KICKER

Introduction:

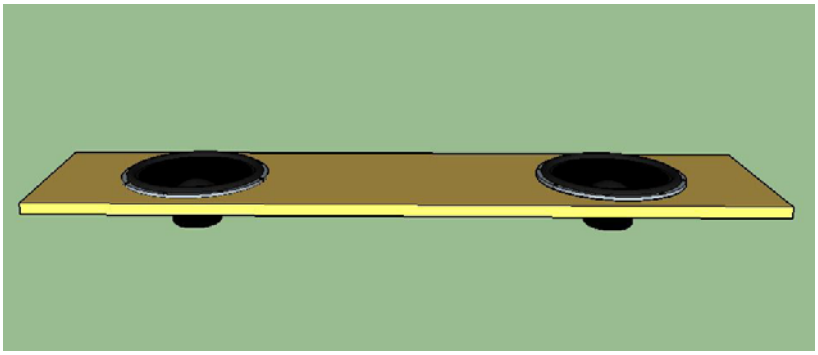
When it comes to selecting an enclosure type to get the best sound from you woofer and matching it to your taste in music, it can be a little confusing. The purpose of an enclosure is to improve bass response and prevent woofer damage from over-excursion. There are a few things you will need to consider before making your final selection that will ultimately affect your choice in subwoofer enclosure style. Here are some of the key points that you will need to consider:

1. **How much room is available in your vehicle and how much are you willing to sacrifice.**
2. **What type of speaker will you be using? Some speakers are designed for specific enclosure types. (refer to the manufacturer's recommendations)**
3. **How much power does the amplifier produce and what type of crossovers and controls does it have?**
4. **What type of music do you listen to? Different enclosure styles will sound slightly different.**

Once you have determined the above conditions, you will then be able to make a choice that will get the best bass response. The next sections will outline the most popular types of enclosures to help you make s selection that is right for you and your listening tastes.

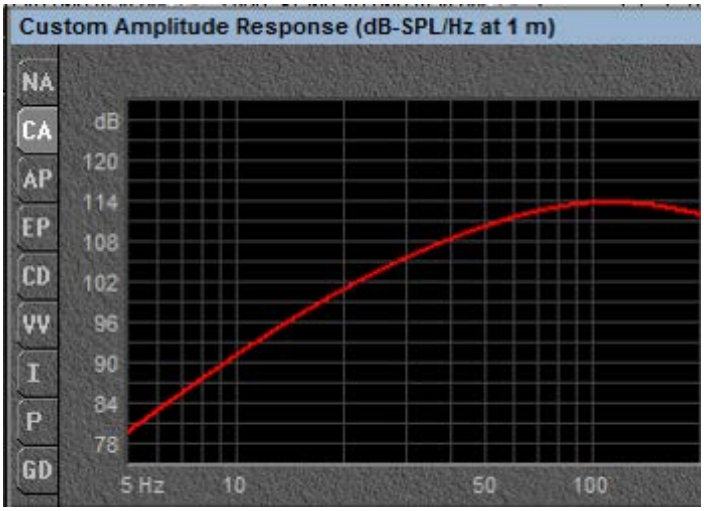
Infinite Baffle:

Simple infinite baffle mounting board:



Infinite baffle example:

Infinite baffle frequency response curve:



An infinite baffle is not necessarily an enclosure. It can be as simple as a board or mounting surface (called a "baffle"). This can be a flat board with the woofers mounted to it and then attached to back of the seat of a sedan. Another example of infinite baffle is how speakers are mounted in the rear package trays of most sedans. The speakers have no enclosure and the speakers are mounted facing up in the package tray. Many vehicles have subwoofers mounted in the rear package tray infinite baffle right next to the full range speakers. With this type of mounting, the trunk is typically used as the "enclosure".

When mounting woofers in an infinite baffle configuration, there are a few things you will have to know. You must have a woofer that is able to be used in an infinite baffle or ported enclosure. You will need to make sure that you seal the mounting baffle as good as possible to the vehicle so that the sound waves from the front of the speaker cannot reach the rear of the speaker to cause cancellation. Remember that bass can travel through anything that is not solid such as the rear seat foam and even other speakers that are mounted near the woofers. Any areas not sealed between the front and rear of the baffle will decrease the amount of bass. An ideal infinite baffle mounting can be a challenge due to the potential difficulty of sealing off the front and rear of the baffle.

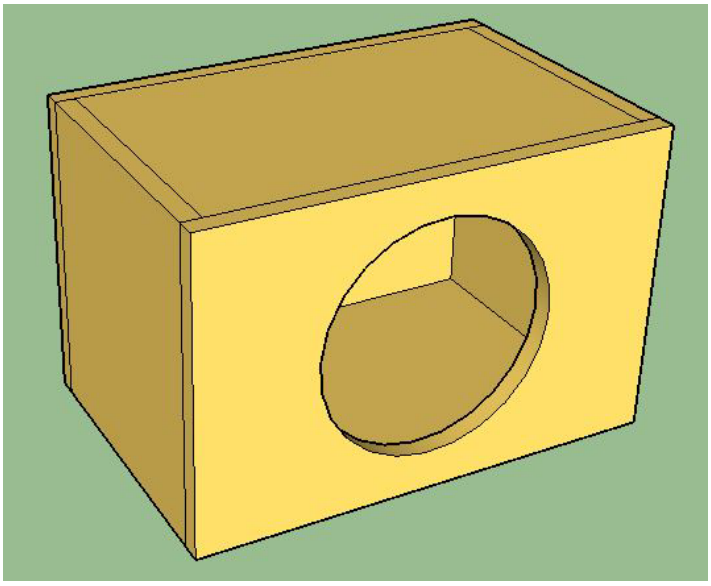
Infinite baffle mounting is often considered the best overall sounding of all the examples we are going to talk about. They do not have an enclosure that will change the way the woofer naturally sounds. Since they don't have an enclosure they will not take up as much room in the vehicle and can be mounted (in some applications) where they may not even be seen as at all.

They do have some limitations. Since they don't have an enclosure, there is nothing but the suspension of the woofer to control cone movement. That is why it is important to have an amplifier that has a subsonic filter to eliminate any damaging frequencies to the subwoofer. Infinite baffle mounting does limit the total output of the woofer and its power handling. That is why it is best to use a woofer specifically designed to be used in this type of mounting configuration. You also have to make sure you have properly isolated the front and rear pressure waves with the baffle or you will have limited output and bass response.

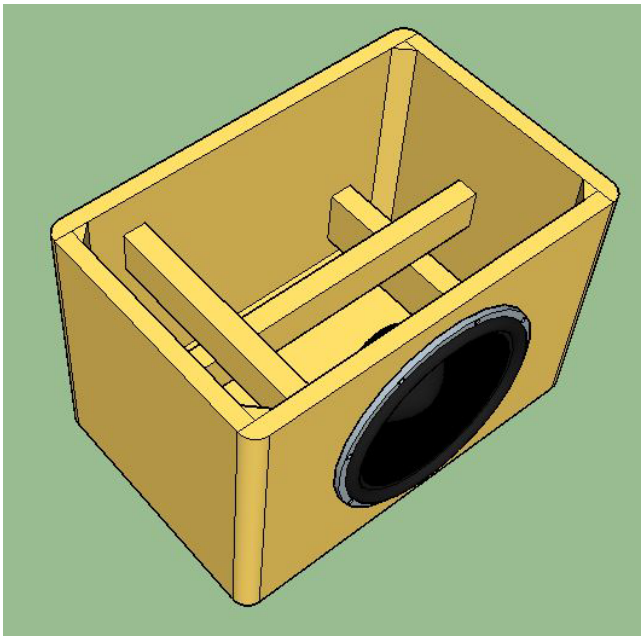
- **Pros-**
  - **Easy to construct**
  - **Smooth frequency response**
  - **Does not take up much room in trunk**
  - **Uses speakers' natural frequency roll-off**
- **Cons-**
  - **Limited power handling**
  - **Limited output**
  - **Require specific crossover capabilities from amplifier for best results.**
  - **Rear side of the driver is exposed along with the wiring and it may not be a clean looking installation**

Sealed enclosure:

Simple sealed enclosure:

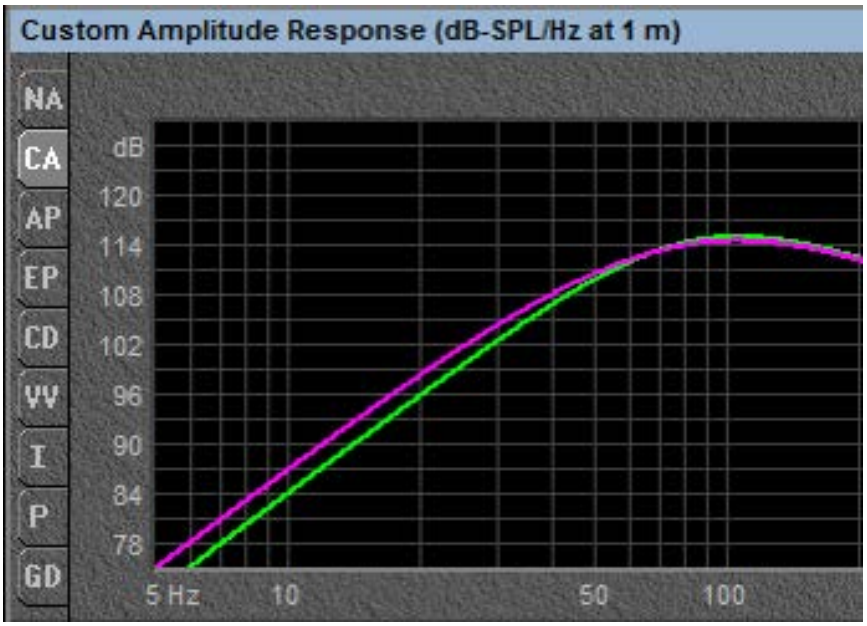


Simple sealed enclosure showing internal cabinet bracing:



OEM Sealed enclosure example:

Sealed enclosure frequency response curve:



Violet - large sealed enclosure

Green - small sealed enclosure

A sealed enclosure is an enclosure that has a "closed" airspace. They are usually built to specified internal volumes within a range of internal airspace specified from the manufacturer. The internal volume will vary depending on the type of sound you are trying to achieve. Sealed enclosures can be large or small in internal volume with no ports or vents in the enclosure. The air inside the enclosure works as an air spring to control cone movement. They are sometimes called "acoustic suspension" enclosures.

When choosing the proper volume of sealed enclosure for you tastes, you will need to consider the following: A large sealed enclosure will have a smoother output with deeper bass but may also limit power handling because woofer cone has less control at lower frequencies. Too much power at lower frequencies can damage the speaker's suspension components (surround, spider, tinsel leads, or voice coil former). You must make sure that your amplifier does not produce more power than the woofers is rated to handle in this size of enclosure. This type of enclosure is usually used when you are trying to reproduce music very accurately at a moderate volume. Sealed enclosures are one of the most popular box designs for someone that is looking for very accurate sound reproduction.

Sealed enclosures are usually used when you want loud music reproduction with very good cone control. For example, small sealed boxes are often designed for the older rock, hard rock, or speed metal. These genres of music usually have a good amount of drums in the recording and do not have a lot of very deep bass information in the recordings.

With a small sealed enclosure, the bass will be very "tight" and controlled. The woofer will handle a large amount of power because the enclosure will limit the cone movement at the lower frequencies which could damage the speaker. The smaller sealed enclosure will give you a little more output, or "bump" as it is called, before it rolls off but will start rolling off bass response at a higher frequency than a larger sealed enclosure.

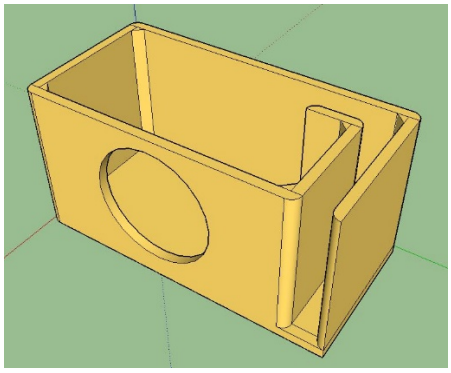
Larger sealed enclosures will play lower bass and are considered to be a bit smoother in frequency response because they have a little less "bump" before they roll off in output. They will not have as much of the punch as a smaller sealed enclosure but will play lower bass overall. They will also take up more space in the vehicle since they require more air volume. They can reproduce low bass response that is very smooth and natural sounding.

The lower bass response in a sealed enclosure will roll off at a rate of 12 dB/octave. This is a smooth gradual roll off that gives them a very good response curve and will not have an excessive peaks in output at certain frequencies.

- **Pros-**
  - **Very accurate bass reproduction**
  - **Tight bass response**
  - **Great power handling**
  - **Somewhat small in size**
  - **Easy to build**
  - **Great low frequency response**
  - **Bass rolls off at 12 dB/octave**
- **Cons-**
  - **Requires larger enclosure for deep bass response.**
  - **Will take up more room than infinite baffle.**
  - **Requires more woofers/enclosures/power for more output**

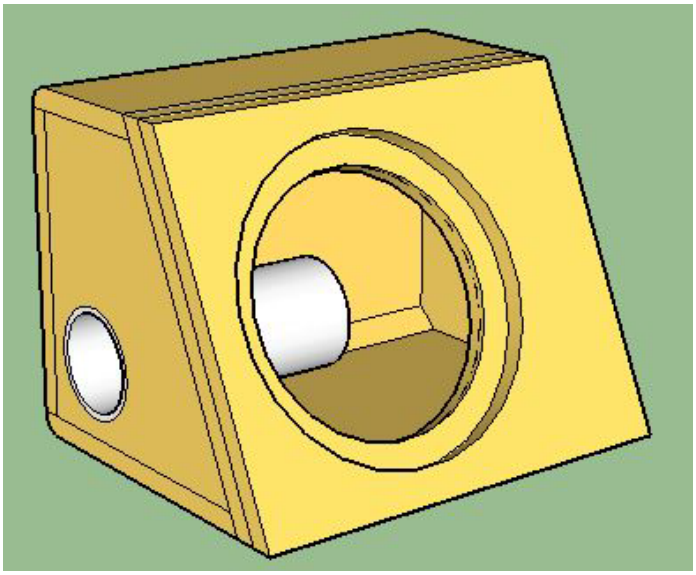
Ported enclosures:

Slot ported enclosure:



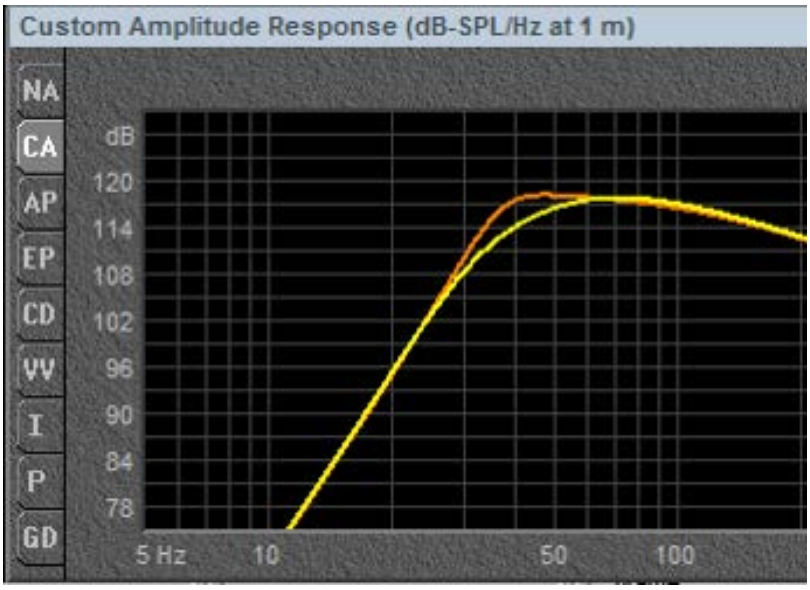
(Shown without top to view inside)

Truck style ported enclosure:



OEM Ported enclosure example:

Ported enclosure frequency response curve:



Orange - large ported enclosure

Yellow - small ported enclosure

A ported enclosure has a port or vent that will increase output at certain frequencies. This type of enclosure is more complicated to construct. You must follow the speaker manufacturer's specifications to get the proper output and to prevent damage to the speaker. The vent will combine the rear side of the woofers output to the front output of the speaker. It can be tuned to specific frequencies to allow added output around the tuning frequency. The enclosure's air volume, vent area and length are critical for proper tuning and power handling. Sometimes they are called "bass reflex boxes" or "vented boxes". If you do not follow the recommend specifications, poor bass response and/or damage to the woofer are very possible.

Ported enclosures are very popular because they can dramatically increase the output at specific lower frequencies. This can be an advantage when extreme output levels are desired or if you are wanting to maximize the output of a subwoofer with a smaller power amplifier. As with anything, there are both good and bad things to consider. To achieve the most output, you will need a very large ported enclosure. This will take up more space in the vehicle. The other factor to consider with a large ported enclosure is they have more "group delay". This is very rarely discussed but is very noticeable with large ported enclosures. A larger ported box will have more group delay because of the size of the enclosure and its design. This will have a softening effect on the bass. The impact or punch that you will perceive does not "hit" as quite as hard. A large ported enclosure can have substantially more output but at the cost of accurate sound quality.

Ported boxes have another set of challenges. The rate at which the bass rolls off on the lower frequencies is 24 dB/octave. This means that they will limit the lower frequencies the enclosure can produce twice as fast as a sealed enclosure. A good sealed enclosure can often play deeper bass than a ported enclosure. The advantage of the ported enclosure is the fact that it can play louder before the lower bass starts to roll off. Ported enclosures are often much larger than the sealed enclosures to get them to produce very low bass frequencies. The other trait of ported

enclosures is they have no control of the driver movement, called excursion, of the driver below the tuning frequency. This is called "unloading". This means that below the tuning frequency of the enclosure, the driver will perform as if it was in an infinite baffle. A lower frequencies, it can damage the driver from "over excursion". This is why smaller ported enclosures handle less power than larger ported ones. Smaller ported boxes are cannot be tuned as low as larger ported enclosures. High power levels below the tuning frequency will overdrive the cone movement and damage the speaker. One of the key ways to control cone movement below tuning frequency is to use a subsonic, or infrasonic filter just like we recommend for infinite baffle. All Kicker subwoofer amplifiers either have filter that is fixed at 25 Hz at 24 dB/octave or an adjustable subsonic filter that is variable from 10 – 80 Hz at 24 dB/octave. An adjustable subsonic filter is necessary to maximize your output and protect your speaker. With proper tuning you will have incredible output from the enclosure with maximum protection of the speaker.

When tuning a ported enclosure, you must make sure that you have the proper volume of airspace, the correct port area, and port length. If the port has too little area, the airspeed in the port will be higher and can cause "port noise" at high output levels. This can sound like "whistling" or "chuffing" coming from the port. One way to see if this is happening is to hold your hand or something over the port opening when playing at high power to see if the noise stops. This noise can be reduced and is some cases eliminated by rounding or flaring the ends of the ports but in extremely small ports, the noise is unavoidable. The length of the port is also an important factor and relates directly to port area. For example, if you increase the port area to eliminate port noise, you must also increase the length of the port to keep the tuning to the same frequency. Now you have another challenge. Large ports sound better but take up more airspace and your enclosure's total volume increases making the box larger overall. Now it is a balancing act between size, sound, and power handling. You want a ported enclosure to play as low and loud as possible but the louder and lower it play you want it to play, the more space it will require.

Venting rules:

When you use ports, you there are a few things to remember. First and most important is that the area and length are very critical for proper tuning. Changing either one will greatly affect sound quality, performance, and durability of the speaker. The vent shape is not as critical as the total area of the vent. It can be round, square, triangle, rectangle, or any other shape as long as the total area is equivalent to what is required for that enclosure. Multiple vents can be used if the total area is equal to the specified design. Also, you must keep the vents away from other surfaces. Example, if you have a 4" diameter round vent, it should not be closer than 4" from the back of the enclosure to prevent it from detuning the enclosure. Just remember that the vent must be able to allow air to flow freely without obstruction from either end. A straight vent is better than a vent that has to be bent or folded to fit into enclosure. Bending the vent will also restrict the airflow and will slightly detune the enclosure. Longer vents tune the enclosure to lower frequencies but require more airspace in enclosure to compensate for their displacement. Small vent areas have shorter lengths but increase airspeed and can have port noise.

A smaller ported enclosure will not play as low of bass notes as a larger one can play. This is because the smaller ported enclosure does not have enough airspace to tune it to a lower frequency. To tune a ported box to a low frequency, you must use a larger enclosure with a larger and longer vent. In a smaller enclosure, this gets very difficult to fit the port into the enclosure due to the limited volume of airspace you have to work with. This will limit the tuning of the enclosure to a higher tuning frequency.

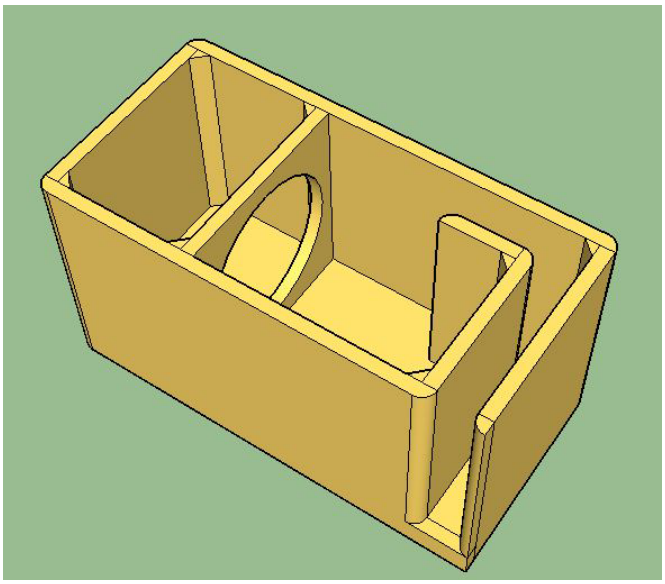
When trying to tune your port volume to minimize the chance of port noise, you will want to make sure the air speed is under 10% of the speed of sound (Mach is the speed of sound) at the tuning frequency with the maximum power you are going to supply to the speaker. The speed of sound is about 1132 ft./second. That means the port

velocity should be no greater than about 110 ft./second, 34.5 meters/second, or .1 Mach. It is always best to keep this number as low as possible to minimize the chance for port noise. If you are getting close to the maximum airspeed and are concerned about port noise, you can also flare both ends of the port to further reduce your chance of having port noise.

- **Pros-**
  - **Increased output**
  - **More efficient**
  - **Great power handling**
- **Cons-**
  - **Harder to build**
  - **Larger than sealed enclosure**
  - **Must be tuned to specific driver and enclosure volume**
  - **Bass is not as tight sounding**
  - **Bass rolls off at 24dB/octave**
  - **Can have "port noise" if built incorrectly**

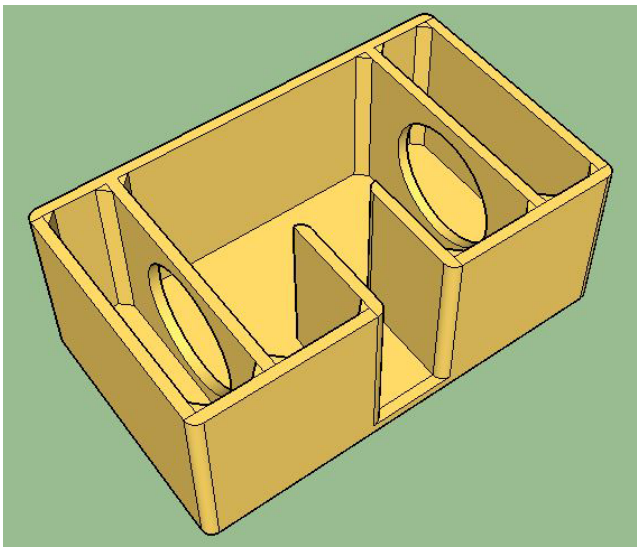
Bandpass enclosures:

Bandpass enclosure example:

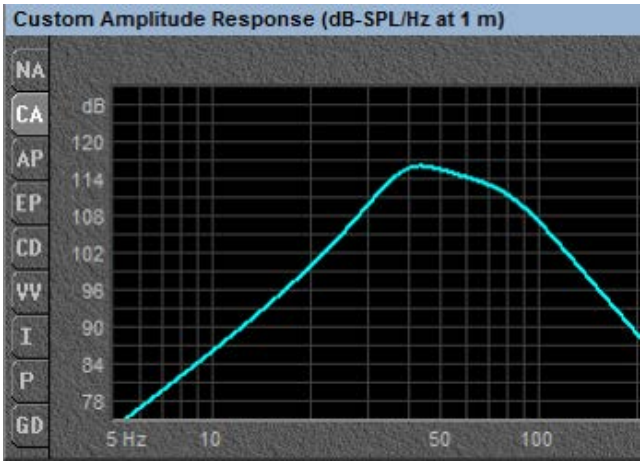


(Shown without top to allow view of inside)

3 Chamber bandpass enclosure



Bandpass frequency response:



A bandpass enclosure is an enclosure that is designed to pass the entire output of an enclosure through a vent that is smaller than the surface area of a speaker. A bandpass enclosure uses both a sealed and a ported chamber. The woofer is mounted inside of a two chamber enclosure in the divider between them. One of the chambers is vented to the outside environment. They are much more complex to design and service of the woofer is much harder since it is mounted inside the enclosure. To service driver, a removable, airtight panel must be designed into the box design making it also harder to construct. The main advantage of a bandpass enclosure is they will allow significant output through a small opening. They can also be tuned to provide increased output in a narrow band of frequencies when specifically tuned to do so. They do share a lot of the traits of both sealed and ported enclosures. The size of the sealed chamber will affect the low frequency response. For deeper bass it will require more airspace, thus a larger box. The ported side tunes the upper frequency response and output level. A larger ported chamber will give a wider band of passed frequencies but will sacrifice output of the enclosure. As with a ported box, the port area and length will greatly affect output and frequency response as well as quality and the reliability of the speaker.

Other concerns with bandpass types of enclosures is with sound quality. Since the speaker is completely enclosed inside the cabinet, they have much more group delay. This means the bass will be delayed from reaching your ears at the same time as the sound energy from the other speakers in the system. This produces a sound that many have described as "slow" or "mushy" bass. Some of this time delay can be improved with the use of a DSP to delay the other speaker's signals to bring the music "back into phase" for a more natural sound. The output of the bandpass boxes are not extremely flat or smooth in frequency response. This means that some frequencies are louder than others and will not accurately reproduce the music as it was recorded. The smaller bandpass enclosures produce the least flat response but can have a huge increase in output in a specific, smaller, frequency band. The last thing to consider is bandpass boxes will "mask" distortion making it harder to hear. This means that if you are clipping your amplifier's output, it will not be as easy to hear the distortion and you are more likely to damage the speaker and possibly the amplifier.

- **Pros-**
  - **Can be more efficient at specific frequencies.**
  - **Can allow porting of bass through smaller openings into listening area**
- **Cons-**
  - **They mask distortion.**
  - **They are more likely to damage speaker.**
  - **Degraded sound quality.**
  - **Harder to construct.**
  - **They can become quite large**
  - **Harder to replace speaker**

Isobaric Enclosures:

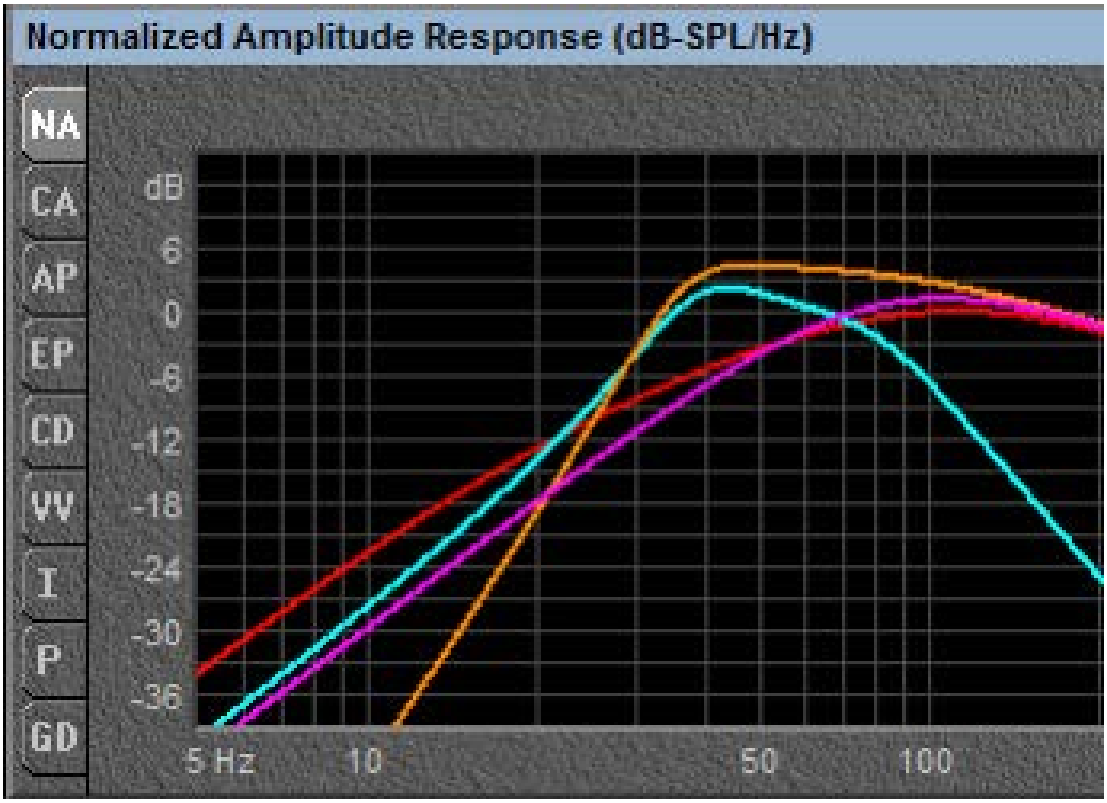
Isobaric enclosures are designed to get the maximum bass from a very small space. An isobaric enclosure is a unique type of enclosure where you use two woofers and couple them together to act as a single woofer with twice as much pushing power. The biggest advantage is the enclosure requirement for this style of enclosure is half of the size of the recommended sealed enclosure for the speaker. This means that you can get great bass out of a very small space. The disadvantages to this enclosure design is you have to buy double the number of speakers and you have to power each one as if it were playing by itself. This means double the power requirement as well. Since you are essentially overlapping two speakers, the overall output will be the same a single speaker.

Construction is very simple. Once you know the volume of enclosure that a single speaker requires, you can just reduce the internal air volume to one half the original specification. The woofers can be mounted into the enclosure face to face with the outward woofer wired out of phase with the woofer that has its magnet inside the enclosure. This will give a push/pull effect and will double the strength of the woofers to allow them work in very small space. The woofers can also be coupled with airspace between them in either a face to face, magnet to magnet, or face to magnet.

The other advantage of mounting woofers face to face or magnet to magnet, is it will smooth out the non-linearity properties of a speaker. With older speaker designs, the pushing force was sometimes not as strong as the pulling force. This created distortion because it would not accurately reproduce the signal that the speaker received. Isobaric helped reduce this distortion but with today's technology, it is no longer necessary. Today's speakers have dramatically improved designs that now make this practice to solve this distortion obsolete.

This type of enclosure is no longer very popular because of the woofer technology that we currently use. Some of the woofers today require very little airspace to produce great sounding, deep bass eliminating the need to cut the box volume in half. In fact, Kicker perfected this by designing the "Solobaric" woofer back in 1992. Kicker combined the electrical and mechanical properties of two woofers and combined them into the single Kicker Solobaric woofer. It had all the bass as a conventional woofer, but in ½ the internal volume requirement of conventional speakers.

Comparison graph of different types of enclosures with the same woofer:



Orange - large ported enclosure

Teal - bandpass enclosure

Red - infinite baffle enclosure

Purple - large sealed enclosure