**Active Feedback-Controlled Acoustic Damping/Absorption**

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, to 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.

An alternative to the use of low-frequency absorbers is incorporating a feedback control scheme into a loudspeaker making the speaker to exhibit the same dynamics as that of a reactive absorber, especially a HR. This feedback control solution which can be viewed as a low-frequency ***'electronic acoustic absorber'*** will add damping to the low-frequency modes. In terms of required hardware, in addition to a speaker, the electronic acoustic absorber needs only a microphone, and a low-cost op-amp circuit or a digital signal processor (to house the control algorithm).

DEICON's patent pending, feedback-controlled, electronic acoustic absorber is highly effective in reducing the boominess of sound at frequencies corresponding to offending (coloring) standing waves of an enclosed space. The controller which is realized by a *low-cost, adaptable, op-amp circuit can be tuned to a single or multiple, low-frequency resonant modes*, add damping to that (those) modes and thus abate the boominess of sound at that (those) resonant frequencies. The actuation is provided by a speaker capable of generating low frequency sound. A microphone, nearly collocated with the actuator, is used for sensing. Due to the absence of the neck and cavity, the size of the feedback control system is smaller than traditional low-frequency silencers. Practically, it has the same size as that of the actuator (speaker). Figures 1-a and 1-b shows the device installed on an enclosure.

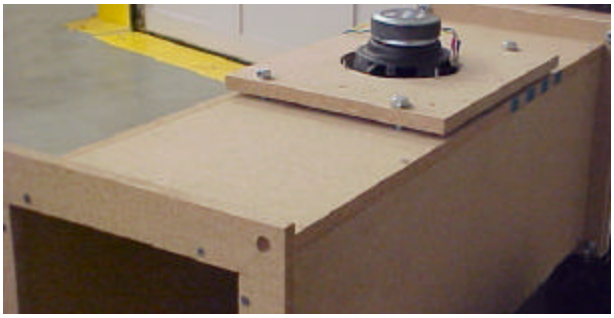

Figure 1-a Electronic acoustic absorber installed on a duct

Figure 1-b Electronic acoustic absorber installed on an enclosure

Figure 2 shows the frequency response functions of the enclosure of Figure 2-b, measured at two different locations, with and without the low-frequency electronic acoustic absorber. The active control system, which is tuned to add damping to the first acoustic mode of the enclosure, is performing effectively. Clear from Figure 2, a considerable amount of damping is added to that mode.

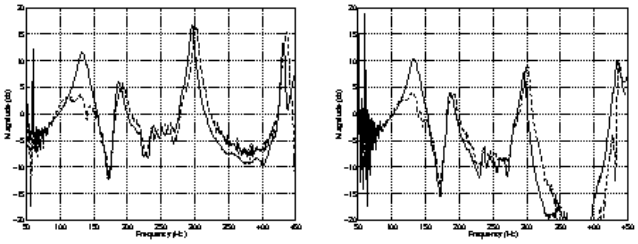

Figure 2 Frequency response functions of an enclosure, with and without the electronic acoustic absorber

The electronic acoustic absorber can be used in other acoustic applications that passive tuned absorber such as HRs and quarter-wave tubes are used. They include, but are not limited to, tuning of acoustic systems such as engine intake and exhaust, mufflers/silencers in ducts (air conditioning ducts and industrial exhaust stacks), pulsation abatement in liquid-carrying lines, recording rooms and other enclosed spaces and more.