NEW E-Trap(tm)

The E-trap(tm) is a tunable electronic bass trap. It offers a new way to think about low frequency room acoustics and provides a precise tool for acoustical design.

What is a bass trap?

A bass trap is a device that absorbs low frequency sound. The bass trap converts sound energy into another form of energy, typically a negligible amount of heat, in order to improve the uniformity of the acoustical characteristics in a room. Bass traps of various types have been in existence for decades and employed in many critical listening and recording rooms. To better understand the bass trap it may be useful to review the basic problem and the solution the bass trap provides.

When sound is produced inside an enclosed space, like a room, the acoustical properties of the room are dominant in the distribution and characteristics of sound within. Sound waves reflect off room boundaries and interact with their own various reflections. The interactions cause higher or lower intensity of sound that vary depending upon the location and frequency. Typically the goal of a listening or recording room is to minimize the magnitude of these variations so that the effect upon the sound is minimal. Typical approaches to achieve this are to absorb and/or to diffuse the sound waves.

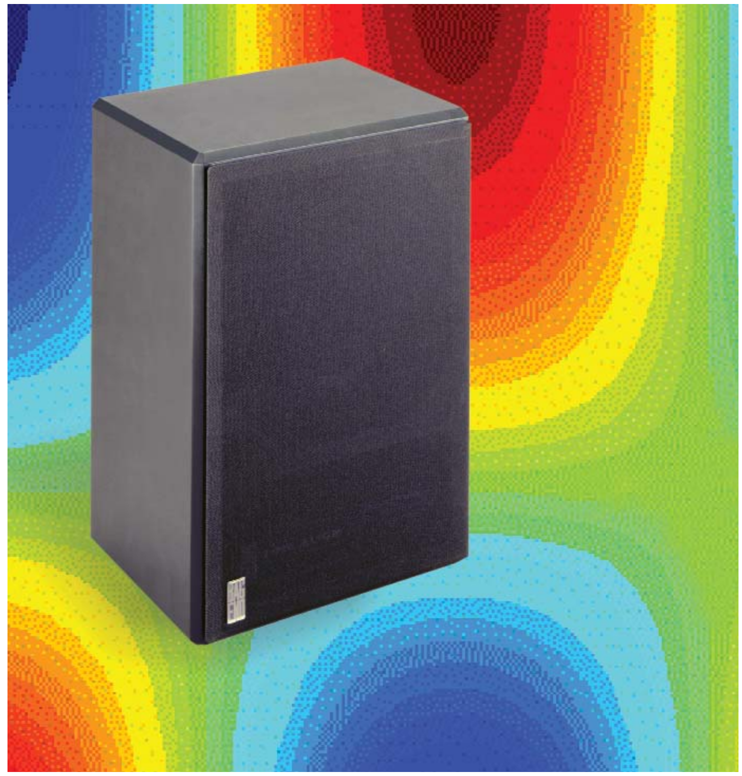
The effectiveness of a passive acoustical absorption material is directly related to its physical size and placement. In general the thickness of the absorption material and its position in the room determines the amount of absorption available at a particular frequency. This is directly related to the wavelength of the frequency. High absorption is achieved by an acoustical panel whose thickness is 1/4 of the wavelength. A quick review of wavelength vs frequency will show that a 1 Hertz wavelength is 1130 feet long, 1130 is also the typical speed of sound in ft./sec. 10 Hertz wavelength is 113', 100 hertz is 11.3', 1000 Hertz is 1.13'. The relationship here becomes clear and it can be seen that lower frequencies have physically longer wavelengths and therefore require physically larger passive absorbers.

Practically speaking, the midrange and upper frequencies can be effectively absorbed using fiberglass wall panels and other room treatments. Lower frequencies require larger absorbing treatments. Professional studios and control rooms may employ 5 and 10 foot chambers with absorbing material to absorb low frequencies. Other techniques employ mechanically resonant membrane absorbers or acoustically resonant Helmholtz absorbers.

Previously we mentioned that the goal of the room designer is to minimize the magnitude of the acoustical variations within the room. The design of a good sounding room is a combination of art and science, where the room dimensions, construction and the implementation of absorption and diffusion will vary with the designers preferences.

It is uniformly agreed however that a dominant reflection that causes the room to ring or have a large increase in magnitude at a single frequency is detrimental to the sound. The prominent presence of a reflection in the bass range is due to one of the low-frequency standing waves of the room and causes the room to sound boomy.

What is actually happening is a single frequency is reflecting back and forth between two walls causing both an increase in magnitude



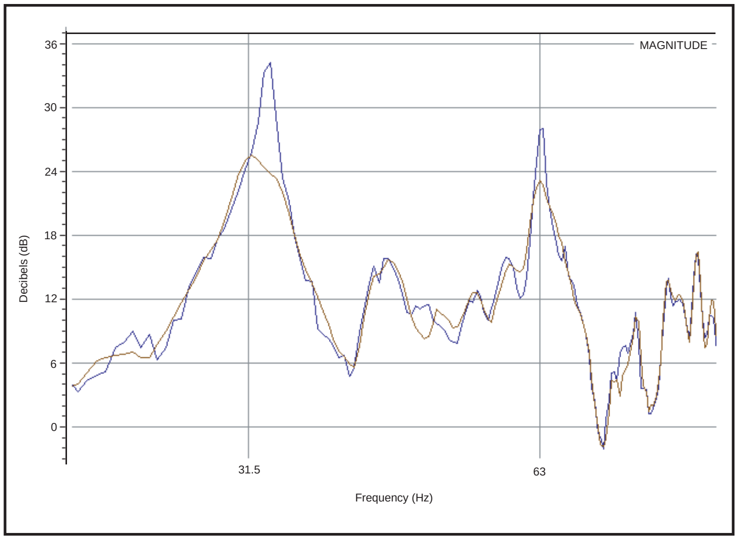
and a ringing, or persistence in time, even after the original sound is no longer present. It is this increase in magnitude and ringing in time that causes the blurring and loss of definition to the sound.

What a bass trap does is actually dampen the ringing. To better understand this, think of a tuning fork that once excited by an impact, will ring for a long time at a single frequency. In the case of a room resonance the excitement comes from the sound source such as a sound system or acoustically generated by a piano, drum or other instrument.

Just as a tuning fork ringing along with a music passage would be distracting, the room resonance in much the same way is booming along with the bass, masking and blurring the low frequency sounds. Bass traps add damping, much like putting your finger on the tuning fork. This reduces the ringing and allows all the sound to be heard more clearly.

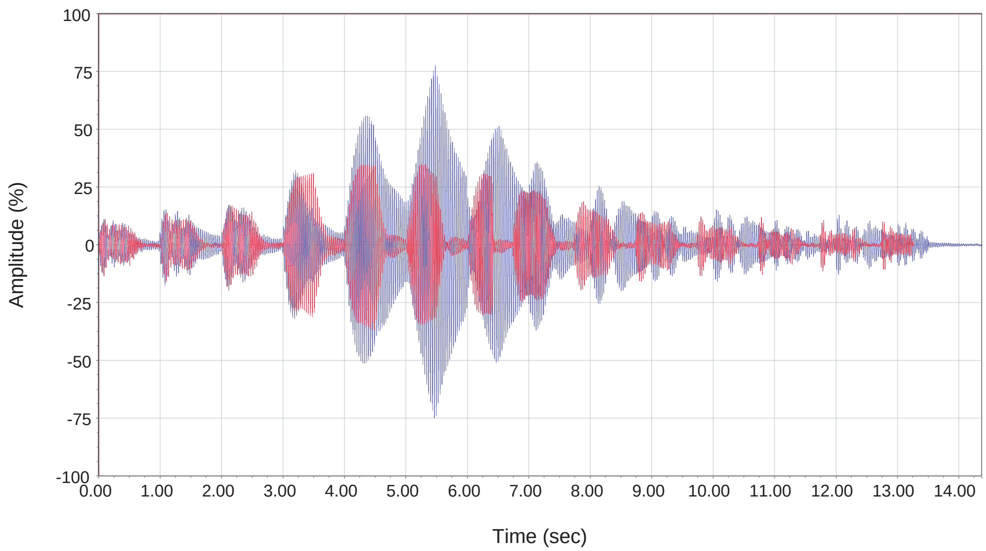
This problem has been well known by designers for decades and is well controlled in the best room designs. These designs require extensive engineering and detailed construction. Passive bass traps are routinely employed to dampen resonance modes. Typically passive bass traps, since they are large, can also affect the midrange and upper frequencies and require careful integration into a room. Reactive absorbers such as Helmholtz resonators (HR) or quarter wave tubes are commonly used as the most effective solution for treating the low frequency standing waves. The problem with these low frequency absorbers is their large size. Moreover, they normally split the mode targeted for treatment into two adjacent modes. In addition, reactive absorbers including HR can only be tuned to a single frequency. When absorption at multiple frequencies is required a number of these absorbers tuned to different frequencies should be used. In practical applications, where space and cost are considerations, passive absorbers have limitations. And unfortunately the re-tuning of a passive bass absorber, once deployed, is impractical.

Equalizing the bass portion of the sound system is sometimes suggested as a method of reducing the energy at the resonance peaks, thereby improving the flatness of the room response. Even those promoting this solution would agree that it would be far preferable to design the room so that it has little or no resonance modes and requires little or no equalization. It is far better to fix the



A concrete room known as the boathouse was chosen as a test location because of the extreme intensity of its low frequency standing waves. The construction is solid concrete on 5 sides. Figures 1 and 2 show two different measurements within the boathouse.

Figure 1: The magnitude vs frequency in the boathouse shows very strong resonant peaks. The red trace is with a single E-trap(tm) tuned to two frequencies and turned on.



TIME DISPLAY

Figure 2: A test signal consisting of sine wave tones, on for 1/2 second, then off for 1/2 second, starting at 27 Hertz, and raising 1 Hertz each time it turns up to 40 Hertz, was played in the room using a flat response Infrasub loudspeaker. The blue trace is the undamped response within the room. The red trace is the well damped response with the E-Trap on.

room acoustically by adding damping than to equalize the signal. Equalizing the sound affects the quality of the original sound and is not effective in reducing the ringing in the time domain when compared to adding acoustical damping to the room mode. And, obviously it is impossible to "equalize" a room where there is no sound system present, such as a recording studio where acoustic instruments such as drums or piano are being recorded.

The E-Trap(tm) Solution

The electronic bass trap, while not likely to replace all passive bass trap implementations, offers a precise tool to attack the very worst problems with a high degree of effectiveness in a fraction of the space. It also offers a practical low cost solution to existing rooms where problems are present and room re-design or large passive absorbers are not an option.

The E-trap(tm) can be viewed as an electronic acoustic absorber. It incorporates a feedback control scheme into a loudspeaker making the speaker exhibit the same dynamics as that of a reactive absorber. Because it is active it is capable of adding considerable damping to a room and still be very small in size (18" x 13" x 10"). The small size allows the designer to place it in acoustically strategic locations without effecting the rooms upper frequency characteristics and with minimal impact to floor space and cosmetics.

The E-trap(tm) offers precise tunability of two well seperated target frequencies simultaneously. The frequency and amount of damping is adjustable via controls. PC measurement software (for Windows(r)) is included with the E-Trap(tm) to allow the user to pinpoint the frequency that requires damping. Once the E-trap(tm) is placed and tuned, it requires no additional attention.

The precision, ease of tuning and small size offered by the E-trap(tm) provide an additional tool to absorb low frequencies and can provide a dramatic improvement in the sound of the room.

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