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Subject: 4Pi - alternate compression driver mounting?  
Posted by [areohbe](#) on Tue, 21 Sep 2021 18:16:01 GMT  
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Disclaimer: My first speaker build was a -- somewhat surprising -- massive success. I mainly followed the plans and didn't invest much time into actually understanding the physics/technical aspects of speaker design. I am planning to change with my upcoming 4Pi build (just placed crossover/waveguide order :d ). But, sorry in advance if this is a totally non-sensical question...

Would there be significant/any drawbacks to modifying the 4Pi plans such that the compression driver was mounted, exposed, on top of the cabinet? It's purely an aesthetic preference. I am willing to make some degree of sonic sacrifice, ideally it wouldn't be noticeable to the average listener.

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [Wayne Parham](#) on Wed, 22 Sep 2021 13:57:24 GMT  
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That's actually been a pretty popular mod around here. The main concerns are keeping the geometry the same between the midwoofer and the waveguide and keeping the geometry the same between the midwoofer and the cabinet walls and the port.

The easiest way to do this is to turn the cabinet upside-down, with the woofer high in the cabinet and rest the waveguide in a cradle sitting on top of the cabinet.

This ensures the polar response remains good because the woofer and tweeter positions are the same in relation to each other. And it ensures the internal standing wave alignment is the same because the woofer and port are each in the same place in the box.

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [areohbe](#) on Wed, 22 Sep 2021 18:11:20 GMT  
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Thanks, Wayne! I tried digging around the forum for build threads with a similar approach, but didn't have any luck. Do you happen to know of one so I can spare you a bunch of follow up questions?

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [Wayne Parham](#) on Wed, 22 Sep 2021 19:53:02 GMT  
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I don't think there are any build threads from people that used that approach. But I've seen a lot of photos of loudspeakers made this way, so you might search again. Hard to search for photos, I guess, just gotta scan the internet for them.

Some people put the waveguide in a box and mount it traditionally, setting the tweeter box on top of the woofer cabinet. Others have the waveguide sitting on top, bare. Many people paint the waveguide.

When sitting the waveguide bare on top, the biggest challenge is what to do with the waveguide mounting holes. I would suggest using a filler material - like is commonly used in auto body repair shops - to fill the holes. Then lightly sand the front face so the filler blends and to remove any mold lines. Paint the waveguides with enamel and set 'em on a cradle. I use the cradle approach when I mount wood horns, and I think it looks really nice. See one of my tweeter cradles, below:

### Tweeter Cradle

One last thing - I mentioned above that the woofer/tweeter geometry should be the same but you can center the tweeter. I assumed you knew that but wasn't sure, so I thought it best to clarify. It's just important that the waveguide face be flush with the midwoofer face and that the two are as close together as possible. That's why most people turn the cabinet upside-down - to make it closer to the tweeter.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Thu, 23 Sep 2021 03:53:02 GMT

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That looks lovely.

Turning the cabinet upside down makes sense. That's what I was planning on. Auto body filler is a great call!

I'd like to modify the port dimensions, also for aesthetic reasons. This is a bit over my head, but sounds like I'll need to consider standing wave issues. Think I will start with an MDF front baffle to take some acoustic measurements and go from there.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Thu, 23 Sep 2021 07:03:39 GMT

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Here's my working design:

Shortened overall height by 1", depth & width not changed  
Port is now 8.75"x2.4" w/ a depth of 3"

This result is a cabinet volume of 2.79 cubic feet, equivalent to the original design. I'm sure there are potential drawbacks with this approach but doubt my ear could pick it up. Getting excited to begin the build!

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### File Attachments

1) [CleanShot 2021-09-22 at 23.55.31.png](#), downloaded 969 times

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [Wayne Parham](#) on Thu, 23 Sep 2021 12:59:41 GMT  
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That looks great, so my hat's off to you for the aesthetics. But you're right about the potential internal standing wave issues. The link you included in your post above describes them, so you know what to look for. Pay attention in particular to the region between 200Hz and 400Hz, and even up to 800Hz.

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [alexg](#) on Wed, 10 Nov 2021 17:35:54 GMT  
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Wayne,

Top mounted wave guide looks interesting.

After flipping box upside down, does the woofer stay in place per plan or should the the woofer be moved higher up in the box to maintain the same spacing as called for in the plans?

Thanks

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [Wayne Parham](#) on Wed, 10 Nov 2021 22:25:57 GMT  
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There's the rub.

When flipping the box over, the waveguide and midwoofer are placed closer together than they

would be if the woofer remained low in the box with the waveguide perched on top. So flipping the box over brings 'em closer together, pretty much the same distance apart as they are in the stock design.

I say "pretty much the same distance apart" but they're not exactly the same distance. Not that we need to split hairs about tenths of an inch or anything like that, but the difference is more than that - they're about an inch further apart.

That's not horrible, but it will draw the vertical nulls closer together making the forward lobe smaller. It's not what we want.

On the other hand, the forward lobe is pretty large and the nulls are spaced far enough apart we don't have to push it. That's why the stock design has a gap between the midwoofer and tweeter. If we needed, we could bring them closer together to get more distance between vertical nulls. But we really don't need that - the nulls are widely spaced.

Then we also have to consider the internal standing waves. If we move the midwoofer or the port, the standing waves will align differently inside the cabinet. So we cannot know for sure if modifications will create midrange anomalies without measuring the cabinet.

I moved stuff around for testing way back when I originally designed this cabinet, and I tried a lot of configurations both with mathematical models and then ultimately with measurements of physical loudspeakers. But that was a long time ago and I cannot remember what movements were OK and what weren't. I know this particular configuration measured well.

So for the person considering this mod, those are things to consider.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [alexg](#) on Sat, 13 Nov 2021 17:03:07 GMT

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Wayne,

Thanks for the info.

Top mounting sounds / looks cool but probably not worth messing with your design.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Sun, 14 Nov 2021 06:23:02 GMT

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I'm a complete amateur and a sucker for aesthetics. I have a pair of Wayne's crossovers and waveguides in hand.

I hope to have some prototype MDF cabinets complete by end of year. Will share results once I get there.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Mon, 29 Nov 2021 18:03:26 GMT

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Squeezed in a couple hours of work over the Thanksgiving holiday.

JBLs arrive later this week. Then, I'll complete the cutouts for the driver and port.

DE250 is backordered until 12/15. :? But, still hoping to have some measurements by end of year.

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#### File Attachments

1) [Plans.png](#), downloaded 1027 times

2) [MDF Panels.png](#), downloaded 756 times

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Mon, 03 Jan 2022 02:31:24 GMT

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All glued up!

Will be diving in to REW for the first time this week. Hoping the frequency response gods are looking fondly on me and everything measures as desired.

The DE250 is still backordered. Hoping it arrives mid Jan when I get back from an upcoming trip.

Had a lot of inspiration/design tweaks while building out this prototype cabinet. And, of course, made a few mistakes that I'll be able to avoid in the final build.

I thought I was excited before, but it's starting to feel real and I can't wait to get these hooked up and in their final resting place.

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#### File Attachments

1) [EA81438A-9D5F-40A4-AD17-F197BD99E7CD.jpeg](#), downloaded 705 times

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [Wayne Parham](#) on Mon, 03 Jan 2022 15:40:57 GMT  
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Lookin' good!

Fingers crossed on the measurements!

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [areohbe](#) on Wed, 12 Jan 2022 03:17:07 GMT  
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The DE250's got pushed back again. Parts Express is now estimating March. :(

I picked up some PSD2002's in a panic. They were already out of stock at PE. I'd imagine they'll be backordered everywhere soon as well.

The 2002s are schedule to arrive tomorrow. :d

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [areohbe](#) on Sat, 15 Jan 2022 00:25:19 GMT  
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\$75 class D amp, no dampening yet, and already pure bliss. :d :d :d

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#### File Attachments

1) [83CE7A83-FF0A-436A-AA2D-4599D4A73151.jpeg](#), downloaded 536 times

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [areohbe](#) on Sun, 16 Jan 2022 02:36:40 GMT  
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Short video if anyone is interested. Nothing fancy, recorded on an iPhone. YouTube link.

I'm by no means an audiophile, but sounds pretty damn good to my ears.

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [Wayne Parham](#) on Sun, 16 Jan 2022 16:56:30 GMT  
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Looks like a really cool build!

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Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [areohbe](#) on Fri, 28 Jan 2022 04:21:31 GMT  
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Wayne - I'm sorry but I have a few quite a few questions about proper measurement technique...

I've dug through the forums and found answers to some but not all of my questions. So here we go...

How "wide open" of an area do you need be in to reap the benefits of testing outside? I'd imagine this depends if your testing with speaker laid on its back or upright?

The performance measurement page indicates the mic should be placed 10 feet from the front baffle. Does this differ depending on the measurement device or any other variables? I am using a UMIK-1.

How important is the quality/type of amp used?

The measurement page says a drive voltage of 8.2vrms was used. Do I need to measure my amp's vrms? Or is this not relevant if I am sending a signal from REW out of my laptop into the amp? (I feel really dumb for asking... does it matter what level the "bass" and "treble" gains are set at?)

Related to vrms, do I need to worry about this "Calibrate Level" setting in REW?

Thanks in advance, Wayne. Really appreciate the care and energy you put in here.

Here's a pic from some preliminary tests the other night. I'm a bit bashful to share my results until I know I am doing everything correctly. :(

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### File Attachments

- 1) [Rew - Calibrate Level.png](#), downloaded 544 times
  - 2) [1st Attempt.png](#), downloaded 531 times
-

Subject: Re: 4Pi - alternate compression driver mounting?  
Posted by [Wayne Parham](#) on Fri, 28 Jan 2022 18:13:49 GMT  
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The quality of your environment will be reflected in the quality of your measurements. Oh, such a pun in that sentence. :lol:

For measurement charts that will be published, I would recommend no less than 30 feet of unobstructed reflection-free area. On the other end of the scale, if you just want to look at the frequency range near crossover - like during development or to see the position of the vertical nulls - then just a few feet is enough. You can use a gated pseudo-anechoic measurement for that.

Your backyard has a lot of items that will reflect sound, so it is really only suitable for the latter. But that's pretty good because the main thing you want to see is the position of the vertical nulls. Being outdoors, you won't have room modes, so you'll be able to see a general trend that is accurate down through the bass range. But it will be only the general trend that's accurate - you'll see plenty of peaks and dips that wouldn't be there in an anechoic environment. So expect that.

As for the amp, it's generally not an issue unless it is pushed into clipping. I doubt you'll do that, but just to be safe, don't push the amp hard. I don't think you're testing max-SPL, so keep the signal under 10v. And on that subject, the drive signal level isn't all that important. It just needs to be enough to overcome the noise floor. I tend to use multiples that easily calculate back to a 2.83v/1M value. This allows me to measure voltage sensitivity along with everything else I'm trying to see.

Which is what that "calibrate level" task is doing for you. If you measure the voltage at the speakers and enter that into your measurement system - and if the system knows the microphone distance too - then it can provide a chart that shows what SPL values would be measured at 2.83v with the microphone at one meter. This has become a standard, so it's useful for comparison with other systems.

Lastly, you're going to want to lay your speaker on its back, facing upwards. Measure it like shown in the video in the post below. Scroll down to the link that says "Vertical Nulls." It will show you how to position your microphone and what to look for.

Crossover optimization for DI-matched two-way speakers

Sadly, this won't be enough to verify the response in the 100-400Hz range, which is where I would expect to find problems from internal standing waves. The objects around the speaker will create reflections that will modify response in this region. What you might want to do is to clear out as many of the things in your back yard as you can, making it as reflection-free as possible. Then set the speaker in the middle of the yard as far from the house and the fences as possible. The further away you can get from reflectors, the lower in frequency your measurements will be accurate. Hopefully that will be enough to see smooth response in the 100-400Hz region, to verify that the port and driver arrangement is not causing any midrange anomalies.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Fri, 28 Jan 2022 23:38:58 GMT

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Excellent explanation, as always, Wayne.

Here is my initial test the other evening. I was mostly just trying to verify my UMIK + REW setup was working.

There's still no dampening in the box. I did throw a blanket in the bottom but that didn't seem to change much. Not sure there's much to really glean from this for now.

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### File Attachments

1) [SPL\\_000.jpg](#), downloaded 448 times

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [Wayne Parham](#) on Sat, 29 Jan 2022 16:41:20 GMT

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As expected, the trend looks right but there's a lot of "grass" from all the nearby reflections. All those deep notches are from interference with some object's reflection that's 180° out-of-phase.

The things we really need to know - and so we need an environment that's reflection-free enough to see - is we need to know what's going on between 100Hz and 400Hz and we need to find the vertical nulls which are around 1.2kHz.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Sun, 30 Jan 2022 02:33:12 GMT

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New setup. Think we're getting somewhere...

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### File Attachments

1) [SPL\\_001.jpg](#), downloaded 473 times

2) [2nd attempt.png](#), downloaded 502 times

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Mon, 31 Jan 2022 07:43:38 GMT

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Doh! Just realized the roll offs in the highs is because I didn't zero out the high and low gain. :lol:

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [Wayne Parham](#) on Mon, 31 Jan 2022 15:21:04 GMT

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Yes, you're working with much cleaner measurements now.

Get some stuffing in the cabinet and see if you can do anything with that peak around 120Hz. That is the difficult region I often talk about.

You'll notice the stock cabinet gently rises from 100Hz to 150Hz and then gradually drops to around 200Hz. This is the result of the positions of the midwoofer driver, port and insulation. It prevents the really big peaks and dips.

The peak in your cabinet is not unusual. I've seen a lot of cabinets like that. It doesn't sound terrible, but you do notice a throaty sound in male voices and other things. It just sounds "boxy."

So try lining the walls with insulation and also try placing a sheet that spans the cross-section of the cabinet between the port and the woofer. Might even use two of those. That cross-section "divider" sheet has proven to be the most effective, in my experience.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Mon, 31 Jan 2022 20:08:04 GMT

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Thanks, Wayne! That was my suspicion. Good to know I wasn't too far off.

Think this gives me enough confidence to move on beyond MDF and start procuring some birch and working on the final cabinet design.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [Wayne Parham](#) on Mon, 31 Jan 2022 21:00:00 GMT

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I would strongly suggest adding insulation first. Especially the cross-section sheet. Try it straight.

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Try it diagonal. Make sure you can mitigate that peak at 120Hz.

I say this because you might find that your efforts to damp the peak are illusive, and you might end up moving the port. This is best learned while you're still in the "cut and try" mode.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Mon, 31 Jan 2022 22:05:00 GMT

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Do you have to be so reasonable, Wayne?! :lol:

Heading out to pick up some R-13...

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Sat, 05 Feb 2022 02:15:52 GMT

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Hmm green is the new measurement. Bout the same? Maybe worse? :cry:

#### File Attachments

1) [SPL\\_002.jpg](#), downloaded 419 times

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [Wayne Parham](#) on Sat, 05 Feb 2022 16:43:13 GMT

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The response in the 100-200Hz region is about the same, so I think you want to look at things you can do about stuffing. Hopefully you can find a solution with damping material. Not sure what's going on above 1kHz, but it looks like there are a lot of reflections. Could be also way off-axis in the vertical, but that wouldn't explain the dip around 2.5kHz.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Mon, 07 Feb 2022 02:07:19 GMT

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Went offsite so I could take my time and not worry about disturbing the neighbors. I heard a lot of "Is that aliens?!?" from the kids two houses down.

I ventured out to one of the quietest places in North America, a mall parking lot.

I'm feeling pretty good about this. There's still a little weirdness in the 1-2k range, but it was highly susceptible to the mic position. Maybe just reflection from the boom itself?

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### File Attachments

1) [SPL\\_003.jpg](#), downloaded 540 times

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [Wayne Parham](#) on Mon, 07 Feb 2022 16:25:35 GMT

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Oh, that's excellent!

I like what I see in the 100-400Hz region, which was really what I was most worried about because of the port change. But I'm no longer worried. That configuration works fine. That tells me that the junk we saw was a result of reflections in the back yard, which is completely understandable and expected.

As for the 1kHz to 2kHz region, I'm a little less worried about that 'cause I know what it looks like based on the fore/aft locations of the drivers and the crossover. Your vertical distance between woofer and tweeter looks to be a little greater than a stock build, but not so wide as to narrow the null angles too much. I expect that to all be fine.

But I would double-check the usual stuff that can cause symptoms like that. Check the connection polarity. It's "weird" on both the woofer and tweeter, in that the 2226H needs positive to black and so does the DE-250. So make sure they're connected right.

And of course, make sure the tweeter face is flush with the baffle and the microphone is on-axis, or at least within +/-20°, maybe +/-15° in your setup with the tweeter a little further from the woofer than stock. When the speaker is on its back, the microphone should be hung above the speaker a few feet away and between the woofer and tweeter. That's the center of the forward lobe. You can then move the microphone along the speaker's vertical plane to find the positions of the vertical nulls.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Fri, 06 May 2022 19:55:35 GMT

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A rather distracting home purchase event put the brakes on this project for a bit. But, we're back!

Ended up encasing the compression driver and tweaking the dimensions a bit.

Still needs a proper finish and a few other details wrapped up, but I am pretty damn happy with how it came out.

I'll share more details about the build in a later post.

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## File Attachments

1) [IMG\\_1506.jpg](#), downloaded 391 times

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [Wayne Parham](#) on Fri, 06 May 2022 20:23:07 GMT

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Your speaker looks great!

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [Barryso](#) on Sat, 07 May 2022 13:26:58 GMT

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Excellent looking speaker. It has an old Altec vibe to it.

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [Rusty](#) on Mon, 09 May 2022 10:58:49 GMT

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Agree with Barry. That is a very nice interpretation. More pictures please!

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Subject: Re: 4Pi - alternate compression driver mounting?

Posted by [areohbe](#) on Wed, 11 May 2022 20:11:04 GMT

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Rusty wrote on Mon, 09 May 2022 05:58 Agree with Barry. That is a very nice interpretation. More pictures please!

Appreciate the comments, Rusty and Barry. I do love old Altecs. :)

I'll share more photos as I have time. Up against a time crunch currently. :(

(These speakers were supposed to go in my living room. But about a month ago, a friend that runs a non-profit, radio station in the Bay Area reached out to see if I could help them with sound for their new studio space. So, I'll have to be patient. But, worth the wait.)

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