Mezzo Galactica

The ultimate cosmic speaker experience in a smaller package

Based on the full-size Galactica loudspeaker, the Mezzo Galactica gives similar results but from a smaller package. The tweeter and midrange driver are the same but the 12" midwoofer and 15" woofer have been replaced by a single 15" midwoofer. Also the crossover design has been simplified. I guess you could call it "less-is-more".

The midwoofer

As I mentioned in the original Galactica article, for me a 15" woofer is the ideal size for realistic sounding bass. It is big enough to give that "ease" that comes with larger woofers, it is small enough not to compromise the upper-bass range articulation and integration with the rest of the speaker. The woofer used here is the Ciare NDH 15-3. I chose this midwoofer for it's smooth response far up into the midrange so it could be used in combination with a relatively small midrange like the PHL 1130. It also has very low mechanical losses (Qms = 23,77 and Rms = 1,17) and a powerful magnet. It's resonance frequency doesn't seem very low for such a large driver (fs = 49,8Hz) but as you will see later on, by setting the crossover point very low, therefore cutting the high efficiency in the upper-bass and midrange, it is still possible to obtain a system bass that is well balanced and deep. Here the midwoofer is used in a ported enclosure with a nett volume of about 100 litres tuned to 39Hz.

The midrange

A matching midrange driver for this project was also found at PHL: the PHL 1130. In the past I have often worked with the 6,5" midwoofers from PHL and was always impressed by the articulate and expressive midrange qualities. Seeing as here the bass and upper-bass would be done by dedicated drivers, I could go for a true midrange driver. PHL makes lots of different versions but carefully searching through all the data I came up with 4 possibilities: the 1120 / 1130 / 1660 / 1670. All four drivers are designed for use in high quality studio monitors, the 1660 / 1670 models have a little more power in the lower midrange but seeing as the 12" PHL 4531 would take care of that, the 1120 / 1130 seemed a more logical choice. The only difference between these two models is their impedance. As I prefer to get the highest possible BL/Mms ratio I decided on the PHL 1130 with its 16 ohm nominal impedance. Its BL-factor of 12,7 is about 1,5x that of the 8 ohm version and with a moving mass of only 8,2 grammes this results in an amazing BL/Mms ratio of 1549. Now compare that with other drivers with 150 square centimetres of cone-area!

The tweeter

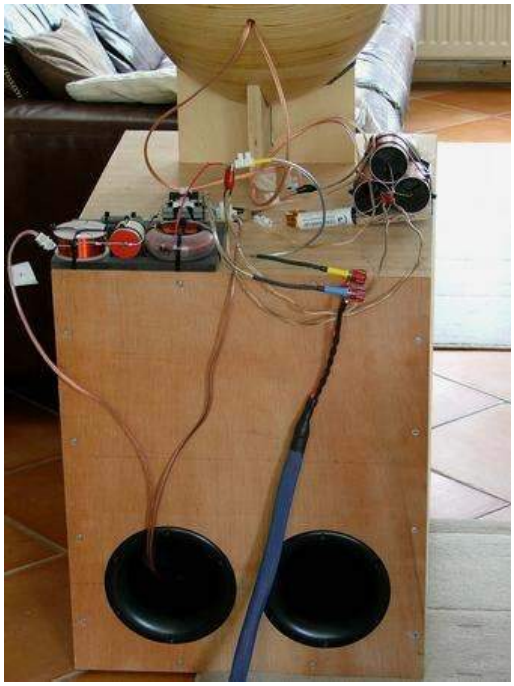
Seeing as the Mezzo Galactica speaker uses paper cones for the bass, midbass and midrange, the logical choice when looking for optimum driver coherence, was to choose a soft-dome tweeter. Now I needed a very high quality driver with reasonable efficiency and a nice low resonance frequency to facilitate crossover design. I found these qualities in the Seas Excel T29CF001-E0038-06. The T29CF001 is a 29mm fabric dome tweeter with a wide surround. An optimally shaped dome and integrated wide surround manufactured by SEAS from SONOMEX ensure excellent performance and consistency. A powerful magnet system based on an axially magnetized NdFeB ring magnet provides efficient ventilation and damping of the cavity behind the dome. Low viscosity magnetic fluid provides excellent cooling while maintaining a low resonance frequency. A generously underhung voice coil with flexible lead-out wires ensures low distortion and allow this driver to be used with low crossover frequencies. A 6mm precision machined aluminium front plate with moderate horn loading combines linear frequency response with high efficiency. The front plate is Nextel painted to obtain a durable and attractive finish. A substantial injection moulded rear chamber made from zinc eliminates unwanted chamber wall resonances and conducts heat away from the magnet system.

The cabinets

The cabinets for the Mezzo Galactica are inspired by the Focal DIY loudspeakers from the previous century such as the Kit 600 and Kit Audiom, those with the famous "eouf" on top of a rectangular bass cabinet. The "egg" has several acoustical advantages, the main one being the curved shape resulting in less diffraction problems at the cabinet edges and a minimal frontal area also resulting in less reflections from the baffle resulting in better imaging. Also the inside of the enclosure has no parallel surfaces, so there are less reflections and standing waves that will reflect back (delayed) through the thin paper cone.

This is a very complex, heavy and time-consuming loudspeaker to build so take your time and double check everything before you start. The "egg" top section for the midrange and tweeter is made from numerous slices of Baltic Birch plywood glued together to form a nearly solid block. The closed midrange volume of about 12 liters is created by donut-shaped circluar cutouts stacked on top of each other. The inside of each segment has an irregular cut-out, the outside is a circle with one side cut straight. This is where the drivers will be mounted when the egg's are completed. The top and bottom part of the "egg" are solid and made of Baltic Birch disc's. When glued together you get an egg-shape that has a stepped outside. Then it's time for a large belt-sander and lots a patience while you sand both rough shapes down to nice smooth eggs. Finally the cabinets are finished with a clear, semi-gloss varnish that high-lights the layered material and structure. For optimum results the egg's are slanted back slightly (about 8 to 10 degrees) and ear-height should be between the midrange driver and tweeter. Positioned like this you should be rewarded with a very spatious image and seemless integration between the drivers. The photo at the beginning of this page shows the eggs on their temporary crossed stands. Of course things will look better when they stand on three anodised IKEA aluminium legs or similar.

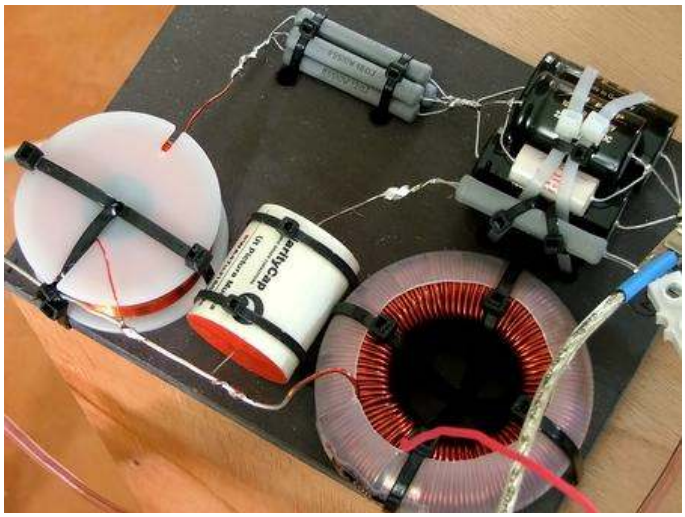

The woofer enclosure is a lot less work! Basicaly it is a rectangular box with some internal bracing and two 100mm diameter rear-firing trumpet ports. The total length of the ports including the inside and outside flairs is 135mm. If you use ports with straight ends, then the length of the ports should be 150mm's. The volume of the woofer enclosure is 100 liters. I don't have a finished CAD-drawing at the moment (all this was done with very crude hand sketches) but look at the 90 litre Andromeda MK-I bass enclosure for inspiration and construction. All the internal walls of the bass enclosure are covered with Intertechnik Damping-30 damping material. This 30mm thick, self-adhesive material is made from recycled cotton. The internal volume for the Ciare NDH 15-3 has a medium fill of Intertechnik Sonofil Bonded Acetate Fibre and the volume for the PHL 1130 has a medium fill of Monacor MDM-3 damping-material that is made from 75% sheep's wool and 25% bonded acetate fibres. Tune the correct amount for each compartment by ear when the drivers are burnt-in. Don't forget to use dedicated gasket sealing strips like Monacor MDM-5 between the counter-sunk driver chassis and the cabinets for an air-tight fix. Internal wiring is standard 4,0mm2 OFC for the woofer and 1,5mm2 OFC for the tweeter and midrange drivers.

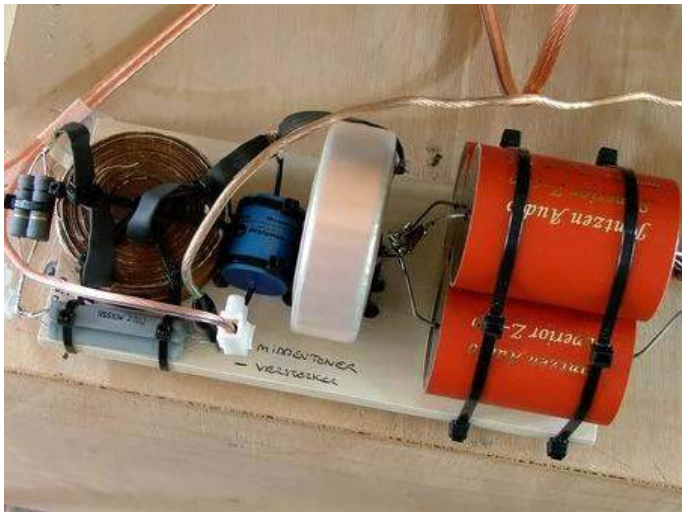
The crossover network

These three drivers are connected together via a 3-way parallel crossover. The low-pass for the woofer is formed by a single 10mH inductor with a very low Rdc to ensure good bass definition. I used a Jantzen Audio C-Coil with an Rdc of 0,10 ohms. For the inductor low Rdc is extremely important if you want tight and well-controlled bass. The Zobel network of 47uF + 8,2 ohms parallel to the woofer cancels the inductive rise of the woofer impedance so that the 10mH inductor does it's job properly. The capacitor

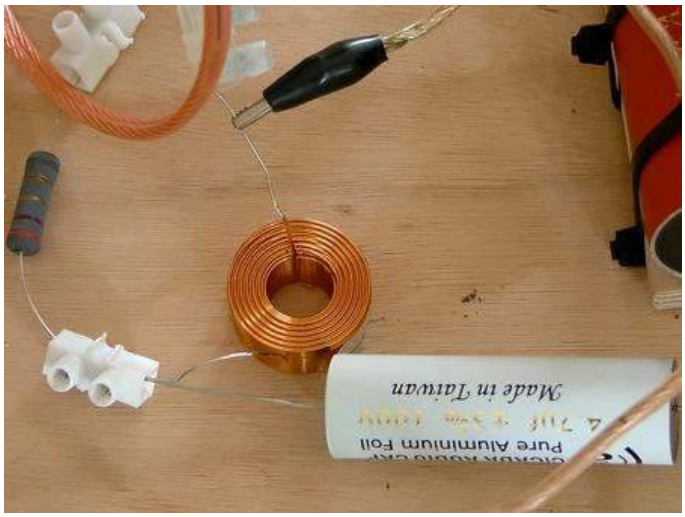
must be an MKP type, cheap standard types like Clarity Cap APW or Intertechnik Q4 work fine. The result is better bass definition compared to using cheap smooth foil electrolytics. The LCR-network parallel to the woofers is to flatten the impedance peak in the bass also so that the low-pass function works properly, without this LCR there is a large bump at lower frequencies resulting in an over bloated and muddy sounding bass. So the woofer has a 1st-order low-pass in combination with two correction networks.

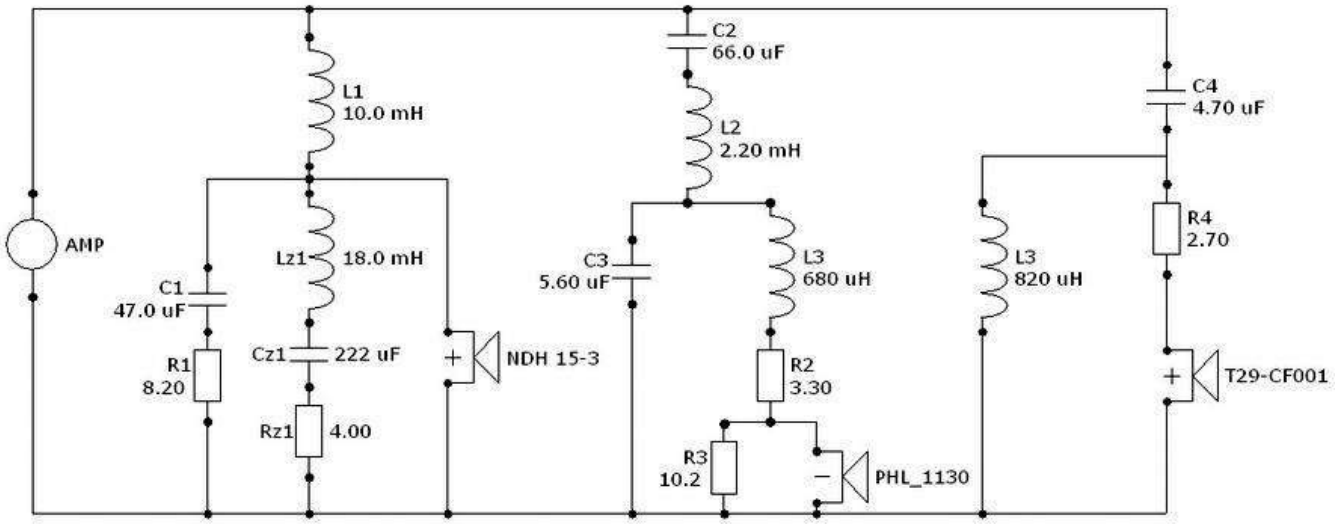


The midrange drivers covers the spectrum from about 240Hz to 2400Hz. To match the woofer, it has a 1st-order high-pass network of 66uF. I used 3x 22uF Jantzen Audio Superior Z-Cap for its high quality and reasonable price. The 3rd-order low-pass is formed by 2,2mH + 5,6uF + 0,68mH. The series inductors are copper-foil types for best imaging, separation and natural harmonics, the parallel capacitor is an MKP type. The resistor-network of the PHL 1130 flattens the impedance peak at fb so that the high-pass function works properly and at the same time tame's the output level to match that of the woofer.



Finally the tweeter high-pass is simplicity itsself. Only three components: a single resistor for level adjustment and a 2nd-order high-pass consisting of 4,7uF + 0,82mH. For C1 personal taste and budget will determine what you use, I had very good results with a Duelund Cast-Cu but a Jantzen Audio Superior Z-Cap or Cicada Pure Aluminium Foil also worked very nicely. The parallel inductor doesn't need to have low Rdc, so a small air-core if fine here. Make sure it's Rdc is about 0,75 ohms, if it is much lower the treble could get a little "edgy".





C1 = 47uF Clarity Cap APW

C2 = 66uF (3x 22uF) Jantzen Audio Superior Z-Cap

C3 = 5,6uF Clarity Cap PX

C4 = 4,7uF Jantzen Audio Superior Z-Cap / Jupiter BeesWax / Duelund VSF-Cu / or something of your personal taste

Cz1 = 222uF (100+100+22uF) Mundorf E-Cap + 2,2uF Mundorf M-Cap bypass

L1 = 10mH Jantzen C-Coil inductor (Rdc = 0,10 ohms)

L2 = 2,2mH Jantzen 16AWG copper-foil Coil (Rdc = 0,55 ohms)

L3 = 0,68mH Jantzen 16AWG copper-foil Coil (Rdc = 0,27 ohms)

L4 = 0,82mH air-core inductor 0,70mm wire (Rdc = 0,76 ohms)

Lz1 = 18,0mH Mundorf air-core inductor 0,70mm wire (Rdc = 4,97 ohms)

R1 = 8,2 ohms / 20 watts MOX resistor (18 + 15 ohms / 10 watts parallel)

R2 = 3,3 ohms / 30 watts MOX resistor (3x 10 ohms / 10 watts parallel)

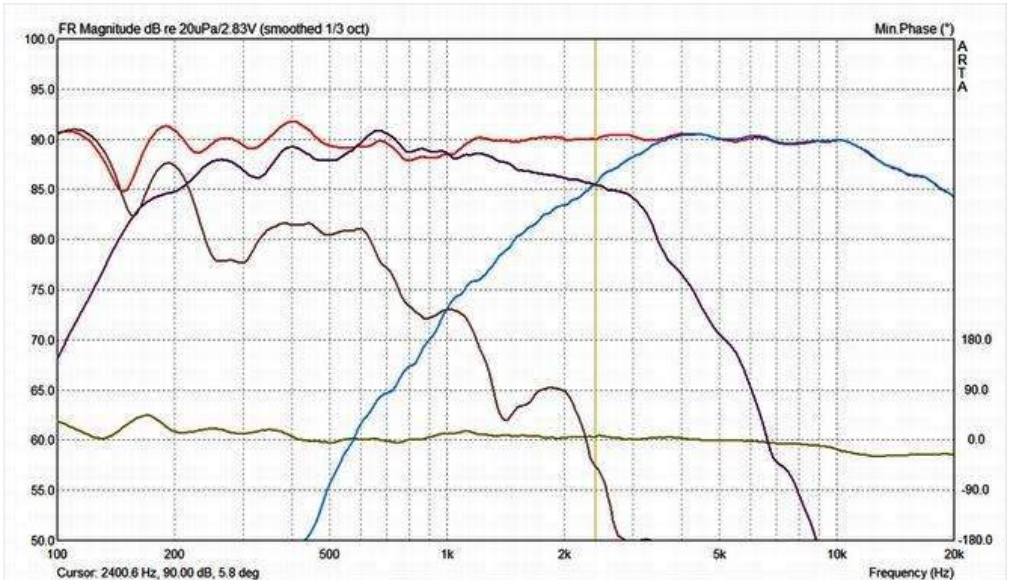
R3 = 10,2 ohms / 30 watts MOX resistor (1x 27 ohms + 2x 33 ohms / 10 watts parallel)

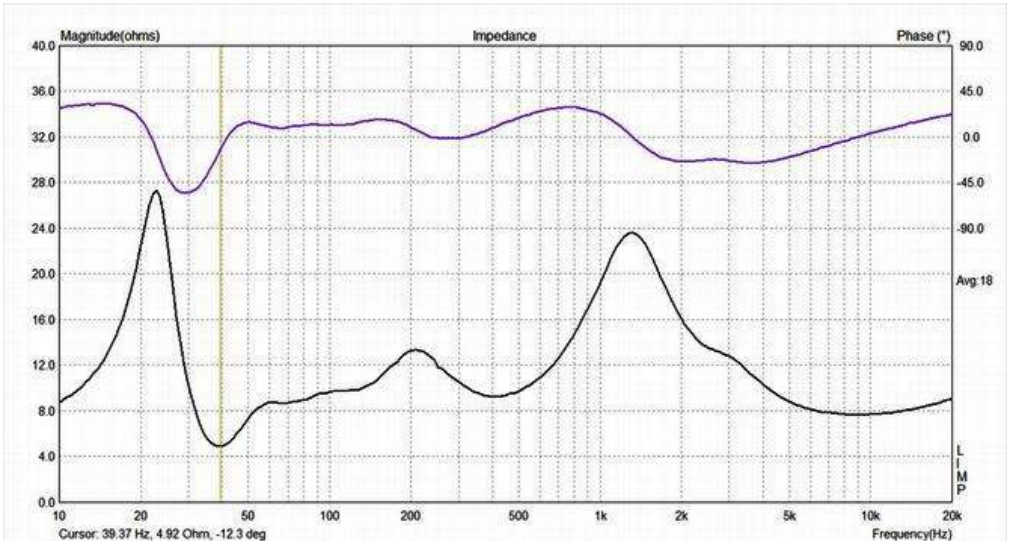
R4 = 2,7 ohms / 10 watts MOX resistor

Rz1 = 4,0 ohms / 40 watts MOX resistor (1x 22 ohms + 3x 15 ohms / 10 watts parallel)

Listening impressions and measurements.

Placed on spikes and slightly toed-in with the middle between the tweeter and midrange driver at ear height, the overall balance is very neutral and smooth with an impression of very low colouration and lots of detail over the whole spectrum. Dynamics are impressive and the coherence extremely good. This loudspeaker just gets louder without any change to the tonal character of the system! Imaging is large and spatial. The low-end has lots of weight and is well in balance with the rest of the spectrum, it also seems to go deeper than the measurements would suggest. Once you get used to 15-inch bass, there is no going back! The midrange is open, well defined and very expressive, it lets you really get into the music. The top-end is well-defined and never tiring. For me personally I even prefer this speaker over the original Galactica, but that is also personal taste.





The measurements show a very smooth overall response (red). The riple in the bass is due to the in-room measurement at some distance. Measured close to the woofer, bass-extension is down to about 39Hz (flat) and efficiency is good at about 90dB's for 2,83V at 1 meter. The crossover-points are situated near 240Hz and 2400Hz. The slight roll-off above 10kHz is due to the angled baffle, so it's like you are measuring the tweeter at 10 degrees off axis. The corresponding phase plot is very flat! The impedance plot (black) shows a healthy 8 ohm load on average with an impedance minimum of 5 ohms at 39Hz. This shouldn't perform any problem for most amplifiers seeing as the corresponding electrical phase is very smooth staying within the +/-30 degrees range from 40Hz upwards and even in the bass it is within +35/-50 degrees. So your amplifier doesn't need to be very powerful although is it a lot of fun when it is!

Tony Gee, The Netherlands, May 2010