Active Acoustic Attenuation for Launch Vehicles

Kevin Farinholt **Donald J. Leo**

CIMSS – Mechanical Engineering Department
Virginia Tech
Blacksburg, VA 24061-0261

An experimental testbed was developed for studying active acoustic control of launch vehicle payload fairings. The testbed consisted of a Lexan enclosure whose geometry was ½ of a medium-sized payload fairing. The enclosure included an electromagnetic speaker at the apex of the fairing and a collocated microphone. Feedback control is implemented with the collocated speaker-microphone. The microphone signal is processed with a digital signal processing system. The DSP output is amplified and then returned to the speaker.

The control system is designed using positive position feedback techniques. Positive position feedback is a control system based on the design of second-order filters. Each filter targets one resonant mode in the system. The advantages of this design technique are that only the resonant frequencies and the low-frequency gain of the system are required to design the compensator.

The natural frequencies were determined using a frequency analysis of the enclosure. Results illustrated that the first three resonant modes were at approximately 90, 140, and 200 Hz. These modes were targeted for feedback control. The control system was designed using these values for the resonant frequencies. Figure 1 is a plot of the open- and closed-loop frequency responses between a disturbance source (external to the enclosure) and a microphone on the interior of the enclosure. The damping introduced using feedback is exhibited by the rounding of the resonant peaks.

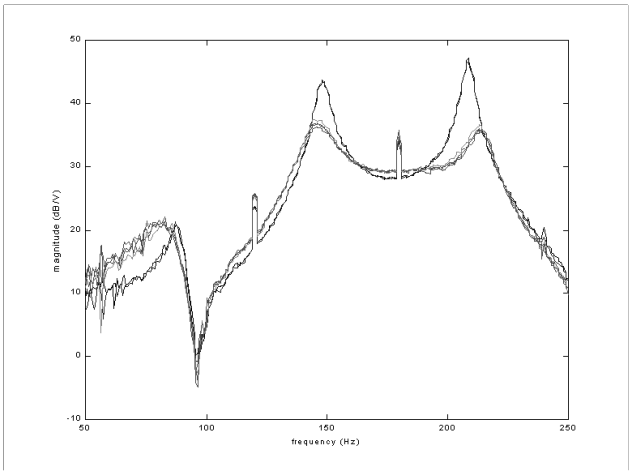

Figure 1: Open- and closed-loop frequency response of the fairing.

Analysis of six locations inside the fairing demonstrate that sound pressure level reductions of between 30 and 40% are achieved throughout the fairing. The power is estimated to be only 1.5 mW for an average interior sound pressure level of 100 dB (C-weighted). This scales to 15 W of power at 140 dB. Scaling the result to the actual geometry of the fairing, we estimate the power requirements are between 50 and 100 W electrical.

Farinholt, K.M.*, Leo, D.J., 2001, "Acoustic control modeling of conical bores with actuating boundary conditions," *Proceedings of the ASME Design Engineering Technical Conference*, Paper Number VIB-21480.