Active, Tuned Acoustic Damper/ Absorber

DEICON's patented, 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 can be realized by a *tunable, analog circui*t or a high-speed micro-controller *can be tuned to one or multiple low frequencies either to dampen the resonant mode(s)/standing waves or* absorb a persistent tonal noise created by a noise source, e.g. an axial fan. The actuation is provided by a loudspeaker. A microphone built into the speaker is used for feedback control. The size of the active tuned acoustic damper is the size of a small subwoofer.

The application of this technology, as an electronic tunable bass trap, to recording studios, listening rooms, and home theaters is licensed to Modular Sound (the reputable manufacturer of Bag End professional grade loudspeakers) and is marketed under the trade name E-trap.

Figure 1 E-trap©

In addition to being used as an electronic bass trap for rooms and recording studios, DEICON's active tuned acoustic absorber has many other applications including vehicular, marine, industrial, etc.

Large vehicles, such as SUVs (Sport Utility Vehicles) and minivans are the size of a small room and thus exhibit bass acoustic coloration, known as *body boom,* the way a small room does [5]. A modified version of the active feedback controlled acoustic damping technology is used to address the boom noise problem in large vehicles. A large sport utility vehicle was used to demonstrate the effectiveness of the active, tuned sound absorption system.

The large vehicle was driven over different road surfaces and with different speeds. The road excitation into the cabin vibro-acoustic system resulted in impact boom noise which was damped/ absorbed using the active system.

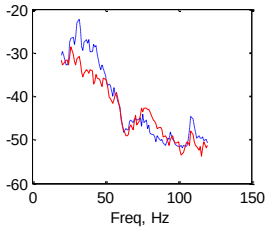
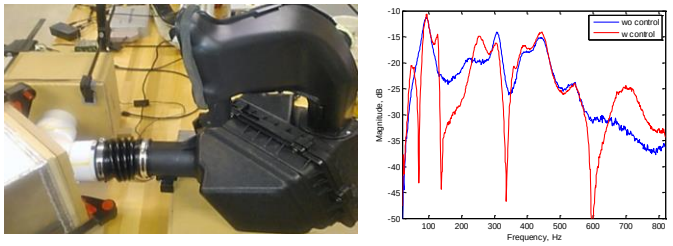


Figure 2 Scaled magnitude of the pressure power spectra without (blue) and with (red) control

Considering the ineffectiveness of sound absorbing material at low frequencies, standing wave (coloration) problem has traditionally been addressed using large reactive damping/absorption devices such as Helmholtz resonators (HR) or quarter-wave tubes. The problem with these low-frequency absorbers are a) their large size, b) once tuned they can not be retuned, and c) 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 reactive dampers/absorbers is active tuned damping/absorption. This active controlled solution which can be viewed as a low-frequency ***'active tuned acoustic damper'*** *or* ***'active tuned acoustic absorber'*** adds damping to low-frequency standing waves and/or absorbs tonal persistent noise.

Figure 2 shows the scaled power spectra of sound pressure measured at the driver's ear location, with and without the active acoustic absorber. The active, tuned acoustic damping system added a substantial low-frequency acoustic absorption to the cabin mitigating the impact boom noise, effectively.

In another vehicular application the effectiveness of DEICON's active tuned acoustic absorber was evaluated on a car engine air induction system in a laboratory environment. Figure 3 shows the frequency response functions mapping the voltage driving the noise source to the pressure measured at the inlet to the induction system, with (red) and without (blue) control. The active control system, which was tuned to absorb tones at 100, 150, and 200 Hz performed effectively. Clear from Figure 3, the radiation of these tones to the surrounding through the air induction system inlet were abated.



(a) (b)

Figure 3 Laboratory set-up (a) and frequency response functions mapping voltage driving the noise speaker to the pressure at the air induction system inlet (b)

The active tuned absorber has also been implemented in industrial applications, absorbing tonal noise in air/gas carrying ducts.