bass-ic instinct

PART 6 - The Final part.

Designer Peter Comeau - Upgrading the WD25 STD Loudspeaker kit

Last month we dealt with possible modifications to the WD25 in XL form, both for the stand mount and floorstanding version. This month we are finalising the WD25 project by taking a look at what you can do to the crossover of the Standard version to tune it to give the sound you really want. And we introduce the floorstanding version too!

First of all you can apply the same mechanical improvement to the WD25A cabinet as recommended last month. Specifically this is to damp any vibration in the cabinet rear panel by applying thick, at least 5mm, bitumen or butyl rubber panel damping material. You will need a massy damping layer, like the 6mm thick Soniqs PDC material described on the World Designs website, to cover the central two thirds of the panel over an area 250mm x 150mm. 1.5 metres of Soniqs PDC is needed to modify two speakers.

Whilst you have the speaker apart it is time to attack the crossover. You can do this in two ways, either by modifying the circuit on the hard wired board and re-bolting it into the speaker, or by working on the crossover externally. If you want to 'tinker' with component values with the crossover outside the speaker then you can obtain blank TP1 terminal panels from World Designs so that you can wire the drive units direct to the rear speaker terminals. After removing the bi-wiring links you can then hook up the crossover to these terminals using some suitable speaker cable.

Of course, having gone to all this trouble, you may wish to leave the crossovers outside the speakers. Doing this removes the crossovers from any internal vibration and the effects of any stray magnetic field inside the speaker. These effects are small, but real nevertheless. Mount the crossovers in wood or plastic boxes, but keep them close to the speakers otherwise the extra cable impedance will affect the crossover performance.

STD CROSSOVER

Although there is a world of difference between the STD and XL treble units used in the WD25 designs that does not mean that we cannot aim for the same level of crossover performance.

If you were following the series of design articles you will have seen last month that the main refinement to the XL crossover was through mapping the crossover slopes to a third order Linkwitz-Riley alignment. Theoretically there is no such thing as an odd order Linkwitz-Riley crossover, so what we have done here is apply the target function of L-R crossovers to a practical third order acoustic alignment. If this leaves you perplexed, don't worry, the key is in the listening, not the theory.

In essence the crossover, as we have developed it, springs from a first order electrical bass crossover which, in combination with the acoustic roll-off of the bass unit above 2kHz, yields an acoustic output that falls naturally at 18dB per octave from a turnover frequency of 1700Hz. For the XL treble unit, with its low fundamental resonance positioned well over an octave lower than the crossover frequency, we were able to map a slope which matched the bass characteristics accurately for a seamless acoustic crossover.

With the STD treble unit things become a little more difficult because of the higher fundamental resonance. Thankfully the latter is perfectly damped by SEAS with the inclusion of just the right amount and viscosity of ferrofluid in the magnet gap to hide most of the acoustic effects of the resonance. Even so it needs some judicious juggling of electrical crossover to get a good phase alignment with the bass unit.

The first development of the crossover utilised a higher crossover frequency by allowing a modicum of midrange lift in the bass unit to extend its range up to 2kHz. However this does produce a 'forward' midrange which might not be to everyone's taste and gives the subjective impression of a 'light' bass output. This latest development therefore follows the lines of the bass performance achieved in the XL version, giving a smoother midrange in balance with a more powerful bass output.

To achieve this we have raised the value of the coil in series with the bass unit, L1, to 0.58mH. You can experiment a little with this value – 0.5mH gives the impression of a lighter, faster bass response whilst up to 0.6mH produces a darker, heavier bass performance. At the same time we removed the original L2, the inductor in the impedance compensation network in parallel with the bass unit, to allow C2 and R2 to help define the bass unit crossover slope. The icing on the cake is the inclusion of C1/R1 across the bass coil to enable us to accurately refine the slope to our target performance.

Actually the closest match to our acoustic third order target slope is with R2 increased in value to 47 Ohms. This has the compromise that the impedance throughout the midband now rises to 16 Ohms, though the minimum throughout the audible bandwidth is a benign 5.7 Ohms. This impedance peak won't worry any solid state amplifiers, and will cause only a minor mismatch with most valve amplifiers, but if you want a flatter impedance performance you can adjust R2 down to 15 Ohms. The choice is yours – just listen and see which you prefer.

Extending the output of the STD treble unit downwards to meet the new bass characteristic took weeks of listening and fine tuning with the aid of our LspCAD software. The listening tests were paramount to achieving that seamless acoustic crossover that moves the sound images outside of the speakers and into the room, whilst aligning the crossover slopes in LspCAD pointed the way to excellent phase alignment.

In fact the solution was simpler than we at first expected. Adopting the series capacitor combination of the XL crossover, 6.8uF in parallel with 3.3uF, required an adjustment of the value of treble inductor L2 to 0.36mH to hit the required target crossover frequency. From there we massaged the treble level to bring it up to meet the midrange by reducing the final series resistance in the treble circuit to 2.7 Ohms. You can also give a touch more treble output if you require it by reducing the first resistor in this network to 1.5 Ohms.

As would be expected these changes sharpen the treble response and your initial reaction might be the same as ours in that the lower treble sounds a touch edgy on some discs. You can smooth this out, easily, by adding a small resistor in series with inductor L2. This smooths the kink in the crossover slope and actually improves the phase integration with the bass/midrange showing that it has done its job properly. 0.47 Ohms up to 0.68 Ohms is all you will need here – again try both and see which you prefer.

FINALLY THE JOB IS DONE

So our final preferred crossover is in Fig. 1. This provides a very transparent, hear-through performance where good recordings move the acoustic behind, above and around the speakers helping you to enjoy the music without the speakers making themselves noticeable. This crossover is also ideal for the floorstanding WD25T STD which makes a lower cost alternative to the XL version reviewed in this issue.

Figure 2 shows the crossover slopes as plotted in LspCAD while Figure 3 is a graph of the anechoic response of the speaker in red. We have also plotted, in blue, the response with the phase of the treble unit reversed to show the cancellation 'notch' indicating how good the phase integration now is. Finally Figure 4 shows the in-room performance of the speaker taken on-axis and 15 degrees off-axis. As you can see the midrange performance is similar in character right up to 10kHz indicating an excellent stereo spread across a variety of listening positions. It also means that the reflected sound in the room has an indentical timbral nature to the direct sound ensuring low perceived coloration.

If you wish to experiment with component values to suit your tastes and listening environment here is a summation of what you can expect when changing each component:

L1: 0.5 mH gives a forward midrange, 0.6mH a more powerful bass, 0.56mH is our preferred balance between bass and midrange.

R2: 15 Ohms gives a smoother, flatter impedance curve to match valve amplifiers but try raising it to 22 Ohms or 47 Ohms for better phase integration.

R3: Reduce to 1.5 Ohms for a higher treble output if you need a touch more 'sparkle'.

R4: 3.3 Ohms gives a very smooth treble but reduce to 2.7 Ohms for a better balance to the midrange output.

C3/C4: We found the best integration with a combination of 6.8 uF and 3.3uF, but you can try two 4.7uF for a slightly more 'laid back' or 'distant' midrange perspective.

R6: Measure the DC resistance of your coil L2 and add a resistance here to bring the total resistance to about 1.3 to 1.4 Ohms. For example if the DC resistance of your coil is 0.9 Ohms then the value of R6 becomes 0.5 Ohms. You can increase this to 0.68 Ohms (for a total DC resistance of coil and resistor of 1.6 Ohms) if you find the lower treble slightly edgy or sharp.

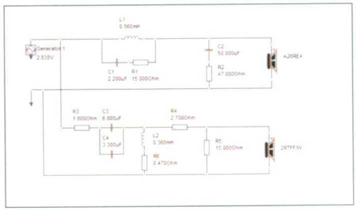

Fig. 1 Stage 4 crossover for WD25 STD

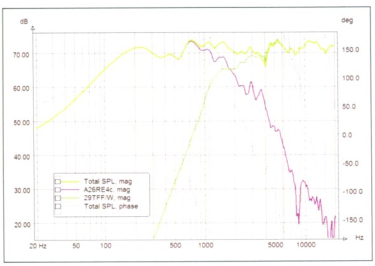

Fig. 2 Alignment to target 3rd order acoustic crossover

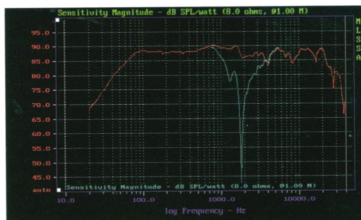

Fig. 3 WD25 STD measured on treble axis at 1 metre. Blue trace shows effect of reversing phase to the treble unit.

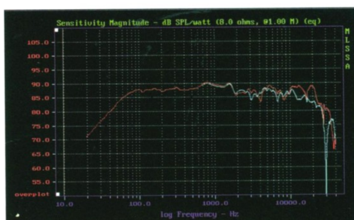

Fig. 4 Response taken on axis and at 15 degrees horizontal showing good linearity through the crossover region.

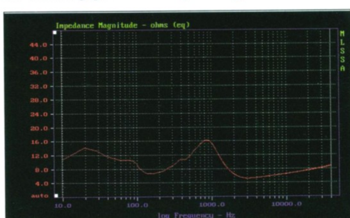

Fig. 5 Impedance of WD25 STD.