

## Twenty Five



### DESCRIPTION

Two-way, bass-reflex loudspeaker with 20cm paper cone midwoofer + 5cm paper cone tweeter.

### SPECIFICATIONS

Sensitivity • 91 dB / 2,83 volts  
Impedance • 5 ohms nominal (minimum 4,4 ohms @ 150 Hz)  
Frequency response • 49 - 19.000 Hz (-3dB) / 35 - 21.000Hz (-6dB)  
Crossover frequency • 2500Hz / 12dB  
Power rating • circa 20 watts RMS  
Dimensions (W x H x D) • 360 x 790 x 270 mm  
Weight (finished product) • 18 kg each

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The loudspeaker kit contains all the components you need, even small items such as black screws for mounting the drivers, gasket sealing tape, etc. The only thing you need to obtain separately is the wood for the cabinets. The hard-wired crossovers come pre-assembled. The price for this DIY loudspeaker kit is EUR. 135,- each / EUR. 270,- per pair with standard crossovers or EUR. 220,- each / EUR. 440,- per pair with deluxe crossovers.

### INTRODUCTION

This loudspeaker is designed to meet the needs for a good sounding loudspeaker with an extremely low price tag. The concept is based around a 20cm paper cone midwoofer and a 5cm paper-cone tweeter. Hence the name "Twenty Five". To get the utmost out of two budget drivers, a lot of effort has gone into finding a low-cost tweeter and a low-cost midwoofer that form a perfect synergy. First of all the system efficiency had to be so that the tweeter could be run without any resistors. Seeing that we are working with a very tight budget, high grade resistors such as Mundorf MResist Supreme, Duelund Audio CAST and Path Audio resistors were totally out of the question. And lower cost resistors for the tweeter would compromise the sound quality too much. The best sounding resistor is still no resistor at all, so by choosing drivers that have the same system efficiency after filtering is done, meant that we could go without any resistors at all in the tweeters crossover. The advantages are not only lower costs but also a much better sound. A tweeter that doesn't have a resistor in its signal path sounds so much more open, spacious and natural. Secondly, a well designed cabinet should work with the drivers, not against them. This rules out those stylish, ultra slim floorstanders that cause problems such as dominant standing waves and baffle edge diffraction in the frequency range most critical to human hearing. A classically shaped cabinet, with a baffle width chosen large enough that the woofer has space to breathe and the tweeter is operating in a range without problems caused by baffle edge diffraction, is the way to go.



## THE DRIVERS

The tweeter used for the Twenty Five is sourced from Monacor. The diaphragm is not a dome, nor a ring-radiator, nor a ribbon of any kind. It is a conventional, very light weight paper cone driven by a small 12mm voice-coil and with an aluminium dust cap to improve efficiency and clarity in the top octave. All parts are mounted in a stamped steel chassis that is closed to the rear, so it can be mounted in speaker cabinet without the need for a dedicated sealed compartment.



The 20cm midwoofer is also sourced from Monacor. This midwoofer has a low-loss surround connected to a light, but stiff paper cone and is driven by a decent sized magnet. To keep costs low the chassis is made from stamped steel. Due to these characteristics and its four ohm nominal impedance, the efficiency is relatively high making it an ideal partner for a resistor-less tweeter. The Qts is a little higher than usual, suggesting use for in a closed box, but as you will see later, with a little "trick" it can



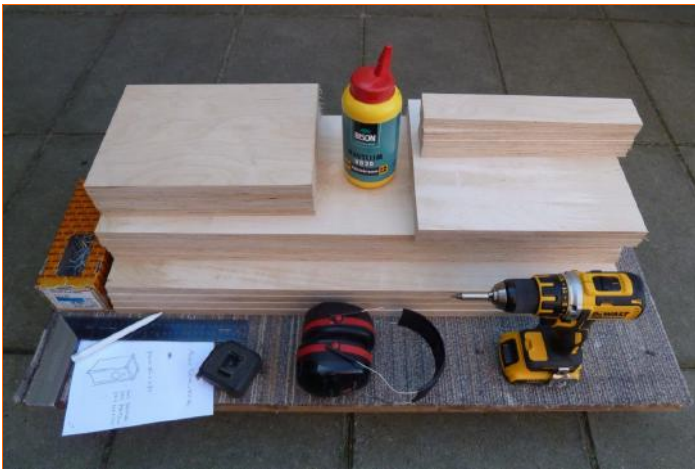
be used in a vented enclosure with very good results. You can download the datasheets of the midwoofer and the tweeter from the grey section at the top of this page.



#### THE CABINET

The cabinets of these loudspeakers are made from 18mm / 13 ply marine grade baltic birch plywood. I find professional quality birch plywood not only to be much more pleasant to work with than MDF (less dust and smell) but because the material is heavier and stiffer than MDF, it sounds better. Here in The Netherlands standard MDF is more like softboard with only the outer few millimeters being dense. The birch plywood I use has a density of 700kg/m<sup>3</sup> and the available MDF is 650kg/m<sup>3</sup>. There are other types of MDF such as V313 and Valchromat that have a higher density, but for most people they are difficult to obtain - after all we are talking about a DIY loudspeaker here. Besides weight and density, the stiffness of the material is equally important. And this is where birch plywood excels, due to the many cross laminated layers with the wood grain of each layer at right-angles to the next, it is much stiffer than MDF. The first test enclosures that I built for the Twenty Five were made from 18mm MDF. It sounded fine, but when I mounted and connected the drivers in their final birch plywood cabinets, ready for the final filter design, the overall sound gained definition and neutrality. Even though this is a very low budget loudspeaker I would strongly advise to build the cabinets from high quality birch plywood and not use MDF. The improvement in sound quality is significant!

The construction of the cabinets is very easy, basically it is a straight forward rectangular box with two small braces and one extra panel that gives the woofer cut-out double thickness. The photos below show a step-by-step build of the cabinets, click on the photo's for a larger image. I chose to build them "quick 'n dirty" by using woodscrews to hold everything in place while the glue was drying. This means that with the pre-cut panels, you can put together a pair of rough cabinets in less than an hour. I planned on veneering the cabinets so it didn't matter using screws. If you want to finish your cabinets with a clear varnish or paint direct on the plywood, then I would advise to use clamps instead of screws. First glue the woofer panel and one of the braces to the inside of the baffle. On purpose the extra panel doesn't touch the side panels of the speaker so that vibrations transmitted via the baffle to the rest of the cabinet are kept to a minimum. The extra panel forms a stiff and strong basis to mount the woofer on. Make sure that you chamfer the inside of this panel so that the woofer can breathe properly. Next up are the top and bottom panel followed by one of the side panels. Then glue the other brace to the rear panel and then the rear panel to the rest of the enclosure. Finally, close the cabinet with the other side panel. Then sand everything with a belt-sander (grit size P120) to obtain a smooth base to veneer or paint on.



Because I chose to veneer the cabinets, the counter-sunk screw heads (and any other uneven spots) had to be filled with two component epoxy filler and then sanded again before applying the veneer. If you don't do this or only use standard one component filler, little indentations will appear after a few months in the veneer or in the paint. I used walnut veneer, book-matched and mirrored which I think makes these low budget speakers look quite chique. The veneer is applied with normal white PVA wood glue that is spread with a fine toothed comb over the whole surface area of the cabinet (one panel at a time). The veneer is then



pressed into the wet glue, clamped and left for a couple of hours to dry before the next panel can be done. When both cabinets are veneered, all the cut-outs are made. To make these cabinets very easy to build, there is no need for a router. None of the components are counter-sunk. When all the cut-outs are made and the whole thing is smoothly sanded, it is time for the surface finishing. I used two layers of matt, water-based clear polyurethane varnish that is hard wearing and normally used on hard-wood flooring. It brings out the wood grain just nicely.



When both cabinets are finished it is time for mounting all the hardware. The DIY loudspeaker kit is sold with all the parts except the cabinets. Even the black screws for mounting the terminal-plates and the drivers are part of the kit. The binding-posts are gold-plated and are pre-mounted on a moulded plastic cup. Internal wiring is flexible copper litz wire and easy to use. Before mounting the woofers, tweeters and terminals, don't forget to apply the self-adhesive sealing tape to the back of each component to ensure an air-tight seal. The crossover can be screwed to the inside of the rear panel, accessible via the cut-out for the woofer.



Damping material is Intertechnik Tyrotex N30 so called "egg-crate foam" with a density of 30kg's/m3. There are two sheets in the kit, one for each cabinet. Each sheet is cut in half length ways and then simply pressed into place forming a continuous layer that covers the inside of both side panels, the top and the bottom panel. No glues is needed. You will only need to make a couple of little cut's so that the Tyrotex N30 fits around the two braces. The inside of the baffle and the rear panel are not covered with damping material.







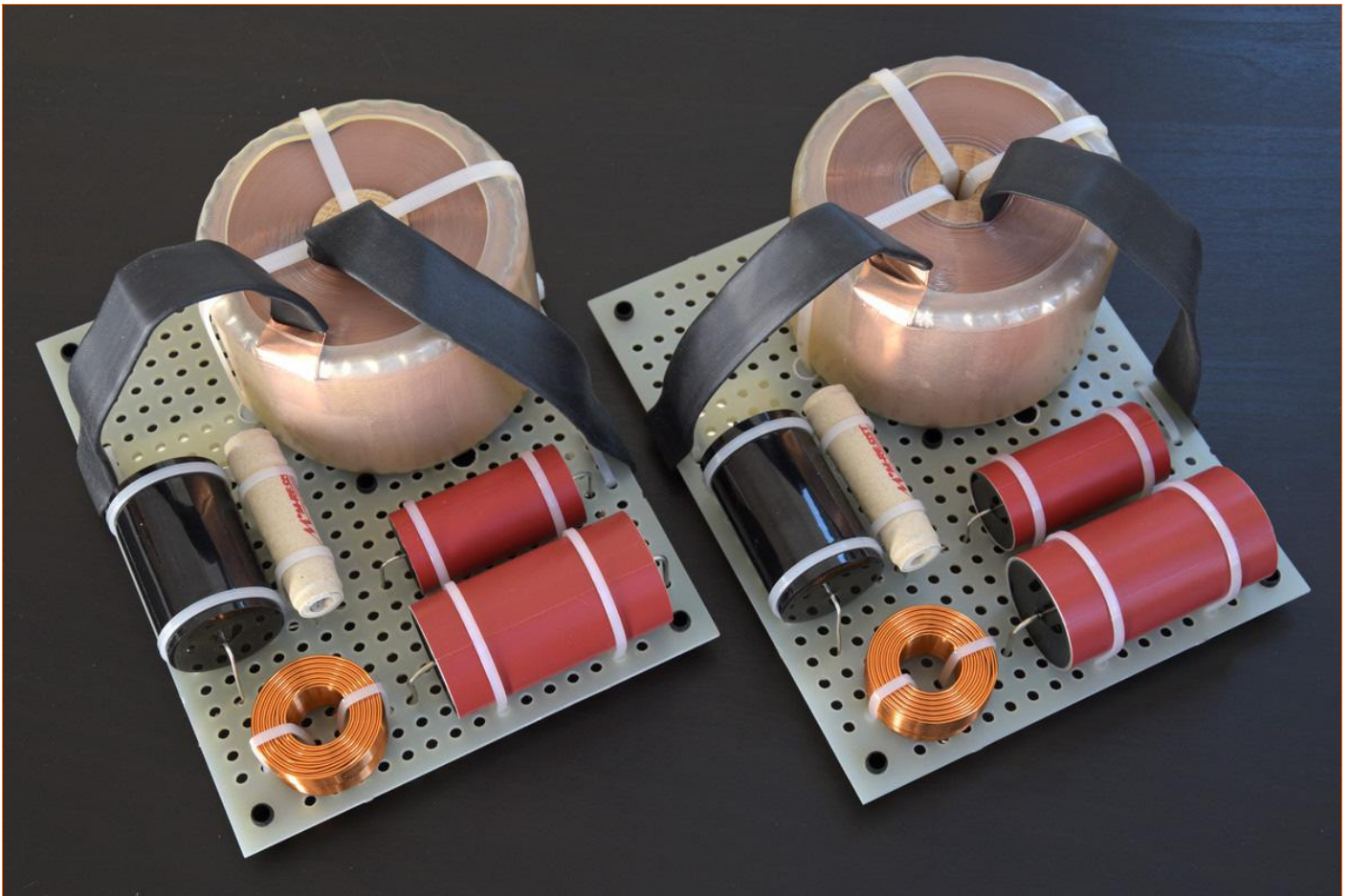
## THE CROSSOVER

As mentioned at the beginning of this article, one of the design criteria was to be able to use a crossover without any resistors (parallel or series) that tame the tweeter output level. Mission accomplished! The crossovers are made with components from Jantzen Audio. All inductors are baked varnish air-core type and all capacitors are Cross Cap MKP's. I know that this is a very low budget loudspeaker but there is one component that couldn't be compromised on too much: the woofer low-pass inductor. For a correct functioning of the cabinet volume and port alignment, this inductor had to have a relatively low internal resistance Rdc. The most obvious option would have been to use a cheap ferrite core inductor. These cost only a couple of euro's and are found in many factory speakers such as the Sonus Faber Amati Tradition and KEF Blade Two, just to name a couple. I did try such a cored inductor and the sound was okay but when I replaced it with an air-core inductor with the same Rdc the increase in spatial information and richness of tone was incredible! So please forgive me for splashing out an extra 20 euro's per speaker, but the money is very well spent. The crossovers are part of the kit and are sold ready-made and tested. The components are all hard-wired from component to component without the use of any extra wire bridges and are mounted on anti static FR4 epoxy circuit boards. The components are held in place with Hellermann Tyton professional grade, halogen free, UL94 V2 rated cable ties.

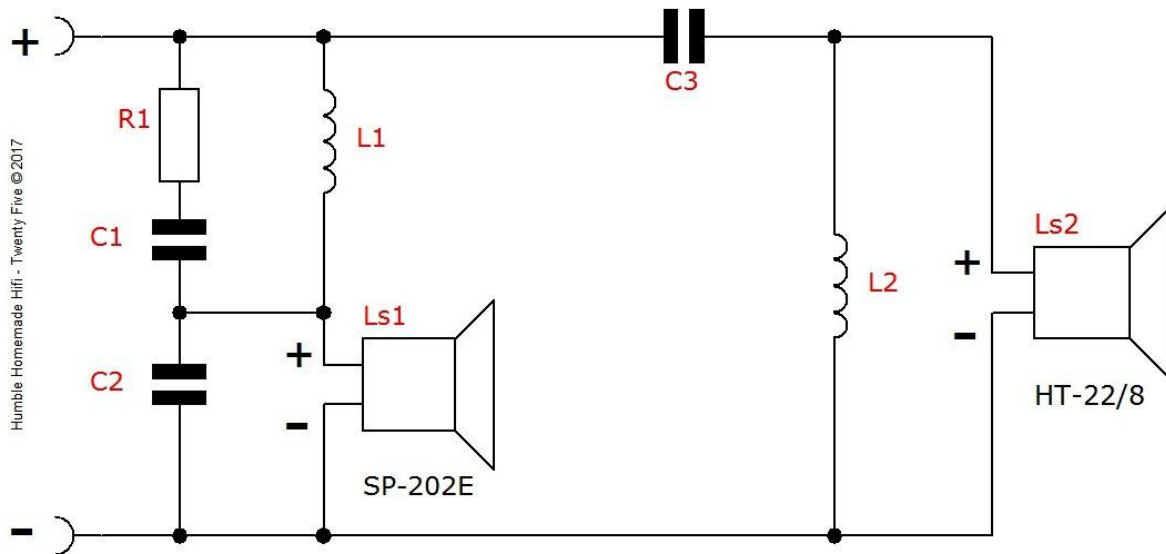


The crossovers are supplied with matching screws and can be screwed to the inside of the rear wall. The crossovers of the Twenty Five use a second order low-pass on the woofer and a second order high-pass on the tweeter consisting of only two components for each driver. The only extra components needed are for a small RC-network parallel to the main woofer inductor. These two components tame a peak in the output level of the woofer at about 3-4kHz so that the 2nd-order low-pass shows a smooth and constant roll-off. Both drivers are connected in the same electric phase.





The photo above shows a deluxe version of the Twenty Five crossovers. These do not come with the standard but are available on request as a special upgrade. The standard crossovers can be seen in the photos below the schematic.



Humble Homemade Hifi - Twenty Five © 2017

### Standard crossover

#### Inductors

L1 = Jantzen Audio Baked Varnish Air Core / 1,80mm wire  
 L2 = Jantzen Audio Baked Varnish Air Core / 0,70mm wire

#### Resistor

R1 = Jantzen Audio MOX / 10 watts

#### Capacitors

C1 = Jantzen Audio Cross Cap / 400VDC  
 C2 = Jantzen Audio Cross Cap / 400VDC  
 C3 = Jantzen Audio Cross Cap / 400VDC

### Deluxe crossover

#### Inductors

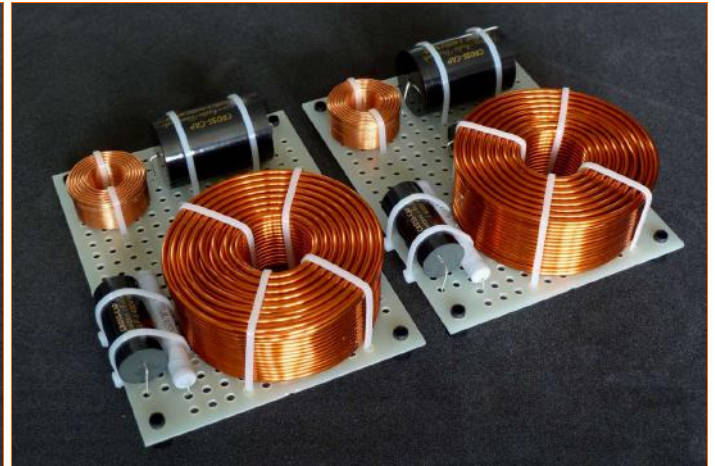
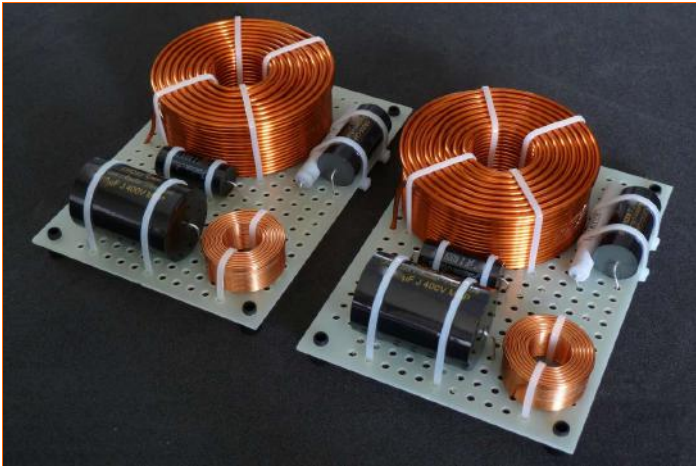
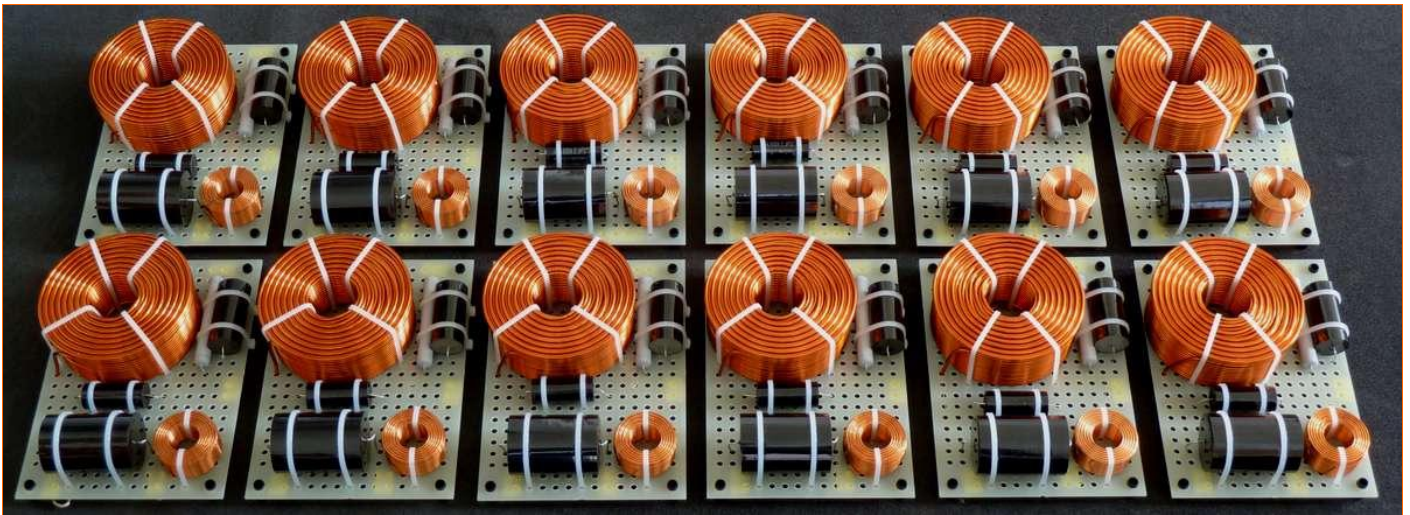
L1 = Jantzen Audio Cross Coil copper foil / 12AWG  
 L2 = Jantzen Audio Baked Varnish Air Core / 0,70mm wire

#### Resistor

R1 = Mundorf MResist Supreme / 20 watts

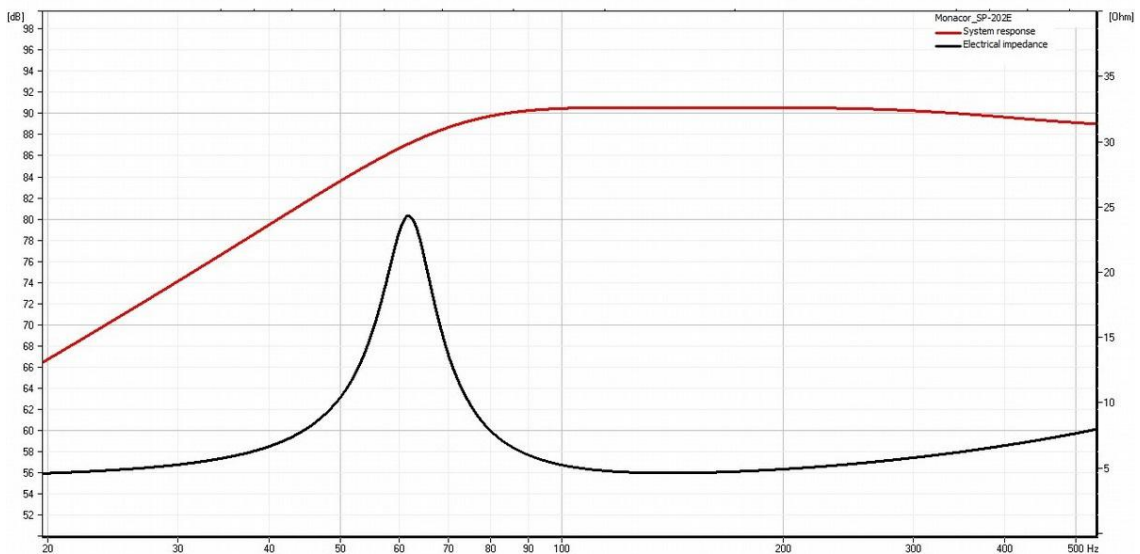
#### Capacitors

C1 = Jantzen Audio Superior Z-Cap / 800VDC  
 C2 = Jantzen Audio Cross Cap / 400VDC  
 C3 = Jantzen Audio Superior Z-Cap / 800VDC



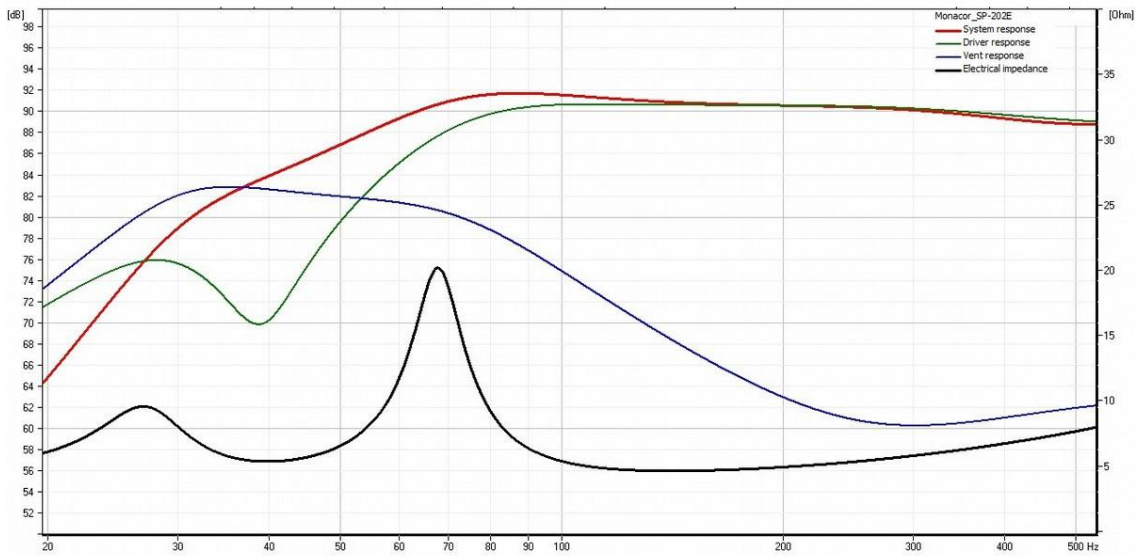
## MEASUREMENTS

The low frequency response was modelled for a closed box and for a vented enclosure. The closed box gives a text book flat response with a -3dB point of around 60Hz. Because the  $Q_{ts}$  of the woofer is a little higher than usual, it would suggest that it should be used in a closed box, but experiments, measurements and listening tests revealed that adding a port gave very good results. The port tuning frequency is lower than standard calculations would suggest but this has several great advantages. By tuning the port to a lower frequency (in this case around 40Hz) the output at very low frequencies, below 40Hz, is increased with only a very slight 1dB around 80-90Hz. This give much deeper sounding bass without any boomy-ness. Furthermore porting the enclosure creates a larger, more spacious sounding image with better bass detail at lower sound levels. So in the end I decided to keep the speaker ported. You can experiment for yourself which is best to suit your room acoustics and personal taste by building the speakers with ports and stuffing the ports if you find the bass is too strong.



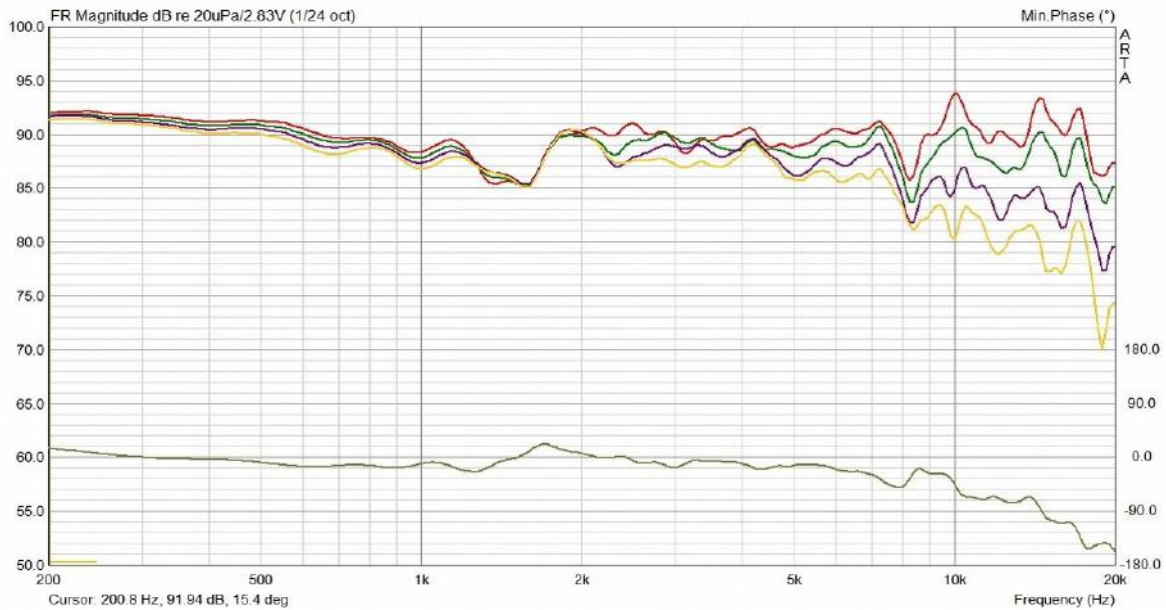
Closed box woofer frequency response (red) and corresponding impedance response (black). Range 20Hz - 500Hz; Vertical SPL scale 50dB to 100dB's; Vertical impedance scale 0 ohms to 24 ohms.



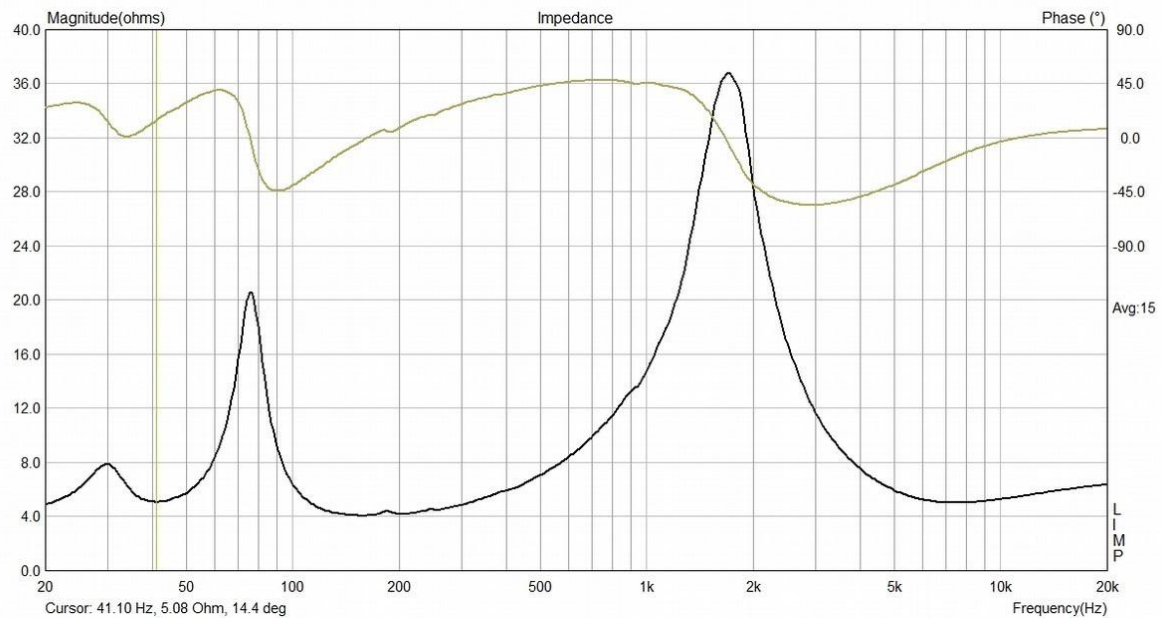


Vented box woofer frequency response (green) / port frequency response (blue) / summed frequency response (red) and corresponding impedance response (black). Range 20Hz - 500Hz; Vertical SPL scale 50dB to 100dB's; Vertical impedance scale 0 ohms to 24 ohms's.

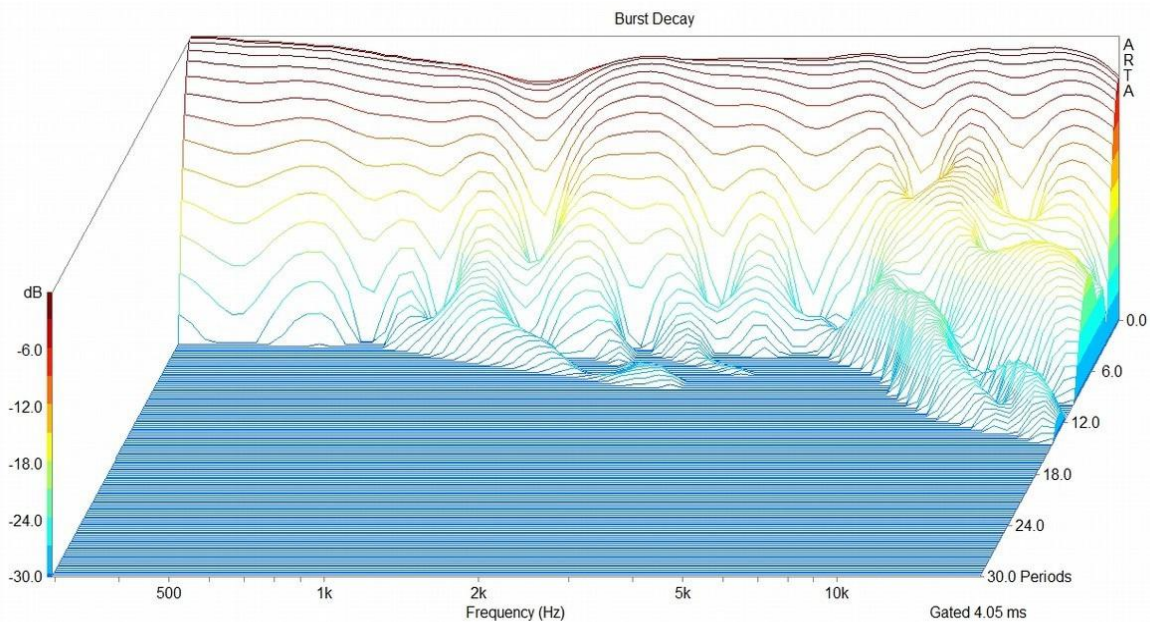
The measurements below show a flat frequency curve that is within +/- 1dB for nearly the entire range except for the top octave where on axis the cone tweeter starts to show a bit more up and down. Off-axis it smooths out rapidly, so by adjusting the amount of toe-in you can influence the character of the speaker slightly. The frequency measurements are taken at listening height (between the midwoofer and the tweeter) of which the red curve is on axis, green is 15 degree's off-axis, purple is 30 degree's off-axis and yellow is 45 degree's off-axis. System efficiency is quite a bit above average for a two-way hifi loudspeaker with around 90,5dB / 2,83V.



The impedance plot, with it's nominal 5 ohm impedance, shows an easy load for most amplifiers. The impedance minimum is just above 4 ohms around 150Hz. In the bass, where most current is demanded by the music, the impedance stays above 5 ohms. So in combination with an above average system efficiency, this speaker is an easy load for just about any amplifier. It even managed to play quite loud with my DIY 2x 8 watt EL84PP valve amplifier. At the other end of the scale I had the opportunity to try the Twenty Five out on a pair of 700 watt Merrill Audio Veritas monoblocks. A very pleasant experience, to say the least!



The burst decay of the finished system shows a very smooth decay. There is some slightly longer decay in the top octave but nothing to get worried about - no jagged ridges or other nasties. Range 200Hz - 20kHz; Vertical scale 0dB to -30dB's; Time scale 30 periods.



## LISTENING IMPRESSIONS

Hooked up to my budget system, consisting of a Marantz PM6006 integrated amplifier, Marantz CD6004 cd-player, Duelund DCA 12GA speaker cables, Audioquest Big Sur interlinks and some DIY Furutech power-cords, the Twenty Five sounds a lot bigger and more "expensive" than it's moderate size and low cost would suggest. The tonal balance of this loudspeaker is neutral, well balanced and coherent with deep bass, an expressive midrange and clean treble. Being neutral in character, they play all types of music well. Voices sound natural with body and clarity, piano music comes across with correct scale (recording permitting) and complex material stays coherent up to reasonably high SPL's. When played very loud you notice that the tweeter starts to reach it's limits, but I forgive a ten euro tweeter for that ;-). What don't you get with such extremely cheap, made-in-china drivers? Well the only thing I can pick on is that the imaging isn't as precise as that of speakers with higher quality drivers such as Scan-Speak, Seas, etc. This is due to the wider production tolerances that are inevitable with any very low cost driver. All in all, the "Twenty Five" is a really fun speaker to have, it still supprises me sometimes when I realize how little it costs and how well it performs.





Contents of the Humble Homemade Hifi DIY loudspeaker kit Twenty Five (standard version).

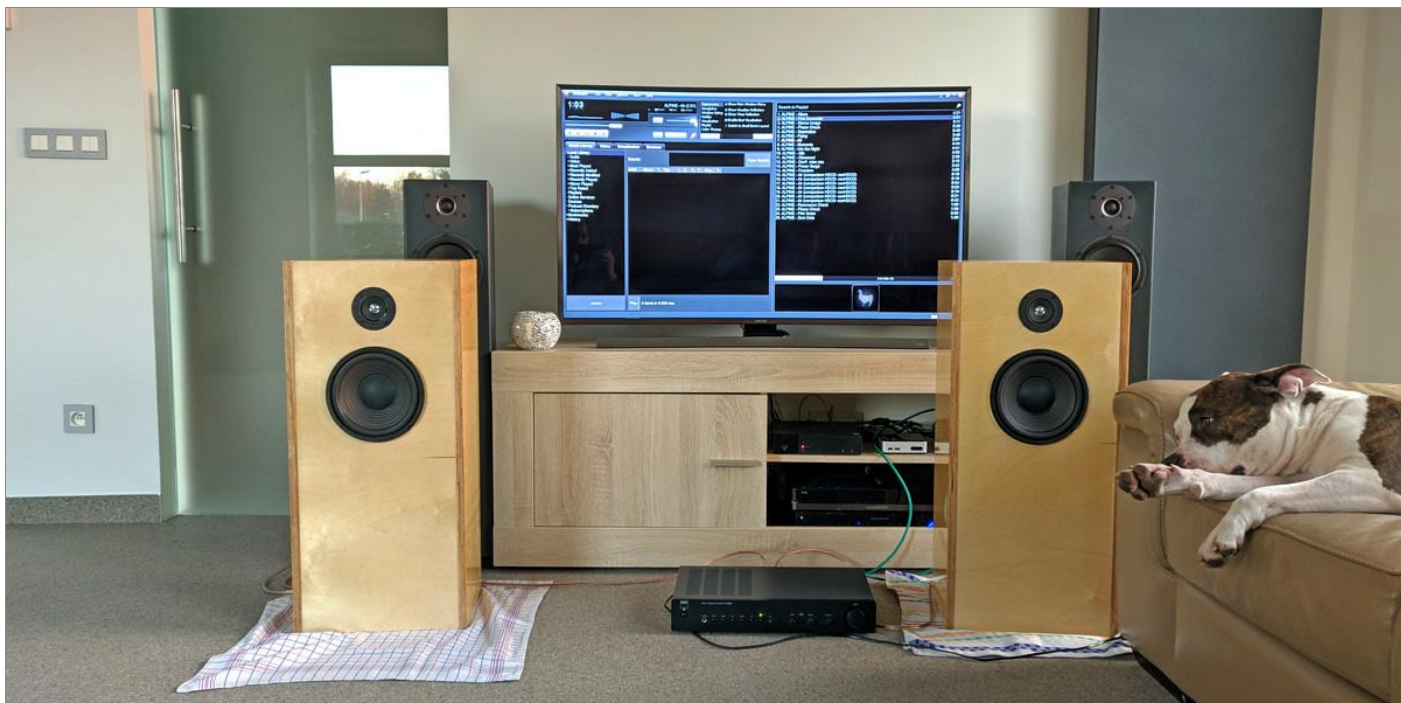
What people say about the Twenty Five:



"Hello Tony, attached you will find the my interpretation of your concept. I followed your instructions for the plywood, the thickness and the design. The veneer is walnut with a nitrocellulose paint finish. I'm very happy of the results, they sound very good and finally I understood what you mean with spatial sound. Moreover, they sound so good that the cats are not afraid indeed; "Ape" loves listening to 'Western Stars' by Bruce Springsteen. (Maurizio - Camposanto, Italy)



"Hi Tony, I can tell you that I am still very happy with the Twenty Five. When I compare them to my Seas loudspeakers, they do a lot of things very well. The only noticeable difference is in the tweeter. But hey, the Seas tweeters were 20 times more expensive so that is not a fair comparison. I am particularly pleasantly surprised how well the speakers fill the room with sound. I don't know how to describe that, but I can stand anywhere in my living space and it always sounds good. With the Seas loudspeakers it doesn't sound pleasant everywhere. The Twenty Five just does that better. The detail that the speakers give has also pleasantly surprised me. So you can say that I have converted to the Humble Homemade Hifi belief ;-)" (Tim - Meeuwen, Belgium)



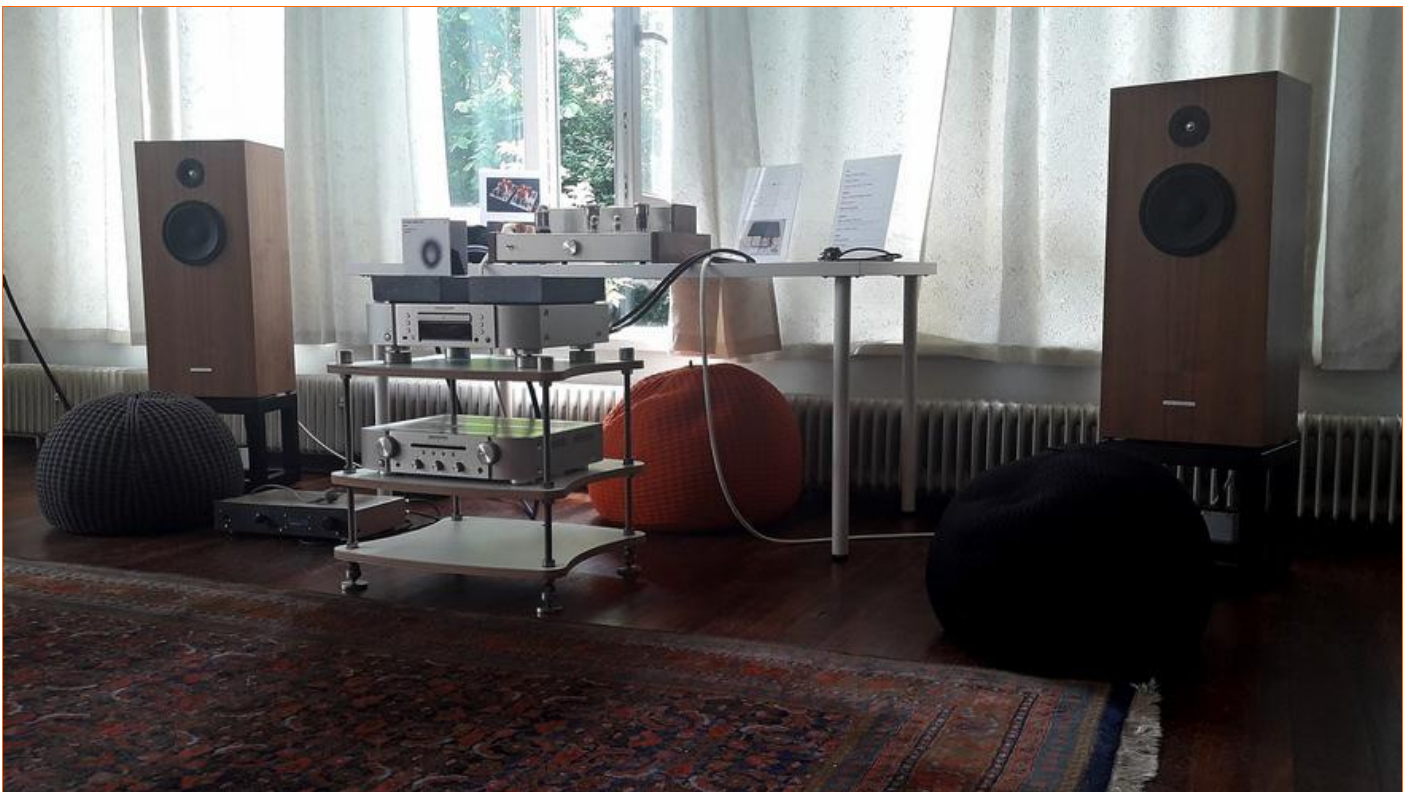
"Hi Tony, I thought I would share a couple of photos of the completed twenty-five speakers we just finished. They sound great, and we are very happy, thanks again." (Peter - Oakland, United States of America)





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*"Tony, super sound and beautiful music variation." - "Outstanding for me: ...the combination of the low budget speakers by Tony with the GU-50 tube amplifier by Knuisje." - "Always amazed by the creations. I thought that the combo of Tony's speakers with Knuisje's GU50 amplifier was ingenious." (various quotes from the DIY Audio Day 2018 - Breda, The Netherlands)*



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*"I like the way they sound, even when you play them at low and mid level they continue to keep warm bass. Jazz and especially voices are perfect. At the beginning I thought that the tweeter would be too small (20W) but in fact it's plenty sufficient. My pre-amplifier is a Chinese tube one and the power-amplifier is a Class T (D), like this I have the efficiency of digital with the warmth of tube. The loudspeaker enclosure body is white, the front is plexiglass orange" (Nicolas - Linas, France)*



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