BRYSTON

HT Series Loudspeakers | Technical Bulletin

## *Enclosure Resonances*

Beyond simply being an attractive place to put all of the driver elements in a loudspeaker, the enclosure needs to be rigid and have desirable resonant characteristics. The ideal loudspeaker cabinet would be perfectly inert, but this is impractical due to material, size, and expense limitations.

Therefore, we must carefully study the resonant behavior of cabinets so they do not disrupt the sound quality of the loudspeaker drivers.

*Why do resonances matter?*

Let's first understand that the drivers designed for Bryston Loudspeakers are developed over the course of years with the goal of exceptional performance with regards to clarity, dynamics, tonal neutrality, and spatial resolution. They are technically referred to as transducers and are so named for their ability to convert electrical energy from the amplifier (and in the case of the Model T passive and signature versions subdivided by the crossover) into analogous acoustical energy. That is, only the drivers should be contributing sound to the room, and no other part of the loudspeaker should participate in this process.

As a driver vibrates, it induces sympathetic vibrations into the enclosure. Every action has an equal an opposite reaction, remember? This energy is stored by the loudspeaker cabinet and re-radiated at a later time. Also, the loudspeaker cabinet has complex resonant characteristics. Some frequencies are more likely to excite the cabinet than others. At which frequencies the cabinet resonates is a function of the shape and strength of the cabinet. As the cabinet resonates, it also vibrates the air around it creating sound in the room. Note though that the sound the cabinet radiates into the room

is delayed in time and contains a substantially different tonal character than the drivers. Though the cabinet vibration comes after the driver vibration, the two are close enough in time to be misunderstood by our brain as being all part of the intial direct signal. Therefore, in a loudspeaker with a poorly constructed enclosure, we perceive the sum of the drivers and cabinet as being tonally inaccurate and spatially smeared, and ultimately, of poor sound quality.

Simply trying to make the cabinet more and more rigid does reduce the magnitude of some resonances, but also increases the frequency. Nearly everyone would agree that an audible resonance in the high frequency range is easily noticeable and very deleterious to the enjoyment of music.

*Mitigating cabinet resonances*

Eliminating cabinet resonances as a source of distortion is done by creative cabinet design and construction including clever bracing strategies. Note that the goal here cannot be to *simply eliminate all cabinet resonances*. This is simply impractical. A more thoughtful approach is to engineer the enclosure so that the resonant behavior is benign.

Bryston constructs all of our speakers using either one or two layers of 19mm thick MDF. Rear and side walls use a single layer, but the front baffle is double laminated to form a 38mm thick panel on which to mount the drivers. We choose to use thicker material on the front baffle because if this surface resonates strongly, it's more likely to be audible than the side or rear panels since those do not face the listening area directly.

For each model, we brace the cabinet in a manner which serves two goals. The first is that no two regions of the cabinet should reinforce the resonant behavior of the other. Second is that the resonaces that do inherently exist must be acoustically benign.

*Asymmetrical Bracing Strategy*

The interior of Bryston loudspeakers are strategically reinforced by a complex network of 19mm thick internal braces which span the width and height of the loudspeaker. Upon inspection, you'll notice that no two braces are spaced equal distant from another pair. By unique spacing of braces from each other, each section of the cabinet is prone to resonate in a different way than the next, so the resonances do not acoustically reinforce each other.

*Controlling resonance frequencies*

For those resonaces that are left over, we need to be certain they are not easily detectible. Using just the right wall thickness and bracing location, we can ensure that the resonances that are left are of sufficiently small magnitude and acoustically benign. Sometimes this means choosing a resonant frequency for a specific area of the cabinet that is lower in frequency and Q than would conventionally be desired. For instance, humans perceive an excess of energy between approximately 3-6kHz as being harsh and edgy. Therefore, it would be entirely unwise for a loudspeaker engineer to develop a cabinet that is prone to excitation in this region.

Bryston views the engineering and construction of our loudspeaker cabinets as being equally vital to superior sound reproduction as driver and crossover elements. Therefore, extreme research and development is undertaken to ensure excellence in this regard.