

Principles of Guitar Cabinet Design

The purpose of this document is to support the player in defining which design and configuration of a speaker cabinet may be best suited to his/her playing style and taste.

Sound character of each different cabinet configuration:

OPEN BACK: Open back design is typical of the vast majority of vintage and contemporary combo amplifiers, regardless of the size and the number of the speakers employed, since the very early age of guitar amplification.

It is also very common in 1x12 and 2x12 extension cabinets.

The area of the rear opening may range from approximately 25% of the back surface of the enclosure to nearly 75%, in certain cases.

The tone of an open back enclosure may be defined as “open” and “airy”. Bass frequencies are fully present, somehow more “transparent” than those from a sealed cabinet. The most significant difference is that an open back cabinet “fills the room” much more than a closed back one, irradiating especially the low mids and the low frequencies in an almost omnidirectional pattern. This may be very good on a smaller stage or a club application but not always desirable on a larger stage, where the player seeks for less spillover of his stage volume to the other musicians.

In an open back cabinet, the speaker is free to react to the electric signal, thus delivering the feel of a very fast, immediate, uncompressed response.

An open back cabinet projects in a less directive way than a closed back one.

It is usually the preferred choice in jazz, country, blues, pop among other genres, where the tones range from sparkly to pushed cleans, to mid-gain crunch and overdrive ones.

In a recording studio environment, an open back enclosure allows for a great deal of experimenting with different microphone techniques, including capturing the tone irradiated from the back side of the cabinet itself.

CLOSED BACK: This configuration became increasingly popular in the late '60s; since then it has been associated with the hard blues, rock, hard and heavy rock tones.

Closed back cabinets, especially in the 2x12 and 4x12 configuration, deliver a very convincing, punchy, authoritative impact, that perfectly fits with overdrive and distortion tones.

Closed back cabinets are “air-tight”, thus the speaker needs to win over the sealed air internal volume load, in order to move forward and backwards to generate tone. Therefore, in a sealed cabinet, the speaker behaviour is significantly different at the low frequency compared to the open back configuration. Physically the load of a closed box moves a part of the energy emitted by the speaker from the mid-bass range to a lower frequency range.

When properly driven, a closed back cabinet is able to generate a strong, bold tone with tight and focused lower mids and basses, and somehow more compressed, slightly rolled-off highs.

It is also quite directional (or “beamy”), not having any irradiation of its sound from the back side.

It would rather project forward more effectively than an open back one. It will not “fill the room” as much as an open back one would, but it will be more predictable and controllable on a bigger stage, and easier to pick up with a microphone. For this reason, in certain situations where the environment reflections give a positive contribution to the direct sound, a speaker in a closed box seems to be marginally less efficient than in an open or ported box, and the feeling is that the closed back cabinets perform at their best at relatively higher levels of loudness.

The closed back enclosure configuration is not very common in combo amplifiers as, being it sealed, it will be less efficient in the dissipation of the heat generated by the amplifier's electronic components.

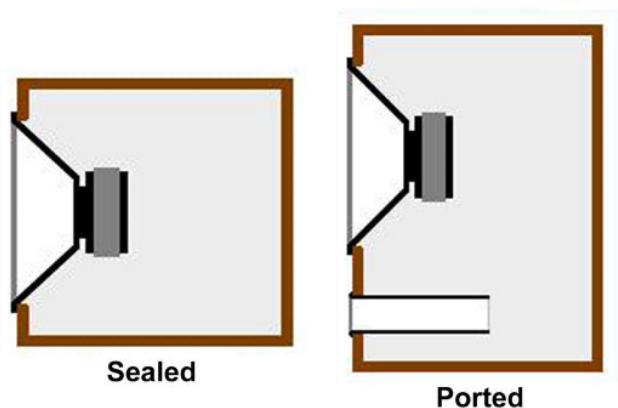
It is more common in speaker cabinets of all sizes. For both classic and contemporary rock applications, including all heavy rock sub-genres, it is the preferred choice, especially in the classic 2x12 and in 4x12 formats.

PORTED: ported cabinets are relatively new and less common in the guitar amplification. The first examples date back in the '80s, and since then, they are regarded as a very interesting solution for a number of reasons.

A ported (or "bass-reflex") enclosure needs a specific and carefully calculated set of measurements, and it is, in theory, designed and optimized for a single loudspeaker and its Thiele-Small parameters. Nevertheless, with a certain degree of compromise, it is possible to design a cabinet that will behave correctly with the most common guitar speakers.

The principle is to design a sealed cabinet and add a port or a duct, either on the front baffle or on the rear one.

The duct will carry to the listening environment a calculated portion of the rear emission of the speaker in the bass range and add it to the front emission, thus reinforcing the performance in the lower frequencies. The frequency range where this reinforcement is centred is called "tuning". The tuning of the cabinet is the result of the combined effect of its dimensions and the dimensions of the port.



Some of the most popular ported cabinets are tuned somewhere in between 80Hz and 90Hz.

Such tuning frequency should manage to reinforce the low end without becoming overly boomy and avoiding unwanted "bottoming" of the loudspeaker.

The port may have any shape or length: it can be a pipe, a hole or a rectangular slot in the baffle. What really counts is the geometric volume (cubic cm. or inches) of the port, as determined from the Thiele Small parameters of the speaker. The port can be either on the front baffle or on the rear. There is no acoustic difference in the bass response, but a front port may be preferable, as the lower bass reinforcement wave will be irradiated in the listening environment, without any potential obstruction. Rear ports may sometimes be disturbed by being too close to a wall, or any surface that could interfere with the propagation of the sound.

The most evident advantage of a ported enclosure is a deep, fast and controlled bass response that is usually unobtainable in compact cabinets. In other words, it is possible to design a very compact cabinet that sounds much bigger and more powerful than you could possibly expect.

It is nearly as directional and controllable as a closed back cabinet but, at the same time, it is as fast and uncompressed as an open back cabinet.

Ported cabs are usually very versatile and equally suitable for clean and distorted, vintage and modern tones. They are becoming increasingly popular with the session and working musicians, because of their "big tone in a small format" character.

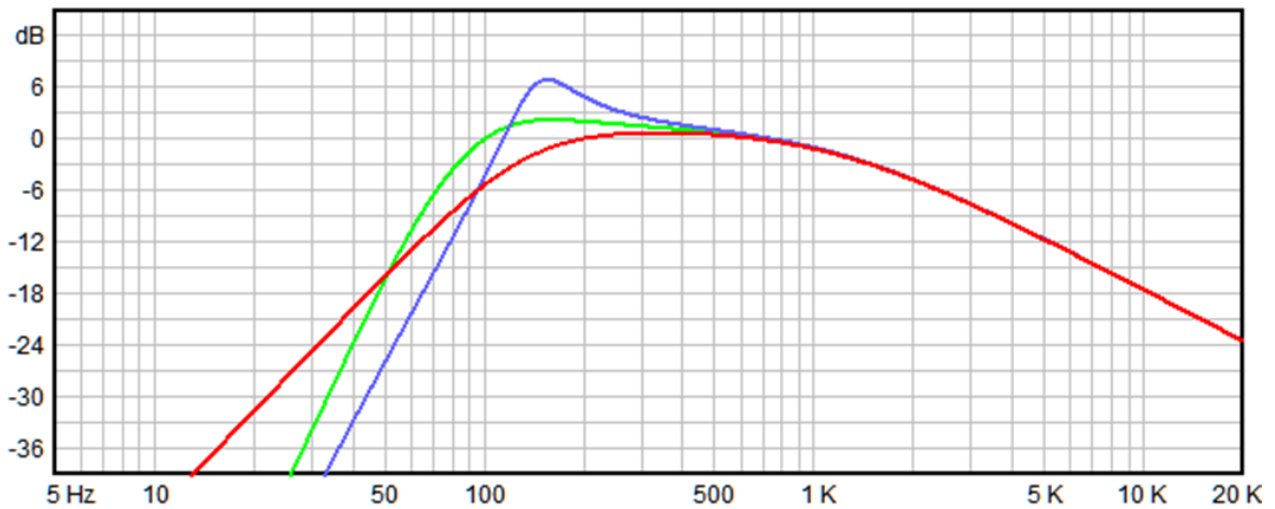
How the Bass Response changes between an Open Back, Closed Back and Ported cabinet?

This graphic simulation shows the different responses in the bass range between three identical 1x12 cabinets, fit with the same speaker, but in Open Back configuration (blue), Closed (Sealed) back (red), and Ported configuration (green).

It is obvious that the bass response changes in a very significant way.

The Open back will have a generous punch in the mid-bass area, but will deliver less true deep basses, the Closed back will have a tighter but deeper bass response, while the Ported cabinet will be somewhere in between the two.

Which one fits best each player's taste and requirements... it's largely a matter of taste.



TIP AND TRICKS

SIZE DOES MATTER:

In general terms, a bigger enclosure will deliver a bigger, fuller, deeper tone. A smaller sized one may gain focus and tightness but, below a certain size, may also sound too dry, boxy and constrained. This is more evident with closed back cabinets where, in most cases, bigger is better even if maybe less handy.

Especially a very small closed back 1x12 may sound thin, weak and abrasive. A useful trick could be adding some sound absorbing material inside the cabinet. Acoustically, this material will trick the speaker, absorbing the back-waves off the speaker itself, making it read a bigger acoustic volume, thus sounding fuller and more convincing.

OPEN BACK: HOW MUCH?

The more open the back is, the more open the sound will be and the more “omnidirectional” the dispersion pattern will be. The more closed it is, the increasingly focused and directional it will be. When the back panel will be closed for more than 75% or 80%, the behaviour of the cabinet will be very similar to a ported one. Unless correctly designed to perform in such configuration, it would be advisable to avoid such extreme closing, as the performance could be unpredictable in the lower end.

TUNING A SPEAKER TO THE ENVIRONMENT:

Since a relevant part of the output of an open back cab comes from the back side, interesting results may come from experimenting with different distances of the cabinet from the back wall (or any solid surface positioned behind the speaker). Moving the speaker even a few inches closer or farther away from the back wall may significantly change the bass response.

A minimum of 4” (10cm) should always be allowed from the back panel to the wall, to allow the rear waves to diffuse properly.

Same goes for the speakers with a rear port.

Also, closed back cabs will be influenced by the rear wall, even though in a less noticeable way.

Coupling the speaker cabinet to the floor will also help increasing the bass performance.

If a speaker on a stand may sound too thin and weak, try to place it on the floor.

If you find the tone to be too bass-heavy and boomy, try putting the speaker on a dedicated stand, or, in worst case, on a chair.

Try and avoid placing the speaker or the combo amp on top of an empty flight case, or any other potentially resonating box, as it may interfere significantly with the bass response of the speaker enclosure itself.

Since all guitar speakers are quite directional in their mid and high frequency dispersion pattern, aiming the cabinet to your listening point is generally a good idea. You should be able to better hear yourself on stage if your speaker will be aimed towards your ears, without increasing the stage volume.