The Vintage JBL West Coast Sound becomes…

The Coast to Coast Sound

by Richard Swerdlow

My first speakers were a pair JBL L-100As that I bought in 1973. I always enjoyed them and still use them today. Their easily identified sound, the so-called West Coast sound, was once a highly touted marketing feature. Ad copy claimed that musicians and recording engineers bought or stole the original model 4310 (a professional studio monitor that preceded the L-100s) for home use. JBL did install these monitors in most large recording studios in the 1970s, including Angel, Capitol, Deutsche Grammophon, Elektra, EMI, London/Decca, MGM, RCA, Reprise, Vanguard, and Warner Bros. Although they may have been responsible for some bad studio mixes from the '70s and '80s, even by today's standards, they do amazingly well for a 3-way speaker with only 2 crossover components. Their relatively high sensitivity generates an attack giving music an energy and presence that few other speakers could reproduce then or today.

When I got a home theater audio set up in 2000, I built it around the nearly 30-year old JBLs because they were still in great shape and I could find no full-range speakers for less than $2,000 a pair that satisfied me. Audiophiles have whined about the vintage JBL sound for as long as I can remember. Some of this may have been sour grapes due to their widespread sales success. And some of this was no doubt due to their obvious coloration. I soon learned to keep silent around the more outspoken audiophiles because I got tired of hearing lectures about my misguided ways. Maybe part of my motivation here is to deliver, at long last, a rebuttal.

A few years ago, I began playing with DIY speaker building. I was originally interested in learning what features are important in making a speaker sound good. To make a long story short, it's all in the crossover, and to a lesser extent, cabinet design. A well designed crossover can make average or even poor drivers sound decent, and a well designed crossover combined with genuinely good drivers can make for a truly excellent speaker. Other exotic or expensive tweaks that we so often hear about all make much smaller differences – if they are audible at all – in comparison to the big improvements from a good crossover.

I eventually hit upon a DIY design that is my favorite, the CAOW1, a small 2-way speaker designed by Dennis Murphy (http://murphyblaster.com/) that combines a 5¼" midwoofer (SEAS CA15RLY) with a ¾" dome tweeter (Hiquphon OW1). Although I didn't realize it at the time, I was carefully avoiding any DIY 3-way design that might compete with my JBLs. After I built the CAOW1s, I found that I preferred listening to music over them. Except for their obvious lack of deep bass below 50 Hz, they sound much more balanced and are more satisfying for listening. Not surprisingly, their frequency response curve is flat. The JBLs, my first love, sat in silence, except for movies. They just didn't do it for me any more. I occasionally cranked them up to get a taste of their wonderful bass attack, but they sounded wrong in the critical midrange frequencies. But before completely giving up on them, I decided to test the idea that it's all in the crossover.

First of all, I rediscovered the remarkable build quality of those JBL drivers. The 12" woofer (JBL 123A) in particular is a gem. Black crackle finish covers a cast aluminum alloy frame. The motor contains a 6 lb. Alnico magnet of 10,000 gauss with a 3" edge-wound copper ribbon voice coil. Immersing the coil in such a strong magnetic field, results in a driver with outstanding sensitivity, range, and dynamic response. The cone, an early version of coated paper, with its characteristic white color, is unusually well-damped, as we shall see. All around close construction tolerances were common, as exemplified by the tiny gap between the voice coil and magnet. They are used in the L-100 with no low-pass filter at all in a vented 1.6 ft^3 (45.3 L) cabinet. The JBL owner's manual claims the vent tuning is at 27 Hz; however I am unsure about that.

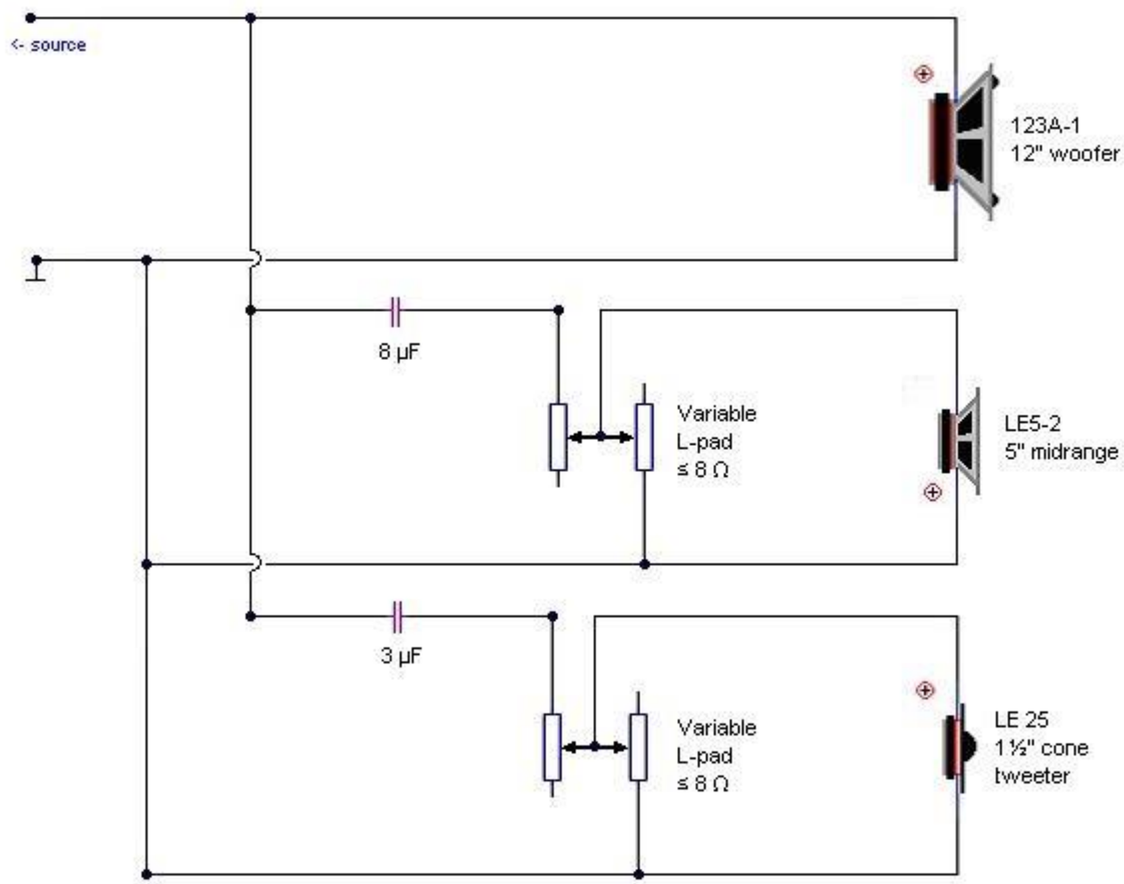
The 5" midrange driver (LE5-2), with a potent 2¾ lb. Alnico magnet of 16,500 gauss, is even more sensitive. Used in the L-100A with a 1st order high pass filter at 1.5 kHz without any low pass filter, I could easily hear prominent upper midrange peaks, and feared that it may not be a very smooth driver.

The 1½" cone tweeter (LE25), although clearly not up to today's dome tweeter standards, does OK below 10 kHz. It is used in the L-100A with a 1st order high pass filter at 6 kHz. Note that on my L-100As the polyurethane foam surrounding the tweeters has long since decayed.

The cabinet is heavy, solid and strong, with a beautiful walnut veneer that has stood up to time without showing its age. An obvious problem is the layout of the drivers.

The original L-100A crossover is a good example that vintage is not always better. It contains only 1st order high-pass filters at 1.5 kHz for the midrange and 6 kHz for the tweeter. The woofer had no filter at all, and the midrange lacked any low-pass filter. It is certainly simple, but as we'll see, it's far too simple. Also note that some JBL drivers at that time were made with the opposite absolute polarity compared to most other manufacturers of today. On the 123A-1 woofer the red terminal is positive. I did not directly see the terminals of the other two drivers, but the midrange had black and white wires attached with the black wire positive, and the tweeter had red and black wires with red the positive.

JBL L-100A Crossover (1971-76)

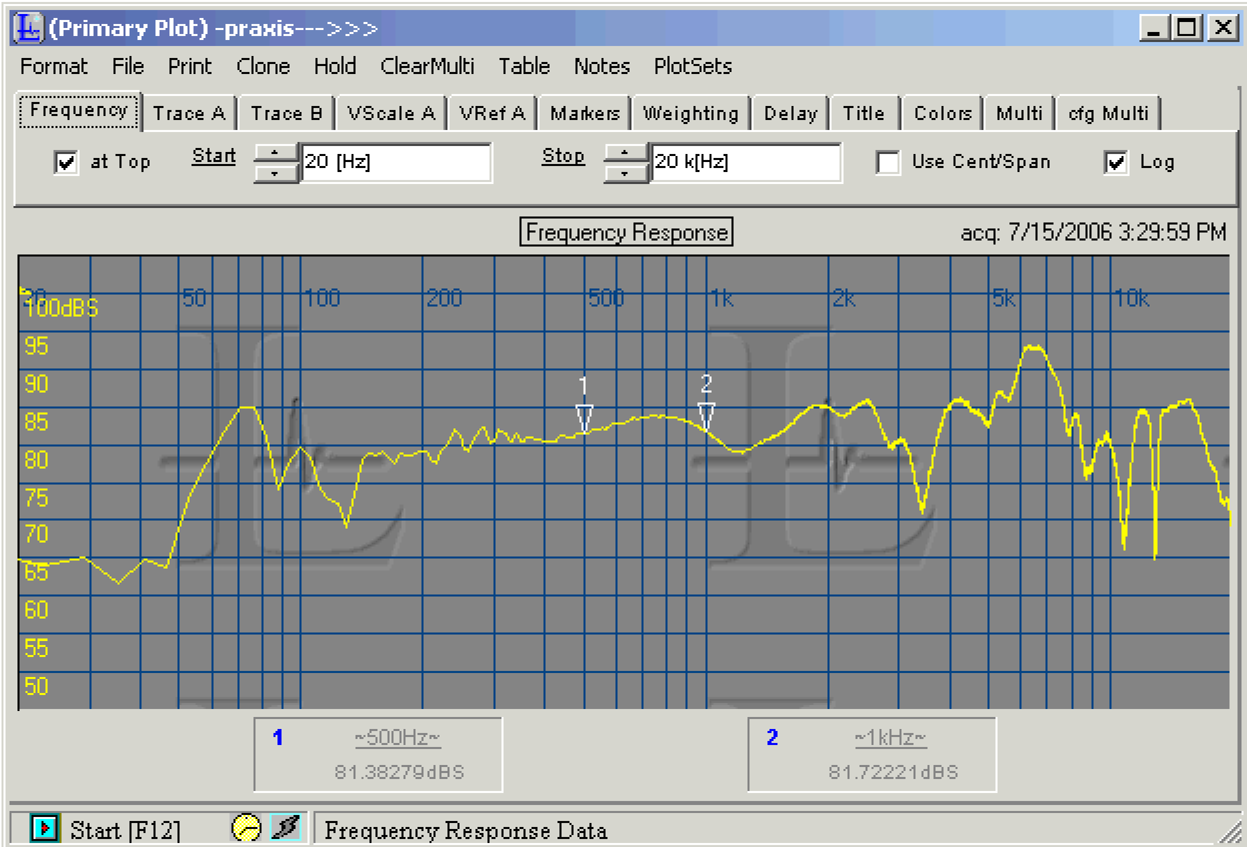


At this point, I asked Dennis Murphy, if he was interested in this vintage make over project. His eager response generated the rest of the details below. I am most grateful for his expert help and enthusiastic guidance.

His first look at the speakers provided a frequency response curve that graphically shows just what "The West Coast Sound" means. Several features are prominent:

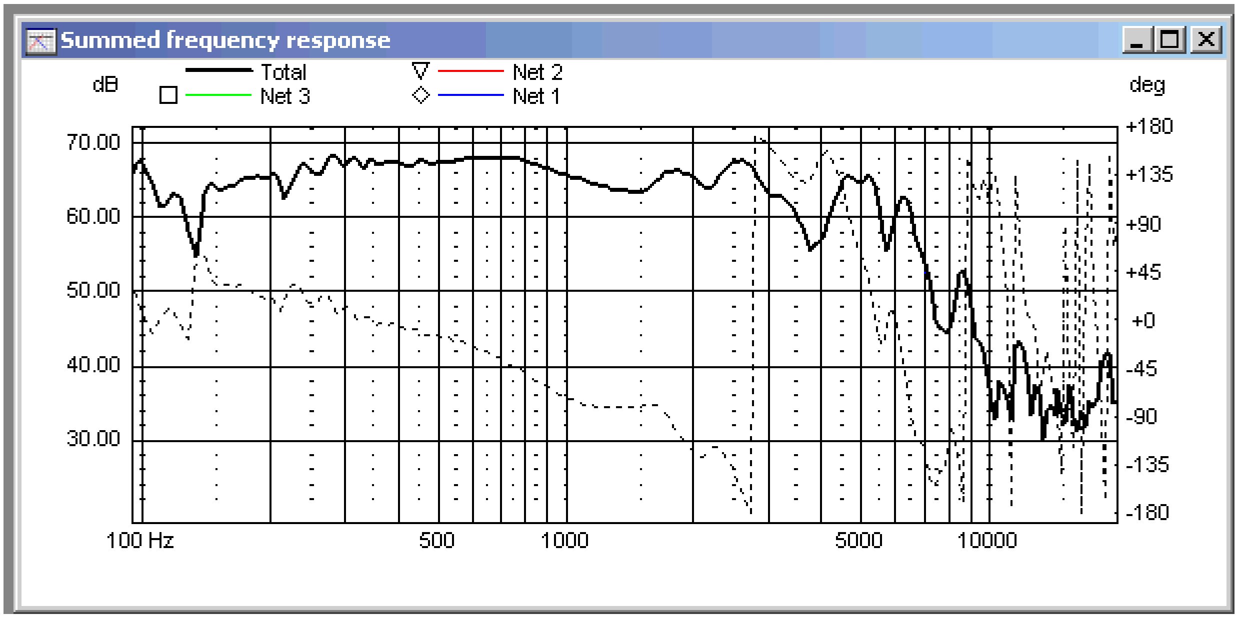
- A big ugly peak from 6 to 7 kHz. Perhaps caused by unfiltered breakup of the midrange driver, this peak certainly would have to be tamed.
- A general rising response as frequency increases, especially above 2 kHz, which contributes to the L-100's forward sound. This probably can be easily corrected.
- Destructive cancellations were seen resulting in deep troughs at 3.3 kHz and above 9 kHz, producing a prominent comb filter effect. This is probably due to the unfortunate placement of the midrange driver relative to the tweeter and woofer on the front baffle.

The prominent rise and fall of frequency response below 200 Hz may be the product of room reflections and their resulting standing waves and cancellations. It may not be directly due to the speaker.



If the 6-7 kHz peak is due to midrange driver breakup, then adding a low-pass filter for this driver may fix it. Along with a better balance between the low and mid-to-high frequencies, correcting the first two problems would alter the most glaring of the West Coast sound features while preserving other desirable attributes of these drivers. If the destructive cancellations are caused solely by midrange and tweeter interaction, an appropriate low-pass filter for the mid driver may correct that; however the destructive cancellations may still remain to some extent due to the driver layout.

Further testing revealed that none of the individual drivers seemed all that bad. In fact, Dennis commented, "Those paper drivers are much better behaved at higher frequencies than many modern drivers." A decent solution might be found without swapping in a different driver as I had originally expected. The unfiltered frequency response of the woofer is shown below, followed by the midrange, and finally by the tweeter.


Summed frequency response
dB
Total
Net 3
Net 2
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deg
70.00
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100 Hz
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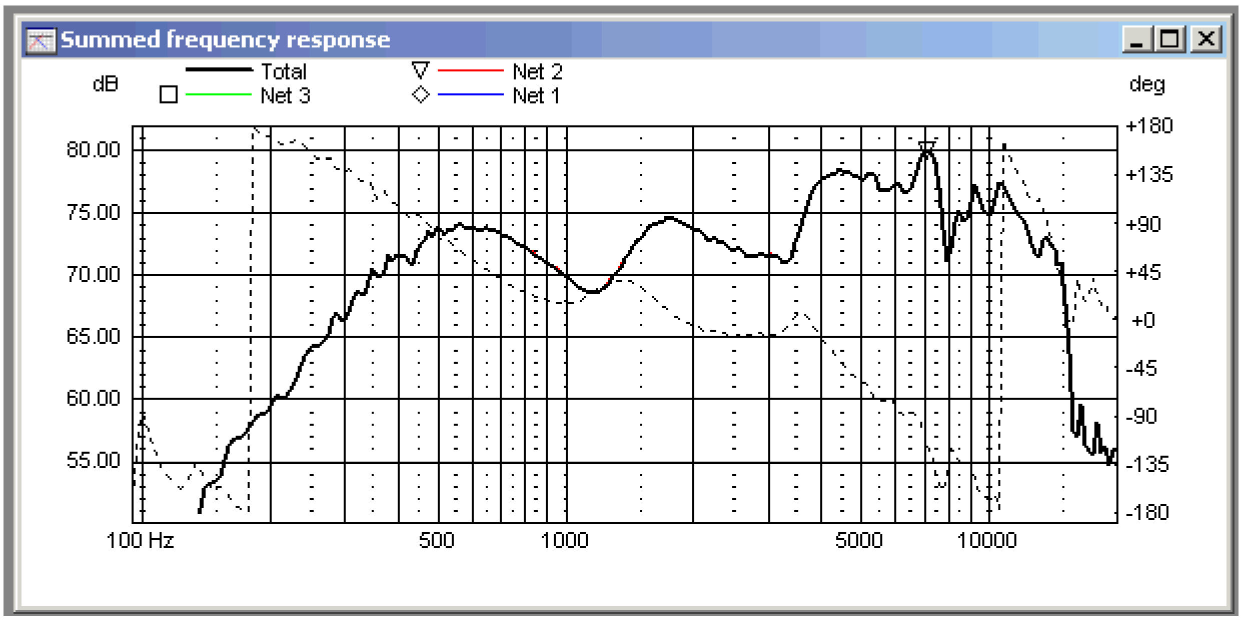
Summed frequency response
dB
Total
Net 3
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deg
80.00
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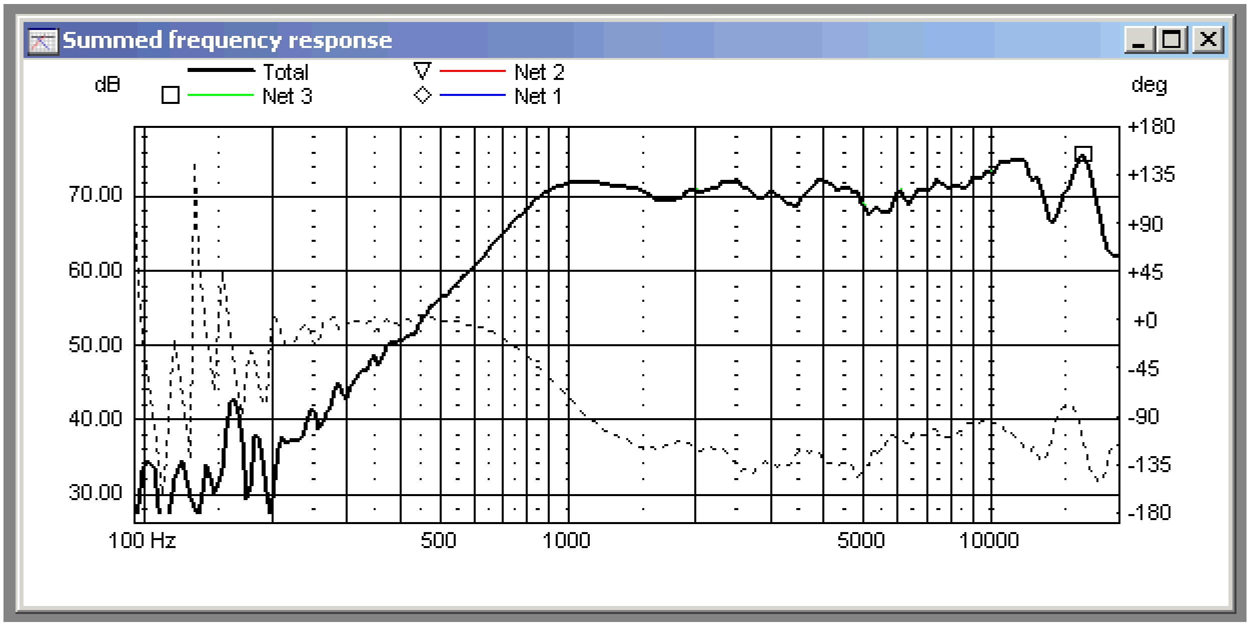
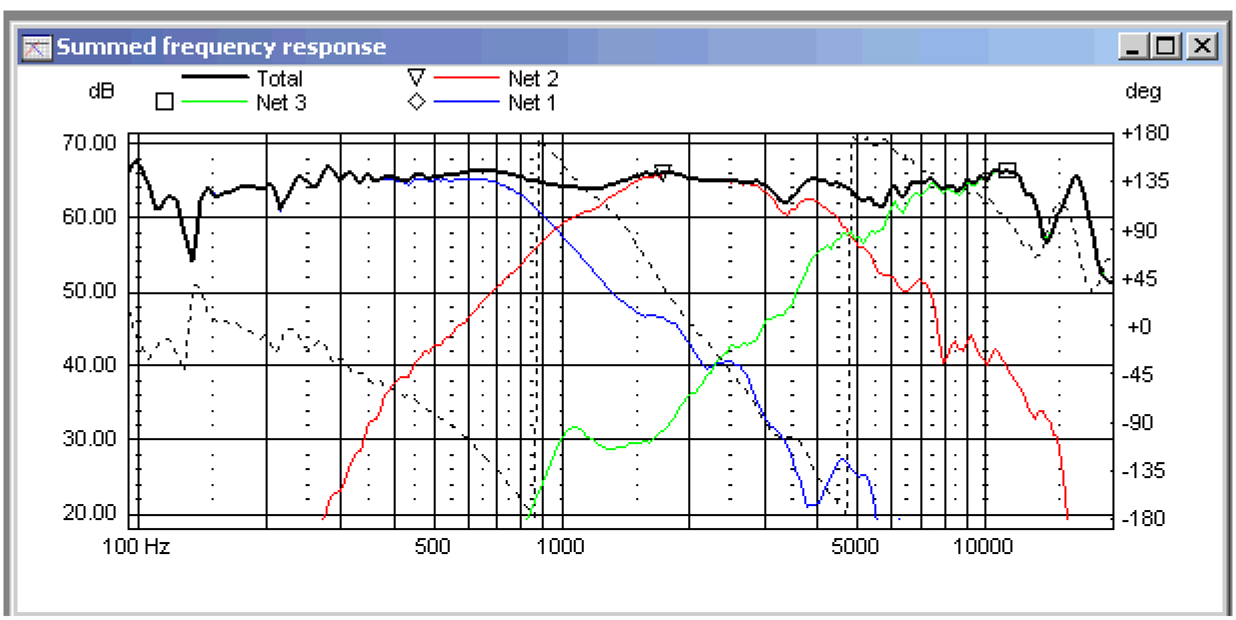
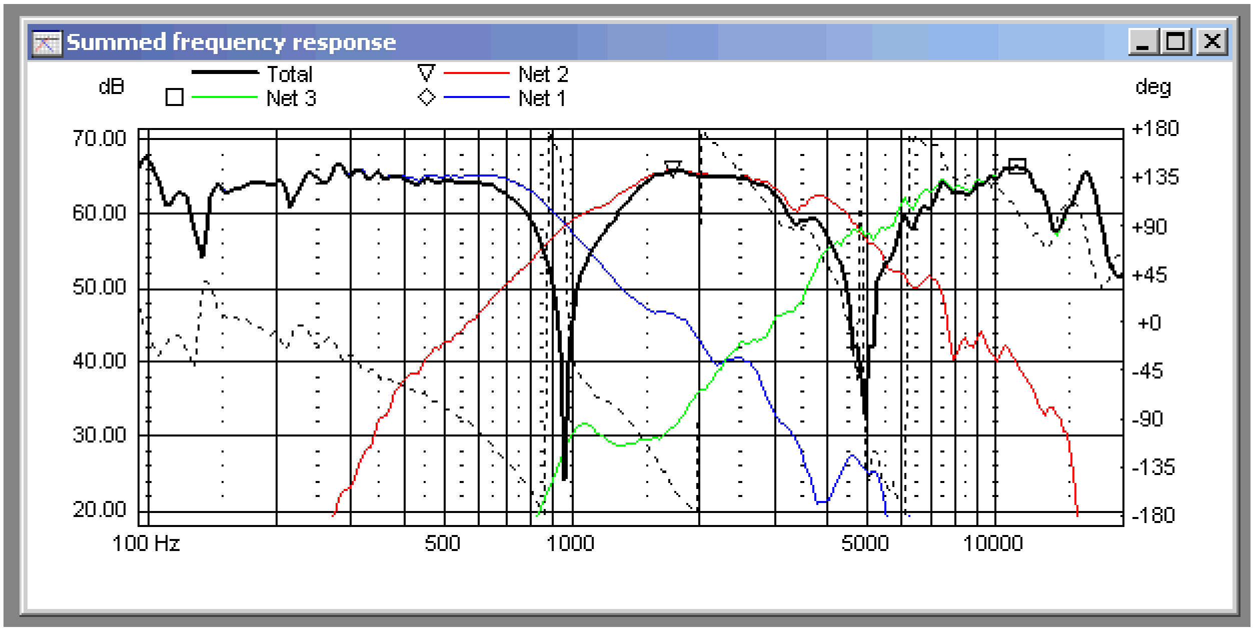


Dennis worked up a crossover design and while listening to it via his crossover emulation software, he sent me this rather provoking email:

"It sounds freaking great to me. The tweeter isn't state of the art, but it gets the job done…"

The predicted frequency response with the redesigned crossover is shown below, first with proper driver polarity and then below that with the midrange's polarity reversed. The latter curve shows the new crossover points, and demonstrates that the drivers are in phase around the crossover frequencies when the polarities of the connections are correct.



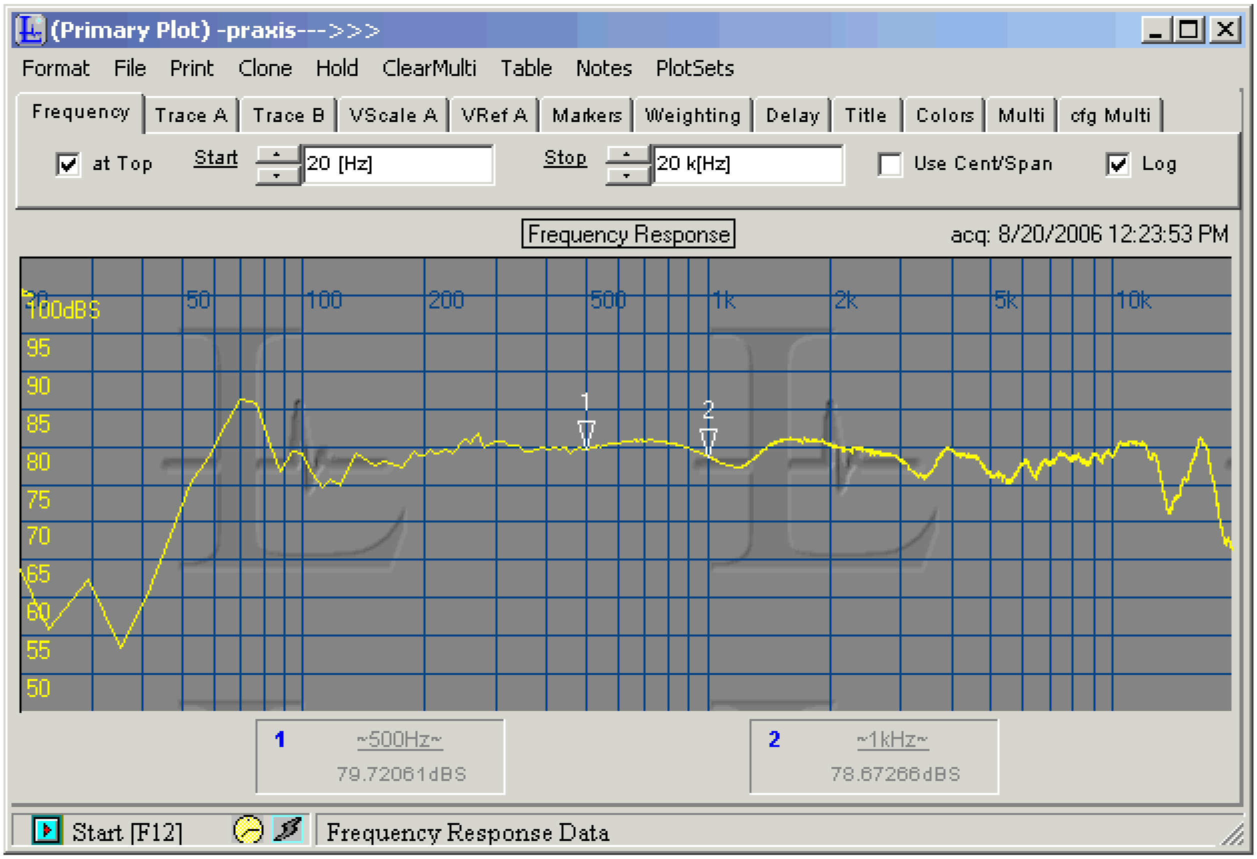


The woofer-mid crossover, at ~950 Hz, involves Linkwitz-Riley 4th order crossover slopes. The mid-tweeter crossover, at 5 kHz is also LR 4th order. The glaring 6-7 kHz peak is essentially eliminated, and the high frequency comb filter cancellations are also gone! According to Dennis,

> "It took more than adding a low pass filter for the midrange driver above 5 kHz because the big peak was not caused by driver break-up. It's actually an additive diffraction artifact caused by the wide baffle and the goofy layout of the drivers. Getting rid of it wasn't easy, and certainly wouldn't have been possible using the design technology of the '70s."

The profile from 10 to 20 kHz remains uneven, and is probably the best the tweeter can do – looking just like the unfiltered tweeter response curve.

Dennis built a test version of the new crossover which produced the following directly measured frequency response curve.



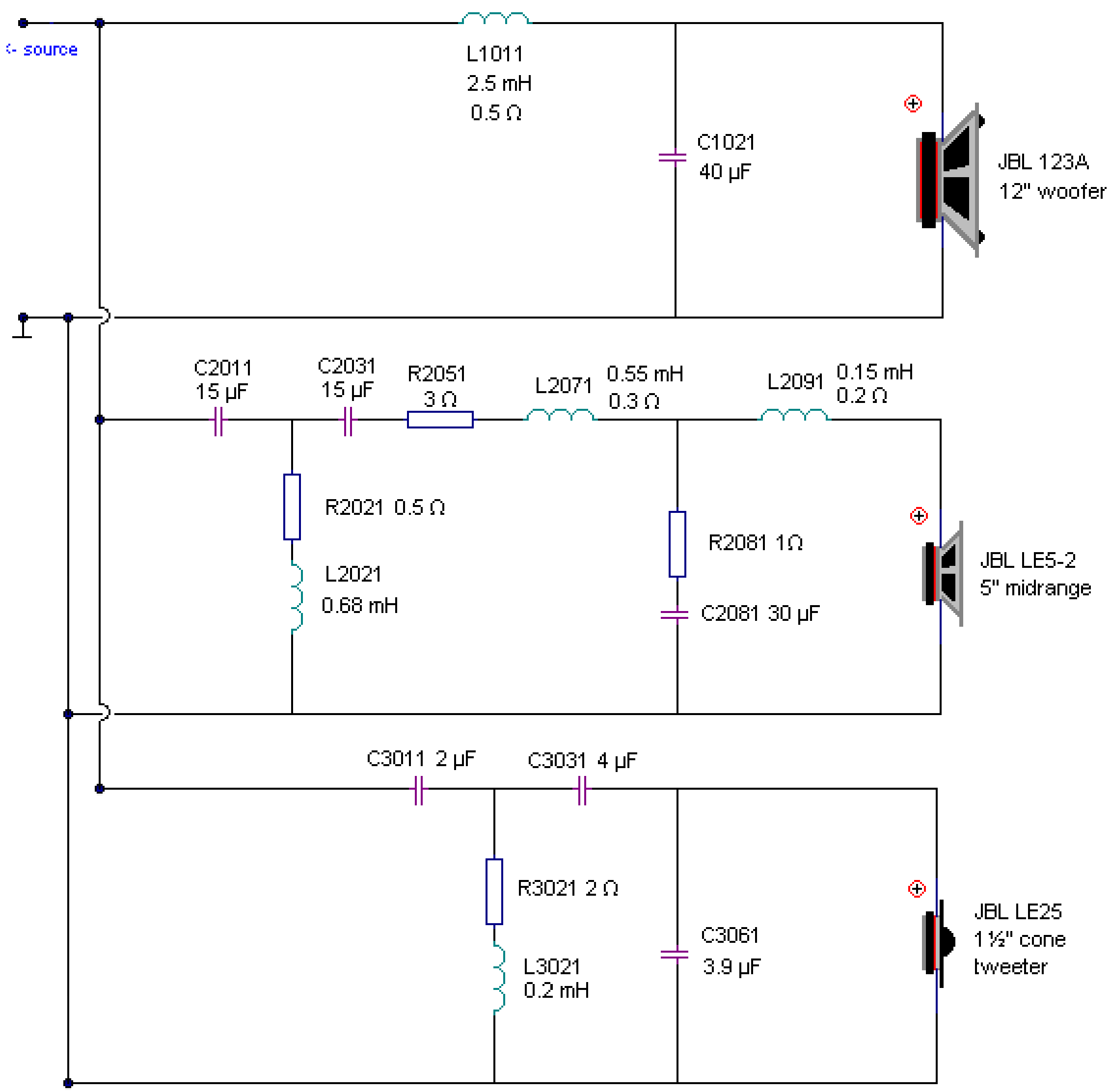
I listened to it and quickly knew that I would be building some crossovers soon. If the original sound of the JBL L-100A was the "West Coast Sound" (page 5), then I will call this the "Coast to Coast Sound".

Building the crossovers was straight forward. With the woofer removed, it was nice having an 11" diameter hole in the cabinet. All the crossover parts mounted on a 10×7 pegboard easily fit in. I mounted the pegboard on the inside bottom of the cabinet using 1" tall plastic spacers and 1½" wood screws so that the pegboard wouldn't crush the fiberglass cabinet lining. I also replaced the original JBL binding posts with some nice but inexpensive standard binding posts ($1.25 each at Madisound).

How do they sound? In a word, excellent! My very first impression after I had installed only one crossover, was that it made the speakers a lot less sensitive. I had expected that, but it was still quite noticeable. But despite that loss of no more than 3 dB, the new crossover did not suck the life out of those JBLs.

I spent about a week listening to one speaker with the new crossover, comparing it to the other speaker with the old crossover, adjusting for the change in volume. Both my wife and I agreed that the new crossover was a clear winner. I tried a wide variety of music that I knew well, including some music where I actually liked the effect that the bright JBL upper-midrange had. The new crossovers eliminate the glare and brightness that I thought I had gotten used to after all these years. The listener fatigue is gone, but the JBL excitement was still there. I remembered that years ago, I used to play with the bass and treble controls, and fiddle with the variable L-pads on the speakers, adjusting midrange and tweeter levels, trying without success to control that ear-fatigue-inducing brightness. The new crossover does it much better. It really amazes me how much better speakers sound when the frequency response curve is flat. You haven't really heard one of these old book-shelf JBL speakers until you have heard it with a proper crossover.

Redesigned JBL L-100A Crossover



I have repeatedly pointed out the problems caused by the driver layout of the L-100A. It has been a vivid lesson for me why almost all speakers today keep the drivers arranged in a vertical line. This photo (borrowed from a highly informative website on the history of James B. Lansing, his companies, and his speaker products: http://www.audioheritage.org/html/profiles/jbl/l100.htm) shows the four different layouts of the various JBL studio monitors made in the '70s.

The redesigned crossover I've described is designed specifically for the L-100A model (2nd from left). The L-100 model (3rd from the left) appears to have its drivers arranged in a vertical line. That might be a more desirable used model to buy if you can find one, but the redesigned L-100A crossover may not work as well for any of the other models.

Left to Right: 4311, L100A, L100, 4310

JBL L100A Crossover Parts List

Here are two different parts lists as of **18 April 2016**. The first is for Madisound, and the second is for Parts Express. Not all parts were available from a single vendor.

In general, I tried to find the lowest price available for each part. Inductor coil prices vary with the gauge of the wire. I stayed with 15 or 16 gauge wire for the inductors in series with drivers, and used smaller gauge (18, 19, or 20 g) for the inductors in parallel. For MPP caps, I used Bennic (Madisound's house brand), Dayton (PE's house brand), and if they weren't available, the cheapest alternative, usually Solen, Carli, or Audyn. There are many other capacitors at much higher prices. Despite what many people believe, they don't sound different.

Madisound has better prices with the inductors, and Parts Express has better prices with most, but not all, capacitors. I would order it all from Madisound, except they don't carry one part, a puny but necessary, 0.5Ω resistor. So you may want to split your order choosing the best prices for each item. I tried to choose equivalent quality for each item. The choice is yours.

There are two large capacitors C1021 (40 µF) and C2081 (30 µF), where I included cheap NPE caps and more expensive MPP caps, to give you a choice. The cheap NPE caps are highlighted in yellow on the Madisound list. The Totals at the bottom reflect the price with the NPE caps are also in yellow, or with the MPP caps (not highlighted). The total prices differed by about $52 US. If you want to keep costs low, do it by ordering those two NPE caps instead of the MPP caps. In general, the MPP caps are considered better construction quality and are more reliable. NPE caps are known to dry out, causing their capacitance values to drift over time (about 30 years). As long as the capacitance values are as intended, the sound from these different cap types are not distinguishable for the listener.

Some abbreviations:

DCR	DC resistance of the wire in inductors
mH	milliHenries (a unit of inductance)
µF	microFarads (a unit of capacitance)
NPE	Non-polar Electrolytic capacitor (a type of capacitor)
MPP	Metalized Polypropylene capacitor (a type of capacitor) also called film caps

Madisound Parts https://www.madisoundspeakerstore.com/alpha-parts-list

As of April 2016 I could not find a 0.5Ω resistor at Madisound.

	Part	Value	Part #	$ each	No.	Price
	Inductors					
L1011	Sledgehammer steel laminate core 15g wire, DC resistance 0.164Ω	2.5 mH	SL2.5	15.90	2	$31.80
L2071	Sidewinder air core, 16g wire, DCR 0.23Ω	0.55 mH	SW.55	9.10	2	$18.20
L2091	Sidewinder air core, 16g wire, DCR 0.11Ω	0.15 mH	SW.15	4.80	2	$9.60
L2021	MB air core, 19g wire, DCR 0.4Ω	0.67 mH	.67MHL	5.20	2	$10.40
L3021	MB air core, 19g wire, DCR 0.17Ω	0.20 mH	.2MHL	3.30	2	$6.60
	Capacitors					
C1021	Bennic NPE	40 µF	M40	1.50	2	$3.00
C1021	or Solen MPP	40 µF	CP40	15.30	2	$30.60
C2081	Bennic NPE	31 µF	M31	1.30	2	$2.60
C2081	or Solen MPP	30 µF	CP30	13.40	2	$26.80
C3061	Bennic XPP MPP	3.9 µF	BP3.9	2.20	2	$4.40
C2011	Carli Mylar	15 µF	M15	4.10	2	$8.20
C2031	Carli Mylar	15 µF	M15	4.10	2	$8.20
C3011	Solen MPP	2 µF	CP2	2.70	2	$5.40
C3031	Solen MPP	4 µF	CP4	3.20	2	$6.40
	Resistors					
R2021	Non-inductive resistor	0.5 Ω	–	–	2	
R2051	15 watt wire wound resistor	3 Ω	15R3	0.50	2	$1.00
R2081	15 watt wire wound resistor	1 Ω	15R1	0.50	2	$1.00
R3021	15 watt wire wound resistor	2 Ω	15R2	0.50	2	$1.00
	Total (with NPE capacitors)					**$117.80**
	Total (with MPP capacitors)					**$169.60**

Parts Express Parts https://www.parts-express.com/cat/crossover-components/21

As of April 2016 Not all parts were available at PE, so I didn't add up the Total.

	Part	Value	Part #	$ each	No.	Price
	Inductors					
L1011	ERSE Super Q magnetic core 16g wire, DC resistance 0.162Ω	2.5 mH	266-908	20.88	2	$41.76
L2071	Air core, 16g wire, DCR 0.23Ω	0.55 mH	–	–	2	
L2091	Air core, 16g wire, DCR 0.11Ω	0.15 mH	–	–	2	
L2021	Air core, 19g wire, DCR 0.4Ω	0.67 mH	–	–	2	
L3021	ERSE air core, 18g wire, DCR 0.18Ω	0.20 mH	266-806	4.85	2	$9.70
	Capacitors					
C1021	NPE	40 µF	–	–	2	
C1021	Or Dayton 5% MPP	40 µF	027-442	11.74	2	$23.48
C2081	NPE	31 µF	–	–		
C2081	Or Dayton 5% MPP	30 µF	027-440	9.76		$19.52
C3061	Audyn Q4 MPP	3.9 µF	027-113	2.29	2	$4.58
C2011	Audyn Q4 MPP	15 µF	027-119	5.23	2	$10.46
C2031	Dayton 5% MPP	15 µF	027-119	5.23	2	$10.46
C3011	Dayton 5% MPP	2 µF	027-414	1.61	2	$3.22
C3031	Dayton 5% MPP	4 µF	027-421	2.19	2	$4.38
	Resistors					
R2021	Dayton Non-inductive resistor	0.5 Ω	004-.51	1.38	2	$2.76
R2051	Dayton Non-inductive resistor	3 Ω	004-3	1.38	2	$2.76
R2081	Dayton Non-inductive resistor	1 Ω	004-1	1.38	2	$2.76
R3021	Dayton Non-inductive resistor	2 Ω	004-2	1.38	2	$2.76
	Total					

No 0.5 Ω resistors are available. Use two 1 Ω resistors in parallel with each other:

For 2 parallel resistors, $R_{eq} = R_1||R_2 = (R_1 \times R_2)/(R_1+R_2)$

If R_1 and R_2 are both 1 Ω, $R_1||R_2 = (1\times1)\div(1+1) = 0.5\ \Omega$

Those large Solen PB30 and PB40 caps are expensive. If you substitute less expensive Bennic Non-Polar Electrolytic (NPE) capacitors (in yellow on previous page) for, you can save $51.80. They are adequate for the job.

General Crossover Construction Tips

I removed the woofer and disconnected the two wires attached to it. On my L100s the woofers had spring-loaded terminals similar to those on the back of the cabinet. Always have some masking tape and a marker pen to label the wires as you work. Label wires (W+ and W–) right away! And write down the wire colors on a sheet of paper. I find it very easy to forget those colors if I don't write it down. (Later you will test the wires to be certain which terminal or wire is plus and which is minus for each driver.)

Inside the cabinet, you will find the existing crossover board glued just inside the front baffle. Eight wires run to and from that board. Two wires go to the terminals on the back of the speaker cabinet, two wires were attached to the woofer you just removed, and two more pairs of wires go to the midrange and tweeter. Rather than remove the midrange and tweeter, I cut those wires. Be sure to leave at least 6" attached to the backs of those drivers, as you will need that when you attach things after installing the new crossover board. **Be sure to label them and write down the wire colors.**

Get a 1.5 volt AA battery. Tape pieces of wire roughly 4-5" long to the plus and minus ends of the battery. Attach one wire to one of the spring-loaded terminals of the woofer. Then touch the other wire to the other terminal. If the woofer cone pops forward, the plus end of the battery is on the woofer plus terminal. If you have it reversed, the woofer pops backward when you touch the wires. Mark the masking tape on each wire as W+ and W–. Do the same battery test with the midrange driver and tweeter. Instead of terminals, attach the battery to those colored wires that come out from behind those drivers. Mark them as M+, M–, T+, and T–.

I also replaced the spring-loaded terminals on the back of the cabinet with new binding posts: Madisound G-POSTB and G-POSTR, as shown. They are $2.75 for 2 red posts and another $2.75 for 2 black posts. They're brass, not steel, hand-tighten the nuts gently. If you torque them too hard with a wrench, the brass post breaks off.

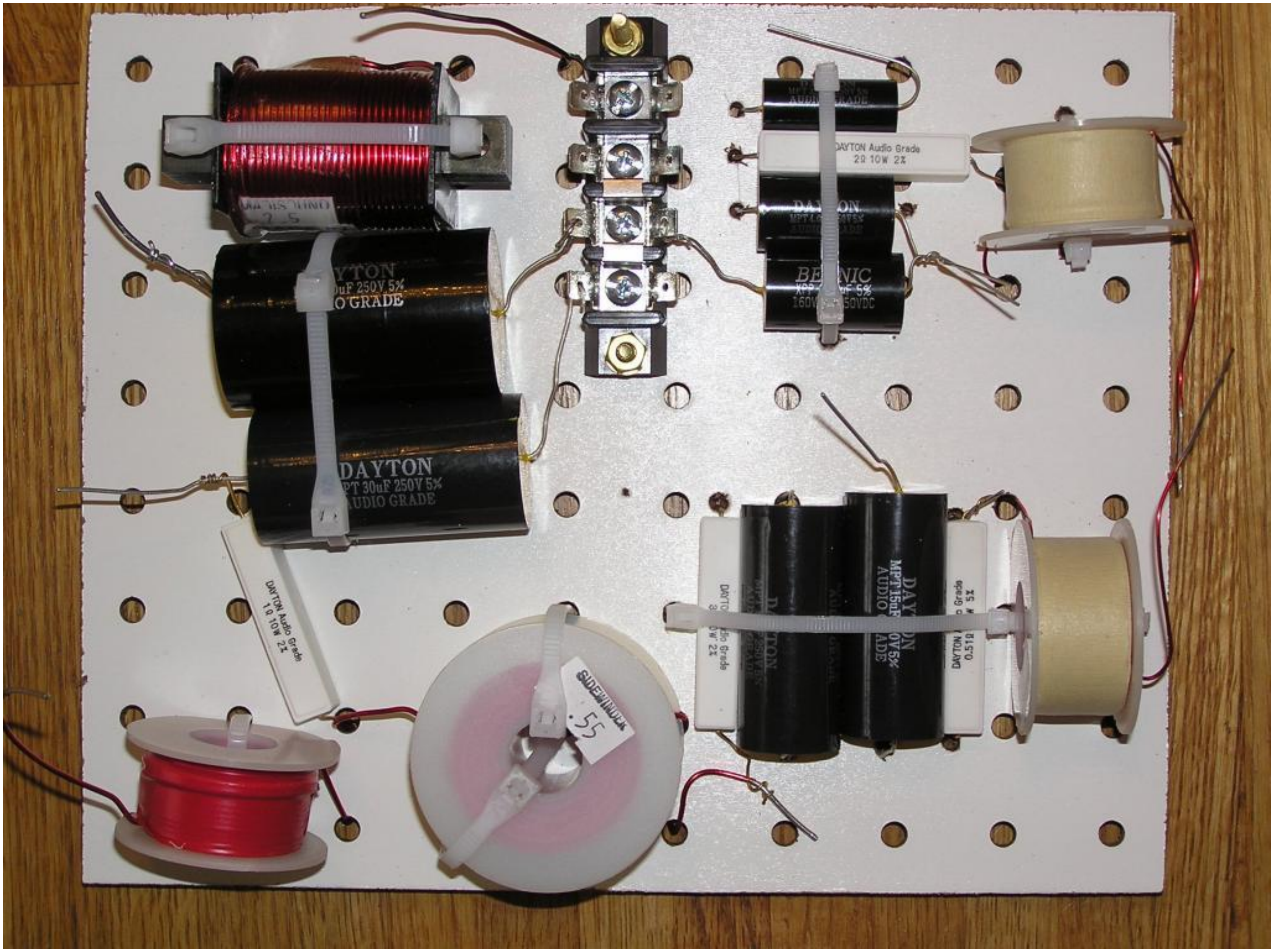
I used a 10"×7" piece of peg board for the new crossovers. That size easily goes through the woofer hole, and fits on the bottom of the cabinet. Any thin piece of plywood or press board (Masonite) will do. No matter how many holes the peg board has, I still had to drill more.

I attached parts to this with plastic cable ties. If things didn't work right, I could cut the cable ties and do it again. Glue is messy, takes time to dry, and is often irreversible.

I used wiring terminals as shown in the photo, but others including simple brass screws work as well. Avoid using steel screws, as they can have unwanted magnetic properties.

I used self-tapping wood screws 1½" long to attach the board to the inside bottom of the cabinet. In a hardware store, I found some plastic 1" spacers with holes for the screws to keep the board from crushing the glass fiber inside the cabinet.

See the photo & diagram of my crossover board (taken before soldering & attaching wires).


DAYTON Audio Grade
2Ω 10W 2%
DAYTON
MPT 30uF 250V 5%
AUDIO GRADE
DAYTON Audio Grade
1Ω 10W 2%
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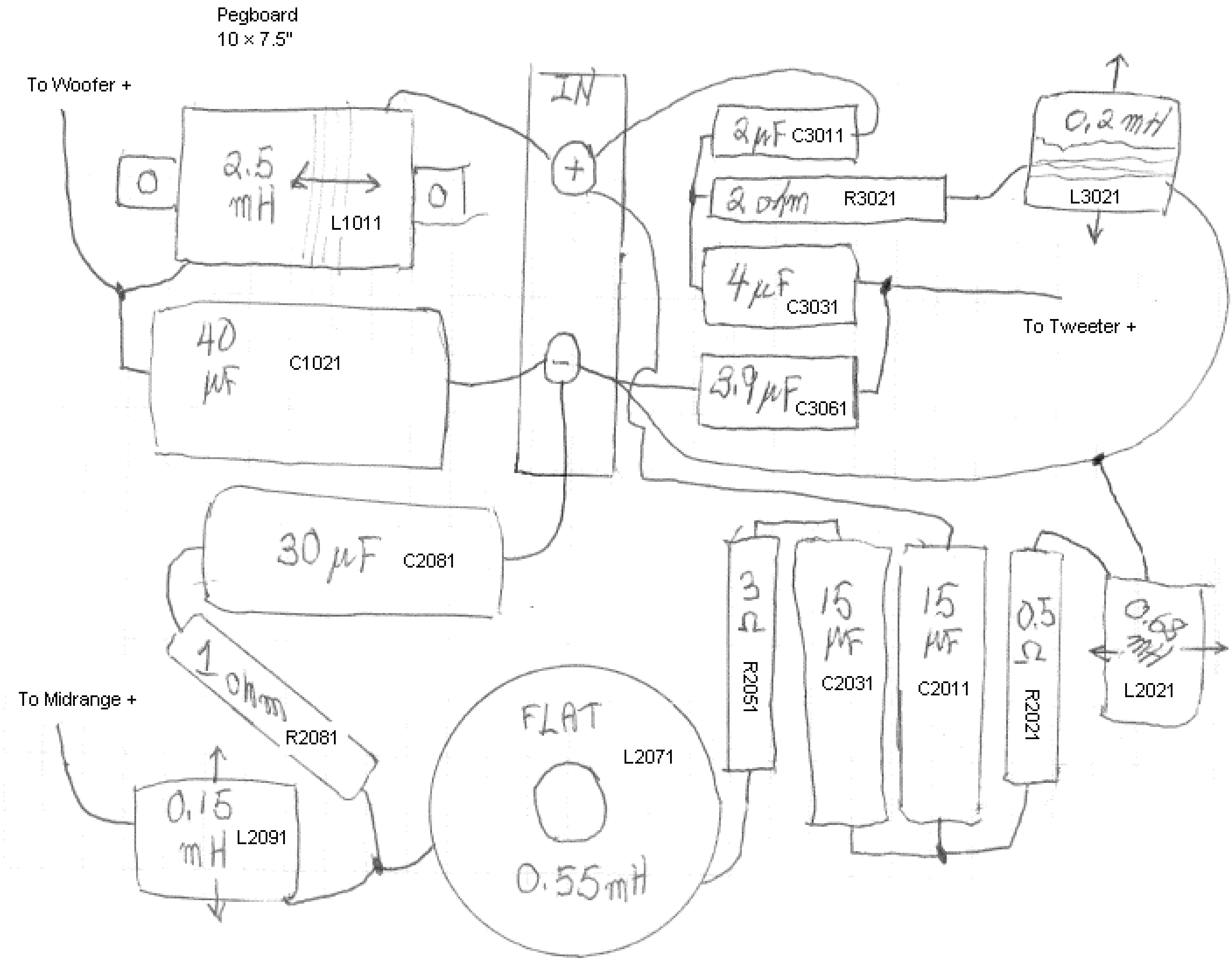
Pegboard
10 × 7.5"
To Woofer +
IN
+
−
2.5 mH
L1011
40 μF
C1021
2 μF
C3011
2 ohm
R3021
0.2 mH
L3021
4 μF
C3031
To Tweeter +
3.9 μF
C3061
30 μF
C2081
1 ohm
R2081
To Midrange +
0.15 mH
L2091
FLAT
0.55 mH
L2071
3 Ω
R2051
15 μF
C2031
15 μF
C2011
0.5 Ω
R2021
0.68 mH
L2021