



# adhoc Flow/1 Maker's Guide

Making Your  
Flow/1  
Audiophile  
Loudspeaker

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## Welcome To the Flow/1™ Maker's Guide

Thank you for taking this journey to create a unique and highly-optimized active loudspeaker!

This Guide takes you step by step through the complete process of creating a Flow/1 reference loudspeaker, from selecting drivers and printed parts, to assembling the enclosure, to integrating the loudspeaker into a working DSP-based reference system. Its purpose is practical: to help you build a Flow/1 that is mechanically sound, electrically correct, and ready for measurement, tuning, and listening.

The Flow/1 is not a conventional small loudspeaker. It is based on the folded coaxial quarter-wave tube principles embodied in U.S. Patent 7,925,036 B2, and combines that patented acoustic architecture with modular construction, active DSP crossover control, and modern additive manufacturing methods. The result is a compact but highly engineered loudspeaker system designed to achieve unusually coherent imaging, strong low-frequency extension, and flexible driver experimentation from a very small form factor. This Maker's Guide shows you how to build that system carefully and repeatably. By the end of the Guide, you will have a finished Flow/1 ready for setup, validation, tuning, and use.

The Flow/1 is a 3D-printed, two-way loudspeaker system that can be built with different High Frequency Drivers (HF Driver) and Low Frequency Drivers (LF Driver) to suit your budget and listening taste. The unique system suspends the HF Driver in front of the LF Driver and can be swiveled 180 degrees, allowing the speaker to be used facing forward on a bookshelf, or standing up vertically on a desk or table. The organic form of the HF Driver enclosure, called the "Egg", lets sound waves wrap around the enclosure, resulting in an open sound with no baffle effect. The LF Driver sits in front of a 1.7-meter folded, coaxial tapered quarter wave tube that is tuned to 48Hz. The versatility of the design lets you position the speakers vertically or horizontally to suit your environment.

Active crossovers and digital signal processing get the most out of this 4.8-liter loudspeaker, and this Guide provides an example DSP-based active crossover reference system. However, while this guide does give examples of 3D printed parts and provides links to 3D printing resources, it does not provide detailed instructions on how to print the bodies needed for construction of a Flow/1; that expertise is left to the PIY (Print-It-Yourself) reader.

The result is a compact, modular, audiophile-grade loudspeaker system designed to deliver unusually coherent imaging, strong low-frequency extension, and the rare satisfaction of hearing exceptional sound from something you built yourself.



*Figure 1 Flow/1 on small stand*

## What you will need to create a Flow/1

### Maker Resources: Your 3D Printer Setup

–FDM, SLA, DLP, MJF, SLS for example.

### Digital Blueprints

–The 3D STL and STEP files of the speaker and stand parts.

You will find STEP and STL files here.

### Tools

–Screwdriver, torque screwdriver or drill with adjustable chuck clutch, wire cutters, soldering iron, painting tools, ... The instructions in this Guide assume that you have reasonable experience using common tools.

### Core Components

–Drivers: HF Driver and LF Driver

–Hardware, wires, jacks & connectors, adhesives, ... All core components used in the making of Flow/1 speakers can be acquired from online sources or your local hardware store.

### Print Partners

–JLC3DP, Craftcloud3D, your favorite printing service... You can print the parts yourself or use the print services of Print Partners listed in this Guide.

### Software

–miniDSP 2x4HD Device Console for uploading filters, rePhase for FIR filter creation, SigmaStudio for uploading DSP projects, REW for measuring speakers.

### Sources & Distributors

–McMASTER-CARR, DigiKey, Mouser, LCSC, Parts Express, Madisound, Solen, GomeSound, Wagner Electronics, and more, depending upon where you are.

This version of the Flow/1 Maker's Guide provides instructions to build a Flow/1 using the Wavecor TW030WA26-8 Neo HF Driver paired with a Dayton Audio ND91-8 LF Driver. However, the versatility of the design lets you easily swap drivers for quick comparison. The Guide lists the drivers supported at the time of publishing; more drivers will be added later.

Please read the *Flow/1 User's Guide* for system wiring, testing and alternate DSP configurations, in-room testing with response graphs, and the use of third-party testing software, such as REW, rePhase, and SigmaStudio.

I recommend reading *Flow/1 Folded Coaxial Quarter-Wave Tube: Principles of Design*, which outlines the acoustic and structural principles behind the Flow/1 and will help you understand the system before starting the build.

If you wish to build the stands for the Flow/1 speakers, follow the instructions in the *Flow/1 Speaker Stand Maker's Guide*.

### Before You Order Anything

Before you begin buying drivers, hardware, or printed parts for the Flow/1, take a few minutes to review the practical realities of the build. The Flow/1 is straightforward to assemble, but it is not a casual "print-and-go" project. A little planning up front will save time, money, and frustration later.

The first thing to understand is print size. The largest single printed body in the Flow/1 is the Tube Section, which has an extent of **344 mm x 172 mm x 172 mm**. That is larger than the build volume of many common FDM printers, especially in the Z direction. If your printer cannot accommodate that size, you will need to either outsource the Tube Section or use the split version when it becomes available. All other rigid parts of the Flow/1 can be printed on more common desktop FDM printers, provided your machine is well-tuned and capable of producing dimensionally accurate parts.

The next thing to understand is material and process. Not all parts have the same requirements. The DM covers should be printed in TPU, because they must be flexible enough to press into place and be removable. That is the only part in the system that requires a flexible material. By contrast, the Egg parts, Arms, and Bezel are tight-tolerance parts. These are best printed in SLA resin, where the finer feature detail and more consistent dimensional accuracy improve fit, finish, and assembly reliability. I have not built Flow/1 units with these parts printed in FDM, so I do **not** recommend FDM for them at this time. If you do not have a resin printer, plan on outsourcing those parts.

The Tube Section and base are more flexible from a manufacturing standpoint. They may be printed by FDM or SLA, depending on your budget, printer capacity, and priorities. SLA generally yields tighter fit and a denser, more rigid result, but it is much more expensive for large parts. FDM is often the more practical route for the Tube Section, especially in ABS or PETG, provided the print is dimensionally accurate and the finished part is properly cleaned and fitted.

Also understand that the Flow/1 is an active loudspeaker system, not a passive one. In addition to printed parts and drivers, you will need amplifiers, DSP, wire, connectors, hardware, adhesives, damping material, and basic assembly tools. The printed enclosure is only part of the project. Review the hardware, tools, and electronics sections of this Guide before placing orders so that you understand the full scope of what is required.

Cost is best thought of as a range, not a single number. Your final cost depends mainly on four variables:

1. which HF and LF drivers you choose,
2. whether you print parts yourself or outsource them,
3. which print technologies and materials you use, and
4. how much of the electronics chain you already own.

If you already have suitable DSP, amplifiers, tools, and some printing capability, your out-of-pocket cost can be relatively modest. If you are starting from scratch and outsourcing all precision parts, the cost will be higher. Review the cost estimates in the parts and hardware tables as a planning guide, but do not treat them as fixed quotations.

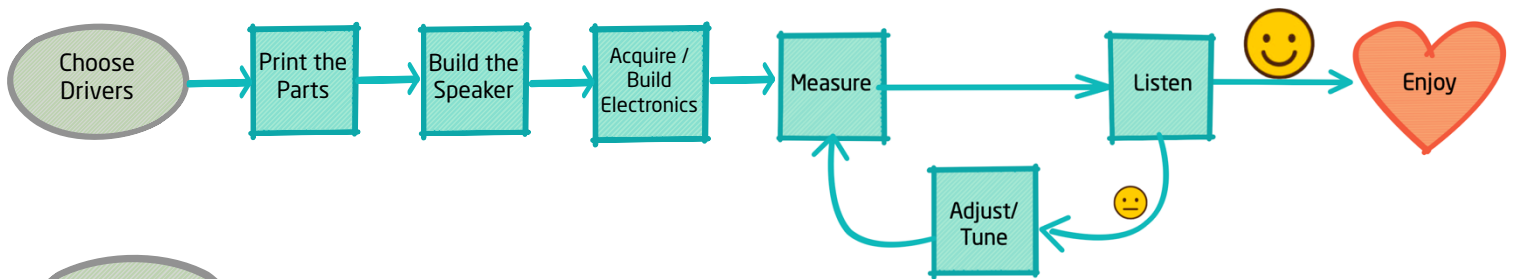
Finally, before ordering, make sure you have selected a complete build path:

- your HF Driver
- your LF Driver
- the exact printed parts that go with those drivers
- your intended print processes and materials
- the required hardware, wire, connectors, adhesives, and damping
- your electronics plan for driving and testing the finished speakers

A careful review before ordering will make the rest of the project go much more smoothly. The Flow/1 rewards precision, and that starts before the first part is ever printed.

# The Journey—Making Your Flow/1

Here’s the roadmap of the journey to your Flow/1 Creation:



## Choose Your Drivers

Start by choosing which drivers you want to build with based on your budget and sound preference. The Flow/1 can be made with HF Drivers from SB Audience, AuraSound and Wavecor, and LF Drivers from Tang Band and Dayton Audio. The SB and Aura drivers are well-matched in level and range with the LF Drivers. The Wavecor drivers are higher efficiency but more expensive.

HF Drivers are mounted in an enclosure, called the ‘Egg’, which is held in front of the LF Driver by Arms, and can be swiveled 180 degrees. LF Drivers are attached to a Driver Mount, called the ‘DM’. The Egg and DM are assembled together and will plug into the main enclosure, which is the Bezel, Tube Section and Base, with banana jacks and plugs, making it easy to swap different LF/HF Driver combinations for comparison.

### Choose Your HF Driver

Figure 2 shows the HF Driver options available in this version of the Flow/1; choose a driver and corresponding Egg parts to print, then select a LF Driver.

Figure 2 HF Driver Options



Table 1 is the current list of Flow/1 HF Drivers to choose from; this list will grow as new HF Drivers are added to the design:

**Table 1 List of HF Drivers**

Driver	Picture	Manufacturer	Manufacturer's Part No.	Distributor	<a href="#">Link to Distributor</a>	Estimated Price
SB Audience SB36WBAC21 1" wideband		SB Audience	SB36WBAC21-8	Madisound	<a href="#">SB Audience HF Driver at Madisound</a>	\$18.30 USD
AuraSound NSW1-205 1" wideband		AuraSound	NSW1-205-8A	Madisound	<a href="#">AuraSound HF Driver at Madisound</a>	\$19.45 USD
Wavecor TW030WA03 OEM no faceplate		Wavecor	TW030WA03	Solen, GomeSound	<a href="#">Wavecor TW030WA03 at Solen, Canada</a>	\$35 CAD
Wavecor TW030WA26-8 Neo no faceplate		Wavecor	TW030WA26-8		<a href="#">Wavecor Distributors</a>	\$32 USD

### HF Driver Frequency Response Graphs

Here are some magnitude response graphs (a.k.a., Bode Plots) that show the magnitude vs frequency response of the drivers listed above. The nominal magnitude of the SB and Aura drivers are about 77dB - 79dB, making them good matches for the Tang Band and Dayton Audio LF Drivers, which are about 76dB and 78dB respectively (see their plots ). The 8-ohm versions of the SB and Aura drivers were chosen over their 4-ohm counterparts because they achieve a better match with the LF Drivers' responses.

Wavecor drivers are more efficient, can handle much more power, and have very low distortion. Wavecor drivers are installed without their manufacturer-supplied mounting plates so they can be fitted into the 'egg' enclosures. Properly padded, the Wavecor HF Drivers match well with the Dayton Audio ND91, and they are an excellent match for higher-efficiency drivers, such as the SB Acoustics SB12PACR25 4" and the Purifi PTT4.OX04-NFC-01 which will be offered in the future.

Note: You can find 3D models of these drivers on [GrabCad](#).

Below are the manufacturer's frequency response and distortion graphs for the HF Drivers available in the Flow/1. Review them to help you decide which one to select for the build.

Figure 3 Wavecor TW030WA26 Frequency Response Graph

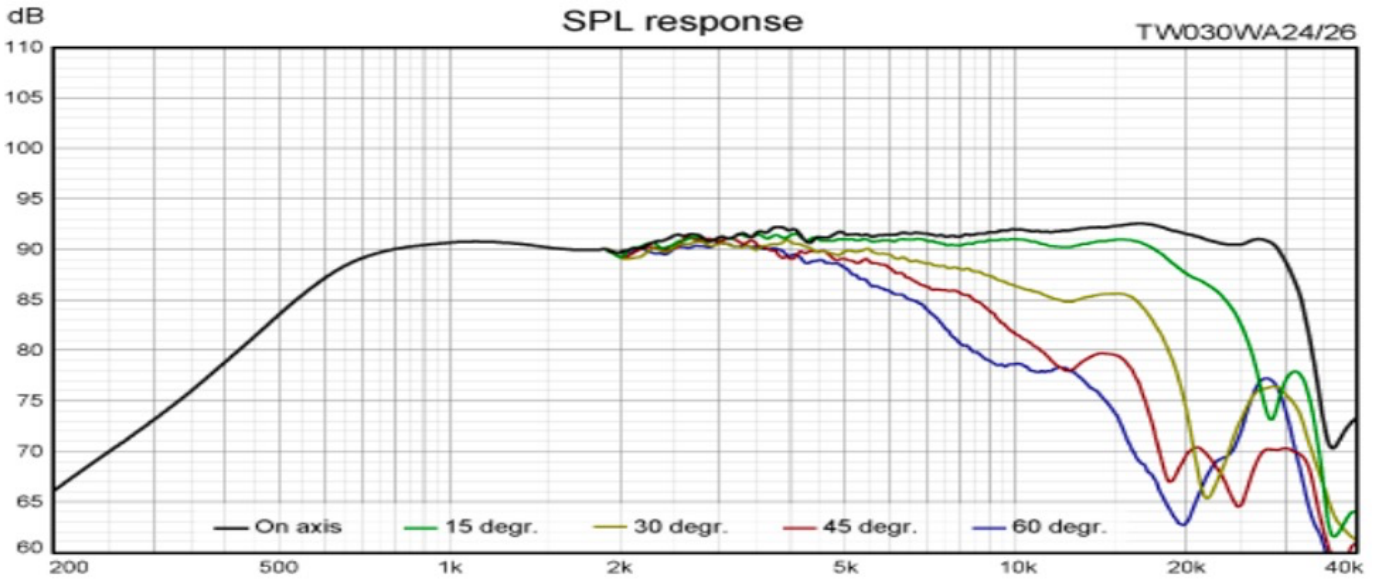


Figure 4 Wavecor TW030WA26 Distortion Graph

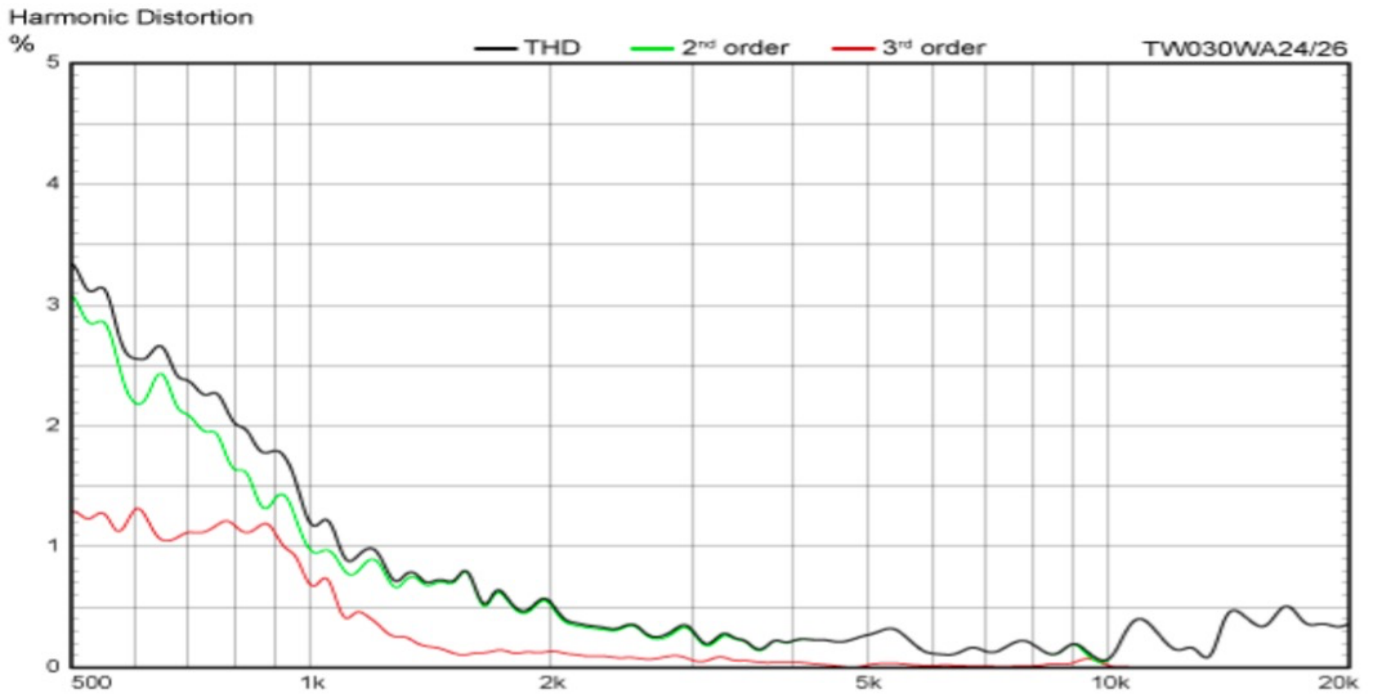


Figure 5 Wavacor TW030WA03, 04 Frequency Response Graphs

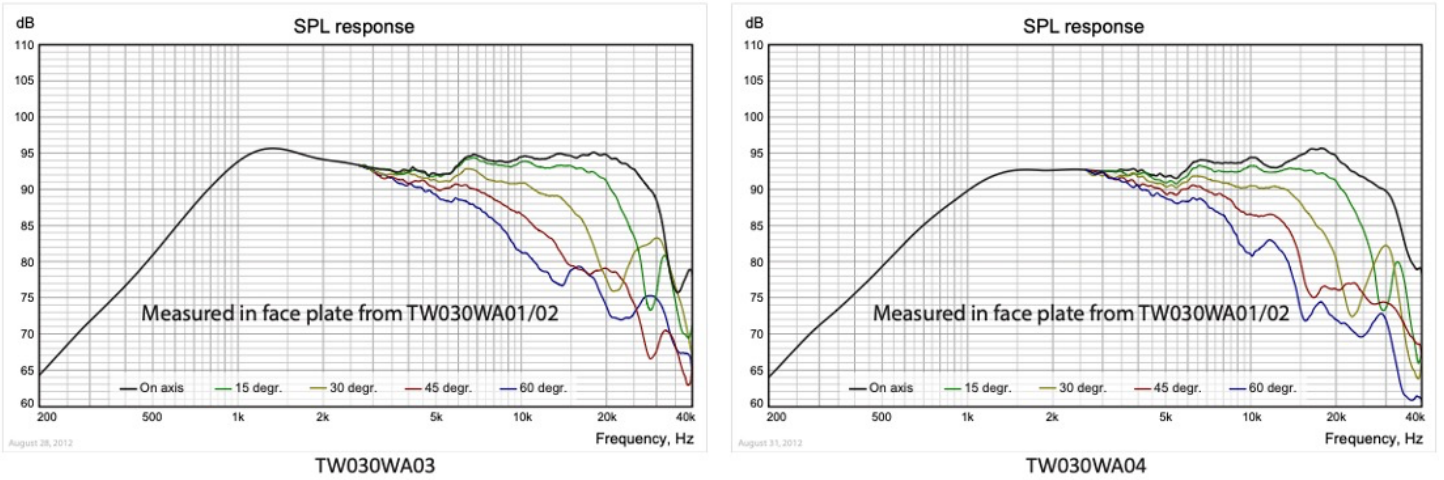


Figure 6 SB Audience SB36WBAC21-8 Frequency Response Graph

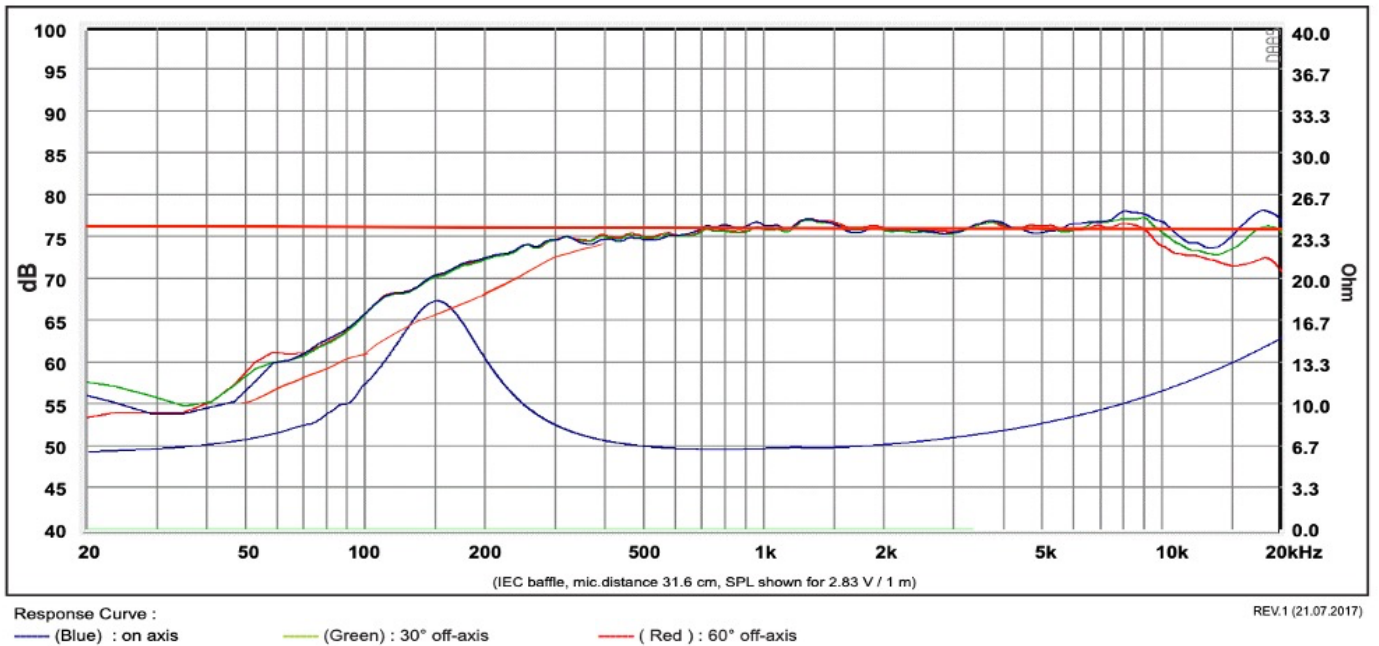
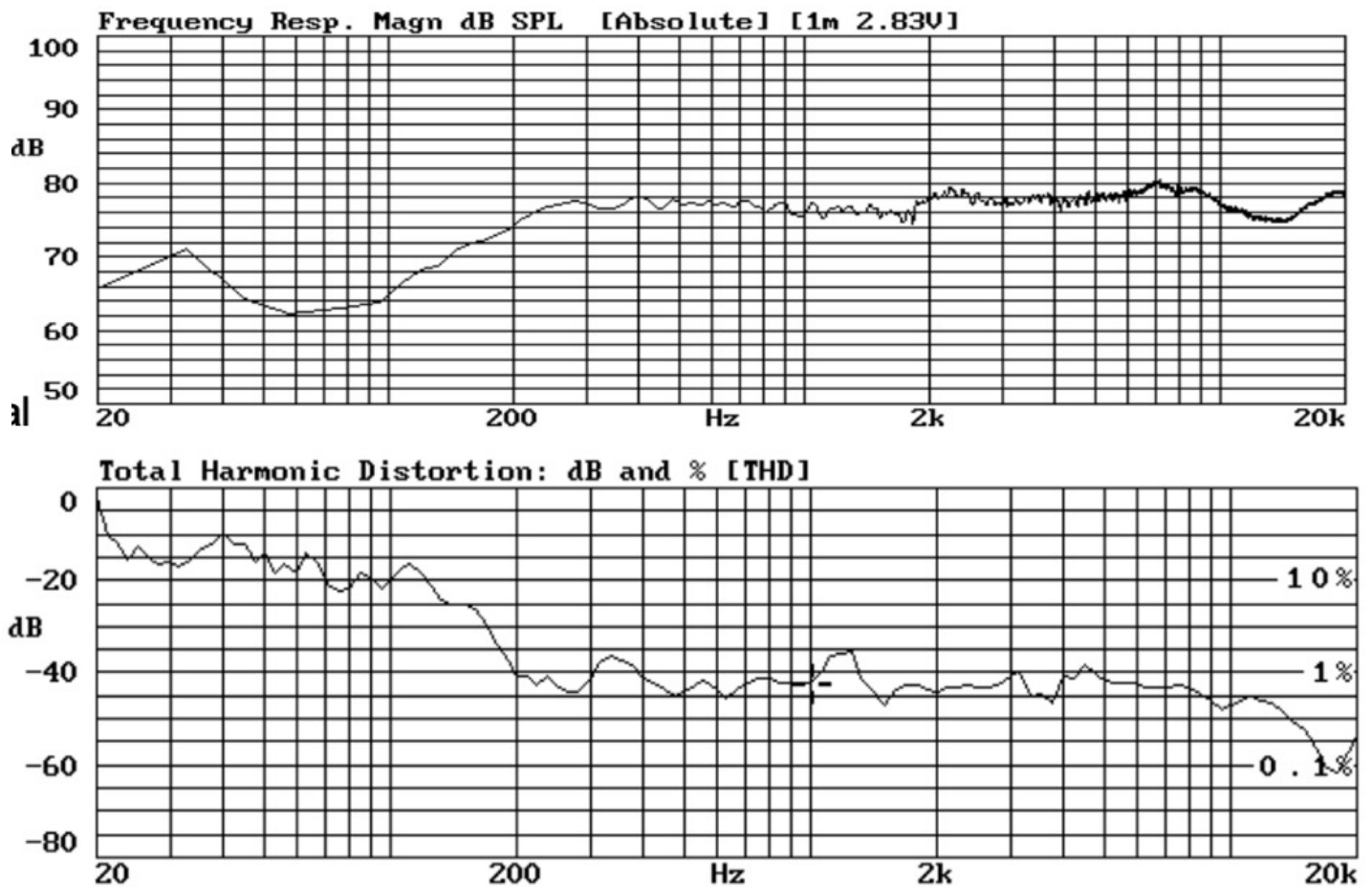


Figure 7 AuraSound NSW1-205-8 Frequency Response and Distortion Graphs



Which HF Driver you choose is based on your taste and budget. The SB and Aura drivers are inexpensive, but do not handle much power so they become strained when played loudly (90+ dB). The Wavecor drivers are more expensive, harder to acquire, but handle much more power and play cleanly at very high volumes (> 95dB). The LF Drivers are attached to the DM, which is then attached to the enclosure containing the transmission line, allowing you to swap out drivers easily for comparison and test. The versatility of the design allows you to make several versions, and plug them in and out for easy comparison.

## Choose Your LF Driver



Figure 8 shows the LF Driver options for this version of Flow/1. The driver you choose will also determine which decorative driver cover and DM to print.

*Figure 8 LF Driver Options*



Choose an LF Driver from the list in Table 2. New drivers may be added in future versions:

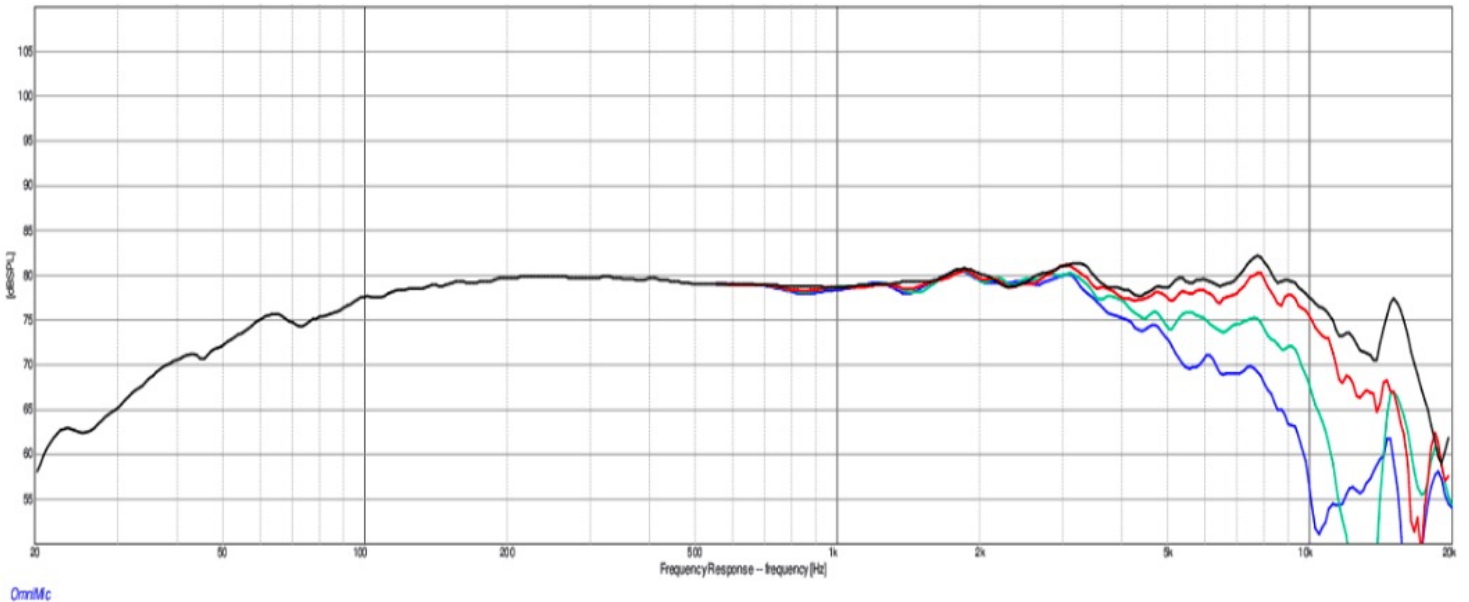
*Table 2 List of LF Drivers*

Driver	Picture	Manufacturer	Manufacturer's Part No.	Distributor	Dist. Part No.	<a href="#">Link to Distributor</a>	Estimated Price
Tang Band W3-1876S 4-ohm 3-inch Mini Subwoofer		Tang Band	W3-1876S	Parts Express.com	264-909	<a href="#">Tang Band W3-1876S at Parts Express.com</a>	\$64.99 US
Dayton Audio ND91-8 8-ohm 3.5-inch Mini Subwoofer		Dayton Audio	ND91-8	Parts Express.com	290-226	<a href="#">Dayton Audio ND91-8 at Parts Express.com</a>	\$27.98 US

### Tang Band and Dayton Audio Frequency Response Graphs

The Flow/1 can be built with a Dayton Audio 3½-inch LF Driver or a Tang Band 3-inch driver. These drivers' nominal range and output match the SB and AuraSound HF Drivers. The ND91 nominally provides around 5dB higher output in its passband than the Tang Band, so it is a better match for the Wavecor HF Driver. Here are the manufacturer's frequency response and distortion graphs for the LF Drivers.

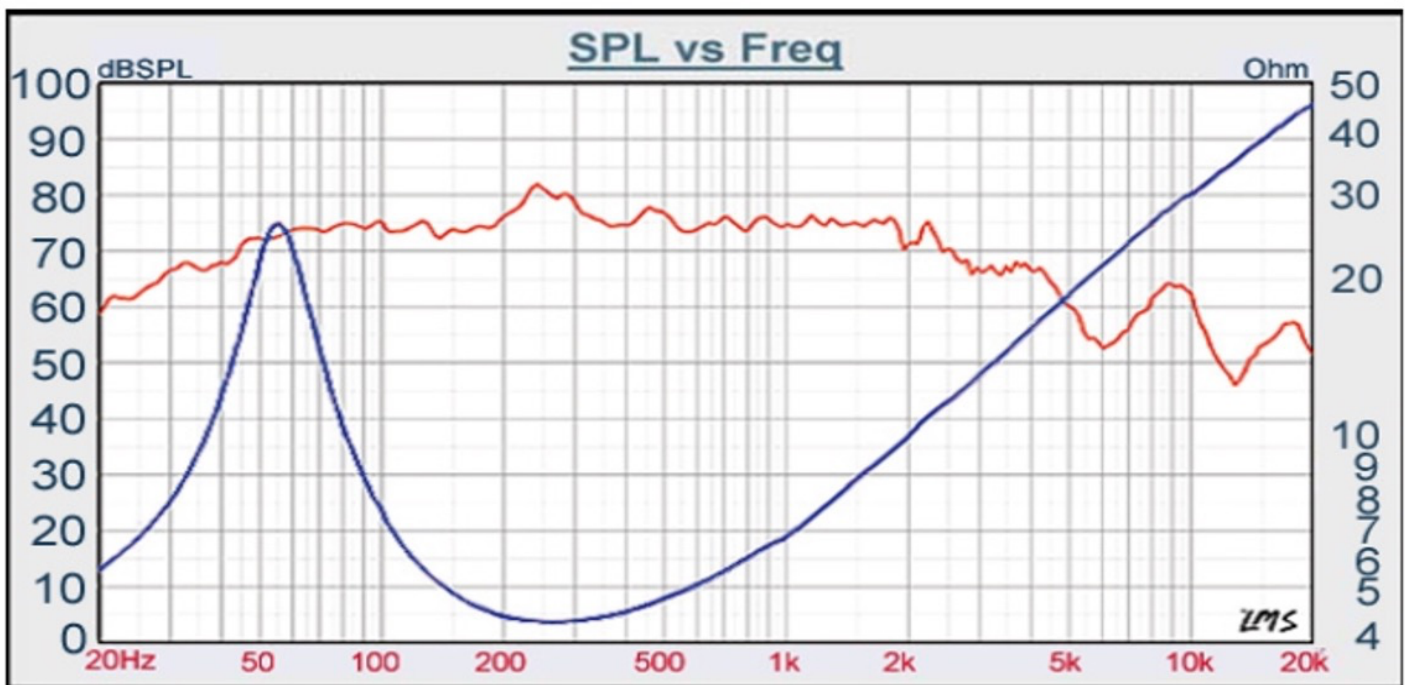
Figure 9 Dayton Audio ND91-8 Frequency Response Graph



Note: 1/24<sup>th</sup> octave smoothing - nearfield response included in graph below 450 Hz.

Black = 0°  
 Red = 15°  
 Green = 30°  
 Blue = 45°

Figure 10 Tang Band W3-1876S Frequency Response Graph



## Print the Parts

### Print The Parts

Now that you've selected the drivers it's time to select the parts you'll need to print.

All parts for making the Flow/1 speaker and stands can be downloaded from the [adhocspeakers.com](http://adhocspeakers.com) website as a zip file. The files are organized by purpose – Speakers, Speaker Stands, Electronics, etc. Subscribers will have lifetime access to these files, and all other resources, from the website, and will always have access to new designs. Figure 11 is an example of that organization, which is subject to change, after being unzipped:

*Figure 11 File Organization*

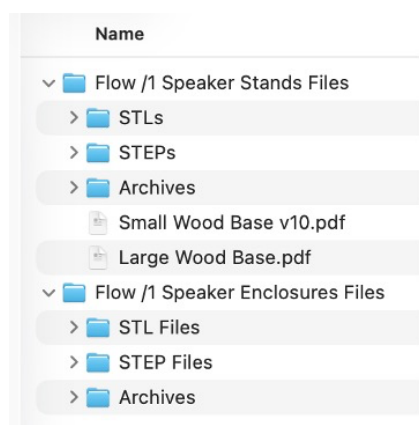


Table 3 is the current list of 3D files for the Flow/1 Enclosures. STL and STEP files are available, but only the STEP files are listed here, and the files required to build the Flow/1 with the Wavecor and Dayton Audio drivers have been highlighted in blue in the table below:

*Table 3 3D Files and Uses*

3D File	Used With
Wavecor Egg Front.step	All Wavecor HF Drivers
Wavecor Egg Rear.step	All Wavecor HF Drivers
Wavecor Holder.step	All Wavecor HF Drivers
Wavecor Arm Minus.step	All Wavecor HF Drivers
Wavecor Arm Plus.step	All Wavecor HF Drivers
ND91 DM.step	Dayton Audio ND91 LF Driver
ND91 DM Cover.step	Dayton Audio ND91 LF Driver
Flow/1 Vented Bezel.step	All Drivers
Flow/1 Tubes.step	All Drivers
Flow/1 Base.step	All Drivers
SB Egg Front.step	SB36WBAC21 HF Driver
AuraSound Egg Front.step	AuraSound NSW1-205 HF Driver
SB Holder.step	SB36WBAC21 HF Driver
SB+AuraSound Rear.step	SB and AuraSound HF Drivers
SB+AuraSound Arm Minus.step	SB and AuraSound HF Drivers
SB+AuraSound Arm Plus.step	SB and AuraSound HF Drivers
Tang Band DM.step	Tang Band TB 1876S LF Driver
Tang Band Cover.step	Tang Band TB 1876S LF Driver

## Flow/1 Maker's Reference Build Bill of Materials

This Maker's Guide describes several variations of the Flow/1, but the reference build that follows focuses on the Wavecor TW030WA26-8 Neo HF Driver paired with the Dayton Audio ND91-8 LF Driver. Table 4 lists the parts needed to build two Flow/1 speakers (one stereo pair) and estimated cost of this reference system.

*Table 4 Parts List to Build One Pair of Flow/1 Speakers*

Description	Type	Filename or Part#	Qty	Ext. Cost (USD est.)
HF Driver	Driver	Wavecor TW030WA26-8 Neo	2	\$64
LF Driver	Driver	Dayton Audio ND91-8	2	\$56
Wavecor Egg front	Printed Part	Wavecor Egg Front.step	2	\$9
Wavecor Egg rear	Printed Part	Wavecor Egg Rear.step	2	\$9
Wavecor holder	Printed Part	Wavecor Holder.step	2	\$1
Wavecor minus Arm	Printed Part	Wavecor Arm Minus.step	2	\$6
Wavecor plus Arm	Printed Part	Wavecor Arm Plus.step	2	\$6
ND91 DM	Printed Part	ND91 DM.step	2	\$15
ND91 DM cover	Printed Part	ND91 DM Cover.step	4	\$8 - \$15
Flow/1 Bezel	Printed Part	Flow/1 Vented Bezel.step	2	\$54
Flow/1 Tubes	Printed Part	Flow/1 Tubes.step	2	\$50 - \$500
Flow/1 base	Printed Part	Flow/1 Base.step	2	\$24 - \$64
Wavecor Egg screw	Hardware	M2 10mm, McMaster-Carr 90380A328	16	\$2
ND91 driver screw	Hardware	M4 20mm, McMaster-Carr 90380A382	8	\$1
Arm screw	Hardware	M3 20mm, McMaster-Carr 90380A356	8	\$1
DM screw	Hardware	M4 20mm, McMaster-Carr 90380A382	16	\$2
Banana jacks	Electrical	Shenzen 28.220	8	\$3
Banana plugs	Electrical	Meuller BU-00246-0	8	\$16
speakON connector	Electrical	Neutrik NL4FXX-W-S	2	\$11
Wire	Electrical	4-conductor 18gage twisted pair	4 m	\$12
Epoxy	Materials	Bonding enclosure parts	~20 gm	\$10
Cotton	Materials	Stuffing for Bezel	~11 gm	\$3
Fiberglass	Materials	Stuffing for Tube Section	~1.5 gm	\$1
Gasket	Materials	Foam gasket for DM to enclosure	~30 cm	\$1

The cost for a pair of Flow/1 speakers varies widely depending on whether you print the parts yourself and which materials and processes you choose, but a realistic range is about \$350 to \$800 per pair. What that investment yields is extraordinary: a unique, audiophile-grade active loudspeaker system of exceptional performance and value. The Flow/1 combines advanced acoustic design, modular construction, DSP-based optimization, and additive manufacturing into a loudspeaker unlike anything you can buy off the shelf anywhere near this price. More than that, you will have made it yourself—carefully, precisely, and with a direct hand in the final result.

## PIY (Print It Yourself)

Details about printing are beyond the scope of this document, but this section provides some suggestions for the type of print method used to print certain parts.

Table 5 lists the recommended material and 3D printing technology for the Flow/1 enclosure parts. A part material marked as 'recommended' means that I have had that part printed with that material and process. A part marked 'acceptable' is one that I have had printed with acceptable results, that is, not detrimental to the acoustic result but is less visually appealing. For example, layers are visible on surfaces using FDM printing, whereas they are smoother when printed using SLA. However, as in most cases with materials, the denser material printed with the process with the highest accuracy will generally yield the best results. In loudspeakers, the heavier, denser the enclosure is, the better the performance, as the enclosure is generally less prone to vibrations.

Table 5 Printed Parts Table

Part	Part Description	Image	Rec. Tech	Rec Mat'l	Notes	Vol, mm <sup>3</sup>	Est Mass (g)	Est Mass (g. Alt)	Est Cost	Est Cost Alt
SB and AuraSound Arm Minus	Egg-to-DM Minus side, Print this for SB or AuraSound		SLA	Std Resin	Recommend SLA for detailed features	14669	16.43	N/A	\$3.05	N/A
SB and AuraSound Arm Plus	Egg-to-DM Plus side, Print this for SB or AuraSound		SLA	Std Resin	Recommend SLA for detailed features	14668	16.43	N/A	\$3.05	N/A
Wavecor Arm Minus	Egg-to-DM Minus side, for Wavecor Print this for TW030WA26 or TW030WA03		SLA	Std Resin	Recommend SLA for detailed features	15445	18.10	N/A	\$3.07	N/A
Wavecor Arm Plus	Egg-to-DM Plus side, for Wavecor Print this for TW030WA26 or TW030WA03		SLA	Std Resin	Recommend SLA for detailed features	15456	18.10	N/A	\$3.07	N/A
Egg Front for SB Driver	Front piece for SB36WBAC21.		SLA	Std Resin	Recommend SLA for detailed features	16315	18.27	N/A	\$1.55	N/A

Part	Part Description	Image	Rec. Tech	Rec Mat'l	Notes	Vol, mm <sup>3</sup>	Est Mass (g)	Est Mass (g, Alt)	Est Cost	Est Cost Alt
Egg Front for AuraSound HF Driver	Front piece for the AuraSound NSW1-205 HF Driver		SLA	Std Resin	Recommend SLA for detailed features	16315	18.27	N/A	\$1.55	N/A
SB Audience Mounting bracket	Bracket to secure SB Audience SB36WBAC21-8 HF Driver		FDM	ABS, PETG, PLA	FDM printing ok.	2094	2.18	N/A	\$0.06	N/A
Egg Rear for AuraSound and SB HF Drivers	Rear piece for Egg front pieces. Print one of these for SB Audience and AuraSound HF Drivers		SLA	Std Resin	Recommend SLA for detailed features	19537	21.88	N/A	\$1.23	N/A
Egg Front for Wavecor HF Drivers	Front piece for Wavecor TW030WA26 and TW030WA03 HF Drivers		SLA	Std Resin	Recommend SLA for detailed features	19131	22.41	N/A	\$4.30	N/A
Egg Rear for Wavecor HF Drivers	Rear piece for Wavecor TW030WA26 and TW030WA03 HF Drivers		SLA	Std Resin	Recommend SLA for detailed features	19383	27.70	N/A	\$4.15	N/A
Holder for Both Wavecor HF Drivers	Universal bracket to secure Wavecor TW030WA26 and TW030WA03		SLA	Std Resin	Recommend SLA for detailed features	3066	3.60	N/A	\$0.35	N/A
Driver Mount (DM) for Tang Band LF Driver	Component to attach Tang Band W3-1876S-4 LF Driver and Arms to Bezel		SLA	Std Resin	Recommend SLA for detailed features	191400	216.28	N/A	\$11.00	N/A

Part	Part Description	Image	Rec. Tech	Rec Mat'l	Notes	Vol, mm <sup>3</sup>	Est Mass (g)	Est Mass (g, Alt)	Est Cost	Est Cost Alt
Driver Mount (DM) for Dayton Audio LF Driver	Component to attach Dayton Audio ND91-8 LF Driver and Arms to Bezel		SLA	Std Resin	Recommend SLA for detailed features	178000	201.14	N/A	\$11.00	N/A
DM Cover half-Tang Band	DM Cover half-piece, for Tang Band W3-1876S, two per speaker, four per speaker pair		FDM, MJF	MJF or FDM TPU	Should be flexible for snug fit but be removable; Medium Shore (A81-A90)	20293	24.55	22.32	\$2.21	\$4.46
DM Cover half-Dayton Audio	DM Cover for Dayton Audio ND91 LF Driver-two per speaker, four per speaker pair		FDM, MJF	MJF or FDM TPU	Should be flexible for snug fit but be removable, medium Shore (A81-A90)	20425	24.71	22.47	\$2.22	\$4.49
Bezel	Enclosure section attaches the DM to Tube section		SLA	Std Resin	Recommend SLA for detailed features	428827	480.29	N/A	\$27	N/A
Tube section	Enclosure section containing the tube segments		SLA, FDM	Standard Resin or ABS	See discussion about Tube section below	2991000	3379.83	845	\$244	\$23.66 Note 1
Base	Enclosure section attaches to the base of the Tube section, forming the base of the speaker		SLA, FDM	Standard Resin or ABS, PETG	FDM Printing OK	40890	479	433	\$32	\$12

Note 1: Estimated raw filament cost for 20% infill

The mass figures in the Printed Parts Table, are calculated at 100% infill volume. For estimating the filament costs for FDM printing at 20% for example, the mass (and thus the amount of filament needed) is somewhat less, depending on shell volume and core volume. For example, the largest part—the Tube Section—if printed in ABS, has a mass of 3,110g, would result in a mass of approximately 845g, if printed at 20% infill.

Assuming the values (Tube Section, ABS) shown in “Table 5 Printed Parts Table”, this next table, Table 6, estimates mass of the Tube Section if they are FDM printed in ABS with 20% infill:

*Table 6 Tube Section Mass Estimate for ABS with 20% Infill*

Property	Value
Solid (100%) volume	2,992,401 mm <sup>3</sup>
Solid mass	3,110.64 g
Estimated shell volume	~268,440 mm <sup>3</sup>
Core volume	~2,723,961 mm <sup>3</sup>
20% infill core	~544,792 mm <sup>3</sup>
Total 20% volume	~813,232 mm <sup>3</sup>
Estimated 20% mass	≈ 845 g

Thus, a Tube Section FDM printed in ABS with 20% infill is substantially less massive than STL printed in resin with 100% infill.

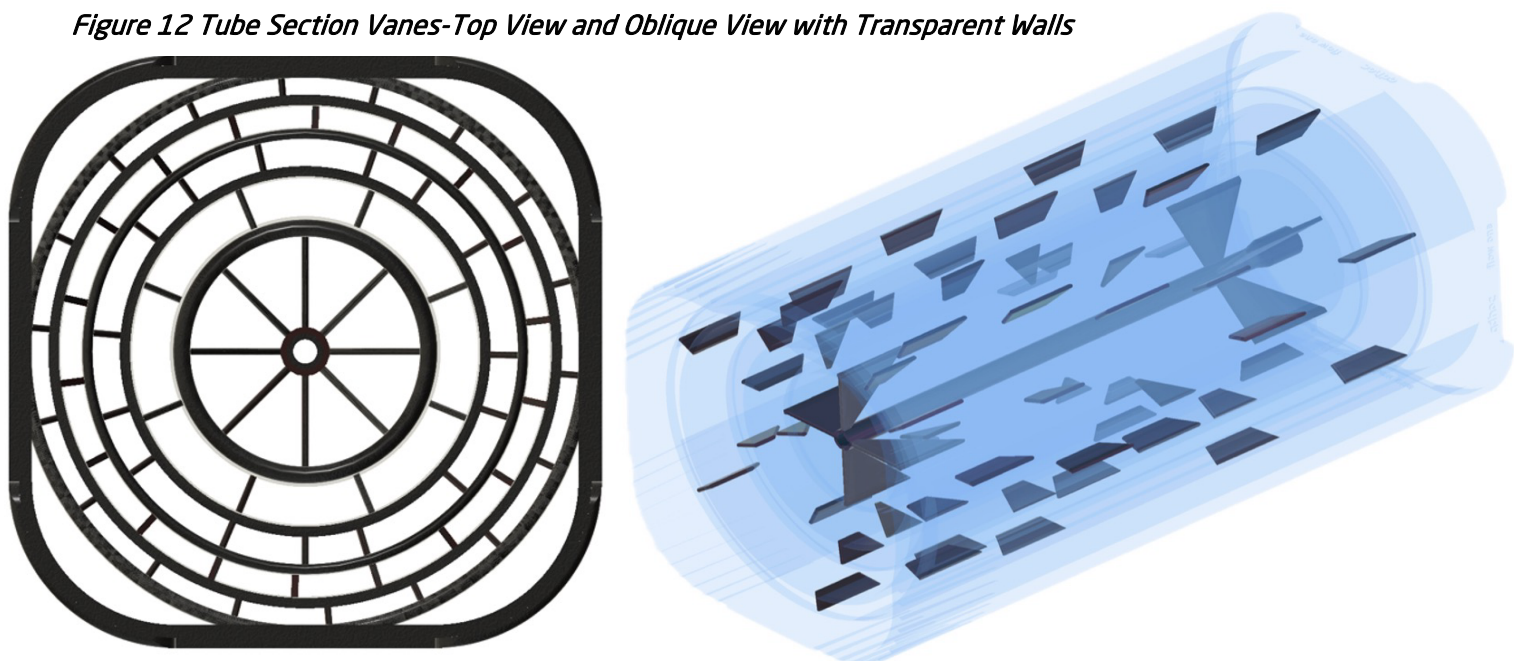
## Tube Section

The largest and most complex body in the Flow/1 is the Tube Section. This body can be printed by FDM or by SLA. SLA-printed parts in general have higher detail, with better visual results and are more dense-which is advantageous as a loudspeaker enclosure. They also fit together better, providing tighter registration at the joints for better bonding, in this case, the Tube Section to the Bezel and the base. Since SLA parts are printed with 100% infill, they are denser than parts printed at less than 100% infill. For the Tube Section, SLA printing provides a more dense, rigid structure, less flexing and acoustic modes, which is essential for loudspeaker enclosures.

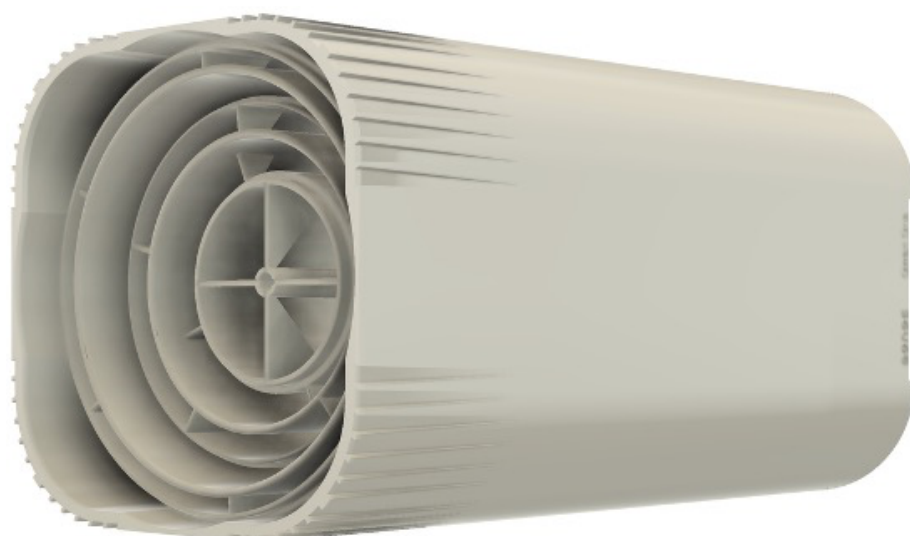
The tube body is large: 344 mm x 172 mm x 172mm; your printer's Z-axis must have a height capacity sufficient to print this part. An option is available that splits this body into two parts, each with 172 mm extent in the Z-direction (height), to support smaller printers. The internal vanes supporting the inner Tube Section are designed for additive manufacturing, or DFAM, allowing for base-down printing without the need for scaffolding.

Here are some images of the Tube Section and vanes, distributed irregularly within the Tube Section.

*Figure 12 Tube Section Vanes-Top View and Oblique View with Transparent Walls*



*Figure 13 Tube Section, Oblique View*



## Bezel

The Bezel, shown in Figure 14 serves as the LF Driver rear chamber, tube segment top folds, and receptacle for the DM. Because of the tight tolerances needed for the holes and the complex Bezel vents, it is recommended that it be SLA-printed in resin. I have no personal experience 3D printing this part FDM, but it is technically feasible and may produce acceptable results providing the 3D printer nozzle size and layer height settings are set for maximum accuracy.

*Figure 14 Bezel*



## Base

The base, shown in Figure 15, provides the folds for the segment ends and seals the bottom of the loudspeaker enclosure, can be printed in via SLA or FDM since its tolerances are less stringent and the part is mostly unseen. I have had the base FDM printed in PETG with very good results.

*Figure 15 Base*



The Bezel, Tube Section and Base can all be FDM-printed, but I strongly recommend printing the Bezel in resin. I have versions of the Flow/1 whose Tube Section is FDM-printed and they provide excellent acoustic results, albeit being much lighter in weight than their resin-printed counterparts.

### Printed Parts Acquired from a Printing Service

If you don't have your own printer, no problem! You can have your parts printed by a printing service. Use your favorite 3D printing service; just upload the 3D files and select the appropriate material, color and finish. Here's a description of CraftCloud3D and JLC3DP.

### Craftcloud3D (Craftcloud3D.com)

Craftcloud3D is a global on-demand manufacturing marketplace. Instead of owning printers itself, Craftcloud3D connects you with a large network of professional 3D-printing partners around the world. You upload your STL or STEP files, select the technology and material you want (FDM, SLA, SLS, MJF, resin, metals, nylons, and more), and Craftcloud presents real-time quotes from multiple vendors. You then choose who prints your parts.

Because production is performed by third-party printing companies, Craftcloud3D acts as the broker and logistics layer: they handle the payment process, order tracking, and customer support, while the selected manufacturing partner prints and ships your part. This structure gives you huge flexibility in terms of materials, finishes, lead times, and price points. It's particularly useful for Makers who need access to technologies like SLS/MJF nylon or metal printing without purchasing an entire service bureau run.

For enclosure designers and DIY audio builders, Craftcloud is excellent when you want access to multiple materials, global vendors, or uncommon print technologies, or when you need to compare prices across several suppliers. However, because quality control varies by vendor, Makers should treat each partner as unique and check reviews or order a small test part before committing to a full enclosure.

Here are example prints I have had made by CraftCloud3D:

Figure 16 is a receipt for a print of two Tube Sections and Bases, FDM-printed in PETG from a printer in Croatia. Notice the shipping cost and time to delivery to Thailand took about 30 days and was expensive-\$85USD. The print turned out quite well but the packaging was inadequate, requiring I rebuild the corners, something you should be aware of. Be sure to communicate with the printer how you want your parts handled. CraftCloud3D does a great job managing your communications with their printers.

Figure 16 FDM PETG Prints from Croatia-CraftCloud3D






Received (May 2, 2025) <a href="#">Track package</a>		By 3D4U from Croatia	<a href="#">See messages</a>
Est. delivery date: Mar. 31 - Apr. 22		<a href="#">Download invoice</a>	<a href="#">Show review</a>
	<b>2x 6 fold 4 piece rectangle no PR v58 tube section.step</b> <a href="#">↓</a> 340.91 × 172.02 × 172.02 mm Production details "This is a fairly complex part; there are fillets, bevels and curves that ... " <a href="#">show</a>	Material — PETG (FDM) Finish — Standard Color — Black	<b>\$267.32</b> <i>Economy</i>
	<b>2x 6 fold 4 piece rectangle no PR v59 base.step</b> <a href="#">↓</a> 52.56 × 165.82 × 165.82 mm Production details "This part fits into the tube section part. I left 0.1mm tolerance betwe... " <a href="#">show</a>	Material — PETG (FDM) Finish — Standard Color — Black	<b>\$35.92</b> <i>Economy</i>
Shipping <b>7-20 business days</b>			<b>\$85.68</b>
Production time: <b>4-7 business days</b>			<b>Total: \$388.92</b>

Figure 17 is a receipt for a print of a single Tube Section and Base, SLA-printed in tough resin, from a printer in China. This job cost much more, but shipping from China to Thailand was much quicker and less expensive. The quality of this print (and everything from this printer) was excellent.

*Figure 17 SLA Resin Prints from China-CraftCloud3D*

<b>Received</b> (July 10, 2025) Est. delivery date: Jul. 4 - 10		By <b>ProtoTi</b> from China <a href="#">Download invoice</a>	<a href="#">See messages</a>
	<b>1x 6 fold 4 piece rectangle no PR v136 bezel and vents.step</b> <a href="#">↓</a> 77.53 × 171.26 × 171.26 mm	Material — Tough Resin (SLA) Finish — Standard Color — Natural Off-White	<b>\$62.47</b> <i>Economy</i>
Shipping <b>2-4 business days</b>			<b>\$6.50</b>
Production time: <b>4-6 business days</b>			<b>Total: \$68.97</b>
<b>Received</b> (July 3, 2025) <a href="#">Track package</a> Est. delivery date: Jul. 3 - 9		By <b>3DPnxt</b> from China <a href="#">Download invoice</a>	<a href="#">See messages</a>
	<b>1x 6 fold 4 piece rectangle no PR v136 tubes with vents.step</b> <a href="#">↓</a> 343.91 × 172.03 × 172.03 mm	Material — Tough Resin (SLA) Finish — Standard Color — Natural Off-White	<b>\$362.75</b> <i>Economy</i>
	<b>1x 6 fold 4 piece rectangle no PR v136 base.step</b> <a href="#">↓</a> 55.56 × 165.82 × 165.82 mm	Material — Tough Resin (SLA) Finish — Standard Color — Natural Off-White	<b>\$57.71</b> <i>Economy</i>
Shipping <b>1-3 business days</b> <i>Express</i>			<b>\$24.38</b>
Production time: <b>4-6 business days</b>			<b>Total: \$444.84</b>

## JLC3DP (jlc3dp.com)









JLC3DP is a dedicated, in-house 3D-printing and manufacturing service, meaning all production is performed on JLC's own equipment in their own facilities. Unlike marketplace models, JLC3DP controls the full workflow – from slicing and print preparation to printing, finishing, and shipping. Because the process is centralized, they maintain consistent print quality, predictable tolerances, and reliable turnaround times as long as your 3D files meet their published requirements.

JLC3DP supports a wide range of materials and technologies – including FDM, SLA, SLS, and MJF – with clear specifications and generally tight tolerances. Their pricing is often competitive, especially for functional parts, and they offer fast production times thanks to a large internal printer fleet.

For DIY loudspeaker builders, enclosure designers, and electronics hobbyists, JLC3DP is ideal when you want repeatable quality, tight dimensional accuracy, and less variation from job to job. If you have a design where fit, alignment, or acoustic geometry must be precise, an in-house service like JLC3DP reduces risk since the entire job is quality-controlled by JLC3DP from order to delivery.

Here are some example prints I have had made by JLC3DP.

**Figure 18 SLA Resin Prints from JLC3DP**

	3D Printing Order #: D2025110501500102-859... Build Time:3 days <a href="#">Product Details</a>	\$2.41 8pcs	Holder-Universal Wavector.step ● Production Progress	<a href="#">Quality Complaint</a>
	3D Printing Order #: D2025110558500235-85... Build Time:3 days <a href="#">Product Details</a>	\$28.03 2pcs	ND91 DM v266.step ● Production Progress	<a href="#">Quality Complaint</a>
	3D Printing Order #: D2025110506500084-85... Build Time:3 days <a href="#">Product Details</a>	\$32.20 1pcs	Base v196.step ● Production Progress	<a href="#">Quality Complaint</a>
	3D Printing Order #: D2025110516500023-85... Build Time:3 days <a href="#">Product Details</a>	\$33.76 1pcs	Grill and Bezel v196.stl ● Production Progress	<a href="#">Quality Complaint</a>
	3D Printing Order #: D2025110526500110-859... Build Time:4 days <a href="#">Product Details</a>	\$244.98 1pcs	Tubes and Vanes Merged v266.step ● Production Progress	<a href="#">Quality Complaint</a>
	3D Printing Order #: D2025110600500130-85... Build Time:3 days <a href="#">Product Details</a>	\$1.20 4pcs	SB36WBAC21 Holder.step ● Production Progress	<a href="#">Quality Complaint</a>
	3D Printing Order #: D2025110600500136-85... Build Time:4 days <a href="#">Product Details</a>	\$7.17 2pcs	SB36WBAC21 Front No Grill.step ● Production Progress	<a href="#">Quality Complaint</a>
	3D Printing Order #: D2025110600500143-85... Build Time:4 days <a href="#">Product Details</a>	\$8.17 2pcs	AuraSBEGgGrillFrontMerged.step ● Production Progress	<a href="#">Quality Complaint</a>

JLC3DP provides excellent feedback and communication prior to production. Some of the parts I've had printed there violate their minimum feature dimensions, but I approved the prints, assuming all risks of defects. All of their prints met or exceeded my expectations.

I have had many parts printed by both CraftCloud3D and JLC3DP, and found that JLC3DP provides a more predictable end-product, but you may get a better deal from CraftCloud3D depending on where in the world you are.

There is another, emerging 3D printing service that I will be testing out for future prints, called Slant (Slant3d.com). This service is unique, in that pre-set prints of Flow/1 parts for subscribers that can be purchased and delivered directly to you. Watch this space for updates.

## Build the Speaker

### Build The Speaker

This is the longest and most hands-on stage of your Maker journey. Here you'll assemble every component into your Flow/1 loudspeaker. Experienced DIY/PIY builders already have their own workflow and should follow their familiar methodologies. If you're newer to this, follow these steps closely and you'll achieve a professional-quality result.

You've selected your drivers and ordered or printed your parts—now it's time to gather all printed components, the hardware listed below, and the tools you'll need to assemble the Egg, Arms, driver module, Bezel—Tube Section—Base assembly, and the wiring (with optional connectors).

Confirm that you have every required part. Inspect your printed pieces to ensure the fit and finish meet your expectations. Light sanding, filling, or edge cleanup may be helpful. If you plan to paint your parts, test-fit them first without gluing them before painting.

Some of these steps can be done in advance at your discretion. For example, prepping the wires and banana jacks ahead of time, or they can be done JIT (just in time) for when they are needed for assembly. It's up to you! The procedure is written for JIT assembly.

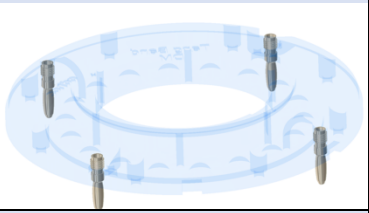
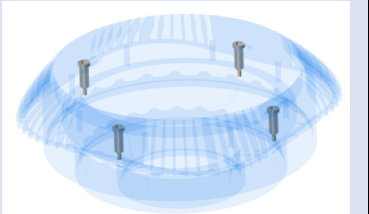
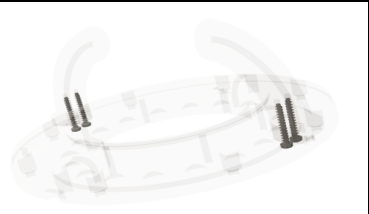

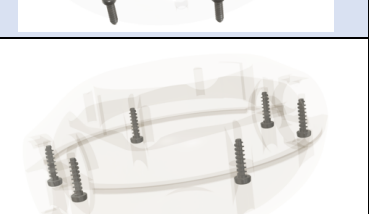
The recommended sequence is

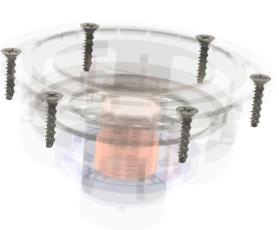
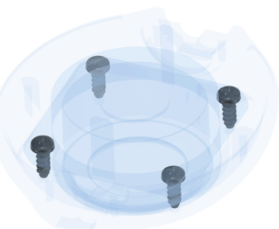
- Assemble the enclosure—bond the Bezel, Tube Section, Base together
- Cut and install wires into the Tube Section and solder to banana jacks
- Assemble the Egg and Arms with your chosen HF Driver
- Assemble the DM with your chosen LF Driver
- Assemble the Egg/Arm assembly to the DM
- Final Assembly: Attach the Egg/Arm/DM to the enclosure and attach the DM covers

This is the point where the design becomes a real loudspeaker: the printed parts, drivers, hardware, and wiring come together into a finished Flow/1 ready to be measured, tuned, and heard.

Table 7 is the complete list of the extra hardware you need to make your Flow/1.

Table 7 Hardware List

Part	Part Description	Qty.	Image / Note	Mfg	Mfg Part No.	Distributor	Distributor's Part No.	Est Price	Link to Distributor Part
Banana plug	Banana plug in DM to insert into Banana jack in Bezel	4		Meuller	BU-00246-0	DigiKey	314-1058-ND	\$1.94	<a href="#">Banana Plug at DigiKey</a>
Banana jack	Banana jack in Bezel to receive DM banana plug	4		Shenzen LCSC Electronics Tech	28.220	LCSC	C19268098	\$0.28	<a href="#">Banana Jack at LCSC Electronics</a>
Screw-Arm to DM	M3 20mm Phillips rounded head thread-forming For attaching Arms to DM	4		McMaster-Carr	90380A356	McMaster-Carr	90380A356	\$9.59 /100	<a href="#">Arm to DM Screw at McMaster-Carr</a>
Screw-ND91 and DM to Bezel	M4 20mm Phillips rounded head thread-forming For attaching DM to Bezel and ND91 to DM	12		McMaster-Carr	90380A382	McMaster-Carr	90380A382	\$5.79 /50	<a href="#">ND91 and DM to Bezel Screw at McMaster-Carr</a>
Screw-SB and Aura Egg fronts to rear	M2 8mm Phillips rounded head thread-forming For attaching Egg front to rear	6		McMaster-Carr	90380A327	McMaster-Carr	90380A327	\$9.42 /100	<a href="#">SB and Aura Egg Screws at McMaster-Carr</a>

Part	Part Description	Qty.	Image / Note	Mfg	Mfg Part No.	Distributor	Distributor's Part No.	Est Price	Link to Distributor Part
Screw, Wavecor Egg enclosure	M2 10mm Phillips rounded head thread-forming Screw For attaching Egg Front and Rear for Wavecor	8		McMaster-Carr	90380A328	McMaster-Carr	90380A328	\$5.00 /50	<a href="#">Wavecor Egg Screw at McMaster-Carr</a>
Screw-Tang Band Driver to DM	#6 3/4" Flat head thread-forming For attaching Tang Band to DM	6		McMaster-Carr	96068A159	McMaster-Carr	96068A159	\$10.98 /100	<a href="#">Tang Band Screws at McMaster-Carr</a>
Screw-SB and Aura Attachment	M3 8mm Phillips rounded head thread-forming For attaching AuraSound NSW1-205 and SB Audience SB36WBAC1 bracket to Egg front	4		McMaster-Carr	90380A349	McMaster-Carr	90380A349	\$8.38 /100	<a href="#">HF Driver Mount Screws at McMaster-Carr</a>
Cable Connector- Neutrik speakON	Connector for speaker cable	1+		Neutrik	NL4FXX-W-S	Parts Express	568-NL4FXX-W-S	\$5.63	<a href="#">Neutrik speakON Connector at Parts Express</a>

Part	Part Description	Qty.	Image / Note	Mfg	Mfg Part No.	Distributor	Distributor's Part No.	Est Price	Link to Distributor Part
Connector, panel mount, Neutrik speakON	Connector for panel mounting	1+		Neutrik	NL4MPXX	Mouser Electronics	568-NL4MPXX	\$4.14	<a href="#">Neutrik Panel Mount Connector at Parts Express</a>
Coupler, Neutrik speakON	IN-line Coupler connects Neutrik connectors together (to extend a cable)	1+		Neutrik	NL4MMX	Mouser Electronics	568-NL4MMX	\$7.84	<a href="#">Neutrik Inline Coupler at Mouser Electronics</a>
Wire	Speaker wire, 4-conductor 1mm twisted pair	2m		Various	LIYCY 2x2x1.0			~\$3.00 /meter	<a href="#">1mm 4 conductor wire at Lazada</a>
Adhesives	Superglue, Long-cure epoxy, contact adhesive		Strong, long-cure (60 min) epoxy for maximum work time, contact adhesive for sealing wires						
Gaskets	Self-adhesive or custom-cut		1mm - 2mm x 5mm self-adhesive gasket for LF Driver and DM-to-Bezel fitment						
Grease	Vaseline or synthetic grease		For greasing Egg-arm and speaker stand swivel joints for smooth movement						

## Tools and Parts

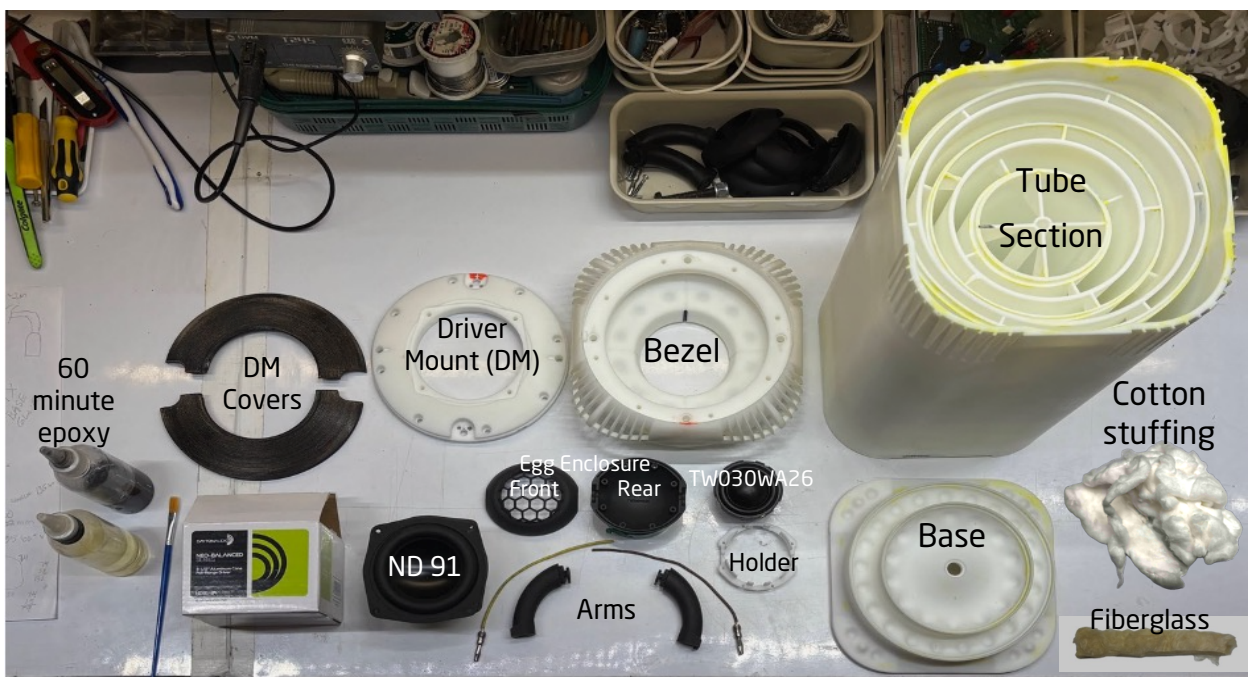
Here is the basic set of tools needed to make a Flow/1 Enclosure:

- Phillips Screwdrivers: PH2, PH1, and PH0 - an adjustable torque screwdriver is recommended,
- Soldering Iron (temperature-controlled highly recommended), solder, solder paste
- Wire cutters,
- Long cure (60 min) epoxy or polyurethane glue, superglue, rubber cement, brushes,
- Rail clamps (2 x 50cm and 2x 30cm),
- Gasket material or self-adhesive gasket strips.

*Figure 19 Tools Needed for Assembly*



*Figure 20 Parts Needed for Assembly*



## General Assembly Notes

I strongly recommend using a temperature-controlled solder station! You will need a PH0 Phillips head driver for the small Egg screws, a PH1 for the Arm-DM screws, and a PH2 for all other screws. A torque screwdriver is highly recommended. Alternatively, a drill with an adjustable clutch is acceptable. Torque and clutch settings are specified where appropriate.

Cotton or fiberglass stuffing is used in the driver chamber and to partially fill the first segment. Only a very small amount is used, and it can be either fiberglass, cotton or a combination.


Use clamps when bonding enclosure parts to secure parts together while the adhesives are curing.

Pre tap each screw hole using an appropriate screw. All screw holes have been sized precisely for the specified plastic-self-threading screws, and each hole is beveled for easier screw insertion. I use an electric torque screwdriver, an electric drill with adjustable clutch, and small PH0 screwdrivers for the Egg screws. Table 8 lists the holes, and the screws to use to tap them prior to assembly:

**Table 8 Screw Torque Values**

Hole	Screw	Bit Size	Torque N·m / in·lb / Clutch#
SB & AuraSound Egg	M2 8mm, 90380A327	PH0	By hand with small screwdriver
AuraSound Mount	M3 8mm, 90380A349	PH1	0.9 / 8 / #3
Wavecor Egg	M2 10mm, 90380A328	PH0	By hand using small screwdriver
Arms to DM	M3 20mm, 90380A356	PH1	0.9 / 8 / #3
Tang Band 1876S	#6 ¾" Flat head	PH2	0.9 / 8 / #3
Dayton Audio ND91	M4 20mm 90380A382	PH2	1.3 / 12 / #4
DM to Bezel	M4 20mm 90380A382	PH2	1.3 / 12 / #4

## Assemble The Enclosure

Follow the steps below to assemble the enclosure, which is made with a Bezel, Tube Section, and base. Each picture has a place for you to put a checkmark,   to help ensure you've read and performed that step. Print out these pictures and enter a checkmark in the box on the picture after you've performed each step. When the entire step is complete, check the box in front of the Step to indicate that entire step is done.

It is essential that the printed parts have been carefully cleaned, de-burred and inspected. I recommend that you pre-assemble the enclosure without gluing to ensure the parts fit together well. It is most likely you'll need to sand or file some parts to fit properly as they are engineered with the tightest tolerances practical, and, depending on which printing technology you use, this can result in parts that don't fit and need sanding or filing to get them to fit properly. You will also get a sense of what the enclosure looks like, and you might decide to paint it before gluing the parts together. Let's get started!



### Step 1: Bonding the Enclosure Parts

It is crucial to have solid bonds to ensure that the enclosure operates as a single, solid component, so we'll spend a lot of time on this step to be sure it's right. We do not want air gaps or unbonded parts contacting each other because it might result in buzzing, which we want to avoid at all costs!

I used a 60-minute-cure epoxy adhesive to ensure there is enough time to position the parts and clamp them together before the epoxy sets up. But any long-cure adhesive with sufficient working time and is solid and rigid when cured can be used.

Gather the clean, inspected Bezel, Tube Section and base parts of the enclosure that will be bonded together

Print this section out so you can place a checkmark in the checkbox after performing each step. Have space and clamps and parts ready to be assembled.

I recommend the steps for bonding the enclosure parts be performed in this order:

- Prepare at least 10 grams of epoxy or adhesive, which is sufficient to bond the Bezel, Tube Section and Base together.
- Apply epoxy/adhesive, first to the Bezel and tube top, mark a check in the checkbox after performing each step—about 5 minutes; set Bezel aside
- Apply epoxy/adhesive to the tube bottom and the base; mark a check in the checkbox after performing each step—about 5 minutes
- Align the parts, join, clamp, and wait for them to fully cure-about 24 hours—before proceeding.

Let's get started!

a. Preparing and Applying Adhesive/Epoxy

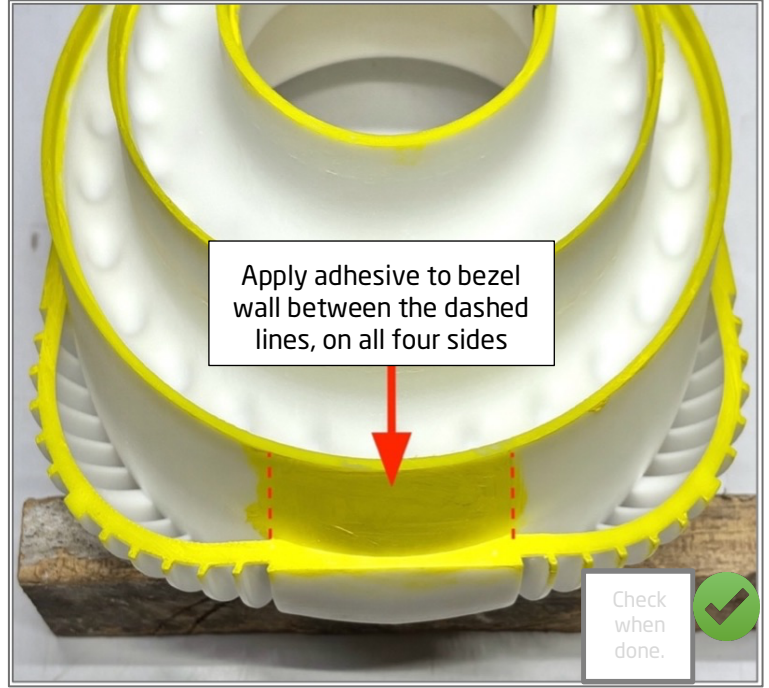
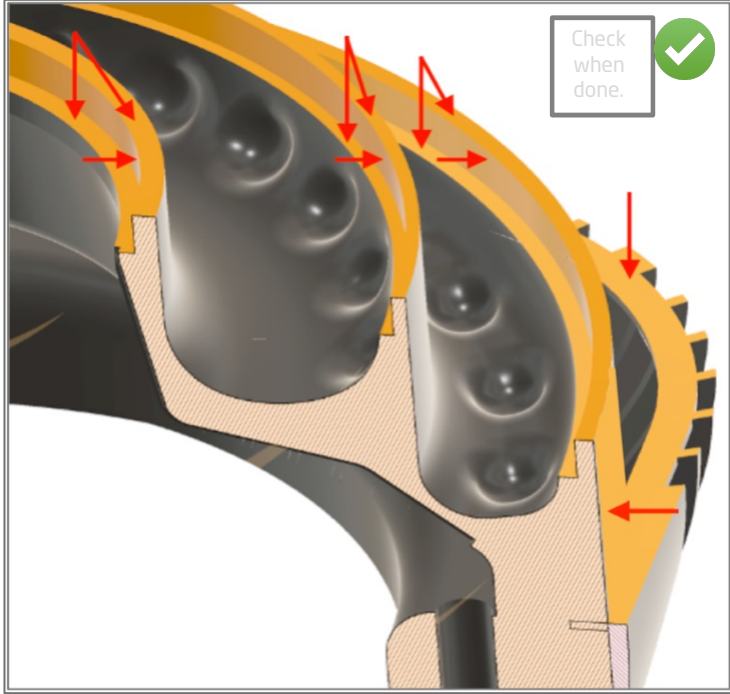
Refer to Figure 21. Carefully apportion, weigh and mix about 8-10 grams of epoxy or other slow-cure adhesive. If you are using epoxy, be sure to mix the epoxy according to instructions to ensure it will cure properly. I use a 1:1, 60 minute epoxy to give me plenty of time to carefully apply, assemble, and clamp the enclosure parts together.

*Figure 21 Preparing Epoxy*



- Bond the Bezel and Tube Section. Using a small brush, apply the epoxy/adhesive to the areas where the Bezel and the Tube Section make contact with each other using a small, stiff brush or other applicator.
- Apply a thin, even coat onto all surfaces before fitting them together. Figure 22 shows the areas to apply adhesive in yellow and orange; they are all the flat surfaces where the two bodies meet. It is important that there be a smooth coating of adhesive on every surface where the two bodies meet to ensure a solid, air-tight seal.

Figure 22 Bezel to Tube Bonding Adhesive Areas...



- d. Apply adhesive to the area on the inside four walls inside the tube top where the Bezel fits in, and to the flat tops of the tube segments as shown in Figure 24 and Figure 23:

Figure 23 Bezel to Tube Adhesive Areas (continued)

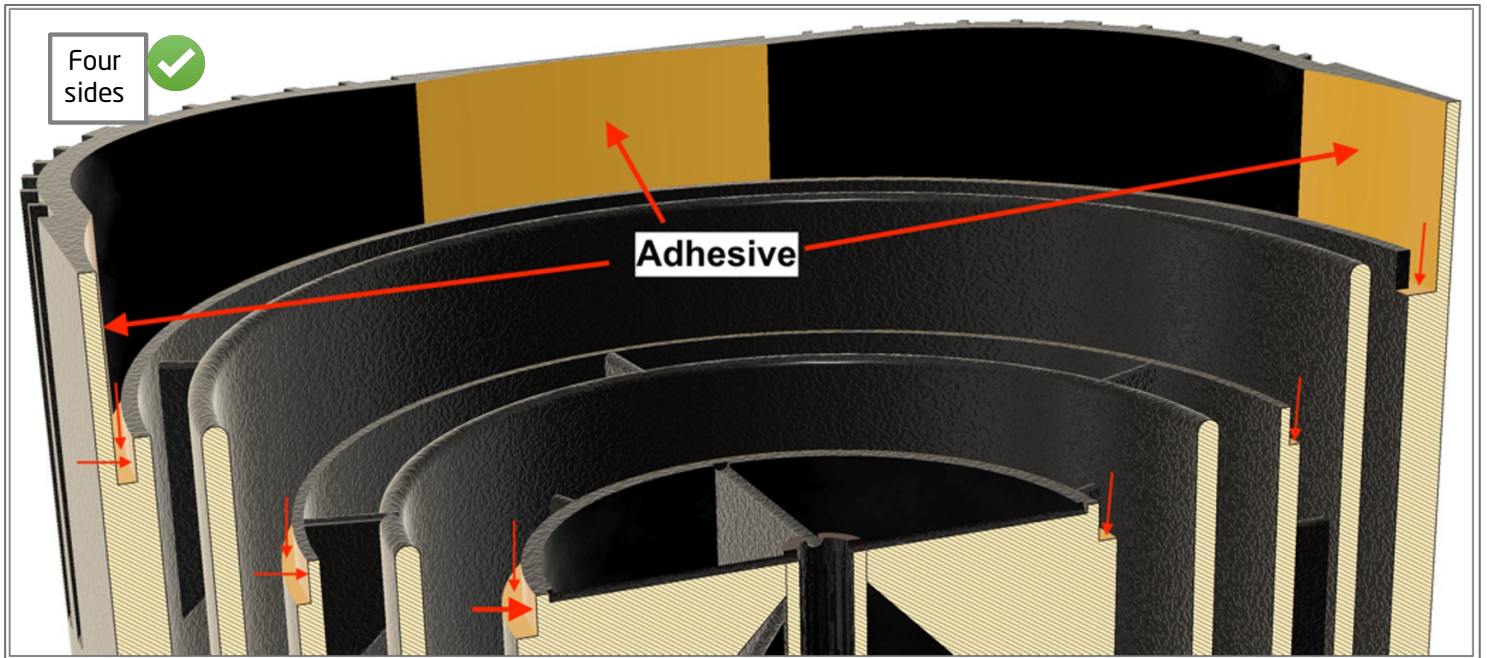
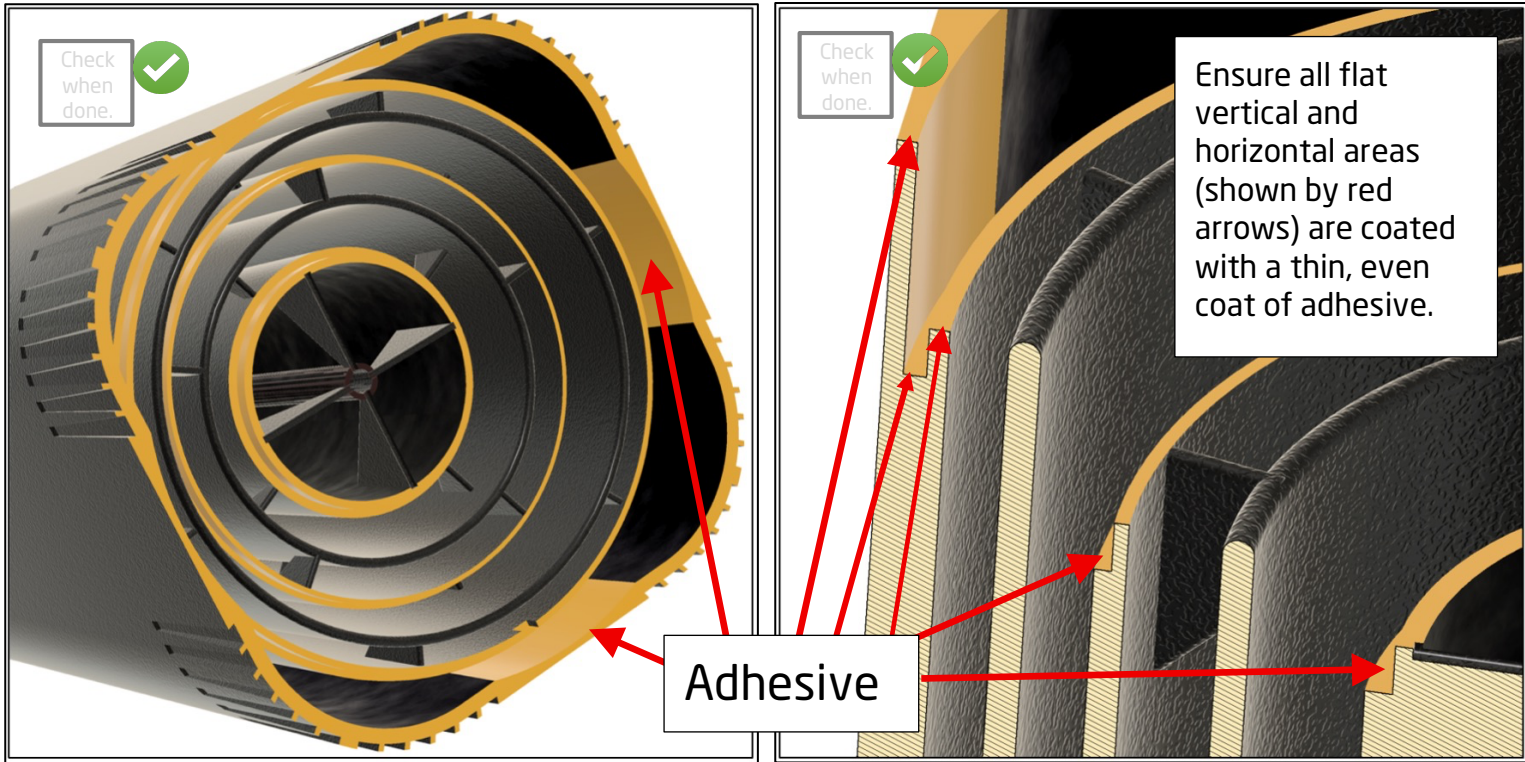


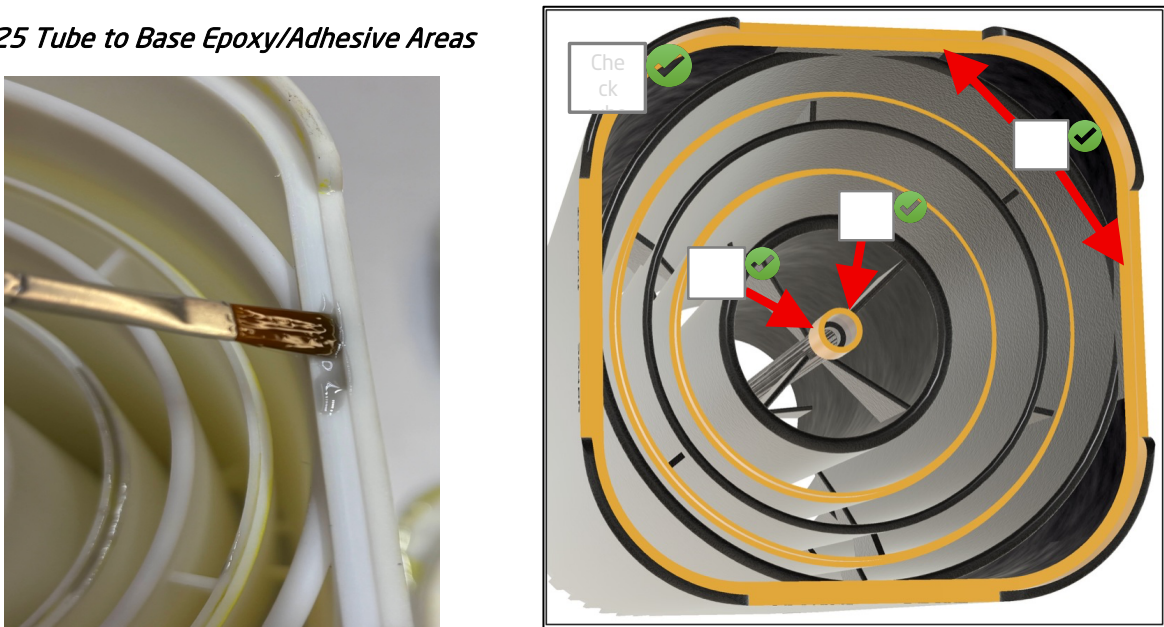
Figure 24 Bezel to Tube Adhesive Areas (continued)



The Bezel and tube top adhesive areas are ready for the bodies to be attached. Set the Bezel aside; we will quickly prepare the other end of the Tube Section and the base for joining. This should take about five minutes.

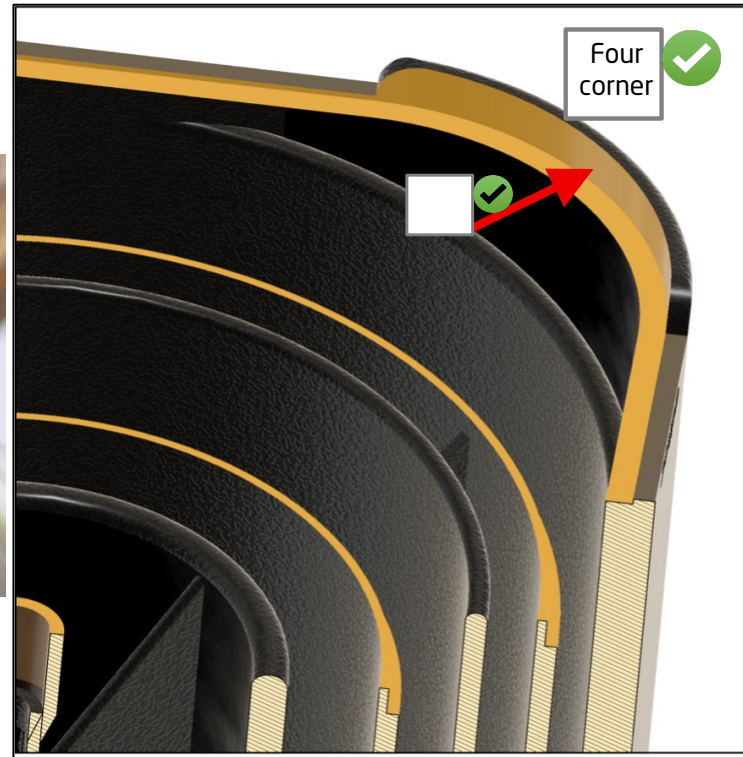
- e. Bond the base to the Tube Section. We will now apply epoxy/adhesive to first to the bottom of the tube and then to the base. Position the tube base to have access to the surfaces to be bonded.
- f. Apply a thin, even coat of adhesive on the inside lip of the tube bottom, and the outside of the central wire tube as shown by the arrows in Figure 25.

Figure 25 Tube to Base Epoxy/Adhesive Areas



- g. Apply a 5 mm band of adhesive on the inside four rounded corners of the base, as shown by the arrows in Figure 26.

*Figure 26 Tube Base Corner Bonding*



- h. Now apply epoxy/adhesive to the base. Apply epoxy/adhesive to the inside center hole in the base, including the flat area as shown by the arrow in Figure 27.

*Figure 27 Base Center Hole Bonding*



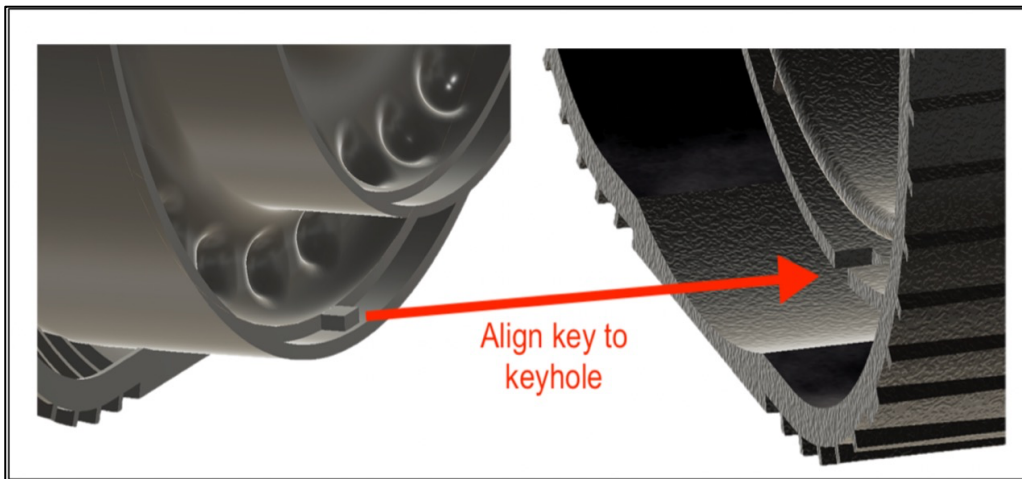
Application of epoxy/adhesive is complete. Ensure all areas with epoxy/adhesive are smooth, evenly spread out and uncured, the next step we'll be aligning the Bezel, Tube Section and base for assembly and clamping.

Check  
when  
done.

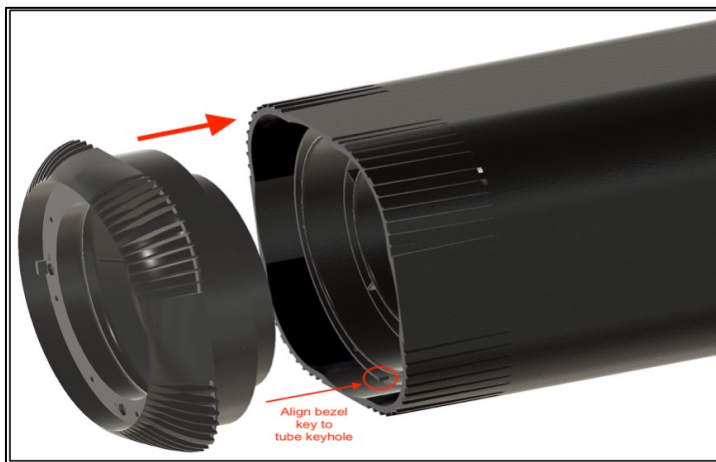
## Step 2: Assemble The Enclosure Parts

This step should be done swiftly to ensure the parts are carefully positioned before the adhesive begins to cure. You have already ensured that the epoxy/adhesive is still uncured and the parts are ready to be assembled together. You have clamps ready and space on the workbench for the parts to rest and the epoxy/adhesive to cure.

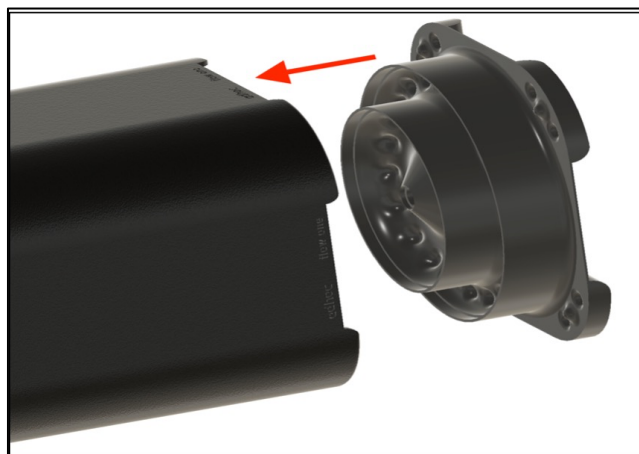
- a. Align Bezel key to keyhole on Tube Section. Rotate the Bezel so that the key in the Bezel aligns with the keyhole in the Tube Section. This key aligns outside edges and inside wire guides.



- b. Join the Bezel to the Tube Section



- c. Join the base to the Tube Section



- d. Clamp the pieces together with rail clamps and set aside until the epoxy/adhesive is fully cured. Use blocks to prevent damage to the parts.

**Figure 28 Clamping The Enclosure Parts For Curing**



Check  
when  
done.



Step 3: Remove the clamps and inspect

After waiting long enough to ensure the epoxy/adhesive is fully cured, it is time to remove the clamps and inspect the completed assembly. Take your time on this step. Imagine you are a final inspector at a loudspeaker company and your job is to look for defects in cabinet fit and integrity.

Inspect the joints, parts alignment, and overall parts fit and bond integrity. There should be no gaps where epoxy/adhesive is not visible. Some parts may not fit perfectly—that's ok; you can use filler to fill them in. But any visible gaps without epoxy/adhesive must be sealed either with sealant or filler to ensure there are no air gaps or unbonded areas that might diminish the integrity of the completed enclosure, which could later lead to buzzing, rattling or enclosure mechanical resonances. Remove excess adhesive with a chisel or with sandpaper. After you have inspected the enclosure and verified its bonding integrity, it is ready for the next step: Finishing.

Check  
when  
done.



#### Step 4: Apply a Finish to the Enclosure

The finish you apply to the Flow/1 enclosure is entirely up to you! The photo on the title page of this Maker's Guide, shown again here, shows an enclosure printed in standard resin and spray painted in white enamel. I have also had them printed in off-white, and black resin, white ABS and black PETG FDM. I have painted them with various paint types such as acrylic, powder-coat and clear coat.

For FDM-printed parts you might want to sand and fill rough areas. However you choose to finish your enclosure parts, it is better to do it before the wires and drivers are attached and the rest of the enclosure is assembled. Be careful not to paint inside edges because they will make assembly (and disassembly) more difficult. Be sure to allow ample time for fillers and finishes to cure—at least 24 hours before handling





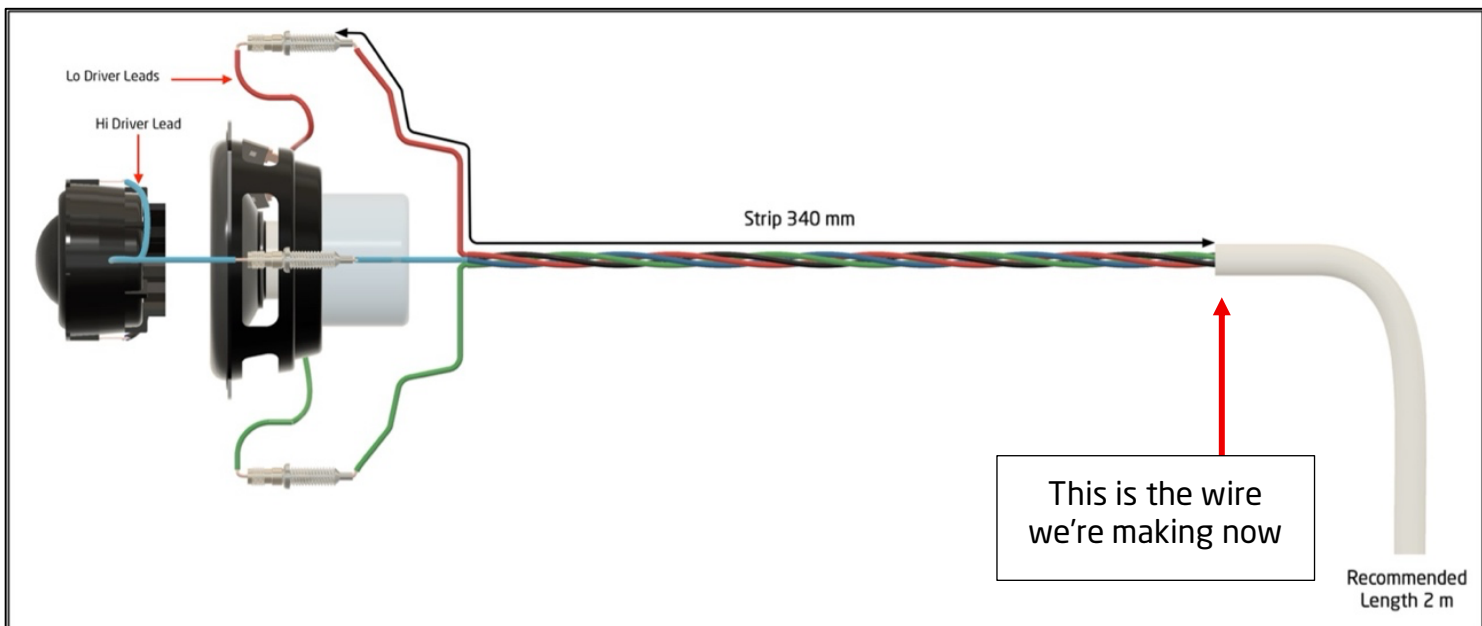
## Step 5: Prepare And Install the Wires

The Flow/1 design is unusual in that there are no speaker terminals as found on most loudspeaker enclosures. This is due mainly to economy of geometry, and because the enclosure is dedicated entirely to air flow, which cannot have any obstructions.

The recommended speaker wire to use is a 4-conductor, 2-twisted pair wire with an attached connector. This configuration has proven to be very convenient, as the connector can be located where it can be easily reached for disconnection. Twisted pairs keep the high-frequency, high-dV/dt Class-D output energy confined, balanced, and non-radiating—improving EMC compliance, reducing audible artifacts.

A length of two meters is recommended as that is long enough to extend through the optional speaker stand. This step shows how to cut the wires for the HF Driver Arms and for insertion into the Tube Section. See Figure 29 for a diagram of the wires we'll be making now:

**Figure 29 Enclosure Wiring**



- Cut a length of wire—the Overall Wire—and strip the jacket from one end for a length shown in Table 9. To ensure the wires remain twisted, apply tape to the cut end about two inches (50mm) from the cut end.

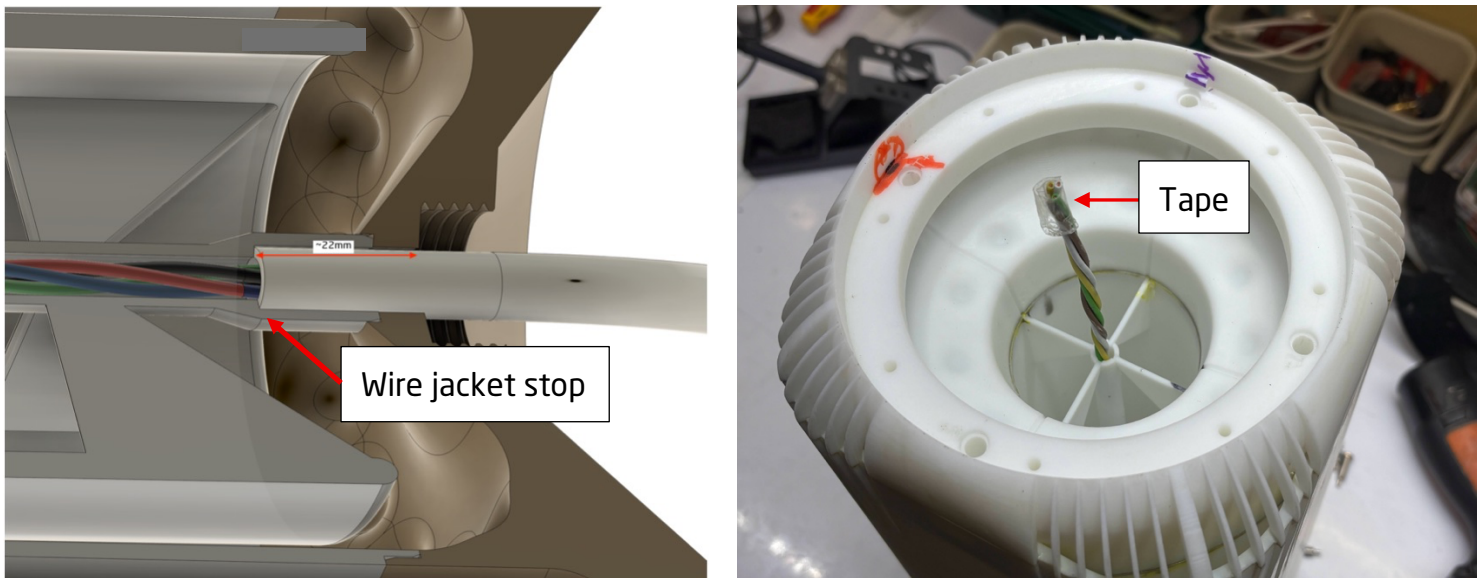
**Table 9 Enclosure Wire Cutting and Stripping**

Wire Section	Cut Length	Jacket Strip Length	Tin length
Overall Wire	2 Meters (suggested)	340 mm	4-5 mm
HF Driver Leads	135 mm	N/A	4-5 mm
LF Driver Leads	130 mm , 75 mm	N/A	4-5 mm

- Strip the ends of each wire 'Tin length' mm, as shown in the table, keeping the wires twisted.
- Tape the tinned wires to make it easier to slip the wires through the center wire guide (this is in addition to the tape to keep the wires twisted).
- Carefully insert the wire into the hole in the base, and push it into the wire hole. Keep pushing until the twisted wires emerge from the wire tube enough to grasp the wires by the tape.

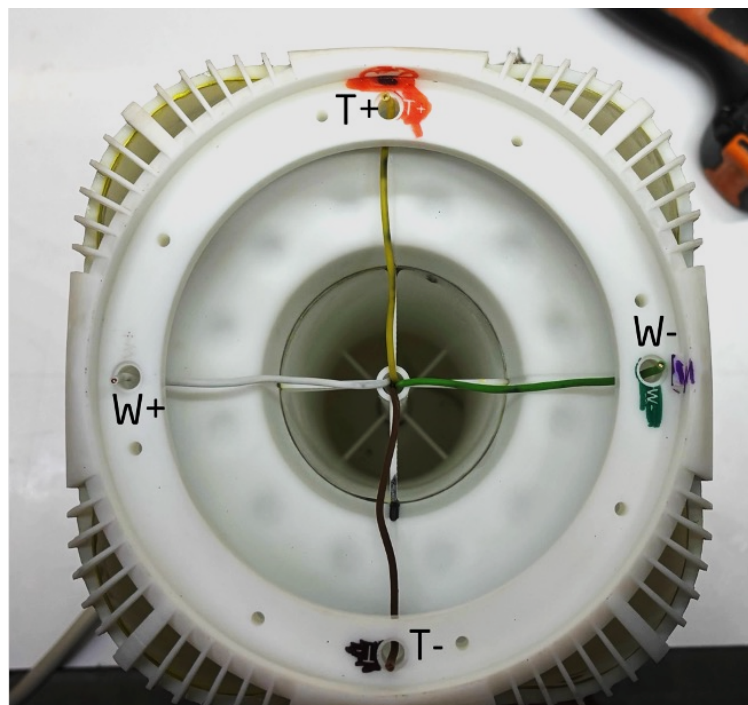
- e. Pull the wires until they can stop; which is when the wire jacket bumps into the stop in the base. At this point you will have about 125 mm of wire emanating from the top of the wire tube. See Figure 30 for reference.

**Figure 30 Enclosure Wire Insertion and Prep**



- f. Remove the tape from the tinned end of the wire and untwist them. Route each wire to its proper jack according to your chosen color scheme. In the image in Figure 31, the yellow/brown pair are the HF Driver T+ and T- wires; the white/green pair are the LF Driver W+ and W- wires. The letters T+, T-, W+ and W- are debossed near their banana jack holes for reference. The leads will extend about 10mm above the banana jack holes, allowing for easier soldering, described later. Align the wires such that they route to their proper holes as indicated on the Bezel as shown in the figure.

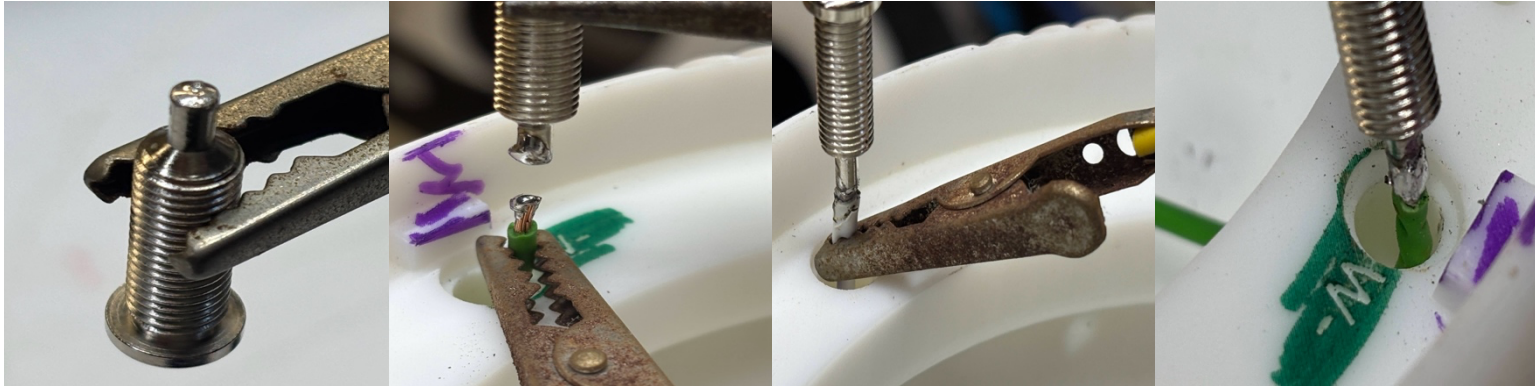
**Figure 31 Bezel Wire Routing**



- g. Refer to Figure 32 for the next steps. Using 4 banana jacks (C19268098), tin each one in preparation for soldering.

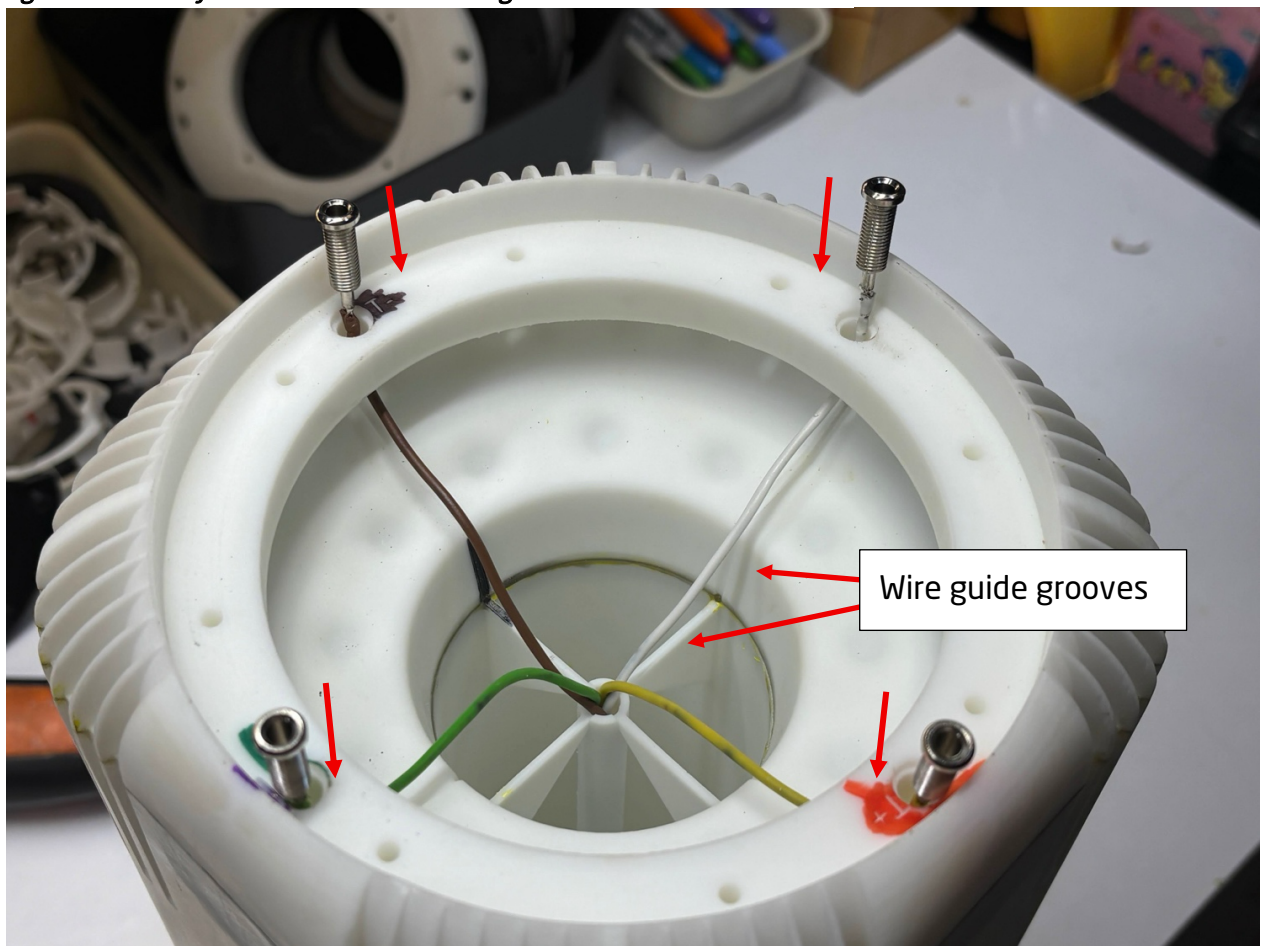
- h. For each wire, pull the wire up through the hole tightly to extend it as far as possible, about 10mm. Clip an alligator clip to hold the wire in place while soldering to the banana jack, as shown in the sequence of photos in Figure 32.

**Figure 32 Soldering to the Bezel Banana Jacks**



- i. After all 4 wires have been soldered and clips removed, your work should look like the picture in Figure 33.
- j. Referring to Figure 33 again, push each jack into its hole until the top of the jack is flush with the flat surface of Bezel.

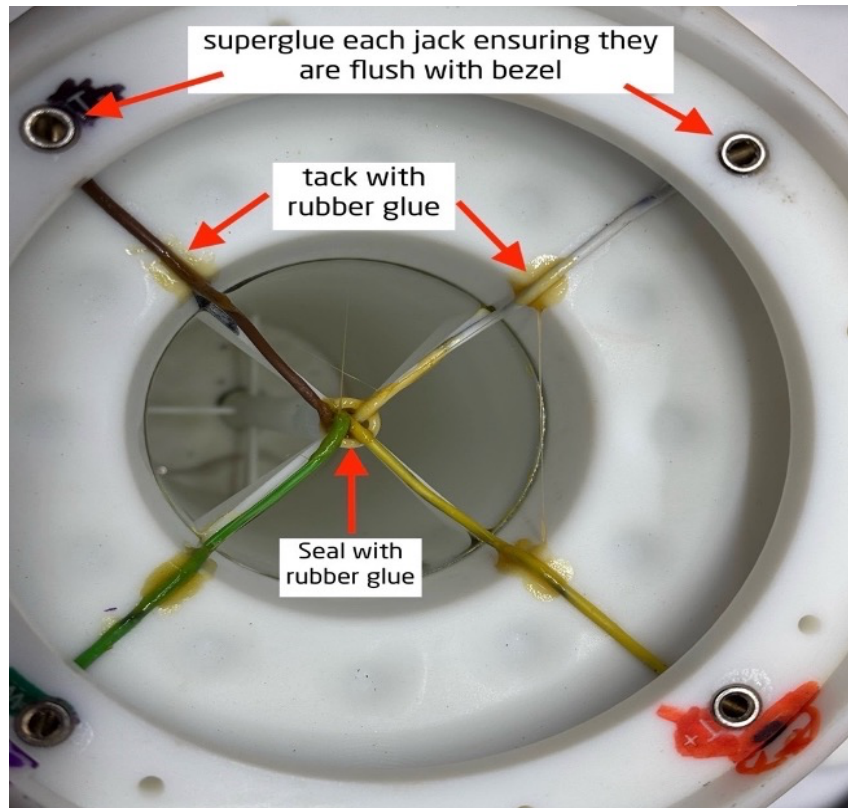
**Figure 33 Bezel Jack Wires After Soldering Wires**



- k. Align the wires emanating from the center tube along the on the top of the tube vanes guides, such that they line up neatly along their grooves. Push any slack into the grooves and along the tops of the Bezel fins and on the Bezel. The wires may not completely land in the grooves but that's okay, we'll be covering them with rubber adhesive later.

- I. Refer to Figure 34 for this next step. Apply adhesive (e.g., cyanoacrylate) to each jack to secure them in place. Ensure the top of each jack is flush with the surface of the Bezel. Allow a few minutes for the glue to set before proceeding. It is important that the top of each jack is perfectly flush with the Bezel surface to prevent interference when the DM is attached.

*Figure 34 Bezel Jacks and Bezel Wire Gluing*



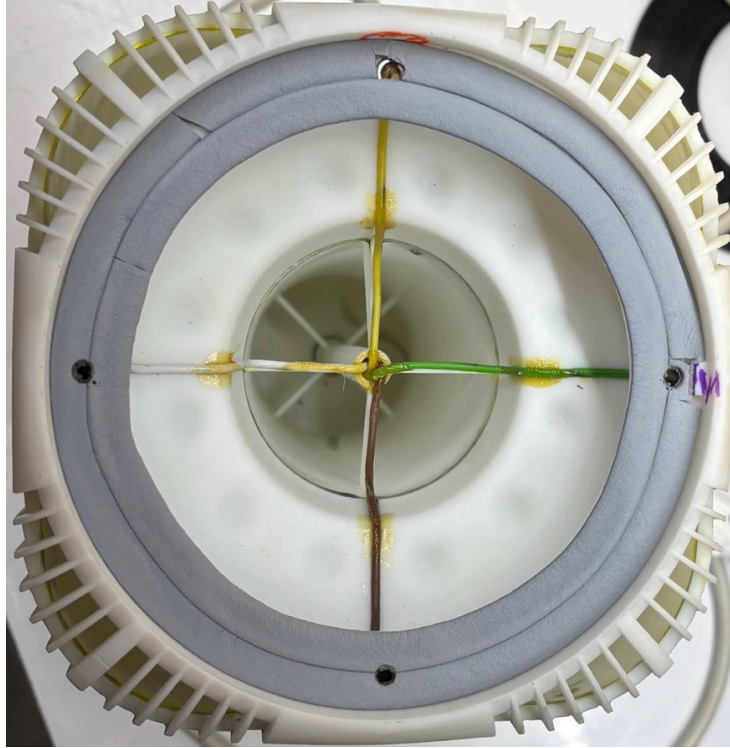
- m. Push the wires into the grooves in the Bezel and the tops of the fins. Apply rubber adhesive to tack the wires in place along their grooves. Apply a generous amount of rubber glue to the top of the wire pipe to ensure an air-tight seal. Urge the wires to align with the grooves. The purpose of this is to ensure the wires are robustly tacked down to prevent vibrations. Allow the adhesive to dry before performing the next step.

You are done with the enclosure wiring. Now we will put the Bezel gasket into place.

Check  
when  
done.**Step 6: Attach the DM Gasket.**

The gasket material should be at least 1mm thick and can be cut from foam or simply applied as self-adhesive gasket strip. Cut holes in the gaskets for the four banana jacks as shown in Figure 35.

*Figure 35 Completed Bezel Wiring with Gasket in Place*

Check  
when  
done.**Step 7: Installing Damping Material**

The Flow/1 tube has been engineered with features that minimize modes and internal reflections, such as pimples (spheroid intrusions), dimples (spheroid depressions) and irregular segment lengths. Fiberglass and cotton damping material is used in critical areas to further dampen unwanted energy. It is critical to use only a minimum amount of damping in the tube to prevent restricting airflow in the tube. This small amount of damping in these key areas further reduces harmonics in the tube. I use fiberglass in the tube because its shape fits nicely in the tube, and cotton inside the Bezel, because it fits nicely in the driver chamber and is easily tucked into the edges. It is also safer and easier to work with; the choice is yours!

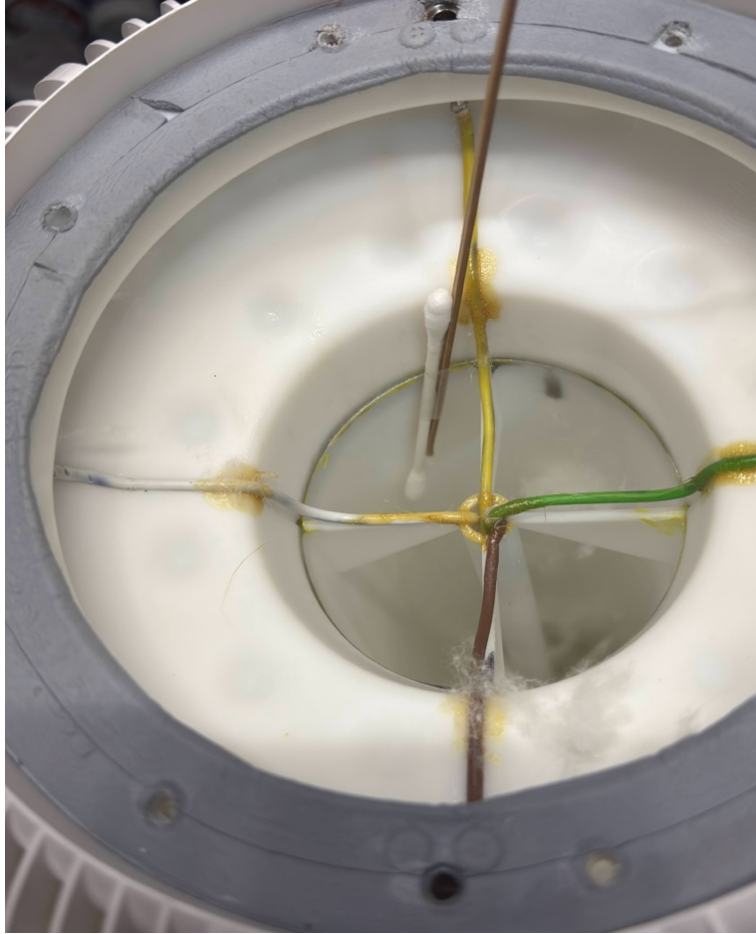
- a. Cut a 23x2.5x2.5cm (about 9"x1"x1") length of fiberglass or cotton wadding as shown in Figure 36.

*Figure 36 Fiberglass Damping Piece*



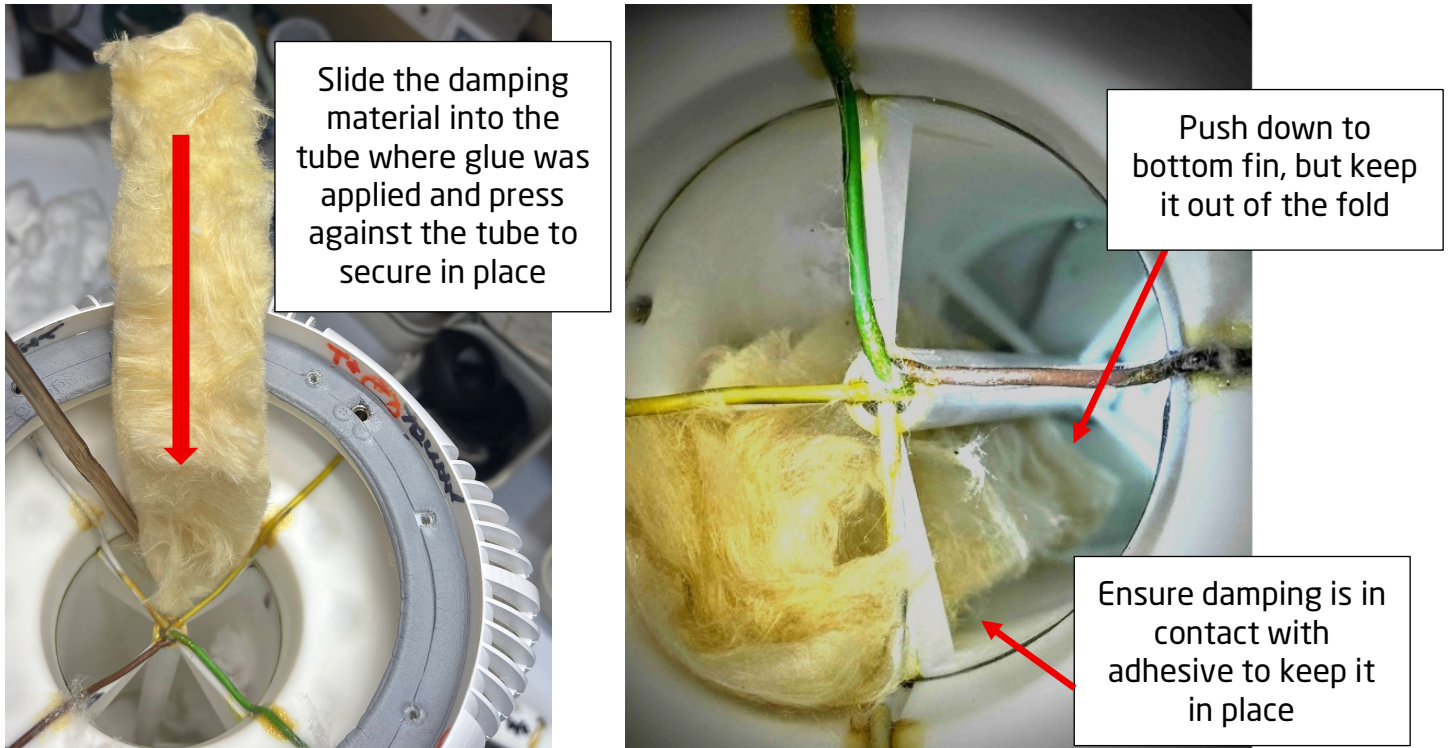
- b. Apply a very small film of Elmer's or latex glue along the inside of the center tube. The glue will hold the damping material in place. I used a Q-tip attached to a piece of wood to apply the glue into the tube as shown in Figure 37.

*Figure 37 Applying Adhesive into Tube*



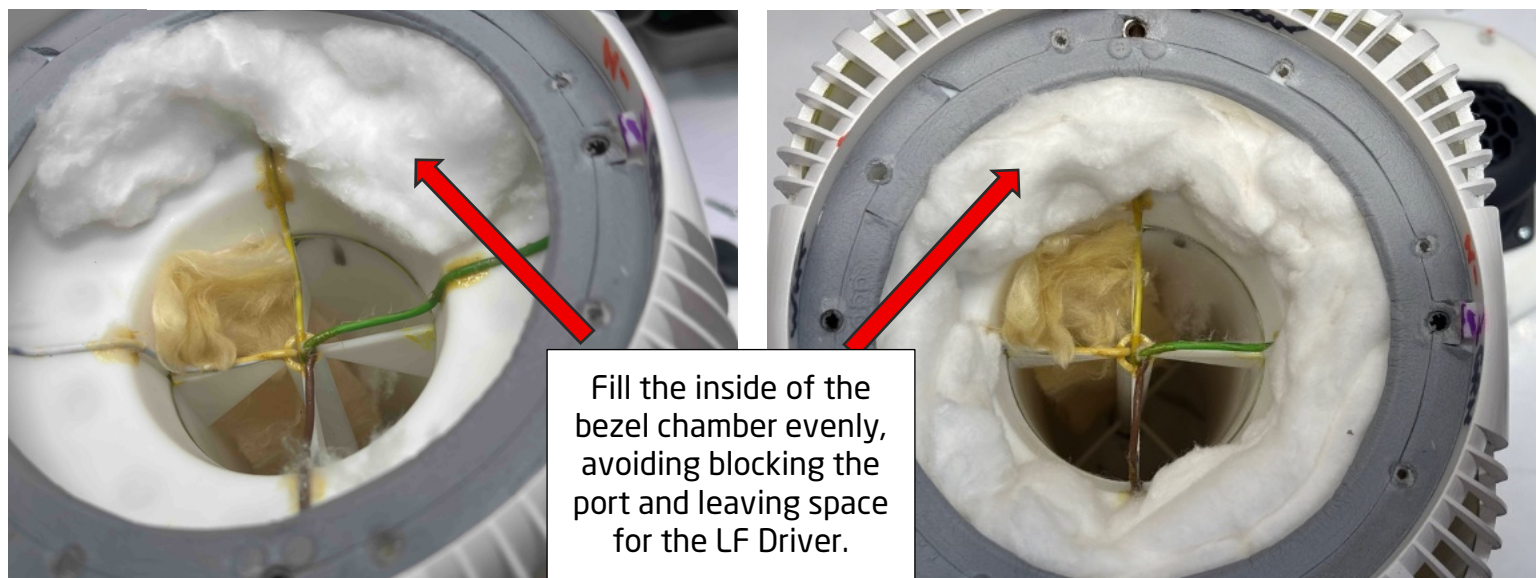
- c. Using a long, thin tool (I use a piece of bamboo), slide the damping material inside of the center tube, making sure it contacts the glued area. Only one piece is needed. Ensure it is contacting the adhesive and extends from the mouth of the tube down to the end of the segment but does not block the fold at the bottom as shown in Figure 38.

**Figure 38 Inserting Damping Material into the Tube**



- d. Stuff the Bezel. Gather about 11 grams of cotton wadding and form into 1"x1"x6" strips to use as damping material in the driver chamber. Stuff the wadding into the driver chamber. Ensure the cotton (or fiberglass) is stuffed well into the chamber leaving a clear, open path to the throat of the tube as shown in Figure 39.

**Figure 39 Stuffing the Bezel Chamber**



## The enclosure is complete!

- ✓ The Bezel, Tube Section and Base are bonded together,
- ✓ the wiring is installed,
- ✓ the banana jacks are installed,
- ✓ the gasket is in place and prepared to receive jacks and screws,
- ✓ the stuffing is installed.

At this point you can attach a connector to the speaker wire. I use the Neutrik speakON connectors and couplers as they are rugged, professional and very easy to use. But you can use anything you like, such as banana plugs, or nothing at all and just go with bare wire attached to binding posts. It's up to you!

The Neutrik web page for the speakON family is [here](#), and you can **download** the assembly instructions from this [URI](#). Figure 40 is a picture of the connector and coupler used in this Make:

*Figure 40 Neutrik speakOn Connector and Coupler*



At this point, you can repeat the above steps to make a second Flow/1 speaker to complete a stereo pair. Or you can wait until you've completely made one speaker, and then use that experience to take different approaches to making the next one; the choice is yours!

## Assemble The Egg

In this section we will build the Egg and Arm assembly. When completed this assembly will be attached to the driver module.



### Step 8: Assemble the HF Driver Wires

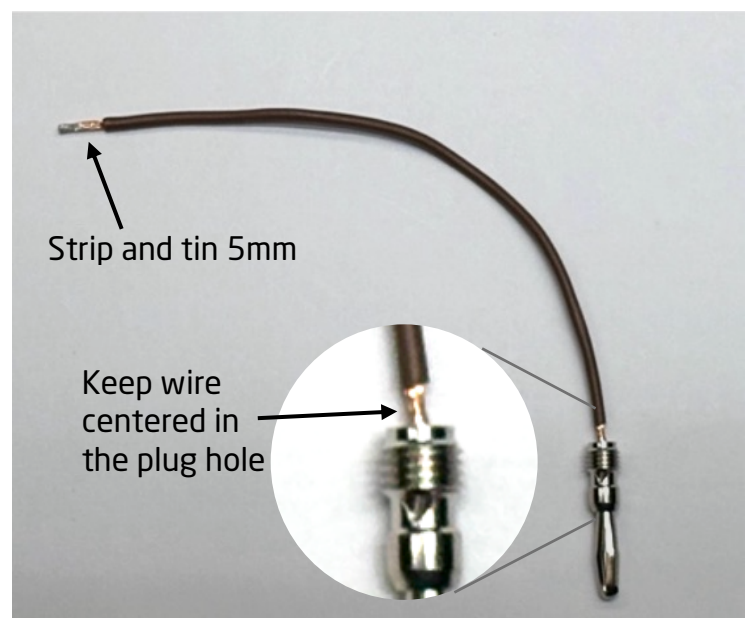
#### Notes:

The following steps are the same for SB, AuraSound and Wavecor drivers.

Pre-tap each Arm screw hole prior to assembly to make it easier when driving screws to attach and tighten the Arms to the DM. Use an Arm-DM screw M3-20mm (90380A356), to carefully drive the screw in 12mm until 8mm remains, then remove the screw from the hole. Do this for each of the four Arm screw holes.

Establish your wire color code by choosing which color represents the '+' signal. For this Make, the HF Driver + wire is yellow and the - wire is brown.

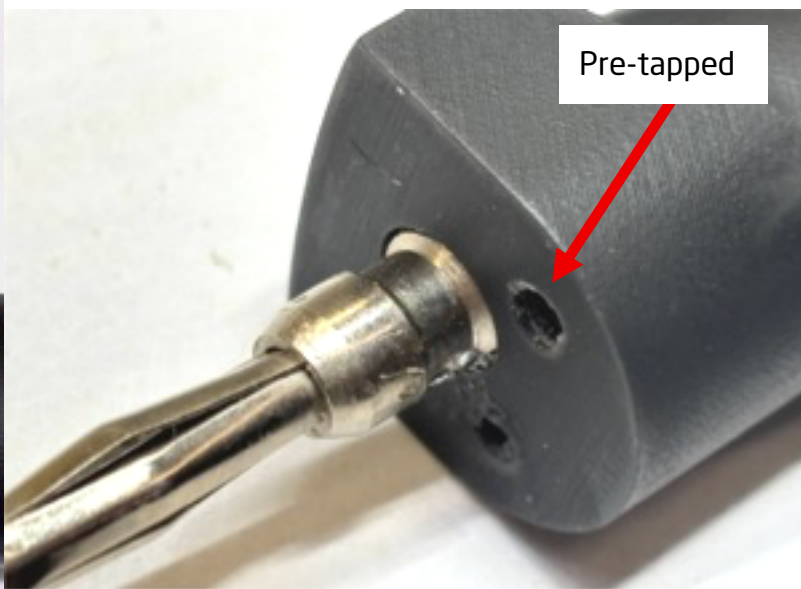
- Strip 4-5mm from one end of the pre-cut 135 mm wires and solder each one into a banana plug, part 314-1058-ND. **Keep the wire centered in the banana plug hole while soldering.**
- Strip 5mm from the other end of each wire to be soldered to the HF Driver.



- c. Insert the wires into the Arms and secure the banana plug



- d. For each Arm, push the wire into the Arm beginning at the flat-end of the Arm. Push the wire until the plug is flush with the base of the Arm. Ensure that the positive wire is inserted into the Arm with the "+" sign and the negative wire into the other Arm.
- e. Tack the banana plug to the Arm with superglue.



- f. The Arms for a single Flow/1 speaker are ready for further assembly. You can optionally prepare a second set of Arms for another Flow/1 speaker to make a stereo pair.

### Step 9: Assemble The Egg and Arms

In this step we will create the Egg-arm assembly that contains our chosen HF Driver. The Egg attaches to the Arms by a radial detent mechanism that urges 15° movements. This mechanism is engineered to be nearly interference-fit and must be well greased for smooth and lasting operation. The next few images show the swivel joint, and later instructions detail where to apply the grease. I use Vaseline, but any plastic grease will work.



- a. Place the Egg front enclosure onto a wire spool or something that holds the Egg steady, such as a roll of electrical tape, with the grill facing down (egg front for AuraSound shown for illustration).



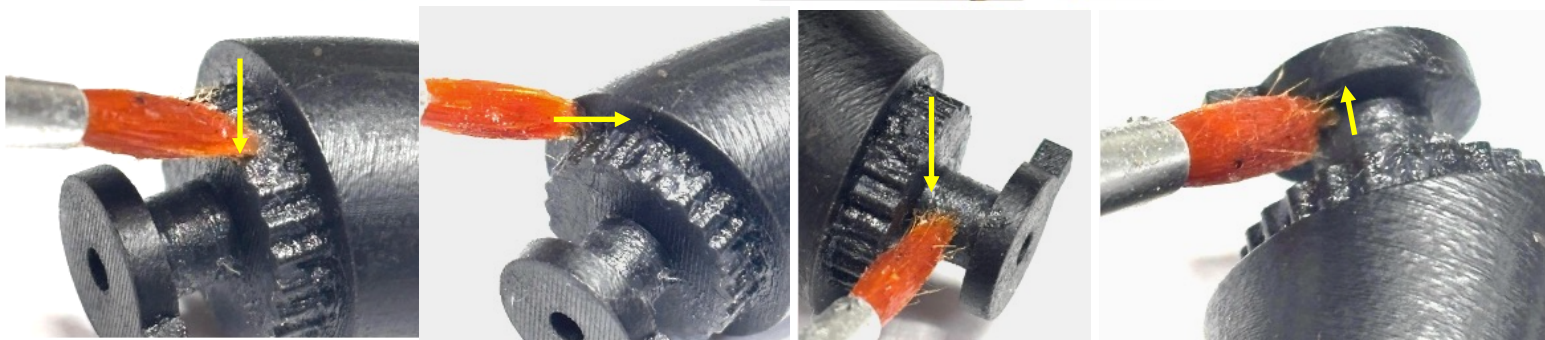
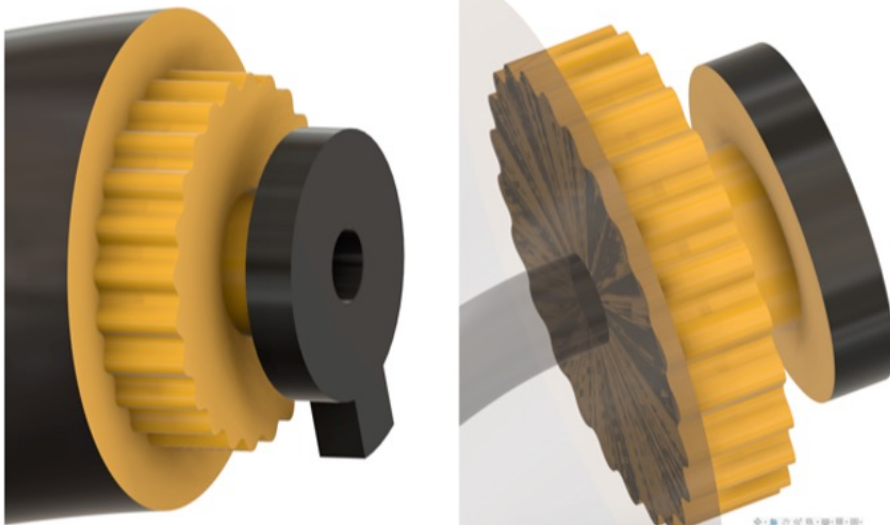
- b. Insert the HF Driver into enclosure with the terminals perpendicular to the swivel slots, aligning the lip of the driver with the slots in the Egg front.



- c. The driver is now seated in the Egg front enclosure, with the terminals perpendicular to the swivel slots.



- d. Prepare the Arm swivel. Using a brush or other applicator, apply a thin, smooth layer of grease to the Arm swivel on all of the faces shown in yellow, as shown in the following pictures.



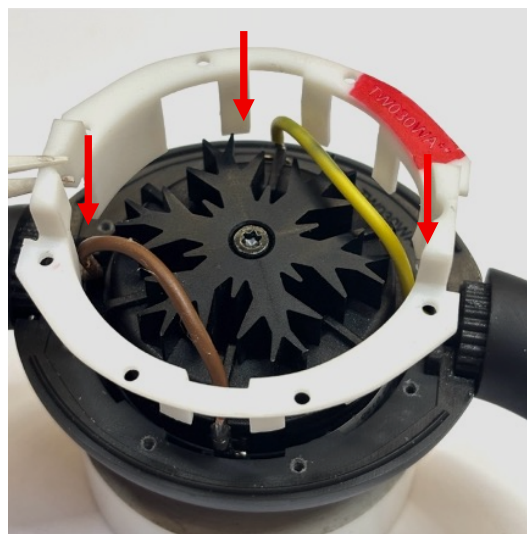
- e. Rest the Arms onto the Egg front, setting the sprocket into the swivel slot.



- f. Run positive wire to +term, negative to narrow - term and solder neatly



- g. Insert the holder by slipping the teeth between the driver and the Egg front keeping the teeth lined up with the slots in the Egg front. The parts are engineered for a tight fit to ensure the HF Driver is captured tightly, so take your time and be patient; the holder will slide into place, fitting between the driver and the enclosure:

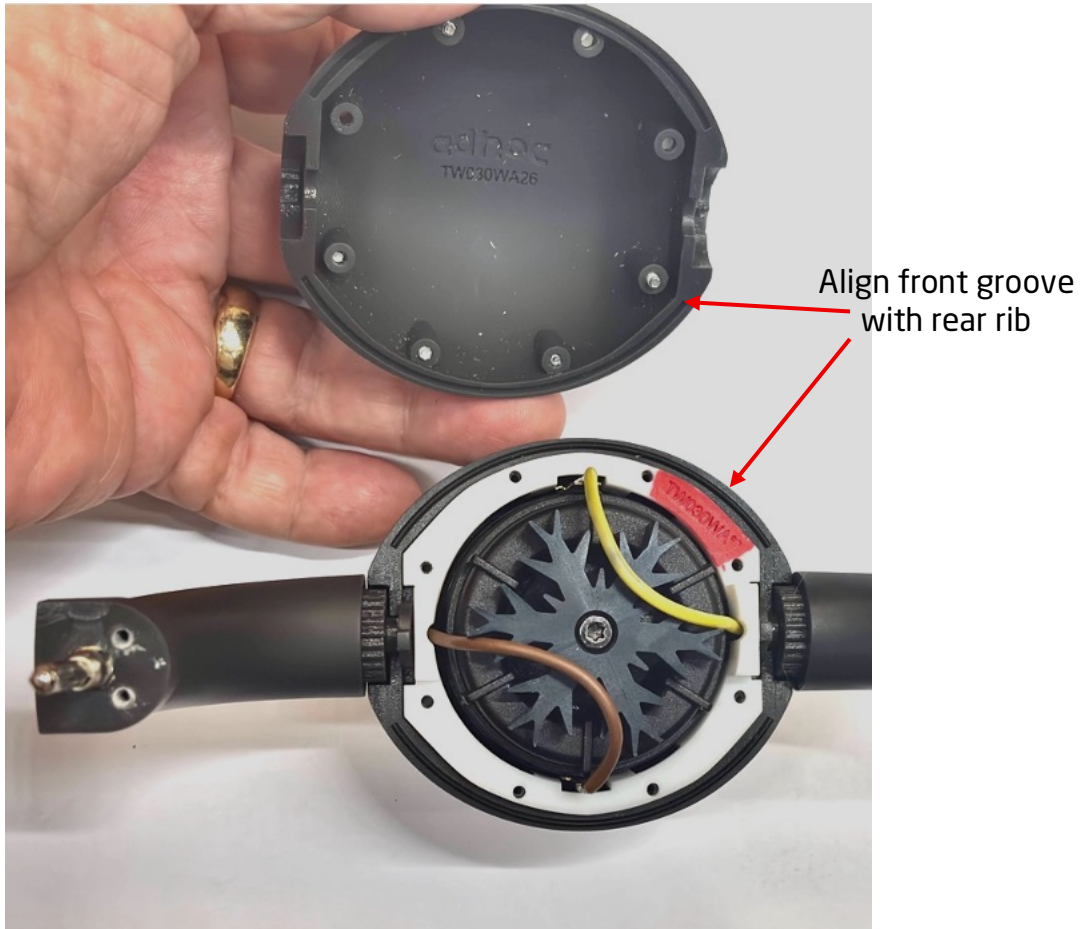


- h. Ensure the holder is seated on the enclosure and the wires are dressed neatly:



- i. Attach Egg rear

The Egg screws are self-tapping, but it helps to pre-tap the screw holes in the Egg front by carefully screwing the 10mm (90380A328) screws into the holes and then removing them (Note: do not screw in the 10mm screws fully as they will bottom out and possibly damage the Egg enclosure). This makes it easier to turn the screws when assembling the Egg, and easier to know when they are tight. The front edge has a rib that mates with a groove on the rear better registration and to form a more rigid, solid attachment.



- j. Insert eight 10mm (90380A328) screws using a PH0 screwdriver, alternating across the rear of the enclosure. Carefully drive each screw until the front and back edges meet. After all screws are inserted, tighten each screw to be sure they are seated. When properly assembled, the front-rear seam should be tight, with no visible gaps:



- k. The assembly of the Egg is completed! Turn the assembly over and confirm everything looks like these photos (Wavecor TW030WA26 Neo shown); Rotate the Arms to ensure the detents are operating smoothly.



- l. Test continuity and polarity. This simple test will verify that the wiring to the HF Driver is correct and that the driver is working. Attach a 1.5V battery across the two banana jacks, with the battery + lead connected to the banana plug on the + Arm, and the battery - to the banana plug on the other Arm. When contact is made, a sound should be heard from the HF Driver indicating that it is connected and basically working. Observe the diaphragm as you touch the contacts—the diaphragm will move outwards if the wiring is correct:



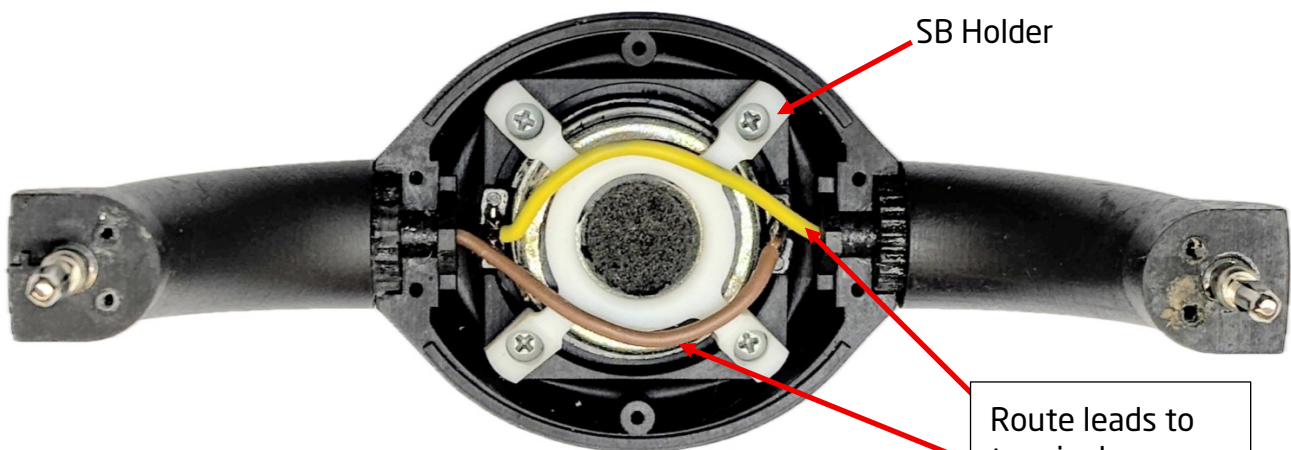
The diaphragm will move outward if the circuit is complete and polarity is correct

If the diaphragm moves inward then you have the + and - terminals reversed. Remove the rear by removing the screws. Unsolder and swap the leads, verifying that the positive lead goes to the positive (wider) terminal and the negative lead goes to the negative, narrow terminal. Repeat the continuity test. After confirming the diaphragm moves out when the circuit is closed, re-attach the rear. Now you can set the Egg and Arm assembly aside for completion later. You can now repeat these steps for a second Flow/1 speaker to make a stereo pair.

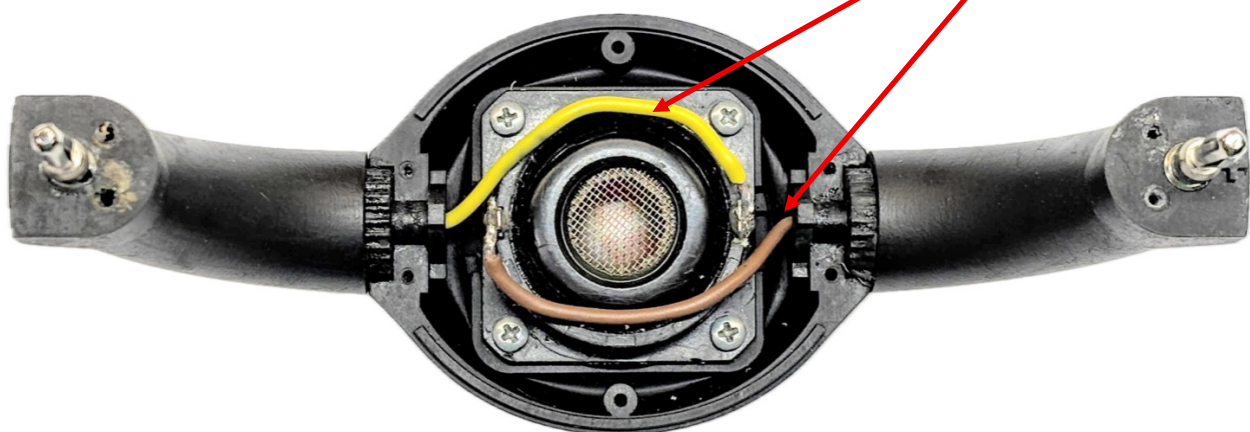
### SB AND AURASOUND Wiring and Mounting

The process for assembling the Egg enclosure with the SB and AuraSound drivers is the same as they are for the Wavecor except for the mounting of the HF Driver. The AuraSound has its own mounting plate and does not need a holder. The SB Audience has a holder and must be used to secure the SB to the Egg front. For these drivers, run the wires across the back for easier routing **Error! Reference source not found.** and **Error! Reference source not found.** show completed SB and AuraSound HF Drivers assembled and wired:

*Figure 41 SB Audience Driver Mounting and Wiring*



*Figure 42 AuraSound Driver Mounting and Wiring*



Route leads to terminals opposite of the Arm from which they exit

### Step 10: Assemble the LF Driver to the DM

This step details the instructions for assembling the DM with the Dayton Audio ND91 driver, but the basic steps are the same for the Tang Band 1876S and Dayton Audio ND91 drivers:

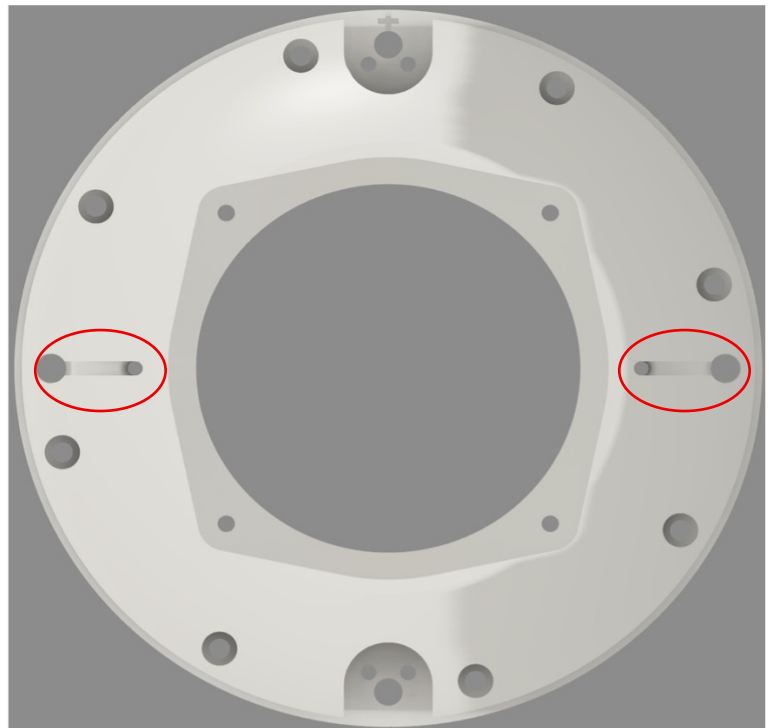
- cut the wires and solder to the banana pins,
- insert and glue the pins into the DM,
- pre-tap the driver screw holes,
- attach the driver and gasket to the DM,
- solder the wires to the terminals,
- seal the wire holes.

Let's get started!

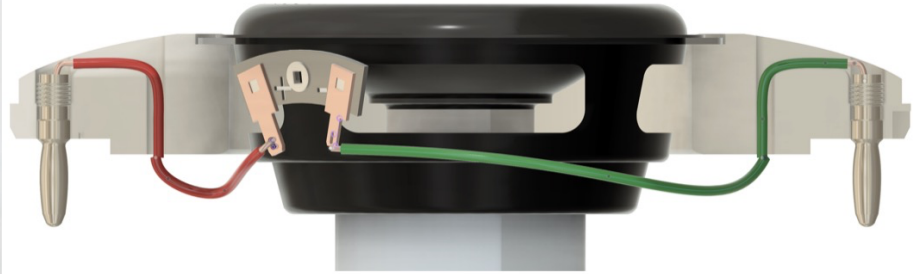
- Cut a 75 mm length of wire for the positive lead and a 135mm length for the negative lead. Optionally now cut leads for a second Flow/1 speaker to make a stereo pair.
- Solder each lead to a banana plug (314-1058-ND) at a 90-degree angle.



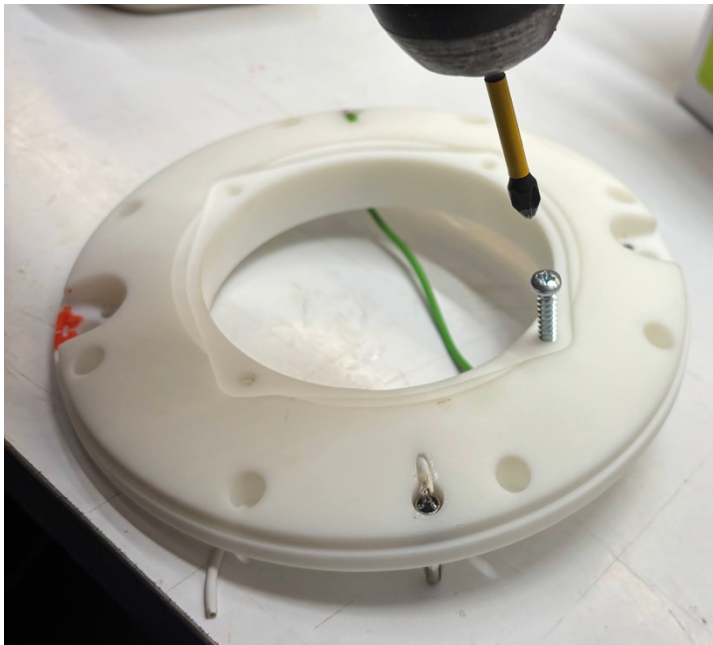
- Position the ND91DM as shown in the picture, with the Arm holes at the top and bottom, and LF Driver pin holes are on the sides.



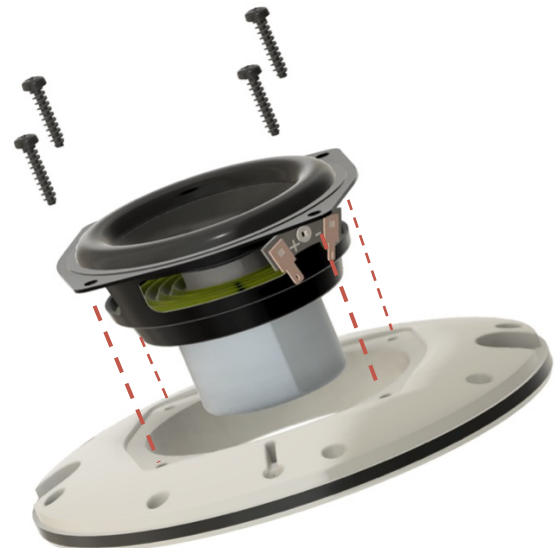
- d. Insert a banana pin into large, outer hole and fish the wire through the smaller hole. Press the wire down until it seats below the top of the DM as shown:



- e. Pre-tap the driver mount holes for easier assembly using one of the driver/DM screws



- f. The Dayton Audio ND91 is supplied with two gaskets: one already attached and a spare. We will use only one gasket. Align the basket with its outline in the DM and seat well. Insert four ND91 Driver screws M4 20mm (90380A382) and torque to 0.9 NM (8 in-Lb, or clutch #4).



- g. Route the wires through the holes and to their respective +/- terminals on the driver, cut and solder
- h. Dress the wires as shown in Figure 43. The leads should be short but long enough to easily reach the speaker terminals:

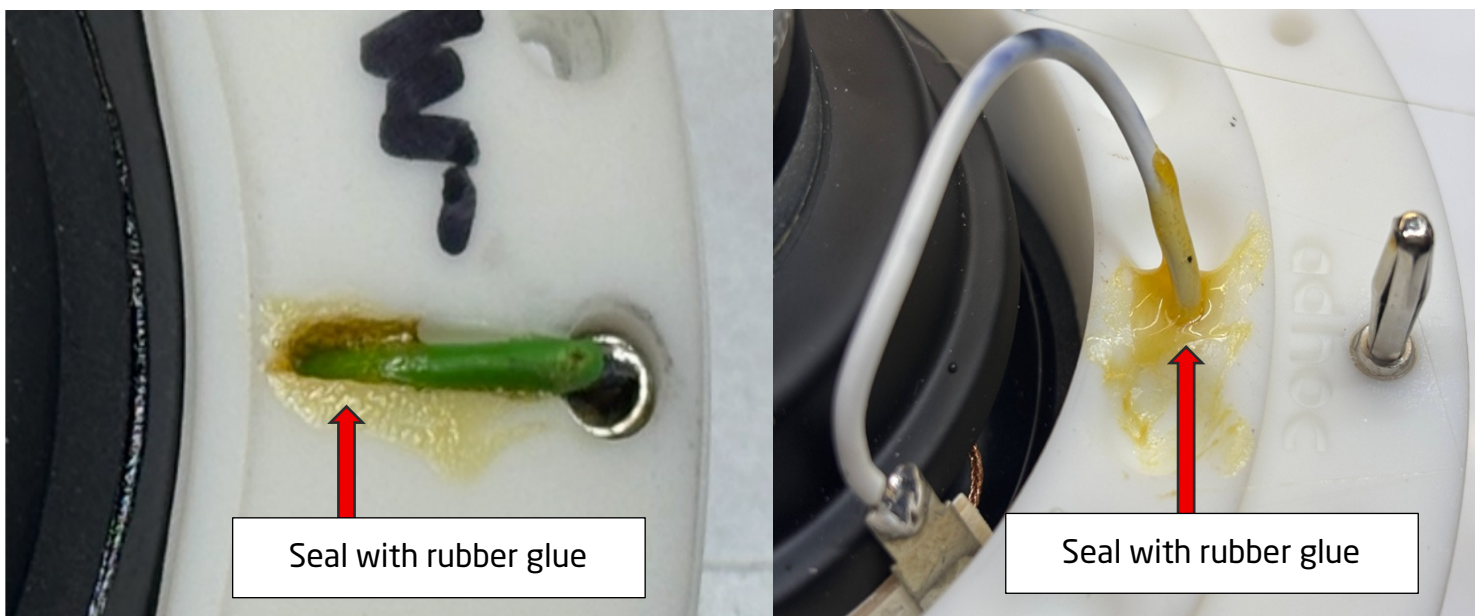
**Figure 43 Dressing and Routing LF Driver Wires**



The gasketed driver is screwed securely in place and the wires are dressed. The banana plugs are seated properly and superglued in place. The lead wires are pressed into the slots on the top of the DM so that they fit beneath the DM cover. The leads on the underside of the DM are dressed neatly. It is now time to apply contact adhesive or rubber glue to the wire holes to seal them to prevent air from escaping.

- i. Apply a generous amount of rubber glue to seal the wire holes. Apply glue to the holes on both the top and bottom of the DM, as shown in Figure 44. Let the glue dry enough to stiffen before proceeding.

**Figure 44 Sealing LF Driver Wire Holes in DM**



- j. Orient the DM/ND91 assembly to view from the top. The completed assembly should look similar to Figure 45 (the wires are marked on this DM). The DM is ready to receive the Egg and Arm assembly

*Figure 45 Completed ND91 DM*



Step 11: Attach the Egg/arm assembly to the DM.

With the Egg/arm assembly and driver/DM assemblies complete, we can now join them. For this you will need four Arm/DM screws (M3 20mm 90380A356) and a PH1 screwdriver.

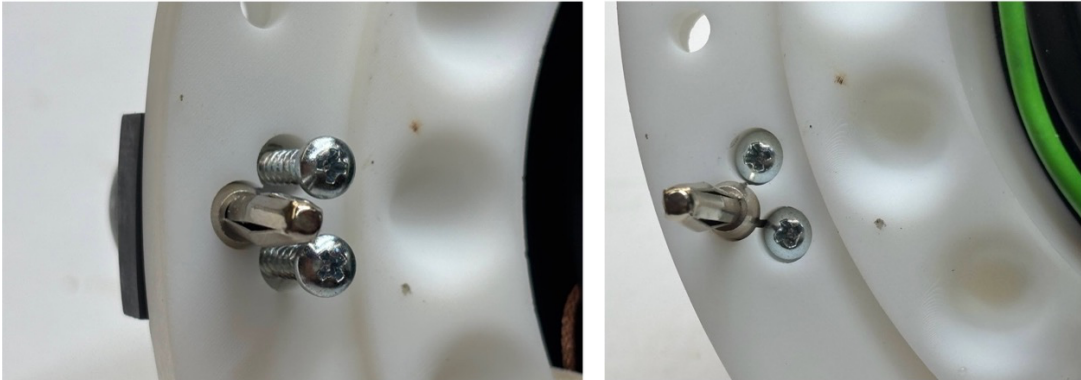
- a. Align the banana jacks with the holes in the DM, ensuring the "+" Arm aligns with the "+" slot in the DM.



- b. Press the Arms into the DM until firmly seated into the slots in the DM.



- c. Attach the Arm to the DM using four M3-20mm (90380A356) screws using a PH1 driver bit. Tighten the screws to 0.9NM (8 in-LB or clutch #3).

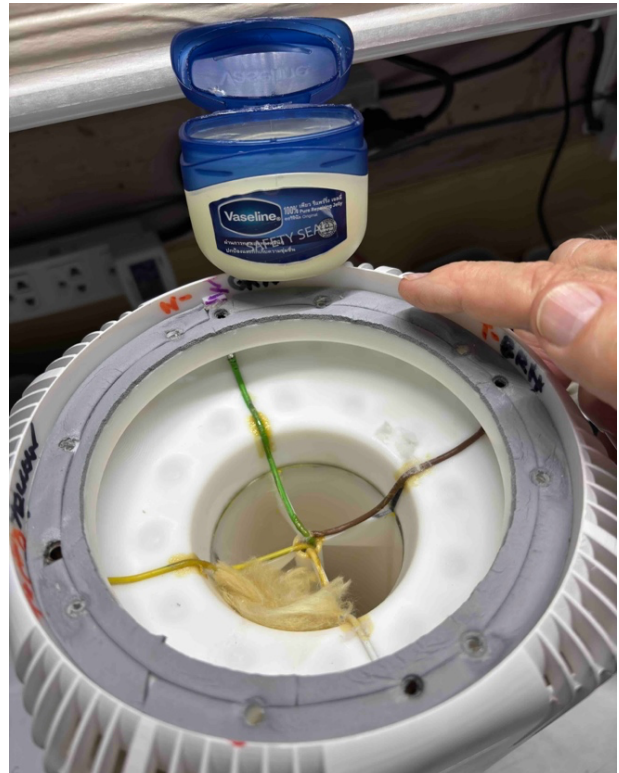


- d. The assembly of the Egg to the DM is completed. Inspect the assembly by ensuring the attachment is a solid tight fit. Swivel the Egg to ensure it moves smoothly and the detents can be felt. We can now move on to the next step of attaching the Egg/DM assembly to the enclosure.
- e. You can repeat the above steps to prepare a second Arm/Egg/DM assembly for a second Flow/1 speaker to complete a stereo pair.



## Final Assembly

- a. Apply a small amount dielectric grease or Vaseline to all of the banana plugs and a very thin coating to the gasket to ensure easy insertion and removal of the DM for easier future removal.



- b. Insert the DM into the Bezel. Note: holes for the jacks were cut in Step 6. Align the keyhole in DM to the key in the Bezel. Ensure the banana plugs align with the holes in the Bezel. Firmly push the DM into the Bezel to seat the banana plugs.



As with all screw holes, use the appropriate screw to pre-tap the screw holes in the enclosure to know when the screws are securely set when attaching the DM to the enclosure.

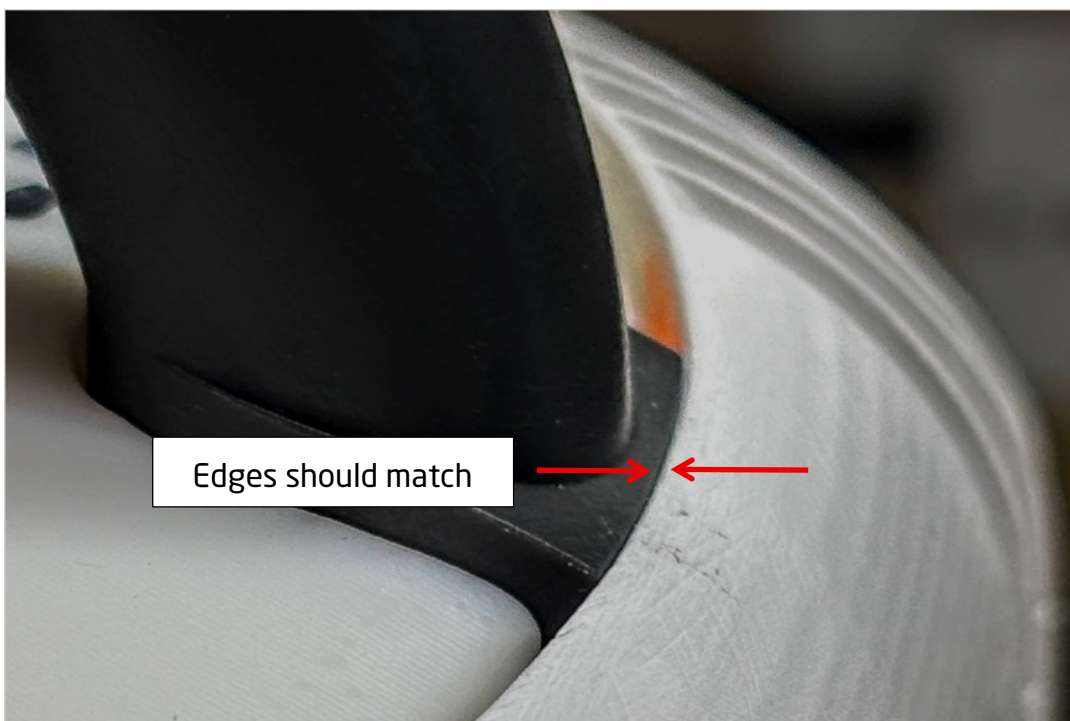
- c. Insert 8 M4 20mm DM screws (90380A382) into the DM screw holes. Torque each screw one by one to 0.9/8/#3, following the pattern shown in Figure 46 to ensure even attachment pressure on the gasket and the DM parallel to the Bezel.
- d. Increase the torque to 1.3/12/#4, and tighten each screw again following the same pattern.

*Figure 46 Securing the DM Screws*

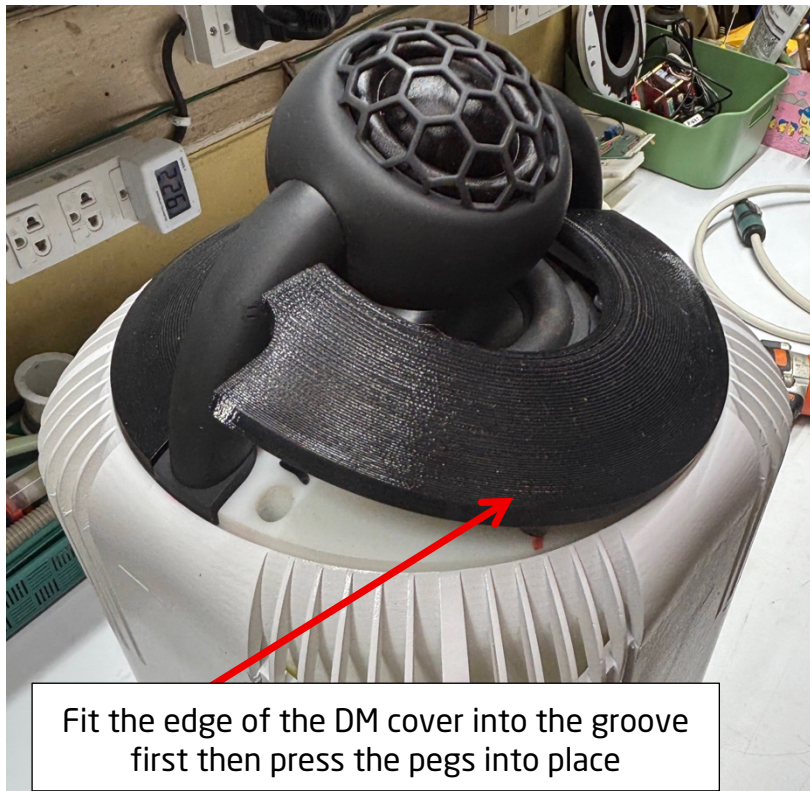
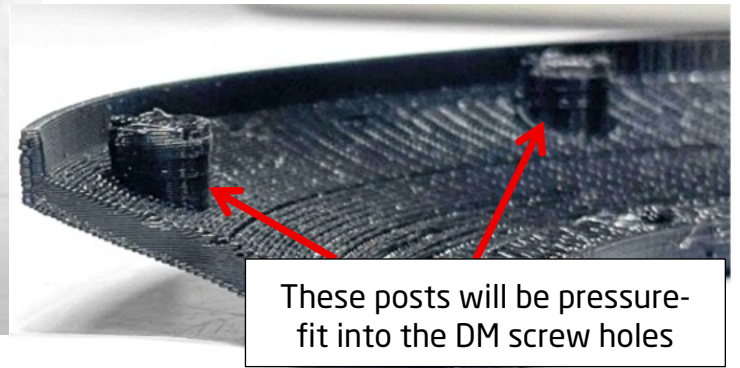


Now the DM should be securely and evenly screwed to the Bezel. The top of the Arm foot should be even with the edge of the Bezel as shown in Figure 47

*Figure 47 DM/Arm Seated in Bezel*

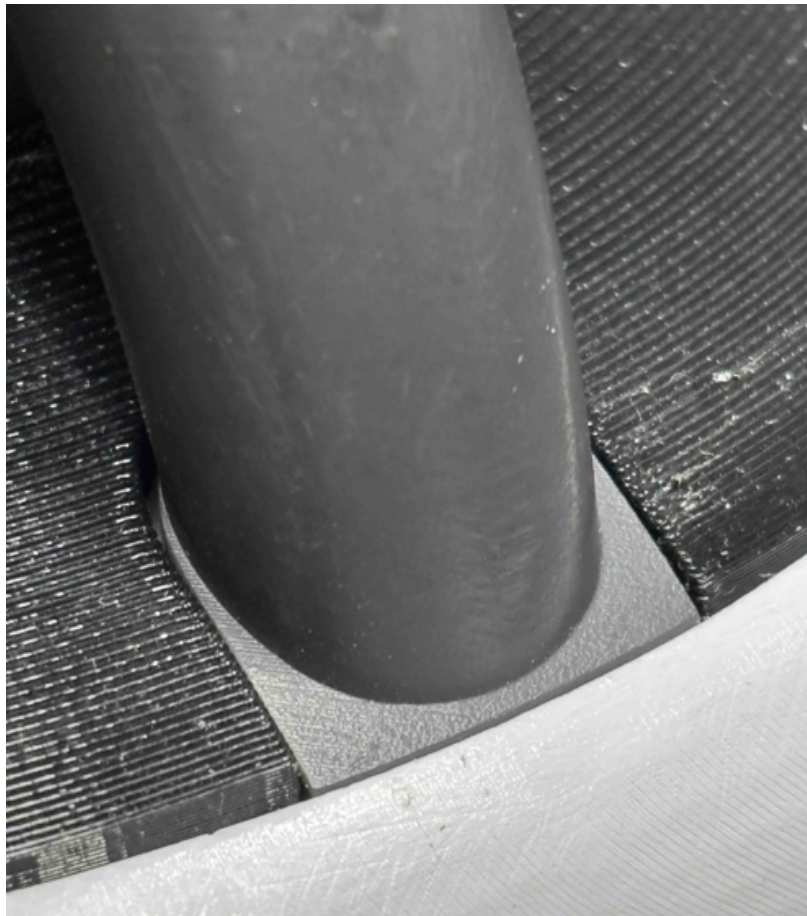


- e. Attach the DM covers. There are two identical DM covers made from flexible TPU so that they can be positioned beneath the Arms and pushed onto the DM. The covers are secured by pressure-fitting them into the DM screw holes. There are eight DM screw holes into which the DM cover pegs are pushed, four per DM cover half.



- f. Finish the DM cover insertion by pushing the outer edge of it into the slot between the DM and the Bezel until the DM cover is even with the edge of the Bezel as shown in Figure 48.

*Figure 48 DM Cover Properly Installed*



Assembly is complete; you have made a Flow/1.



Perform an overall inspection:

- √ Check overall form and fit
- √ Check the swivel for smooth, detented 180° motion
- √ Check connectivity and driver polarity with a battery connected to the end of the cable
- √ Inspect the overall condition of the speaker assembly.

At this point you have created at least one Flow/1, or a stereo pair if you performed the above steps twice, once for each speaker along the way. If you have already painted your parts you can move on to testing and voicing, otherwise you can finish your Flow/1 with paint or veneer or whatever suits your taste!

**It's time to fire up the speakers!**

Acquire /  
Build  
Electronics

## Flow/1 System

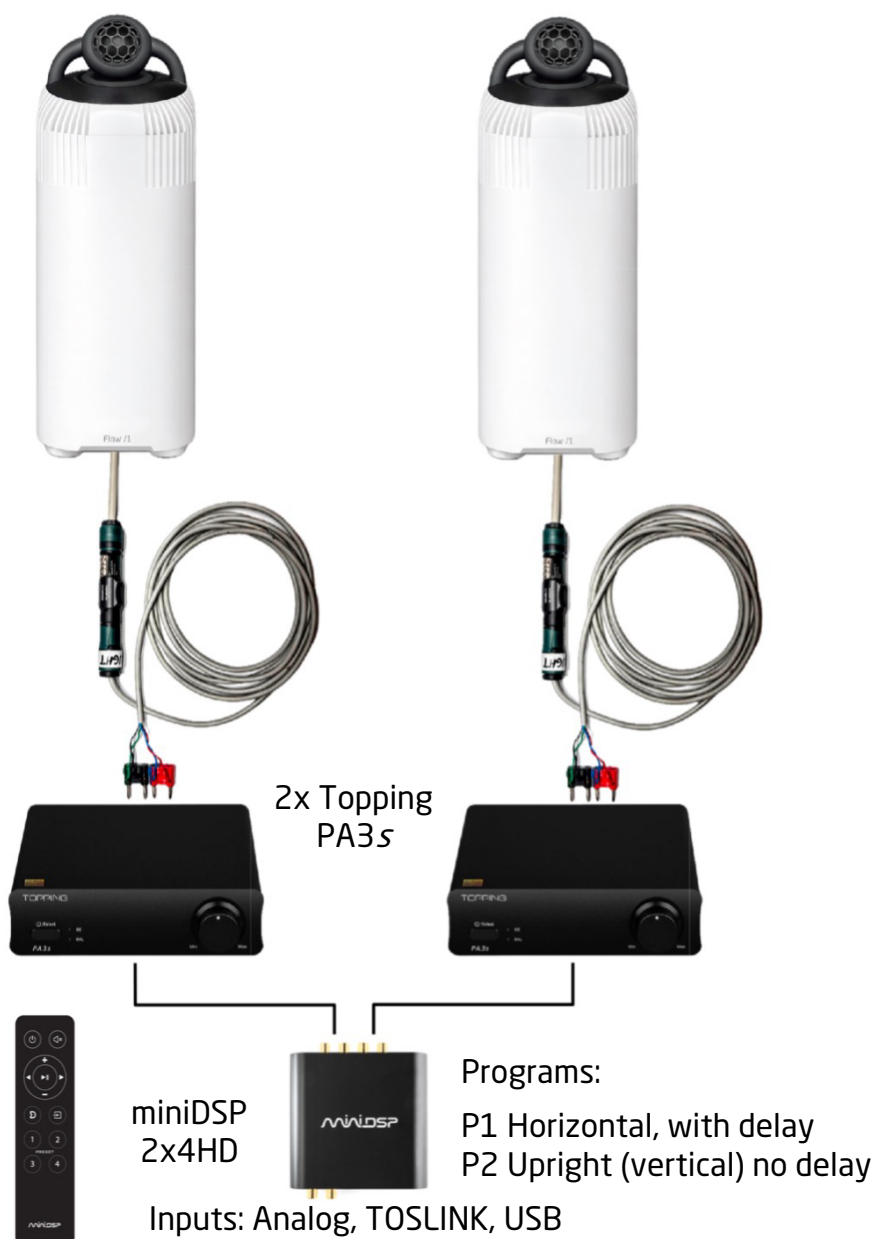
This section describes several variations of electronics that I use to drive the loudspeakers. It is included in the Maker's Guide because Flow/1 speakers are part of a system, and this shows a basic system that can be used as a starting point for enjoying the Flow/1 speakers you just made.

Flow/1 speakers have always been designed around an active crossover to maximize flexibility and minimize enclosure size; there is no space within the enclosure for conventional, passive crossover components. Several variations of DSP and amplifiers are discussed in this section but we will focus on a basic configuration using off-the-shelf components first, then DIY components later.

### Flow/1 Reference System: miniDSP 2x4HD DSP and Topping PA3s Amps

Figure 49 shows a basic system using a miniDSP 2x4HD DSP that implements the crossover (abbreviated XO), and accepts inputs from various sources.

*Figure 49 Flow/1 Reference System*



## DSP

The reference Flow/1 system described in this Guide uses a miniDSP 2x4 HD feeding Topping PA3s amplifiers in an active bi-amplified arrangement. This architecture provides precise control of crossover filtering, gain, delay, and stored presets, while also enabling the FIR processing used in the final crossover design. After extensive listening and measurement with both IIR and FIR topologies, the preferred solution proved to be a 1.6 kHz crossover with 48 dB/octave acoustic slopes (8th-order Linkwitz-Riley equivalent), implemented as minimum-phase FIR filters using the full 4,096 taps available in the miniDSP 2x4HD. This combination produced the best overall integration of the drivers, with excellent imaging, smooth tonal balance, and a crossover region that is largely inaudible in normal listening.

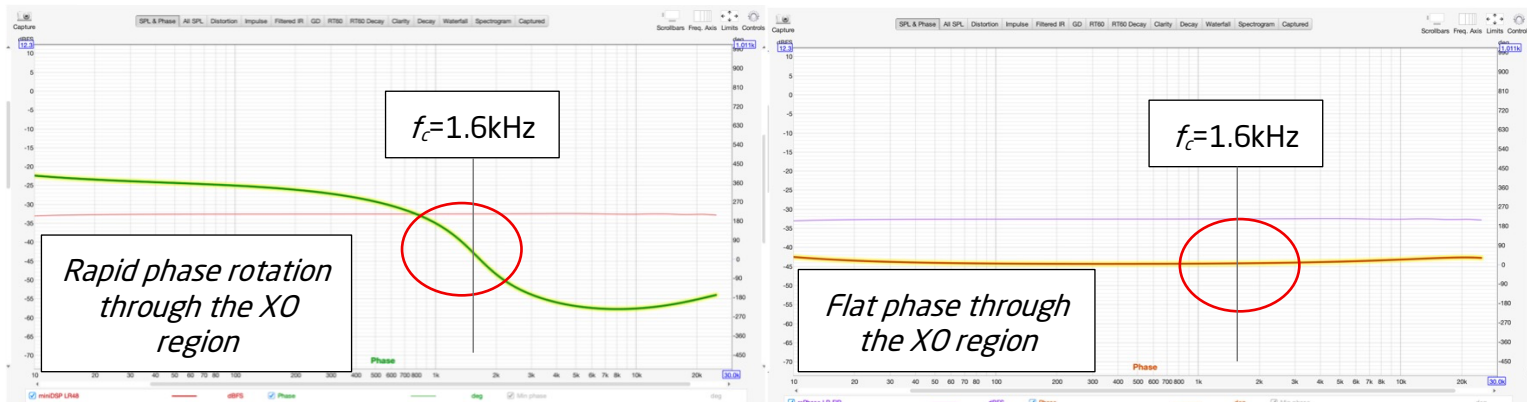
A delay of 150us is added to the HF Driver path when the speaker is in a horizontal position, where the HF Driver is in front of the LF Driver, such as when it is lying flat on a bookshelf facing forward, to compensate for the HF Driver's positioning in front of the LF Driver. The delay is removed when the Flow/1 is standing upright and the HF Driver is swiveled 90° forward. Preset files for XO FIR coefficients for the miniDSP 2x4HD are available for download on the adhoc website.

The selected crossover frequency lies in a favorable operating region for both drivers: well within their usable passbands, well away from resonance and native rolloff, and within their lowest-distortion region. The steep FIR slopes sharply reduce upper-frequency energy sent to the LF Driver, minimizing the amount of unwanted mid and high frequency content entering the quarter-wave tube, where it could otherwise excite internal modes and add coloration. They also strongly reduce low-frequency energy reaching the HF Driver, helping keep the high-frequency driver in its lowest-THD operating range. The miniDSP 2x4HD presets further allow quick switching among filter and delay configurations, including compensation for the small driver-offset changes that occur when the speaker is used in different orientations.

The figures below show the differences between IIR and FIR crossovers at the signal and as measured with a mic in front of the speakers. The IIR XO, in this case an 8<sup>th</sup>-order Linkwitz-Riley, introduces frequency-dependent phase shift between drivers, whereas the minimum-phase FIR crossover optimizes phase and group delay for better time alignment, yielding clearer transients and stable stereo imaging.

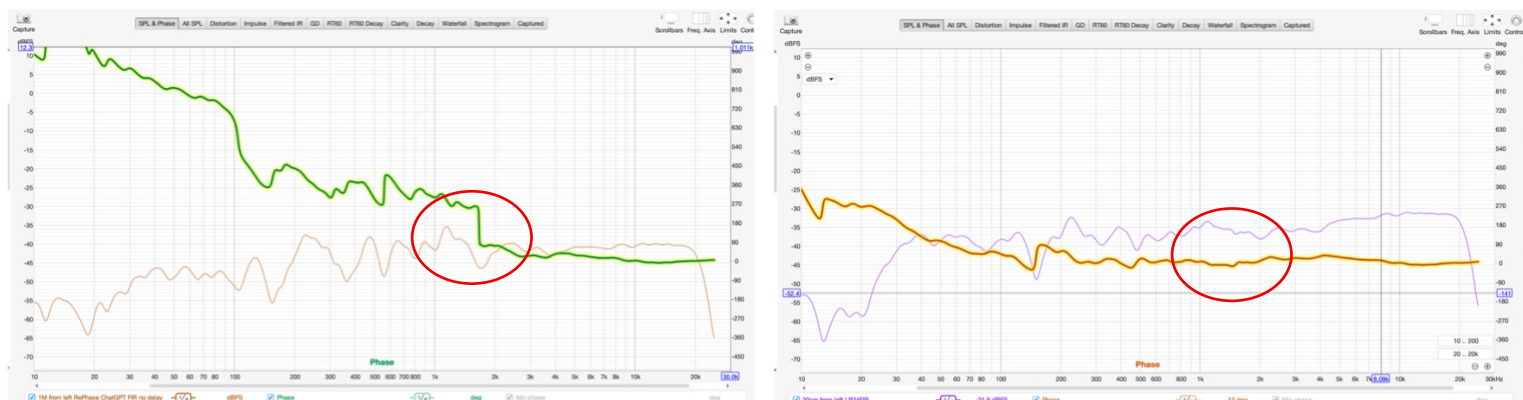
Figure 50 compares the phase shift at the XO between IIR and FIR filters at the signal level. The phase shifts over the XO frequency band in the IIR XO, whereas it remains constant in the FIR XO:

**Figure 50 IIR vs FIR XO Signal Phase Comparison**



The following images compare IIR and FIR filters at the speaker, as measured with a microphone. In Figure 51, observe the phase inversion at the XO with the IIR filter, and flat phase with the FIR filter:

**Figure 51 IIR vs FIR XO Speaker Phase Comparison;  $f_c = 1.6\text{kHz}$**



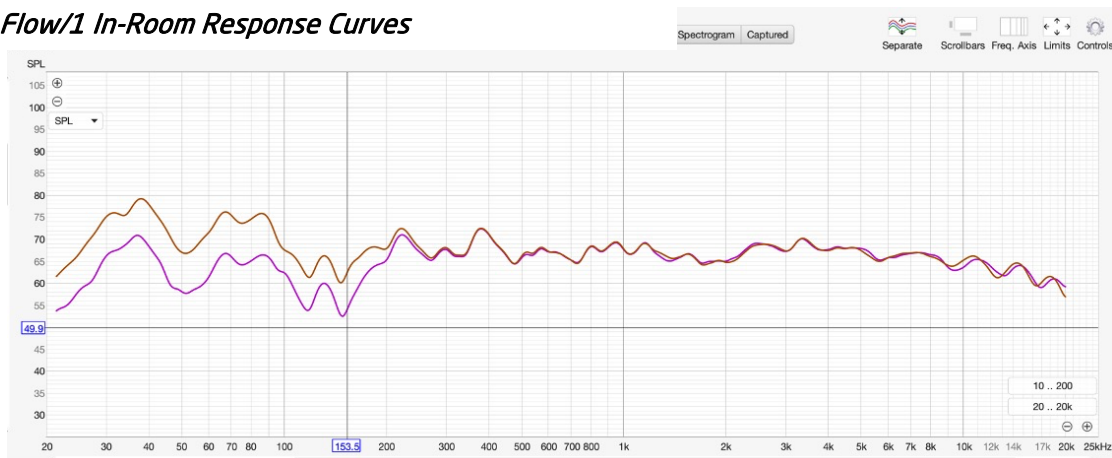
Compared with traditional IIR crossovers, an FIR implementation allows greater control over both magnitude and phase response, allowing the drivers to sum more precisely in time as well as in level. Traditional IIR crossovers concentrate phase rotation at the crossover frequency, while FIR filters maintain a smooth, controlled phase transition across the band. This improved time coherence can produce cleaner transients, more stable imaging, and a more convincing soundstage, helping the loudspeakers “disappear” so that listeners perceive the recorded space rather than the physical location of the speakers.

## Amplifiers

I use two Topping PA3s stereo amplifiers, one unit per speaker, for a total of four amplifier channels in an active bi-amplified arrangement. The PA3s can deliver 45 watts per channel into 8 ohms with low distortion and has proven to be a very good match for the Dayton Audio ND91-8 LF Driver and Wavecor TW030WA26-8 HF Driver. More powerful amplifiers may also be used; in practice, they can provide lower distortion at ordinary listening levels by operating with greater headroom and farther from their limits. Care must still be taken not to overpower the ND91, whose maximum rated power handling is 60 watts.

The measurement shown in Figure 52 is the in-room response of a pair of Flow/1 speakers in my living room, which is approximately 4 meters by 5 meters by 2.5 meters high, with a coffered ceiling. The red trace includes a +5 dB low-shelf filter at 100 Hz and is displayed with 1/6-octave smoothing. For a loudspeaker system with only about 5 liters of internal volume, the low-frequency performance is unusually satisfying, with useful in-room output extending into the 30 Hz region.

**Figure 52 Flow/1 In-Room Response Curves**

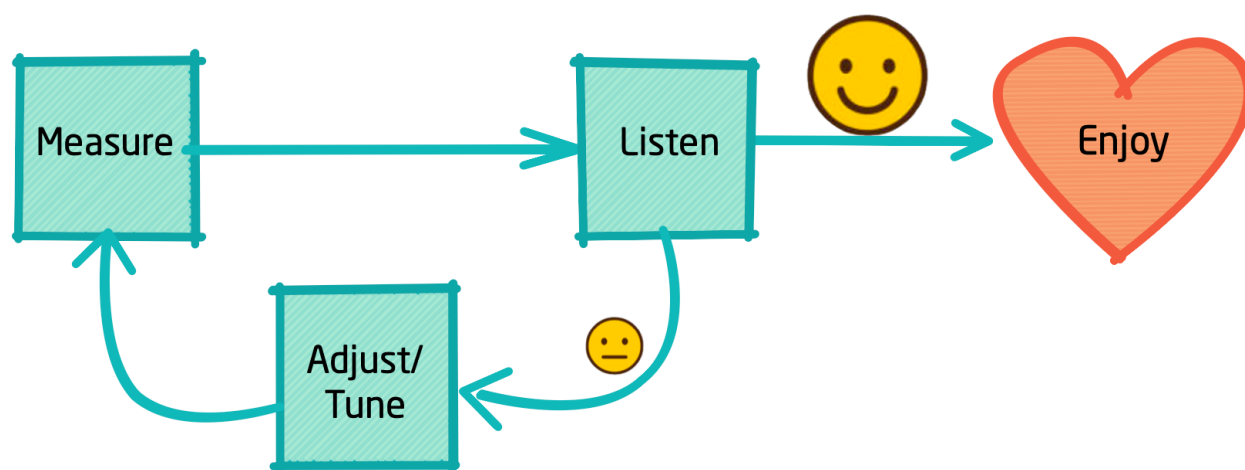


## Next Steps

You have now completed the Maker phase of the Flow/1 project: selecting the drivers, sourcing or printing the parts, assembling the enclosure and modular driver structures, preparing the wiring, and building the loudspeaker into a complete reference system. At this point, your Flow/1 is no longer a collection of files, printed parts, hardware, and ideas; it is a finished loudspeaker system built to be measured, tuned, listened to, maintained, and enjoyed. The care taken in each stage of the build matters, because the performance of the finished system depends on the precision of the geometry, the quality of the assembly, and the integrity of the electrical and acoustic integration.

From here, the next stage is no longer fabrication, but use. The forthcoming *Flow/1 User's Guide* will pick up where this Maker's Guide leaves off, covering system wiring, setup, measurement, DSP loading, listening orientation, tuning workflow, and practical operation in a real room. In other words, this Guide has shown you how to make the Flow/1; the User's Guide will show you how to get the best from it. Until then, the best next steps are the same ones shown in your roadmap: measure, listen, adjust, and enjoy.

And if you want custom stands, follow the *Flow/1 Speaker Stands Maker's Guide*, which shows you how to make custom stands designed to showcase your Flow/1 speakers.



## References

Distributors, manufacturers and printer partners listed in this document.

Table 10 is the list of distributors and manufacturers of products mentioned in this Maker's Guide.

*Table 10 Distributors, Manufacturers, and Printing Partners List*

Name	Used For	Link
DigiKey	Jacks and connectors	<a href="https://www.digikey.com/">https://www.digikey.com/</a>
LCSC Electronics	Jacks and connectors	<a href="https://www.lcsc.com/">https://www.lcsc.com/</a>
Madisound	Drivers	<a href="https://www.madisoundspeakerstore.com/">https://www.madisoundspeakerstore.com/</a>
McMaster-Carr	Screws and hardware	<a href="https://www.mcmaster.com/">https://www.mcmaster.com/</a>
Parts Express	Drivers and other parts	<a href="https://www.parts-express.com/">https://www.parts-express.com/</a>
Mouser Electronics	Connectors	<a href="https://www.mouser.com/">https://www.mouser.com/</a>
Solen Online	Drivers	<a href="https://solen.ca/en">https://solen.ca/en</a>
GomeSound	Drivers	<a href="http://www.gomesound.com/">http://www.gomesound.com/</a>
Wagner Electronics	Drivers and parts	<a href="https://www.wagneronline.com.au/">https://www.wagneronline.com.au/</a>
Wavecor	Drivers	<a href="https://www.wavecor.com/">https://www.wavecor.com/</a>
Neutrik speakON	Connectors	<a href="https://www.neutrik.com/en">https://www.neutrik.com/en</a>
Sound Imports	Drivers	<a href="https://www.soundimports.eu/en/">https://www.soundimports.eu/en/</a>
Dayton Audio	Drivers and Electronics	<a href="https://daytonaudio.com/">https://daytonaudio.com/</a>
Tang Band	Drivers	<a href="https://www.tb-speaker.com/products">https://www.tb-speaker.com/products</a>
SB Audience	Drivers	<a href="https://www.sbaudience.com/">https://www.sbaudience.com/</a>
JLC3DP	3D Printing and PCBs	<a href="https://jlc3dp.com/">https://jlc3dp.com/</a>
CraftCloud3D	3D Printing	<a href="https://craftcloud3d.com/">https://craftcloud3d.com/</a>
Slant	3D Printing	<a href="https://www.slantpod.com/">https://www.slantpod.com/</a>
Lazada	Wires, tools	<a href="https://www.lazada.co.th/">https://www.lazada.co.th/</a>
miniDSP 2x4 HD	Flow/1 Reference System	<a href="https://www.minidsp.com/">https://www.minidsp.com/</a>
Topping Amps	Flow/1 Reference System	<a href="https://toppingaudio.com/">https://toppingaudio.com/</a>

## Closing Note

Thank you for taking the time and care to make a Flow/1. If you have reached this point, you have done more than assemble parts—you have created a highly engineered loudspeaker system designed to be measured, tuned, refined, and enjoyed. Build carefully, listen critically, and enjoy the process of discovering what the Flow/1 can do in your own room.

## Public Guide and Subscriber Resources

This Maker's Guide is provided publicly as an introduction to the Flow/1 project. Access to the Flow/1 3D design files, future design updates, and subscriber discussion resources is provided separately through [adhocspeakers.com](https://adhocspeakers.com).

## Disclaimer

This document is provided for informational and educational purposes only. The builder is solely responsible for safe use of tools, materials, adhesives, electrical equipment, amplifiers, DSP hardware, and loudspeaker components, and for verifying the suitability, fit, and performance of all parts, processes, and finished assemblies. [adhocspeakers.com](https://adhocspeakers.com) assumes no liability for injury, damage, loss, or unsatisfactory results arising from the use of this guide or from the construction or use of the finished loudspeaker system.

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