
Subject: The AudioKarma Econo-Waveguide Speaker
Posted by [AudioFred](#) on Tue, 12 Apr 2011 13:10:03 GMT
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I'm in the final completion steps of a speaker that shows great promise as a waveguide speaker for audiophiles and HT enthusiasts who are on a very limited budget. It's the AudioKarma Econo-Wavguide speaker, a design that includes a generic woofer crossover so the builder can choose his own woofer, ideally a 10" or 12". A design summary can be found here:
<http://www.audiokarma.org/forums/showthread.php?t=150939&highlight=econo+waveguide>

AudioKarma is orientd toward vintage audio, so many builders have chosen vintage woofers ranging from highly efficient JBL and Altec drivers to relatively inefficient woofers from vintage acoustic suspension designs. I believe this design makes great use of a modern high sensitivity pro woofer such as the Eminence Delta 12LFA, which I selected for this project.

My version is a specialized design because it had to be light enough to be lifted by two people onto a speaker pole for use in my house concerts. This limited the enclosure to plywood construction and a box no bigger than two cubic feet, less than ideal for the Delta 12. If one is building this design for home audio use only I would recommend a 3.5 cu ft box, which would result in greater bass extension. The 2 cu ft box is a good size for HT use since you'll be using a 70hz hi pass filter. Home audio use for my version doesn't absolutely require as subwoofer, but one is highly desirable. If you hear this speaker with a sub you probably will not want to use it without one after that. In keeping with the economy oriented design I'm using a diy sealed sub with a 12" Dayton DVC budget driver and a buyout 150W plate amp.

Total cost of the parts for a pair of speakers, all sourced from Parts Express, is \$430. This includes air core inductors, Dayton poly caps, audio quality non inductive resistors, ports, quick disconnects, woofers, compression drivers, waveguides, speaker binding posts, and driver mounting screws - everyting except the wire (which you probably already have) and the enclosures. And now for the good news: If you don't have the ability and equipment to build your own enclosures, this design will fit in the PE 1.6 cu ft flat pack trapezoidal enclosures (#245-324) which sell for \$69/ea. The woofer hole is pre cut, so all you need to do with a skilsaw is to cut the port openings and rectangular openings for the tweeter and speaker binding posts.

Here's a picture of an unfinished speaker. I'll be posting details later.

File Attachments

1) [002.JPG](#), downloaded 19844 times

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [Wayne Parham](#) on Tue, 12 Apr 2011 14:50:09 GMT
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Looks good, Fred. I spoke with Evan from time to time and we regularly exchanged emails, so I

was sad to hear of his passing.

It shares the same design concepts, and even uses my crossover. I was pretty regular on the Econowave thread when it was being developed, since they had chosen to use my crossover topology and because there was so much overlap in design approaches. I helped them understand the way to steer the position of the forward lobe and vertical nulls with crossover slope and driver spacing.

The whole Econowave thing reminds me very much of the early days of the Pi Speakers forum. Ten years ago, I had a lot more time to kick around new drivers, mods and things like that. We used a lot of different drivers and even a handful of different horns. So there was a lot of activity and various directions that people went in. Eventually things sort of gelled into a smaller number of highly optimized designs, which are more refined but less DIY-tinker-able. I see this as an evolution path for the Ewave guys too. It has already started going that way, in fact.

loudspeaker. The only real difference is in the drivers you choose. I really like it, and think it is an excellent design. I guess that goes without saying, but there, I said it anyway.

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [AudioFred](#) on Tue, 12 Apr 2011 15:57:30 GMT
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The crossover schematic is here:

<http://www.audiokarma.org/forums/attachment.php?attachmentid=151281&d=1242968714>

I made a few changes. The LP1 L-pad is omitted. The R1 series resistor in the tweeter filter is 25 ohms. I also added a zobel to the woofer filter consisting of an 8 ohm resistor and a 10uF capacitor. The woofer is the Eminence Delta 12 LFA. The tweeter is the Selenium D220Ti-8. The waveguide horn is the Dayton H6512 (#270-318). This \$13.50 horn is less expensive than the equivalent \$40 Eminence H290 used on the three Pi, and when you compare their construction you'll see why. The Eminence horn is built of much heavier material and will be far less likely to "ring" than the Dayton, but this is a budget design with some compromises.

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [Wayne Parham](#) on Tue, 12 Apr 2011 16:09:01 GMT
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Yes, I am familiar with that crossover. It's essentially a Pi Crossover but with an L-Pad acting as part of the R1/R2 network. There was a lot of discussion about that in the early months of the Econowave thread. They used my crossover to base their design on, and I supported them in that

effort.

I agree with your decision to omit the L-Pad. I never really liked them for several reasons. You simply select the R1/R2 pair that provides the requisite attenuation.

An L-Pad is used by the Ewave guys to allow one crossover to be used with many different woofers, but I prefer selecting the right pair of R1/R2 values instead. There's a chart of values I listed at the link below that shows what values give the necessary attenuation and provide the right transfer function at the same time.

Compensation component values

Subject: Re: The AudioKarma Econo-Waveguide Speaker

Posted by [AudioFred](#) on Tue, 12 Apr 2011 16:15:56 GMT

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Wayne Parham wrote on Tue, 12 April 2011 11:09

I agree with your decision to omit the L-Pad. I never really liked them for several reasons. You simply select the R1/R2 pair that provides the requisite attenuation.

My one experience with variable L-Pads was they introduced some distortion, especially when you're using good drivers, crossover parts and wire. Even though I had a couple of PE 100W 8 ohm L-Pads in the parts box I chose not to use them.

Subject: Re: The AudioKarma Econo-Waveguide Speaker

Posted by [AudioFred](#) on Tue, 12 Apr 2011 16:59:54 GMT

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The measured in-room response. Microphone placed on tweeter axis at 40", 1/3 octave smoothing. It's +/-3dB from about 60hz to 20khz.

File Attachments

1) [Econowave Eminence.bmp](#), downloaded 17310 times

Subject: Re: The AudioKarma Econo-Waveguide Speaker

Posted by [Wayne Parham](#) on Tue, 12 Apr 2011 17:41:03 GMT

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Looks good!

You might want to also measure the verticals to make sure your forward lobe is right. Do something like this:

Crossover optimization for DI-matched two-way speakers There's a video in that post, and it shows an easy way to find the position of the vertical nulls. Sometimes, if the forward lobe isn't perfectly straight ahead (as is often the case), it will help you decide if you want to add a little tilt to the platform on the stands.

Here's a little 30-page whitepaper on this design approach that you might enjoy:
High-Fidelity Uniform-Directivity Loudspeakers

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [AudioFred](#) on Wed, 13 Apr 2011 00:46:06 GMT
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Wayne Parham wrote on Tue, 12 April 2011 12:41
You might want to also measure the verticals to make sure your forward lobe is right.

Thanks for the suggestion. I'll do that.

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [Wayne Parham](#) on Wed, 13 Apr 2011 02:45:31 GMT
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Great work, Fred. Looks like a really nice speaker. Please do keep us informed on your progress with this build.

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [Duke](#) on Sat, 23 Apr 2011 12:55:47 GMT
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Looks great, Fred! Very nice job.

I stumbled across that horn on the Parts Express website while researching a bass guitar cab project. The first time I ran a suite of measurements, I thought there was something wrong with my setup. The polars looked too good to be true, so I ran the data again. Nope, it's really that good. Not perfect, but certainly work-with-able (which was not the case for most of the horns I measured). I now use it in most of my speakers.

The horn body itself is a bit resonant and "plasticky" sounding, so I stick some Dynamat to the backside, and that cures it. I also use a bit of blue loc-tite on the threads, just in case it wants to wobble loose from the vibrations. Maybe all of this is covered in the AudioKarma megathread, I

dunno; only glanced at a few pages of it.

Again this year I'll be showing a speaker that is conceptually pretty much identical to the 3Pi and Zilch's Econowave. Gee, so much for originality (though mine isn't a deliberate copy). Okay maybe my angle enclosure is original (well, except that NHT did it long before me).

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [AudioFred](#) on Sat, 23 Apr 2011 14:36:56 GMT
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Here's the BOM. All parts from Parts Express. The total cost of the parts for a stereo pair is about \$440. (For a stereo pair order two of each unless otherwise noted):

16 ohm 10 W resistor #004-16
25 ohm 10W resistor #004-25
2 ohm 10W resistor #004-2 (in series with 25 ohm resistor)
8 ohm 20W resistor #017-8 (woofer zoebel)
0.47uF capacitor #027-406
4.7uF capacitor #027-422
10uF capacitor #027-428 (woofer zoebel)
12uF capacitor #027-430
#8 X 3/4 screws black 100 pcs #081-422 (one pkg required)
1/4" female disconnects 50 pcs #095-290 (one pkg required)
Speaker binding post #260-303
Eminence Delta-12LFA #290-416
0.60mH 18awg air core inductor #255-234
1.5mH 15awg air core inductor #255-426
2.5" flared port tube #260-478 (two required per speaker)
Selenium D220Ti-8 driver #264-270
H6512 waveguide #270-318

These speakers are capable of sustained high power/output levels, but only if you quadruple the wattage ratings of all the resistors. For typical home audio levels the 10 and 20 watt capacities in the BOM are ok, because they will play to room filling levels with only a few watts.

If you don't have the equipment to build diy enclosures you can use the (\$69/ea) Parts Express flat pack trapezoid birch cabinets #245-324. (Be sure to cut all the holes before you assemble them). These are marginally small for the Delta 12LFA and will have little output below 70hz, so you'll want to use a subwoofer with them.

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [AudioFred](#) on Mon, 16 May 2011 15:43:53 GMT
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A few LSAF visitors asked me to post in one place all the information needed to build a pair of EconoWaves like the ones I exhibited using the Eminence Delta 12LFA driver. So here it is:

The crossover is almost identical to the original one in the Audio Karma Econowave thread. Here's the link:
<http://www.audiokarma.org/forums/attachment.php?attachmentid=151281&d=1242968714>

This crossover is a generic prescription for almost any woofer. I made three specific changes to better accommodate the Eminence woofer:

- 1) In the woofer crossover I added a zobel consisting of an 8 ohm 20 watt resistor in series with a 10uF capacitor. The zobel is installed parallel to the 12uF shunt capacitor, connecting the positive and negative woofer terminals.
- 2) For the series resistor in the tweeter L-Pad I used a 25 ohm resistor in series with a 2 ohm resistor for a total of 27 ohms. This voices the tweeter a bit on the quiet side, and other builders may prefer to use only the 25 ohm.
- 3) I omitted the variable L-Pad, instead trying different fixed resistor combinations until the speaker tested and sounded the way I like it.

All the parts are sourced from Parts Express. The total cost of the parts for a stereo pair is about \$440. (For a stereo pair order two of each unless otherwise noted). I assume you will supply your own wire and will line opposite interior walls of the enclosure with R-13 fiberglass insulation from Home Depot.

16 ohm 10 W resistor #004-16
25 ohm 10W resistor #004-25
2 ohm 10W resistor #004-2 (in series with 25 ohm resistor)
8 ohm 20W resistor #017-8 (woofer zobel)
0.47uF capacitor #027-406
4.7uF capacitor #027-422
10uF capacitor #027-428 (woofer zobel)
12uF capacitor #027-430
#8 X 3/4 screws black 100 pcs #081-422 (one pkg required)
1/4" female disconnects 50 pcs #095-290 (one pkg required)
Speaker binding post #260-303
Eminence Delta-12LFA #290-416
0.60mH 18awg air core inductor #255-234
1.5mH 15awg air core inductor #255-426
2.5" flared port tube #260-478 (two required per speaker)
Selenium D220Ti-8 driver #264-270
H6512 waveguide #270-318

Small DIY Enclosure (Seen at LSAF) Details

The pair I exhibited were in an approximately 2 cu ft enclosure, which is marginally small for the

Delta 12LFA. I would use this enclosure only if you know you will be using a subwoofer. In other words, it's a good choice for HT use, but not the best for music only use. The enclosure dimensions are 16"W, 13.5"D, 24"H.

For driver and port placement look at the picture and consider this: The tweeter is mounted with the outside of its flange about 1" from the top of the enclosure. The woofer is positioned with its frame about 1" from the tweeter. The ports are centered in the available space below the woofer. You should determine the proper mounting positions by placing the drivers and ports on the front baffle and marking their position with pencil.

This enclosure has one "window-frame" brace between the woofer and tweeter.

Large DIY Enclosure Details

This is the preferred enclosure for music use without a sub. The dimensions are 16"W, 13.5"D (same as the small enclosure), but 40"H. This height places the center of the tweeter horn at 36" seated ear level. I recommend three window-frame braces, one between the woofer and tweeter, one just below the woofer, and one halfway between the below-woofer brace and the enclosure bottom. The drivers are mounted the same distances from the top of the enclosure as in the small enclosure. One 4" port (PE #260-411) should be used cut to 3" length. The port can be centered on the front or the back, midway between the lowest two braces. Front mounting is preferred if the speaker will be placed close to the back wall.

I plan to build this version soon and will post construction pictures here.

PE Flat Pack Trapezoidal Enclosure Kit Details

Here's some really good news for anybody who wants to build this speaker but doesn't have the equipment to build DIY enclosures. You can build a pair of the \$69 Parts Express flat pack enclosures using only an electric drill, a skil saw, and a screwdriver. Here's the link to this product:

The folks at PE were kind enough to supply the kit with an 11" hole to accommodate any 12" pro woofer. You must cut the rectangle for the tweeter. Place the tweeter on the baffle with the woofer already set in place, position it one inch from the woofer, draw the outline of the tweeter, and use that as a guide to cut the tweeter hole.

This does not leave enough space on the front for the ports, so you will use a single 3" port (PE #260-404) on the back panel. This port is already the required 4.5" length, so no cutting is needed. Center the port so its inside opening isn't blocked by either the woofer or the tweeter magnet. A good location would be about halfway between the woofer and tweeter center lines.

This enclosure is a bit smaller than the one I exhibited at LSAF. The F3 will be about 60hz, and a subwoofer is highly recommended.

If you visited my room at the LSAF and you plan to build the AudioFred EconoWave, PM me for the "Show Special" price on the parts. If you were unable to attend the LSAF you can get the parts directly from Parts Express.

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [AudioFred](#) on Tue, 07 Jun 2011 22:50:31 GMT
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The AudioFred AudioKarma EconoWaves continue to evolve, first with the replacement of the 2 cu ft standmount enclosure with a 4 cu ft floorstander, and then with the addition of a rear-firing bipolar waveguide tweeter. The larger enclosure has extended the bass response enough for these speakers to sound good without a subwoofer. For the rear-firing tweeter I used a Dayton 6X6 waveguide with an Eminence ASD-1001 compression tweeter.

File Attachments

1) [006.JPG](#), downloaded 15679 times

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [AudioFred](#) on Tue, 07 Jun 2011 22:52:50 GMT
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Here's a picture of the back of the new enclosures showing the waveguide, the 4" port and the speaker terminals. A miniature switch on the speaker terminals allows me to turn the rear firing tweeter on or off:

File Attachments

1) [005.JPG](#), downloaded 14196 times

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [Wayne Parham](#) on Tue, 07 Jun 2011 23:19:03 GMT
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That larger box looks great! I'll bet it sounds good too.

Subject: Re: The AudioKarma Econo-Waveguide Speaker
Posted by [AudioFred](#) on Wed, 15 Jun 2011 02:56:17 GMT
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Since I've upgraded to larger enclosures the smaller ones that I was demonstrating at the LSAF are free for anybody who's willing to pick them up at my house in Houston. PM me if you're interested.

Subject: Re: The AudioKarma Econo-Waveguide Speaker

Posted by [AudioFred](#) on Fri, 09 Sep 2011 23:12:10 GMT

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Wayne Parham wrote on Tue, 12 April 2011 12:41

You might want to also measure the verticals to make sure your forward lobe is right.

Finally got around to doing this, and the result wasn't pretty. The upper lobe with the stock Econowave crossover is about 10 degrees above perpendicular. This places it exactly in the path to the ears of a standing listener. I never listen standing, but that's still a narrow angle.

I had the right parts in the bin to convert the tweeter crossover to a 3 Pi. In fact, I had a 6.8uF Clarity SA cap (good) and a 20uF Northcreek Zen cap (better). With the 3 Pi crossover the null has moved up to where you measured it in your video, well above the ears of even a standing listener.

I also found the 3Pi third-order crossover sounds better than the Econowave crossover, so it will stay in the speaker. The improvement isn't subtle; it's enough to elevate the sound quality of this speaker from being a "good sounding" speaker to one that's truly involving. The improvement isn't due to better parts because I used Jantzen Z Superior caps in the old crossover. I've noticed with several speakers that asymmetrical crossovers (e.g. 2nd order woofer, 3rd order tweeter) sound better to my ears.

Subject: Re: The AudioKarma Econo-Waveguide Speaker

Posted by [Wayne Parham](#) on Sat, 10 Sep 2011 03:03:56 GMT

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Yes, you really have to dial in speakers like these for best results. It's what separates the good speakers from the great ones, even more than the horn chosen. I mean, a bad horn can't be fixed, so I'm not saying one of those spitty CD horns will sound as good as a radial or waveguide. But I am saying that the crossover is as important, really even more so, and that even if you have an excellent waveguide, with the wrong crossover, the speaker will not sound good. Like you noticed, if the null is in your face, the response is horrible. That's the biggest problem for the round horn guys, you can't dial in the crossover, it just isn't possible.
