Implementation of Advanced Capabilities to the P-POD

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14th Annual CubeSat Developers Workshop
April 27th, 2017
P-POD Mk. IV Design Motivation

• As CubeSat payloads become more sophisticated, basic dispenser function does not fully support some mission requirements
• High power transmitters or missions that require a power-on state during flight must be shielded to not disrupt any other LV functions
• Sensitive instruments require can require an inert gas purge (such as GN2) in order to survive the ground phase
• In some cases, the ability to receive power, telemetry, and command from the launch vehicle could make new missions possible
  ☝️ Referred to as “Power-On” system
Overall P-POD Design Updates

- EMI Shielding Incorporation
  - Gasketed door-collar interface
  - Gasketed access ports
- Purge/Power-On accommodation incorporated to the back plate
- Door design modification to provide a stiffer load path and reduced stress concentration

Weight Reduction: Material has been removed in areas that already exhibited higher margins

Door has been modified to provide a stiffer load path with less stress concentration.

EMI: Access Ports have been modified to use conductive gaskets to ensure EMI shielding at interface. Door-Collar interface has been modified to accept a gasket that will provide EMI shielding, even under deflection.
EMI Shielding Design

• Sources of RF leakage -> large fastener spacing
  - Access Port Gaps and Door interface
• Gaskets installed at appropriate interfaces
  - Collar/Door gasket held in place with conductive epoxy
• Sealing the gaps creates a need for ventable area
  - Vent hole array designed based on an analytical model and added to the +Y Top Panel
  - Meets launch vehicle ascent venting requirements
EMI Testing

• Initial testing utilized an antenna connected to a coaxial cable
  Cable was not shielded enough to accurately measure shielding effectiveness

• Test setup changed to eliminate the coaxial cable to the inside of the P-POD

• Utilize a self-sustained transmitter inside of the P-POD and a receiving antenna 1-2 m away on the outside
  Eliminates cable coupling concerns as there is no cabling on the receive end outside of the P-POD
EMI Testing Results

- Shielding ranged from 30 to 74 dB from 437 MHz to 10 GHz

<table>
<thead>
<tr>
<th>Frequency</th>
<th>P-POD +Y Attenuation (dB)</th>
<th>P-POD +X Attenuation (dB)</th>
<th>P-POD -Y Attenuation (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>437 MHz</td>
<td>64.6</td>
<td>73.8</td>
<td>66.1</td>
</tr>
<tr>
<td>4.3 GHz</td>
<td>40.5</td>
<td>36.3</td>
<td>43.3</td>
</tr>
<tr>
<td>5.2 GHz</td>
<td>39.9</td>
<td>36.9</td>
<td>42.9</td>
</tr>
<tr>
<td>8.6 GHz</td>
<td>40.8</td>
<td>35.7</td>
<td>35.1</td>
</tr>
<tr>
<td>10 GHz</td>
<td>30</td>
<td>38.6</td>
<td>31.8</td>
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</table>
CubeSat Mission Requiring EMI Shielding

- Cal Poly’s “LEO” spacecraft is designed to measure the launch environment and transmit data to another CubeSat over Wi-Fi during launch.
- The LV required that the CubeSat carrier be shielded in order for the mission to fly.
  - Decision was to fly a P-POD Mk. IV to make the mission possible!
- P-POD Mk. IV first manifest
P-POD Mk. IV Back Plate Options

• Mk. IV back plate designed to easily add any optional capability on to the back plate of the P-POD
• Options include inert gas purge and “Power-On” Electrical Interface
• Nitrogen purge system flown successfully on ORS-3 on a Mk. III Rev. E P-POD
  ➤ Design compatible with the P-POD Mk. IV
CubeSat Electrical Interface

- Electrical system to facilitate power-on signal, data, and battery charging
- Zero-force connector to facilitate a resistance-free disengagement
- Up to 15 pins or more

Photo credit: Glenair
Summary

- P-POD Mk. IV with EMI improvements successfully implemented, qualified for flight, and manifested

- EMI Shielding efforts successful
  - At least 30 dB attenuation across all frequencies (Over 60 dB at 437 MHz)

- Designed back plate to be adaptable to optional capabilities such as Nitrogen Purge and Power-On packages

- Increased door stiffness and minor reduction in overall P-POD mass