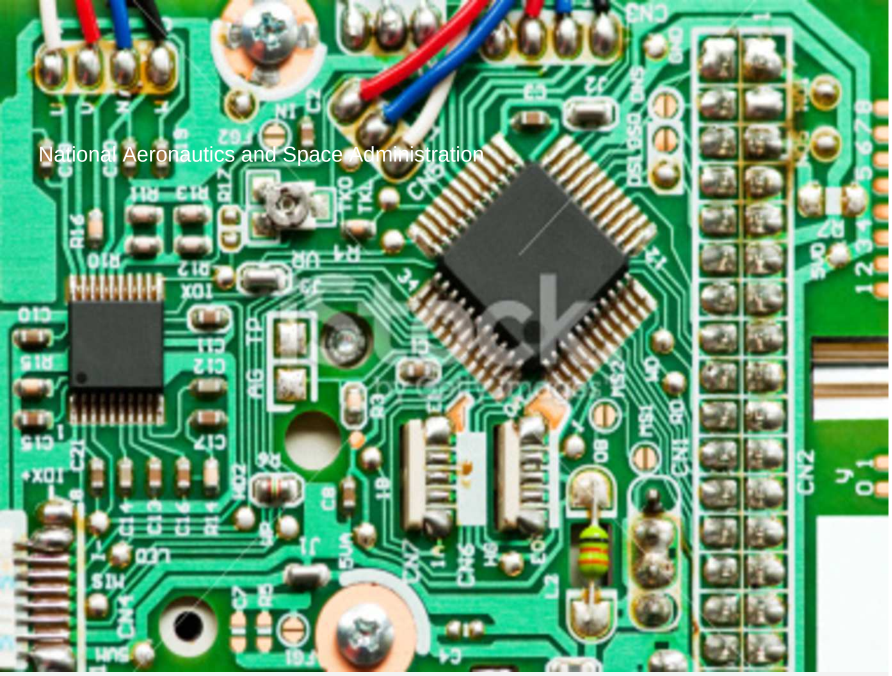
National Aeronautics and Space Administration



Electrical and Electronics

Particle Impact Damper for Circuit Cards

Passive device to ruggedize circuit cards in harsh environments

NASAs Marshall Space Flight Center has developed a particle impact damper (NASA damper) that can be used in circuit card assemblies to reduce vibrations encountered during space vehicle launch. The damper, filled with high-density metallic beads, is attached to printed circuit boards (PCBs) and printed wiring assemblies (PWAs) to dissipate vibrations and improve component reliability and robustness. Testing has demonstrated an order of magnitude reduction in observed peak vibration response and dramatic improvement in circuit component life span. The NASA technology provides simple and inexpensive vibration reduction for sensitive heritage or commercial-off-the-shelf (COTS) electronics in applications where the vibration environment is either severe or exceeding its original design envelope. The technology can benefit heritage hardware in a wide range of applications as a retrofitted upgrade, or can be incorporated into the design of new circuit cards.

BENEFITS

- Superior damping: PCBs fundamental mode reduced by order of magnitude
- Easily retrofittable: enables qualification of less expensive COTS equipment
- Low mass: alternative to massive avionics or shelf-level damping technologies
- Temperature independent: can be used in extremely cold/hot environments

APPLICATIONS

- Aerospace: launch systems, and rotary and fixed-wing aircraft
- Industrial: heavy factory equipment and construction machinery
- Marine: barges, merchant marine vessels, and cruise ships
- Transportation: railroad, trucking, and farm equipment

THE TECHNOLOGY

The NASA damper comprises a sealed cylindrical housing filled with high-density metallic beads. While attached to a circuit card, the damper dissipates vibrations as particles collide. The inventors of this technology conducted random vibration testing and finite element analysis to demonstrate the dampers effect on the vibration response and fatigue life of circuit componentry. In one case, bending mode attenuation proved critical to significantly extending the fatigue life of circuit card components. In undamped assemblies, 19 of 100 channels failed within 12 minutes, as opposed to 306 minutes for damped assemblies (see Figure 1). In another experiment, the damper attenuated the vibration response of a 165 Hz bending mode by more than 10 dB with no detrimental frequency shift observed (see Figure 2).

Additional data collected during testing also shows that the NASA damper became more effective as the number of particles increased. Results confirm that the damping effect is not localized or due to the simple addition of mass, and is more effective than varying board thickness to control vibration. High-speed video, accelerometer, and strain measurements have been collected to correlate with analytical results.

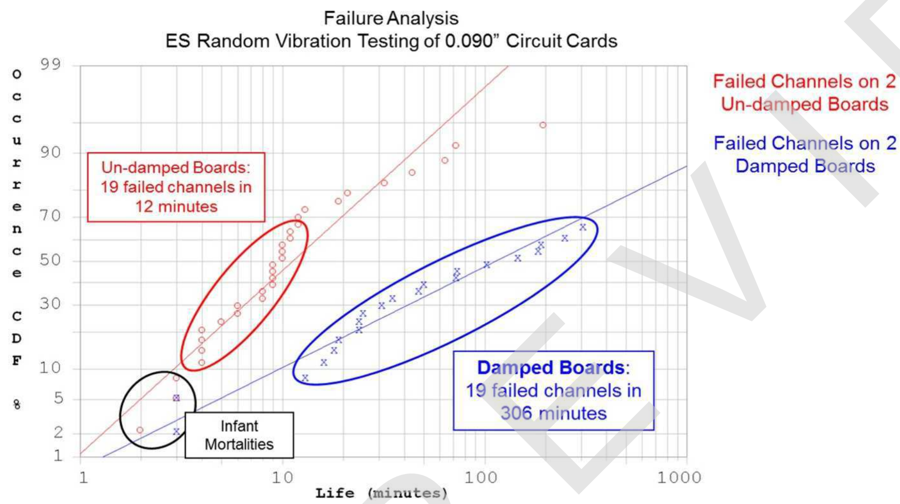


Figure 1. Weibull life analysis for column grid arrays shows improvement in fatigue life for damped vs undamped boards. Channels failed as circuit leads were broken during random vibration.

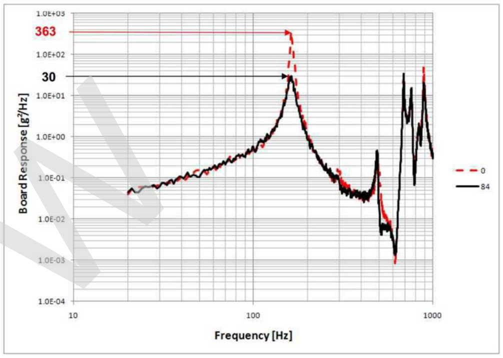


Figure 2. Damping reduced the bending vibration mode response at ~165 Hz by an order of magnitude during random vibration. Damped and undamped shown by black and red line, respectively.

PUBLICATIONS

Patent Pending

More Information

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