Internally Isolated 12U Rail CubeSat Dispenser with Analyzable Boundary Conditions

SSC18-IX-06

Aug 2018
Small Satellite Conference
Logan, Utah
Aggregated Tyvak Launch Systems

- Tyvak ESPA Mount
- Small Launcher Payload Stack (INCA)
- Tyvak Avionics/Sequence
- Tyvak 6U
- Tyvak 3U
- Tyvak 12U
- Moog ESPA Grande Accommodations
- Moog SL-OMV
Tyvak 12U Dispenser - Overview

- The Tyvak 12U Dispenser was developed for highly sensitive spacecraft and builds on customer feedback combined with Tyvak flight heritage.

- The Dispenser is designed with a 3-axis isolation system built directly into the dispenser chassis – eliminating the need for expensive, volume-consuming external isolation system.
  - Uses elastomeric isolators, low outgassing aerospace-qualified silicone.

- The dispenser employs 4-corner pivoting smooth and continuous rails which move in to cradle the spacecraft during launch and retract to release and deploy.
  - Creates an analyzable boundary condition between payload and dispenser.

- An optional door allows for expansion into previously unusable volume. The satellite is supported by the four rails in all axis, and the door is not load bearing.

- Single hold down and release mechanism to actuate deployment.
  - Payload is spring ejected upon deployment.
  - Tunable with low tip-off rates.

- Completed performance characterization and flight certification.

- Launch of the 12U Dispenser is set for this year.
Tyvak 12U Dispenser - Internal Payload Isolation - Approach

- **Outer Structure**
  - Interfaces with LV

- **Isolators**
  - Interface between Outer Structure and Inner Structure
  - Provide complete 3-axis isolation

- **Inner Structure**
  - Interfaces with Payload
    - Rails
    - Pusher Plate
    - Payload supports

- **Payload**
  - Complete isolation from LV environments
  - Analyzable boundary conditions
Tyvak 12U Dispenser Isolation: Test Results

- Significant attenuation achieved
  - Overall gRMS response levels reduced by 70%-90%
  - Attenuation begins at ~40Hz and reduces vibe inputs by a factor of 10-100x starting at 100Hz.
    - Low frequency amplification results from the isolators
    - Typical for payloads to have fundamental modes >100Hz

Sample Data: X/Y Axes, GEVS, 25kg

Sample Data: Z Axis, GEVS, 25kg

Tested using two mass models: 20 and 25kg
Tested to GEVS and ABC MPE+3dB
12U Internally Isolated Dispenser: Transfer Function

- Transfer function developed to estimate payload environments for a variety of launch vehicle inputs
  - Resulting from detailed analysis of testing data
- Significant benefit to the payload developer
  - Can design and test to realistic environments
- To estimate payload environment, simply multiply launch vehicle input by the transfer function
  - Transfer function derived using worst-case data encompassing multiple test configurations, so predicted levels are conservative

**Input:** 10.78 Grms (ABC MPE+3dB)
**Output:** 3.5 Grms
**Measures:** 2.3 Grms
Dispenser Summary

• Tyvak Internally Isolated Dispensers provide reduced satellite response
  – NLAS MkII (1U-6U) typically ~ 20-90%. Attenuation starts around 70Hz. Some amplification at low freq
  – 12U Dispenser: ~70-90%. Attenuation starts around 40Hz. Some amplification at low freq
  – Also eliminates the need for customized, expensive, volume-consuming external isolation system
• Tyvak 12U solves the problem of “floating” rail CubeSat with nonlinear response
  – Cradling rails create an analyzable boundary condition
• Significant for developer
  • Can focus on the space mission rather than surviving launch
  • Reduce satellite structural mass: accommodate more payload
  • Higher probability of surviving test regiment and launch