases later crossover installation.

PHOTO 12: A ¼″ bit rounds the exit of the port. Note the plywood plugs covering the screws which secure the port walls.

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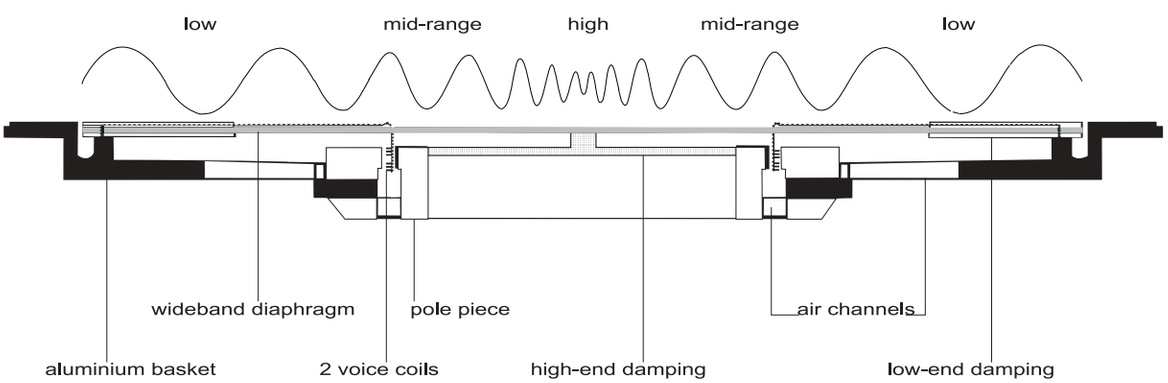

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tic wood and sand them to smooth any mismatched joints. If you use a belt sander, which is a potent tool, equip it with 80 or 120 grit and keep the device moving at all times. It can reshape the panels in ways you won't like if you're not very attentive. Finish the job with a palm sander.

Use the ⅝″ roundover cutter in your router to round each of the cabinet's edges, except around the back edges. If you have a router table, the job is much easier.

A jig saw completes the job of opening the port tube, after having pre-drilled ¼″ holes in opposite corners of the marked area before assembly. The same method works in opening the space for the input terminals. I used the router with a ¼″ roundover bit to run around the port exits (*Photo 12*), again guessing that rounded edges of a port, however modest in size, might minimize diffraction effects.

Before putting two coats of oil-based primer (on the advice of a local paint vendor, even though I thoroughly dislike cleaning oil-based paint from brushes), I covered each of the brass mounting inserts (*Photo 13*) with masking tape. My three coats of finish paint was water-based and mixed a near-black shade slightly darker than the primer. Each coat was followed by palm-sanding with 180 grit paper, after coats 1–3 and 400 after coat 4 (*Photo 14*).

Attaching the interwiring on the inputs and outputs of the crossover boards is next (*Photo 15*). I used #14 AWG stranded copper, leaving enough slack to reach the three drivers in each box. A bit of tape identified the tweeter lead. Putting these in place and installing the mounting screws with a shorty Phillips-head driver is a bit tricky, but do-able. Thread the connecting wires to their respective driver opening and prepare the stuffing.

SEAS recommend 80 grammes of Dacron® wool to lightly stuff each box. Thickness is about 5cm, or 360 grammes per square meter. I used 40 grammes of high loft quilting in each compartment behind the mid/woofers, avoiding blocking the port. Cut the leads to a length making access to the drivers possible and solder each to their respective terminals, being sure to observe polarity, of course (*Photo 16*).

I placed a single bead of Mortite® beneath the rims of each of the mid/woofers before installing the drivers with #8 machine screws. The tweeter openings were very snug and did not need sealant. Be careful with the tweeter because the dome protrudes beyond the mounting frame.

The shipping packing includes a protective insert which you can use in the mounting process. SEAS offers a replacement for the tweeter diaphragm, coil, and connector assembly (which they call "a butterfly"), if you damage yours. Mount the mid/woofers last. It is a

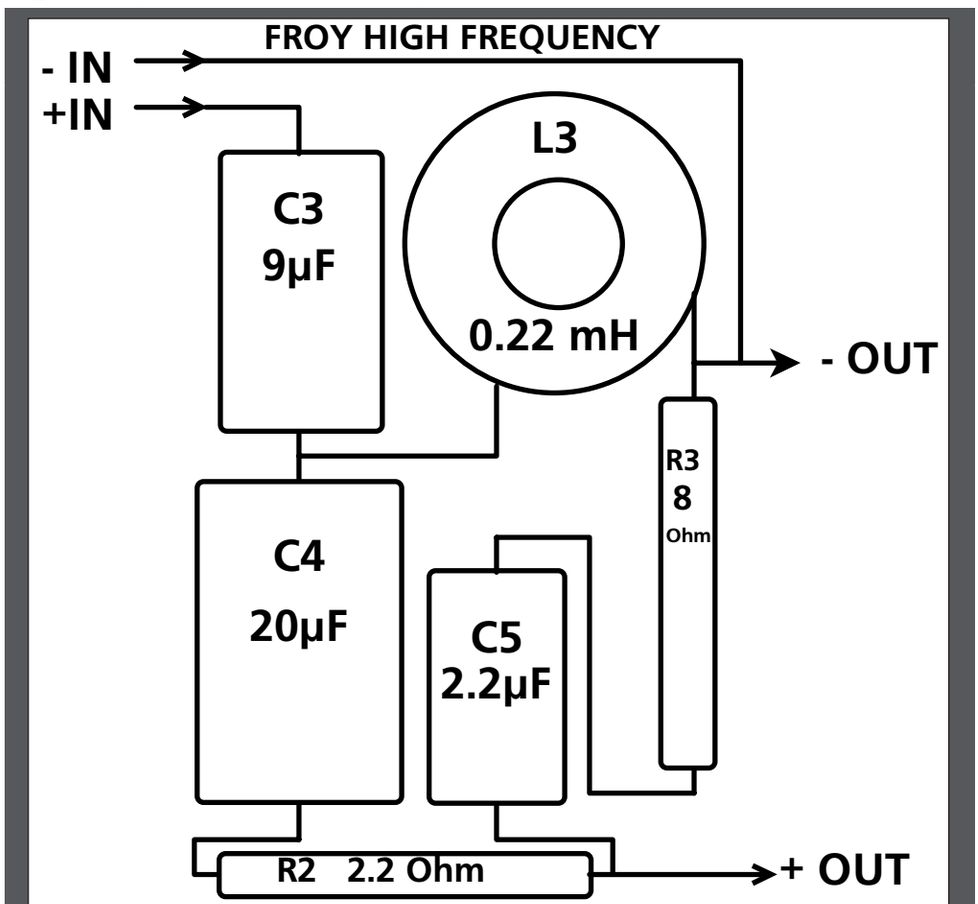

FIGURE 2C: High-frequency crossover template. Minimum size 3¼″ × 4¾″.

PHOTO 13: Second primer coat is complete, all mounting inserts covered by masking tape.

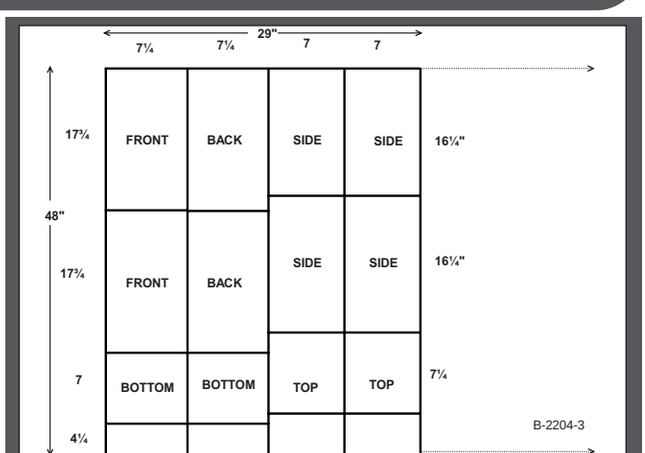

FIGURE 3: Cutting guide. After making the four vertical cuts and the cross-cuts for the fronts, backs, sides, bottoms, and tops, cut the remaining small scrap pieces to 4¼″ × 5¾″ to form the sides of the ports.

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good idea to test continuity and polarity of each driver by using a battery on each one, positive to positive, negative to negative. The motion of the cones should be outward in every case.

Next issue, you will find Joe D'Appolito's measurements of Froy Mk. 3, accompanied by a listening evaluation from Dennis Colin. How did I react to them? Before I saw Joe's report I was frankly surprised how close they were in sound profile to the THORs. I noticed a slight edginess in the upper end, which is surprising since they have the same tweeter as the THORs. They do require stands, which should be 26″ high, to lift the tweeters to ear level. They have excellent horizontal dispersion, although like the THORs, the vertical sweet spot is quite narrow.

Building this pair was a very great pleasure, as speaker construction always is for me. ❖

REFERENCES

1. "Building the THORs," *audioXpress*, Sept. 2002, pp. 14–23.
2. *Shop Notes*, Vol. 6, #34, p. 5, July 1997, www.augusthome.com.

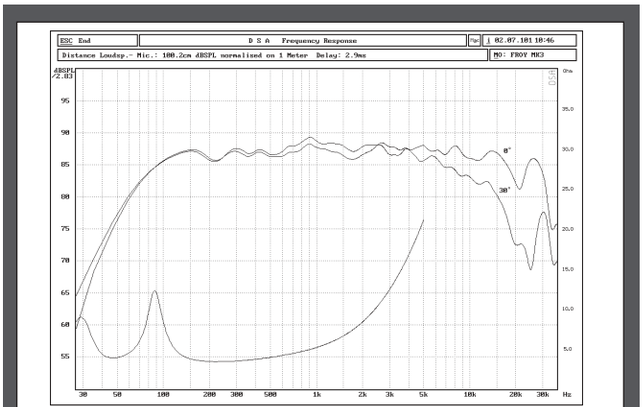

FIGURE 4: SEAS frequency response chart for the Froy system. B-2204-4

TABLE 1
SEAS FROY MK. 3 BILLS OF MATERIALS

QUANTITY	ITEM	DETAIL
4	W15CY001	SEAS mid/bass driver
2	T25CF002	SEAS tweeter
2	L1	0.68mH, 1.63mm #14AWG
2	L2	0.10mH, 0.10mH #24AWG
2	L3	0.22mH, 0.64mH, #22AWG
2	C1	20µF 250V Polypro or Polyester foil
2	C2	2.2µF 160V "
2	C3	9µF 400V "
2	C4	20µF 400V "
2	C5	2.0µF 400 "
4	R1	2.0Ω, 10W metal oxide or non-inductive WW
2	R2	2R2Ω " "
2	R3	8.0Ω " "
8	Dual terminals for crossovers	
2	Twin cup input with gold 5-way posts	
8′	#14 cable	
160 grammes	Quilt polyester	
32	#8 threaded brass inserts	
32	#8/32 × ½″ stainless round head machine screws	
1	⅓ sheet ¾″ medium density fiberboard	

Elmer's carpenter's glue
Sandpaper, Mortite caulk
A number of vendors offer a variety of crossover variations, as well as a variety of complete parts kits. Prices for full kits vary from $850 to $950, depending on options. Some offer finished cabinets for the Froy.

PHOTO 14: Fifth coat of paint completed with the box ready for hardware installation.

PHOTO 15: One pair of crossovers with connecting wires in place, ready for installation.

PHOTO 16: Tweeter is connected, stuffing installed and machine screws ready for final mounting of the drivers.

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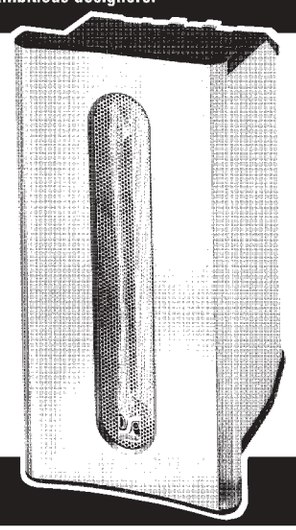

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