



Weddings are supposed to be a time of joy and celebration, but after attending many of them this summer, I realized that they usually do not bring joy to the eardrums. It seems that most mobile DJ's have no regard for the quality of the music they are reproducing, and are content to provide ear-splitting, distorted sound. While some of this is due to poor amplification and electronics, much of it is attributable to bad-sounding, poor-quality speakers. So, I decided that I would take up the challenge of producing a high-quality, low-distortion pro-sound monitor that would be suitable for DJ use or as a stage monitor.

## 1 Design Goals

In the simplest sense, the goal of this project was to create a great-sounding compact monitor with the versatility to be used as a stage monitor, with a portable DJ setup, or for any other high-output sound application. Since these speakers would need to produce high SPLs, it was important that they be fairly efficient and had significant power handling. Extended frequency response at both extremes was not as important as an overall good tonal balance free from large peaks in output. Last-but-not least, these speakers needed to have the overall build quality to stand up to the rigors of "pro sound" duty.

## 2 Driver Selection

Initially, I was focused on keeping the budget for this design as low as possible. However, after beginning to look further into the specs and quality of most typical pro-sound monitors, I quickly realized that even a modest investment in drivers could yield results that would rival some of the best products on the market. Not to mention that the associated costs of amplification, hardware, construction time, and the need for long-term reliability do not jive with an ultra-budget design. Not to say that I totally disregarded price—instead I first looked at which drivers would meet my requirements, and then chose the ones that did so for the least amount of money.

The horn driver that I selected is the Eminence PSD2002-8, which I liked because of its smooth frequency response, and because it has excellent reliability in the field. While the top end extension isn't quite as good as what can be found on some more esoteric drivers, it met the needs of this project and did so at a very reasonable price. This was mated to the Eminence LT250 horn lens, which is very rugged in construction, has a shallow mounting depth, and a wide but well-controlled dispersion.

Looking at the low-frequency drivers that offered high power handling, robust construction, and modest cost, I was immediately drawn to the Selenium WPU1209-SLF. This driver has a lot of features for the money, including a 4" voice coil, dual spiders, water-resistant treated paper cone, huge vented pole piece, and bumped back plate. Add to this a healthy X<sub>MAX</sub> and a breakup-free top end, and this driver is an excellent value in high-performance woofers.

## 3 Enclosure Design

Since one of the main goals of this project was versatility, I wanted to develop a cabinet design that could be used either stand mounted or as a stage floor monitor. From looking at

# THE SMITHEREENS



Front-of-House Use

Floor Monitor Use

some existing cabinets and designs, I came up with a flat front design with a combination of 50 and 40 degree rear angles. While these angles are less extreme than on many floor monitors, I found that they are good angles for medium-distance stage monitoring use.

The overall cabinet height and width were based on what would fit the #269-970 surplus perforated metal grill. If these grills are still available, I highly recommend that you pick up a pair to use in your project, as they provide very professional looks and great protection for the drivers. The overall cabinet height is 24", width is 15-1/2", and the depth is 16"; net internal volume is approximately 1.8 cu. ft. The cabinet is tuned to about 50 Hz via a 4" diameter by 4" length port.

## 4 Enclosure Construction & Assembly

Since this cabinet is for portable and sometimes unpredictable pro-sound use, we want to use a high-quality "Baltic Birch" type plywood, which is very rigid due to its 13-layer construction. I found a 3/4" 11-layer plywood at my local lumber center, and while technically not Baltic Birch, it had near-identical properties and characteristics. It ran about \$35.00 for a 4' x 8' sheet, which is enough to build a pair of these cabinets. Please visit the website for detailed drawings, panel dimensions, and cut sheets.

I chose to assemble the cabinet using biscuits and glue for the majority of the joints, which makes the cabinet very rigid. The side panels were glued together first, and then I attached the end caps to both ends. The front baffle was designed as a separate panel, and is secured into the cabinet via screws driven into a series of 1" x 1" stringers running behind the edge of the baffle. This makes it easy to cut or modify the driver cutouts and allows the baffle to be removed from the cabinet if necessary. All outside edges and corners were rounded with a router and 3/8" roundover bit.

**For more information on this project go to [parts-express.com](http://parts-express.com)**

**Look for These Products**

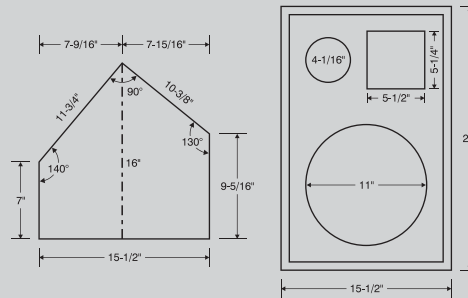
-  **Woofer #264-343**
-  **Horn Driver #290-442**
-  **Horn Lens #290-558**

*\*Turn to page 27 for more items featured in this article*

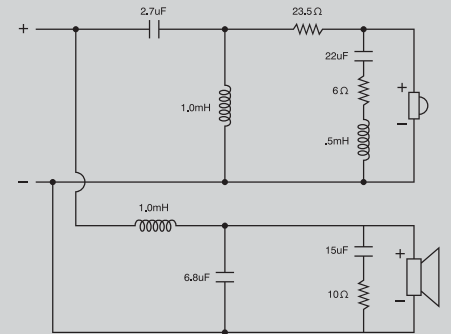
## THE SMITHEREENS

Part #	Description	Qty.
004-6	Dayton 6 Ohm Non-Inductive Resistor	2
016-47	47 Ohm 10 Watt Resistor	4
017-40	40 Ohm 20 Watt Resistor	8
027-344	15 uF Non-Polar Capacitor	2
027-348	22 uF Non-Polar Capacitor	2
027-416	Dayton 2.7 uF Capacitor	2
027-424	Dayton 6.8 uF Capacitor	2
092-052	Neutrik 4-pole Speakon Connector	4
092-122	Neutrik 1/4" Mono Jack	4
245-012	1-3/8" Top Hat	2
255-036	Jantzen .50 mH 20 ga. Air Core Inductor	2
255-048	Jantzen 1.0 mH 20 ga. Air Core Inductor	2
255-422	Jantzen 1.0 mH 15 ga. Air Core Inductor	2
260-114	5" x 7" Input Plate 4 Holes	2
260-768	Black Cabinet Carpet Yard	3
260-771	1-1/2" Diameter Rubber Foot	8
262-150	Cabinet Corner 3-Leg	4
262-160	Wrap-Around Metal Corner	8
262-319	Compact P.A. Handle	2
264-343	Selenium WPU1209-SLF 12" Driver	2
269-970	Perforated Metal Grill Pair	1
290-442	Eminence PSD2002-8 Horn Driver	2
290-558	Eminence LT250 Horn Lens	2

### External Dimensions



### Crossover Schematic



### Listener's Comments

**Mike:** Unlike other monitors that use a "hyped" frequency response to cut through the noisy stage environment, these speakers are able to stand out because of their smoothness, punch, and clarity. The absence of large peaks in the response allows you to get a lot of gain before microphone feedback becomes a problem.

**Jarrod:** Great full-range sound with wide dispersion and coverage. The low-end response is impressive for a 12" driver, and comparable to many speakers that use a 15". Far Superior to typical low-cost woofer/piezo horn tweeter combos.

**Donna:** These speakers are able to play extremely loud without becoming distorted or harsh. At any distance from a few feet to several dozen feet the sound remained very balanced and accurate. Definitely much better than what I've heard at recent clubs or events.

## 5 Crossover Design

One of the goals of this project was to have a speaker that offered great sound quality, and as such, I put a little more work into the crossover than what you would probably find in most other "music store" cabinets. I did initially test the design with a stock passive pro-sound crossover, which produced fair results, but I decided that a little more effort in the crossover design could deliver dramatically improved results.

My final passive crossover design includes a second order low-pass filter plus impedance compensation network on the woofer, which works with its natural roll-off and eliminates higher frequency hash. The horn driver also has a second order high-pass filter in addition to an impedance notch filter at the resonance frequency. Without the notch filter, I was getting excess excursion and distortion at the resonance frequency. This circuit really cleans up the sound of the high-frequency driver.

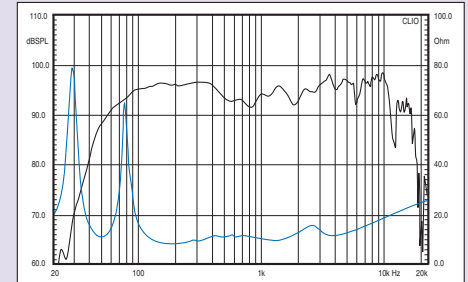
The net crossover point is about 2.5 kHz, though the drivers are slightly underlapped, meaning that the woofer rolls-off a little lower and the tweeter rolls-off a little higher. Note that because of the high power levels that this speaker will see, it is important that high wattage resistors are used, especially in the woofer impedance compensation leg. I chose to make a high-power resistor pack by connecting four 20-watt resistors in parallel.

This is an excellent opportunity to mention that bi-amplifying with an active 2-way crossover could be a very viable option for these drivers. Thanks to the woofer and tweeters' smooth frequency responses, a standard electronic crossover should work well. Not to mention that this approach would eliminate the crossover component cost and the need for high-power resistors. Just center the crossover around 2.5 kHz with about 10 dB of attenuation on the tweeter and you should be most of the way there.

## 6 Comments & Conclusions

The frequency response of this speaker is relatively flat, which definitely gives this monitor more of a "hi-fi" sound than what you get from many other pro-sound cabinets. I'm not going to claim that I personally would be happy using them in my home system, but they are probably not too far off from some vintage large woofer and horn tweeter home speakers.

### Frequency Response Chart



The overall sensitivity of these monitors is a little lower than what you would typically find on this type of cabinet, due to the greater excursion capabilities of the woofer. While this does mean you will need a powerful amplifier to push them hard, it also means that they have much more bass and maximum output potential. I would surmise that for a small DJ venue, you could probably EQ the low end on these monitors and get away without using a sub. For a larger venue, you will need to cross over to a sub and dedicate a high power amp just for the monitors.

All in all, as either a stage monitor or a DJ front-of-house speaker, I think this design is pretty tough to beat; it offers a slew of practical features at a reasonable price. Even without any EQ, they sound quite good, and lend themselves to simple DJ setups that have a minimum amount of processing available. But, they have the performance and reliability to meet the needs of even the seasoned pro-sound veteran.



### About the Designer

During the daytime, Darren Kuzma is a mild-mannered product manager, handling the everyday business of making sure Parts Express has the best speaker building offerings and the most in-depth information available. At night, the DIYer in him comes out, and he spends most of his time working on projects, fixing things around the house, cooking, and keeping up with the speaker building community. He's been building speakers for many years, and says "I learned the most by talking to other speaker builders, reading, doing experiments, and by trial-and-error. There's nothing like getting your hands dirty, that's why they call it DIY!"

