

Foreword

Since iv'e been a kid i was always fascinated by my parent's stereo system. A silver Marantz amplifier with a red VU-Meter, the fitting stereotuner, a recordplayer, a turntable and a cassette deck were my personal highlight in our living room. The Songs by Led Zepelin, Deep Purple and other classics were my entry into the world of music. Soon i got my first own CD - "Master of Puppets" by Metallica.

Coming from a craftmans family with a workshop on the property, i've always been tinkering around with different things and never stopped trying new stuff. There have been childish tries to make PC speakers portable with 9V batteries and other things like that long ago.

Since 2 years iv'e been learning how to properly developpe speakers from the ground up. I started the hobby by building various fullrange speakers. Now iv'e reached the point that i want to developpe my first own 2 way speaker.

A huge thanks goes out to the guys of **D.A.U.** (Der Akustische Untergrund). Specifically to **Rouven Wulff**, **Alexander Gresler** and **Oliver Eser**. Without your knowledge and all the awnsers to my questions i wouldn't have come this far.

May i present: **Fion** (First One) - a 2 way compact speaker in a BR enclosure



Drivers



Dayton Audio DSA135-8

For the beginning, i wanted to build a free standing 2 way speaker that is compact and affordable. I was thinking about a small speaker that sounds big in a medium room - perfect for my living room. After searching a bit i found the DSA135-8 by Dayton Audio. Not only does it look great with its black anodized aluminium membrane, it also promises a solid bass response from a small bass reflex enclosure, judging by its TS parameters. Looking at the datasheet reveals that the midbass driver is usable up to 3 kHz.

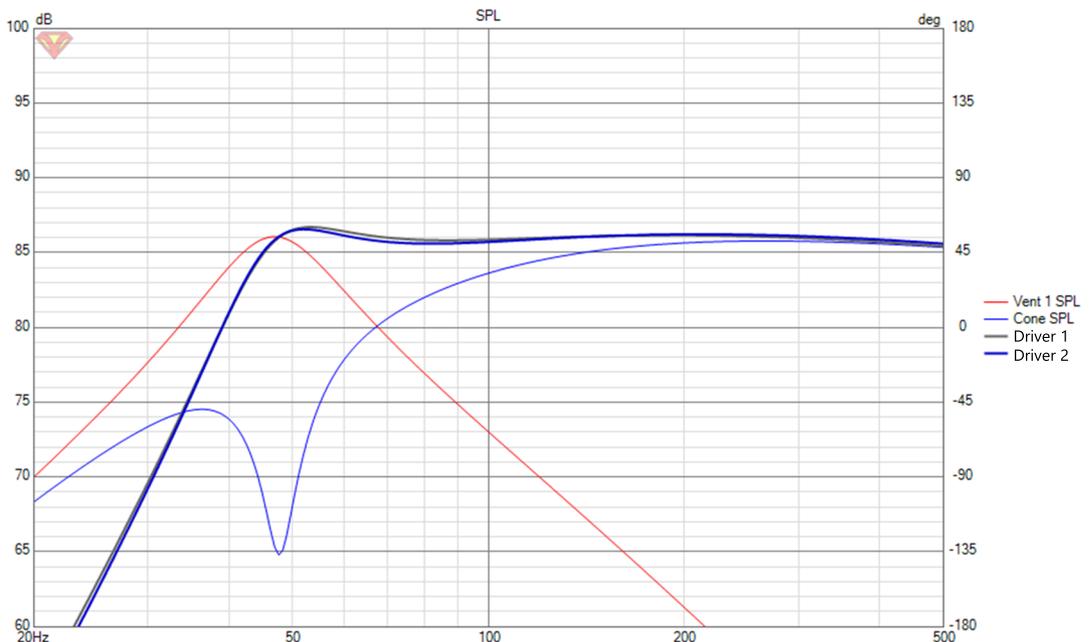
Dayton Audio DSA135-8			
	Datasheet	Driver 1	Driver 2
Re	5,9	5,7	5,7
fs	51,8	50,5	53,7
Qms	2,04	2,76	2,56
Qes	0,47	0,46	0,48
Qts	0,38	0,4	0,4
Rms	1,52	1,312	1,509
Mms	9,5	11,4	11,4
Cms	0,99	0,87	0,767
Vas	7,93	6,95	6,13
Sd	75,4	75,4	75,4
BL	6,22	6,67	6,75
Z1k	7,7	7,6	7,5
Z10k	23,4	23,5	23,8

The Datasheet TSP differ a bit from the ones i measured with DATS but since both drivers are that close, there won't be any problem doing enclosure simulations with the TSP i measured myself. Looking at the simulation, the DSA135-8 will play in a 10 liter BR enclosure down to an f3 of 43 Hz.

The small bump in the bass region is wanted and makes a small speaker sound a bit more grown up.

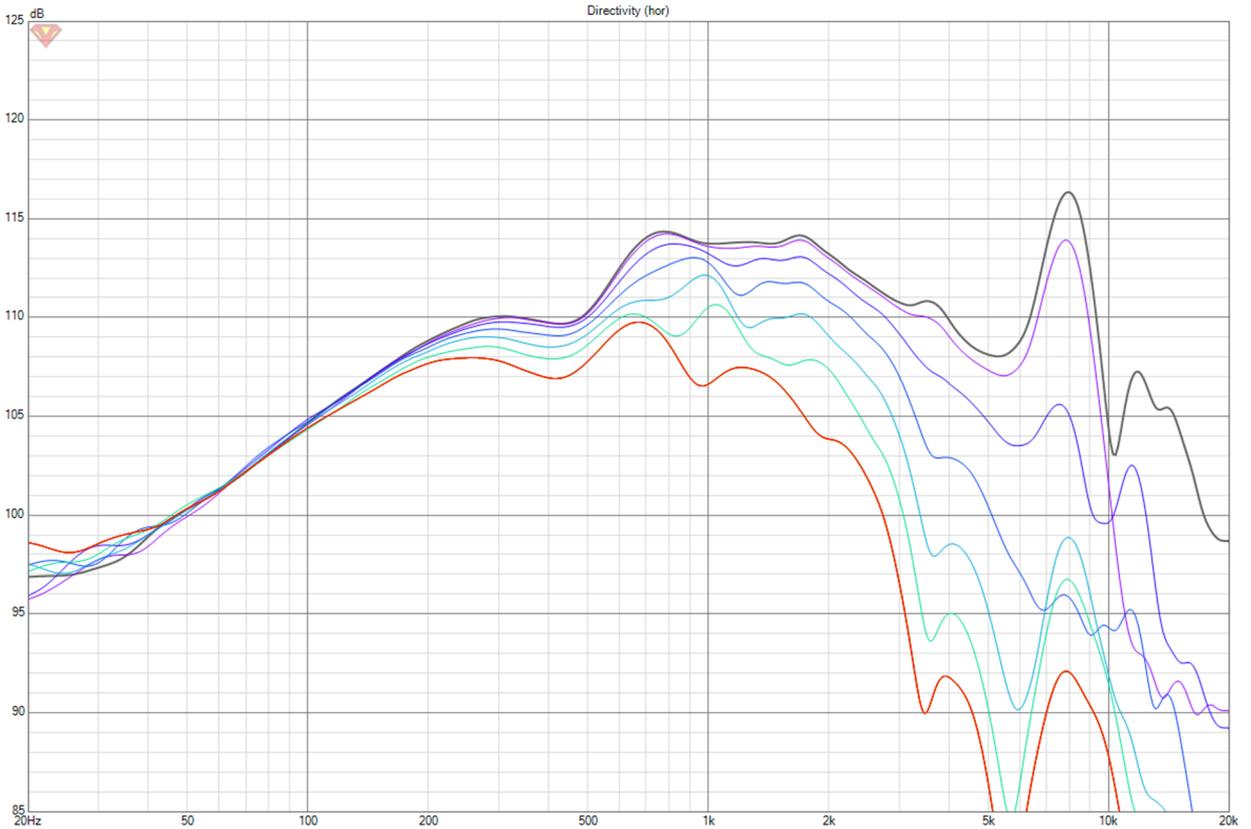
The simulation suggests a port with a length of 180 mm.

But in reality we can only reach the desired tuning if we use a port of 140 mm length. This is due to the simulation program not considering walls and the enclosure itself being very small.



The off axis measurements of the DSA135-8 confirm the assumption of it being usable up to 3 kHz. The bump at around 800 Hz will need some taming, other than that it's already looking great so far. Depending on the crossoverpoint, the bump at 8 kHz could become problematic. We'll have to keep an eye on that when developing the crossover.

Note: this measurement is not level calibrated. Since midbass and tweeter have been measured in the same positions at the same amplifiergain, we can use these measurements for crossover simulation. I will record the true level at 2,83V/1m in the end when the speaker is finished. All measurements are 2 channel measurements.



At first i thought about pairing the midbass with the SB19ST-C000-4 by SB Acoustics. Since its dome is only 19 mm in diameter there would most likely be problems with beaming around the crossover point, people in the FB group of D.A.U. quickly suggested some alternatives.

After some thinking and comparing i chose to go with the **SB26ST-C000-5**. With a diameter of 28 mm it should be way easier to get a smooth transition between the drivers.

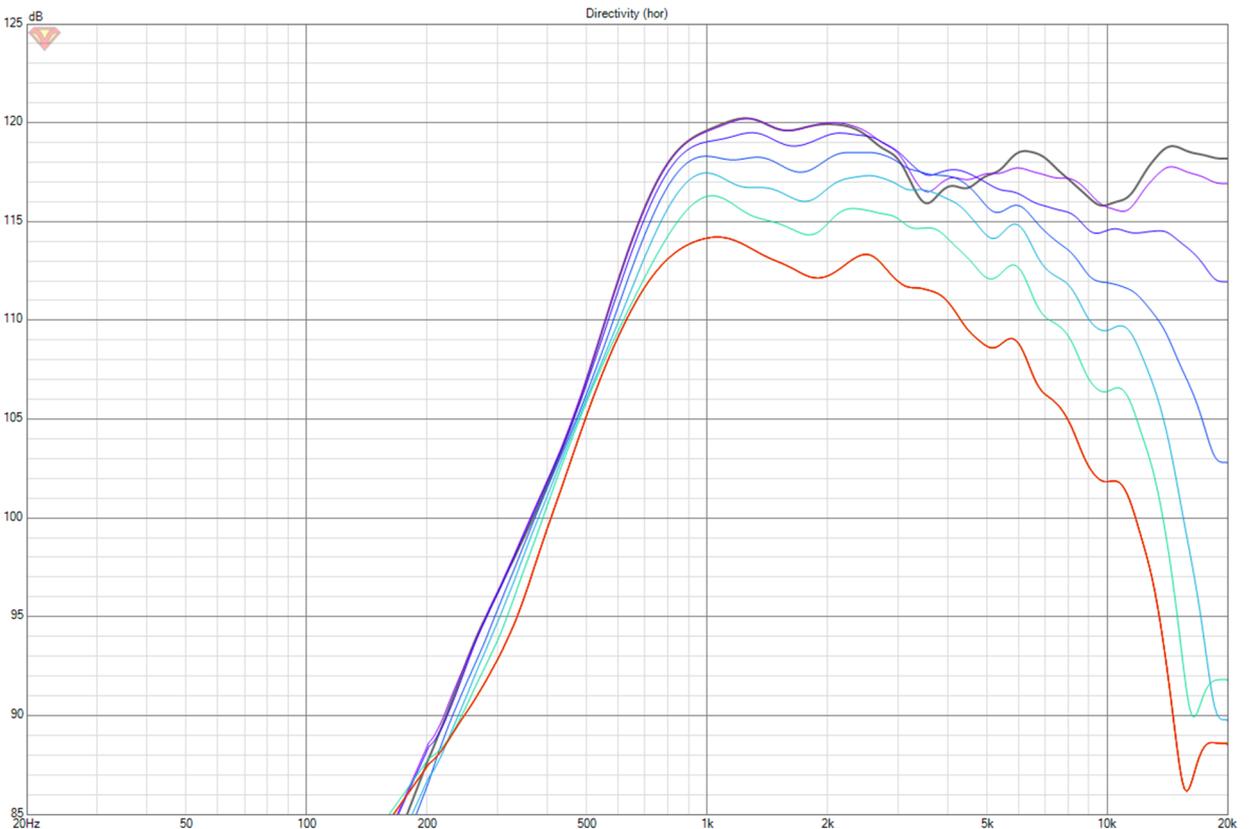


SB Acoustics SB26ST-C000-5

Following the rule of thumb, the tweeter with its F_s of 870 Hz should be usable from around 2 kHz, which should make it easy to pair it with the DSA135-8.

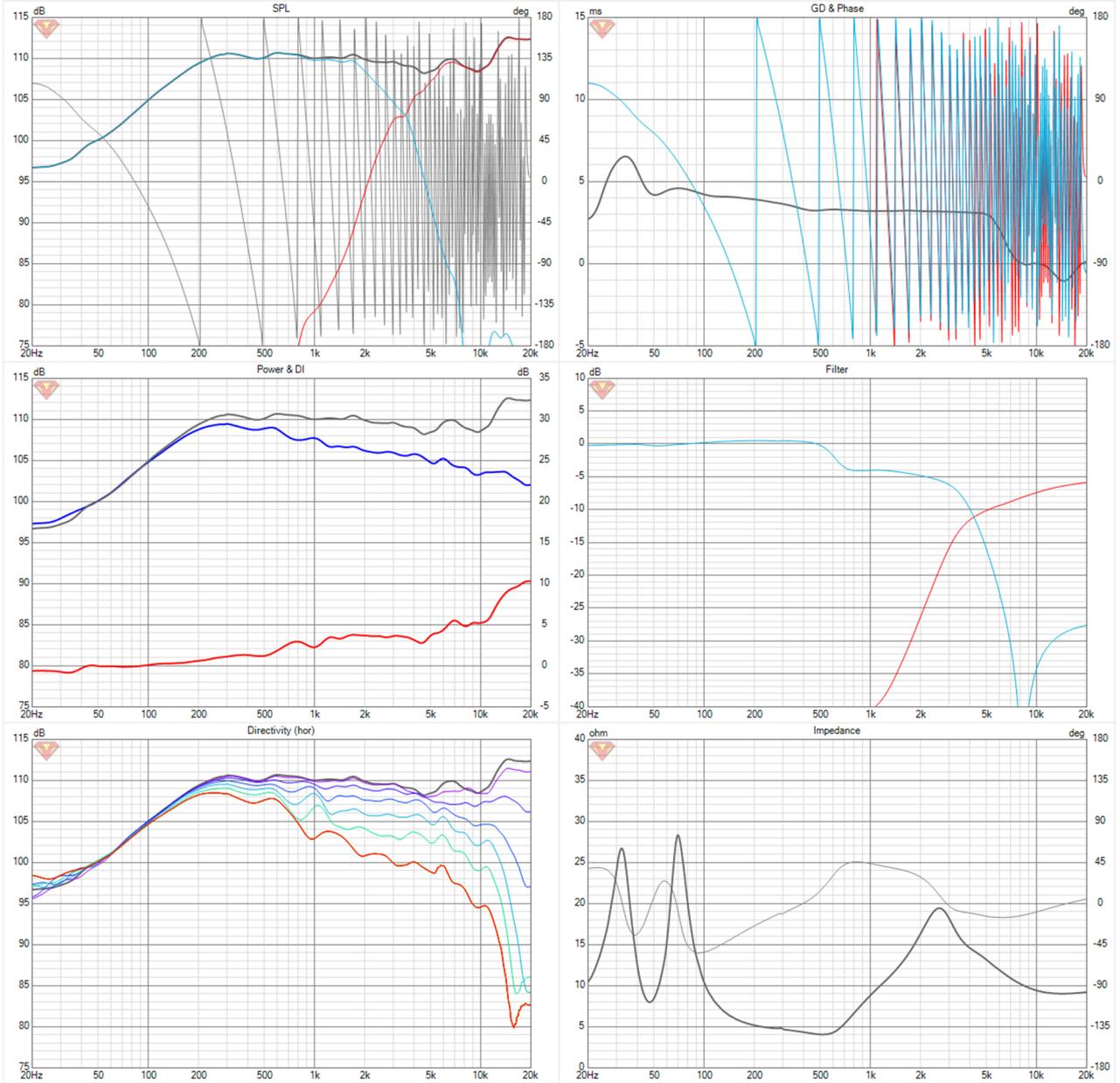
The quite affordable tweeter is very well made and feels heavy and solid.

On axis we can see a nasty dip at around 4 kHz. This is due to diffraction (caused by the tweeter position on the baffle) and is already being fought against with 16 mm chamfers on the baffle. The sloping off axis levels suggest that energy response is going to be nice already.



Crossover Simulation

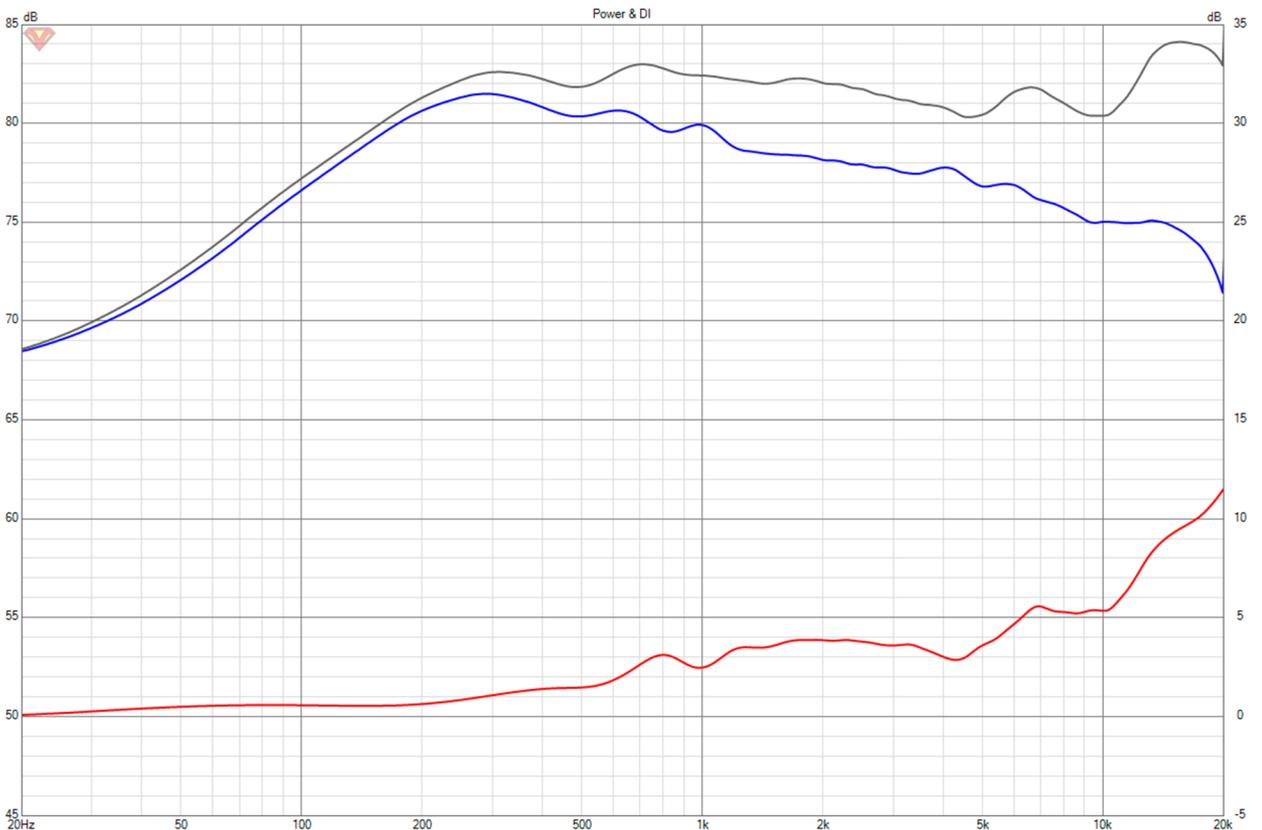
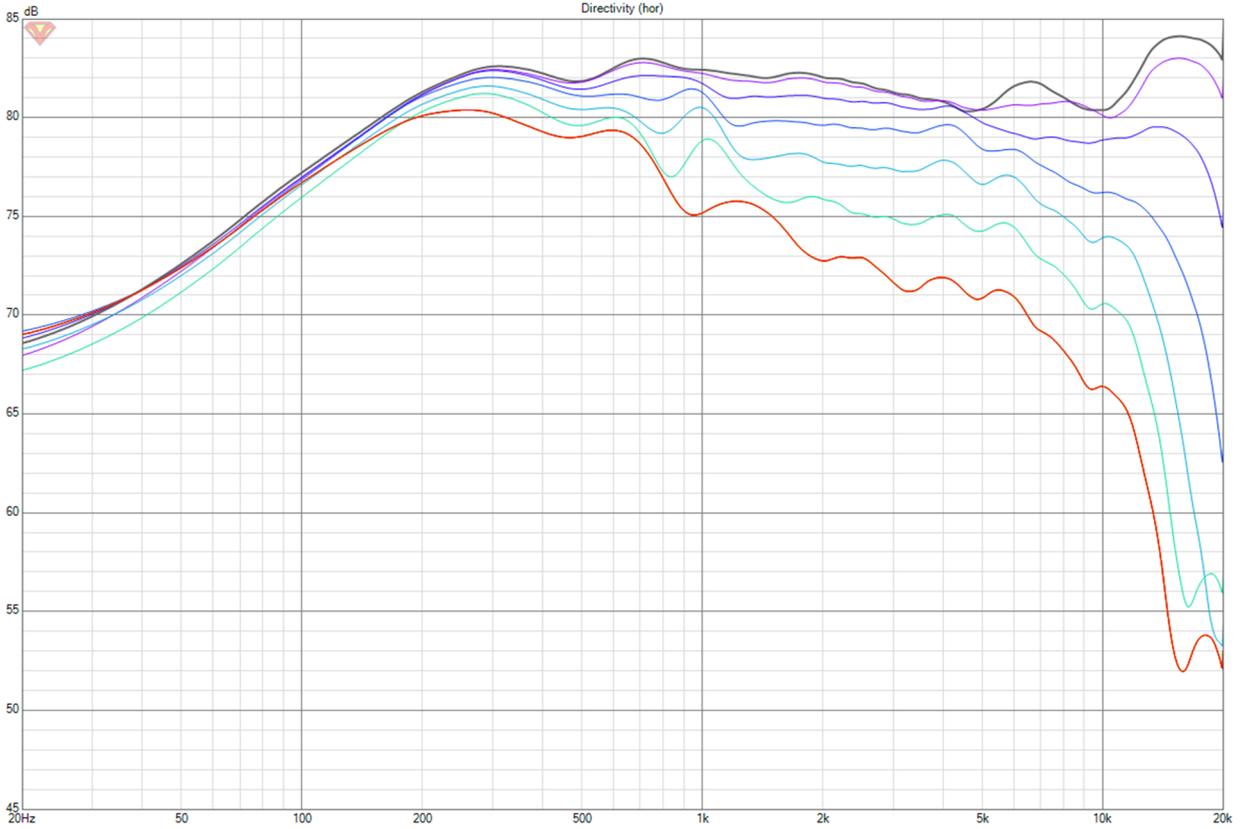
With the measurements we made of the drivers being in the enclosure we can start to simulate a crossover. In the beginning i was going to try to have the on axis response as flat as possible. This would have resulted in a crossover with many parts making it unnecessarily expensive. Thankfully Rouven told me not to pay too much attention to on axis response especially since the small off axis bumps equalize the dip. This way i was able to simulate an affordable crossover that results in an evenly sloping energy response. This is a good indicator for a balanced sound.

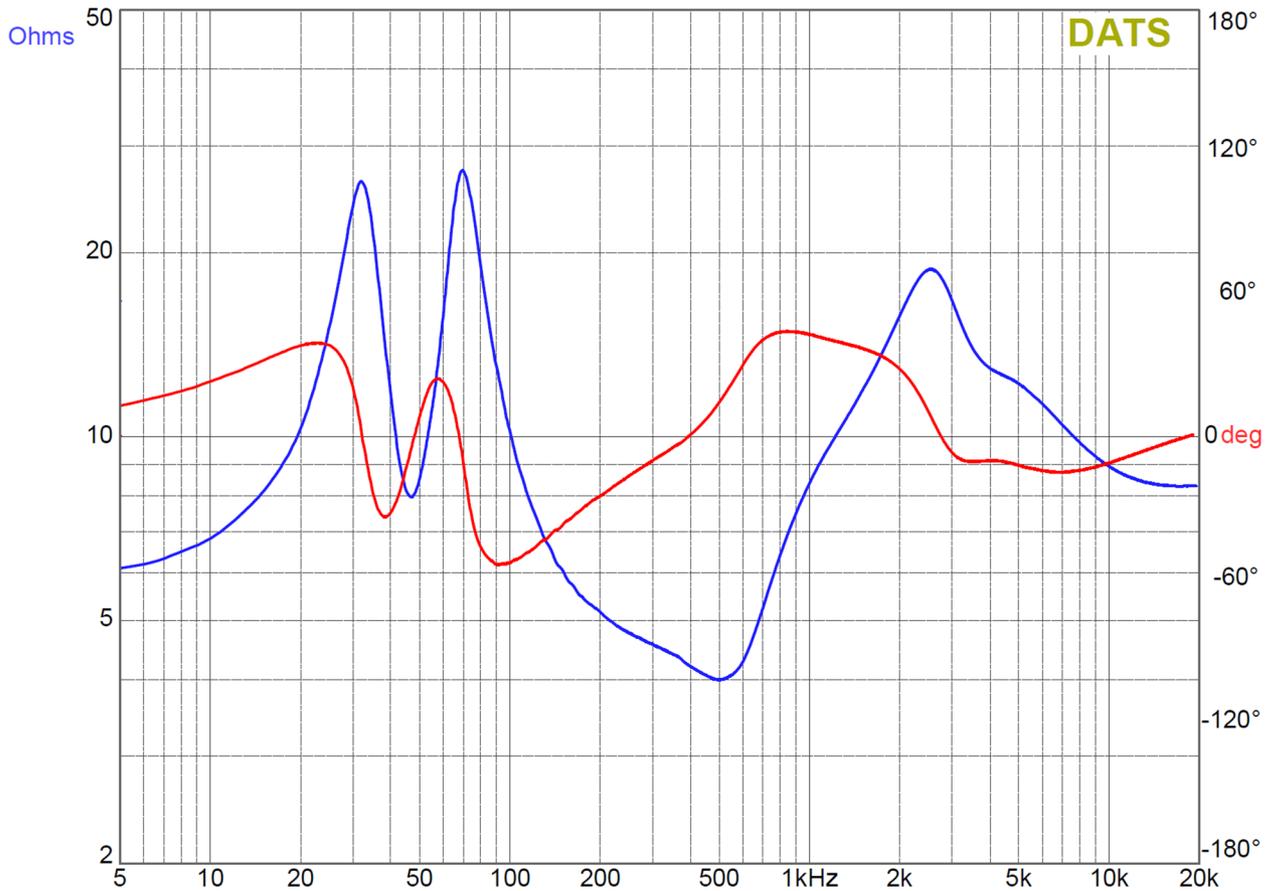


As soon as all the components arrived i put the crossover together and made a measurement. Oops, theres something wrong. The tweeter is playing way too loud!
After simulating a bit the culprit was quickly found. If you increase the value of the L pad resistor that is parallel to the tweeter it exactly recreates what i just measured.
Meaning in reality i will have to lower the resistors value. Instead of 18 Ohm R2 has 9,1 Ohm now.
Now simulation and measurement match up.

Final Measurement

Here are the calibrated measurements, energy response and impedance of the finished Fion:





Comparing measurements and simulation we can see they match up well. Only R2 had to be smaller to reach this goal. It's not unusual that some components might need another value that differs from the simulation.

Diffraction was almost eliminated because of the relatively high crossover point.

The irregularities in the high frequency region are evened out with the off axis response which creates an overall balanced sound.

Fion isn't an efficiency wonder but still the speaker shouldn't be underestimated.

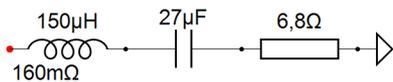
Especially bass performance is putting a smile to my face since its clean and wont let me down even at higher levels.

The Speakers impedance is absolutely uncritical and reaches its lowest value at exactly 500 Hz with 4 Ohm.

Every modern amplifier should be able to handle these.

If you want to drive the Fions with a tube amp you will need to add an impedance linearisation

This is easy to do with another series notch parallel to the crossover:



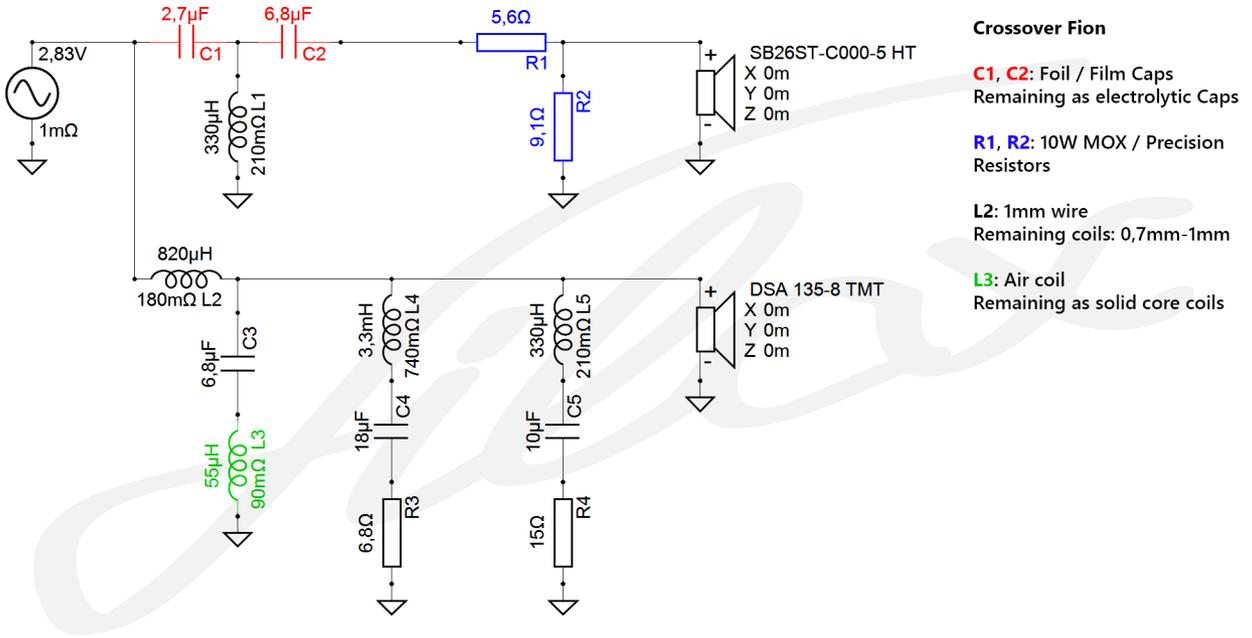
A shout out goes to the members of the **D.A.U. FB-Group!**

In this small community i learned so much that you are reading this PDF today. Without you i wouldnt be doing this hobby today in the way i am now!

Thank you!

And a lot of fun to everyone wanting to build the **Fion** speakers :)

Crossover Plan



A picture of the crossover can be seen on the last page.

Costs, Boardsizes and Port

SB Acoustics - SB26ST-C000-5: ~ 26,45 € (Soundimports)
 Dayton Audio - DSA 135-8: ~ 32,45 € (Soundimports)
 Crossover components per side: ~ 32,75 € (Quint-Store)

Price per side: ~ 91,65 € / 106,40 \$ (Prices for parts bought in germany)

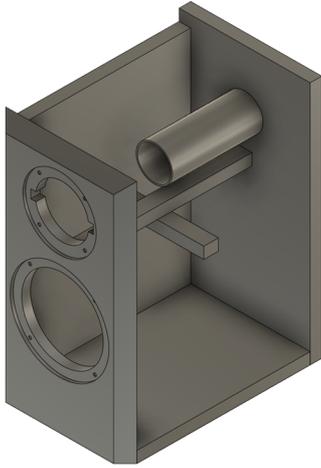
For one enclosure a 16mm thick MDF board of 0,7m x 0,7m (0,5m²) is enough.
 All boards can be cut from this without much leftovers:

Top/Bottom:	180mm x 238mm x 16mm	2 Pieces
Sides:	308mm x 238mm x 16mm	2 Pieces
Front-/Backside:	340mm x 180mm x 16mm	2 Pieces
Braces:	238mm x 20mm x 16mm	1 Piece
	148mm x 20mm x 16mm	1 piece

Port: 140mm x 46mm (Inner diameter)

The port is made from a 50mm PVC-Pipe.
 The port is sunken into the backside of the speaker so its total length is 140 mm. The port's outlet is given a radius chamfer. Make this as big as possible.

Enclosure Plan



Materialthickness: 16mm
Tweeter cut out: 3,2mm deep
Midbass cut out: 3,5mm deep
 45° chamfer from the backside.

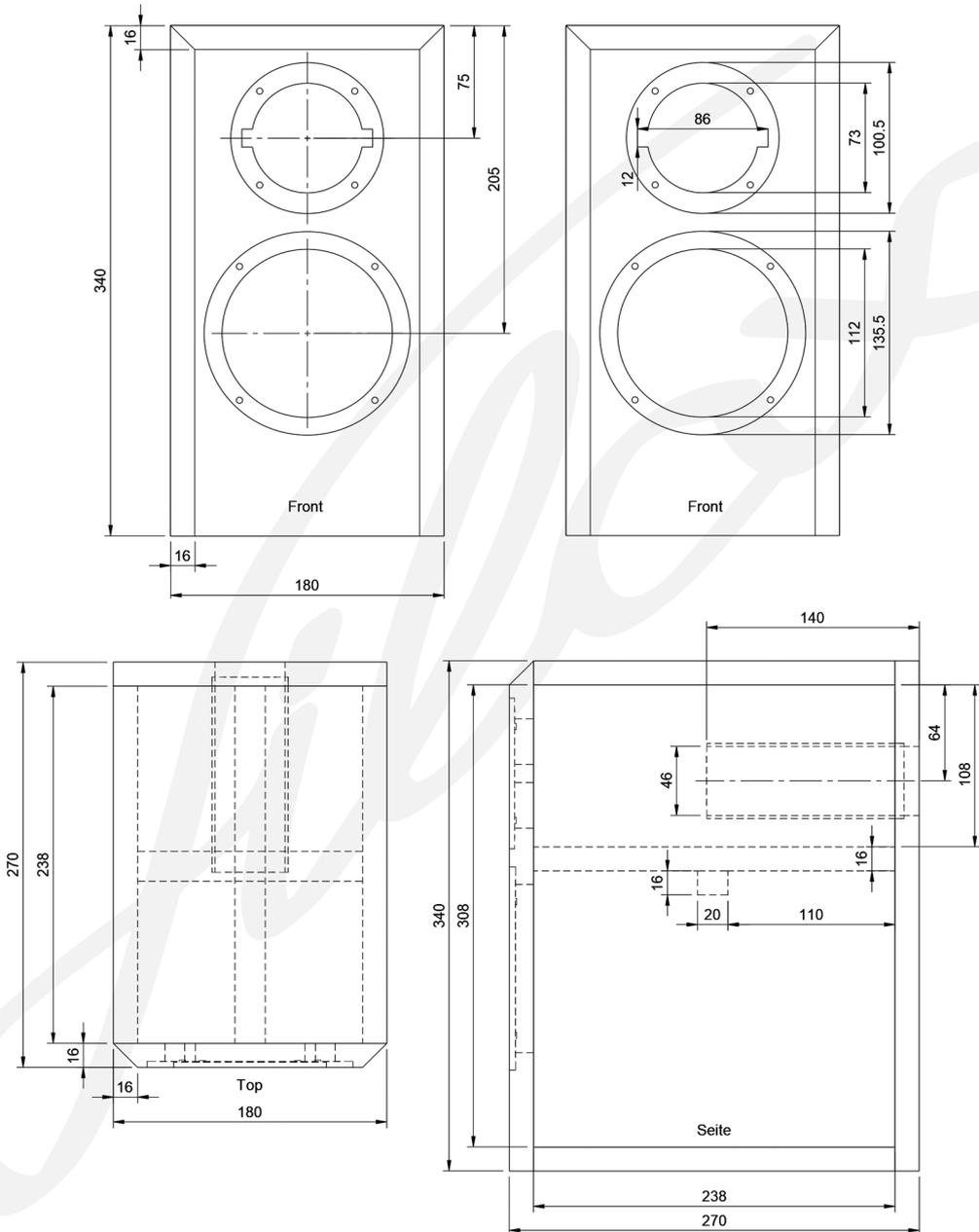
Damping:

Back and Topside get 40mm acoustic foam.

Both sides get one layer of polyester wool.
 Between port and braces, put some polyester wool as well.
 The port opening needs to stay clear.

The crossover is mounted to the bottom board. Put one layer of polyester wool on top of it.

A picture of the dampening can be seen on the last page.





Recommended websites:

www.der-akustische-untergrund.de | www.donhighend.de | www.roul-diy.de

Contact : Janosch Petry | fi3ur@yahoo.de

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