A Step-Change in CubeSat Architecture: Moving from Stacked to Slotted Design

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Introduction

Current CubeSat Design State
- Inflexible architecture of current CubeSats necessitates custom builds for 1-off solutions
- Average timeline for CubeSats takes more than 12 months from conception to final product
- Feedback from university engineering programs echoed the idea that there is a need for faster testing methods and more ergonomic designs in the lab

Slotted CubeSat Design
- Individual electronic boards can be inserted and removed independently of each other by sliding them along rails
- Eliminates the need for PC-104 headers and standoffs between boards
- Compared to a standard CubeSat, the usable surface area on an electronic board increased by 10% with the Slotted CubeSat
- 1U CubeSat can be assembled in 15 minutes rather than ~3+ hours

Structural Design

● Slotted Chassis comprises six panels: a front panel, bottom panel, top panel, back panel and two side panels
● Modular chassis allows access to electronic boards without complete disassembly as the front, top, or bottom panels can be removed without compromising the structure
● The chassis can accommodate six boards with 12.4 mm spacing between them
● Each side panel has six protruding rails along its horizontal axes. The rails help guide the electronic boards into the structure and secure them in place

Slotted Chassis

Simulation and Analysis

Thermal Analysis Results

<table>
<thead>
<tr>
<th>Component</th>
<th>Max Temp [°C]</th>
<th>Min Temp [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slotted Chassis</td>
<td>15.4</td>
<td>-54.5</td>
</tr>
<tr>
<td>Bus Connector Card</td>
<td>8.5</td>
<td>-65.9</td>
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</tbody>
</table>

Thermal Simulation

Vibration Analysis Results with GEVS Levels

<table>
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<tr>
<th>Material</th>
<th>Max Stress Value [MPa]</th>
<th>Material Yield Strength [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al 6061-T6</td>
<td>22.5</td>
<td>237</td>
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<tr>
<td>FR4</td>
<td>0.61</td>
<td>70</td>
</tr>
</tbody>
</table>

Vibration Simulation

Electronics Design

Bus Connector Card (BCC)

● BCC is the CubeSats common electrical backplane
● 120 pin High Speed Edge Card (HSEC) connectors on the BCC are used for power and data transfer between all boards of the CubeSat
● HSEC connectors are rated for up to 240 V and 2.8A current, and speeds of up to 34 Gbps
● Boards connect to BCC through gold fingers on PCB
● The BCC also contains top and bottom solar panel connectors and a separation switch

BCC Overall Schematic

Integration and Testing

Prototype CubeSat

LED Testing

● Made from 3D printed material
● Integrated with two demo boards
● Power routed from external supply to LED’s using the BCC

References