Enclosure-Type Performance Comparison

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Sub–30 Hertz Behavior

Sealed box designs and single-reflex bandpasses are much better at controlling excursion at extremely low-frequencies (below 30 Hertz). For this reason, they can usually handle more power in these frequency ranges than ported designs and dual-reflex bandpass designs, which makes them less prone to low-frequency induced speaker damage. At frequencies below the tuning frequency of the port, a woofer in a ported box (or a dual-reflex bandpass) starts to de-couple. This means that the controlling function of the enclosure begins to disappear. The collapse is gradual rather than immediate, but at some point below the tuning of the port, the speaker behaves as if it were operating without an enclosure and suffers from potentially damaging over-excursion. (This is why it is a good practice to use an infrasonic filter when running a ported enclosure or a dual-reflex bandpass. JL Audio “Slash Series” subwoofer amplifiers offer this feature, as do many good quality active crossovers). Related to the loss of enclosure damping, ported and dual-reflex bandpass designs also exhibit higher distortion levels at very low frequencies than sealed or single-reflex bandpass designs. The importance of this is questionable, however, since little program material extends to below 30 Hertz. Sealed enclosures and single-reflex bandpass designs have a rather shallow low-frequency roll-off rate of around 12dB/octave, whereas ported enclosures and dual-reflex bandpasses typically exhibit 18- 24dB/octave roll-off. For this reason, sealed enclosures and single-reflex bandpass boxes can have much higher –3dB points (the frequency at which the output dips 3dB below the reference efficiency of the speaker) than ported designs while still producing very good ultra-low frequency output.

30–80 Hertz Behavior

This is the frequency range that is most important because it encompasses the vast majority of low-frequency information present in music. Serious audiophiles assign much more importance to good performance in this range than in the extreme low-frequency range. At moderate power levels, all of these enclosure types exhibit pretty decent manners. The ported box and the bandpass designs produce less distortion than the sealed box, but the difference is marginal. At higher power levels things change considerably. Since the ports in a dual-reflex bandpass control cone motion over a wider range of frequencies, the dual-flex bandpass produces the least distortion and exhibits the best power-handling characteristics. The ported enclosure and the single-reflex bandpass also do a very good job producing high-levels of undistorted bass output, again due to reduced cone motion in this frequency range. Bringing up the rear in this category is the sealed enclosure, which produces higher levels of distortion at high power levels. There is a common misconception that ported designs produce more distortion than sealed boxes. As you can see, this is not entirely accurate; it depends on the frequency and the power level.

Transient Response

Transient response refers to the ability of the subwoofer system to reproduce quick changes (transients) in the program material accurately. This is often interpreted as “tightness” or “looseness,” which might be a dangerous terminology, since many people are more influenced by tonal characteristics when asked to qualify the “tightness” of the bass. Transient response is actually a function of accuracy in relation to time, rather than frequency. In music, sounds like drum strikes and quick bass guitar pulses are good tests of a subwoofer system’s transient performance. A system with good transient response will reproduce these sounds with clear, “tight” definition. A system with poor transient response tends to blur these sounds over time, due to the speaker’s inability to stop and start quickly enough to react to the signal accurately. It is generally accepted that an optimized sealed enclosure exhibits the best transient response characteristics. The control provided by the air-spring in a good sealed system contributes to generally outstanding transient behavior (Please note that at very high power levels, the increased distortion can overshadow this advantage). A ported enclosure can also achieve good transient behavior, but it will never be as good as an optimized sealed enclosure. It is possible, however, for a well-designed ported enclosure to have better transient response characteristics than sealed enclosures with higher Qtc’s (above 1.0). The specific alignment of the sealed and ported enclosures plays a huge role in determining the transient characteristics of each individual subwoofer system. Single-reflex bandpass designs can also have good transient characteristics if their bandwidth is fairly narrow, but again, not as good as an optimized sealed enclosure. As the bandwidth becomes wider, their transient response can degrade considerably. Dual-reflex designs generally exhibit inferior transient response characteristics when compared to the other designs. As with single-reflex designs, narrower bandwidths produce better transient performance than wider ones.

Efficiency

The term “efficiency” refers to the ability of a speaker system to convert electrical energy (power from the amplifier) into acoustic output. Consequently, it also serves as an indication of which system will produce the loudest possible output given the same size amplifier (assuming they can all handle the power). For the purposes of this comparison, we are looking at efficiency in the 40–80 Hertz octave. Generally speaking, the most efficient enclosures are the two narrow-bandwidth bandpass designs with the dual-reflex version having a slight edge. Next in line, the wide-bandwidth dual-reflex and the ported enclosure exhibit very good efficiency as well. The sealed enclosure and the wide-bandwidth single-reflex bandpass are the least efficient designs.Midbass TransitionFor sub-bass to sound natural, the system must have good mid-bass capability as well. These two are interrelated because harmonic components of the sounds produced by instruments that play in the sub-bass range must be accurately reproduced in the mid-bass range for a system to sound accurate.In car audio, we normally don’t have the luxury of using very large drivers to reproduce mid-bass. For this reason, the ability of a subwoofer system to smoothly transition to the mid-bass region becomes very important to achieving top-notch fidelity.The sealed and ported enclosures usually produce the smoothest mid-bass transition because the speakers play directly into the listening environment. Wide bandwidth bandpass designs are a little more ragged, but still deliver good mid-bass reinforcement. The narrow bandwidth bandpass designs can create serious problems because their high-frequency roll-off can begin as low as 75–80 Hertz, and the amplitude of their response peaks is very high, which necessitates the use of larger, very capable mid-bass speakers in order to blend smoothly with the sub-bass.

There Is No Free Lunch

As you can see by the comparison, no enclosure design is superior in all respects. They all have advantages and disadvantages. Analyzing the characteristics of each enclosure type will help you decide which enclosure type is right for your application. An informed decision involves an analysis of the following factors: the space that you want to make available in your car for the enclosure, your performance expectations (loudness, tonal qualities, etc.) the amount of amplifier power you will be using, and of course, your budget. Top-notch car audio specialists will weigh all the factors and consider all enclosure types before recommending a subwoofer system. Many will even show you specific data to support their suggestions.Remember that the information presented here assumes that each enclosure type has been properly designed and executed. This means that the speaker and the enclosure are carefully matched as a system. The skills of a competent designer, installer and cabinet builder are every bit as important to the end result as the design of the box or the type of woofers that you buy.Despite the very general scope of this piece, we hope it leaves you with a better understanding of subwoofer systems. At the very least, we hope that the next time you hear someone say “whatever you do, don’t port the box” or “sealed boxes don’t sound good,” you will ask them to thoroughly explain their position. It could be amusing.