Acapella

Fig. 1. Maddy Prior CD cover.

The following pages should be read in line with the Point75A&B paper that describes the construction of a hybrid dipole loudspeaker based on the Scan Speak 18W/8535 bass driver, the SEAS W15CY001 midrange driver and the Expolinear NDRL81 ribbon tweeter. The B-version suggests an alternative tweeter, the NEO3PDR planar driver making the construction a dipole from 300 Hz all the way up.

My distant friend Darryl, Australia, made me aware of a particular CD, “Bib & Tuck” performed by Maddy Prior and The Girls.
The first track on this CD, “Acapella Stella”, is an example of this musical tradition and proved to be somewhat the ultimate test for a loudspeaker.
Three vocals closely miked, recorded and overdubbed in a reverberant environment and possible added further reverb. The reproduction of this (and other tracks on the CD) is something of a challenge to any loudspeaker constructor. As you may have noticed from the “2.5 Clone” and the “Point75A&B” papers, I have often referred to a speaker’s capability of reproducing the human voice. To my knowledge the human voice is by far the most difficult sound to reproduce.
We cannot be fooled by the human voice. We all know the sound of the human voice.
Very often recording engineers in the pursuit of a particular sound, position the microphone very close to the artist and excessive sibilance can be the result.
On the “Acapella Stella” track, one vocal is closely miked, the others with a little more distance.
The Point75A&B can reproduce the “Acapella Stella”, but not loud, and by loud I mean quite loud. That’s a lot to expect from a 6½" bass driver and a 5" midrange. It has its limits.

So, let’s try to summarise the lessons learned from the Point75:

The P75A is a great tool for monitoring and getting to know the better recordings in your CD or vinyl collection from the poorer ones. The transient attack is astonishing and leaves most behind. The soundstage is huge and transparency is phenomenal thanks to the magnesium midrange driver. There are things with this version that could be a little better. The upper bass/lower midrange could have more weight due to the limited membrane area of the midrange driver and the chosen point of crossover. However, those who have auditioned the speaker have claimed it to be a great-sounding speaker with a very good tonal balance and lots of “see-through” capability. The NDRL/ATD ribbons may not be among the top-ranking ribbons in this world, but careful tweaking and equalisation as described can improve the situation considerably as described in the P75 paper.
I have auditioned the Red Rose Music **Rosebud II** speaker with a probably higher quality ribbon, an OEM Aurus Cantus driver. This speaker had a similar immediate appeal but failed nevertheless on vocal performance. Quite disappointing considering the price tag of 4,200 EUR. No bass and too much “tizz”. To my ears.
An alternative tweeter was considered and the NEO3 PDR was an obvious option with a wide frequency range and lightweight membrane of considerable area, 10 cm^2. And it comes cheap too, at least in the US. 40 US$ at www.partsexpress.com.
The tweeter/mid integration was slightly improved due to this change (latest modifications not included) and for a while I thought this was the final answer to the construction, but in the end I stayed with the NDRL and the final solution to this midrange/tweeter problem was the change of the bass LP-section from 12 to 18 dB as it

appeared the upper midrange/lower treble problems were due to overlapping from the bass driver (read P75 paper).
Talking about vocal presentation it's hard to ignore the history of Spendor and the whole BBC school of loudspeakers paying particular attention to this problem. And there's lots of material on the web.
Spendor will use a 6½" driver from only 600 Hz up to 4 kHz in the SP100. They will use a 1½" mid dome from only 3 kHz in the SP1/2 construction. A 19 mm dome will not go lower than 4-4.5 kHz, and so on.
The lesson learned from this exercise is: always use drivers capable of reaching preferably two octaves below the intended operational range (for good reasons this doesn't count for the bass driver!).

The new drivers

I have long wanted to try the TPX cone material, mostly used by SEAS, and reading a review of the Canadian Verity Audio X.2 loudspeaker in the German magazine Image HIFI, made me realise the time was ripe. This 5.460 €/pair of loudspeakers come with what looks like a standard T17 driver costing 80€!
However, the Verity version should be a SD version. For treble a Scan Speak 8512 tweeter, all driven by a simple 12 dB crossover. Quite easy to clone I would say.
Talking about hard cones, this T17RE has a rather rigid cone, where the dust cap is made from soft rubber giving the driver a smooth roll-off characteristic. This driver is easy when it comes to crossovers. And going from a 5" driver to a 6" driver increases membrane area considerably, from 75 cm^2 for the W15 to 130 cm^2 for the T17 and should possibly reduce non-linear distortion.

Fig. 2. SEAS T17RE, TPX cone material.

Fig. 3. Scan Speak D2905/9500 tweeter.

No further comments on the Scan Speak D2905/9500 tweeter. This driver is well known from the 2.5 clone papers. It's simply a great tweeter and so far I like it better than my 9700 tweeters, but I may still have to explore the 9700 in detail.
Implementing these drivers didn't take long and the crossover is presented here:

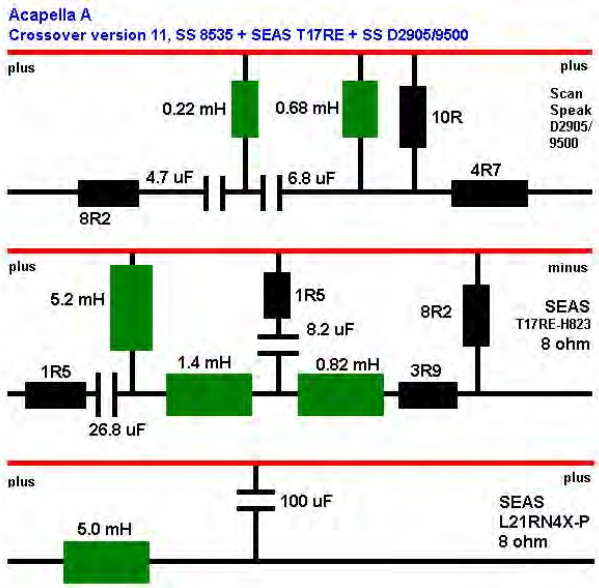


Fig. 4. **Acapella** $_{8535+T17+9500}$ crossover.

Fig. 4 shows the response of both speakers at 1 meter distance. The "voicing" is on the bright side with 5R6 to the tweeter and might do better with a further 1-2 dB attenuation. This setup can blow your head off without noticeable distortion, so I left it here for some time, but finally settled for 8R2 as shown in the schematic.

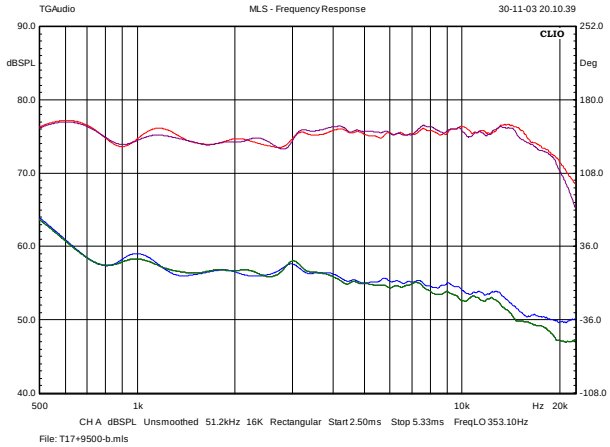


Fig. 5. Red and purple = response from left and right speaker. Blue and green = minimum phase.

Fig. 6. New drivers mounted on separate panel of test cabinet.

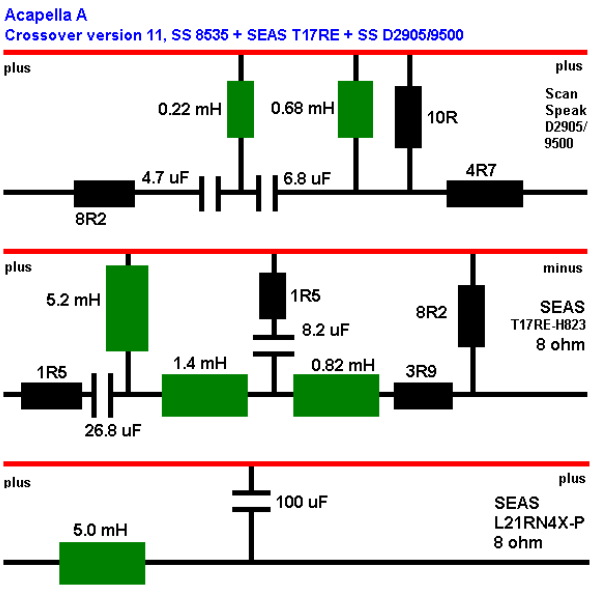


Fig. 7. SS 8535 + T17RE + 9500

A new problem became obvious here, the 8535 driver. This has been a true follower for the last 12 months from the 2.5 clone to the Point75. But with the increased SPL capability of the T17 and 9500 drivers, this bass simply cannot move sufficient amounts of air. So, it's a goodbye to this well-proven driver.

Fig. 8. Acapella, new bass driver.

To keep a cabinet of modest size, several 8" bass drivers were considered. The Scan Speak 21W/8554, the Dynaudio 21W54 (no longer available) and the SEAS L21RN4X/P, which is an aluminium cone driver with a suitable TS-data-set and a modest price tag. With a point of crossover at 300 Hz this driver with its 4-layer voice coil (high inductance) doesn't need additional notch filters to overcome the inevitable break-up modes of the alu cone. Actually the roll-off characteristic is better than the 8535 driver. 8-10 dB lower response at 2000 Hz. This with the same crossover components.

Fig. 8a. SEAS L21RN4X/P, H956 alu bass driver.

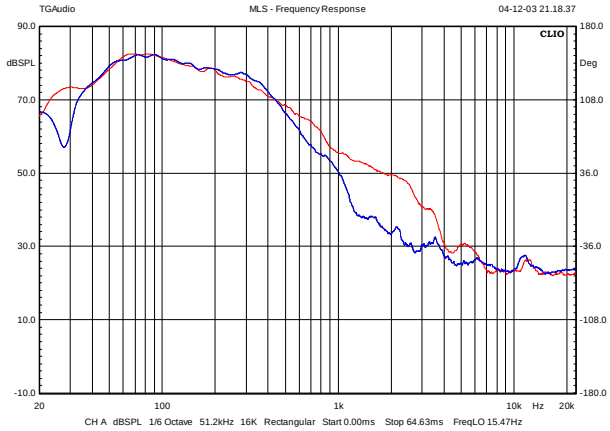


Fig. 9. Bass driver response:
Red = Scan Speak 18W/8535
Blue = SEAS L21RN4X/P
The 8535 being 30 dB down at 2 kHz may seem irrelevant, but it isn't. It has an impact on the midrange and consequently the Point75A bass LP crossover section was changed from 12 dB to 18 dB with improved midrange presentation.

Acapella L21+T17+Esotar

Having a pair of Dynaudio Esotar T330DA-D-magnets at hand, it was obvious to try this driver in replacement of the SS 9500.
The Esotar is an awesome tweeter. Two huge magnets larger than the combined magnets of the bass and midrange drivers, run this tiny 1" fabric dome.

Fig. 10. Esotar (left) and 9500 tweeters.

Fig. 11. **Acapella** L21+T17+Esotar

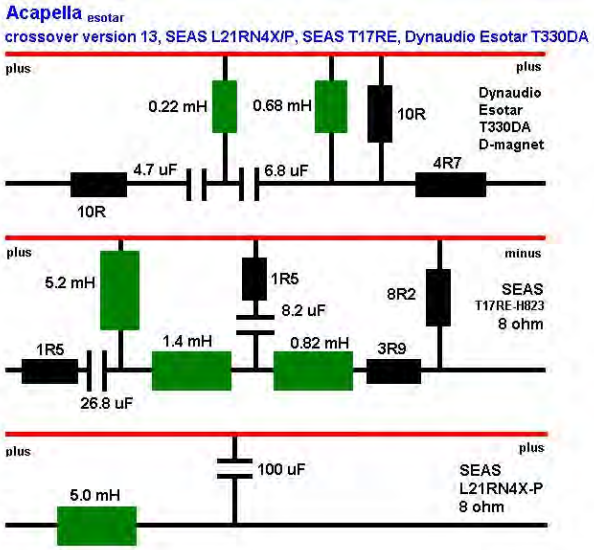


Fig. 12. Acapella L21+T17+Esotar crossover.

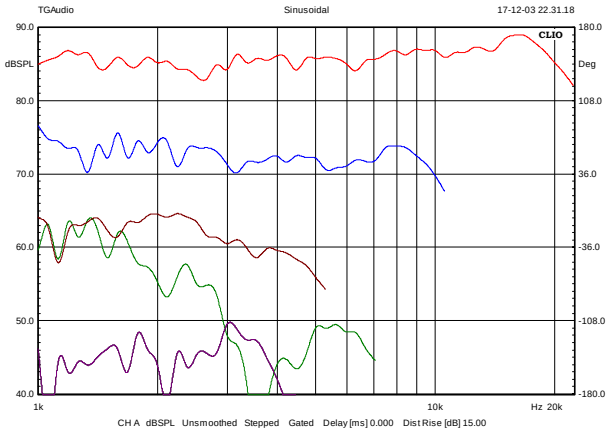


Fig. 13. Acapella L21+T17+Esotar distortion.

Red = T17+Esotar sinusoidal response from 1 kHz. Harmonic distortion: blue = 2nd, green = 3rd , brown = 4th ,purple = 5th .
Response raised by 15 dB.
Notice the very low 3rd harmonic distortion.

Summary

What could be learned from these initial experiments?

First of all the bass cabinet received a new port of 72 x 150 mm giving a port tuning of 38 Hz. The response from this driver doesn't go lower than the 8535, but there's an improvement in quality being more dry and solid. And it can play much louder.

The T17RE driver is a remarkable driver delivering a midrange with clean and apparent undistorted sound. It's very easy in terms of crossover, which has been simplified compared to the Point75. An 18 dB upper roll-off characteristic and no notch filters needed.
The price is only 79 EUR from http://www.lautsprecher-hop.de/hifi/index.htm; here it's called W171XP, the SEAS id. H823. This driver is not available from ELTEK Norway.

The 9500 tweeter is in its right place here, delivering all the best this tweeter can provide and that's a lot.
I wouldn't hesitate to recommend the "L21+T17+9500" whether you like classical, jazz or rock music. It does it all with a solid, dry bass, an undistorted midrange and a fluid, transparent treble. I have never heard the 9500 as good as in this combination. This is truly a phenomenal tweeter when properly matched to the midrange driver.
The L21 driver takes some break-in time and needs some heavy beating to do so. Play some heavy bass for a month or so to loosen up the heavy rubber surround and the rear suspension.
The overall system can play loud and the only reservation is the "Acapella Stella" played very loud. A minor compression appears from the tweeter when run very loud. No surprise. We're talking 95-100 dB peak levels in 2.5 meter listening distance.
So, what about the famous Dynaudio Esotar tweeter?
Well, this is a great tweeter with an apparent astonishing low distortion. This tweeter can go loud, louder than the 9500 without apparent compression.
The sound? Very much like the 9500. This tweeter in on hold, while we explore other possibilities.

The SEAS L21RN4X + SEAS T17RE + SS 9500 is going to be my low-cost suggestion for a very capable "Acapella".
The bass cabinet dimensions and tuning need further refinement. Details to come.

Introduction of the Scan Speak D3806/8200 mid-dome/tweeter.

Recalling the notes I made on the Spendor approach, I have always wondered why on Earth would anyone bring in a 1½" midrange/tweeter dome at 3 kHz!? Plus an 8513 tweeter from 13 kHz!
Most people would insert a 1" dome from this point of crossover.
Joachim Gerhard from the German "Audio Physic" uses the 9500 from 1300 Hz in the Caldera speaker!
I have tried my 9500 tweeter with the Caldera crossover and it sounds awful.
Well, the Spendor SP1/2 uses the Scan Speak D3806/8200 1½" driver and this is readily available from ELTEK, Norway, and Strassacker, Germany. And it comes cheaper than a pair of 9500 drivers!

Fig. 14. Scan Speak D3806/8200 driver.

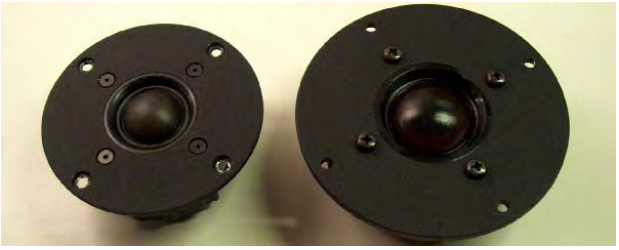


Fig. 15. The 9500 tweeter next to the D3806 driver.

Looking at the D3806 as a tweeter it appears huge. The pole piece is covered with a thin copper foil, symmetric drive, to reduce eddy currents and reduce distortion. The voice coil gap is made from machined parts. Not an everyday sight.

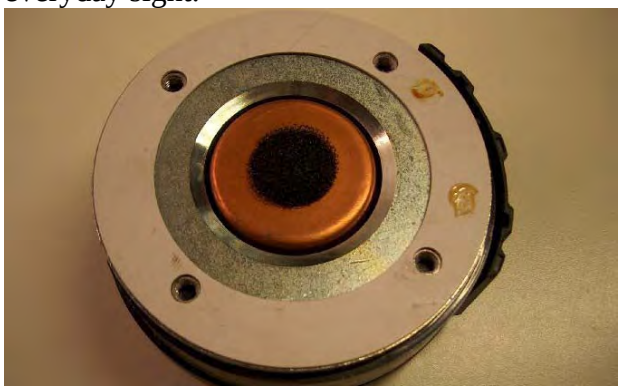


Fig. 16. D3806 pole piece covered with copper.

The frequency response of the D3806 driver is not that flat but is easily equalised to gain a flat response up to 15 kHz. This driver can almost be used as a stand-alone tweeter.
I guess some damping material on the pole piece might do good and will be tried later.

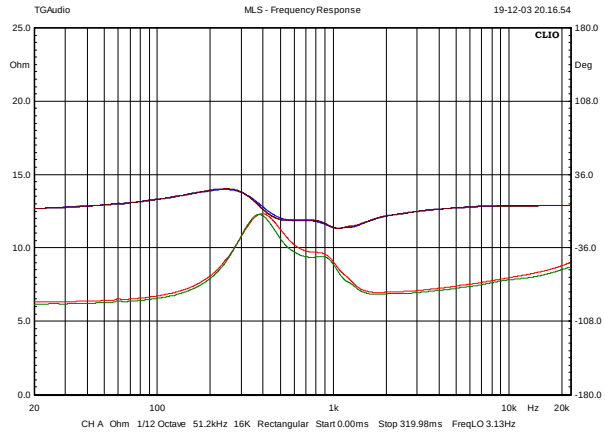


Fig. 17. D3806 impedance plot (red and green), phase response above.
The copper plating of the pole piece appears to do its job producing an almost flat impedance response from 1500 Hz to 22 kHz.
The D3806 mid dome was inserted into the front panel together with the HIQUPHON OWI used as supertweeter.

Fig. 18. HIQUPHON OWI tweeters.

This is probably somewhat overkill in terms of cost and performance, but these were at hand. I think a 19 mm dome like the SEAS 19TAF-D (H561) will do the job.

This way the **Acapella** $_{\text{L21+T17+D3806+OWI}}$ was born:

Fig. 19. L18+T17+D3806+OWI.

Sonic evaluation of the L21+T17+D3806+OWI setup:

The implementation of the D3806 + OWI changed the sound quite dramatically. I've always thought that a high quality 1" dome tweeter cut off at 3 kHz by a 18-24 dB HP filter never would suffer lack of power handling, but this doesn't seem to be the case. Not that the 9500 and the Esotar perform badly, on the contrary, but the D3806 can just play louder and the overall impact of this is an improved upper midrange with better sense of detail and better mid/tweeter integration when played loud. The D3806 is a splendid "tweeter" and the lack of "airiness" easily compensated by addition of a supertweeter working from 13-14 kHz. I'm not sure I can hear a 14 kHz tone, but masking off the supertweeter with tape leaves no doubt of the benefit of this approach.

It very much appears that the Spendor philosophy is right, and the cost of the D3806 plus supertweeter (not the OWI) is not much more than a high-quality 1" dome tweeter.

Audio Technology

Next in line of exploring different drivers for the Acapella were the new Audio Technology drivers C-Quenze at a more reasonable price compared to the hand-made chassis usually produced by Per and Eivind Skåning at Audio Technology (230 €/piece here in DK, but I know the Australian price is horrific for some reason). The new chassis appears to be just as ventilated as the "classic" and all other parts of course are the same.

The membrane area is approximately 140 cm^2, almost double that of the W15CY001 mid driver from Point 75A&B. It'll be interesting to hear what this does to the lower midrange compared to the W15 driver.

Only a few changes were needed for initial evaluation of the new mid driver:

Fig. 20. SEAS L21RN4X-P + AudioTechnology C-Quenze 18H52 1706 SD, 6" midrange + D3806/8200 mid dome + Hiquphon OWI supertweeter in test cabinet.

Fig. 21. Acapella$_{\text{L21+18H52+D3806+OWI}}$ preliminary crossover.

Fig. 21. Audio Technology 18H52 1706 SD driver.

Sonic evaluation of the L21+18H52+D3806+OWI setup:

The main difference between the two latter driver combinations will be found in the upper bass/lower midrange area. The Audio Technology driver is certainly a magnificent driver and bass lines are better defined and in general the overall midrange sound is improved compared to the T17RE driver. I guess the symmetric drive feature plays its role here.

And comparing the **Acapella$_{L21+18H52+D3806+OWI}$** to the newly fine-tuned Point75A, the upper bass/lower midrange is again the most predominant difference. The modified Point75A is certainly some fine speaker with a very transparent midrange and the treble has been tamed to sound like the very best domes with the addition of an almost weightless performance.

The **Acapella$_{L21-18H52+D3806+OWI}$** for good reasons is a much larger speaker and can play loud. Very loud!

The Point75A is quite revealing on poor recordings, where the Acapella is a more tolerant performer.

The voicing of the Point75A is perfect to my ears and in tonal balance supersedes the **Acapella$_{L21-18H52+D3806+OWI}$** that at this stage still needs fine-tuning of the midrange and tweeter sections. Distortion in all its forms is one thing, tonal balance quite another.

Crossover tuning of Acapella$_{L21+18H52+D3806+OWI}$

A few changes were made to the crossover in order to adjust performance of D3806 mid-dome.

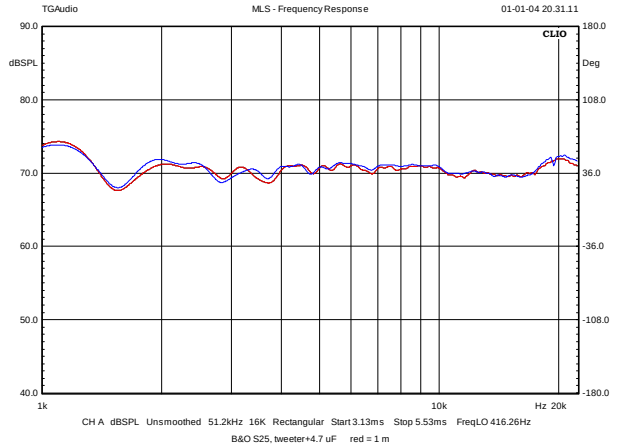


Fig. 22. Modified crossover, 0.27 mH replaces 0.22 mH to D3806.
Red and blue = left and right speaker.

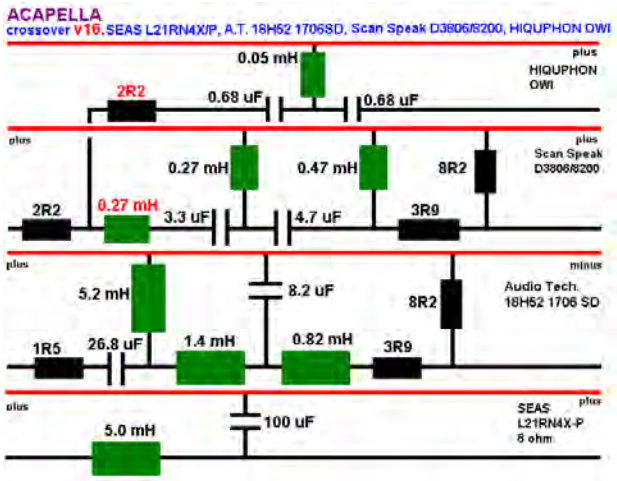


Fig. 23. Modified **Acapella$_{L21-18H52+D3806+OWI}$** v.16 crossover.

Bass cabinet tuning:

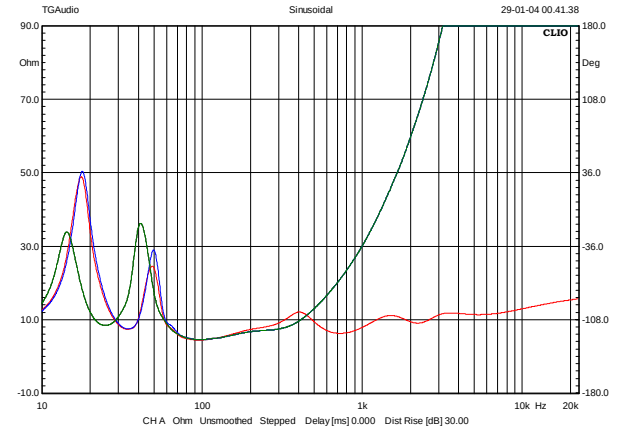


Fig. 24.Impedance, bass tuning.
Green = 46 (ID) x 150 mm tube. Tuning frequency = 26 Hz (woofer only). Blue = 72 (ID) x 150 mm tube, tuning frequency = 36 Hz. (woofer only).Red = system impedance.

Acapella LT95

January 28th -2004

Giving a loudspeaker a name is a difficult task, but obviously helps a lot when we have to identify what we're talking about.
The name "Acapella" came from the recording by Maddy Prior and The Girls as stated at the beginning of this article.
But two constructions need two names…. Well, Acapella One or Two, A or B, is simply too boring.
And you cannot name a "low-cost" version "LC". "Low-Cost" doesn't work. Who want to own a "low-cost" loudspeaker? And it is actually not that low-cost, just low-cost relatively to the more costly final Acapella.
The first Acapella construction is going to be named:

Acapella LT95

No surprice. Drivers are the SEAS L21RN4X/P 8" aluminium bass driver, the SEAS T17RE XP membrane driver and the ScanSpeak D2905/9500 1" softdome.
Here are my newly painted prototypes with flexible upper panel.

Fig. 24. L21+T17+9500

To reduce complexity I decided on this driver layout. The T17 and 9500 are doing a great job and - what did I write on page 5?
"I wouldn't hesitate to recommend the "L21+T17+9500" whether you like classical, jazz or rock music. It does it all with a solid, dry bass, an undistorted midrange and a fluid, transparent treble".
No need to elaborate much on that statement. The Acapella LT95s project a wide soundstage with lots of transparency and engagement. And they are tolerable on the majority of my CD collection.
And it's gotten better due to fine-tuning of the crossover. More on this later.

This is definitely a bigger speaker compared to the Point75A, mostly due to the bigger bass driver and larger cabinet. The port is placed at the rear panel, 15 cm from the floor and this appear to be much more optimal to my listening room than the floor-vented P75. I'll have to change this on the P75 cabinet. With the addition of the under-carriage recently, the bass became slightly too boomy on the P75A.

Fig. 25. Acapella LT95, rear view.

The rear of the bass enclosure has been made 70 mm deeper by removing the rear panel and adding a new “tray” on top of the framework, this way giving a total volume of approx. 35 liters. The vent is 72 (ID) x 150 mm and produces a box tuning of 36 Hz. The sides and top of the “tray” has been chamfered to match the cabinet design.

Fig. 26. Bass cab extension.

Former vent holes at bottom panel masked off by a MDF plate internally.

Fig. 27. New vents at rear panel.

The bass cab extensions were made from 30-50 mm MDF to allow chamfering of the edges.

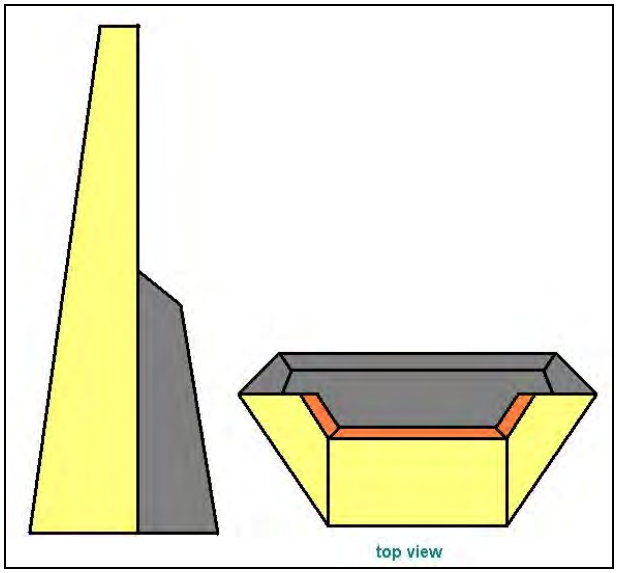


Fig. 27a. Bass cab extension.

The prototypes were added a straight vertical additional cabinet. To further enhance stability the rear panel may be tilted like the front panel. No dimensions will be given here, just this sketch as a possible inspiration.

Bass cabinet tuning.

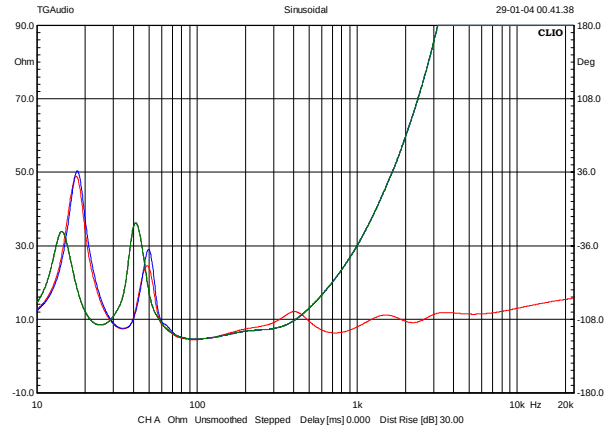


Fig. 28. Impedance, bass tuning.

Green = 46 (ID) x 150 mm tube. Tuning frequency = 26 Hz (woofer only).

Blue = 72 (ID) x 150 mm tube, tuning frequency = 36 Hz. (woofer only).

Red = system impedance.

Fine tuning of crossover

Some serious work was done to the crossover in order the optimize frequency response and phase tracking in the T17/9500 crossover region.

The tweeter point of crossover was moved slightly upwards and tweeter attenuation was

increased to gain a more flat frequency response.

The roll-off characteristic targeting a 24dB/octave profile was so good that tweeter polarity could be changed without noticeable effect on frequency response. However, polarity as indicated on crossover the schematic, fig.29, is recommended.

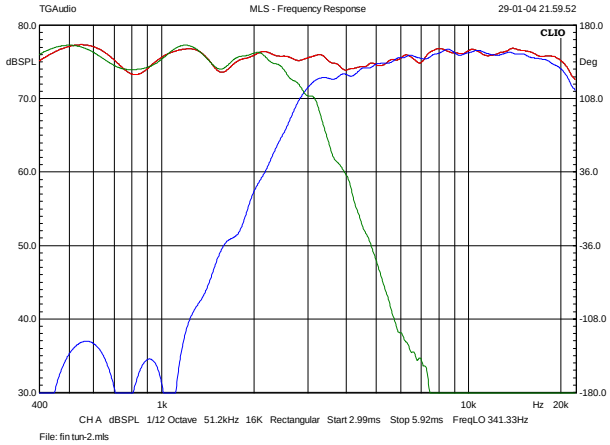


Fig. 29. Frequency response from Acapella LT95 connected to crossover fig. 29.

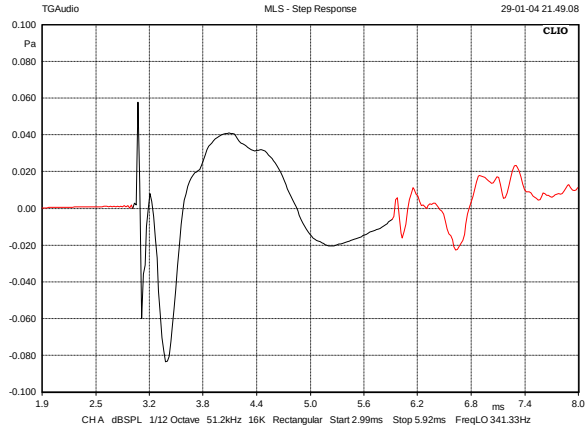


Fig. 30. Acapella LT95, step response, midrange and tweeter, reverse polarity.

Acapella LT95 version 12, crossover

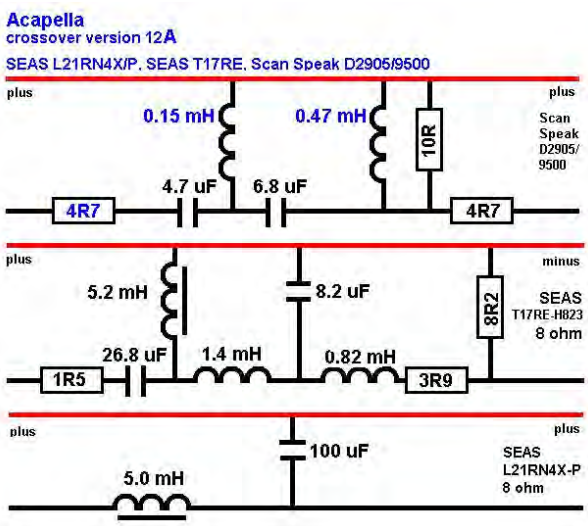


Fig. 31. Acapella LT95 crossover.

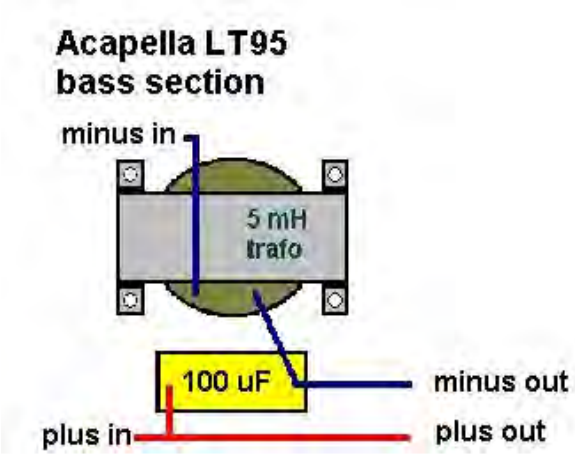


Fig. 32, bass driver crossover, layout. To be placed inside bass cabinet.

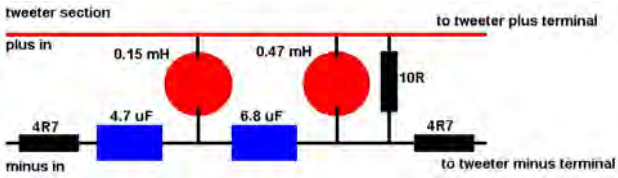


Fig. 33. Tweeter crossover, Acapella LT95, layout

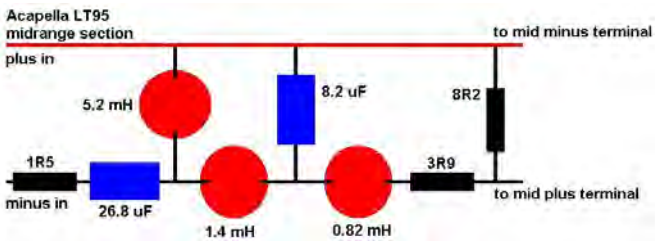


Fig. 34. Acapella LT95 midrange section, layout.

Acapella LWJ

Acapella prototype.

Acapella LWJ drivers:

Fig. 35. Acapella LWJ driver selection.

So, what is behind L, W and J?

L

The L = SEAS L21RN4X/P, 8" alu-driver, same driver as seen in the "LT95". No wonder, this driver is doing a great job.
Some confusion on the range of 8" alu bass driver from SEAS has been reported.
The one used here is the H956, L21RN4X/P, 4-layer voice coil, not on the SEAS list at http://www.seas.no/.
Here we find the L22RNX/P and the L22RN4X/P, so let's summarize:

SEAS 8" alu-drivers:

	Code	Vas	Fs	Qt	Mms, gram
L21RN4X/P	H956	77	23	0.28	40
L21RN4X/P	H956	53	27	0.32	41
L21RNX/P	H955	73	28	0.36	28
L22RN4X/P	H1208	72	23	0.32	43
L22RNX/P	H1252	116	23	0.33	26

Fig. 36. SEAS 8" alu drivers.
Red = my CLIO measurements.

As usual, the Vas is lower than expected (driver not burned in) and the Qt higher than specified.
I would not expect any major difference between the L22RN4X/O and the L21RN4X/P. The L22 has the new open basket. What's important is the 4-layer voice coil giving a high inductance and this is taken into account in the design of the crossover.

I've come to like this 8" alu-driver a lot, giving a solid, firm bass response. I was considering the 10" SEAS L26RFX-P for the final Acapella, but fine-tuning of the L21 bass enclosure and subsequent task of re-arranging or removing things from our living room due to rattling, made me realize that 8 inches would do!
In the latest round of driver testing, the AudioTechnology C-Quenze driver was for some time thought to be the final choice for the midrange. When I had to deliver these drivers back, I threw in some Scan Speak 18W/8545 drivers and much to my surprise, these drivers performed better than the Audio Technology drivers on a number of parameters.
To put it simply: these drivers appeared to have less distortion when played loud. The AudioTecnology C-Quenze18H52 drivers have some rather soft and flexible polypropylene cones where the 8545 drivers have the well-known ugly paper-pulp/carbon-fiber cones. A very rigid and heavily coated cone in this 8545 incarnation.
The L21+8545+D3806+OWI set-up could indeed deliver some heavy undistorted sound. Transparency was quite good without necessarily taking your breath away.
A very tolerable speaker I would say, and a speaker with a sound that would please a lot of people, being able to reproduce all musical sources without having to dismiss half your record/CD collection due to poor recording practice.
But being used to this magical "something" (possibly lack of distortion) from the SEAS W15 magnesium driver, it would be

unfulfilling to stop here. The final Acapella should have all the qualities from the Point75A plus the capability of playing louder.
The SEAS T17RE, AudioTechnology 18H52SD and the ScanSpeak 18W/8545 all do a great job for the Acapella, but they all miss the final refinement of the W15 driver. I have been hesitant to consider the SEAS W18E001 or W18EX001 drivers for up-grading the Point75A to Acapella. Another ½ year fine tuning is ahead and numerous times where you think you finally got it right, just to discover two weeks later that you still have a job to do.
Will it be possible to make a larger Point75 by "simply" applying an 8" alu-bass driver, a 6" magnesium midrange driver and a new ribbon to the Acapella?
Or do we need the 1½" ScanSpeak mid-dome in between?
Well, all the former experiments have suggested that there were still things to explore.
Linkwitz uses an 8" SEAS magnesium driver up to 2 kHz and recommends the SEAS W18 driver based on his distortion tests.

W

"W" = W18EX001, magnesium cone driver from SEAS.

Fig. 36. SEAS W18EX001 driver.

I'll come back to this magnificent driver. This is truly the best 6" driver I have ever had.

J

"J" = Fountek **J**P3ribbon tweeter.

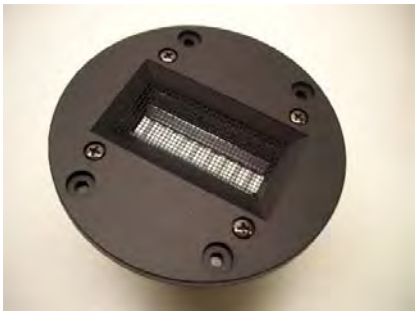


Fig. 37. Fountek JP3 ribbon tweeter.

This was indeed a "trial and error" purchase. I have found no references to this driver.
A Google search on "Fountek" reveals a new China based company founded in April 2003 having so far only two drivers, the JP2 and JP3 ribbon tweeters.
Well, it looks an awful lot like a number of other ribbons and the price is nice, 81 US$, from Madisound. The specs look nice and sensitivity = 95 dB. Why not?
Regarding the performance of the JP3, it doesn't disappoint you.
Mounted on the Acapella front panel with an 8 uF capacitor in between the amp and the ribbon, the frequency response looks like this:

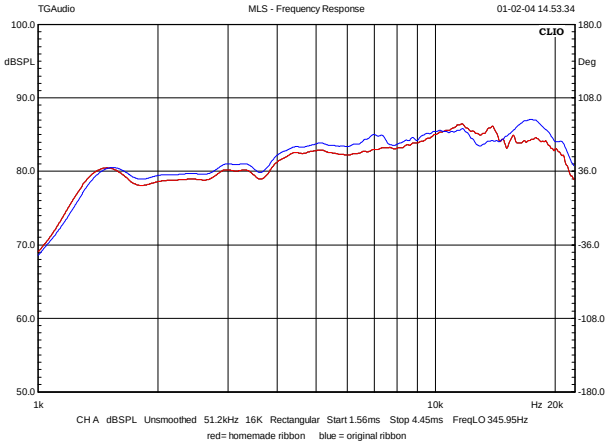


Fig. 38. Blue = JP3 ribbon tweeter frequency response from 1 kHz to 22 kHz.
Red = response from new homemade ribbon. What?!
Well, at the time I had to install the ribbon tweeters it appeared that the alu ribbon was hanging like a hammock in the magnet gap of one of the drivers.
One thing you do not do is tightening an alu foil in a ribbon tweeter. No way. It is out and gone and you better learn how to make a new ribbon yourself. Once done, you can do this in 20 minutes and the cost = zero.

More on this problem later.
This ribbon has a smooth rising response all the way from 1500 Hz to 18 kHz and a 0.1 mH coil in front equalises this to a suitable flat response.

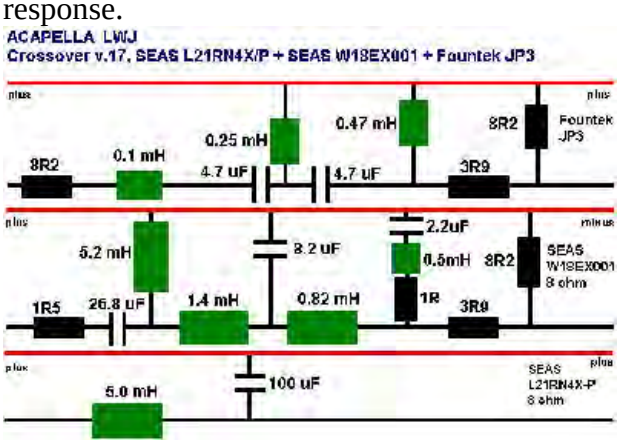


Fig. 39.
Preliminary crossover for Acapella LWJ.
Getting rid of the inevitable cone break-up of the magnesium midrange cone is the first thing to do. It turned out to be less difficult with the W18 driver compared to the W15 for some reason.

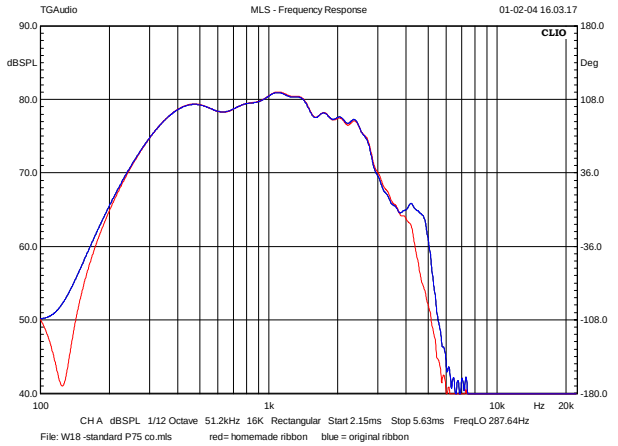


Fig. 40. Midrange frequency response. Notch-filter tuning.
The LCR = 2.2 uF + 0.5 mH + 1R0 did a nice job and left a smooth roll-off profile at 3-7 kHz. Actual fine-tuning includes measuring response and listening to pink noise. You may have a good-looking response reading and still prefer slightly different component values based on what your ears tell you. It has to sound like running water with no detectable "edges" or peaks.

Tweeter level

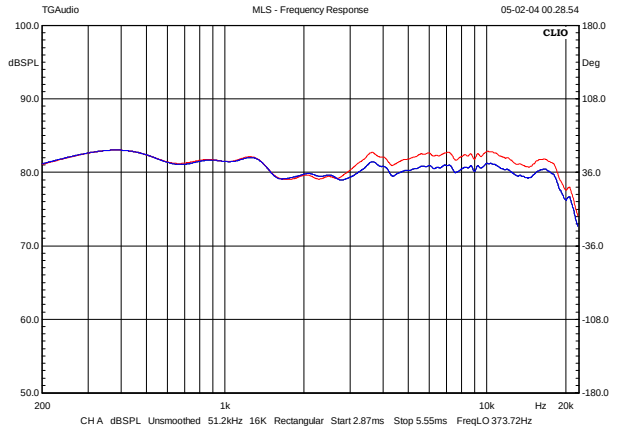


Fig. 41. Red = 6R8 to tweeter, blue = 10R to tweeter.
Initially I started listening sessions with 6R8 to the tweeter and was quite happy with this for some time. Comparing the overall response to the Point75A suggested trying 6R8 giving a 3-18 kHz response similar to the P75A. Actually targeting the BBC-dip. This, however, made the sound a little too much laid-back and I compromised on 8R2.

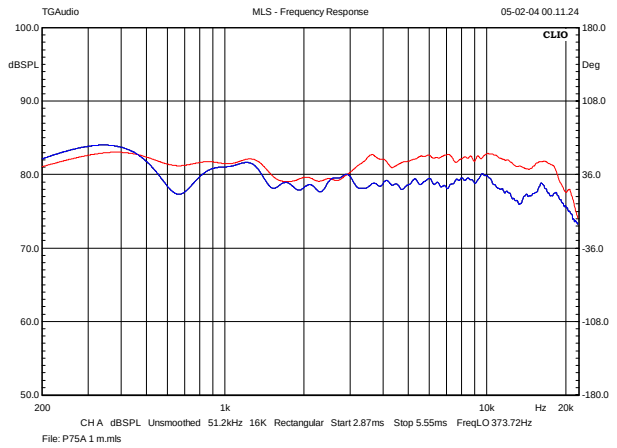


Fig. 42. Blue = Point 75A, red = Acapella LWJ with 6R8 to the tweeter. 1 meter distance, tweeter height.
Quite some difference. I wonder why this felt equally pleasing to the ear. The response in the 300-1000 kHz region were well aligned here and I tried to measure the lateral dispersion of the JP3 having a suspicion that this tweeter never could meet the NDRL ribbon on this parameter. See Point75A paper, page 15.

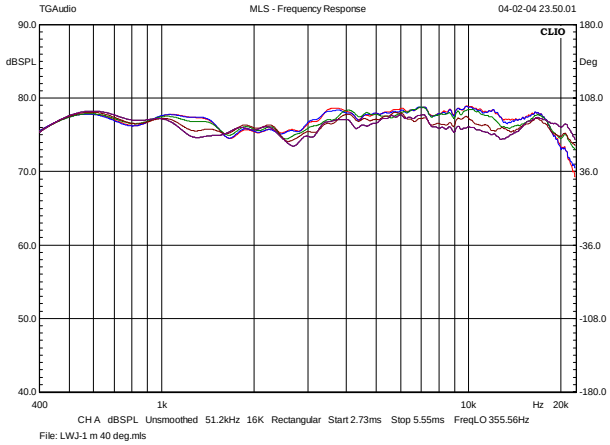


Fig. 43. Lateral dispersion of Acapella LWJ, 0-45°.

This was much better than expected. The NDRL goes flat all the way to 50° which is exceptional. May not be desirable, but that's another story.
The NDRL/ATDs are bright sounding ribbons where the JP3 appear to have a slightly more laid-back sound. In fact it sounds less colored. Harmonic distortion analysis did not suggest any explanation for this. It has to be said that I'm more cautious than ever in not applying a specific "sound" to any driver without thinking of the driver it has to mate. Changing either the tweeter or mid driver can completely change your perception of the sound coming from the other driver. They very much interact and "color" each other, hopefully in a good sense.

Acapella sound

The troublesome part of this presentation is to describe the sound without repeating myself in stereotype terms.
To postpone this moment of writing I've been going through a number of loudspeaker reviews and came across this one:

Once properly set up, these are great-sounding speakers. They have an unforced presentation that still conveys the attack and momentum in music beautifully. And these floorstanders don't discriminate against any genre of music – they have the finesse to do justice to chamber music, yet still pack the muscle to cope with a sonic onslaught Eminem-style. Those mid/bass drivers deliver far more low-frequency weight and power than their appearance suggests, and pleasingly there's no trade-off with speed or agility.

The midrange is equally impressive. It's rare to find speakers that sound so convincing with vocals, yet still have the dynamics to cope with hard-driven drum machines.

Let's get a couple of things clear. The nn aren't the most analytical speakers £2000 will buy, and neither are they as tonally neutral as some. No, these are music speakers first and foremost. Sure, they get hi-fi aspects such as resolution, timing and dynamics spot-on, but these things aren't the main point of the Proacs. On a quick audition, their subtle, music-first approach may not impress, but take a longer listen and you'll be hooked.

Hmm…
Well, reviewers have to make a living too and don't get away with saying that this is a crap speaker; don't buy!
Probably wouldn't be fair to the product in focus here, but this review very much makes you wonder why you still buy HIFI magazines. First the product is praised on a number of parameters like appearance, quality of drivers, etc., etc.
Finally there's some interesting remarks: (these speakers) "- aren't the most analytical speakers £ 2000 will buy, and neither are they as tonally neutral as some".

So, for £ 2000 we don't get tonal neutrality or loads of see-through capability.
At this price tag it's got to be darn good in most aspects I should think.
I add these few reservations to the reviewer's credit but would certainly have liked him to elaborate on these areas of sonic performance.

I general I think magazine reviewers are fare from being critical enough on the products they have under examination.
I find HIFI-WORLD to have some critical reviews from time to time.
The Danish hi-fi magazine HIGH FIDELITY used to be quite critical about products under scrutiny. Not any more. Now they don't even bother to dismantle loudspeakers any more and give us a glimpse of what's behind the impeccable veneer finish.
How often have we read that this is the best sound they have ever experienced from their set-up? Over and over again. You cannot audition hundreds of products and continuously experience the best sound ever. Not possible.

I recently went to a demonstration of LINN products and a 250,000 DKK (~40,000 US$) set-up with AKURATE speakers was supposed to make us drool. Yes, it looks gorgeous but the sound wasn't more than average from what you could expect from this price tag.
I guess mister Tiefenbrun should have kept the midrange driver from the Komri loudspeaker here, as the bass didn't integrate well with the 3" dome.

So, should I write that the sound from the Acapella LWJs is the best I have ever had from my humble home stereo?
I'm afraid I have to.
Well, I shouldn't be auditioning my own construction, but I can't bring in a number competent people to review my products.
If anyone should ever build this loudspeaker I hope to have some comments in return and I'll add these to the article.

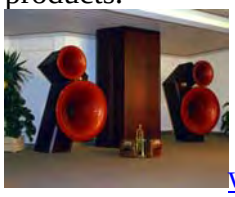
The first think that struck me after firing up the Acapella LWJs were the sound of drum kits and people clapping their hands.
The sound of applause can be just as troublesome as vocals when it comes to truthful sonic reproduction.

Going through a number of live recordings I got a never before had ability to focus on what a drummer would do, while a sax or guitar solo was smacked into your face. The drummer gently tapping his cymbals or high-hat. "Standards Live" by Keith Jarrett never sounded better and the "Pawnshop" gave me new insight into how the bartender handles his beer glasses.

For the first time I think Joni Michel's "Travelogue" was given the dynamics and soundstage this great recording deserves.
Pity this is her proclaimed final recording.

Next I took the speakers into a larger room of 30 m^2 and these speakers grow with the size of the listening room.
The bass needs space to fully develop and the W18 mid drivers have the capability of firing up considerable space without apparent compression.
I'm pretty amazed by these JP3 tweeters despite I had to replace one of the ribbons without knowing what had happened to it.

So, how about the "Acapella Stella" track, the Maddy Prior recording that started the project?
Well, it's almost there.
Almost?
After all, I don't care about the Acapella Stella track any more. I've come to the conclusion, that the true "Acapella" loudspeaker possibly is a 15" Tannoy studio monitor that could have been used for mixing this recording. At least a studio monitor with a 10" midrange.
This track can possibly not be reproduced to full satisfaction without compromising on other parameters when we're talking moderate sized loudspeakers for domestic use.
I've been through a wide range of vocal recordings and come to the conclusion that you cannot produce a decent speaker that will be tolerant to every single vocal recording you come about. Not possible. Some recordings are simply less than adequate and you better leave it there.
But I like the Acapella name and will keep it despite I've recently discovered that a German company uses this name for a number of their products.


www.acapella.de

This is definitely another ball game and I guess I won't be sued for giving my speaker the same name. These Germans don't compromise, do they?

Last but not least I brought in my digital amplifier, the first generation from LCAudio. (http://www.lcaudio.dk/com/forst.htm).

I used to think this amp wasn't quite as good as my Millennium amplifier from the same company. Not here. CD after CD, sweet sounds. I don't know if this amp by coincident works better with the Acapella LWJ, but it is highly recommended here. This 200 W/channel amplifier is cool as ice.

Next: fine tuning of the crossover.

Well, time was up to start from scratch on the crossover.
The LP section for the bass has been working properly throughout a number of midrange drivers, and there was no need to make any changes here.
The midrange might however need an overhaul and eventually only a few changes were made smoothing the 1.5-3 kHz region.
Fig. 44 shows the impact of the capacitor between the two coils in the LP section of the midrange crossover.

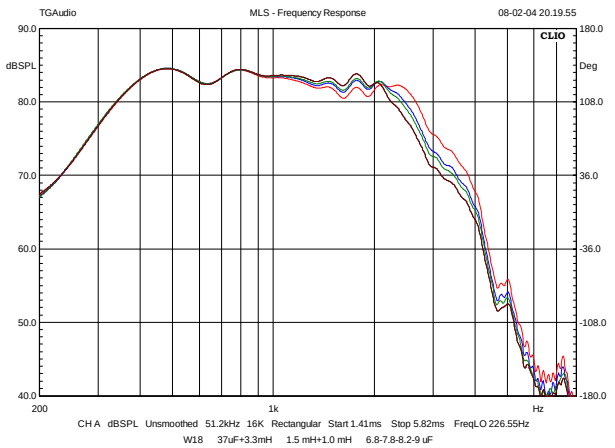


Fig. 44.
Braun = 9 uF, green = 8.2 uF, blue = 7.8 uF, red = 6.8 uF.
As a starting point 8.2 uF was tried, suggesting a point of crossover at 2700 Hz.
The notch filter stayed the same: 2.2 uF + 0.5 mH + 1R0.
Listening to pink noise didn't reveal any disturbing "edges" in the response.

The tweeter section eventually wasn't changed except for the equalisation of the 8-18 kHz range. This circuit was left out, giving a steady rise on response from 9 kHz to 18 kHz. I'm still a little puzzled by the "sound" of this ribbon tweeter as I in other cases have had to equalised this region to smooth the sound and prevent some aggressiveness. Not here. Subjectively this rise in response is hardly noticeable and it may be a result of the limited vertical dispersion of the ribbon. Moving the microphone vertically immediately reduces response around 15 kHz. So for the time being I left out the equalisation circuit.

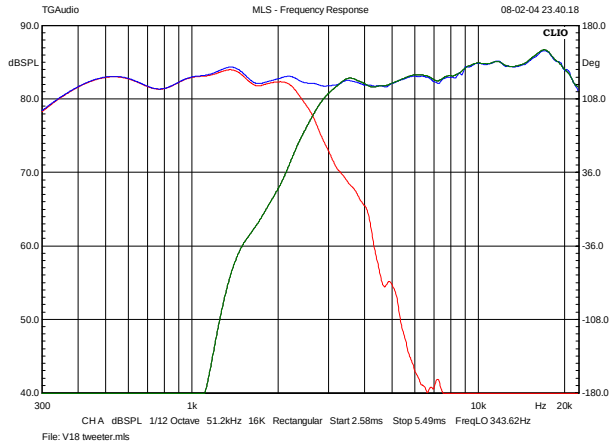


Fig. 45. Response of midrange and tweeter at 1 meter distance, tweeter height.
Notice perfect summation of mid and treble at point of crossover.

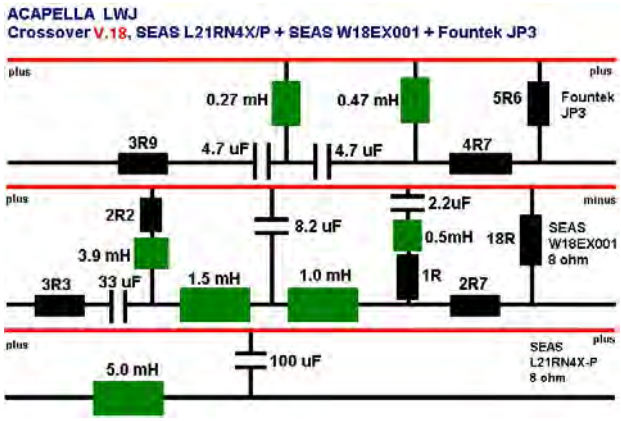


Fig. 46. Acapella LWJ, preliminary crossover, V.18.

Some days later:
After having had the Acapella LWJ running for some days with the v.18 crossover, it was found that especially piano high notes had a little too much attack and it was decided to put back the tweeter equalisation circuit, which is simply a 0.l mH coil paralleled by a 4R7 resistor.

Fig. 47. Tweeter equalisation.

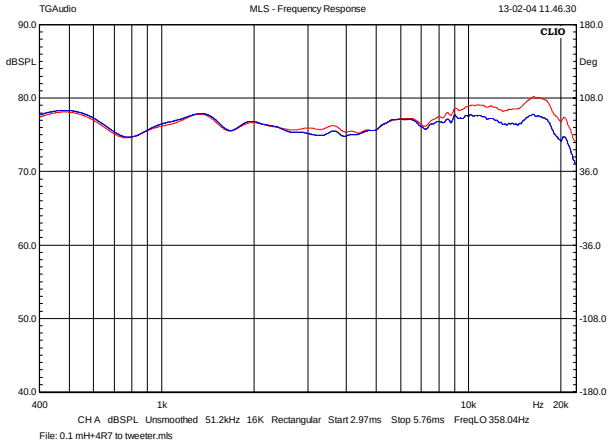


Fig. 48. Tweeter equalisation.
Is this audible? You bet it is.
Hence the v .19 crossover. Looks like this:

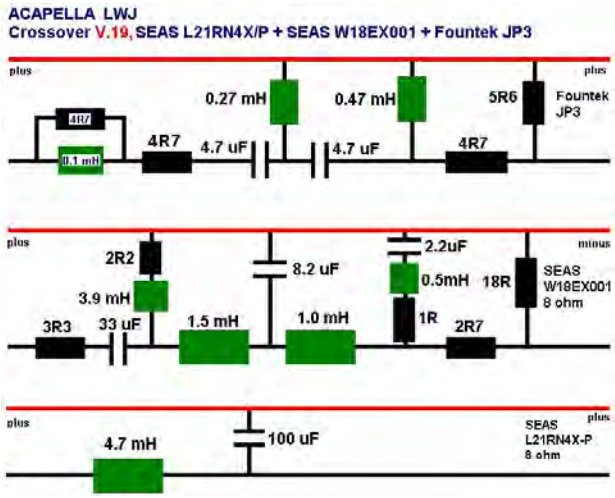


Fig. 49. Acapella crossover, v. 19

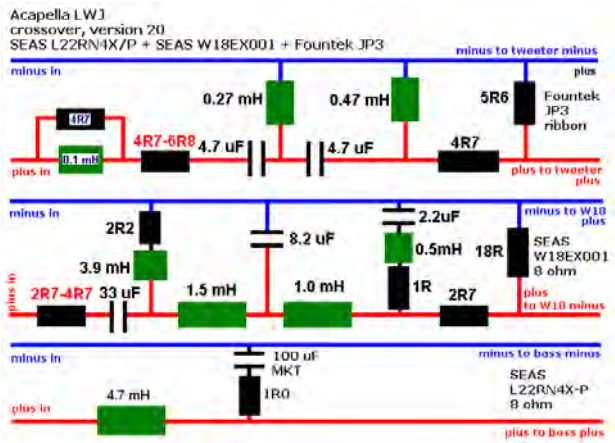


Fig. 50. Acapella crossover, v. 20. Read page 13. Bass response fine tuning.

The change in the bass section of 5.0 mH to 4.7 mH does not affect the bass response, therefore complete crossover can be build from standard values.
The 3.9 mH in the mid-section can be a cored inductor of relative high resistance as it has to be in series with a 2R2 resistor. 1 – 1.2 mm will do.

Measurements, Acapella LWJ

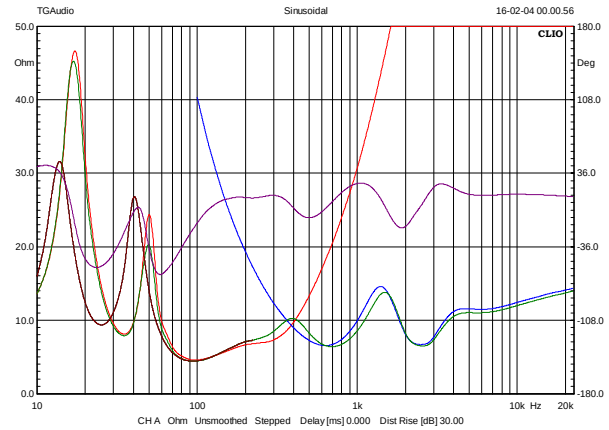


Fig. 53. Acapella LWJ, impedance.
Red = bas-section. Blue = mid + tweeter section. Green = all, 36 Hz port-tuning.
Brown = 26 Hz port-tuning (4.6 x 15 cm vent)
Purple = phase.

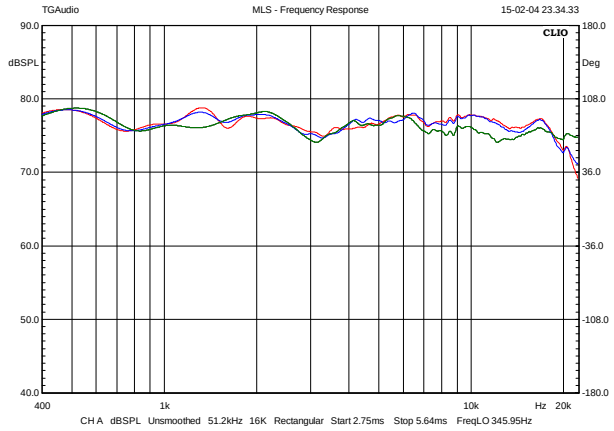


Fig. 54. Acapella LWJ, horizontal dispersion.
Red = on axis. Blue = 15^0. Green = 30^0.

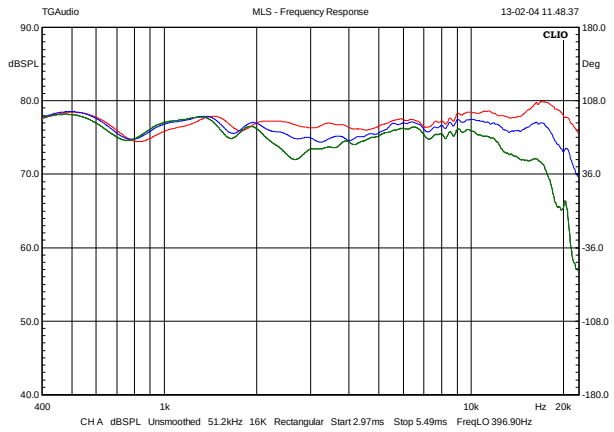


Fig. 55. Acapella LWJ, lateral dispersion. Measurements taken at 1 meter distance. Red = tweeter height. Red = +10 cm. Green = -10 cm. Front panel tilted 11^0 backwards, i.e. as the angle will be when the speaker is standing on the floor.

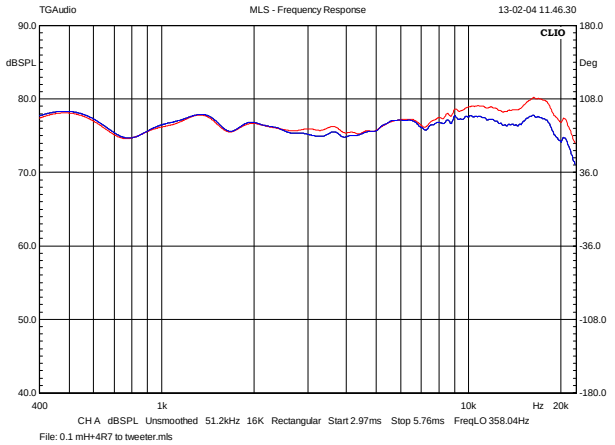


Fig. 56. Acapella LWJ. (= Fig. 47, shown again for comparison).
Red = without tweeter equalisation.

Comments to measurements

Some may notice the less than symmetrical port tuning. Fig. 55 displays the impedance of the L21 driver in the 35 liter cabinet with a port of 72 x 150 mm. When the crossover is applied the impedance takes the fig. 51 appearance.

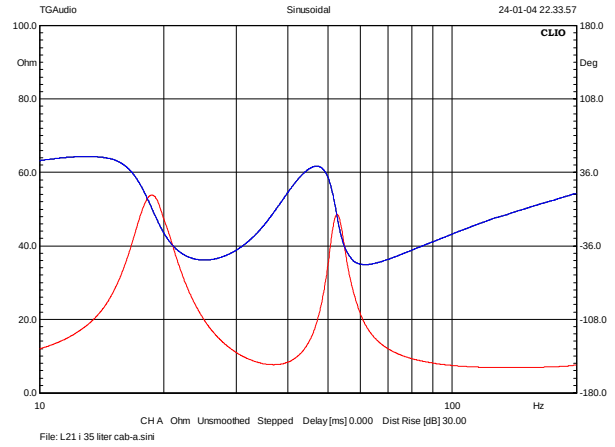


Fig. 57. Impedance of L21 driver in 35 cabinet without crossover.

The Acapella LWJ has an even and wide horizontal dispersion characteristic, fig. 52, where the lateral dispersion, as usual when it comes to ribbon drivers, is more restricted. This is usually associated with good imaging properties due to reduced reflection from floor and ceiling.

How to replace the alu ribbon in the JP3 driver.

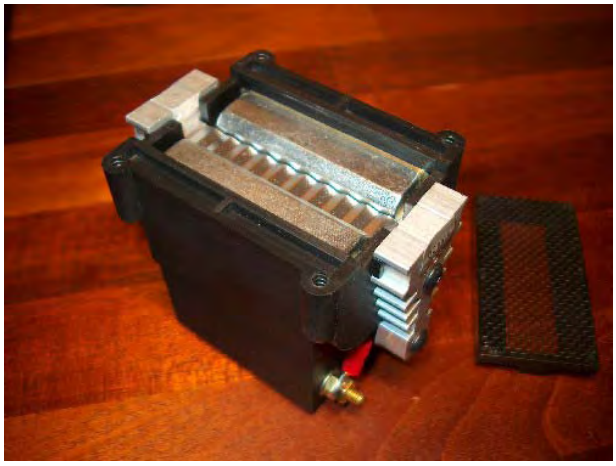


Fig. 58. JP3 ribbon and magnets.

Before we start making alu ribbons, let's see what's on the market in terms of 8 x 60 mm neodymium driven ribbon tweeters.

This Fountek driver comes from a newly started factory in China. Homepage: http://www.fountek.net/.
Two drivers are on the program: the JP2 (8 x 120 mm) and the JP3 (8 x 60 mm).
Price from Madisound: JP2: 118 US$, JP3: 81 US$. Fair enough, these drivers come in a plastic housing but construction and finish in impeccable. And the sound is great too. Importing two of these to Europe you have to add 40 US$ in shipping plus local VAT and custom tax.
In all, something like 263 US$ at your doorstep.
(25% VAT and 4% tax). Total: 1578 DKK. Still fair enough, but you better buy something more at Madisound if you choose this route. Like the W18EX drivers, much cheaper in the US compared to Europe and this was only 10 US$ additional shipping.

I recently came across the website of:
http://www.hifisound.de/chassis/programm/seite.php?Her=Harwood
"Hifisound" in Germany. They list a driver named HARWOOD ACOU - UR-2.0-RD.
So, how does this one look?

Fig. 59. Harwood UR2 ribbon tweeter.

Alu housing, etc.
Price is 248 EUR including shipping = 310 US$ a pair = 1860 DKK.

Hmm…I think I've seen this ribbon before:

Fig. 60. Aurum Cantus G2Si ribbon tweeter.

My eyesight may be weakening, but I should think this is the same driver. So, we're dealing with an 8 x 60 mm neodymium driver in an alu housing.
This comes from Norway:
http://www.musicaltransparency.com/
- and costs 1350 NOK = 191 US$ each. If you import from this company, subtract Norwegian VAT, add local VAT + shipment + possible tax. Quite expensive from Norway. But they do pay 7 US$ for a beer in Norway, so fair enough.

Summary, prices in EUR:
Price/pair including shipping to DK.
2 x JP3, Madisound = 210 EUR.
2 x Harwood UR2, Hifisound = 248 EUR.
2 x G2Si, Musical Trans. = 342 EUR + shipping.
My next pair of ribbons will probably be the UR2s alias Aurum Cantus G2Si. I have no expectations that the alu casing will improve the sound but 248 EUR from Hifisound is competitive.
They're probably all copies of the Raven R1 driver and it takes two neo magnets, an alu ribbon you can make yourself plus a transformer. How hard can it be?

Fig. 61. Raven R1.0 ribbon tweeter.

Whether these alternatives are compatible with the Fountek drivers is not known. Probably minor crossover adjustments are needed.
And then there's a new range of ribbons at Strassacker, Germany. Cantare, here the ARG2.

Fig. 62. Cantare ERG2 ribbon tweeter.
This one comes at 498 EUR a pair! Quite expensive.

OBS!

Fig. 62a. Fountek JP3 ribbon seen from the rear.

<u>According to international standards, a driver should have the positive terminal marked in such a way that when a positive voltage is applied to this terminal, the membrane shall move outwards.</u>

This is NOT the case for the Fountek ribbon. Initially I assumed the terminal with the red ring terminal was PLUS.

Fig. 62b. This is a ring terminal.

So, to make a long story short, this is how the JP3 is wired.

Fig. 62c. JP3 polarity.

Quite confusing, isn't it? I only know of JBL that decades ago kept using a reversed polarity policy opposite to all others.

Well, I wasn't aware of this until I had to re-check the layout schematics for the Acapella and the TJL Loudspeaker.

All schematics in the files have been correct, and the listening tests performed have naturally been conducted with correct polarity being performed after measuring the SPL response from the various constructions.

But a number of people may have been confused and taken the red ring terminal for PLUS. I have pointed out this to the Fountek Company and I'm waiting for their response. To my knowledge all pictures of Fountek drivers show this configuration.

How to check polarity of a ribbon tweeter:

Checking the polarity of any "normal" moving coil driver is easy. You connect a 1.5 V battery to speaker terminals (just for a fraction of second) and when a positive voltage makes the cone move outwards you have found the PLUS terminal. Usually this is not a problem as almost all manufacturers comply with this practice.

A ribbon tweeter is a little more tricky. Applying 1.5 V to the terminals will most likely make the ribbon pop out of the magnet gab and the ribbon will be deformed and not retract to its normal position. So you insert a 100 ohms resistor in series with the voltage applied and the ribbon is likely to move < 1 mm. This shouldn't damage the aluminium foil but I take no responsibility for your drivers. This approach worked for my JP3 drivers.

Fig. 62d. Checking ribbon tweeter polarity.

Optimising bass performance of L21 driver:

Having a pair of Dynaudio 21W54 bass/mid drivers, these were tried as a substitute for the SEAS L21 alu drivers. The 21W54 driver doesn't have a particular linear frequency response from 1-3 kHz and some work on the crossover was necessary to get it right. One thing it did better was having a perfect response in the 100-300 Hz region and this proved to have a positive impact on the lower midrange performance.

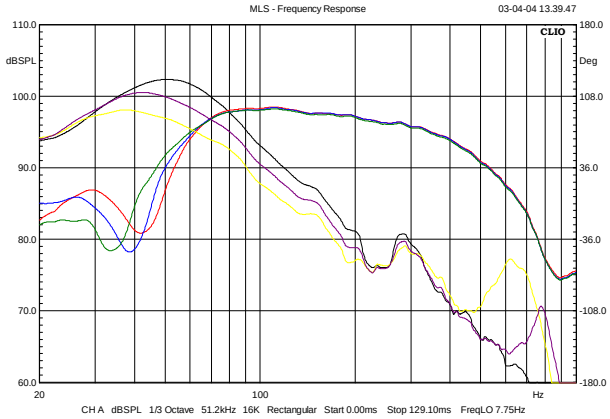


Fig. 63. Dynaudio 21W54 bass driver near-field response with various tunings:
Red/black = 100 x 72 mm (L x ID)
Blue/purple = 150 x 72 mm
Green/yellow = 220 x 72 mm
Actual output of driver and vent is not aligned in this presentation.
Sonic evaluation proved the 10 cm vent (42 Hz tuning) to be the best, where lower tuning gave a too lean and recessed bass. This at the expense of the 30-40 Hz region.

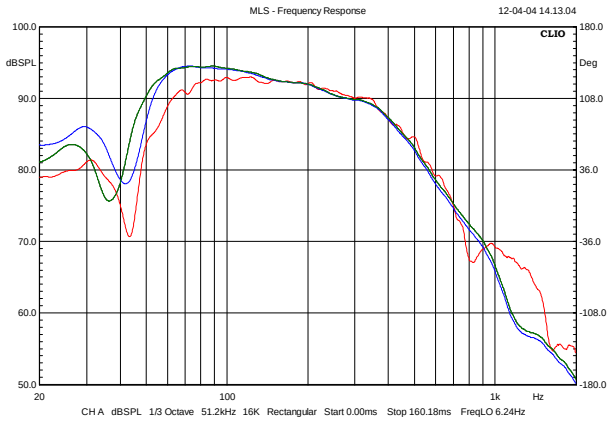


Fig. 64. Dynaudio 21W54 and SEAS L21 bass drivers, near-field response aligned for response in the 200-700 Hz region.
Red = 21W54 with 10 cm vent.
Blue = L21 with 10 cm vent.
Green = L21 with 15 cm vent.
As can be seen from fig. 63, the response of the L21 has reached the target 21W54 response in the critical region from 200-700 Hz and in addition to this has a significant higher output at 40-100 Hz.

New crossover bass low-pass section:

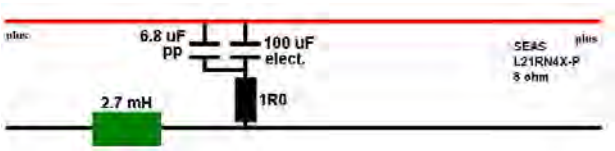


Fig. 65. New bass LP-section.
The by-pass capacitor is a Mundorf Mcap polypropylene. The 100 uF electrolytic capacitor might be substituted with a 100 uF foil capacitor, MKT or MKP and the 6.8 uF be omitted.
The 2.7 mH coil is with transformer core and a resistance of 0.12 ohm. Low resistance is important here.

Quality of crossover components

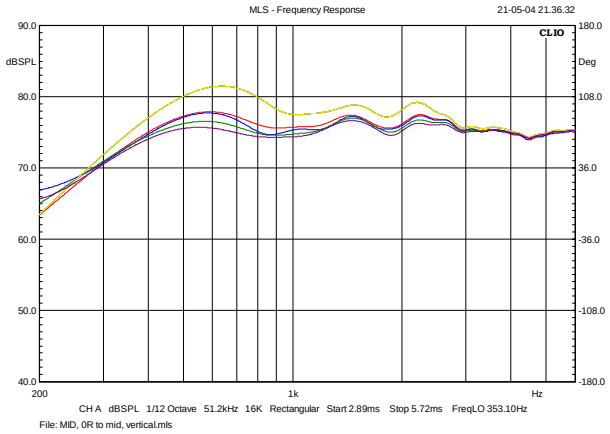
I have recently inserted Mundorf Mcap capacitors in my prototype crossover substituting the Monacor polypropylene capacitors I usually use for prototypes. This proved a clearly improved midrange and treble and I have plans to try the Mundorf Mcap Supreme for the tweeter.
Substituting the 33 uF capacitors for the midrange drivers with Mcap Supreme would be an additional 200 €. This will have to wait.
I'm currently using foil coils for the midrange and would like to try the Mundorf Tritec coils at an additional 114 €. Very easy to spend a small fortune on crossover components! But sometimes worthwhile.

14-04-2004

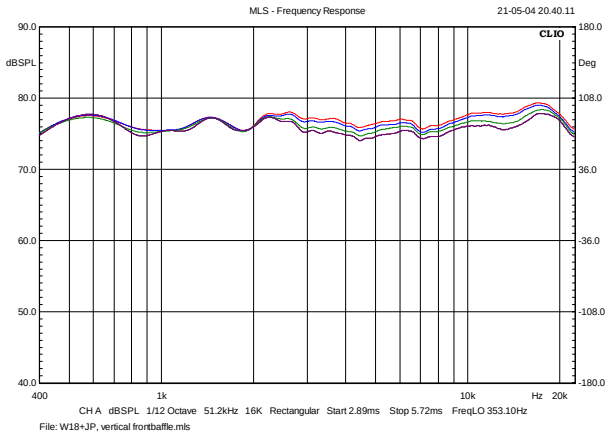
Fine tuning of midrange and tweeter, getting attenuation right.

No matter how the response profile looks, getting the right midrange and tweeter attenuation is necessary. Currently I'm running 3R9 to the midrange and 6R8 to the tweeter.

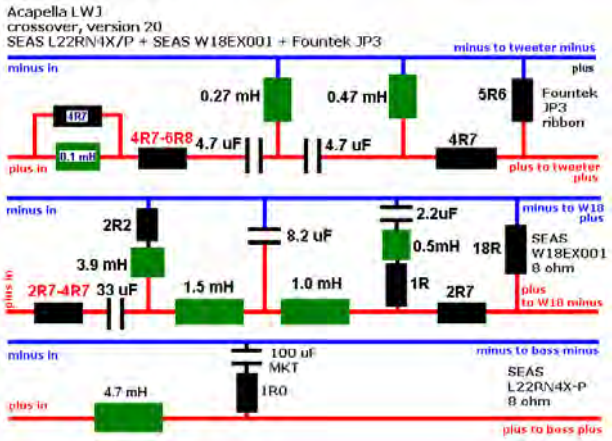
This is how it looks when measuring the response of the midrange and treble from 1 meter distance at tweeter height:



Midrange attenuation (intro series resistor):
Yellow = no resistor
Red = 2R7, blue = 3R3, green = 3R9 and brown = 4R7.



Tweeter attenuation (intro series resistor):
Red = 3R9, blue = 4R7, green = 5R6 and brown = 6R8.



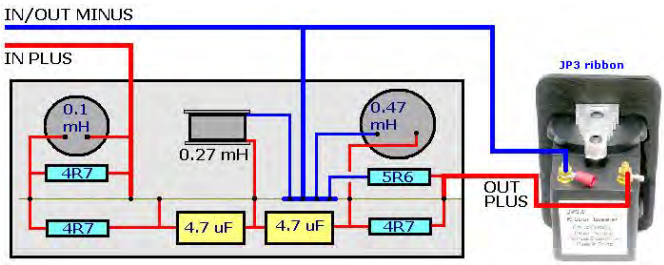
Acapella crossover V.20. As a starting point I recommend 5R6 to the tweeter and 3R3 to the midrange.

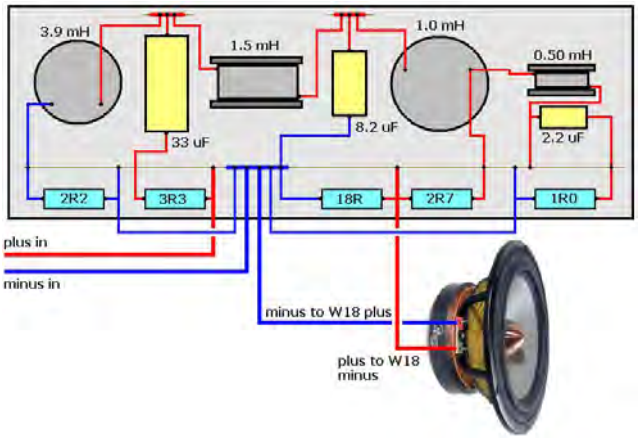
23.05.2004

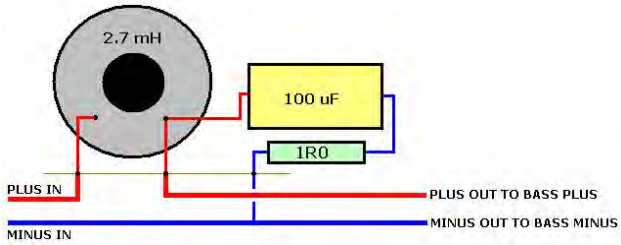
From a number of mails it has turned out that when we are talking frequency ranges we are not always talking about the same thing. I have done a google-search and found this one:

20-40 Hz	Low Bass
40-80 Hz	Mid Bass
80-160 Hz	Upper Bass
160-320 Hz	Lower Midrange
320-640 Hz	Middle Midrange
640 Hz -1.28 kHz	Upper Midrange
1.28-2.56 kHz	Lower Treble
2.56-5.12 kHz	Middle Treble
5.12-10.2 kHz	Upper Treble
10.2-20.4 kHz	Top Octave

Midrange from 160 to 1280 Hz.
Treble from 1280 to 10200 Hz.







Acapella cabinet construction

The file here is constructed from the experiences gained from the Point75 test cabinets.

The front and side panels have the same dimensions, where the Acapella has an additional 50 mm internal depth to the bass cabinet. Removing the Point75 test cab rear panel left an additional 20 mm depth. In all an approximate 10 liter was added to the bass cabinet.

These cabinets are definitely not for beginners and you will need access to a decent table saw or hand-held circular saw with a 48-teeth quality blade. Except for the front panel there are no parallel cuts in this construction. All other panels are going to be cut at odd angles and I suggest you make a test of one front panel + side panels. Once you have these glued in place, a lot of things become quite obvious, and it gives you a good feeling of size and appearance. Compared to the 2.5 clones, they appear quite smallish due to the pointy top.

The presented test cabs were made from 19 mm MDF, and the final cabs are intended being made from a 20 mm laminate consisting of 10 mm hardwood glued to 10 mm MDF. This is my favourite material, as it gives you the possibility of sanding away irregularities, but it's a tedious task to make the laminate panels.

<u>If you use pre-veneered MDF, don't forget to order the side panels with the same veneer on both sides!</u>

The dimensions of the front and side panels are fairly accurate and once these are glued in place ensuring correct rear width at base and top, the rest is pretty much cut and try. The dimensions of bass enclosure panels should be taken with caution. Mark top panel attachment on front and side panels and check all dimensions and angles before cutting these panels.

The pictures do not necessarily follow order of construction.

As long as the front and side panel dimensions + the bass cab volume are correct, there's a lot of freedom in the design to follow your own practice of cabinet construction.

Fig. 1. Front and side panel assembly.

Fig. 2. Front and side panel assembly. Tape is used to keep panels in place.

Fig. 3. IMPORTANT! Use a sliding bevel to ensure same angles of side panels to front panel.

Fig. 4. Gluing front and side panels. Check width at base and top for correct dimensions. These dimensions are very important for the further work. Keep panels in place with tape while drying.

Fig. 5. Gluing front and side panels.

Fig. 6. Bass enclosure assembly. The Acapella bottom panel has to be bigger as seen here.

Fig. 7. Support for rear grille.

Panel cutting:

Since I constructed these test cabs I have tried to figure out an easier way to cut the panels, and from my "The Woodworker's Bible" I learned that an ordinary hand-held circular saw can do the job a lot easier and better than cutting free hand on a table saw. These are the few tools needed to cut all panels:

Fig. 8.
A: A decent-size circular saw, here 185 mm blade. If you use pre-veneered MDF I recommend a 40-48 teeth saw blade to avoid ripping edges.
B: 2-3 clamps.
C: 30 x 50 cm 19 mm MDF for test cutting and determining distance from cut to straightedge.
D: 3 wooden bars to support panels to be cut.
E: 30 x 120 cm 12 mm MDF for straightedge. Have this one cut at your local MDF supplier to be absolutely straight.

Example:
With the circular saw seen on the picture, the distance – at a given cutting angle – from cut to straightedge has to be:
4^0 cut = 99 mm
11^0 cut = 98 mm
19^0 cut = 95 mm
35^0 cut = 90 mm

Fasten the straightedge to the 19 mm MDF test sheet and try cutting at all the angles needed and record the distances.

Fig. 9. Marking side panels (disregard numbers; this is a test cut for a larger cabinet).

Fig. 10. Cutting bottom of front panel 11^0.

Fig. 11. Cutting rear of side panel 19^0.

With a fresh blade to the circular saw this provides nice clean cuts with no edge ripping and the possibility of using pre-veneered MDF.

Hope the pictures tell the story.
I strongly recommend doing a test cut on the side panels and front panel. I did use quite some MDF sheets before I got a good sense of the shape of these panels.

Fig. 12, 12a.
A couple of pictures showing the extension of the bass enclosure on the test cabs. Vents are 72 mm (ID) x 150 mm, placed on the rear panel 200 mm above floor level.

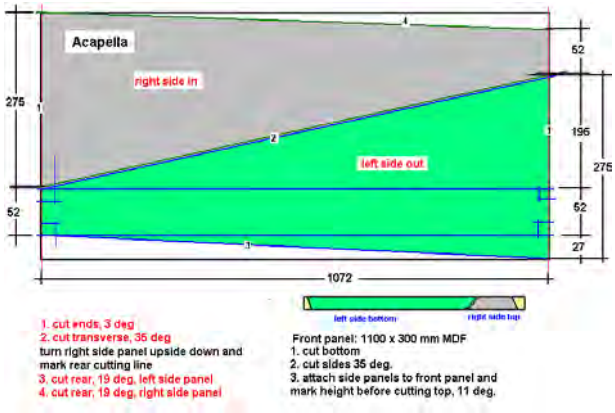


Fig. 13.

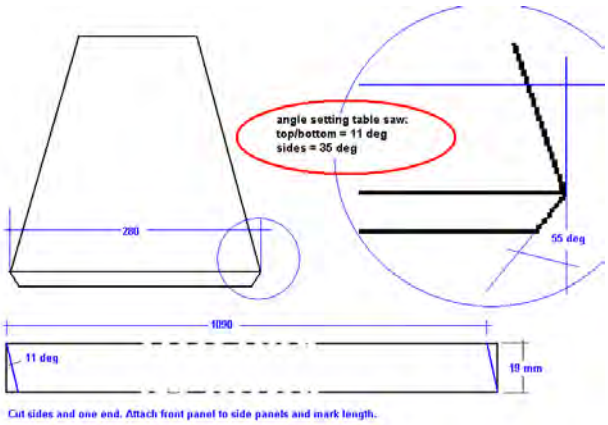


Fig.14.

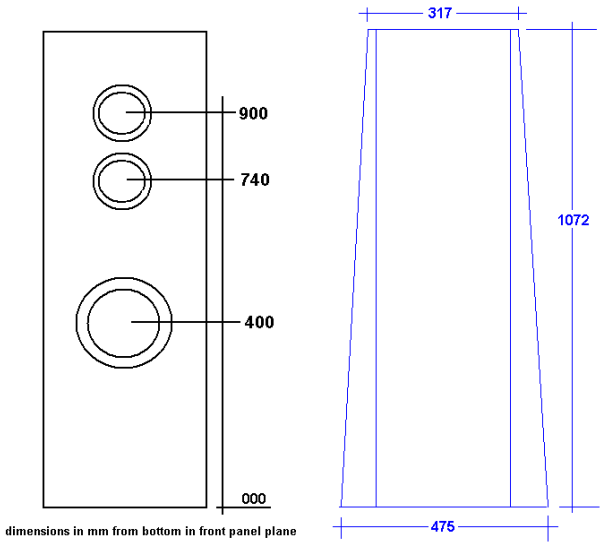


Fig.15.

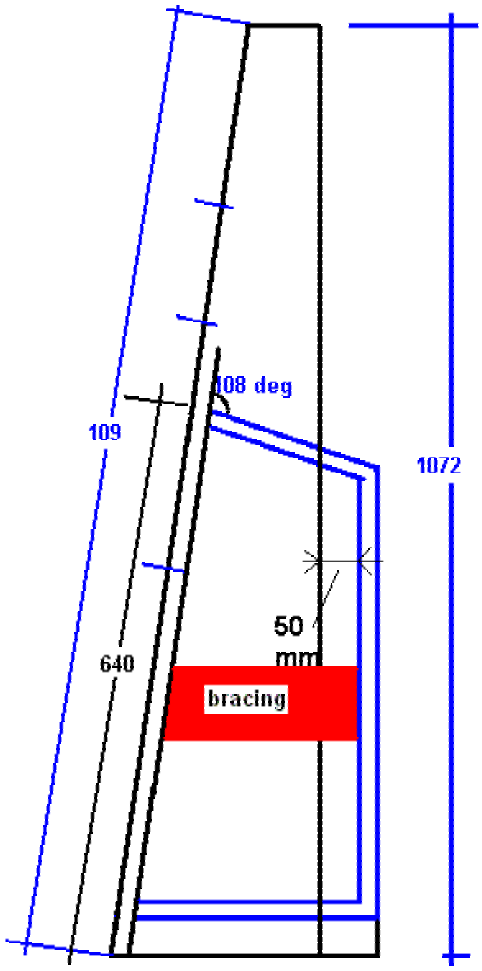


Fig. 16.

The Acapella SE

- drivers, drawings and construction pictures

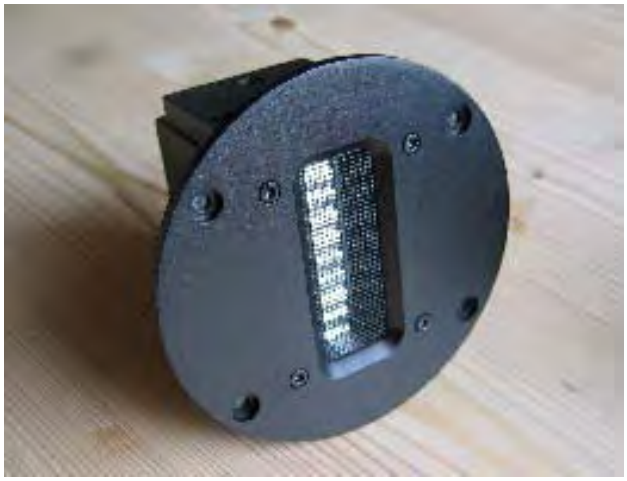


Fig. 1. New ribbon tweeters: Aurum Cantus G2Si

Fig. 2. Midrange driver:SEAS W18EX001

Fig. 3. New bass driver: SEAS W22EX001

Fig. 4. Cutting rear edge of side panels.

Fig. 5. Marking right side panel.

Fig. 6. Checking panels with drawing.

Fig. 7. Chamfering driver hole.

Fig. 8. Making a mould for gluing the side and front panels. This ensures correct angles and rear width.

Fig. 9 and 10: Thanks to the mould used for gluing: two identical structures.

Not that easy to accomplish I can tell from previous projects.Now the top, rear and bottom panels can be made. A small 5 x 5 mm fillet will be inserted between side and front panels.

Cabinet drawings:

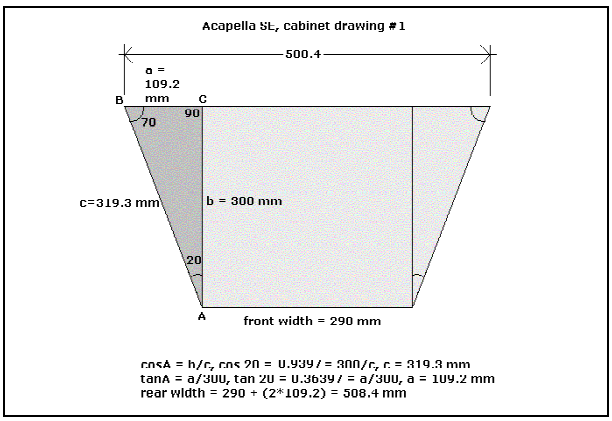


Fig. 11. Drawing of bottom plane. Calculating with of side panels and total width of cabinet rear.

The Acapella SE cabinet is based on the following preconditions: Front width = 290 mm.

Total depth at bottom = 300 mm.

The angle between front and side panel is 110 deg.

Front panel is tilted 10 deg.Total height = 1190 mm.

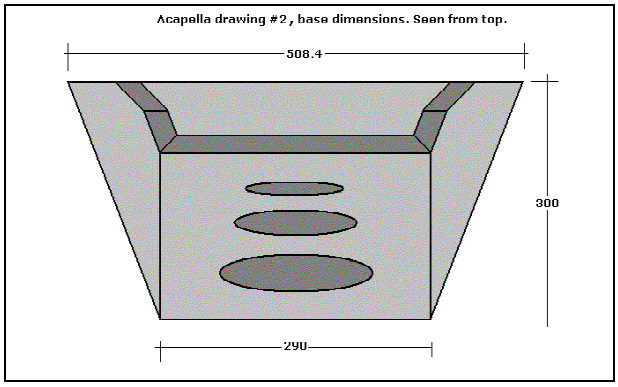


Fig. 12. Acapella SE cabinet dimensions. Seen from top

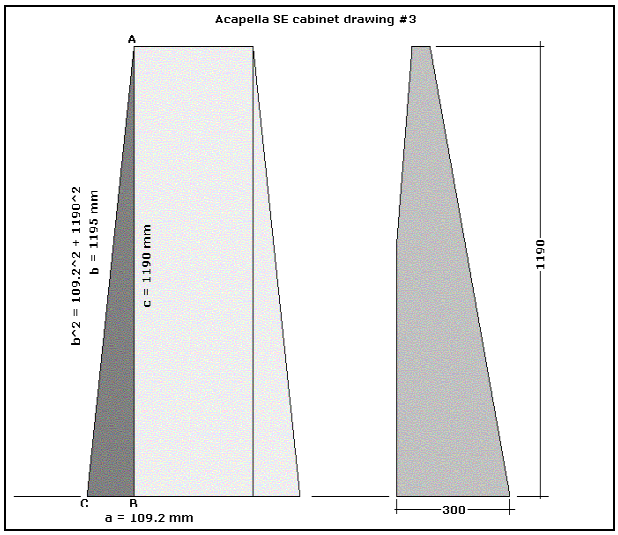


Fig. 13. Drawing of cabinet seen from front and side. Dimensions of rear plane.

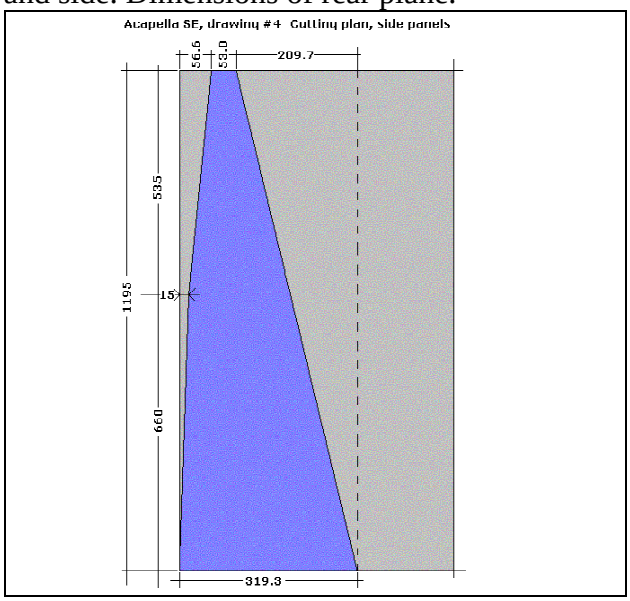


Fig. 14. Drawing #4: Side panel cutting plan. The side panels are made from a 1220 x 450 mm pre-veneered 25 mm MDF, same veneer on both sides (!). Top and bottom is cut 4 deg., front edge is cut 35 deg. and rear edge is cut 20 deg.The transverse cut forms the front edge of both side panels. After cutting the first side panel, place this panel mirrored on the residual MDF panel and mark the cutting lines with a pencil. Then cut the second side panel. See fig. 15.As mentioned several times in the Point75 and Acapella files: do yourself a favour and make a test cut of the side panels. This can be done in 16 or 19 mm MDF. All you need is a sheet of 122 x 450 mm MDF.

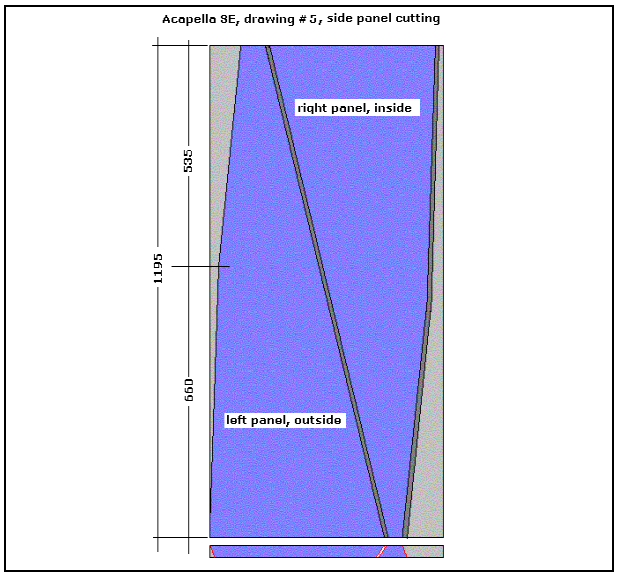


Fig. 15. This drawing shows how you first make the left side panel seen from outside and the right side panel seen from the inside.

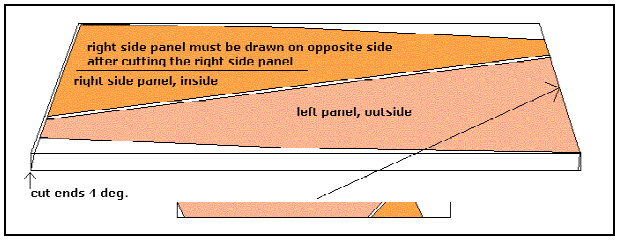


Fig. 16. Additional drawing on side panel cutting. Ends are cut 4 deg. due to minor tilting of the side panels towards the front panel.

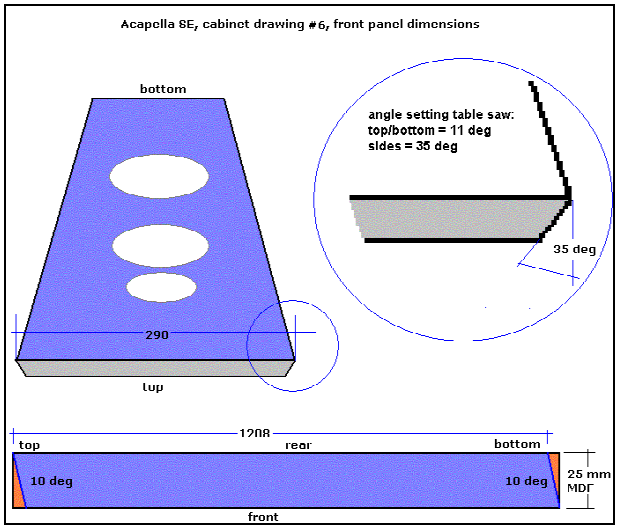


Fig. 17. Cutting plan for front panel.

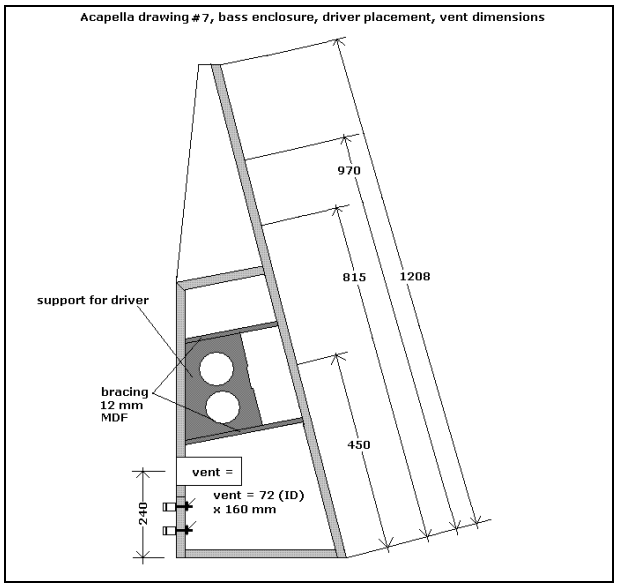


Fig. 18. Vent dimensions/placement, bracing and driver placement.Final vent length still to be determined. 160 mm produces a vent tuning of 35-37 Hz, which is likely to be the end result.

Fig. 19. The bottom panel is going to be attached by screws, thus fillets being glued in place here.

Fig. 20. The top panel is 90 deg. to the front panel (fig. 19),
so the rear and top panel are both cut at a 40 degree angle.

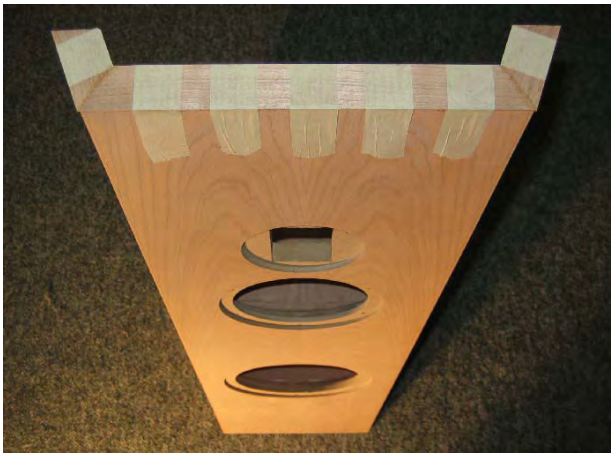


Fig. 21. Gluing fillets to the top.

Fig. 22. Finally, the cabs are finished and ready for all the fun work.

Fig. 23. Crossovers are piling up. Here for the tweeter and bass driver.

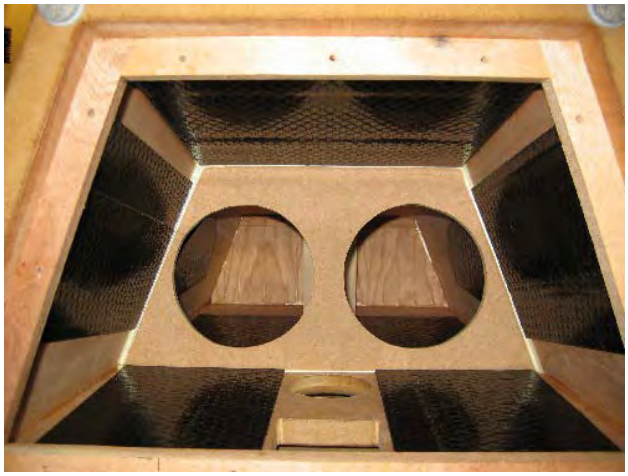


Fig. 24. Applying bitumen pads to bass enclosure.

Fig. 25. Bitumen pad on rear of front panel.

Fig. 26. Mounting ribbon crossover. Still some polyester foam to be glued to the rear.
Fillets will be glued to the sides to support rear grille as seen in Point75A file.

Fig. 26a: Fillets for supporting the rear grille. Residual rear damping on top of bass enclosure and side panels.

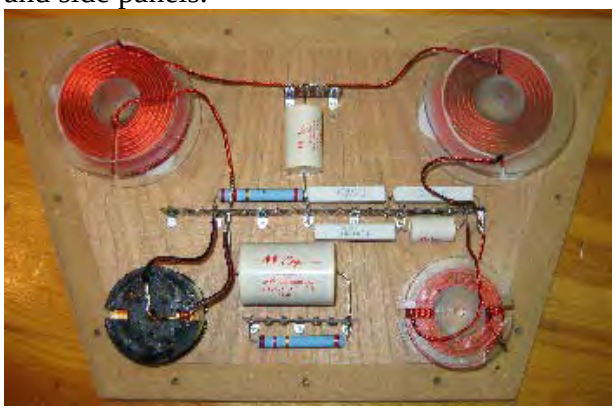


Fig. 27. Midrange crossover on inside of bottom panel.

Fig. 28. Wiring up the mid-section and fine-tuning LCR-circuit. A piece of 30 x 60 cm damping material is folded and placed on top of bottom panel before assembly.

Fig. 29.
31 October, 2004: So, here is the final result on display for the camera. These speakers throw a wide, solid soundstage with a clarity and lack of distortion better than any other speaker system I have ever had. I'm sure they would make up to even better amps than what I have,

although I'm very pleased with the sound from my homemade valve preamp and Copland power amp.

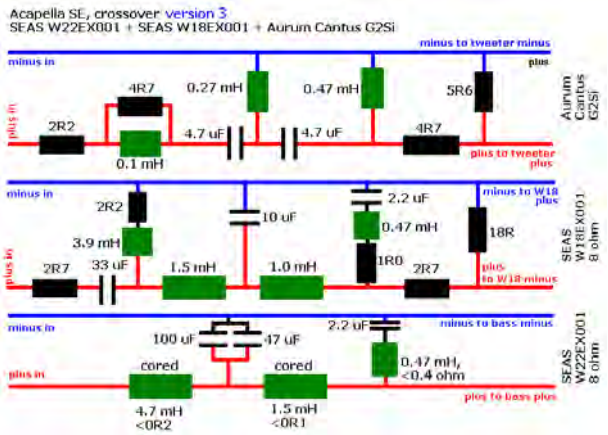


Fig. 30. Acapella SE, crossover, version 3.Initially I left out the bass driver notch filter (0.47 mH + 2.2 uF), thinking it was a bit too much targeting a small notch more than 40 dB down, but it does appear to have a minor impact on tweeter performance in the 5-8 kHz region. Try listening to pink noise with only the bass driver connected and then insert the notch filter and hear a faint hiss disappear. It's clearly audible. So in it goes again. Small operation and for the benefit of the doubt.

Crossover parts:

Tweeter:

2.2 ohm, 5 W, MOX
4.7 ohm, 5 W, MOX
5.6 ohm, 5 W, MOX
0.1 mH, 0.17 ohm, 0.9 mm wire
0.27 mH, 0.29 ohm, 0.9 mm wire
0.47 mH, 0.41 ohm, 0.9 mm wire
4.7 uF, 400 Vdc, polypropylene, Mundorf Mcap

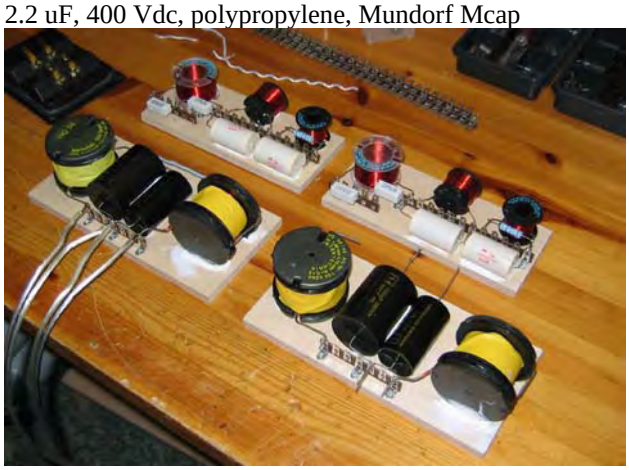
Midrange:

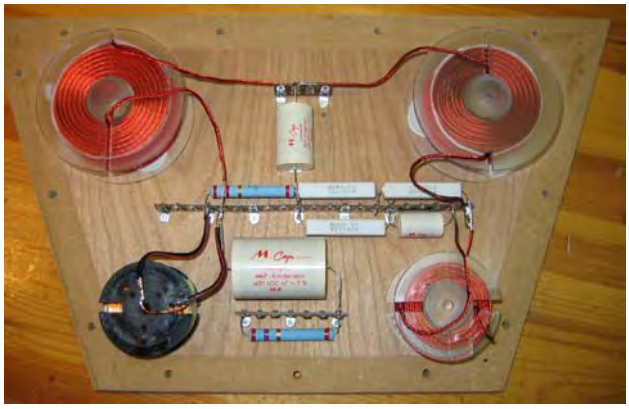
2.7 ohm, 10 W, MOX
2.2 ohm, 10 W, MOX
1.0 ohm, 10 W, MOX
2.7 ohm, 10 W, MOX
18 ohm, 10 W, MOX
3.9 mH, cored, 0.42 ohm, 1.12 mm wire
1.5 mH, 0.33 ohm, multistrand wire, 7 x 0.6 mm = 1.98 mm^2
1.0 mH, 0.27 ohm, multistrand wire, 7 x 0.6 mm = 1.98 mm^2
0.47 mH, 0.17 ohm, multistrand wire, 7 x 0.6 mm = 1.98 mm^2
33 uF, 400 Vdc, polypropylene, Mundorf Mcap
10 uF, 400 Vdc, polypropylene, Mundorf Mcap
2.2 uF, 400 Vdc, polypropylene, Mundorf Mcap

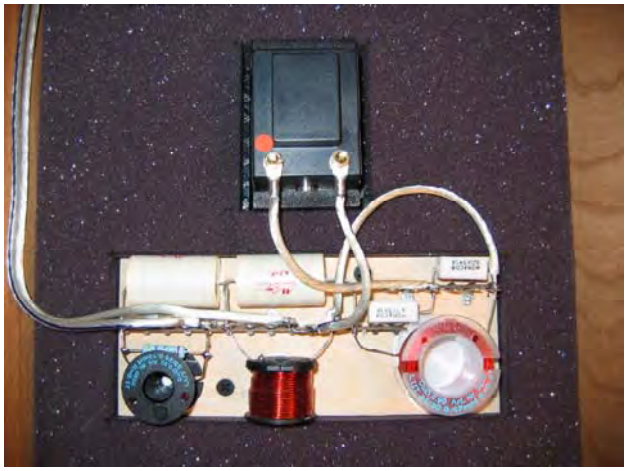
Bass:

4.7 mH, cored, 0.19 ohm, 1.4 mm wire
1.5 mH, cored, 0.07 ohm, 1.4 mm wire
0.47 mH, 0.41 ohm, 0.9m mm wire (0.41 ohm is OK)
100 uF, MKT, polyester, 100 Vac
47 uF, MKT, polyester, 100 Vac

2.2 uF, 400 Vdc, polypropylene, Mundorf Mcap





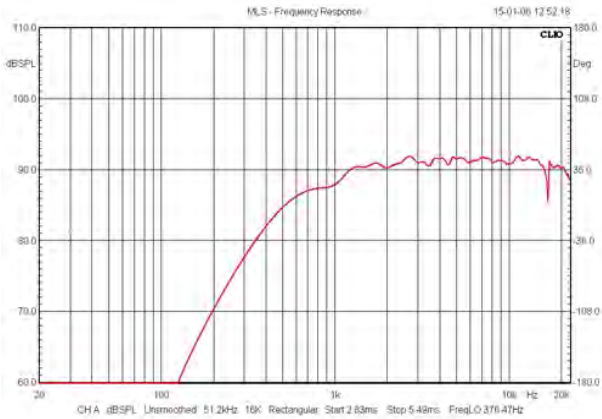


Acapella SEas

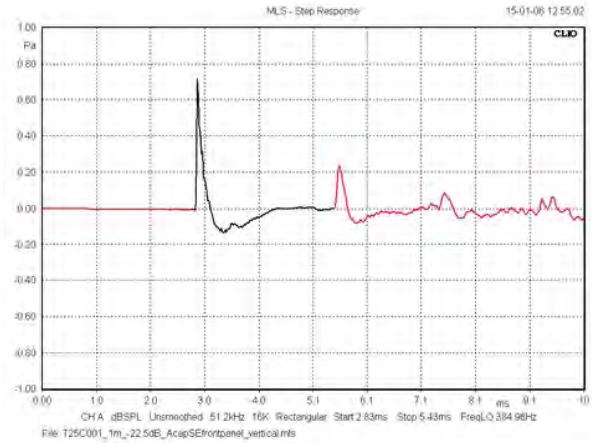
The all-SEAS Acapella
31-01-2006

SEAS T25C001 on top of SEAS W18EX001 midbass. Family reunion!

Tweeter performance:

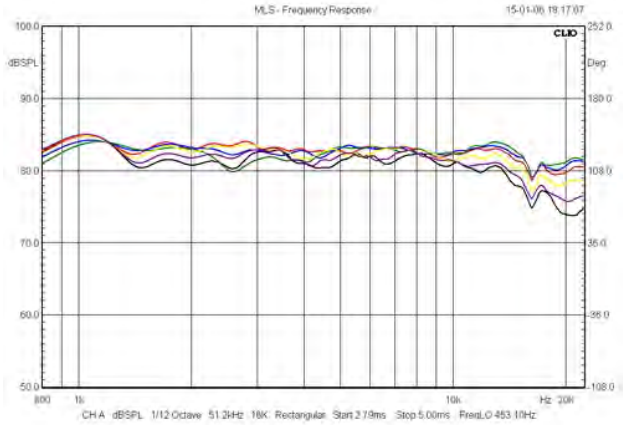


T25 response from Acapella front panel with no crossover attached.
Now this is some nice response! The T25 has a strange dip at 16-17 kHz. Not
present from the SEAS measurements, but it can be seen here at:
http://ldsg.snippets.org/graphics/seas/e006w.gif

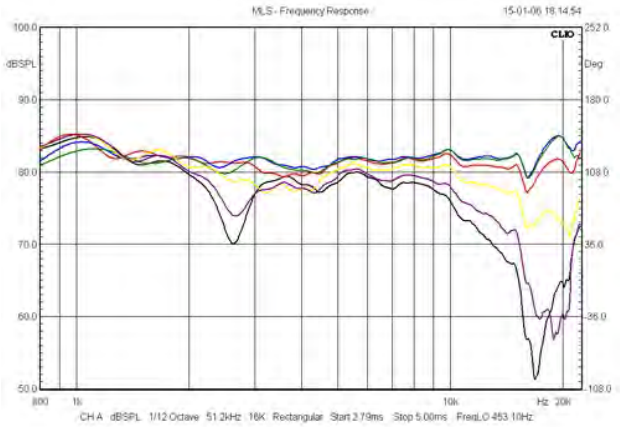


T25 step response. Nice!

Vertical dispersion
Intro at TJL3W page.

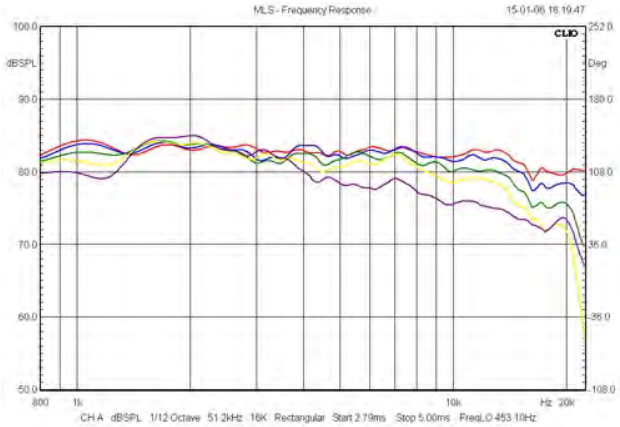


Acapella SEas vertical dispersion at 1 metre distance.
Red = tweeter height, blue = +10 cm, green = +20 cm, yellow = -10 cm,
purple = -20 cm. (+ = up, - = down)

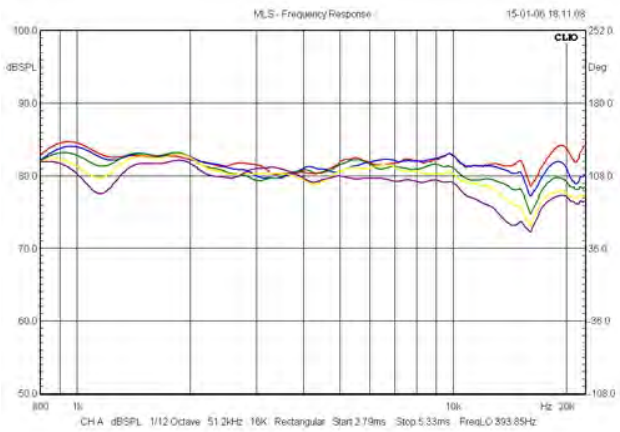


For comparison: The Acapella SE (ribbon) at same conditions as above.

Horizontal dispersion:

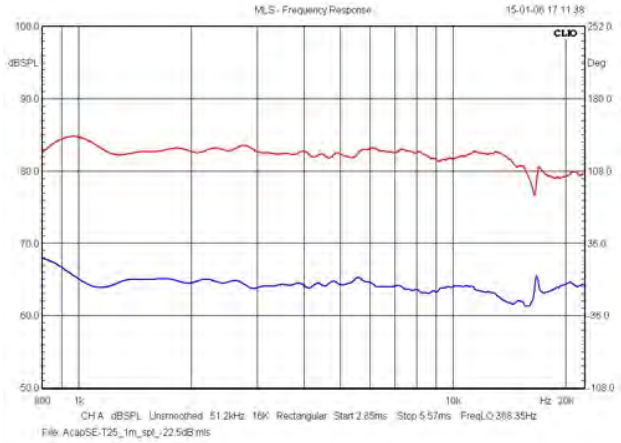


Horizontal dispersion with T25 tweeter. Red = on-axis, red = 10 deg., blue = 20 deg., green = 30 deg., yellow = 40 deg., purple = 50 deg.

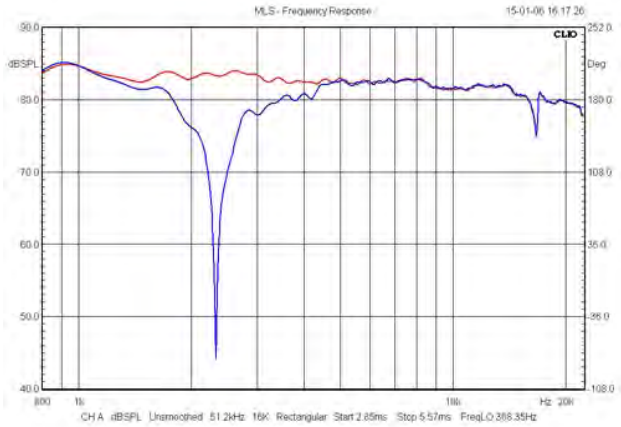


Horizontal dispersion with Aurum Cantus ribbon: Red = on-axis, red = 10 deg., blue = 20 deg., green = 30 deg., yellow = 40 deg., purple = 50 deg. Actually the ribbon is doing better at 50 deg. compared to the T25, extremely even dispersion up to 10 kHz.

Final performance, Acapella SEas

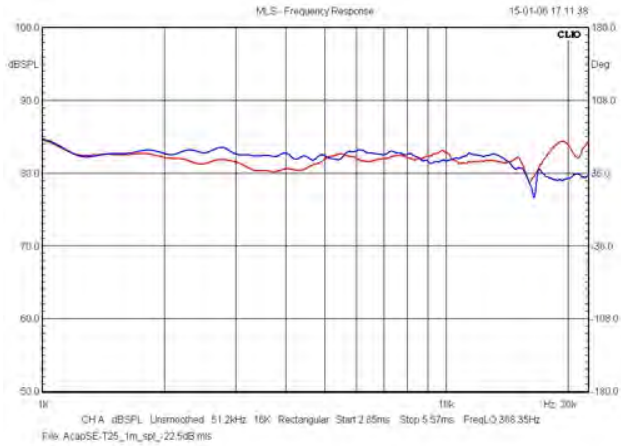


Frequency response at 1 metre distance. Red = SPL, blue = minimum phase.



Blue = tweeter with positive polarity. Red = negative polarity.
(the mid and tweeter both have negative polarity)

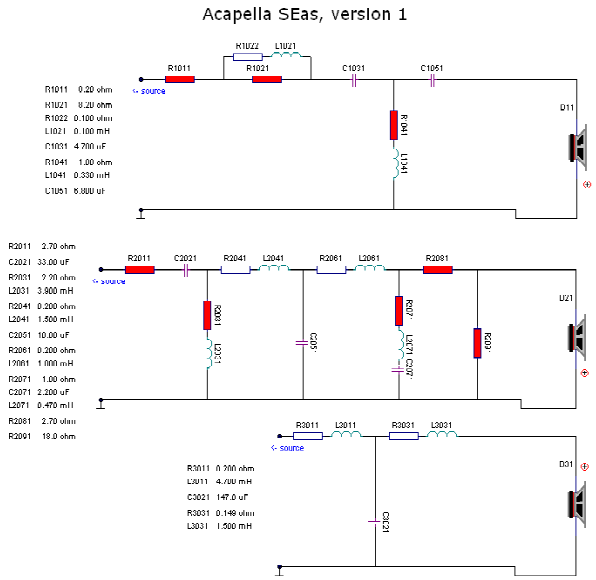
Before and after -



Before and after: Red is the Acapella SE and blue is the Acapella SEas. The SEas version for sure is linear. It's difficult to change only one thing at a time when dealing with tweeter

replacement. What we hear is not only the intrinsic qualities of the new "thing" but also the impact on overall performance from a changed crossover and changed SPL amplitude. And there are some differences here. The 2-5 kHz region has a lift of 1-2 dB lift, and I'm sure this counts for some of the sonic differences. 1-2 dB is a lot and would the ribbon solution sound the same from this change? Probably some, but it wouldn't make the same off-axis performance as seen from the T25. Normally I wouldn't voice a speaker this flat, but here it goes well and probably due to the mid having an overall higher power response being a dipole. What we see here is on-axis; what we hear is this plus all room reflections.

New tweeter crossover



LspCAD lay-out.

Yes, the crossover is on top of the tweeter.

February 2006.
Troels Gravesen