



LBS

The Low Budget Speaker

After many rather costly and time-consuming loudspeaker projects it is time for something that is easy to build and doesn't cost an arm and a leg, ideal if your shares have recently dropped in value. The basic concept is an affordable bass-reflex floor-standing enclosure using two paper-coned woofers and a soft dome tweeter in an MTM-configuration. So basically a lot of speaker for your money.



The woofers

To keep things simple the speaker had to be a two-way design. To obtain a good compromise between bass-response and midrange quality that leads to a woofer of about 17 to 18cm in diameter. Now I didn't want to design another one of those standard two-way monitors, I wanted something larger, floor-standing with good efficiency and good power-handling. The solution: double the amount of woofers. I know this does raise the budget by nearly fifty euro's per speaker for the extra woofers but this is compensated slightly by the fact that the woofer inductor can be half the value (and therefore cheaper) than if I were to use a single woofer. Depending on the quality chosen, this can save anything from a few euro's to many ten's of euro's per speaker. Furthermore you get higher efficiency, lower distortion for the same output level and greater power-handling. And double the cone area in the bass is always pleasant. :-)

The woofer used here is the [Monacor SPH-176](#). A well-built 7-inch coated paper midwoofer with a cone-area of about 140 squared centimetres. The cone has a natural rubber surround and in the centre is a soft dust-cap. On the rear is a reasonable sized magnet to give the light-weight cone plenty of driving force. A relatively long voice-coil gives a linear stroke of +/- 5,5mm. All these components are held together by a stamped steel chassis with plenty of ventilation. You can even see the voice-coil between the rear suspension and the front pole-plate (so be careful with dust and other particles!). The woofers works in separate bass-reflex enclosure of 21 litres nett volume. The rear-firing ports are tuned to 47Hz resulting in a -3dB-point around 45Hz.

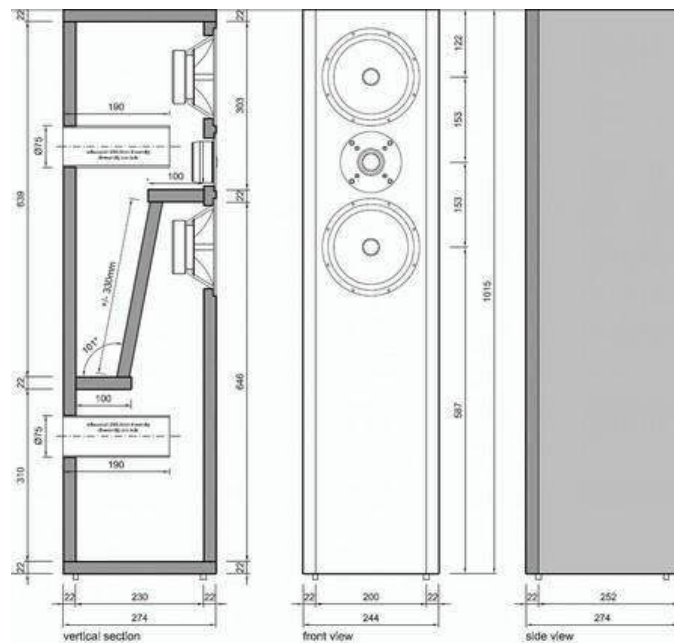


The tweeter

A matching tweeter for this project was also found in the large Monacor catalogue: the [Monacor DT-254](#). A soft textile dome is hung in a wide surround and protected from curious fingers by a fine metal grille. There is no rear chamber but the damped volume inside the magnet is large enough to keep the resonance frequency well below 1kHz. The tweeter has, like the woofers, a nice smooth response so hopefully I won't need many correction networks in the crossover. Another important issue when trying to keep the total system costs down.

The cabinet

The just over one meter tall cabinets are made of 22mm thick mdf. An angled partition inside the cabinet divides the cabinet into two separate volumes of 21 litres each. This internal division also supports the cabinet walls, making a stronger construction with less panel resonances. Furthermore the angled panel reduces standing waves between the top and bottom of the speaker. The reflex-ports on the rear are made from thick-walled PVC drain-pipe with an internal diameter of 68,6mm's (external 75mm). The total length of each port is 190mm. If you want to do a "one-shop-stop" then you can also use [Monacor MBR-70](#) ports adjusted to 175mm length. The baffles have a 45-degree trim from top to bottom to make the speaker look slender and to minimize diffraction from the baffle edges. A higher resolution drawing of the cabinet is available on request.



Humble Homemade Hifi - LBS (Low Budget Speaker)

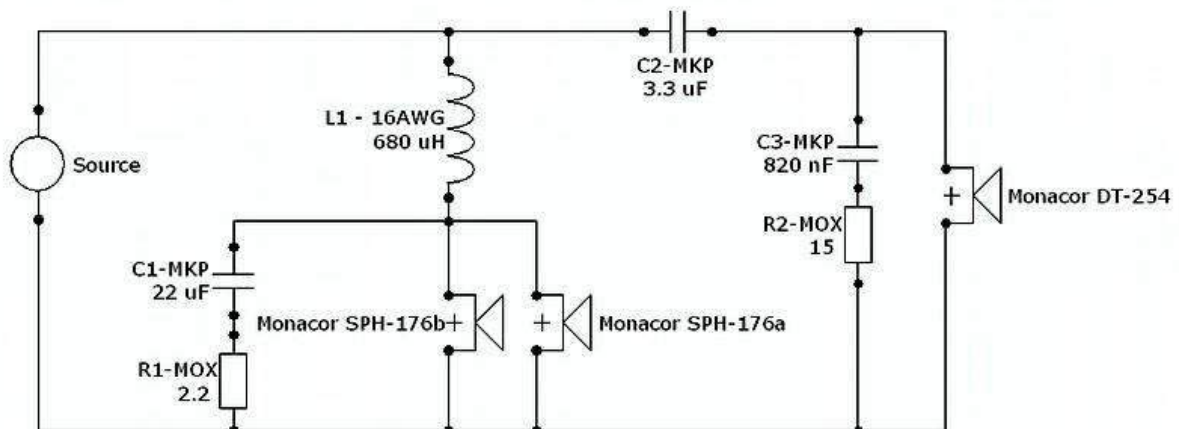
All the internal walls and panels, except for the baffles near the drivers, are covered with high-pile carpet. Cheap or even free leftovers can be obtained from your local carpet store. The carpet is completely glued to the inside of the panels and can also best be done before the cabinet is assembled. The rest of the internal volumes have a medium fill of [Monacor MDM-3](#) damping material that is made from 75% sheep's wool and 25% bonded acetate fibres. You will need 4 bags total. If you have to place the speakers near a corner or very close to the rear wall, you may need to add a bit more stuffing. Don't forget to use dedicated gasket sealing strips like [Monacor MDM-5](#) between the counter-sunk driver chassis and the mdf cabinet for an air-tight fix. All internal wiring is standard 1,5mm² OFC.



The crossover

As mentioned early, one of the design criteria was to use "easy" drivers so that the crossover could be kept as simple as possible. The less parts the better and this gives room to invest in very high-quality components (budget permitting of course). The LBS uses a simple first-order parallel filter with a Zobel-network for each set of drivers. A parallel crossover was chosen for its simplicity to design and making it easy to tweak to personal taste if wanted. There are no resistors in the signal-path of the tweeter, a slight attenuation of the top octaves is achieved by the Zobel-network parallel to the tweeter. This makes the choice of the tweeter series capacitor very important, because it is the only component in the tweeters signal-path. I advise to use something at least at the level of a Clarity Cap SA but your investment in something better will be rewarded with even greater imaging and better transparency.

The RC-network parallel to the two woofers creates a more constant impedance for the network so that the low-pass function works more according to the book. The slightly smaller resistor value is done on purpose to create some extra correction around the crossover-point. Inductor L1 is in the direct signal-path of the woofer, so this is the critical one here. To keep distortion levels very low, even at high levels, an air-core inductor is a must here. Minimum is a 1,4mm wire type, preferably vacuum impregnated. If you have just taken some valuable items to the pawn-shop, you could invest your fresh cash in a nice 16-AWG copper-foil type to increase separation and depth. Icing on the cake could be a 14-AWG Wax-Coil if you are looking for very realistic harmonics. The remaining capacitors can be standard quality MKP's like the Clarity Cap APW. The resistors are all 10 watt MOX types.



L1 = 0,68 mH air-core inductor 1,4mm wire - R = 0,24 ohms (or 16-AWG copper-foil type)

C1 = 22uF standard quality MKP

C2 = 3,3uF (very) high quality MKP

C3 = 0,82uF standard quality MKP

R1 = 2,2 ohms / 10 watts MOX

R2 = 15 ohms / 10 watts MOX

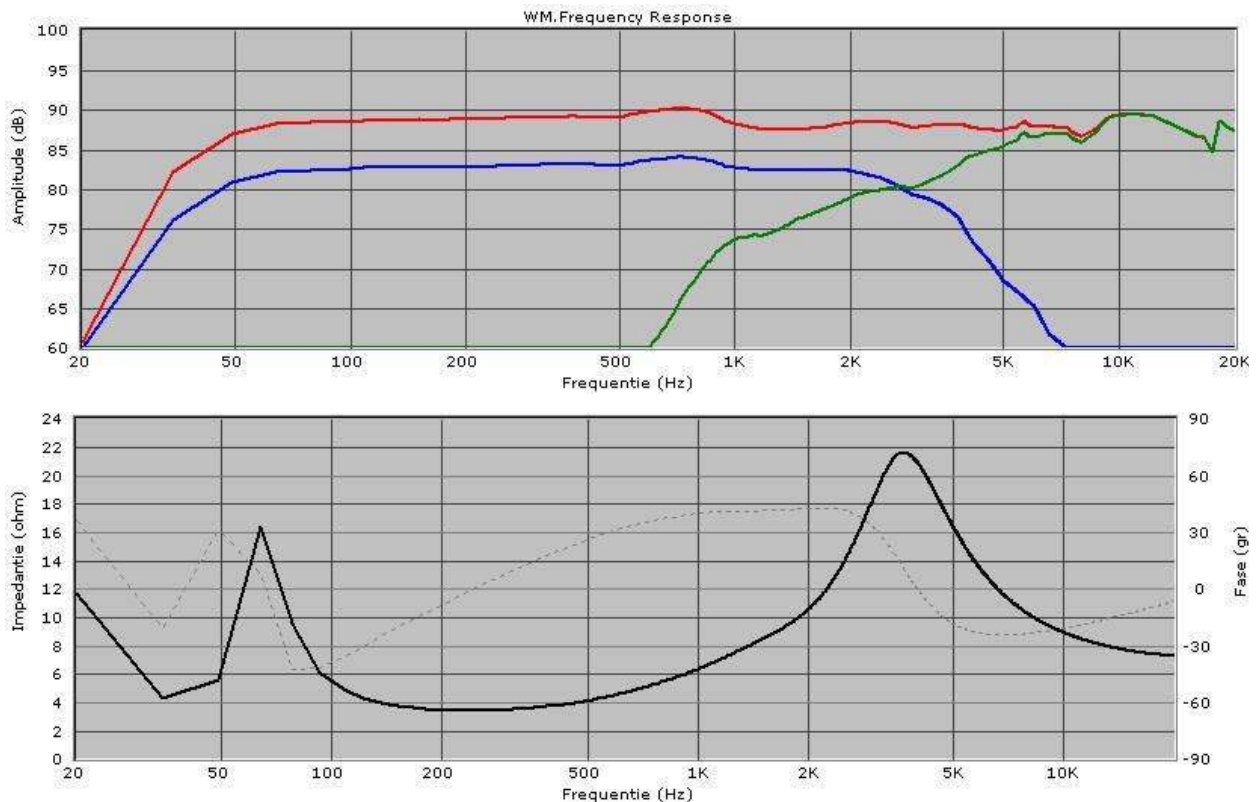


For all you Swedish loudspeaker builders: [Musik Hemma](#) is offering a kit for these loudspeakers.

Listening impressions and measurements.

Like all speakers, give them a few weeks to fully burn-in. With normal height arm-chairs and couches, the best image is obtained if the speakers are leant back about 5 degrees. This can be done by mounting short spikes under the rear of the cabinets and long spikes under the front. Once this is done the image should be large and spatial. Give the speakers at least 20cm from the rear wall so that the rear-firing ports have enough air to breathe. The character of these floor standers can best be described as coherent and dynamic. The low-end has enough weight and is well in balance with the rest of the spectrum. The midrange is nicely open, well defined and spacious. All the musicians and vocalists are separated reasonably realistic. Even with large choral works (difficult for any speaker) the picture stays intact. The top-end is well-defined and clear (the clarity will vary depending on the type of capacitor used). These low budget tweeters do sometimes miss the extreme smoothness you get with top-notch products but hey, we are listening to no more than 35,- euro's per tweeter here! So overall they are well balanced with good band-width, enough detail and smoothness.

The measurements show a very smooth overall response (red), seeing that the crossover is very simple it proves that the drivers are easy to implement. Bass-extension is down to about 45Hz and efficiency is good at about 88-89dB's for 2,83V at 1 meter. So your amplifier doesn't need to be very heavy. The crossover-point is situated near 3kHz with a gradual roll-off of the tweeter (green) and a slightly steeper roll-off of the two woofers (blue). On the impedance plot (black) you can see that the two peaks centred around the tuning frequency in the bass and the peak around the crossover-point. The impedance minimum are 4,4 ohms at 45Hz and 3,5 ohms at 240Hz. This shouldn't perform much of a problem for most amplifiers seeing as the electrical phase is relatively smooth staying within the +/-45 degrees range.



Tony Gee, The Netherlands, December 2008

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