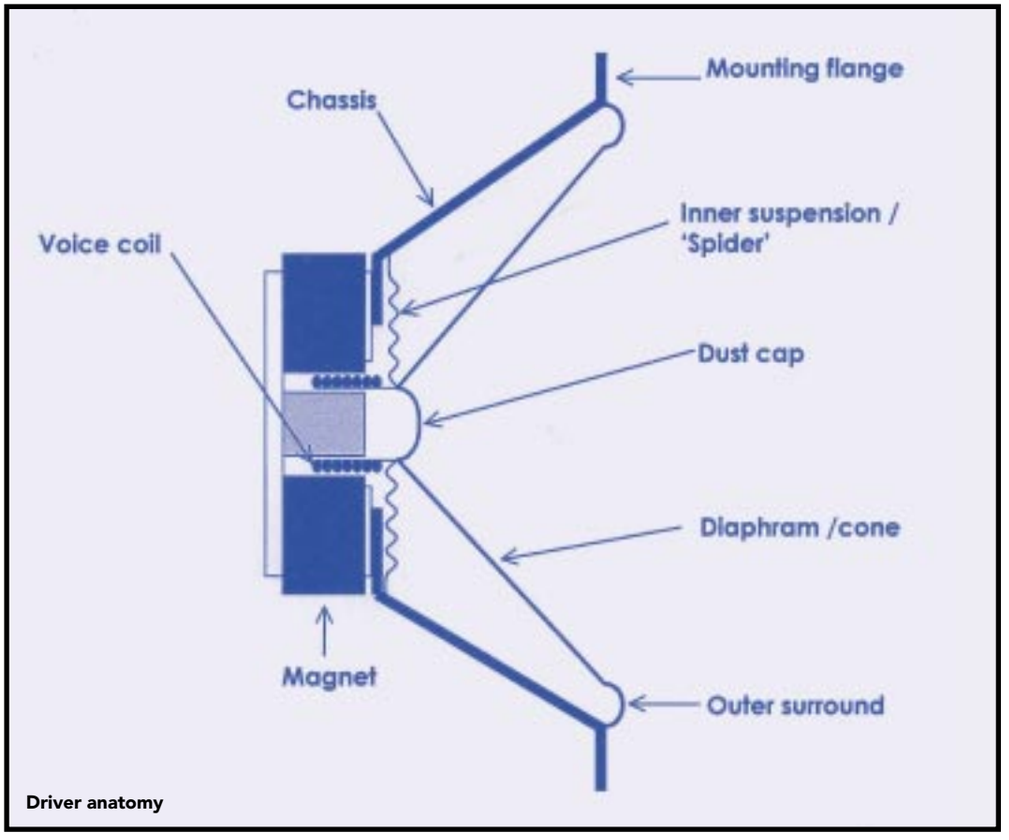
Loudspeaker designs and interpretations

You use them on a daily basis and base all your judgements upon their output, but do you understand the fundamental differences between the different types of loudspeaker box? PMC's JOSEF ALBERS gives a crash course in loudspeaker basics.



Driver anatomy

THERE IS A BEWILDERING array of loudspeakers on the market all of which claim to be 'monitors' and, in an ideal world, they would all give a perfectly natural response at all listening levels anywhere in the room. This is obviously not the case as every manufacturer has adopted a particular design philosophy and chosen to follow particular pricing considerations, which in turn imparts a particular character to the signal.

The perfect monitor should be able to accurately relay any type of material whether it is a shot from a gun-toting ghetto pimp or the dulcet tones of Vanessa May's G-String. There are brands that pigeon hole themselves and state that their monitors are really made for the reproduction of speech and classical music or hard core dance and rock. This usually means they have huge failings and weaknesses. It wouldn't be much of a selling point if a TV monitor had great definition for Gardener's World, but wasn't so good for fast moving F1.

There are no free lunches when it comes to loudspeaker design and there are pros and cons to all of them. It's a case of choosing the right type of product for your application, environment and budget. This is best done by careful evaluation using a range of material in a room with a neutral and natural acoustic. The true test of a monitor is the amount of information it can resolve. This makes the job of creating a great mix a far easier one and also means that the result will need very little alteration after it leaves you.

There are three main types of monitor design that you are likely to find currently deployed : infinite baffle (closed box); reflex (ported); and transmission line. All use conventional moving coil drive units of varying cone and dome material.

Many manufacturers try to differentiate their products from the masses by having a unique selling point, such as 'Quantum forged air flow technology', which doesn't usually add up to much but looks great on the literature. Funnily enough, most of the least coloured and most reliable drive units available are still made from good old doped paper. However, natural materials don't have the same ring as 'drivers developed for the last NASA space mission to Mars'.

The conventional moving coil driver converts electrical signals from the amplifier into sound by the use of a coil (the voice coil), which is placed within the field of a permanent magnet. When current is passed through the coil it creates a magnetic field, this acts with the field of the magnet causing the coil to move and as the drive unit is directly coupled to the coil it moves forward pushing the air. When in operation, only bass frequencies can be seen with the naked eye, the higher stuff is way too quick.

When a drive unit vibrates in free air it creates two equal waves, one in front and one to the rear, which at low frequencies cancel each other out making very little sound. To rid the effects of cancellation, a divider or baffle is introduced to separate the front and rear of the drivers and their waves, this reinforces both waves and sound is heard. In theory extending this baffle to an infinite size would be ideal but it is not exactly practical in an average room, so folding the edges of this infinite baffle back on themselves to create a sealed box is far more convenient. This gives rise to the infinite baffle or closed box, which is the first and most simple design.

This design uses an air tight sealed cabinet to effectively divide the front and rear outputs of the drive units and in turn traps a volume of air behind them. The trapped air acts like a spring and resonates with the drive unit. The internal volume of the box is stuffed full of acoustically absorbent material to soak up as much of the unwanted rear waves as possible. The idea is that no sound can reflect back to the driver making the forward radiation the only one audible to the outside world. Filling the cabinet with absorbent material also changes the characteristics of the air contained which reduces the velocity of the sound fooling the driver into believing the cabinet is of a larger volume. An excellent idea as it helps keep box size down to a minimum.

Infinite baffle designs tend to use high-mass, long-throw drivers with large excursions to produce adequate bass response and level. These types of drivers teamed with the action of compressing the air in the cabinet make these designs fairly inefficient, so higher powered amps are needed. One advantage is that their bass response rolls off nice and smoothly without too many irregularities, but they are fairly limited in the depth of bass and distortion can be pretty high at moderate to high levels.

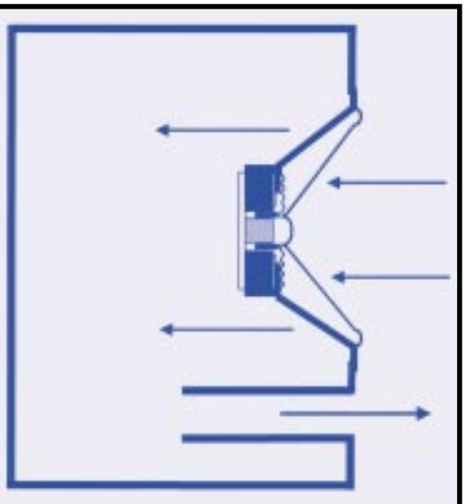
The reflex, or ported, design is slightly more complex to construct than the infinite baffle as it uses the same sealed box idea but with a tube or port to assist bass response. The port or ports usually appear on the front baffle as tubes or wide slots.

This design again uses the air as a spring but the port acts like another piston to extend the bass response. The port size is calculated so the mass of air

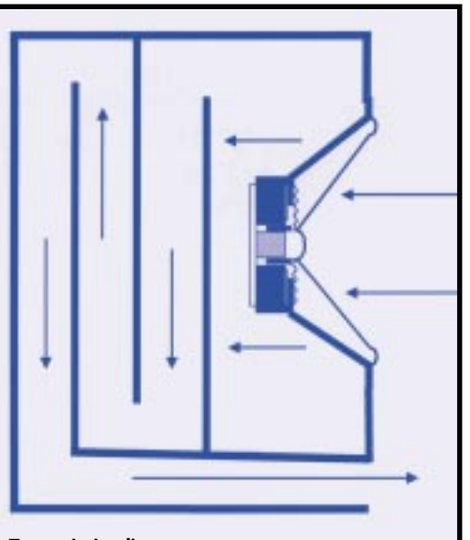
inside it resonates with the air trapped in the main cabinet. At low frequencies the air in the vent will move back and forward mimicking the same movements of the bass driver and therefore extending its low-end performance. The effectiveness of the ports' operation is easily seen when a swept bass tone is passed through the monitor. At the point where the port is resonating at its maximum, the bass driver is barely moving though it is still producing a reasonably high level. Above and below these points the driver's movements are easily seen.

The reflex design tends to be far more efficient than infinite baffle designs making them more popular due to the ease of driving them. The disadvantage is that above and below where the port is functioning there is little air pressure behind the driver to 'spring' it back into place. This makes the driver less well-controlled and more likely to create unwanted resonances.

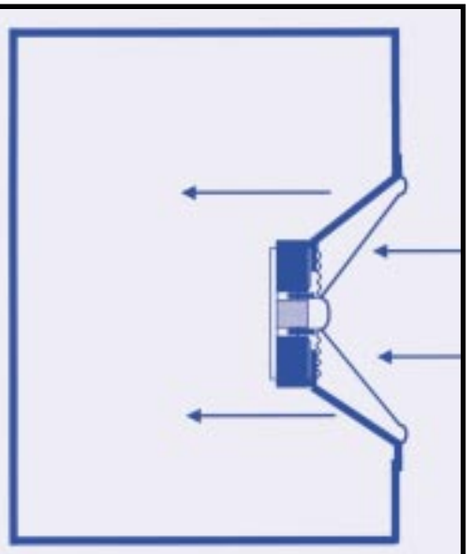
The transmission line uses a more complex cabinet design and acoustic absorption materials. The main driver is placed at one end of a long tunnel (the transmission line), which is heavily damped with absorbent acoustic material. In some cases long hair wool is used but contoured foams are far more predictable in their characteristics and are favoured by the leading manufacturers. This foam is specified to soak up the upper bass frequencies that radiate from the rear of the main driver and the lowest frequencies emerge from a large vent at the end of the line, acting as a second driver. One advantage is that the rear air



Ported or bass reflex



Transmission line



Infinite baffle or sealed box

pressure is maintained controlling the driver over a wide frequency range.

The arrangement also means that this design will go louder and lower than the two other designs using the same drivers. Major drawbacks include the fact that the cabinets are expensive to make and there are lots of variables involved in the design, such as line length, driver position, absorption material and width of the line to mention a few, that have to be got right.

Most small loudspeaker designs will use two drivers, larger ones have a mid range driver, which can appear as a small cone or 3-4-inch soft dome. Dividing the sound up so specific drivers deal with their specialist frequency is more effective than trying to design a single unit to do the job. It sounds simple to keep adding drivers to do these specific jobs but trying to get drivers to integrate and not suffer from phasing effects is tricky.

A good test of driver integration and good crossover design is to simply stand up, sit down, and move from one end of the desk to the other while listening to new monitors. If the balance changes, or there is only a tiny window with a stable image, it would suggest that the monitors are not as good as they could be. Crossovers are either active, where powered electronics divide the frequencies to each driver, or passive, where there is no external power source and the process is activated by the signal passing through it.

To make a sweeping generalisation about one system being better than the other would be rash as you have to compare like with like and particularly with reference to price. However, active designs have grown in popularity as they offer a self-contained box with power amps, adjustable crossover and EQ. While this certainly takes the stress out of deciding which amplifier to pair with which box, it doesn't always mean that you are getting the very best available as many contain fairly cheap, low-resolution chip amps.

Another trick of the smaller active monitor is to EQ the bass end, giving the impression of greater extension, but it simply increases the risk of distortion and reduces the headroom. Active models can also suffer when modest drivers with average power handling are used and driver protection circuits come into play far too early so you may end up listening to the effects of compression and limiting. This factor obviously doesn't come into play with passive models but you will have to judge for yourself when to back off.

Implemented properly with high quality componentry, the active route is superb, but in many cases a good passive monitor will out-perform an active one at a similar cost. ■