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Subject: Tim's 4Pi Speaker Build

Posted by [timkur](#) on Sun, 04 Jan 2015 07:42:15 GMT

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Hey guys,

I've recently kicked off the construction of some 4pi speakers, and I thought I'd share some pics and my experience. I'd also appreciate any feedback if folks see I'm doing something horribly wrong.

I consider myself a "weekend handyman". I've done rough framing, drywall, electrical, etc... but I'm not a skilled wood worker and I've been learning lots about cabinet building while doing this. I'm impressed with the skills of other folks I see posting in these forums, and am excited to see how close I can get to a good looking speaker. Hopefully it will sound great, no matter how it looks.

Last year I build 2 3pi subwoofers, had a lot of fun building those, was impressed with what they added to my setup... see my dog George posing with them.

When I built those, I bought myself a router and a circle cutting jig, and learned how useful a router really is. Definitely something I had been missing before.

After hearing the 3pi subs for a year, I got the itch to replace my front 3 speakers. They are currently M&K 750THX speakers... I got them 12+ years ago and have been happy with them, but just wondering if there was something better out there. I guess we'll soon find out.

Thanks!

Tim

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### File Attachments

1) [subsSmall.jpg](#), downloaded 8551 times

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Subject: Re: Tim's 4Pi Speaker Build

Posted by [timkur](#) on Sun, 04 Jan 2015 07:48:58 GMT

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For my 4pi build, this is what I'm targeting.

To cut down on costs, I purchased 4 JBL 2226H's used from eBay. The seller mentioned that they have been re-coned by a JBL authorized dealer, and they look in good shape. Only cause of concern is the seller mentioned they were originally 4 ohm speakers and reconed to be 8 ohms. However, I'm hopeful I'll be ok

I'm not an electronics guy, and I didn't want to learn how to build the crossovers myself. Instead, I ordered one, and my father in-law got me two of them for Christmas. Standard components... no upgrades for that.

I couldn't find the B&C DE250 used, so I ordered one new, and my parents gave me 2 more for a Christmas present (see a trend here?)

I like the look of the recessed speakers, but after doing the math, it seemed like recessing the JBLs would leave the frame around the front baffle very thin. There has been discussion in the forums about re-enforcing the baffle from the back, but I decided I'd do the same thing as I did with the 3pi subs, and do a double thick front baffle. Just cut 2 different sized circles, and be done.

I won't bore you with the details of the initial cutting of the wood, or gluing big pieces together. I'll just touch on the interesting things I picked up while combing through the forums and actually doing it.

When cutting holes, the only hiccup I ran across was the hole for the JBL. The plans called for a 13 15/16" hole, but that wasn't large enough for my speakers. I ended up going with a 14 1/16" hole. I didn't try a 14" hole, so I may have sacrificed more wood than needed, but the speaker fits now. Maybe the larger size is related to the original 4 ohm speakers I got. Who knows.

I'm excited to figure out how to recess the waveguide. The rounded corners look like they'll be fun to cut.

Thanks

Tim

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Subject: Re: Tim's 4Pi Speaker Build  
Posted by [timkur](#) on Sun, 04 Jan 2015 07:54:41 GMT  
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#### Port Construction

For the port, I built an actual little box that is 8.5" long. The double baffle will add another 1.5" of thickness to give me the full 10" port.

Once the boxes were built, I glued them to the baffle.

A nice tip in the forums about the port hole in the baffle is to do a rough cut first, and then use a flush trim bit on the router to get it nice and smooth. It works great and is an (almost) idiot proof way to do this, and is now my new favorite tool+bit combo that I own.

See the front... pencil marks is where the hole should be cut.

Through the back of the port... you can see the overlap that the bit will cut off.

And 20 seconds of using the flush trim bit. You can see my pencil lines were off a little bit. That would have been a pain to try and correct had I cut it where I marked. And not only that, but I've got rounded corners for the port. That looks cool.

Thanks!

Tim

#### File Attachments

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- 1) [PortBack.jpg](#), downloaded 8313 times
  - 2) [PortSmall.jpg](#), downloaded 8364 times
  - 3) [RoughPortFront.jpg](#), downloaded 8346 times
  - 4) [FrontPortSmooth.jpg](#), downloaded 8391 times
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Subject: Re: Tim's 4Pi Speaker Build

Posted by [timkur](#) on Sun, 04 Jan 2015 07:57:30 GMT

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#### Cross Bracing

I see that a lot of folks built their 4pis and attached the back as the last piece. I thought about that, but then I couldn't figure out how to get the cross bracing installed, so I decided to leave the top for the last piece to glue on.

I had some leftover 1x2 maple from a cabinet I installed, and decided to use that. The plans say to install the cross braces with a "slight amount of preload". I took that to mean that they should fit really tight, so I cut the braces 1/16"-1/32" too long, and really wedged them in there. They weren't going to move easily, but I glued them in to be safe.

Thanks!

Tim

## File Attachments

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- 1) [FrontCrossBrace.jpg](#), downloaded 8305 times
  - 2) [TopCrossBrace.jpg](#), downloaded 8278 times
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Subject: Re: Tim's 4Pi Speaker Build

Posted by [Wayne Parham](#) on Sun, 04 Jan 2015 15:16:00 GMT

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Those are looking really good! Thanks for posting pics of your progress!

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Subject: Re: Tim's 4Pi Speaker Build

Posted by [timkur](#) on Thu, 15 Jan 2015 05:20:31 GMT

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Thanks Wayne. My day job has me sitting at a desk all day, so it feels great to actually build something in my free time. I'm looking forward to getting this all together and hearing what I built!

Tim

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Subject: Re: Tim's 4Pi Speaker Build

Posted by [timkur](#) on Thu, 15 Jan 2015 05:39:25 GMT

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T-Nut installation.

There is a great thread

[http://audioroundtable.com/forum/index.php?t=msg&goto=71620#msg\\_71620](http://audioroundtable.com/forum/index.php?t=msg&goto=71620#msg_71620)

about installing T-Nuts. I thought I'd add some pictures and post some of my experience.

It wasn't clear to me if the T-Nuts should go on the frontside of the baffle, or the backside. When I built my 3pi subs, I put them on the front side. They were easy to install and easy access if something should go wrong. Even though that causes the mounting surface to not be smooth, the gasket helps seal it up real nice.

6 months later the sub failed in my M&K sub, and when I went to replace that, I noticed those T-Nuts were located on the back side. Additionally, one of the T-Nuts had come loose, which turned a 5 minute replacement job into a multi-hour ordeal to get that speaker out. Ugh. I wish M&K added glue to their T-Nuts like Wayne suggests.

This time around, I decided to mount the T-Nuts on the backside. The big reason why I decided to do that is that I may have cut my hole a bit too big. I guess I should have tried a 14" hole instead

of a 14 1/16" hole. However, with the T-Nuts on the back side, and the taper of the speaker, this wasn't a problem.

The above thread mentioned 2 different ways to install the T-Nuts... one with a screw, and another with a C clamp. I couldn't quite visualize the screw method, so I went with a C clamp.

In order to get enough torque to push the T-Nut in, I needed to use one of the "crank style" clamps. I couldn't generate enough pressure with the "handle style" clamps I was using to glue the boards together.

Since I put these on the backside, I figured it would be easier to do this before I glued the box together, so I could see what I was doing. Unfortunately, at this point, I had already glued one of the baffles to a box, so one of them I needed to do blind. It turned out not to be as hard as I would have expected, but it was definitely easier to do it when I could see it.

Here is one of the baffles with the T-Nuts installed. I made sure I glued them in. Before I put in the T-Nut, I wet the area with a paper towel, added a drop of gorilla glue, and clamped them in.

Pretty straightforward, but putting in 24 of these things took some time.

Tim

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#### File Attachments

- 1) [TNutOverlap.jpg](#), downloaded 7841 times
  - 2) [TNutAllDone.jpg](#), downloaded 7896 times
  - 3) [TNutClampPress.jpg](#), downloaded 7907 times
  - 4) [Clamp.jpg](#), downloaded 7902 times
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Subject: Re: Tim's 4Pi Speaker Build  
Posted by [timkur](#) on Thu, 15 Jan 2015 06:06:25 GMT  
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Insulation

This was pretty straightforward. The only R13 insulation I could find at Home Depot was faced (has the brown paper backing on it), but that made it really easy to install. For the back, side, and top, I glued the paper backing to the inside of the speaker box. Pretty simple. For the insulation on the cross brace, I removed the paper, so as not to interfere with the absorption of the insulation.

I installed the insulation before I glued on the top of the speaker box. It made access very easy.

Insulation on the back and side.

Insulation sitting on the cross brace.

And then I glued the insulation to the top before I glued the top onto the box.

Next up, the 2nd baffle, and cutting those curved corners for the waveform. I was able to successfully do it on a test piece. We'll see how it works when I do it for real.

Tim

#### File Attachments

- 1) [InsulBackAndSide.jpg](#), downloaded 7910 times
  - 2) [InsulOnBrace.jpg](#), downloaded 7908 times
  - 3) [InsulOnTop.jpg](#), downloaded 7940 times
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Subject: Re: Tim's 4Pi Speaker Build

Posted by [Wayne Parham](#) on Thu, 15 Jan 2015 16:39:01 GMT

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That looks really good, Tim. Thanks for showing us your build as it comes together.

I usually remove the paper backing because I worry it might buzz. But I suppose if you press it firmly onto the cabinet panel while the glue is drying, it would prevent that.

And I agree with your observations about T-Nuts. I've seen enough of 'em get loose that I always glue them in. I pull them in place with a clamp just like you did, or by tightening a screw to pull them in place. I never hammer them in.

The reason I mount T-Nuts from the inside is I don't want to pull them out the front when tightening. I suppose the glue will probably prevent this, but I prefer the added security of having

them inside the cabinet, where tightening the fastener pulls them further in rather than further out. It puts the joint in compression rather than in tension.

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Subject: Re: Tim's 4Pi Speaker Build  
Posted by [timkur](#) on Mon, 26 Jan 2015 00:55:25 GMT  
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Thanks Wayne.

That makes complete sense about mounting the T-Nuts on the inside... makes me feel kind of stupid for not thinking about it sooner.

I'll keep my ears open for buzzing. If I hear it, I'll go in and remove the paper.

Thanks!

Tim

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Subject: Re: Tim's 4Pi Speaker Build  
Posted by [timkur](#) on Mon, 26 Jan 2015 01:16:05 GMT  
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Cutting the rounded corners for the waveform.

I really like the look of the recessed waveform, but I didn't really know how to cut the rounded corners to fit it in.

This is the approach I took.

First, I traced the outline of the waveform onto the baffle. The distance from the edge of my router to the bit is  $2 \frac{5}{16}$ ", so I created another large rectangle around the waveform trace. I needed to clamp pieces of scrap around the baffle to get the guide lines to fit, since  $2 \frac{5}{16}$ " went off the piece on 3 of the edges.

Once I did that, I clamped down straight edges on the outer rectangle to create myself a temporary jig.

Then I ran my router all around the jig, and cut out a rectangle. This was easy, as the jig prevented me from cutting something I wasn't supposed to cut.

I thought long and hard about how to cut these corners. That was really the tough part of this cutout. Ultimately I ended up using a dremel. The rounded sanding bit made it pretty simple to cut the rounded corners. I would have preferred a method that didn't require a steady hand, but I was stumped.

Overall, it was a nice fit. I'm sure a real woodworker would have been able to do it better, but I'm happy with it.

Tim

#### File Attachments

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- 1) [GuideLines.jpg](#), downloaded 4517 times
  - 2) [Jig.jpg](#), downloaded 4498 times
  - 3) [CutWithJig.jpg](#), downloaded 4421 times
  - 4) [RoundedEdge.jpg](#), downloaded 4462 times
  - 5) [NiceFit.jpg](#), downloaded 4472 times
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Subject: Re: Tim's 4Pi Speaker Build

Posted by [timkur](#) on Mon, 26 Jan 2015 01:32:45 GMT

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First impressions... uh-oh.

Once everything was cut out, I decided to do some quick sanding and put all the pieces in and try it out before painting it.

I plugged it all in, set it up to do an easy A/B testing with my M&Ks, and started playing some music, expecting to hear pure awesomeness. The bass was definitely more full, but something seemed to be missing on the higher end. My wife said something along the lines of "you probably don't want to hear this, but this sounds muffled compared to your existing speakers." And she was right.

I'm in the process of building 3 of these, so I swapped out the tweeter, midwoofer, and crossover one at a time, and there wasn't any effect.

I was wondering if this was just the case of "different types of speakers sound different", but I wanted to do some measurements anyways to make sure things were ok.

I grabbed a copy of HOLMImpulse (folks seemed to like it and it is free), pulled out the calibration mic that came with my receiver, and stacked my M&K on top of the 4pi... I wanted to make sure



the speakers were super close to rule out any room effects. The mic was about 9 feet away.

The results were pretty clear... I did something wrong with the construction of my 4pi. M&K's are blue, 4pis are red.

Any suggestions what I did wrong?

I purchased the B&C DE250 8ohm driver... was that the correct one?

Also, as a reminder, I purchased used JBL 2226H's from eBay, which were originally 4 ohm versions but according to the seller were reconed to be 8 ohms.

Any suggestions?

Thanks!

Tim

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#### File Attachments

- 1) [MeasurementSetup.jpg](#), downloaded 4461 times
  - 2) [sidebysideMeasurements.jpg](#), downloaded 4454 times
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Subject: Re: Tim's 4Pi Speaker Build

Posted by [Wayne Parham](#) on Mon, 26 Jan 2015 03:50:41 GMT

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I suppose the JBL recones might be bad, but check the obvious first - Did you get the polarity on the woofer and tweeter right? That notch looks like what you'd see with polarity reversed on one of the drivers.

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Subject: Re: Tim's 4Pi Speaker Build

Posted by [timkur](#) on Mon, 26 Jan 2015 06:29:51 GMT

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Great suggestion Wayne. It ended up being a reversed polarity on the JBL. I guess mine are backwards compared to what the standard is.

It sounds really nice. A very full and warm sound. It didn't make my M&Ks sound like cheap

speakers by comparison, but it is definitely an upgrade!

Not a super flat response curve, but I thought it sounded great. Maybe it's because it was on the floor (compared to the M&K which was sitting on top of it). With better placement and some EQ I bet it will measure out well too.

Thanks for the quick response Wayne!

Tim

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### File Attachments

1) [fixed4pi.jpg](#), downloaded 4431 times

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Subject: Re: Tim's 4Pi Speaker Build

Posted by [Wayne Parham](#) on Mon, 26 Jan 2015 22:05:28 GMT

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From the looks of that response curve, I'd still say there's something wrong. I hate to say it but my guess is the 2226 cones aren't genuine JBL. I see that pretty often in reconed JBL drivers. With good parts, the region between 500Hz and 1kHz is full and doesn't droop. In fact, since directivity increases, the on-axis output at 1kHz is actually slightly higher than it is at 500Hz.

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Subject: Re: Tim's 4Pi Speaker Build

Posted by [timkur](#) on Tue, 27 Jan 2015 07:04:23 GMT

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Thanks Wayne. You definitely had me worried.

I started by swapping out the one 2226H for the other 2 that I had. The other 2 were phase wired correctly (not reversed like the first one... now I know what to look for).

The speaker/mic was in a slightly different place compared to yesterday, but both of them had similar curves.

I was pretty frustrated at that, and so I looked at your response charts on the website, and

something caught my eye. They were very similar to the vertical off-axis response (down) chart that you have. So I played around a bit, put the original speaker back in (that had the bad curve in the previous reply) and raised my microphone 2 feet up.

From what I can tell, this was a measuring error and not a speaker issue. Is that how you would interpret this?

Apparently these are pretty finicky when it comes to vertical placement. I'm guessing you've got a post somewhere that describes the best way to align the speakers. When I get a chance, I'll look for it and if I can find it, I'll post a link here.

Thanks!

Tim

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#### File Attachments

- 1) [otherjbl.jpg](#), downloaded 4347 times
  - 2) [raisedup.jpg](#), downloaded 4364 times
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Subject: Re: Tim's 4Pi Speaker Build

Posted by [Wayne Parham](#) on Tue, 27 Jan 2015 16:43:29 GMT

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Your chart with the green plot is what the response looks like when measured in the forward lobe. The forward lobe is between  $\pm 20^\circ$  of the center of the speaker, normal to the baffle.

At the edges of the lobe, you'll see nulls like your red measurement charts show. Then as you move the microphone further outside the pattern, you'll move into the secondary lobes. Response in the secondary lobes has no nulls but HF is rolled off.

You can see measurement of these lobes and nulls in the "Vertical Nulls" video at the link below:

Crossover optimization for DI-matched two-way speakers

You may have had polarity right initially, but measured in one of the nulls that are  $20^\circ$  above or below the forward centerline. Please see the notes in the crossover schematic for wiring. The 2226H should be connected with red to 2- and black to 2+, which seems backwards. The DE250 also is connected like this, with black to 1+ and red to 1-.

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