



Solo-201

There is only one way!

Sometimes in life it's good to back to the basics, away from the complex day to day hassle. Make some time for a reality check so you can re-load. With loudspeakers it the same thing. Designing, building and filtering complex loudspeakers is fun, but sometimes it's good to take a totally different approach. Due time for a one-way, single-driver system.



All alone

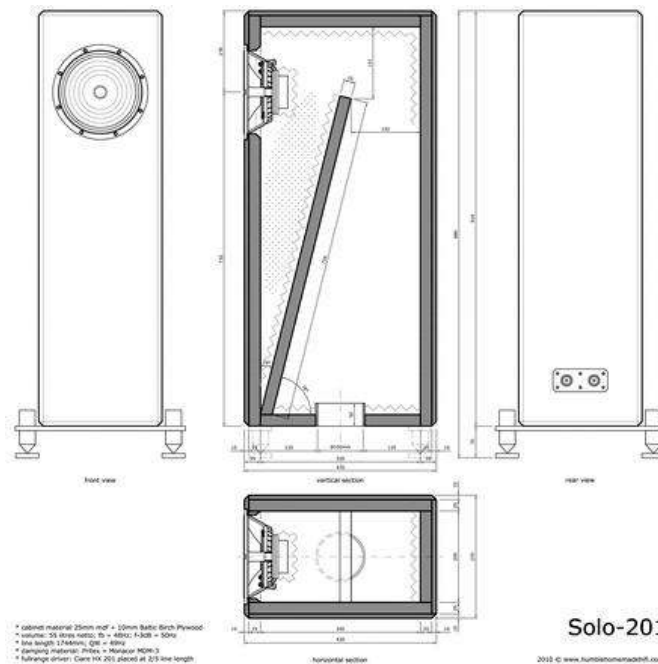
A single-driver system puts a heavy burden on the drivers shoulders. With multiple driver systems you split the frequency spectrum up into "bite-size" pieces for each dedicated driver to cope with, with a single-driver system the poor little chap has to do it all on his own, from deep lows to sparkling highs. Rather a difficult job seeing that the driver has to have enough cone area to produce any meaningful bass and very small moving mass to produce "airy" treble. The cone excursion must be small not to cause intermodulation distortion at higher frequencies and also the mechanical losses must be as low as possible so that the image is well detailed at all sound pressure levels.

In my search for the ideal full range driver I ended up with the cast frame Ciare [HX 201](#) from Italy. This driver doesn't have a so called "wizzer cone" but produces the treble range by means of a small 25mm dome that is attached to the top of the voice-coil former in the centre of the cone. At higher frequencies the 20cm cone is too slow to produce anything that you might call delicate, but this little dome acts as a sort of "tweeter" to extend the usable range to nearly 20kHz. The voice-coil former is made from a non-conductive poly-amide so that losses inside the air-gap are reduced to a minimum. Furthermore the front suspension is made from a very fine woven cotton and the rear suspension is so thin it reminds me of that of the very expensive Seas Exotic full-ranger. All these parts add up to a very light-weight moving mass, comparable with that of a small 15cm Hi-Fi mid-woofer, not a 20cm type. The suspension is very compliant so that despite the small moving mass, the resonance frequency is sufficiently low. At 43Hz and combined with a Qts of 0,34 this driver is not doomed to work in a "colourful" horn the rest of his life.



An efficient cabinet

This nice little chap deserves an equally nice cabinet that shouldn't be too big but must still produce some bass. An ideal solution for this is the so-called "Mass Loaded Tapered Quarter Wavelength Tube" or to put it short: ML-TQWT. Quite a long name for a rather simple and efficient enclosure. In principle it is a sort of reverse transmission-line in which the cross-section increases towards the end unlike the classic transmission-line that decreases. The length of this line is about 175cm which corresponds with a quarter wavelength of about 49Hz. In this case the driver is placed at 2/5 of the line - this helps reduce the amount of standing waves compared to a driver that is placed at the beginning of the line. This TQWT is terminated (mass-loaded) with a 100mm diameter port that is tuned to 48Hz. The length of this port is 50mm. I suppose you could also see this cabinet as a sort of 55 litre bass-reflex enclosure with a angled partition in the middle. What ever you want to call it, in practice it seems to work well in combination with the Ciare HX-201 full-range driver.



The cabinet is constructed very sturdily, even though the partition acts as a bracing, the cabinet walls are built from a sandwich with a total thickness of 35mm. These cabinet walls are made from a 25mm mdf inside layer and a professional grade, 10mm thick Baltic Birch plywood outer layer. Together these two layers form a very stiff and heavy construction - a pair of these cabinets weigh in at about 80kg's! The inside of the baffle opening around the driver has been radius-ed to minimize unwanted reflections so close to the cone. The vertical edges of the front of the cabinet have been cut at 45 degrees to make it more pleasing to the eye. The cabinets are placed on solid oak outriggers with height adjustable spikes creating enough free space beneath the loudspeaker so that the port can function properly. Between the bottom of the cabinet and the floor there should be about 7cm's of free space. The cabinet has a matte, semi transparent water based white-wash finish. A higher resolution drawing is available on request.

The damping plan is quite specific seeing as I had to find the right balance between bass extension, dynamics and absorbing unwanted standing waves inside the cabinet. First of all the neodymium magnet assembly is covered with a strip of Interteknik Tyrotex-30 wedge moulded foam. The easiest way to attach it is to use some double-sided sticky tape and then pull it all together with a long tie-rop. The idea behind covering the magnet is to minimize reflections against this hard object that is so close to the cone. The wedge moulded foam is also glued to the whole front side of the centre partition, the inside of the top panel and partly on the rear wall. Also the bottom panel is covered with the same stuff, leaving out a hole for the port to poke through. Furthermore the entire first half of the line is lightly filled with Monacor MDM-3 damping wool. The drawing also shows the damping plan. For the internal wiring I chose some Audioquest Blue Hyperlitz solid-core, high grade copper cable.

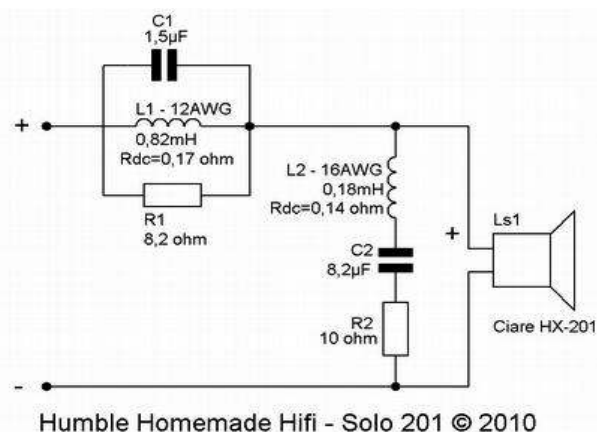
Not much to correct

A full-range driver can't really work without some form of passive correction (except for the rare exception). Full-rangers, once mounted in an enclosure, also meet things such as baffle-step and diffraction issues like any other driver does when mounted in a

real-life cabinet instead of the standard IEC measuring baffle. The "art" is too correct just enough to create a neutral image without sucking out the life from the speaker. The Solo-210 ended up with two LCR correction networks.

The combination L1+C1+R1 has the most effect on the overall response and is designed to lower the steady rise in the response curve down to a more horizontal line. Because these three components are in the direct signal-path of the driver, their sonic quality is very important on the overall perceived sound quality. A copper-foil inductor is a minimum, a wax impregnated coil would be even better. C1 is only 1,5uF so very affordable, even if you choose something exotic. If you want to keep it simple you could try a Jantzen Audio Silver Z-Cap, Intertechnik Audyn Cap True Silver or Mundorf Supreme Silver-Oil. I used some NOS Russian paper-in-oil types that I bypassed with a very small value Styroflex until the "blend" was just right.

The combination L2+R2+C2 parallel to the Ciare removes a slight edge from the treble. The sonic quality of these components is less critical but seeing that the values are very small I would advise to use a copper-foil inductor, an MKP capacitor and a metal-oxide resistor here.



L1 = 0,82mH / 12AWG copper-foil / Rdc = 0,17 ohms

L2 = 0,18mH / 16AWG copper-foil / Rdc = 0,14 ohms

C1 = 1,5uF something very nice

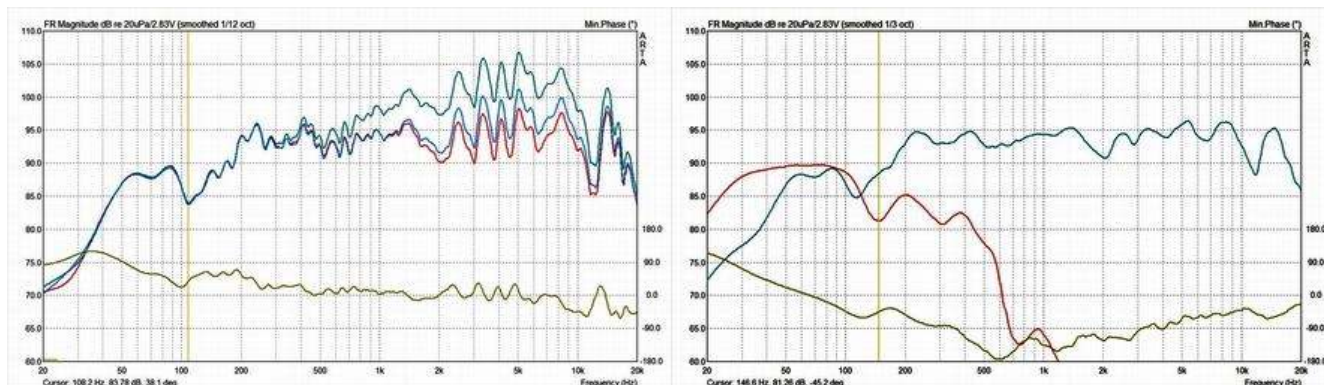
C2 = 8,2uF standard quality MKP

R1 = 8,2 ohms / 20 watts MOX resistor (15 + 18 ohms parallel)

R2 = 10 ohms / 10 watts MOX resistor

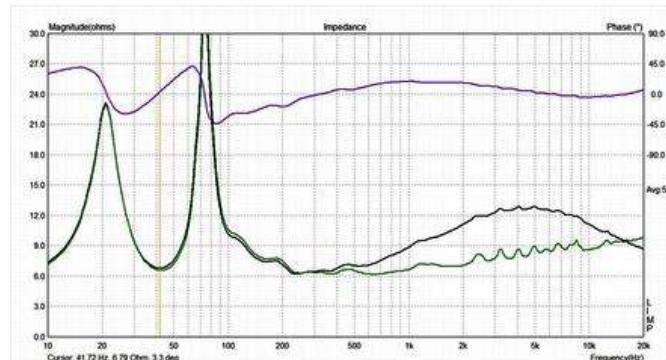
Measuring and listening

Like with any loudspeaker this loudspeaker also needs some time to burn-in. After a few weeks of everyday use they open up nicely. The speakers are best positioned if the speakers and the listening seat form an equal sided triangle. They should be toed-in far enough that the inside panels of each speaker can just still be seen. Furthermore the loudspeakers should be tilted back at about five to seven degrees so that the drivers are firing on-axis at your ears. You are then rewarded with a large and very spacious image in which you can pin-point each artist front to back and left to right - oh I love a good full-ranger every now and then! The whole picture is placed on a steady foundation, this speaker sound full-bodied and very coherent. The midrange has a nice bite to it without getting shouty and the top octaves contain lots of fine detail. Capacitor C1 does a lot here, the first prototypes had a standard quality MKP in that position and they lacked micro-detail and transparency. So be warned - don't save on C1! Furthermore this speaker isn't fussy on what type of amplifier you connect to it. I used it with various types from small tube amps to big heavy transistor types and in all cases there was a kind of synthesis between them. The Solo-201 does let you hear what you have connected to its terminals, so a cheap transistor amplifier will sound like a cheap transistor amplifier but hook-up a nice class-A amplifier (be it transistor or valve) and enjoy!



The frequency measurements on the left show the different curves with and without the various correction networks. The green curve is the Ciare HX-201 in the ML-TQWT enclosure without any form of correction. Up to 8kHz you can see a constant rise. If we add correction network L1+C1+R1 we get the blue curve. Capacitor C1 lets through the very top octave while L1 (damped by R1) lowers the midrange level. When we add L2+C2+R2 as well it takes away some excess energy in the 2-10kHz range. The end result is a healthy output level that hovers around 93 to 96dB's so you won't be needing many watts to produce some noise. Because these curves on the left don't take into account the output from the port I did another measurement (curves on the right) with the ports output next to the overall output level. The sound coming directly from the cone is a relatively smooth curve in which the range from about 50Hz to 170Hz is about 5dB's down from the rest. This shelf is filled up nicely by the wide output

range from the port. Already from 30Hz the port is at full level and holds this level to about 100Hz before it rolls-off gently. The complex sum of the two curves isn't shown, but according to many listening sessions this speakers does bass rather well.



The impedance plot finally shows a curve a lot like that of a bass-reflex box with the port tuning frequency centred at 42Hz. The green curve is the Ciare HX-201 without the correction networks, the black curve with both of them in place. The overall impedance never drops below 6 ohms and has a correspondingly smooth phase characteristic. This should make life easy for your amplifier, it doesn't need to deliver heaps of current.

Tony Gee, The Netherlands, February 2011

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