



Serious Sub

The Serious Sub, the ultimate in subwoofers

Being a bass-player, I have always had a soft-spot for low notes (or maybe it is the other way around). Anyway for me, "real" bass is only possible with lots of cone area. Back in 2000 in my Andromeda article I stated that you can only produce "real" bass by moving a large area of air gently and not by moving a small area of air violently. This means that anything smaller than a 10-inch woofer would simply not do. When designing the ultimate subwoofer solution, it would lead to even larger woofers.



The Serious Subwoofer driver

In the past I have experimented with various woofers for subwoofer use. Small woofers like the Peerless XXLS10 and XXLS12 and similar designs could produce deep bass from a small cabinet, but to me it never sounded right. It was like the drivers were working to hard trying to do something that, due to their limited size, physically wasn't possible. I mean: sub 20Hz from 350-450cm² - that's what I call a *Contradictio in Terminis*. So after further experimentation I found that low-bass reproduction started to get interesting with a 15-inch woofer and with an 18-inch woofer it got even better. To stay on the safe side I chose a 21-inch (55cm) woofer. In this woofer size the [Precision Devices PD.2150](#) seemed to fit my needs: low resonance frequency and Qts, very strong magnet system and enough Xmax. According to Precision Devices the PD.2150 is a unique high power, high efficiency cone transducer designed specifically to provide powerful and accurate sub bass frequencies with minimal distortion and power compression, just how I like it! And, before I forget, 1630cm² of cone-area each! Yes indeed, each - I am using two of them so that gives me a nice 3260cm² of cone-area for the bottom two octaves.

Cabinet experiments

With all this cone area, power handling, efficiency and volume displacement I was free to choose basically any type of woofer/cabinet loading I wanted to find out what would fit my needs the best. First of all the most basic solution: the woofers free-standing on their own without any form of cabinet - just a wooden block to support the magnet (see photo on the right), you can't beat more open-baffle than that! And surprisingly they can actually produce deep, fast bass without any loading! The only down-side to this solution is that with children about the house it isn't very practical.

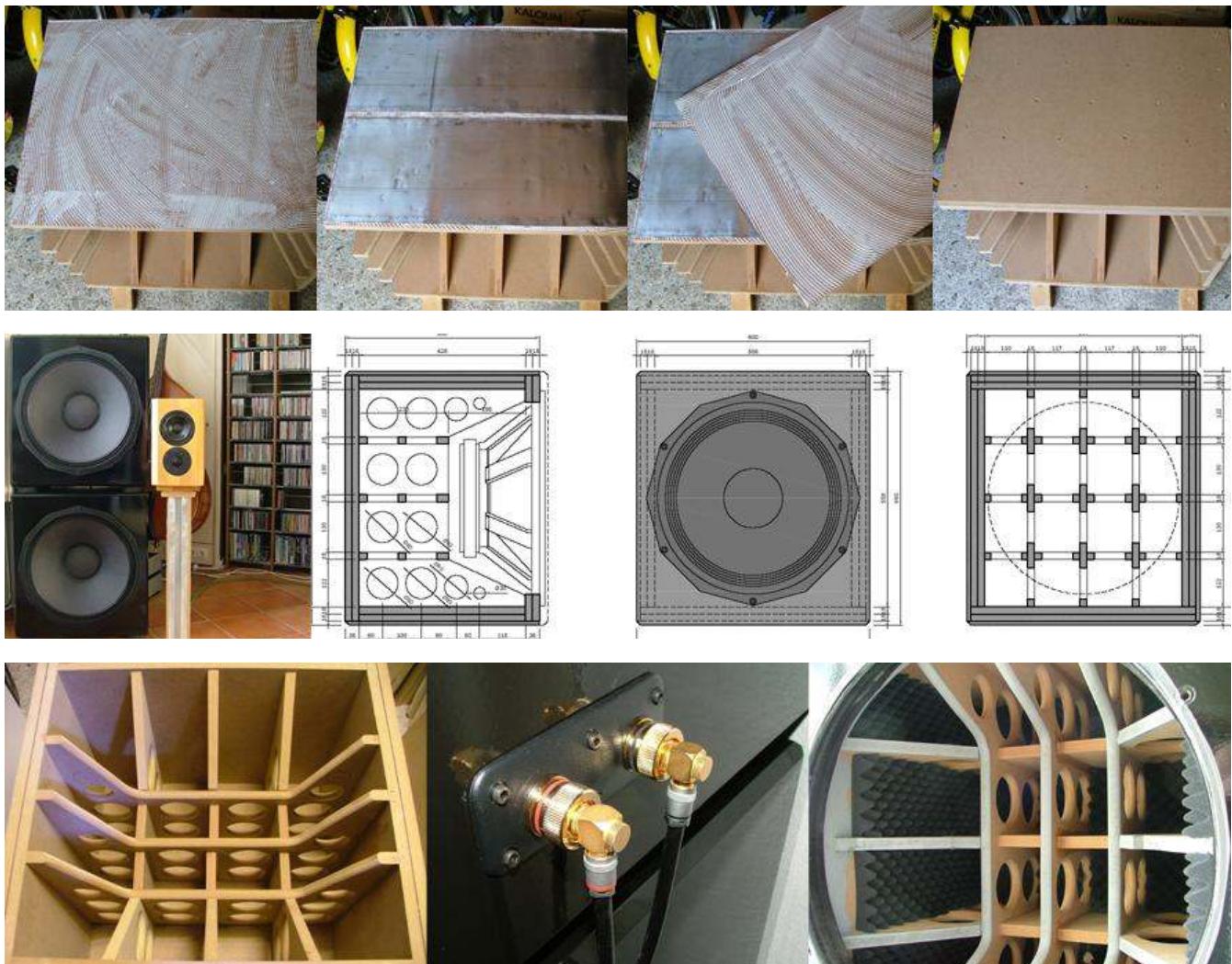


The next step was to add an open-backed enclosure, a so called U-frame making the system more practical and at the same time extending the bass response even further. Also there was a significant increase in efficiency. Bass from these U-frames was perfect! Extremely well defined, totally free from any colouration, deep and easy. The downside is that there is a "sweet-spot" in the bass. Open-baffles always have a figure-eight radiation pattern with maximum output on-axis front and rear and maximum cancellation 90-degrees off-axis, so to the left and right sides. In practice this meant that on our 4-seater couch the "being there" effect was only reserved for 1 to 2 people, not very democratic. To make a more compact subwoofer-system I then placed the two woofers face-to-face in a so called W-frame cabinet (see photo on the left). This gave even more efficiency in the lowest registers but at the same time added a little colouration due to reflections inside the open enclosure. Next stop was the closed box (photo left of centre). Now both woofers were placed back-to-back in a so called "impulse compensation" set-up resulting in an extremely compact enclosure. Result was a very tight and dry bass with lots of slamm. Bass drum had some real "kick" to it. Compared to the W-frame the bass wasn't quite as easy-going and open but at least now there was no sweet-spot anymore, the room was now filled

with deep-bass, more around you, less distant. The final experiment was a hybrid design consisting of a closed box for one woofer and a U-frame for the other woofer (photo right of centre). This way I hoped to combine the fast and colour-free bass of the open-baffle with the omnidirectional and driving bass of the closed box. This was the case but at the same time it was neither fish nor flesh. The two types of bass loading didn't create a true harmonious one-ness, so I ditched this concept as well.

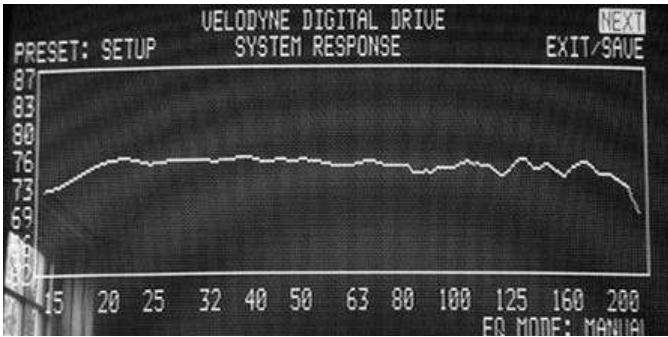
What did I choose in the end?

Well, after all this experimenting and weighing all the pro's and con's I decided to go for two slightly larger closed cabinets. Purely based on musicality I would have chosen the U-frame, I liked those the best due to their absolute colour-free reproduction of the lowest frequencies, but in the end the limited sweet-spot made me decide to go for a closed-box design. This of course had the advantage of more efficiency in the lowest octave and easier room placement. A closed box with a woofer this size meant that the cabinet must be extremely rigid and heavy to counter-act the forces produced by the driver. The internal volume is about 110 litres designed with a Qtc of about 0,5 for optimum pulse response. The total weight of the woofer + cabinet is 120 kg, partly due to the weight of the woofer (34kg's) but mainly due to the cabinet construction with sandwich walls made of mdf and lead sheets (not RoHS-conform). All walls consist (from the inside to the outside) of 18mm mdf / 1,5mm lead sheet / 18mm mdf / 10mm mdf resulting in a total wall thickness of nearly 5 centimeters. The last 10mm top layer has 45-degree bevelled edges and is used to give a smooth finish without any visible hair-cracks, etc. in the paintwork. All internal walls are covered with Pritex foam to minimise flutter echo's at higher frequencies. A higher resolution drawing of the closed box cabinet is available on request.



The Serious Subwoofer amplification

So, now we have two very sturdy and heavy subwoofer cabinets with the drivers fitted and a set of heavy-duty binding posts in the back. For the terminals I used the Monacor ST-975GM, they are gold plated and can take up to 20mm² cable and have nice strong screw terminals. If necessary they can also take banana plugs. Now we need something to drive these subwoofers and get the maximum out of them. First of all the amplification: these drivers are rated at 1000 watts continuous power handling so they should be able to take a nice large amplifier. Also (as you will see later) I will be using some EQ-ing to obtain a flat response to infra frequencies some and amplifier with plenty of headroom is a must. To keep things compact and to eliminate the need of (noisy) fan-cooled amplification I choose class-D amps, the [Hypex UCD-700](#) to be more exact. Each subwoofer is powered by a dedicated monoblock. These monoblocks in turn are driven by a [Velodyne SMS-1](#) subwoofer management system connected to the pre-amp output of my main hi-fi amplifier. The SMS-1 has 8-band digital parametric equalizer controls for room EQ, fully adjustable low-pass functions, bass-boost, etc. and comes complete with a measuring microphone. The end result of this total system is an in-room response that is extremely flat (within +/-1dB) and with a -3dB point of 15Hz.



Important update regarding the Velodyne SMS-1

Recent testing of the Velodyne SMS-1 has revealed that in some cases it can produce very high levels of distortion, that, even at these very low frequencies, are audible! The distortion is caused by the input signal being too high for the SMS-1 to cope with. Even if your pre-amp output has a normal output level and the SMS-1 is updated with the latest firmware, it can still cause problems. The SMS-1 seems to be rather over-sensitive to say the least! It would appear that it is rather easy to clip the input of the SMS-1, especially via the RCA input. In an ideal world, consumer equipment should be able to accept +8dBu without dipping (about 2 V rms). I therefore cannot guarantee optimum results when the Velodyne is used, even though in my set-up I encountered no problems. More information (including measurements) can be found at the [Home Theatre Shack](#) and [AV Talk UK](#). My advise is to look for an alternative room-correction / crossover management system.

Was it worth it?

I suppose by now you are wondering what they sound like. Well, it's like there are no subwoofers there! By this I mean they just extend the response of the existing main loudspeakers by an octave or two without adding any sonic signature of their own. Integration is just amazing, it will does take a few days to get the subwoofers perfectly "one" with the rest of the system. Forget the Auto-EQ button on the Velodyne, that will only get you about 50% of the way. For maximum integration it is all about getting the exact correct mix of phase (adjustable per 15 degrees), lowpass frequency (adjustable per Hertz) and lowpass slope (adjustable from 6dB-48dB per 6dB intervals). The EQ-ing is fine for counter-acting room-nodes and does help to make the subwoofers disappear, but the final focussing has to be done by ear, listening to lots of types of music, not only movies with deep bass. This bass-extention not only gives you deeper bass, but also creates a larger image even with music that has no low frequencies content. The soundstage becomes wider, higher and deeper. But if you want to have some fun, put in your favourite DVD with lots of low frequency information (Alien, The Matrix, Two Fast 2 Furious, The House of the Flying Daggers, Jurassic Park, etc), sit back and enjoy!

Tony Gee, The Netherlands, May 2008, updated January 2009 (SMS-1 update)

No part of this website may be reproduced in any form without written or email consent from the author. These designs are free for non-commercial use. Copyright © Tony Gee 2008