

GoldenEar Technology®

A Passion for Sonic Perfection®

Passive Radiator Bass System Design



The SuperSubs utilize our patented dual-plane inertially-balanced driver and sub-bass radiator technology.

Quadratic Planar Infrasonic Bass Radiators

There are many kinds of loudspeaker enclosures including sealed boxes ("infinite baffle" and "acoustic suspension"), ported, transmission line, passive radiator, and a slew of bandpass designs. The primary technologies incorporated in these enclosures are focused on enhancing and/or modifying their bass performance. For years there was an "Iron Law" of loudspeaker acoustic design: "You can't have deep bass extension, good system sensitivity, and reasonable enclosure size all in one design". You had to pick any two at the expense of the third. Engineers have been slowly chipping away at that rule over the years and, although there's still truth to it, today you can find some reasonably sized speakers with good sensitivity

delivering deep, powerful bass. Sandy Gross has been designing passive radiator systems for over 40 years and the whole GoldenEar engineering team has spent over 25 years at the forefront of this charge, optimizing passive radiator enclosures and then pioneering active bass sections to achieve exceptional bass performance from relatively compact enclosures with good sensitivity and at reasonable cost.

What exactly is a Passive Radiator (PR)?



At their simplest it is a speaker driver without the motor structure (magnet, front and back plate and voice coil) mounted in a speaker enclosure along with one or more active drivers. The passive cone reacts to the pressure changes inside the otherwise sealed enclosure created by the active driver. As the active driver moves inward the passive radiator responds by moving outward and vice versa.

Passive radiators are a variation of ported (vented) speaker design. You know, speakers with a hole in the enclosure (and usually an attached tube inside the box) designed to enhance the system's deep bass performance and sensitivity. As implemented in GoldenEar speakers, the design is actually closer to the transmission line variation of a port-based design (which incorporate a long, tuned, complex internal passageway which both optimally loads the active driver, as well as is tuned to extend the response of the system below the free air resonance of the active drivers). Among the problems ported enclosures can exhibit are the following:

- There's total loss of control of the driver below the vent's tuning frequency which can lead to high distortion and possible driver damage.
- Midrange sounds can come through the vent, coloring the speaker's output.
- Vented enclosures typically don't sound as "tight" as some other enclosure types due to out of phase vent resonances which can interact with the drivers' output.
- Air moving in and out of the port can generate extraneous noises like "chuffing" sounds.

In many cases optimizing bass performance with a port in a reasonably sized enclosure requires an impractically sized port and/or tube so serious compromises must be employed, reducing the bass performance actually achieved. For example one highly regarded raw driver manufacturer recommending passive radiator enclosures explains that their dual 15" driver subwoofer would require a port 18-inches in diameter and 46 feet long!

The GoldenEar approach

Using advanced, sophisticated computer modeling has allowed GoldenEar's team to design passive radiator systems that deliver truly amazing and articulate deep bass without any of the problems typically associated with ported or poorly designed passive radiator enclosures. As described above, there are many variations of the implementation and tuning of passive radiator designs. In the case of GoldenEar loudspeakers, we design and tune the systems to approximate that of a properly designed transmission line. Here are some technical highlights of our designs:

Quadratic Planar Infrasonic Bass Radiators - Rather than simply use off the shelf motor-less passives or even motor free versions of our proprietary bass drivers, our engineering team developed unique high mass, high excursion radiators that tune our speakers to deliver exceptionally deep bass with good sensitivity in relatively small enclosures.

Multiple passive radiators - Used in many GoldenEar systems, they allow for even deeper bass tuning in slim design compact enclosures with lower distortion and tight, fast response.



The Triton 1 incorporates three active subwoofer drivers and four Planar Radiators.

The moving mass of a passive radiator in action can impact the stability of the speaker and can cause unwanted enclosure wall vibration - Many GoldenEar Quadratic Radiators are located on opposite sides of the enclosures. Their "equal but opposite" motion cancels enclosure instability and dramatically reduces the vibration that would normally be transmitted to the enclosure walls. The models with a single radiator are less prone to have these difficulties as they're either massive subwoofer enclosures with the radiators located on the bottom, or they're very stiff, compact enclosures that are relatively impervious to these forces, or they are in speaker models not designed for deep bass (like SuperSats and SuperCenters).

Woofers specifically designed to work with passive radiators - GoldenEar woofer / woofer-midrange drivers are not typical off the shelf sealed box or ported enclosure speakers. They've been designed from the outset and built specifically to optimize their performance in passive radiator enclosures. Powerful motor structures, stiff cones and long throw damped suspensions add up to dramatic bass with exceptionally low levels of distortion.

Passive radiators carefully located to reduce the possibility of midrange coloration - Locating the passives on the sides of the enclosures and not directly in-line with the active drivers eliminates the potential for midrange coloration "leaking" through the passive radiators. This is especially critical in smaller models where the midrange/woofer(s) is not in its own sealed sub-enclosure. Were the passive radiator to be located directly behind the driver, for example, there would be a much greater chance that unwanted sound would be "rebroadcast" into the room by the passive driver.

High mass passive diaphragms - Reduce distortion, "break up" potential, and tune the system for deeper bass response.

GoldenEar Quadratic Bass Radiators won't compress (reduce the dynamic range) the lowest frequencies - Ported designs will, but our designs won't until the PR's reach the extreme limit of their suspension travel. Therefore, we design our PR's to provide long excursion and to have a very low resonant frequency to help keep this effect below the lowest frequencies the system will reproduce.

As a general rule the larger the passive radiator the better - Still, we want reasonably sized enclosures. Our answer? Multiple smaller passive radiators. The result? Accurate, powerful, deep bass that belies the size of the enclosures.

So, bottom line (pun intended) what's the ultimate benefit of the advanced GoldenEar Planar Quadratic Bass Radiator designs? They are capable of generating prodigious amounts of deep articulate bass yet sound as tight and detailed as a well-designed sealed enclosure, with the high output capability and efficiency of a properly ported system. What's not to like?