

Active Feedback-Controlled Boom Noise Damping/Absorption in a Large SUV

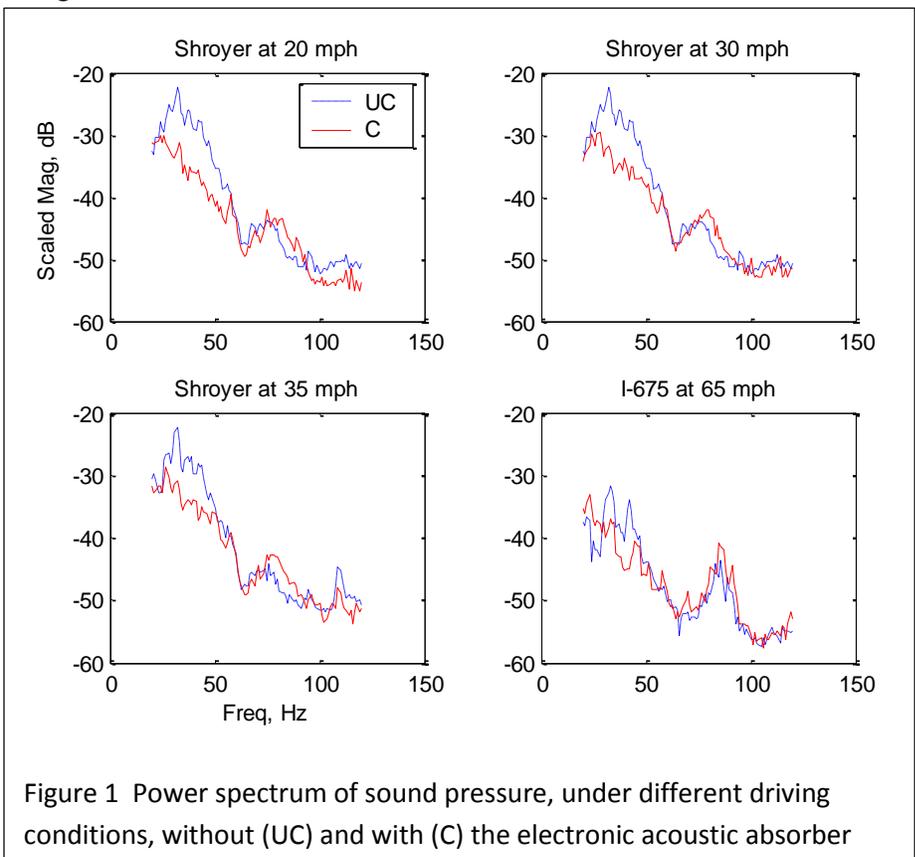
Large vehicles, such as SUVs (Sport Utility Vehicle) and minivans, exhibit body boom phenomena during multiple source excitation events including rough road/impact and powertrain induced events. The main cause of the boom is the low-frequency acoustic/vibro-acoustic modes of the cavity being excited via the high acoustic transfer functions at multiple paths, due to an inherently weak body structure and/or existence of popular features such as tailgates with their corresponding dynamics. Abating the boom noise by modifying the response is the more viable and less costly option than body changes.

DEICON's active acoustic damping/absorption system does such modification, cost-effectively. The scheme that rely on a speaker, a low-cost microphone and/or an accelerometer, and an electronic circuit (or a micro-controller) add a substantial amount of damping to the first (or first few) vibro-acoustic modes of an enclosure such as the cabin of a vehicle. It should be noted that measurement quality accelerometers are not necessary in this application. The low-cost, MEMS accelerometers such as the ones used in air-bag systems does perform satisfactorily. The simplicity of the active boom noise damping system lends itself to be incorporated into a vehicle's sound system.

A large SUV is used to demonstrate the effectiveness of the active feedback-controlled sound absorption system. The vehicle exhibits a 30, 40, and 45 Hz vibro-acoustic modes due to tailgate, roof, and cavity first structural and acoustic modes, respectively. Under most driving conditions, these 3 resonances appear as one mode with the magnitude peak spread over the 20-45 Hz range (similar to a bandpass filter).

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

Figure 1 shows the power spectrum of sound pressure measured at the driver's ear location, under different driving conditions, with and without the feedback controlled acoustic absorber. The active control system, which is designed to add low-frequency absorption to the cabin and hence lower the boominess of sound, is performing extremely effectively.



The alternative passive tuned solutions would be objectionably large in size and weight. Besides, the passive devices are single frequency (narrow band) treatments; when multiple frequencies need to be treated, a number of such passive tuned absorbers/dampers should be used. This would exacerbate the size and weight issue, even further.