



HATT-SE

The HATT Special Edition – A high-end mini monitor



Introduction

The original HATT had been a very surprising little speaker. Combining excellent sound with a very small package. Pushing the basic concept of HATT miniature speaker a little further I decided to use even better drivers but still keep close to the original design. The woofer size was kept but upgraded to a driver from the Seas Excel range. After good experience with the tweeter of the DD8 I decided it would also work well in this situation. I also wanted to lower the crossover point a bit so I went from a 19mm tweeter to a 25mm tweeter. These loudspeakers were built for someone who lives in a houseboat. He wanted a pair of very small but very good speakers. So the HATT-SE looked like the ideal speaker for his needs.

The tweeter

The [Seas 27TAFC/G \(H883\)](#). A 27mm aluminium/magnesium alloy dome tweeter with a wide, soft fabric surround made from SONOTEX. The dome and surround materials give high consistency and excellent stability against variations in air humidity and temperature according to Seas. The diaphragm is protected by a highly perforated hexagrid carrying an acoustic lens that 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. A stiff and stable plastic rear chamber with acoustic damping allows 27TAFC/G to be used with moderately low crossover frequencies. The chassis is precision moulded from glass fibre reinforced plastic, and its front design offers optimum radiation conditions. I chose this driver because of the good experience I had with it in the DD8 speaker. It has a very good price-to-quality ratio. A Scanspeak D2904-9800 tweeter would have been very nice but the budget didn't allow that (maybe some other time).



The Seas 27TAFC/G tweeter.

The mid-woofer

The [Seas W12CY001 \(E0021\)](#). A 12cm (4,5") cone driver developed for use as a high fidelity woofer/midrange unit. The extremely stiff, yet light cone gives good bass precision and midrange detail. Precision cast and surface treated magnesium cone coupled to a natural rubber surround showing no sign of midrange (edge) resonance's. Well matched moving parts for a smooth,

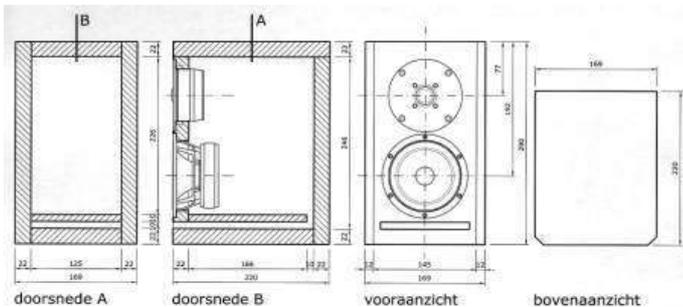
extended frequency response. Heavy copper rings mounted above and below the T-shaped pole piece, to reduce non-linear and modulation distortion and increase overload margin. An extra large magnet system for good sensitivity and transient response. Copper plating of the top and bottom plates and a solid copper phase plug, which enhance the performance of the copper rings and improve heat conduction away from the pole piece. Gold plated terminals mounted on a stiff Bakelite plate to reduce contact resistance and improve reliability. Extremely stiff and stable injection moulded metal basket to keep the critical components in perfect alignment. Large windows in the basket both above and below the spider to reduce sound reflection, air flow noise and cavity resonance to a minimum. I believe this is one of the best miniature woofers available!



Seas W12CY001 (E0021) mid-woofer.

The cabinet

Here we go again! Yet another cabinet made from leftovers! All walls are made of 22mm MDF except the reflex tunnel, which is made of 10mm MDF. Just the standard 6 planks plus one extra for the port. No difficult matrix constructions or sandwich walls seeing as they are so small. Of course there is nothing to stop you doing this if you want to go all extreme but don't forget to make the cabinet larger accordingly.



HATT Special Edition

- * 22mm mdf, Genoest Esdoorn gefineerd, blank gelekt zijde glans
- * bespoort 10mm mdf
- * aansluitterminal Monacor BP-250G
- * woofer: Seas Excal W12CY-001 Vmax=4,5 liter netto fb=58,5Hz f3=53Hz
- * tweeter: Seas 27 TAFc/G - H0683

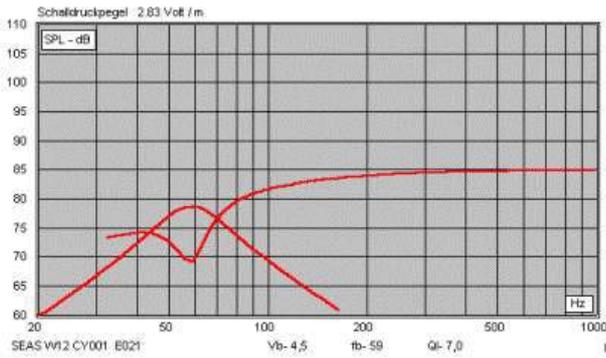
A higher resolution drawing is available on request.

Placing the reflex port in the front baffle is a very wise thing to do. Seeing as it is a two-way system a lot of midrange energy will be coming out of the port, in this case there is a minimum of damping material inside the cabinet so it is all the more important. If you place the ports in the rear panel then this energy will arrive delayed compared to the midrange energy coming from the drivers. This will result in some blurring of the stereo image. To save space again I made a slotted port directly under the W12CY001. The tunnel is made from a piece of mdf.

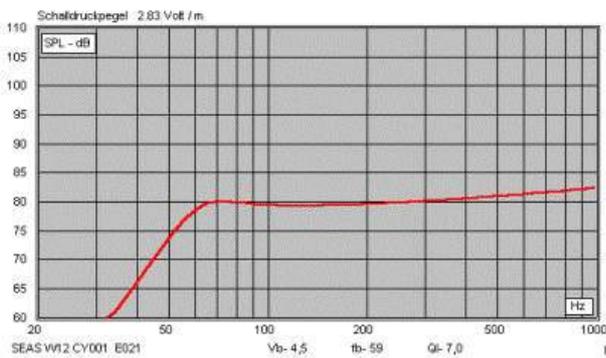
The inside of all the walls except the baffle are covered with lead bitumen sheets and heavy-duty carpet tiles. The reflex port is kept clear but the top of the reflex tunnel is also covered with lead bitumen and carpet tiles. The carpet tiles have a nice heavy backing that adds mass to the enclosure. Glue them to the MDF and bitumen using lots of so called "contact cement". Adding a few screws or nails helps hold them in place and stop them curling up while the glue hardens. A piece of Bonded Acetate Fibre damping material is rolled up and lightly fills the centre of the enclosure. I used Monacor MDM-3 damping pads that consist of 2/3 sheep's wool and 1/3 polyester fibre. I found the best results with a piece of about 15x25cm rolled up like a sort of "Jam Roly Poly" cake and stood on end between the inside of the top of the cabinet and the top of the reflex port.

The vertical edges of the baffle are routed with 10mm's at 45 degrees for looks and to remove the sharp edges that would cause baffle diffraction problems. All other edges and the opening of the reflex port are routed with 4mm's at 45 degrees just for looks.

The internal volume is only 4,5 litres and the bass-reflex ports are tuned to 59Hz. The images show the separate output for the woofer and the reflex port as also the summed output. Note in the lower image that due to the baffle step losses the efficiency in the bass region is only around 80dB's measured in free field conditions. Placing the speakers against a wall will boost this area and bring it up to the same level as the higher frequencies. The resulting output level will then be about 82dB's.



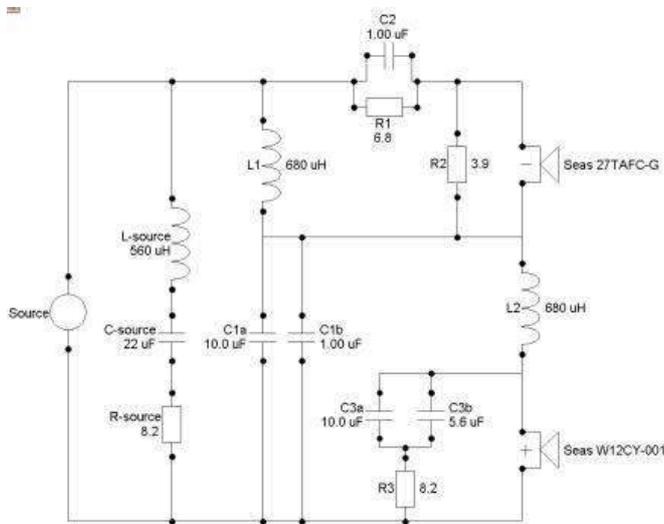
The separate port and woofer outputs at low frequencies.



The summed port and woofer outputs at low frequencies.

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's 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. The two parallel capacitors are used just to get the correct value. The cap parallel to R1 is used to compensate the slight top-end roll-off of the tweeter, it lifts the 10-20kHz range up with about 1,5dB's. 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 10kHz. This is about 18dB's down and therefore it doesn't mess-up the total output. The inductors are air core type using reasonably thick wire for low Rdc and are matched within 1/100 of a millihenry using a LCR meter. The capacitors use metallised polypropylene foil and the metal film resistor is also matched for minimum tolerance. The tweeter is connected with reversed polarity.



Filter components:

L1 = 0,68 mH air-core inductor 1,40 mm wire, R = 0,26 ohms

L2 = 0,68 mH air-core inductor 1,40 mm wire, R = 0,26 ohms

Ls = 0,56 mH air-core inductor 0,71 mm wire, R = 0,64 ohms

C1a = 10uF MKP polypropylene foil capacitor - at least LeClanché; better: Audyn Cap Plus or Mundorf Supreme Cap

C1b = 1,0uF MKP polypropylene foil capacitor - Audyn Cap Plus or Mundorf Supreme Cap

C2 = 1,0uF MKP polypropylene foil capacitor - Audyn Cap Plus or Mundorf Supreme Cap

C3a = 5,6uF MKP polypropylene foil capacitor - LeClanché or Mundorf Mcap

C3b = 10uF MKP polypropylene foil capacitor - LeClanché or Mundorf Mcap

Cs = 22uF bipolar electrolytic capacitor

R1 = 6,8 ohms, 10 watts metal film resistor

R2 = 3,9 or 4,7 ohms, 10 watts metal film resistor - 3,9 ohms gives a warmer overall sound; 4,7 ohms sounds a little brighter.

R3 = 8,2 ohms, 10 watts metal film resistor

Rs = 8,2 ohms, 10 watts cement resistor

Listening impressions and remarks

Here I will try (for fun) to right one of those professional reviews you often see in Hifi magazines. All stated is true!

Right out of the gate, the fun factor was pegged at ten and stayed there for the duration of the review period. There are a couple of contributing reasons for this. First and foremost were the stunning imaging capabilities over most of the frequency range. This little box simply disappeared as a source of sound, notably deep into the upper bass, which in my experience is rare indeed. Concerning imaging capabilities in general, I differ from some in the audiophile community in that I tend to value this characteristic quite highly, up to the point of being willing to sacrifice a certain amount of tonal deviation to obtain it. While some consider imaging to be a stereo "artefact," I consider it to be a necessary ingredient for the suspension of disbelief in home playback, helping to replace the lack of visual clues you have in a live setting.

As stated, the HATT-SE extends the "wrap around your head" image well into the bass region. This capability in a small speaker has a very important subjective effect. Connect the rare speaker that performs this feat with a good subwoofer, and what often happens is an end result of a "larger" sonic footprint than that of an all-in-one, physically larger speaker. I've heard far too many large speakers that just could not get out of their own way. The physical set-up of the HATT-SE is best an equilateral triangle. The best position in my room was 50cm off the rear wall, with the speakers separated 2,5 metres, measured from the inside corner of each speaker, with the listening position being 2-2,5 metres away. The speakers were toed in to aim just behind the listener's head, with the inside of each cabinet still slightly visible. While being able to disappear sonically and throw a spacious sound field are large positive factors, if a speaker throws, or distorts, spatial clues along with this, the illusion collapses. The HATT-SE handles this fine line rather well, seemingly possessing mini-monitor, sharply sculpted image outlines while simultaneously exhibiting a touch of the addictive "dipole bloom." I attribute this to the good dynamic capabilities and wide mid-bass radiation pattern of the mid-woofer. Vocals, unless electronically manipulated, were sharply focused centrally, but not minimized too much in size, a common complaint with small speakers. Usually a speaker exhibiting this problem can display life-size female vocals, but can diminish the size of male vocals. Not so the HATT-SE Mini Monitor. Depth was above average. Clearly discernible on well-recorded discs was the arc of the violin section in orchestral works, timpani emanating from way back on the stage and, surprisingly, a decidedly articulate cello and bass-section stage presence. Re-creation of stage depth is a bit truncated in the lateral plane as the physical stage depth increases, but the HATT-SE provided decidedly over-the-top imaging capabilities for their price. With this imaging prowess, especially into the upper bass, the sonic result was the perception of a much larger model -- not in frequency-response extension, mind you, but in the ability to cast image outlines and hall ambience.

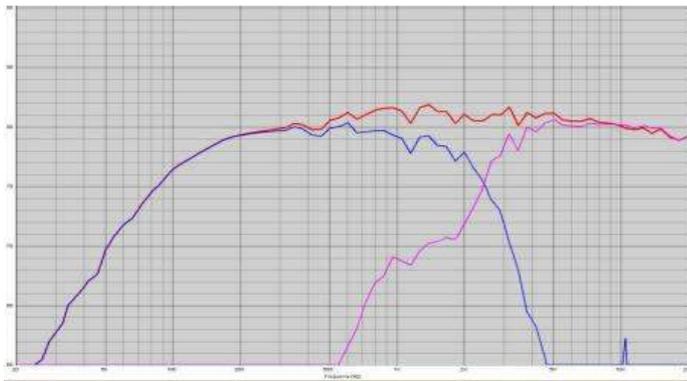
Starting with the tweeter, at no time did the sound appear peaky or harsh. Always open and free of congestion, the HATT-SE just performed its function without calling undue attention to its self. It was fully capable of floating the ambient hall sound about the room without accentuating cymbals, bells, or other metallic instruments. The tweeter is actually very controlled and smooth, almost sweet. The midrange is open, dynamic, and capable of surprising robustness. Acoustic guitars had the requisite amount of "ring" to the body. And cellos actually sound like the large, resonating, spiked-to-the-floor cavities they are. From midrange to bass, of which I obtained a very usable 50Hz in my room, the sound was very even. Once again, the HATT-SE displayed performance far belying its diminutive stature. Like I found out with the DD8 the impedance correction across the input terminals also has a positive and audible effect on the clarity of the image. Not only when tube amps are used but also even with lightweight solid-state amplifiers. It lifts a sort of haze off the image and increases the depth of the sound stage.

Comparing the HATT-SE to the original HATT I come to the following conclusion: The Special Edition version has deeper and warmer bass, can play louder and produces a deeper sound stage. I also have the impression that there is less "distortion", things seem more open and dearer. All in all, I found the Humble Homemade Hifi HATT-SE Mini Monitor to be just the answer for space-minded, music-loving audiophiles. Mission accomplished! Before I go, I feel there is a need to mention one more response the HATT-SE led to: Every single serious listening session ended up going on far too long, far too late. Mornings after found me too tired, filing away stacks of discs left piled on the transport...!

The relative output level

The major horizontal scale is 5dB's ranging from 60 to 90dB for 2,83V/1m. It has a relatively flat response with +/-1dB! over the whole range with a gradual roll-off towards the top. This top end roll-off suggests a non-aggressive sounding tweeter even though it has a metal dome - cone break-up doesn't happen until about 27kHz. The drop in the bass is due to the free-field closed box simulation; the real life reflex loaded bass will be at the same level as the rest (see also the woofer/port simulations). I must stress that this graph doesn't take into account the lift of the bass and lower mid-range region when placed near a rear wall. In an average size room with rear wall support the response is very even over the whole spectrum. The crossover point is at a standard

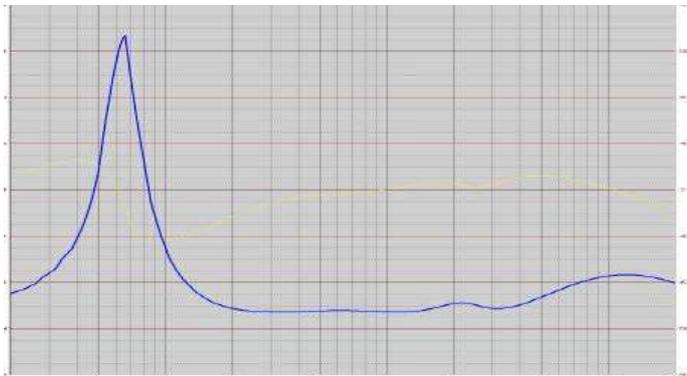
2500Hz with a perfect -6dB point for both drivers at fs. This indicates nice phase integration at the crossover region.



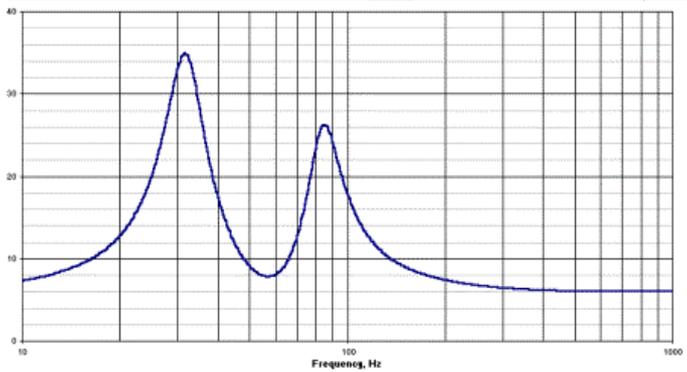
The main hor. division is 5 dB's with sub divisions of 1 dB.

The impedance

The major horizontal scale is 4 ohms ranging from 0 to 32 ohms. The impedance varies around 6 ohms with a minimum of 5,5 ohms at 320Hz. It should be a very easy load for most amplifiers with no extreme swings except for at the port tuning frequency. The first graph is for the closed box simulation; the second graph is a simulation of the reflex cabinet and shows two peaks in the bass with a minimum between at the tuning frequency of 59Hz. Due to the nearly flat impedance the electrical phase (the yellow line) is also nearly perfect within +/-10 degrees from 200-20.00Hz.



The main hor. division is 4 ohms with sub divisions of 1 ohms.



IMP from 10-1000Hz. The main hor. div. 10, sub div. 2 ohms.

Summing things up

If you are looking for a compact pair of loudspeakers that are easy to build and have high-end qualities, then the HATT-SE is your speaker! They sound smooth, even and dean and reveal lots of detail. The bass response is quite remarkable considering the size of the cabinet and woofer. And they won't cost you an arm and a leg!



Nice!

NOTE: This design is strictly for the home DIY enthusiast and not to be used professionally without my permission!

Tony Gee, The Netherlands

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