HATT-MkIII

The HATT Mk-III – The evolution of the mini monitor

The idea of building a mark-three version of the HATT has several reasons: The drivers for the original HATT are starting to get a bit hard to find now, they've been around for quite a while so they needed up-dating. This gave way for another challenge, I wanted to have the best of both worlds: the good price quality of the original HATT combined with high sound quality of the HATT-SE.

The tweeter

Okay, what must it be: latest model Seas metal dome with a flat SPL down to at least 1 octave below the crossover frequency of about 2500Hz, so that leaves out the version with a rear chamber. The Seas 27TBFG-H1214 fitted this description perfectly. It's a 27mm aluminium/magnesium alloy dome tweeter with a wide, soft polymer surround. The dome and surround materials give high consistency and excellent stability against variations in air humidity. The diaphragm is protected by a highly perforated hex grid carrying an acoustic lens (clear plastic spot attached to the centre of the grill), which tailors the high frequency roll off characteristic. The voice coil is wound on an aluminium voice coil former with adequate ventilating holes to eliminate noise from internal airflow. The voice coil is immersed in low viscosity magnetic fluid for high power handling capacity and simplified crossover design. The chassis is precision moulded from glass fibre reinforced plastic, and its front design offers optimum radiation condition (according to Seas).

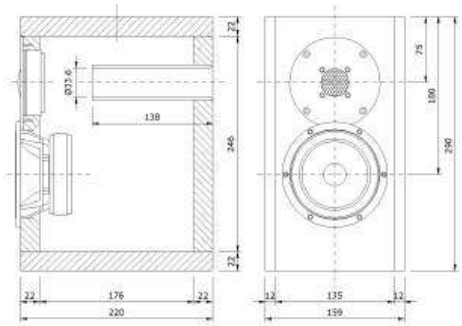
The mid-woofer

Easy one here: the standard version of the 12cm woofer, it shares the same magnet, surround and basket as the Excel version. The cone is made of aluminium instead of magnesium and they have left out a lot of expensive copper: the Seas L12RCYP-H1207. It's a 4.5" mini woofer with a stiff and stable injection moulded metal chassis. The stiff, yet light aluminium cone and the low loss rubber surround show no sign of the familiar 500-1500 Hz cone edge resonance and distortion associated with soft cones. On the other hand, the cone break-up modes at higher frequencies call for special attention in the crossover design work. The high temperature voice coil wound on an aluminium voice coil former gives high power handling capacity. A black plastic bullet shaped phase plug reduces compression due to temperature variations in the voice coil, avoids resonance problems which would occur in the volume between the dust cap and the pole piece and increases the long term power handling capacity. An extra large magnet provides high efficiency and low Q. The unit may be used in very small two-way ported systems producing an astonishingly deep bass and a clean, neutral midrange – I can agree on that.

The drivers: Seas L12RCYP-H1207 and Seas 27TBFG-H1214

The cabinet

With the basic version all walls are made of 22mm MDF, just the standard 6 planks. No difficult matrix constructions seeing, as they are so small. I made a variation on the cabinet construction: keeping the internal dimensions the same, I built a 18mm cabinet completely covered with 10mm thick hardwood. This gives a total cabinet wall thickness of 28mm made of two different material densities, when you tap the cabinet it sounds very hard and dense. The reflex port is made from a piece 40mm thick-walled PVC sewer pipe.

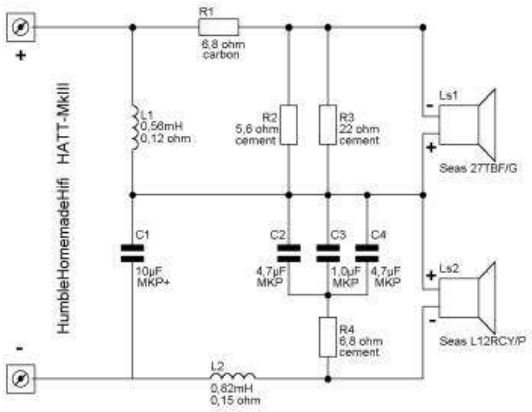


This is the standard cabinet made of 22mm mdf.

The inside of all the walls except the baffle are covered with lead bitumen sheets and heavy-duty carpet tiles. The carpet tiles have a nice heavy backing that adds mass to the enclosure. Some Bonded Acetate Fibre damping material is rolled up and fills the centre of the enclosure. I used Monacor MDM-3 damping pad that consist of 2/3 sheep's wool and 1/3 polyester fibre. All the edges of the cabinet are routed with 10mm's radius for looks and to remove the sharp edges that would cause baffle diffraction problems. The internal volume is only 4,5 litres and the bass-reflex port is tuned to 65Hz.The cabinets are finished with clear high-gloss polyester boat-lacquer. The images show the building of the mdf/hard-wood sandwich cabinet.

The crossover network

It uses a combination of a first and a second-order series-filter. First order on the tweeter and second order on the woofer due to the extra inductor before the woofer. The whole filter is nice and simple using only three active components for two drivers but still giving a crossover with electrical slopes of nearly 15dB per octave. The only extra components are the resistors to tame the tweeter and a Zobel network to compensate the inductive rise of the woofers voice-coil. What happens to the woofer is especially interesting; there are no special LC networks to cut out the resonance due to cone break-up but the roll-off is nice and smooth with only one minor low-level peak at just above 8600Hz. This is about 18dB's down and therefore it doesn't mess-up the total output. The inductors are air core type using thick wire for low Rdc and are matched within 1/100 of a millihenry using a LCR meter. The capacitors use metalled polypropylene foil and the film resistors are also matched for minimum tolerance. The tweeter is connected with reversed polarity.



The final crossover!

Filter components:

L1 = 0,56 mH air-core inductor 2,00 mm wire, R = 0,11 ohms (tolerance max 2%)

L2 = 0,82 mH air-core inductor 2,00 mm wire, R = 0,15 ohms (tolerance max 2%)

C1 = 10uF MKP polypropylene foil capacitor – quality and taste count here!

C2 = 4,7uF MKP polypropylene foil capacitor – Intertechnik Audyn Cap, LeClanché or Mundorf Mcap (tolerance max 5%)

C3 = 1,0uF MKP polypropylene foil capacitor – Intertechnik Audyn Cap, LeClanché or Mundorf Mcap (tolerance max 5%)

C4 = 4,7uF MKP polypropylene foil capacitor – Intertechnik Audyn Cap, LeClanché or Mundorf Mcap (tolerance max 5%)

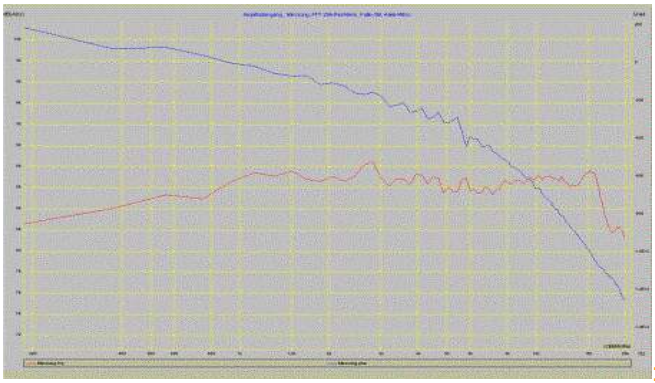
R1 = 6,8 ohms, 4 watts carbon film resistor (tolerance 2%)

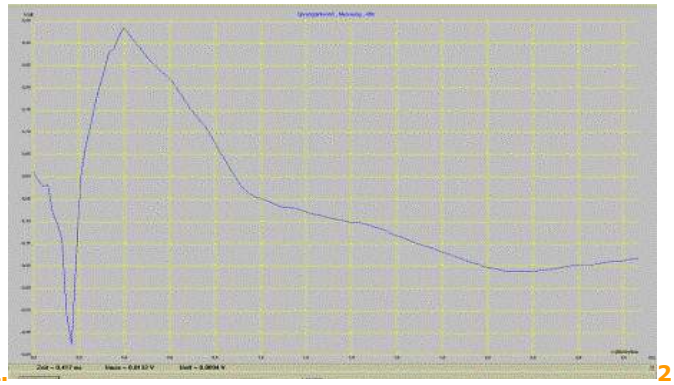
R2 = 5,6 ohms, 10 watts cement resistor (tolerance 5%)

R3 = 22 ohms, 10 watts cement resistor (tolerance 5%)

R4 = 6,8 ohms, 10 watts cement resistor (tolerance 5%)

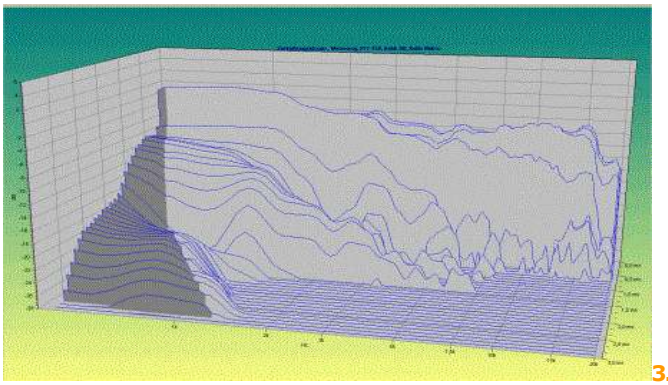
Measurements


1.


2.

1). Output level and acoustic phase 200-20.000Hz – horizontal division 2dB. Good linearity well within +/- 1,5dB, the drop towards the lower end is due to the measurement being done in free-air (so no boundary re-enforcement) – typical in room response is down to about 60Hz. The phase plot is smooth and shows no irregularities. The roll-off above 15kHz is the upper limit of my measuring equipment and not the speaker.

2). Step response – time window 3,0ms. As can be seen from this plot, the tweeter has a fast rise well within 0,2ms and is connected out of phase; the in-phase woofer follows very quickly at about 0,4ms.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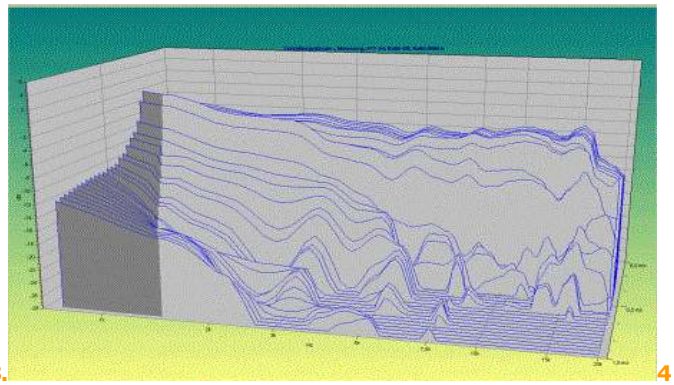
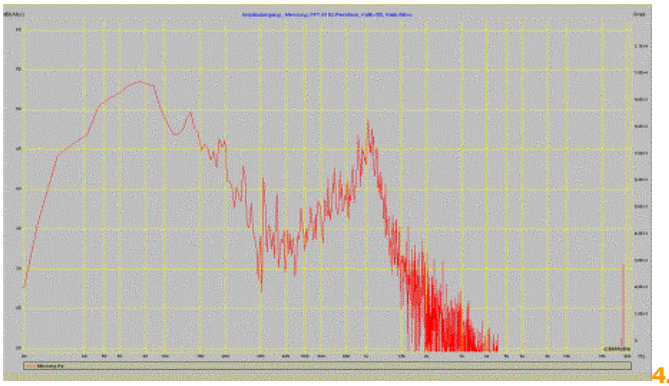

4.

3). Waterfall plot 400-20.000Hz, time window 3,0ms corresponding with the step response. Smooth with no large ridges.

4). Waterfall plot 800-20.000Hz, time window 1,0ms (zoomed-in on the upper range) the tweeter is –30dB down within 0,5ms!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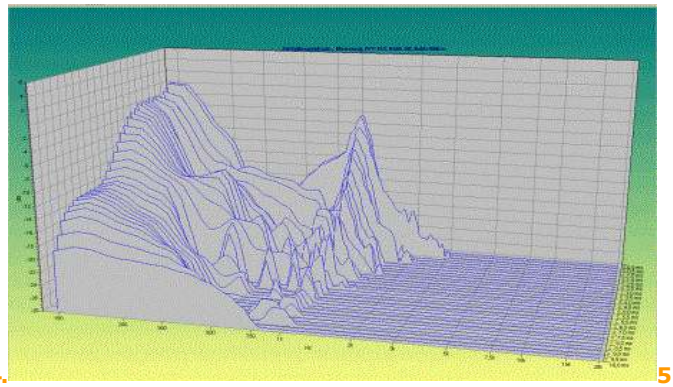
5.

4). Near field output level of the reflex-port on the rear 20-20.000Hz – horizontal division 5dB. Maximum output centred around 60-80Hz (gives the "lot-of-bass-from-a-small-cabinet-sound") followed by a nice drop of 20dB and then a rise to the port resonance at about 1kHz.

5). Waterfall plot 80-20.000Hz, time window 10,0ms. Now you can see why I prefer closed boxes when possible! More stuffing in the box would have shortened the decay time but would have also killed bass.

Sound

Okay, was it worth all the effort? Should you upgrade from the original HATT? Is the HATT-SE worth the extra money? The answer to these questions you should decide on yourself, but to put it shortly: personally I think this is the best of the three HATT designs. Compared to the original HATT the bass is stronger, deeper and more detailed, the new L12 woofer is quite remarkable - but it still is a mini-monitor, so don't expect earthquake bass from these little babies! The total spectrum is seamless from top to bottom. Midrange is more forward and "one". The treble is less laid-back but never harsh. Compared to the HATT-SE the differences are smaller, both have good bass and treble. The overall picture of the HATT-SE is slightly warmer with a slightly less deep sound stage. The HATT-MkIII paints a large soundscape with width and depth, Diana Krall is standing in front of you with her sensual voice (woof-woof), piano's sound realistic with a nice dynamic leading edge and very spacious (if the recording is up to it). The

overall tonal balance is very realistic. All in all, as you may have gathered, I am very pleased with the result.



Front and rear view; note how the port is done!

Tony Gee, The Netherlands

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