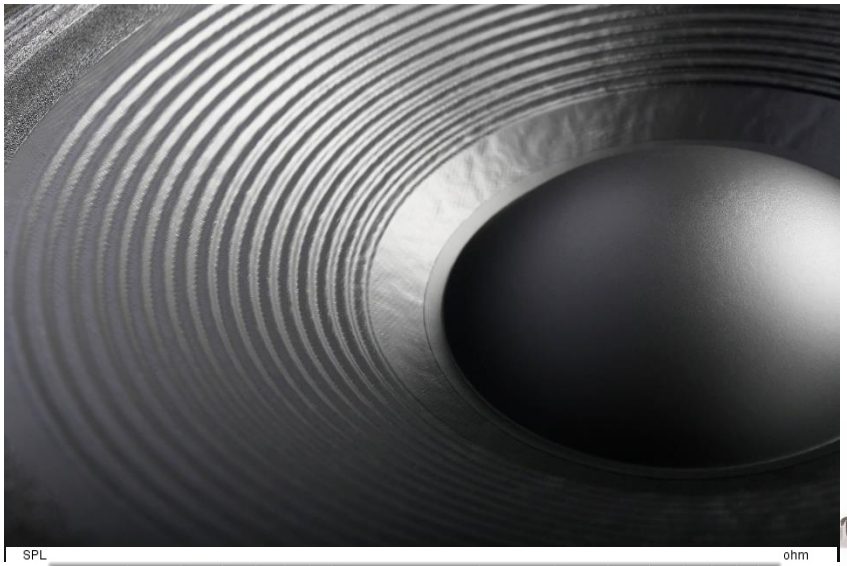
The Sub of Doom: Neman Horn

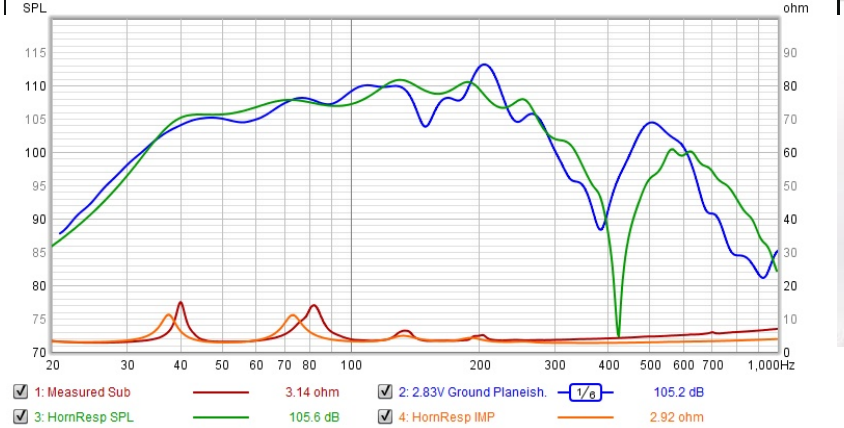
Or

“@!#$!@#$ that’s loud”

By

Scott Hinson





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Introduction

Okay…now that I have your attention with my admittedly clickbait title, let's talk about what I really mean. OMFG THIS SUBWOOFER WILL MELT YOUR FACE.

I'm okay…really….I've recovered.

YAALLL THIS THING IS UHMAZBALLS

I'm calm. I'm good.[1]

Background

I've had this fascination for bass since ~1990 when I sat in a Rockford-Fosgate demo van with 6 18" woofers and 6 of their Power 1000 amplifiers. I was hooked. The track was Madonna's Vogue and they had seriously upped the EQ in the bass range. High School aged Scott would be stupidly jealous of the bass middle aged Scott can generate in his garage, or a medium sized music venue for that matter. (FWIW I looked up the specs on those SPP-184s that I experienced…that kind of performance can be had from the basic Dayton Classic subwoofer line now….3" voice coil, 300W continuous power handling, and +/-6mm xmax.)

In the speaker world there is no replacement for displacement, to make sound you have to move air. I'm not sure that enough speaker designers stop to think how far we've come. Back then you could pay a fortune for small quantities of OEM series drivers from JBL, Altec, Cetec/Gauss or you went to the catalogs and got a CTS, Tonegen, MISCO, Eminence that had been rebadged. In High School I didn't know about a lot of these sources, I was stuck with the local electronics shop (Pyle/Pyramid/worse) or Radio shack. With the revolution of CNC machining, FEA, advanced adhesives and materials, performance the performance of drivers has vastly improved. If someone showed us a 15" woofer with a 1" voice coil, 80W thermal handling and 3mm xmax, now we laugh, then we used it because it's what we could get.

I've already published some bass reflex designs, basic double 18" and single 18". I did a lot of testing on those, CEA bursts, distortion, frequency response etc. They are great boxes, but I still yearned for more. And the only way to do that without breaking the bank on both amplifiers and drivers…was to make a pretty bonkers front-loaded horn sub.

So I did.

@#$!% I have two in my house!!!! My EYEBALLS ARE WOBBLING AND I CAN'T SEE STRAIGGGHTTT…. I'm good I'm calm…..

[1] Heck…I don't even believe that.

Reality Check

There's a couple of things I think every horn designer knows, but relatively few are willing to admit. Especially about bass horns. One is the fact that nearly every single bass (and a lot of low midrange) horns are undersized. Horns need to be large, if you're going to truly evenly horn load a driver down to bass frequencies the size requirements to hit the ¼ wavelength rules associated with making a good impedance match the horn size gets ridiculous fast.

That means every design out there has some compromises…it's just part of the speaker design process. To complicate matters for DIY'ers and users alike, there's also a lot of designs where the physics of operation don't seem to add up to the performance claims, both commercial and DIY. I've seen designs out there with what look like crayon drawn frequency response plots, and ~800 square inch mouths with some performance claims I'm not sure I buy. Or other designs where the stated sensitivity plot looks about 6-9dB too high compared with the BEST work I can come up with in simulation. The catch is, that unless the builder/owner has impeccable measurement protocols we'll never be able to catch issues with those performance claims, or at least it'll be hard.

Much like the Speaker Freakers double 18 bass reflex box I decided to design a horn sub with as few compromises as I could that I thought DIY folks had a shot of building. Despite spending many, many hours trying to simplify construction/there's only so much I could do. I avoided compound miters, and things like that, but this isn't a simple box.

It will take quite a bit of planning and patience, but it is possible to make these with some basic tools. I constructed my pair by myself without outside help, but I did buy and install an electric cable hoist to assist. Empty cabinets clock in at ~236 pounds, with the woofers I put in them, they weigh 310 pounds.

No speaker design is bullet proof. There are always ways to destroy them…these horns are no exceptions. In my house I can't test the long term power handling like I'd like. I've driven my family nuts in this quarantine by driving these two subs at each other out of phase in an attempt to figure out what the thermal rise over ambient is for the voice coils. Even with the level of cancellation I get, the leakage noise is troublesome and annoying and I'd rather come out of this thing without a divorce if that's okay with errybody. I have added features to help with thermal lifetime (more on that later) but I don't know exactly how well they work yet.

This project is not for everyone. I get that. But I built a pair of them, and middle age Scott giggles a **lot** whenever I play them…hopefully you will too.

Design Constraints

Front loaded horns can be a bit of a challenge to design. Folding them is difficult, making sure you'll be able to build it is a bunch of work, and then there's always the doubt, will it work as well as I hope, or did I screw something up? For this design I had a couple of constraints I tried to work in:

1. Buildable with a circle cutting jig and router, table saw, drill press, jig saw, pocket screw jig and hand tools. You'll have to make some templates for things like the handles and stuff like that. There's one part with a bunch of angles that would be made easy on a CNC. Contact me if you need a template…but you could also simplify that part and still have a great box.. I did cheat and use the little hobby CNC I have for parts, but you can absolutely make it with the stuff I described.

2. Can be made with common sheet goods, I built mine using Baltic Birch, and if it's going to see serious long term use I recommend sticking with that. In a pinch though you could probably get a lot of life out of lesser grades of plywood. You'll lose some output because those materials will flex more, especially around the access panels. Avoid OSB, MDF, or particle board though…no good.

3. Size. This is where I expect to get a lot of, ahem, armchair speaker designing. I wanted this to be easily transportable with vehicles I own. And since I don't own a 16' box truck with a 90" inside width I designed them to be moveable with my full-sized Ford pickup. And I wanted the maximum output I could cram in that vehicle. That meant external dimensions of 48"x48"x24". Someone buy me a box truck and I'll design for that for now on.

It does mean than 6 people, with a standard full-size pickup can get 4 of these to a venue without having to rent a box truck. I've actually used my two by loading them into the truck…driving…parking…and then…using them. I never unloaded…I just dropped the tailgate, and we were off and running. Should I have made them 45x45x24? Well…for absolute universal truck pack sure…but you go fold a horn into that dimension and tell me you're willing to lose that F3, max output and add that ripple.

4. Low frequency extension. Every speaker is a juggle between bandwidth and sensitivity. In this case I was willing to trade off the absolute depths of extension for increased sensitivity.

It's not that it's a slouch by any means, but I wasn't going to shoot for a particular "marketing" F3 at the expensive of smoothness or overall usability.

So, after that…what did I design?

This:

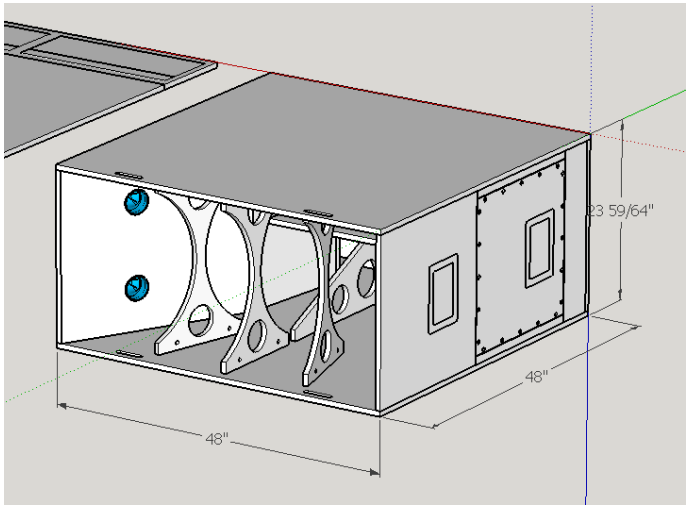


Figure 1 Behold. The Horn.

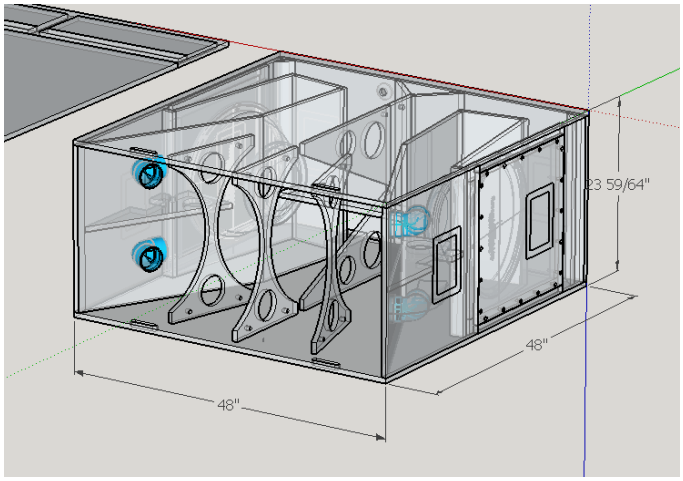


Figure 2 Behold, the see-through horn.

The Driver

The driver I used was the SB Audience Rosso-18SW1000D. The driver is a 1000W AES class 18" subwoofer with a healthy 13.7mm one way xmax and a 25mm one way xdamage. Power compression is reduced by substantial gap, spider and pole venting and a special cooling device (heatsink) added to the pole vent. The motor includes a shorting ring and a 4.5" voice coil. When I opened the box of the first woofer I was impressed with the fit and finish on all parts, glue lines were impeccable…the cast frame/magnet/motor are impressive.

The cutout/mounting hole dimensions are slightly different than some common frame sizes, so it's not necessarily a drop in replacement, but it's relatively easy to accommodate a retrofit if you're handy with some simple power tools. I do like the extra space that the octagonal frame gives for t-nuts. Sometimes the larger-flanged t-nuts/hurricane nuts will overhang the cutout…that's not the case on this one.

The T/S parameters of the driver make it a bit of a jack of all trades, you could easily do a really nice vented box with it, but as I explained I wasn't after the ordinary.

Figure 3 Rosso 18SW1000D Subwoofer

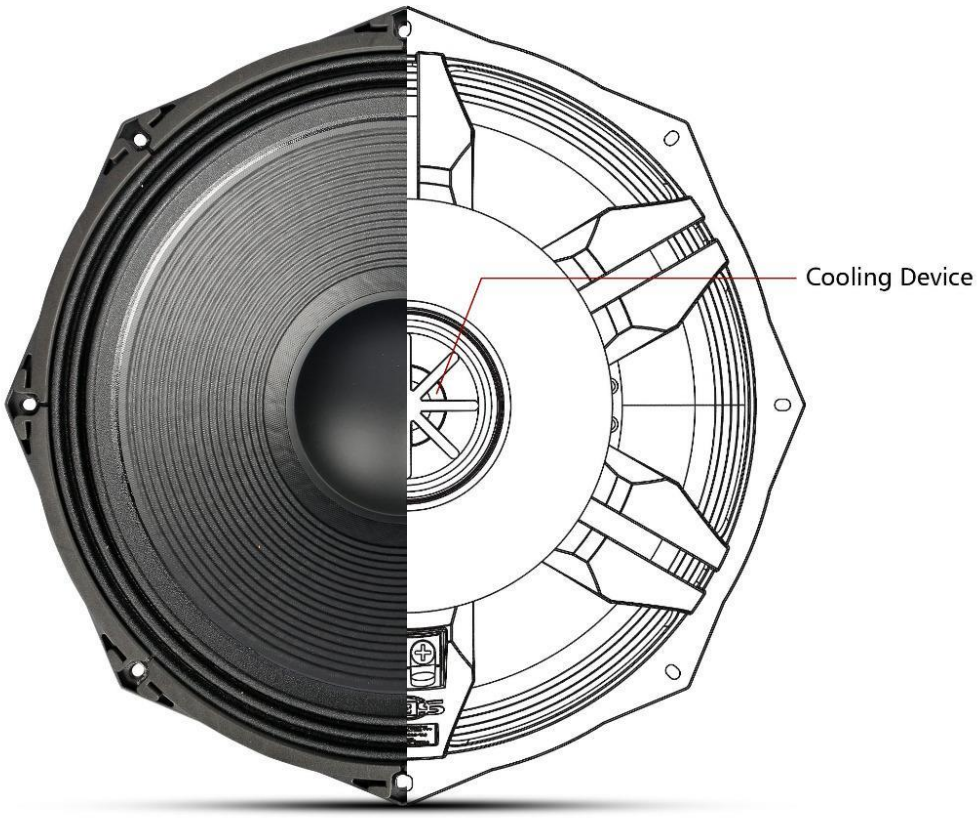


Figure 4 Pole Vent Heatsink

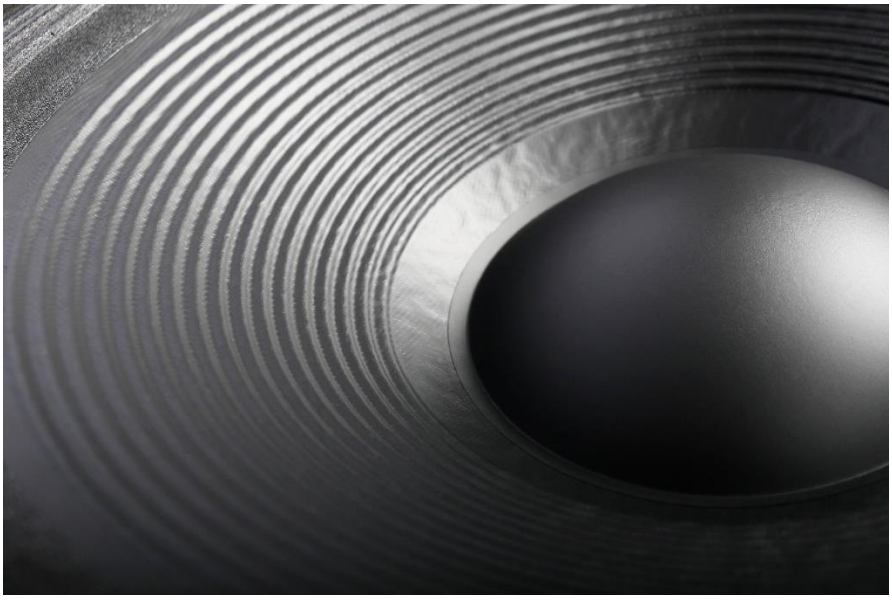


Figure 5 Just a pretty woofer picture.

Hornresp Modeling

The Hornresp for the horn are as follows:

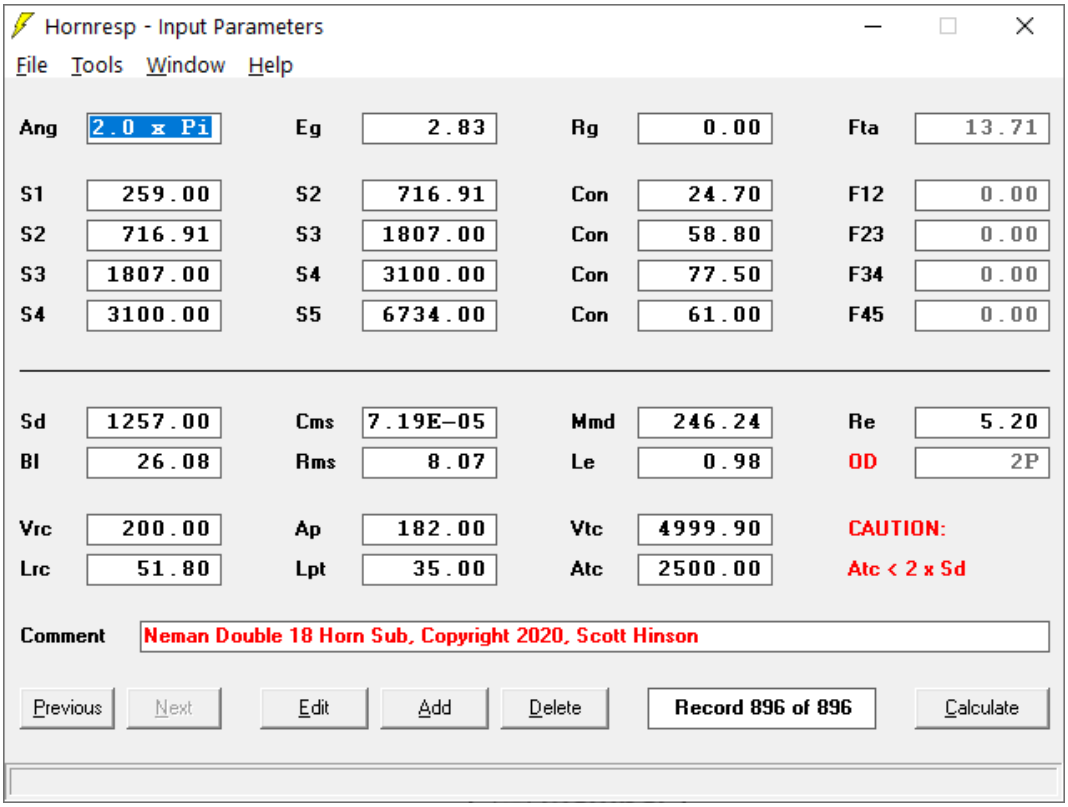


Figure 6 Hornresp Inputs

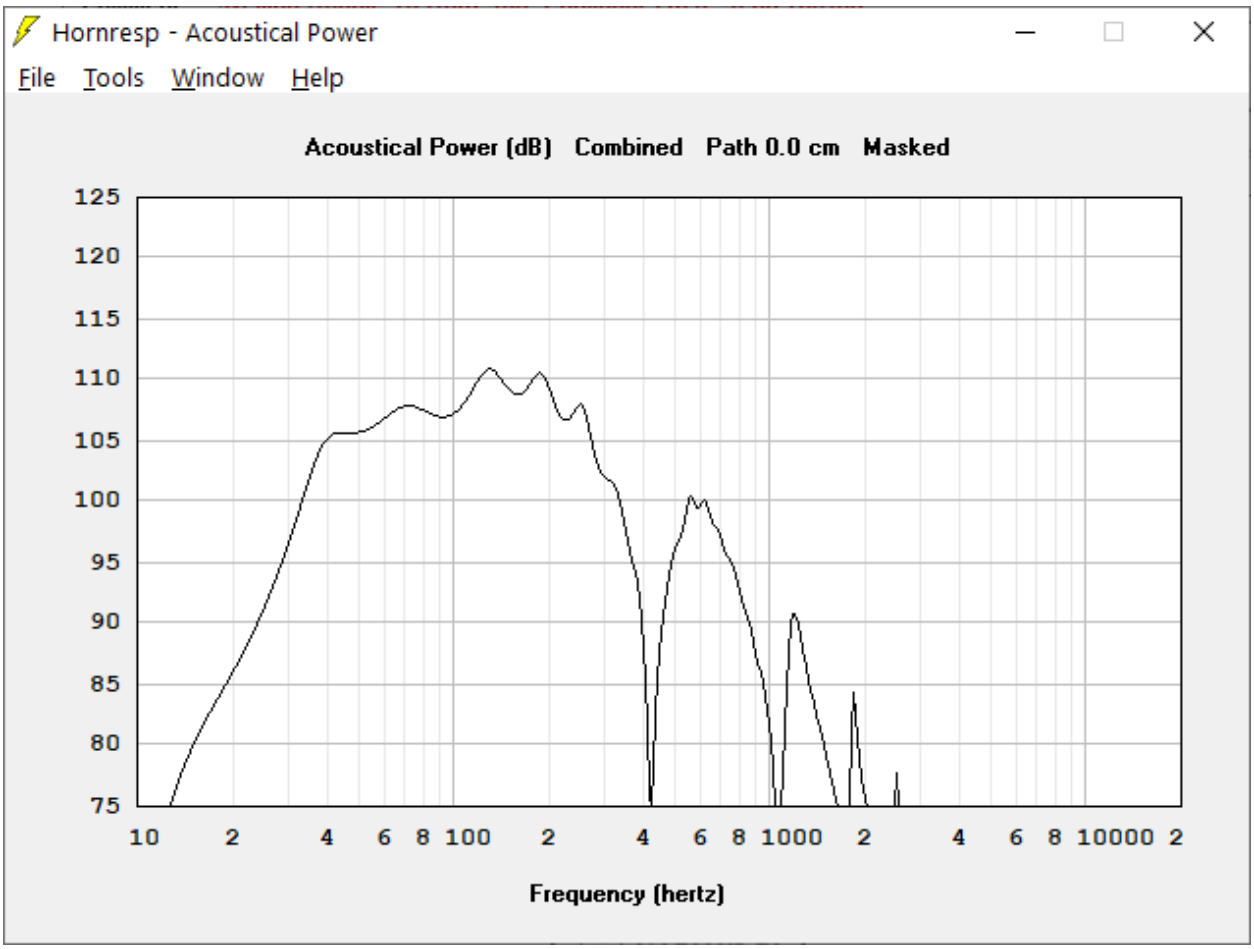


Figure 7 Response Prediction

Since there's no truly flat response area like many bass reflex boxes, you can play a bit of specsmanship with most horns. For instance if I said sensitivity was 105dB that would mean my F3 for a single horn was 35Hz….if I said it was 107dB my F3 would be 38Hz. In reality I'm not really sure I care either way…I'm usually more interested in maximum output. If you put in AES power and the rated Xmax of the driver….that looks like this:

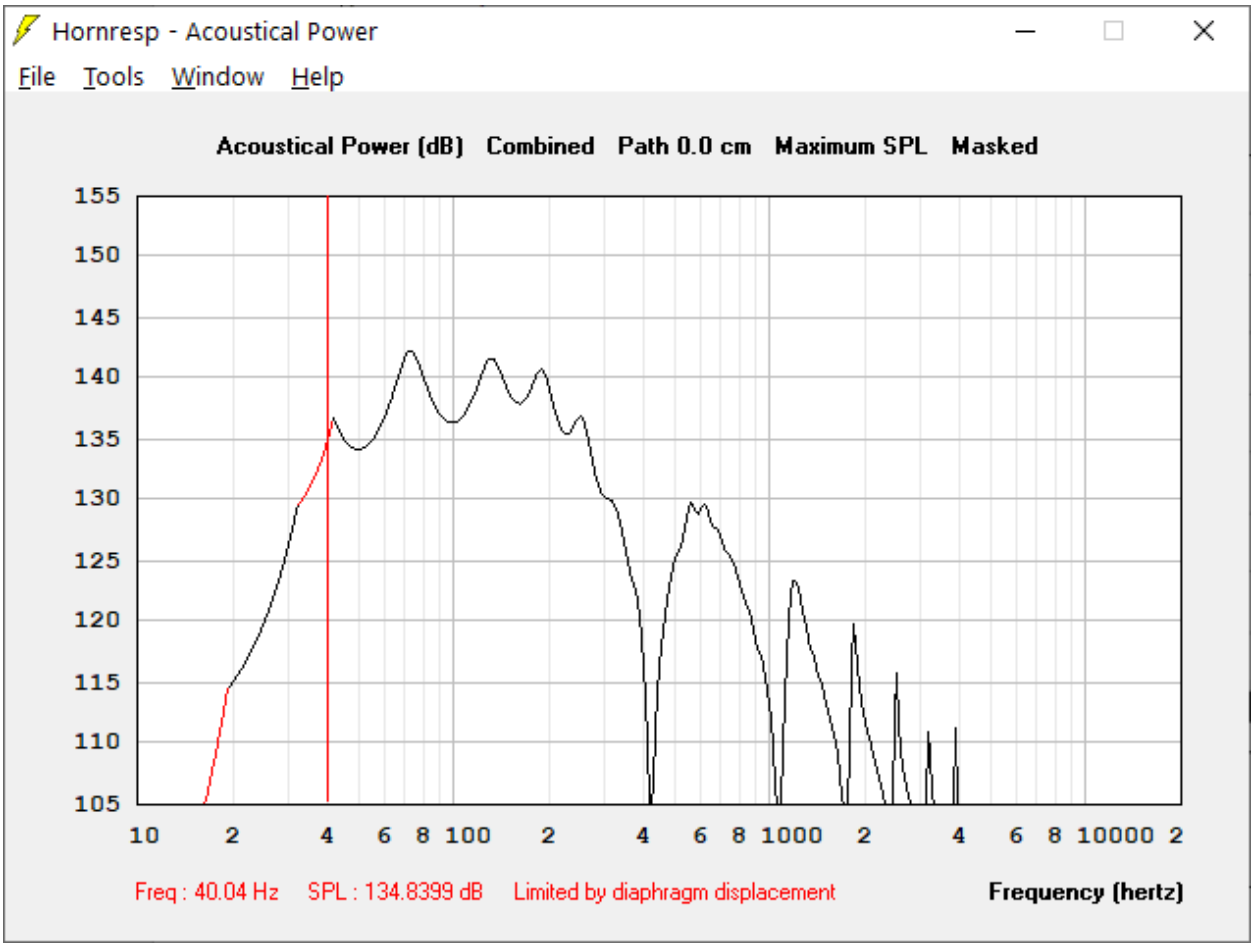


Figure 8: Maximum Output at AES/Linear Xmax

Now…bass horns like this have a cool acoustical thing that happens. When you use them together in groups they can, for lack of a better term, acoustically "see" each other. The end effect is increased low frequency sensitivity, lower ripple and a lower F3. This isn't necessarily the case for tapped horns or similar higher order designs.

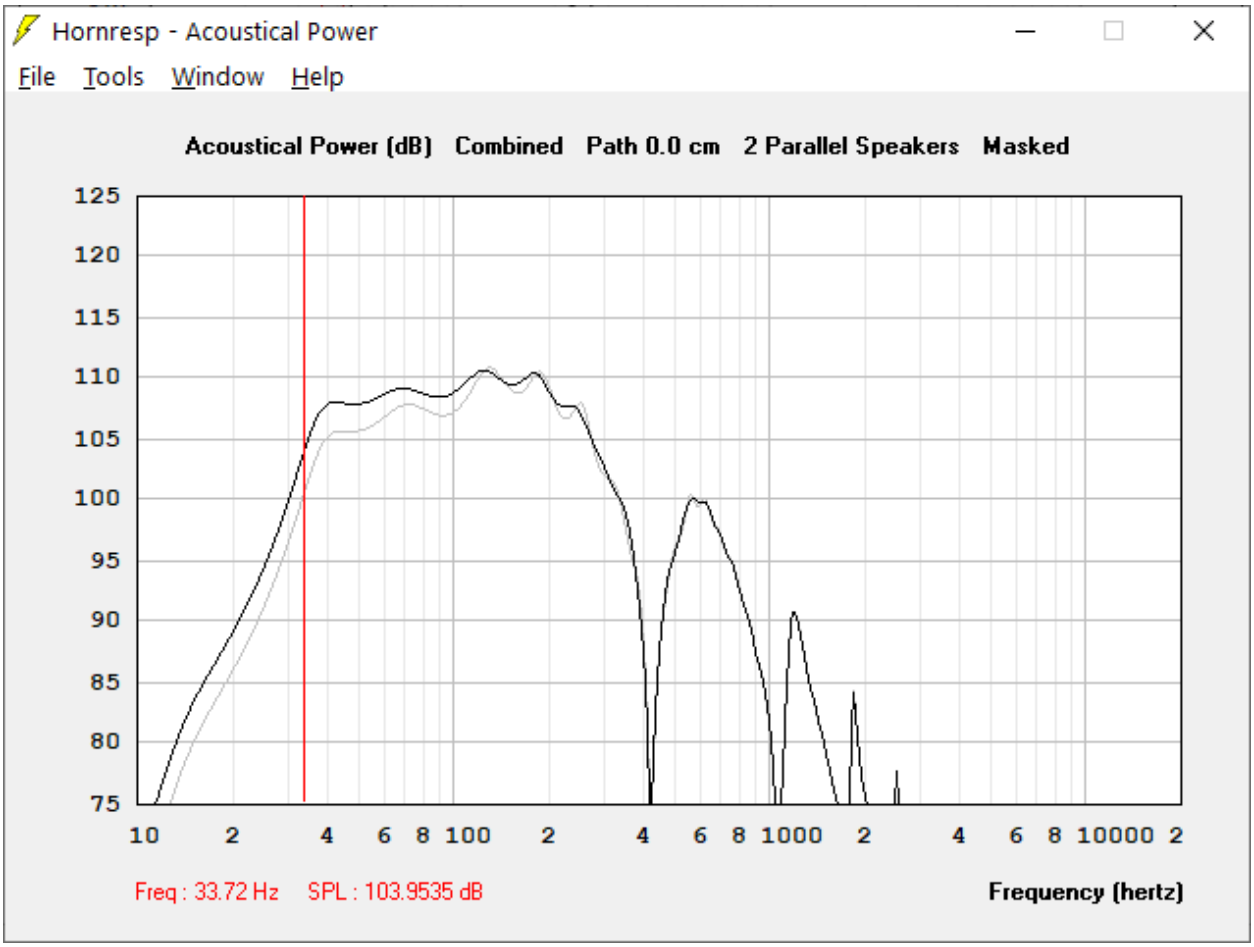


Figure 9 Low Frequency Coupling Gain

This kind of gain is kind of hard to verify precisely in the actual subs acoustically, you need a location flat for well…a long distance in every direction, a good microphone calibration, no wind, wide bandwidth amplifiers…all that jazz.

But it doesn't just show up in the output…it shows up in impedance too….

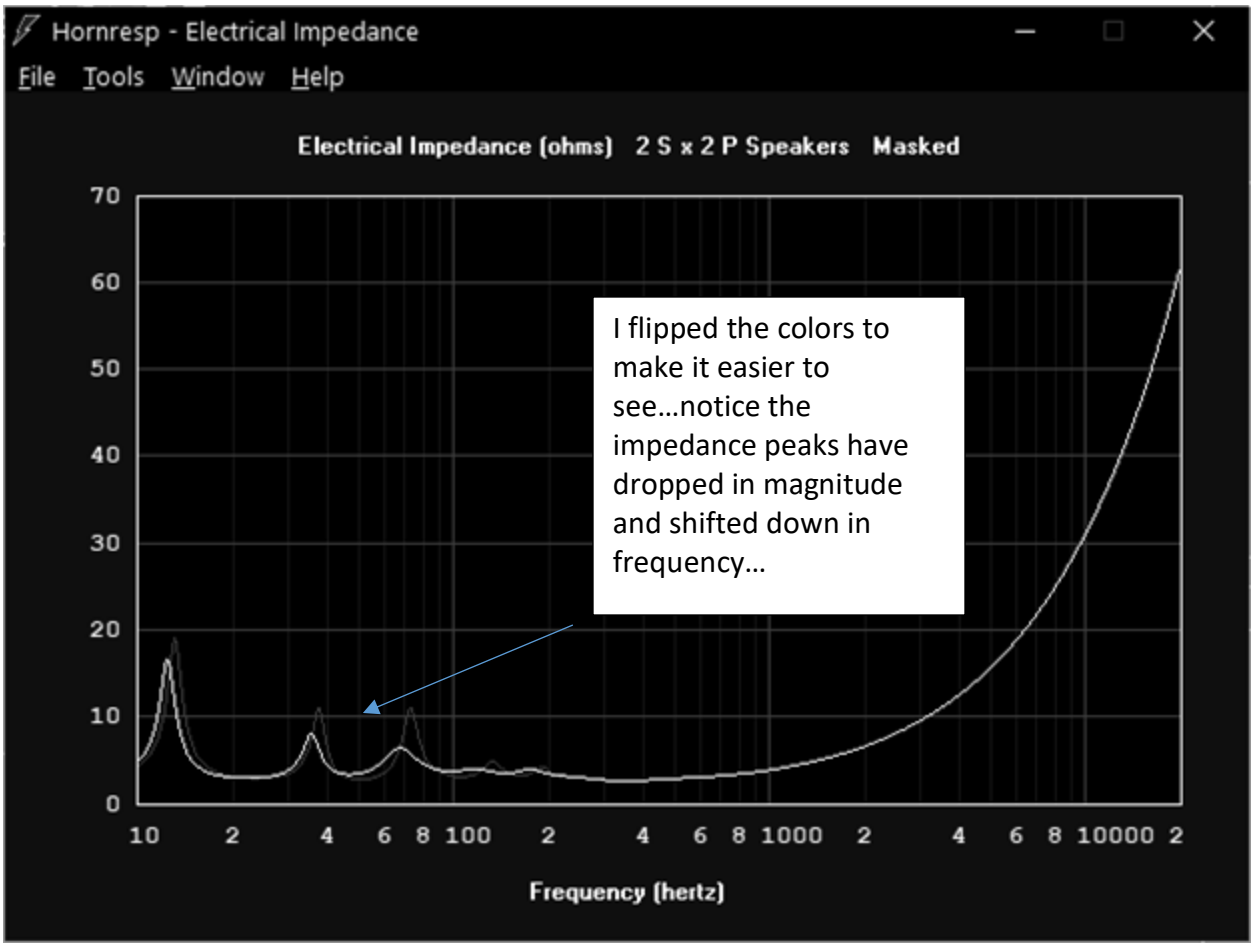


Figure 10 Impedance Shift of a Block of Horns

Using these horns I was able to verify the impact…but not through frequency response, that was too hard because I couldn't get good enough measurement conditions, but I could through impedance, but more on that in the measurement section.

Maximum output of the horn is substantial, to put it lightly.

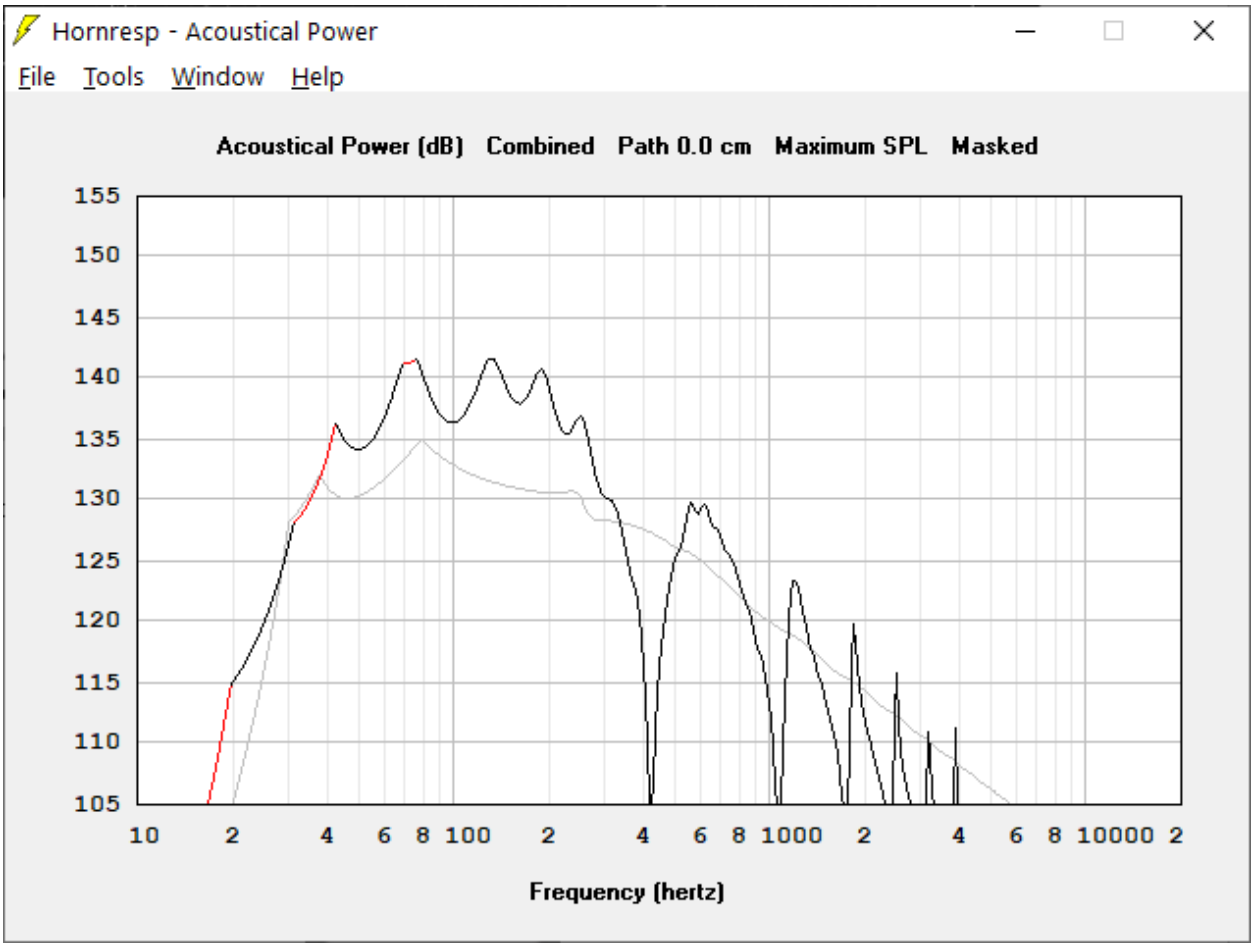


Figure 11 Modelled Maximum Output, AES Power Linear Xmax

Figure 11 shows the output of the horn compared to my Speaker Freakers Double 18 bass reflex box, with both speaker cabinets having woofers with the same Xmax and AES power handling rating. Above 40Hz the horn really starts to run away from the bass reflex box, between 40Hz and 30Hz they are around the same. So…why build the horns? Remember that part where I said the horns couple and you get a benefit?

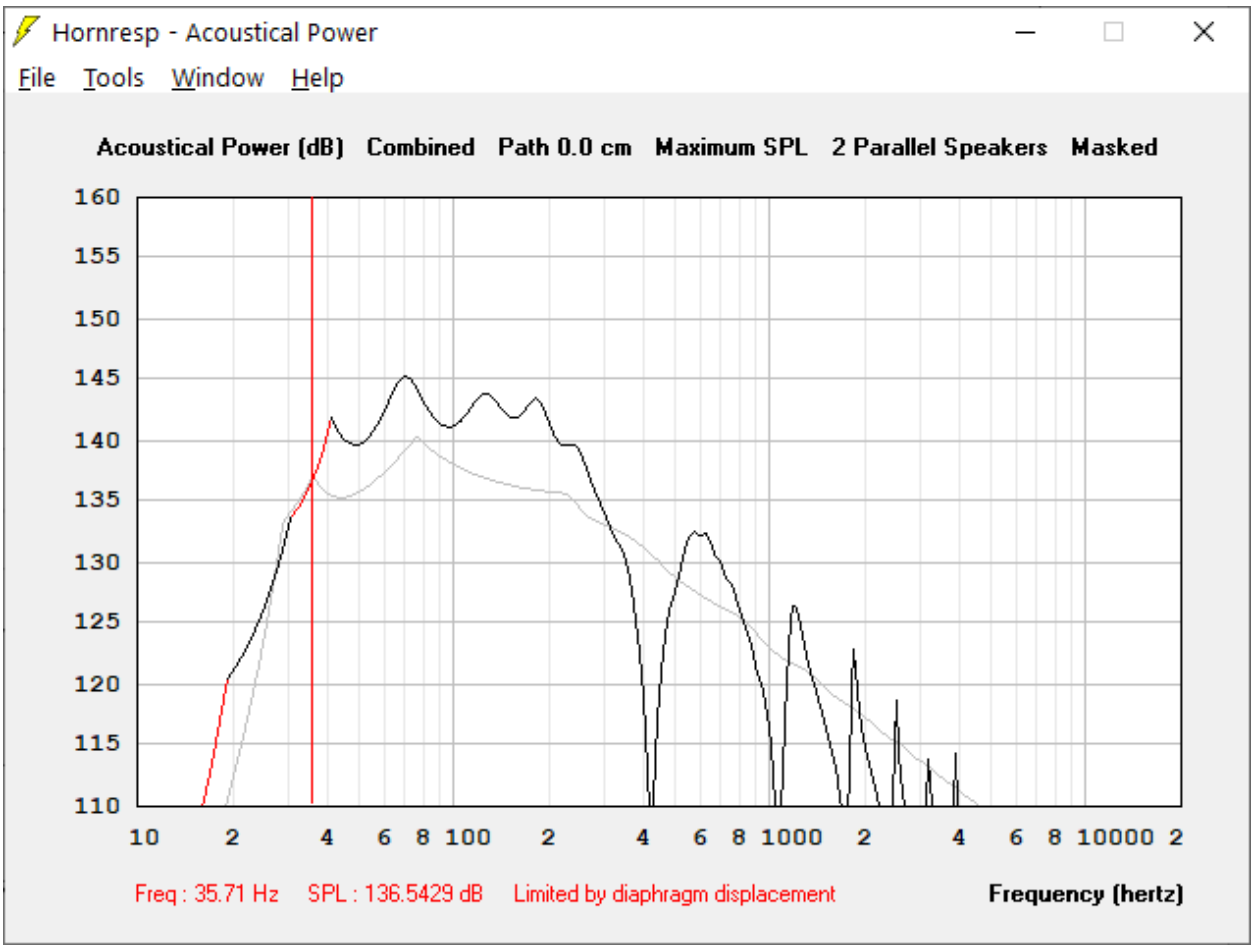


Figure 12 Max output in pairs...

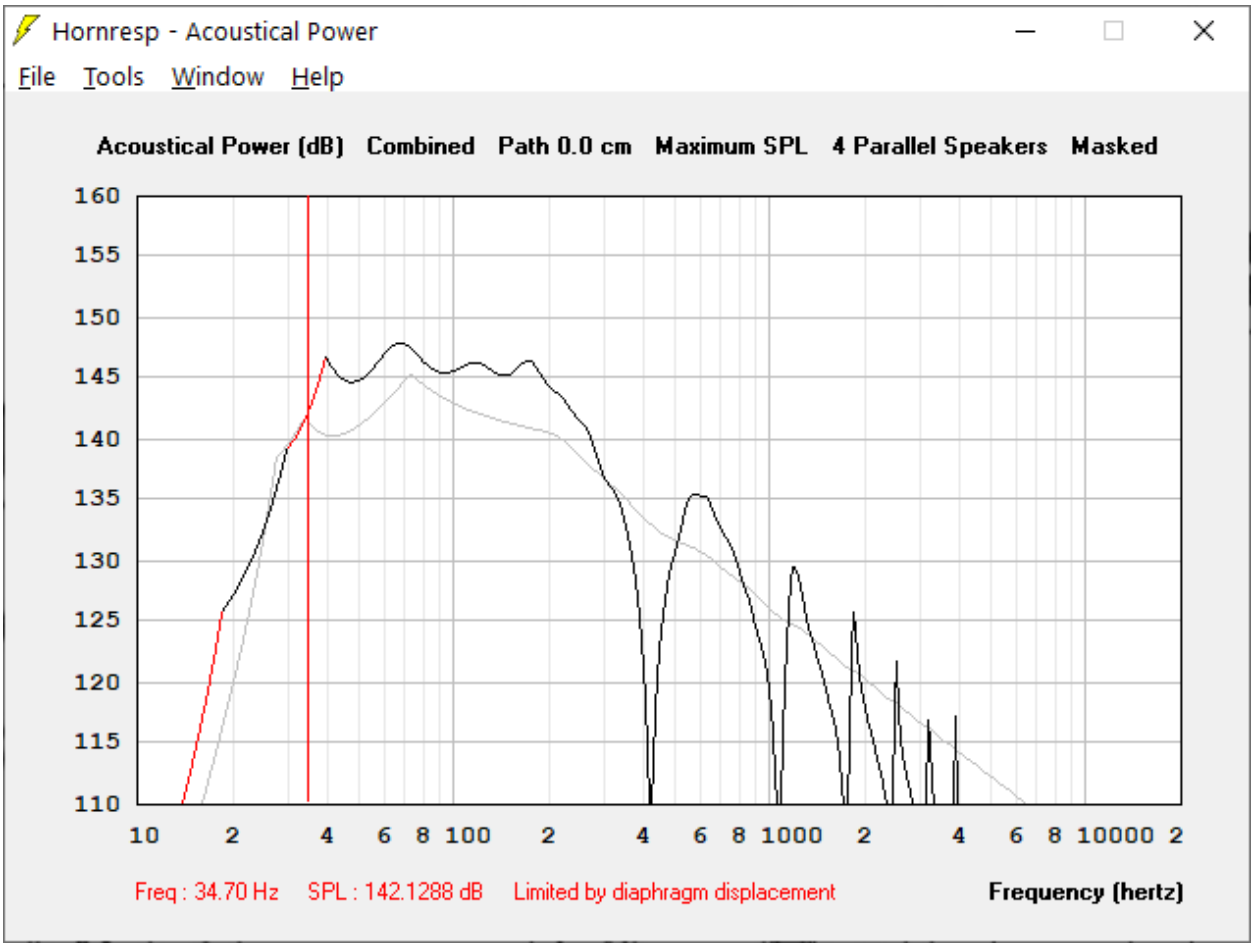


Figure 13 Max Output in Quads

As you can see the maximum output of the horn starts to really pull away >40Hz from the bass reflex design as you get a few blocked together.

Now….as I post these simulations I can assure you that someone is reading this thinking: *That's SILLY. Scott is dumb. Brand GigantorBassAcoustics dual 18" sub does 145dB max SPL…and that's just a single double 18!*

They might[2]. But they probably didn't specify frequency, or distortion, or for what duration they would do it, or many other test conditions. Or, more likely they don't….that might just be marketing. I've been on forum threads where people claim SPLs for 18" woofer boxes that would require 80,000W AES power handling or 200mm xmax. Physics isn't just a good idea, it's the law….the numbers I'm posting above are far more realistic for continuous use…and even then I have concerns about long term power handling. I don't have access to any structure I'm willing to put these in for long enough to do a toaster test. They have done frightening things to

[2] Actually…ummm….

my house as it is. Which brings us back to that thing I talked about with the long term power handling of any front loaded horn.

About Those Ports….

When I posted the first photos of the sub online I got a lot of questions about the ports. All of them centred around the typical operation of vented horn subs….they don't go low. Well…that's often true but remember the purpose of these wasn't to dive to the depths of infrabass with a horn. There's also something I knew about them but wasn't ready to talk about yet.

I didn't port them with the intent that the ports would contribute to the low frequency output. I didn't put them there for the sound they would make…at all.

….
…
..
.

You still there? We okay?

Seriously…I didn't port them with the intent of using the ports to contribute to the output. These are 18" woofers with only 2 3" ports….each. I've done bass reflex designs with the same port area for 8" woofers, so this would seem under-ported. Has Scott lost his mind? Well…yes…I did build two 300-pound subwoofers I now use in a residential setting…but I ported this sub for a real valid reason.

Heat.

Among good PA professionals that have used FLH it's well known that they tend to struggle with long term durability to heat. In a vented box there's some amount of fresh air exchange because ports are never linear, and they do allow some heat exchange. Salvatti, Devntier and Button had a great paper[3] in the AES showing how much difference the port design could make and how clearly any of them were to a sealed box. Air temperature inside the box is dropped by 20-30 degrees Fahrenheit or more by porting it. Funny enough, less linear ports are better for heat exchange than highly linear designs because the turbulence and vortex shedding aids in transferring heat. Highly linear ports don't allow the outside air in, and vice versa, the air mass excursion isn't enough in the ports to change the heat out.

So…I **wanted** a not particularly great port design to huff and puff, but not loudly enough to be noticeable.

[3] Maximizing Performance from Loudspeaker Ports, JAES, Vol. 0, No. ½, 2002 Jan/Feb

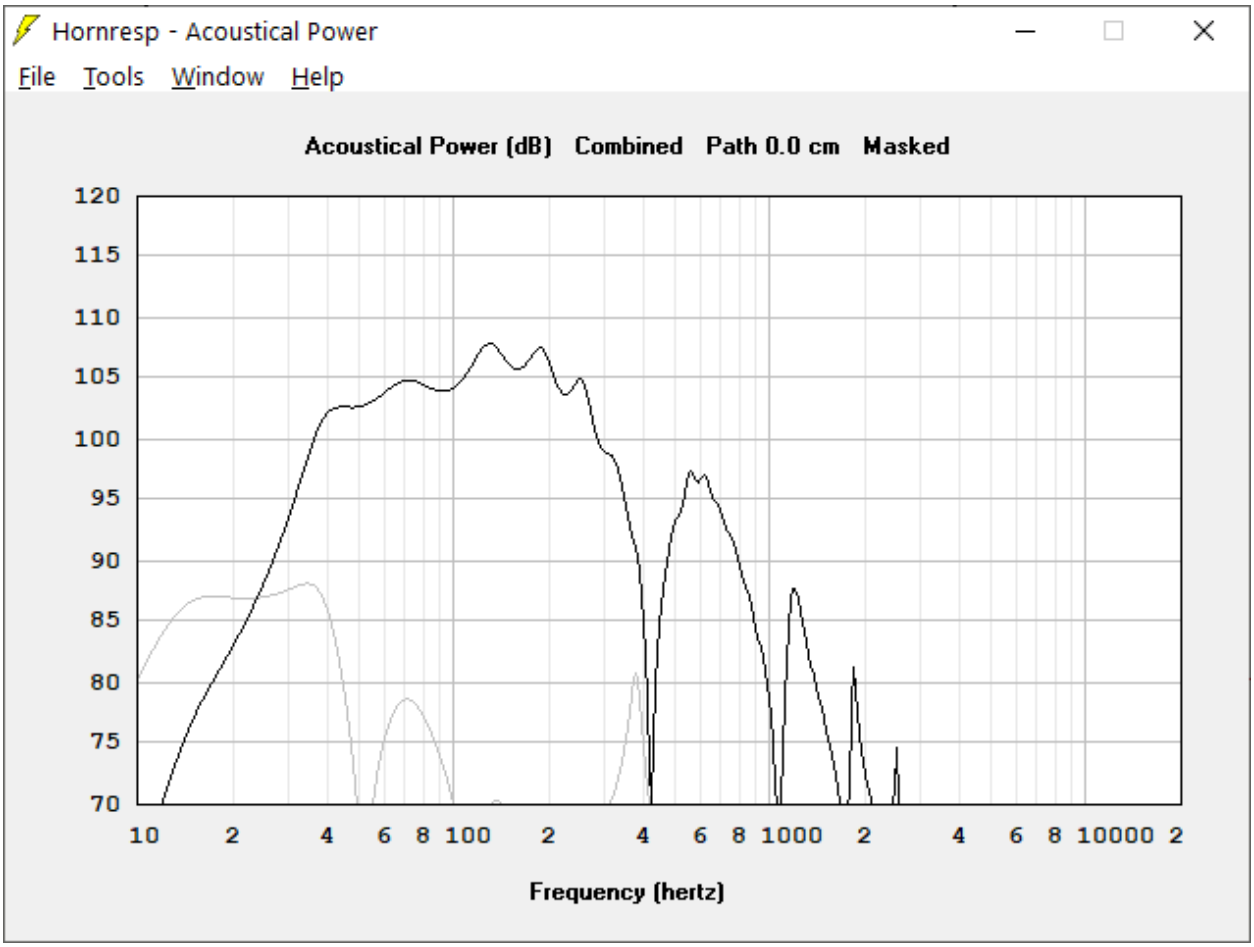


Figure 14 Port vs. Horn Output

So, there's the port output vs the horn. As I said…it's really not helpful for acoustical output. But if we apply a 4'th order 25Hz Butterworth highpass filter, and simulate at 70VRMS we get the following response.

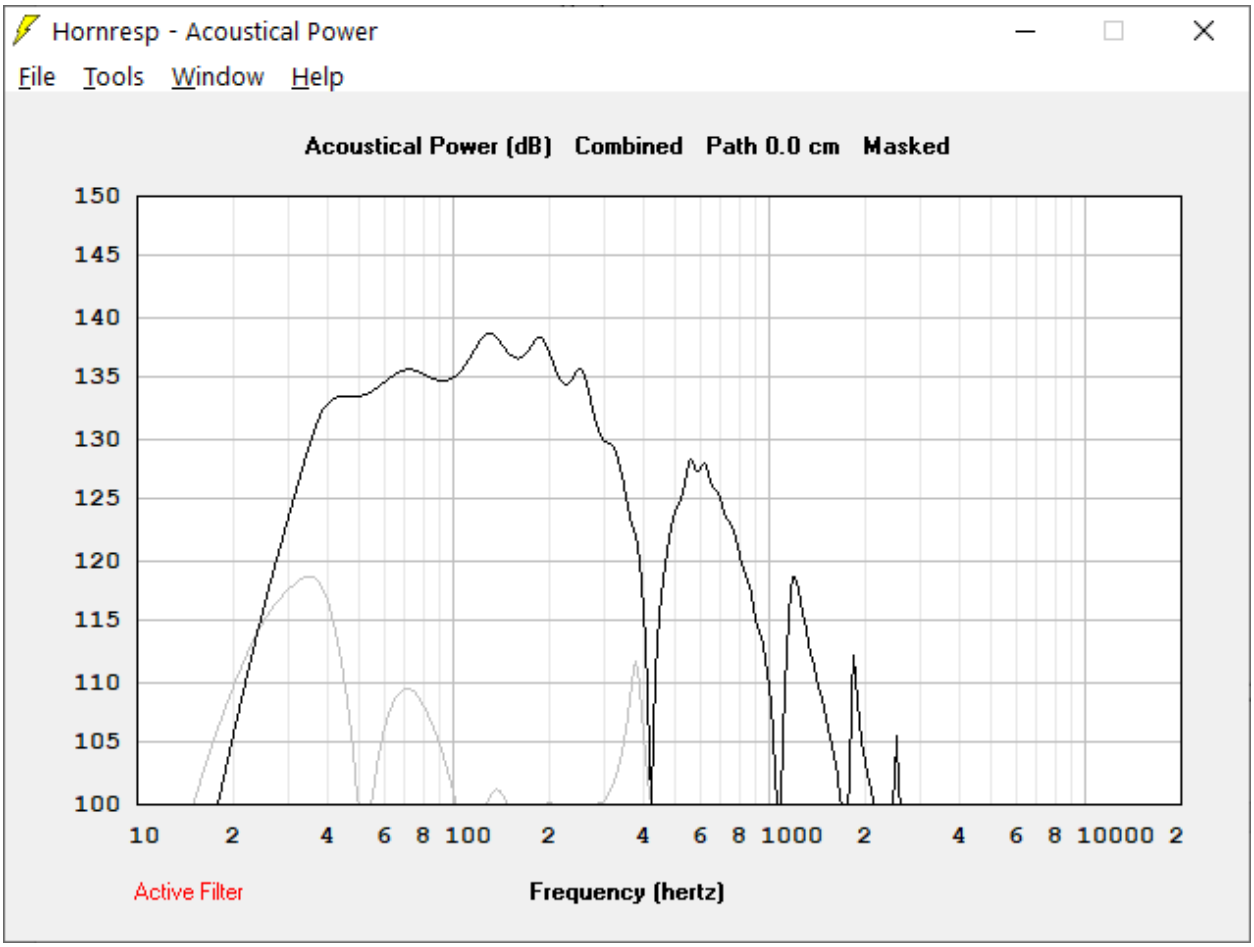


Figure 15 Output of Horn and Port with High Pass Filter, 70VRMS drive

Still looks good from an overall response perspective…but what about that port velocity.

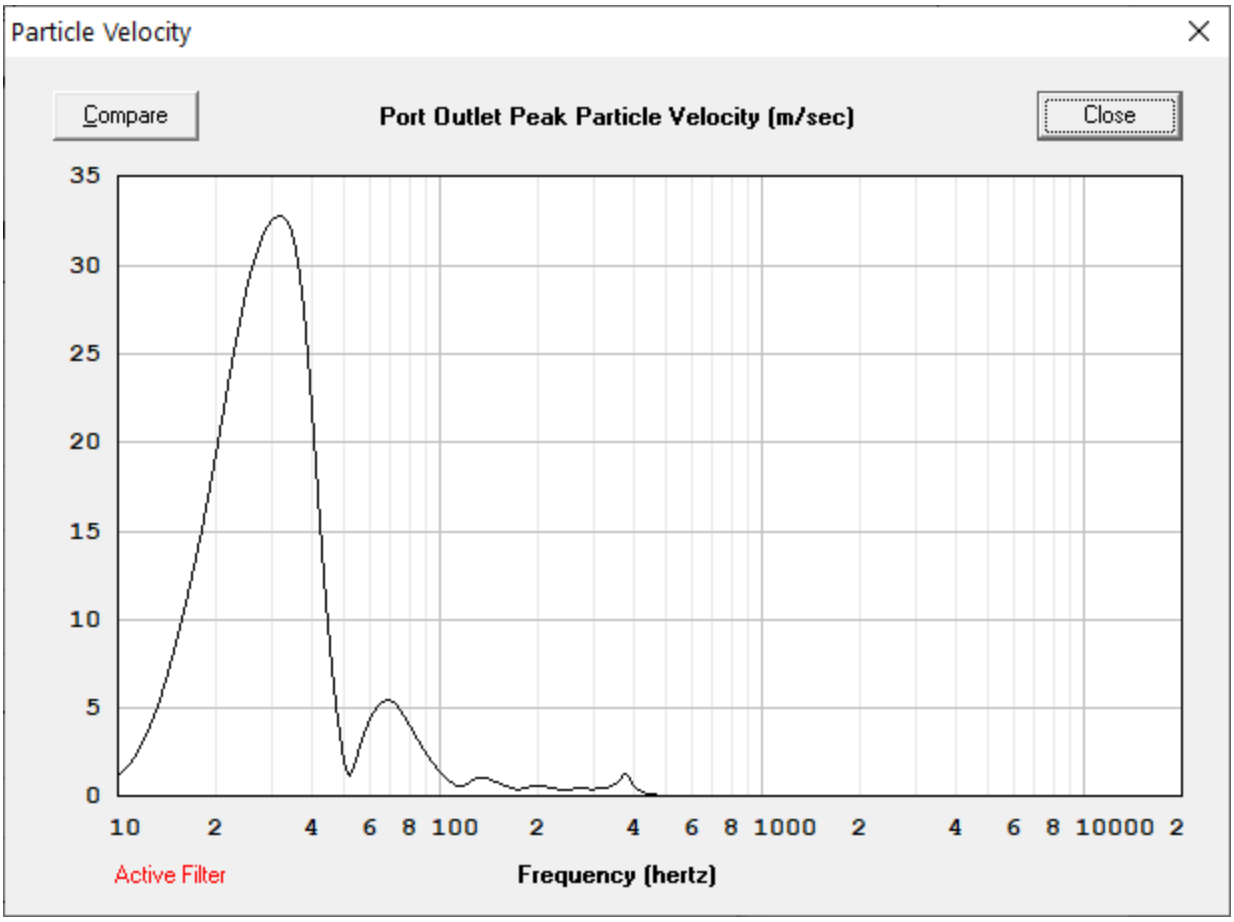


Figure 16 Port Velocity with HP Filter. Chuffing will be induced…but this time it's good.

The simulation shows that at this drive level, port velocity is way higher than you'd ever want in a bass reflex design. In those designs the chuffing of the port will be clearly audible as distortion…but in those bass reflex designs the port output is nominally supposed to be the same magnitude as the driver. In this design the port was designed to be 20+dB down from the main output, which is less than 10% THD, even if the port output was all distortion compared to the output of the speaker. In practice I've run these things HARD for a few seconds at the tuning frequency of the port, and heard nothing but my house coming apart at the seams. I sincerely doubt port noise will be audible once full range music is being played at a volume to keep up.

In simulations port velocity remains usefully high for highpass filters up to 35Hz…where it starts to drop enough I worry about air exchange. So how well does it work? Uhh…again…I need an airport hanger and 48 hours to test. I tried to test it by putting some power resistors in one of the woofer chambers with 150W dissipation. I brought the internal air temperature up to what looked like steady state at about 55C…which **only** took 5.5 hours. I then drove the speakers moderately hard, facing each other and out of phase. Drive level was about 30VRMS with pink noise….and what happened?

Well…the air temperature in the chamber was at 55C but the surface of the heatsink was hotter. The air movement improved thermal dissipation off the heatsink so that the internal temp jumped up ~12C in only a few minutes. Le sigh. Another best laid plan….

Instead of referencing of the air temp I should have looked at the heatsink…but in reality that wouldn't have been a good test either…I needed to look at the voice coil temperature. Since the air movement was enough to pull that much heat off the heatsink that fast I fully expect the technique to be quite effective for the speaker driver….I just don't know how effective.

Building the Horn

Oh…you want to build it? You are an awesome human being. You may also need help. Physical and psychological, but I am your co-dependant enabler…so I applaud your efforts.

There's one miter cut that will be difficult/impossible to do without cutting it on a table saw with the board vertical. I tried and tried to avoid it, but couldn't figure out a way without introducing a weird double miter at the end of the mouth. You could totally cheat with some Bondo, but more on that later.

You'll need a sturdy work surface…I did the first one on a rolling work bench with a 4'x3' top…and the second one used the first one as the work bench. My rolling cart for these uses 2x4's and 8" casters….if you've got a super smooth floor you could probably get away with 3", but mine isn't…and I have a lip to my driveway I needed to be able to navigate by myself. The 8" casters with a nice head of steam allow me to get the subs into the driveway and back into the garage. I'll include the Sketchup 2016 model so that you can pull the design into Sketchup and measure, manipulate the parts.

The design makes efficient use of 5 5x5 sheets of Baltic Birch plywood…and all dimensions assume 18mm material. I built mine with 10-32 hardware for the access panels, but ¼-20 probably isn't unwarranted.

To pocket screw? Or not to pocket screw?

For something like this…totally pocket screw. I used a BUNCH…a lot of times they can be pre-drilled and installed on the inside panels of the horns. I find this to be way easier than trying to mark and pre-drill external screws.

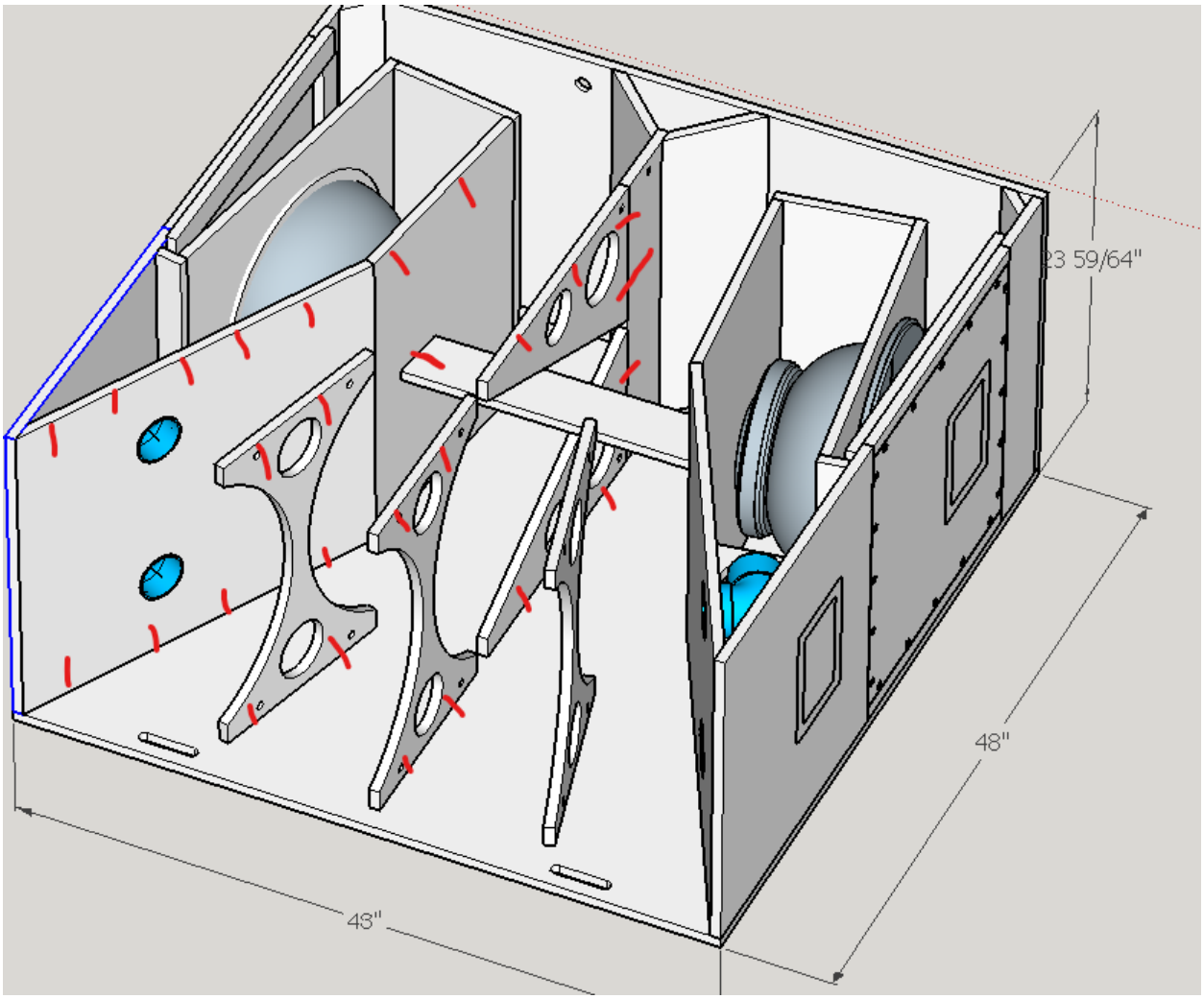


Figure 17 Pocket Screw, partial list of approximate locations.

I promised myself that I would take a bunch of assembly photos…and I did…but not near enough. So…here goes a series of figures for the assembly order that I used. Again with more markings for pocket hole screws.

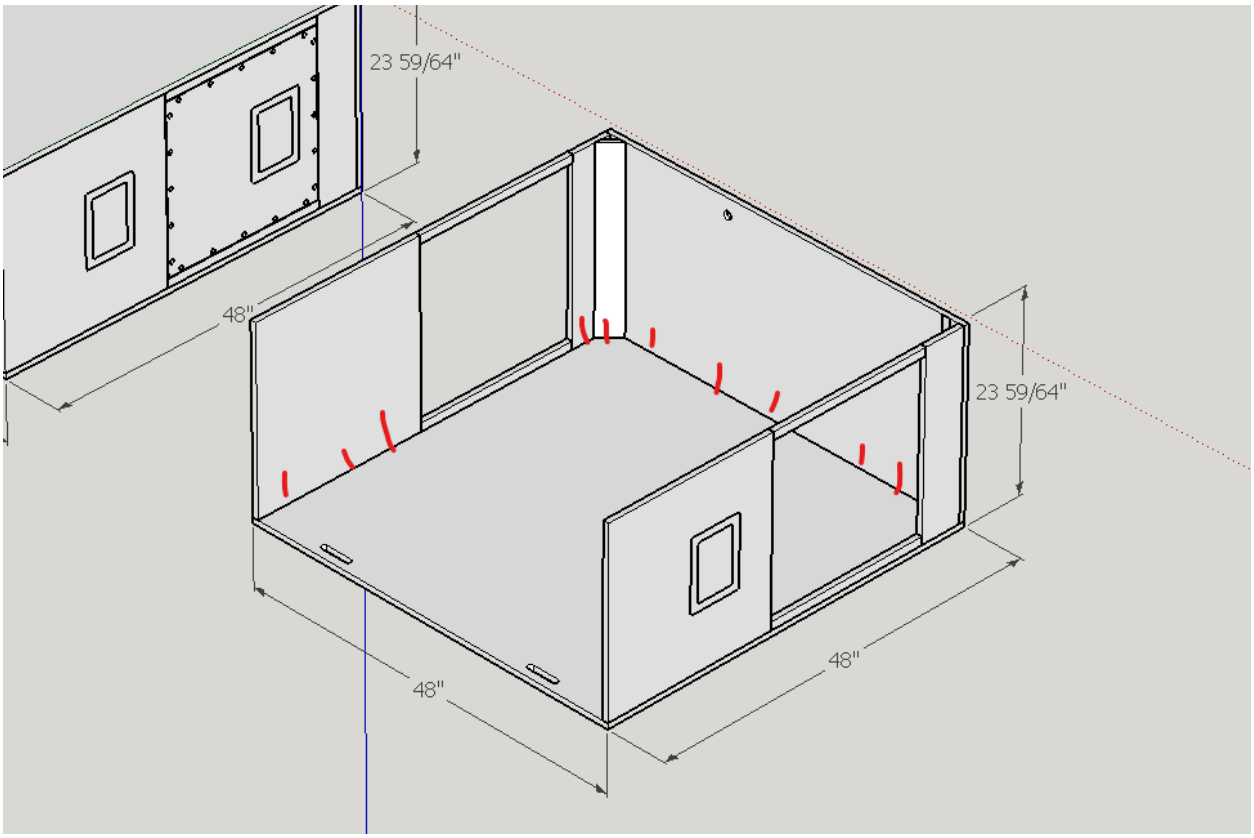


Figure 18 Step 1, Build Outer Walls

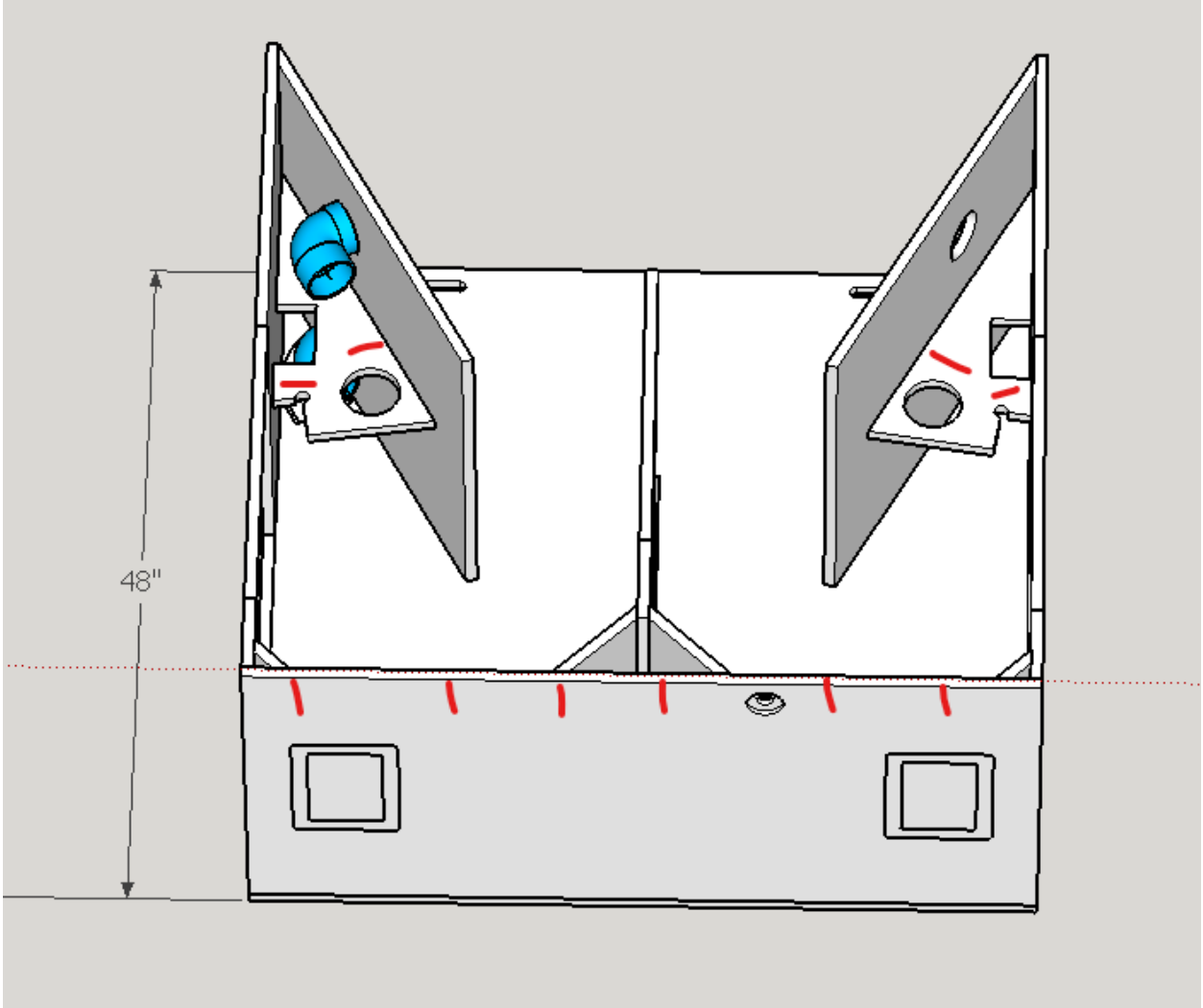


Figure 19 Step 2: First Flare, center braces.

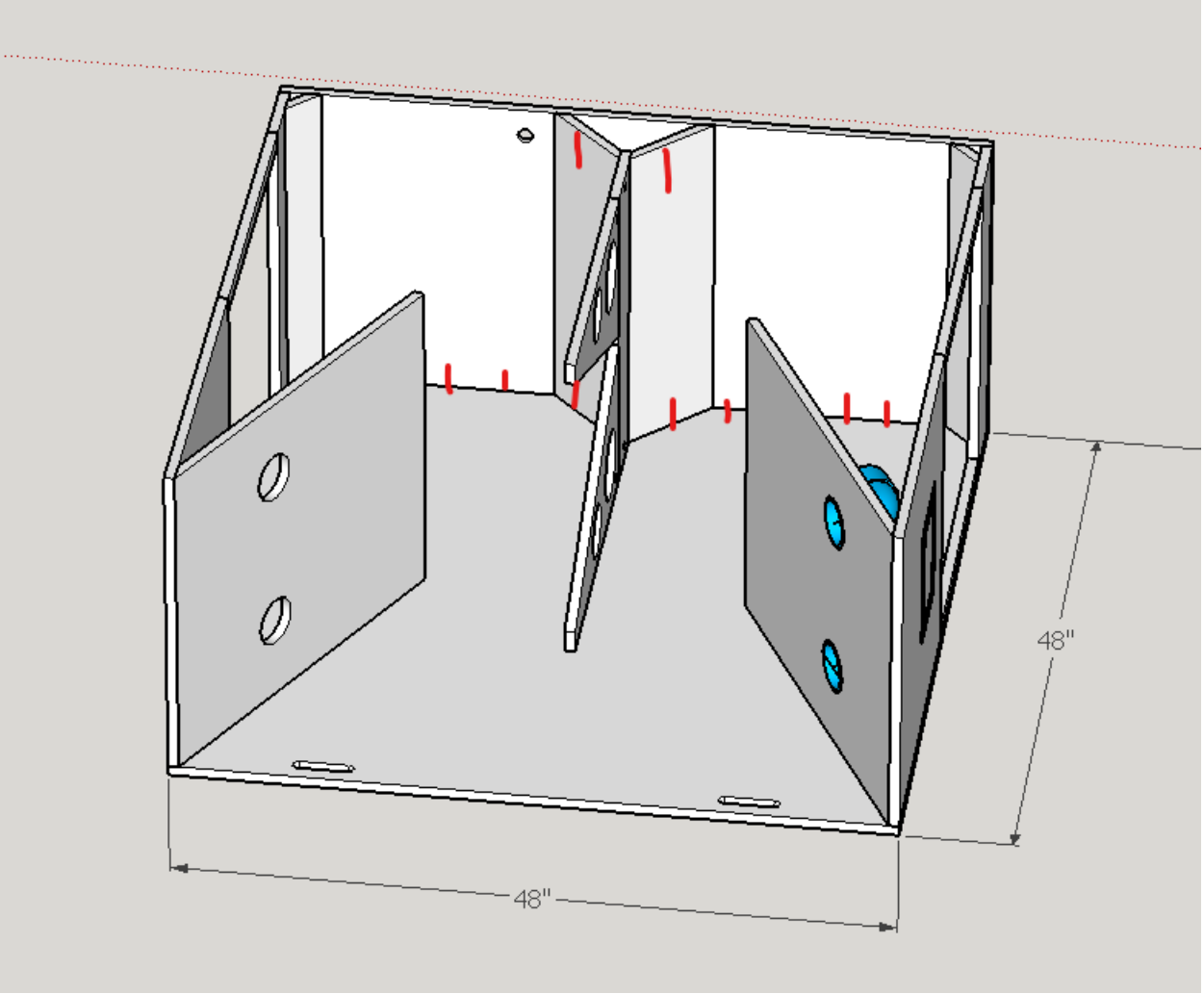


Figure 20 Step 2(b), More Pocket Screws

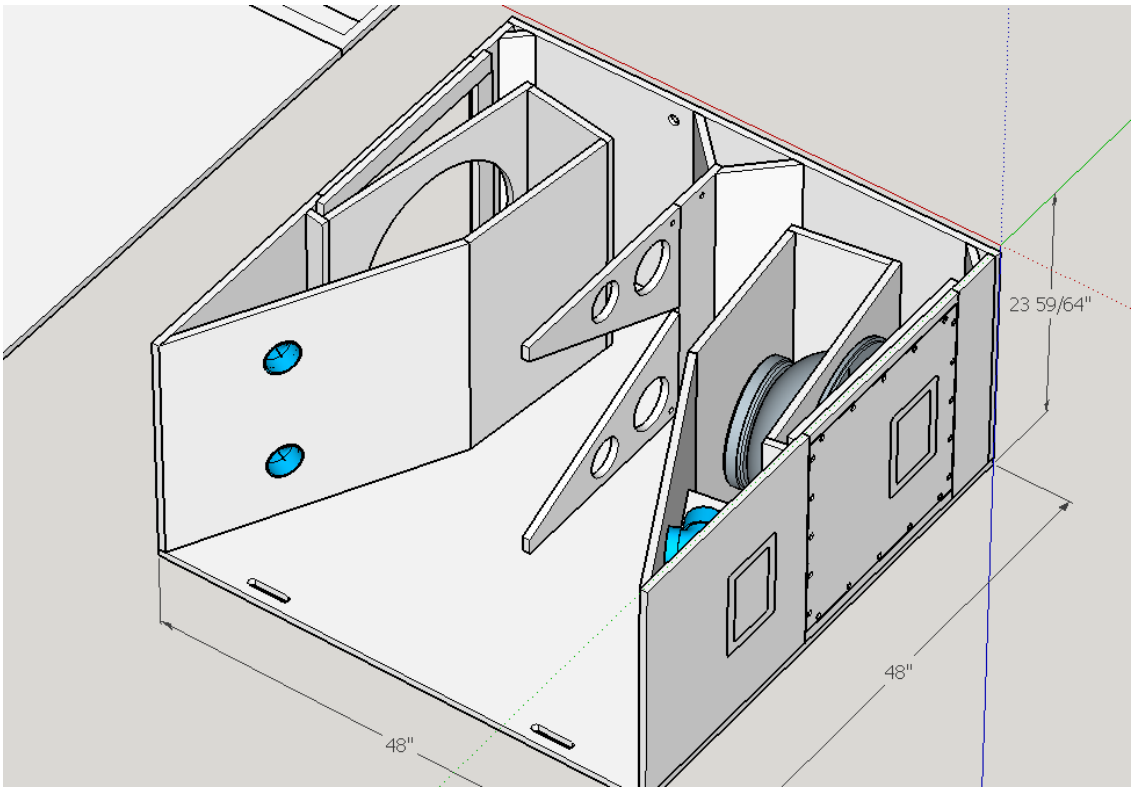


Figure 21 Step 3, More Parts. Pocket Screws? Yeah...next picture.

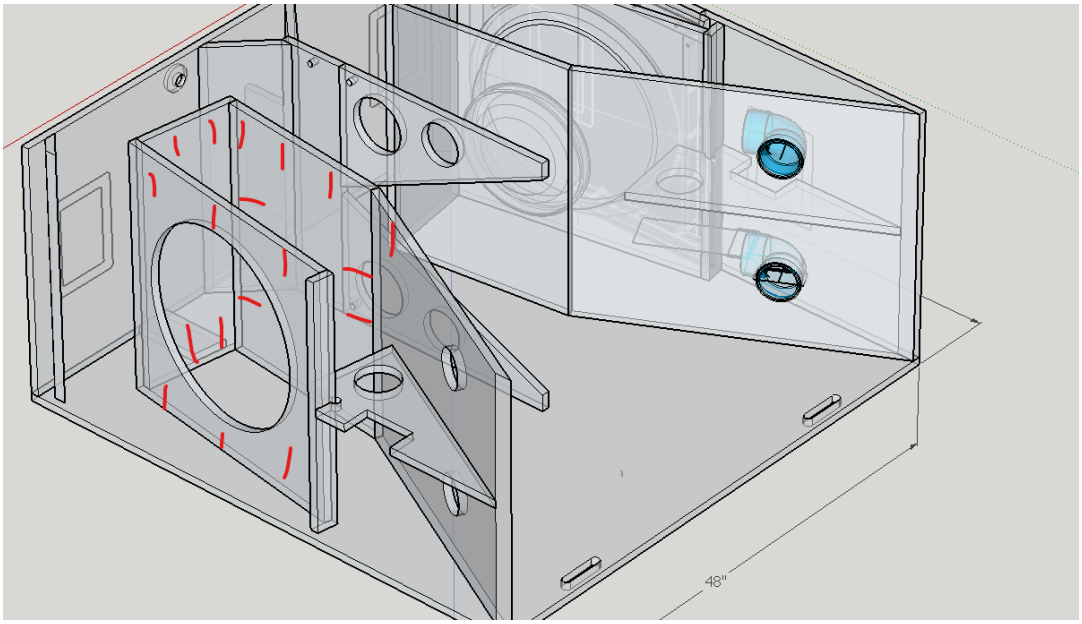


Figure 22 MORE Lots more....

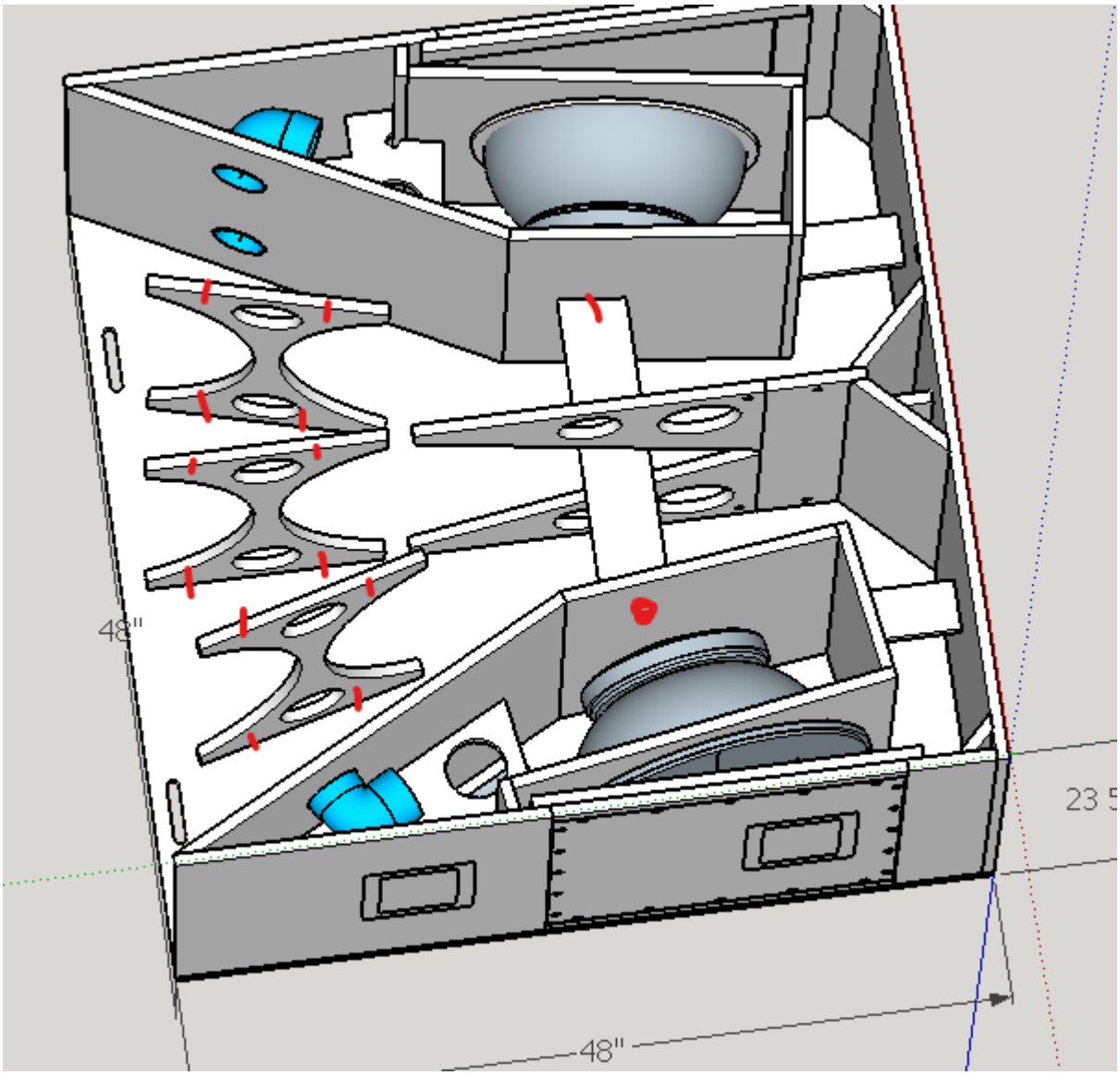


Figure 23 Bracing...and more pocket screws.

Construction Tips and Tricks

Over the years I've picked up a lot techniques that I find helpful….so here's a few that hopefully you can use and incorporate into your own builds.

First use temporary physical guides to ensure your pieces end up the right spot.

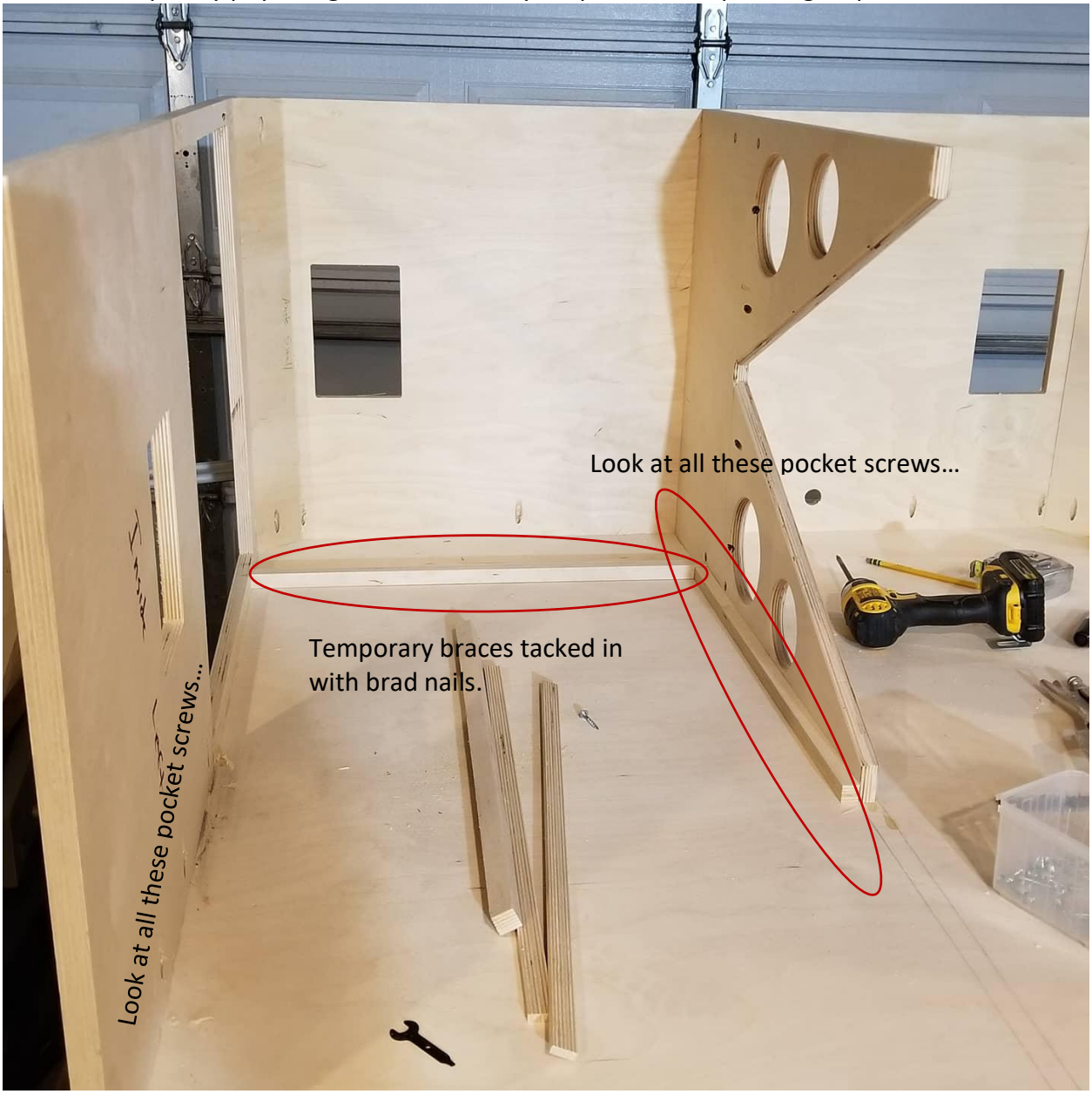


Figure 24 Center Brace Installation

Notice the pieces I've installed in Figure 24, these were put in to help align the center brace to be truly center. I used pieces of scrap to help make sure nothing shifted. The piece going side to side was trimmed down until it centered the brace, once I had it the right length I would flip sides with it until I had the center brace in the right spot. Next I tacked down a scrap strip using the brad nailer along the length of the brace opposite the side of the pocket screws. When you put the pocket screws in, the piece will often shift, roughly 1/16" away from that side….causing all sorts of issues in a build as precise as this.

Figure 25 More Stabilizing Pieces, and did you see all these pocket screws?

Again, I tacked down pieces so that as I put in the pocket screws the part I was trying to affix permanently stayed in the correct spot.

To cut the miter on the front mouth, I made a vertical hold jig for the table saw. My table saw tilts right, so it fits on the left side. First, glue a piece of wood that fits through your table saw slot, to a board that will extend past the blade. Once that's dry run it through the saw so that the board is cut exactly even/parallel to the blade. The glue a board vertical at that edge, tall enough so you can clamp to it…and the clamps will miss the blade. You can then run boards

through vertically much safer. This is a challenging cut, and if you are hesitant in your capabilities don't be afraid to reach out to a local cabinet maker or furniture builder. They'll likely have this jig on hand and run the boards for you if needed. Everything else is mitered flat on the saw. Under zero circumstances do you want to try this cut against a regular fence. No don't do it..it's just not safe. Be safe people!

Figure 26 Vertical Miter Cut, jig and clamps to keep me way out of the way of the cut.

To align the top to the sub, I again cheated and tacked in temporary stops at the front. This meant I didn't have to try and flush cut to open space. I made the top slightly oversized and

this meant I could use a router with a flush cut bit on the other three sides and the mouth would be perfectly aligned.

Figure 27 Top Alignment Stops.

Glue. This is a far more controversial subject than it needs to be. A glue joint is typically stronger than the wood itself, at least for quality glues, and reasonably cut/clean glue joints. There are three main choices for this, Type II/III PVA, polyurethane resin expanding glue and construction adhesives. I wouldn't use the PVA glues for this, unless your cuts and glue lines are all absolute perfection. (If you do go the PVA route, try to line every glue joint with

caulk….they can develop microscopic pin-holes that will leak, sometimes audibly.) I also dislike the construction adhesive, it's too thick, and my cut/glue lines/assembly techniques mean that the thickness of the glue pushes pieces out of place enough where the tolerance starts to get really messed up.

I use the expanding polyurethane resin, seals any microscopic gaps quite nicely and for a butt joint without a pocket screw is strong enough that the failure is at the wood, not the glue line. Do pay attention to the instruction, moisten one side, I usually do the cut side and make sure the joint is free of dust. I usually hit it with a bit of compressed air to make sure. Once you add the pocket screws to the mixture the assembly is stupid strong and isn't coming apart any time soon.

Other tips:

- Gasket your driver installation, and access doors. They will leak like crazy otherwise. But be careful of the material. The common stuff for windows/doors at the big box stores is too thick and stiff…I like https://www.mcmaster.com/8709K22/, 100 feet of ½" open cell…there is also a ¾" version. Under compression these are quite tight, but they don't seem to get sticky over time locking your pieces in.
- Since there are a billion t-nuts in this thing for access doors and drivers…for the love of all that is holy use anti-seize on your bolts. Get an acid brush and put some on the threads of the bolt. It will save you so much trouble.
- I have used many, many means to keep t-nuts from backing out and slipping on me over the years, but now my favourite method is to use two truss head screws put in on opposite sides. Seems to work better than epoxy….
- The PVC sweep for the ports are a tight fit….I used the C4807 from NIBCO (Amazon) To get the correct tuning add a 3" PVC tube, 9" long to each elbow.

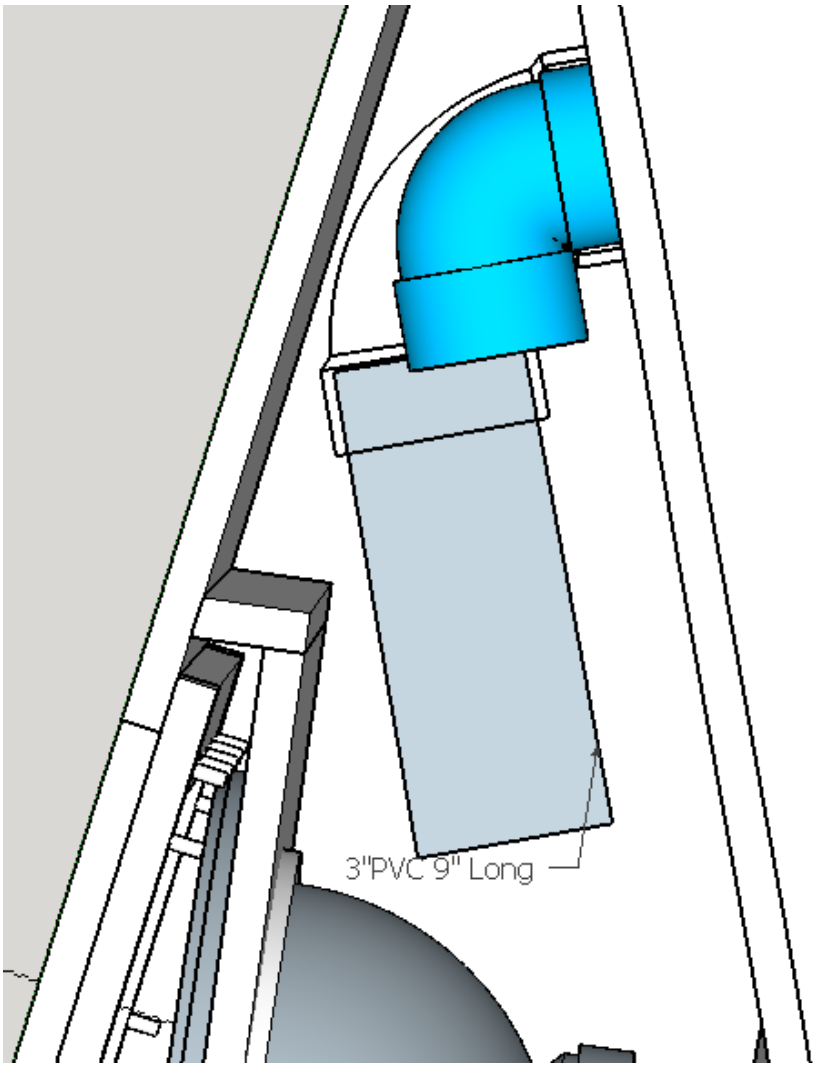


Figure 28 PVC Port...it's a tight fit. Also shown in blue is a sewer 3" right angle, but that's not compatible with schedule 40 PVC

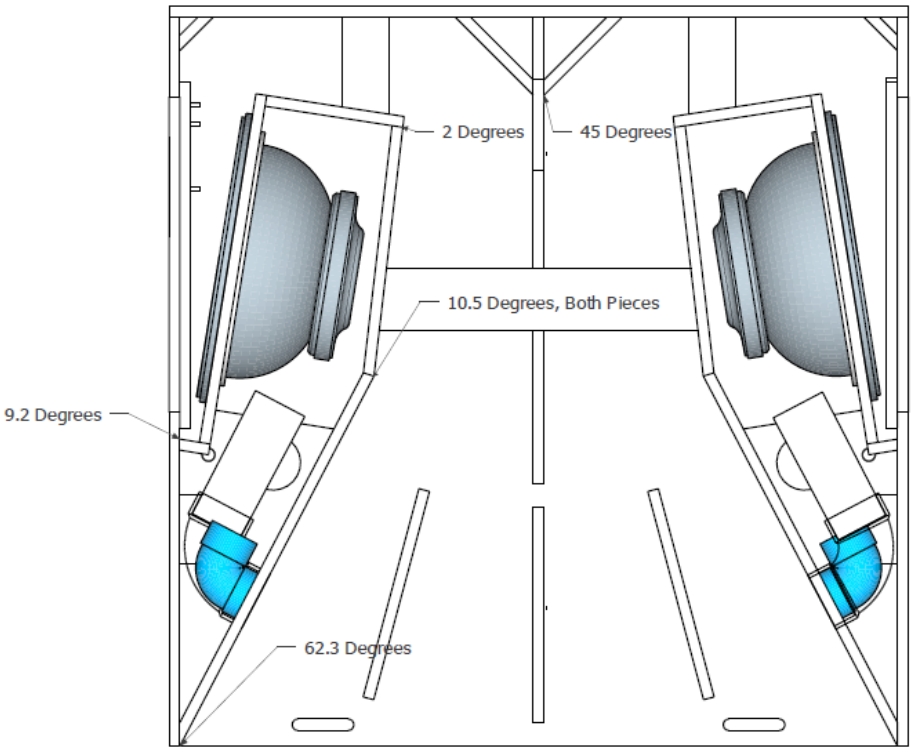


Figure 29 Mitre Angles

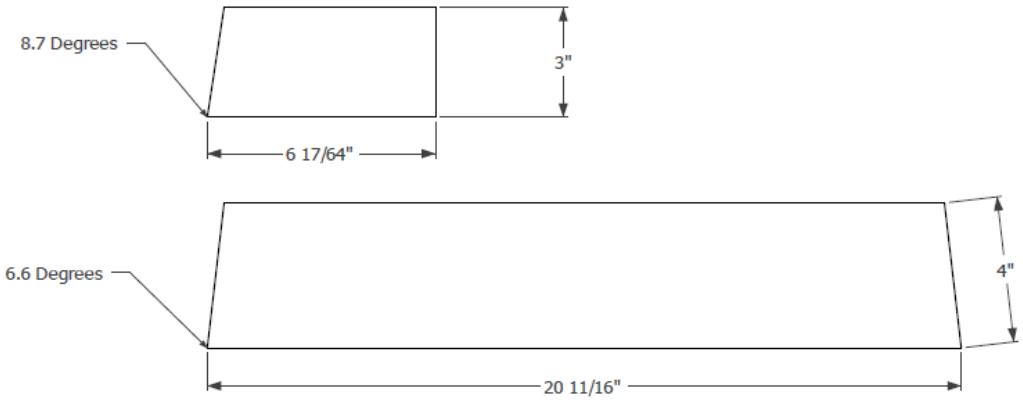


Figure 30 Brace Pieces Angles, Note: Longer mouth brace has identical angles on both sides.

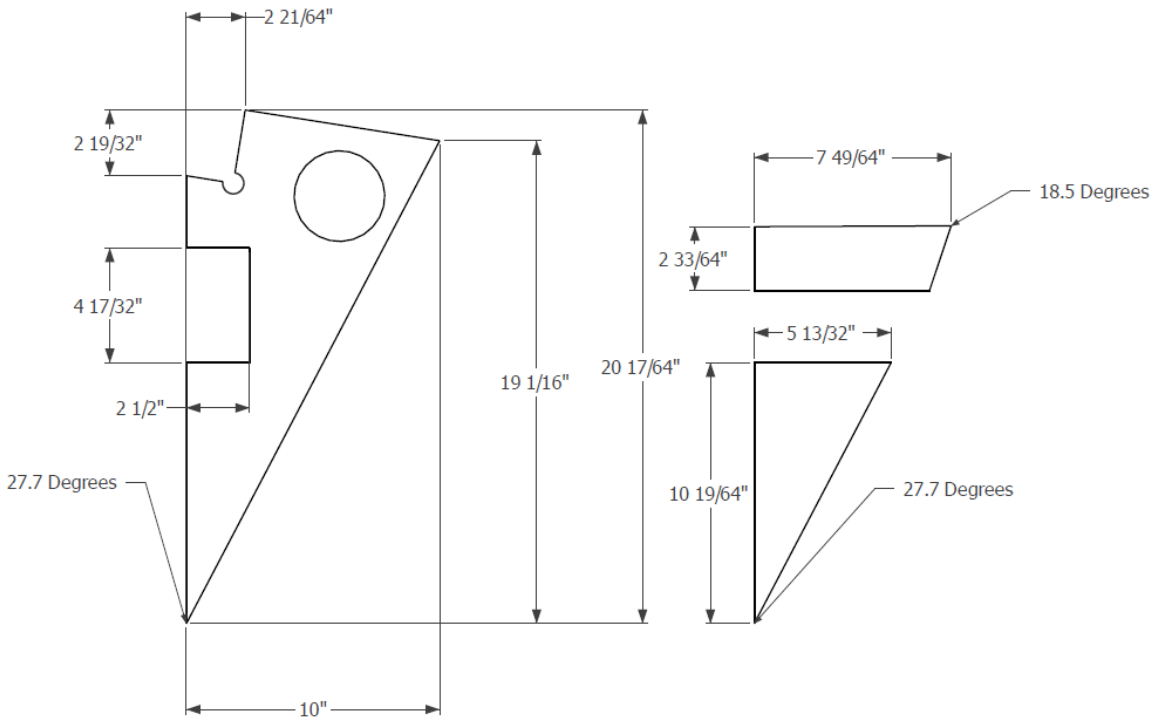


Figure 31 Crazy Brace...simpler alternatives...

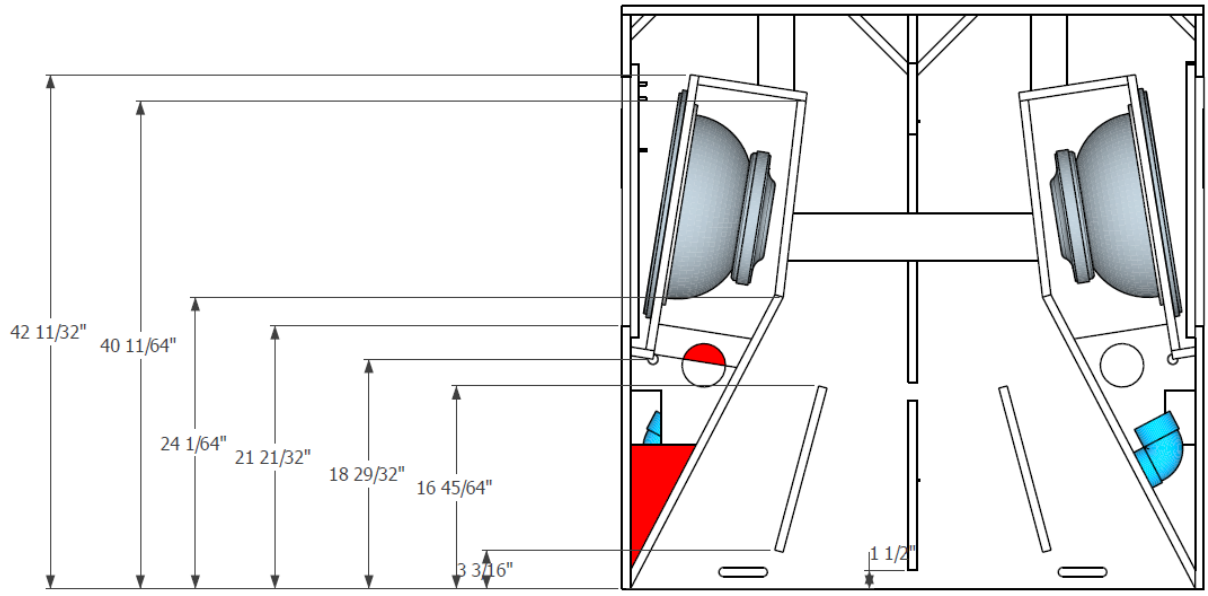


Figure 32 Dimensions....

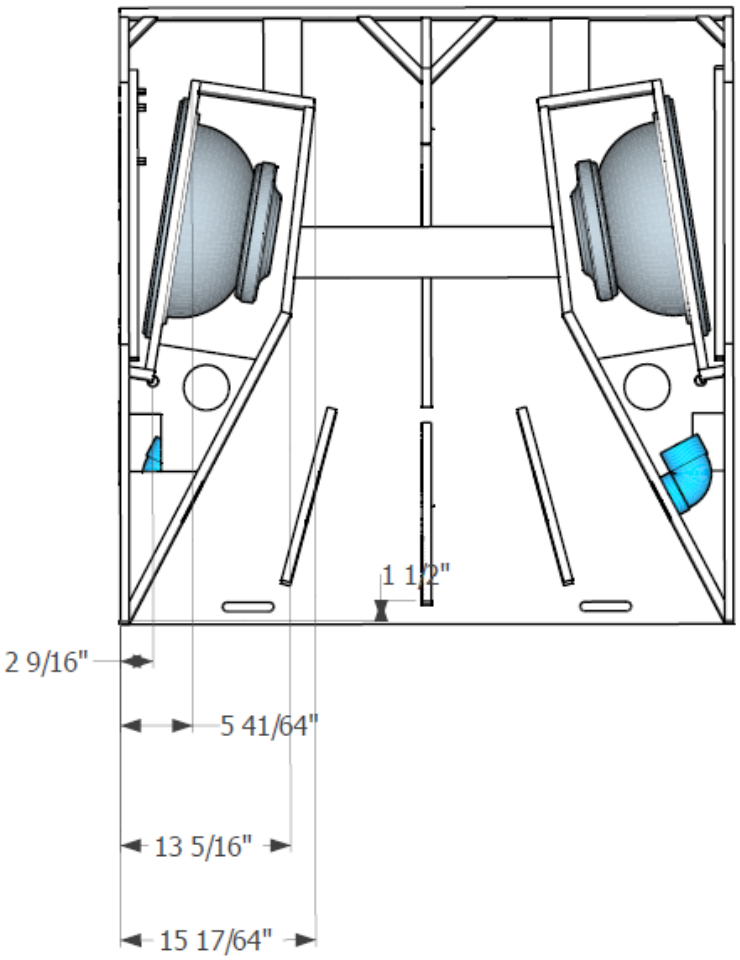


Figure 33 More Dimensions…

Now a couple of words of caution. These drawings are not the horns I built.

Really.

They aren't[4].

My two horns are, in fact ever so slightly different from each other, here's why.

When I was just starting out building speakers I tried to cut everything to extraordinary precision before assembly, and then I spent an extra-ordinary amount of time trying to get the

[4] And it's at this point where like 4000 people are reading this document and wondering why I've put them through it all.

stupid things assembled. Why? Well, every cut would have a slight error, if you're on a good table saw this can be a fraction of a degree and only a few thousandths of an inch…but these errors stack up.

It wasn't until I started studying furniture makers that I realized how small quantities of things are built. They would cut the first pieces to the intended size put them in place hold them together with clamps and then start measuring from the work piece. Sure they'd go back to the drawings to reference basic sizes and angles but the individual pieces from that point on would be cut to fit the work…not the drawing. The farther you go the more the errors would stack up if you had pre-cut.

In a production environment where CNC machines or templates can be employed you can eventually figure out which pieces need to be cut with what fudge factors, or rework the design so that the tolerances stack a certain way to make it easier for everything to true up. Since I only built two….I didn't do that. I built them like furniture. I cut the bottom…then I started milling the outside pieces getting everything to fit…gluing as I went. Then I started milling the inside pieces…again…fitting and gluing as I went. I did cheat and cut the crazy triangle pieces, baffle and access panel pieces on the CNC, but those could be done without it…just make templates and work at a slower pace with higher precision. I bet if you measured my two subs you'd see differences of > 1/16" between them…but for my application…I literally don't care.

Speaking of access panels…I didn't include a called out drawing for them…you'll need to work that out for yourself from the SketchUp files. These require tremendous precision in order to make them work, so do take your time making them. The SketchUp file also has the suggested cut-sheet…which enables you to get a single horn out of 5 sheets of plywood. For those inclined you can export them to DXF and if you know someone or have access to a CNC with a bed large enough you can cut the pieces out pretty quick. You'll want to check tolerances on those bevels though (remember that whole conversation about how errors can stack up?)

The SketchUp drawings also have cutouts for the Penn-Elcom H1105 handles. Again I cheated and used my little hobby CNC, but you can pretty easily flush mount these using a router with a guide bushing set and making a template oversized to handle the guide bushing. I will take the college professor route and say:

"I'll leave that as an exercise for the reader[5]."

[5] Insert evil laugh.

Measurements

The bigger the speaker the more problems there are in measuring that speaker. The lower in frequency you want to go…the harder it is to get an accurate measurement. There are some great white papers on low frequency measurement accuracy and precision by a French line source manufacture. I did the best I could…and it's pretty good. I actually expect that if I got even better measurements, I'd be even closer to the Hornresp model.

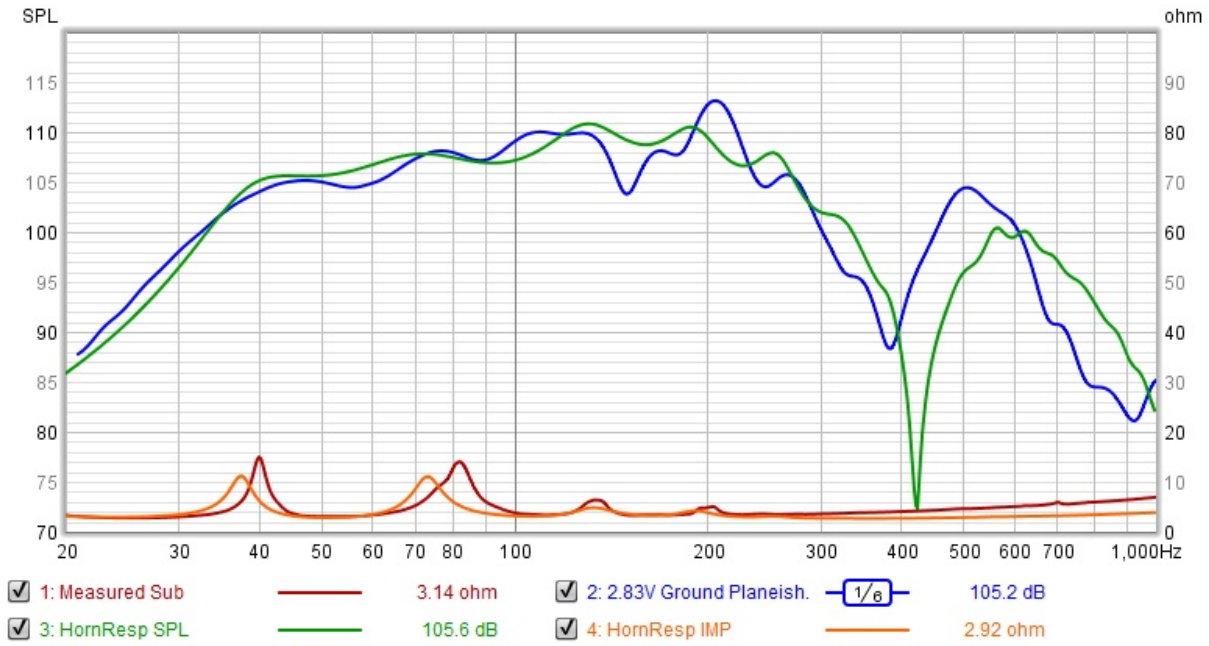


Figure 34 Model vs. Reality (kinda)

In blue is the subwoofer measured in my back yard. My house is two stories…there's a three story apartment complex around 30 feet of where I had this sub. There's trash cans, fences all sorts of stuff. Meaning…there's going to be some frequency response wobbles from a 4 meter ground plane measurement that aren't actually there, they are just reflections from nearby objects.

Even so…the agreement with the predicted frequency response (scaled to 1 meter) in Hornresp is quite good (green). I am quite happy with how that turned out.

The impedance(red/orange) show bigger differences than I expected given how close the sound pressure measurements are but again, close enough for me to be happy. One of the things you have to keep in mind is that Hornresp assumes a straight horn, with no bends and infinitely rigid walls. I've done some tapped horns where the impedance and SPL differences are pretty far apart (and not in a pleasant good way). In that case I really do think that it has to do with the multiple 180 degree bends made to wrap the longer path….especially since there was no

effort to turn those into 90 degree bends or add corner reflectors on the outside path like I did this horn. So…am I happy? Yes. I folded it right…so very happy.

Now….let's go back to that coupling concept. I didn't think I could measure the two horns driven accurately enough to see that coupling in the acoustical domain. I did give it a shot electrically.

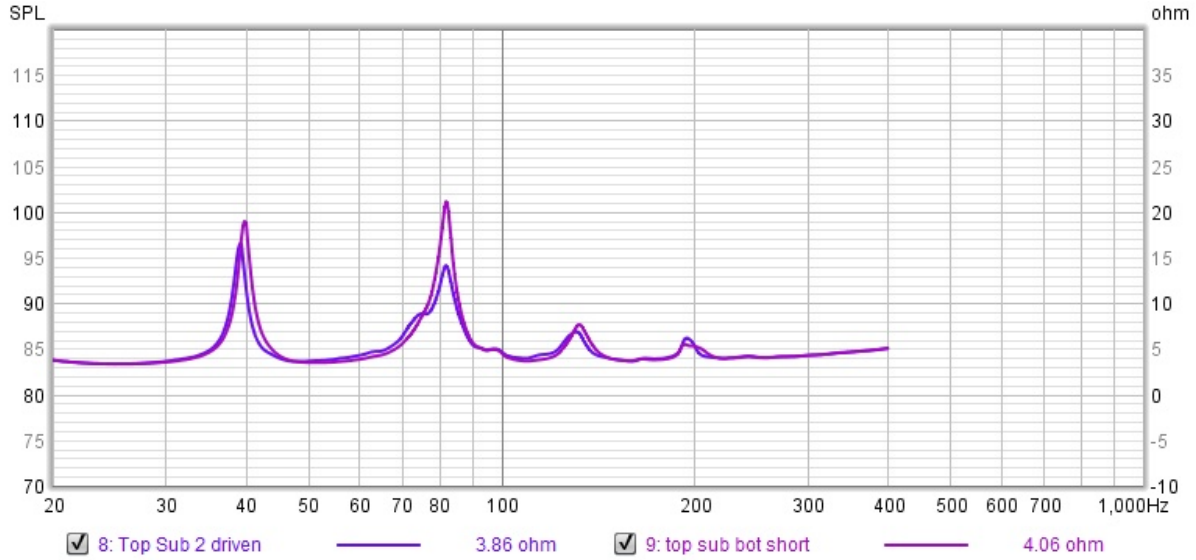
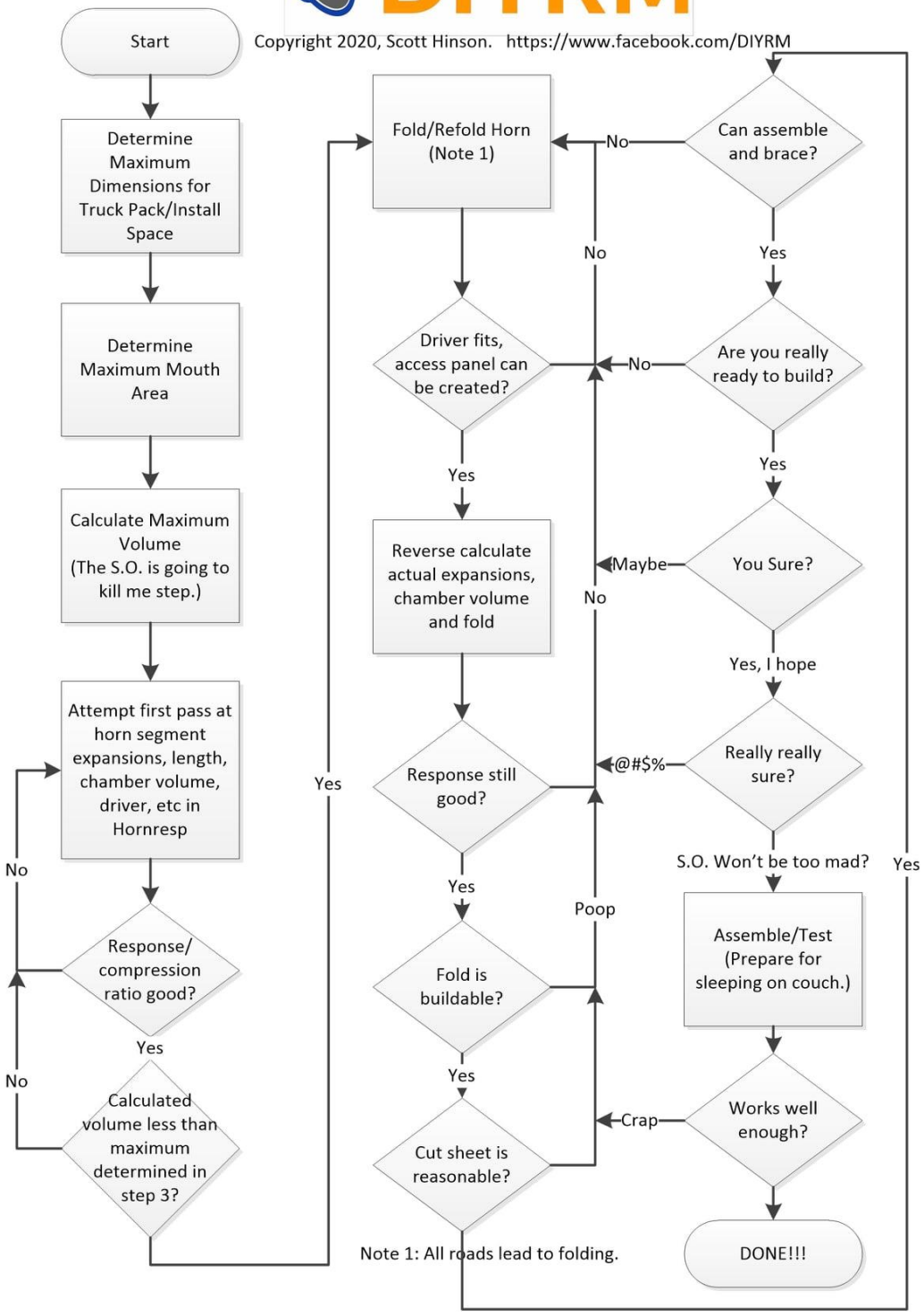


Figure 35 Impedance 1 horn vs. 2

Low and behold I see the same sort of impact that horn response predicted…with both horns driven the impedance peaks are lower in frequency and shifted down in magnitude. SWEET.

Bass Horn Folding Flowchart V1.0



Acknowledgements:

I would first of all like to thank my loving wife, who has not kicked me out of the house to live and sleep in these horns. She is the best. My children for bringing me all the bass heavy Tik-Tok songs to play…and again my wife for putting up with that too.

I would also like to thank SB Audience for their support in bringing this project to light.

Lastly, many thanks to David McBean for his wonderful Hornresp software.

About the name:

Neman (or Nemain) is a figure in Irish mythology who is the spirit-woman or goddess best described as personifying the frenzied havoc of war. Her cry is said to be able to kill 100 men on the battlefield. While this horn can't do that…it has certainly added nearly that many cracks to my drywall.

Commercial Rights:

For license information on building and selling this horn on a commercial basis please contact me at facebook.com/DIYRM