space structures laboratory

AAReST Electronics Boards

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Overview

- Mirror Electronics
  - Multiplexer board
  - HV board
  - Microcontroller board

- Camera Electronics
  - Motherboard
  - Shack Hartmann board
## Current Status

<table>
<thead>
<tr>
<th>Board</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mirror Electronics</strong></td>
<td></td>
</tr>
<tr>
<td>Multiplexer board</td>
<td>Flight version being sent out for assembly</td>
</tr>
<tr>
<td>HV board</td>
<td>Tested V1.0, incorporating minor changes for flight version</td>
</tr>
<tr>
<td>Microcontroller board</td>
<td>Tested V1.0, incorporating minor changes for flight version</td>
</tr>
<tr>
<td><strong>Camera Electronics</strong></td>
<td></td>
</tr>
<tr>
<td>Motherboard</td>
<td>Debugging issues in V1.0</td>
</tr>
<tr>
<td>Shack-Hartmann board</td>
<td>Yet to be fabricated</td>
</tr>
</tbody>
</table>

*Caltech*
Multiplexer Board

- Distributes HV to mirror electrodes through 41 optoisolator switches

[Images of the multiplexer board with labeled parts: Optoisolator switch, FFC connector for electrode routing layer on the mirror, Multiplexer]
HV Board

• Modules to produce
  • 150 V for picomotor supply
  • Fixed mirror bias supply (variable in the future) ~ 175 V
  • Variable electrode HV supply (0 – 350 V)

• I/O expander to switch from one picomotor to another

• Picomotor drivers x3

• Temperature sensor
HV Board

I/O Expander

Picomotor driver x3

Picomotor connector

Picomotor driver x3

Variable electrode HV supply

Picomotor power

Fixed mirror bias supply (variable in next version)

Picomotor power

Fixed mirror bias supply (variable in next version)

Variable electrode HV supply
Microcontroller Board

• DC-DC converters to produce regulated
  • 12 V for HV electronics
  • 5 V for DAC for HV electronics
  • 3.3 V for microcontroller and all digital electronics
  • 2.8 V for encoder sensors
• Atmega 1284P microcontroller
• External EEPROM for storing flight software
• XBEE for communicating with camera
• Current source for separation device
• Current and Voltage monitoring at USB supply
• Current limiting switches for HV supply
• Temperature sensor
## Connectors and Cabling - Mirrorbox

<table>
<thead>
<tr>
<th>End 1 Connection</th>
<th>End 2 Connection</th>
<th>End 1 Connector</th>
<th>End 2 connector</th>
<th># Wires</th>
<th>Qty</th>
<th>Cable Length</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV board</td>
<td>Picomotor</td>
<td>DF13</td>
<td>Patch cable</td>
<td>2</td>
<td>3</td>
<td></td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>μC board</td>
<td>Separation device</td>
<td>JST rectangular</td>
<td>Soldering or Brazing</td>
<td>2</td>
<td>1</td>
<td></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>μC board</td>
<td>Encoder sensor</td>
<td>DF13</td>
<td>Direct solder</td>
<td>4</td>
<td>3</td>
<td></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>μC board</td>
<td>Thermopile</td>
<td>Locking flex</td>
<td>TBD</td>
<td>4</td>
<td>3</td>
<td></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>μC board</td>
<td>Mirrorsat</td>
<td>Locking USB</td>
<td>TBD</td>
<td>4</td>
<td>1</td>
<td></td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>μC board</td>
<td>Limit Switch</td>
<td>DF13</td>
<td>Direct Solder</td>
<td>2</td>
<td>1</td>
<td></td>
<td><img src="image6.png" alt="Image" /></td>
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<tr>
<td>μC board</td>
<td>Desktop computer</td>
<td>3 x 2 header</td>
<td>USB</td>
<td>6</td>
<td>1</td>
<td></td>
<td><img src="image7.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Custom cabling using PTFE wires through DigiKey
Camera Motherboard

Based on Atmel Cortex A5 ARM processor development board
Components:
- USB B & USB C to communicate with imaging & boom inspection cameras
- Power management circuit
- GigE for Baumer camera
- SD card
- XBee module
- CPU daughter board
Shack Hartmann Board

- Switches from one Shack Hartmann sensor to another (allows operation with single camera to save power)
- Contains connectors for mask motor, temperature sensors and receiving power from Coresat
Components:
- USBA to communicate with spacecraft
- 2 Hirose Plugs to receive SHWS signals
- 1 Hirose Receptacle for Baumer camera
- 21 pin MDM connector for mask motor, contact detectors, 3 temperature sensors
- 4 LVDS switches
- Mask motor driver circuit
## Connectors and Cabling - Camera

<table>
<thead>
<tr>
<th>End 1 Connection</th>
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<th>End 1 Connector</th>
<th>End 2 connector</th>
<th># Wires</th>
<th>Qty</th>
<th>Cable Length</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motherboard</td>
<td>Science Camera</td>
<td>Locking USB</td>
<td>Patch cable</td>
<td>4</td>
<td>1</td>
<td></td>
<td><img src="image1.jpg" alt="Image" /></td>
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<tr>
<td>Motherboard</td>
<td>Boom Inspection Camera</td>
<td>Locking USB</td>
<td>Patch cable</td>
<td>4</td>
<td>1</td>
<td></td>
<td><img src="image2.jpg" alt="Image" /></td>
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<tr>
<td>Motherboard</td>
<td>Baumer Camera</td>
<td>GigE</td>
<td>GigE</td>
<td>1</td>
<td>1</td>
<td>(Cat6 cable)</td>
<td><img src="image3.jpg" alt="Image" /></td>
</tr>
<tr>
<td>Motherboard</td>
<td>Baumer Camera</td>
<td>Direct Solder</td>
<td>JST 03</td>
<td>2</td>
<td>1</td>
<td></td>
<td><img src="image4.jpg" alt="Image" /></td>
</tr>
<tr>
<td>Shack Hartmann Board</td>
<td>Temp. sensors, mask motor, contact detectors</td>
<td>MDM</td>
<td>Direct Solder</td>
<td>20</td>
<td>1</td>
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<td><img src="image5.jpg" alt="Image" /></td>
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<tr>
<td>Shack Hartmann Board</td>
<td>CoreSat</td>
<td>Locking USB</td>
<td>TBD</td>
<td>4</td>
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<td><img src="image6.jpg" alt="Image" /></td>
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<tr>
<td>Shack Hartmann Board</td>
<td>Shack Hartmann Sensor</td>
<td>Hirose FX12</td>
<td>Hirose FX12</td>
<td>1 (Flex)</td>
<td>2</td>
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<td><img src="image7.jpg" alt="Image" /></td>
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<tr>
<td>Shack Hartmann Board</td>
<td>Baumer Camera</td>
<td>Hirose FX12</td>
<td>Hirose FX12</td>
<td>1 (Flex)</td>
<td>1</td>
<td></td>
<td><img src="image8.jpg" alt="Image" /></td>
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</table>
Mirror Calibration Timing

- **Simple calibration** – One electrode at a time
  - Total calibration time: 3.4 s (1.7 s after next iteration)

- **Modal calibration**
  - Total calibration time: 140 s (70 s after next iteration)

- **Modal calibration supposed to give better results (experiments under progress)**

- **From attitude control standpoint, is 140 s (70 s) too long for satellite to remain pointed at a star with 0.1 degrees accuracy?**
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Additional Slides
PCB Layout for Shack Hartmann Board
PCB Layout for Camera Motherboard
Power Distribution

- HV Board
  - Voltage Regulators
  - Current Limiting Switch x3
  - Variable HV Supply
  - Fixed 100V Supply
  - Fixed 150V Supply

- USB BUS
  - Control Switch
  - Device Power Separation

- MCU Board
  - 5V
  - 2.8V
  - 12V
  - 3.3V
Power Control & Monitoring

- **HV Board**
  - MCU Board
  - ADC
  - Current Switch 1
  - EN
- **MCU Board**
- **Fixed 100V Supply**
- **Variable HV Supply**
- **Fixed 150V Supply**

**USB BUS**

- **MCU**

(caltech.edu)
Overall Block Diagram

- SHWS2 Detector
- SHWS2 Microlens Array
- LVDS Switch
  - Switches between 2 SHWS
- LVDS Switch
- Contact Detectors
- Pupil Mask
- Mask Motor
- Baumer Camera
- Camera CPU
  - Communicates with mirror box
- Boom Inspection Camera
  - USB 2.0
- Imaging Camera
  - USB 2.0
- Spacecraft
  - USB 2.0
- UART
- GPIO
- Xbee Transceiver
Camera Boards Stackup

USB from Imaging & Boom inspection camera

OPTICS

12 lines of I2C to 3 temperature sensors

8 Lines to Mask Motor & Contact detectors

Baumer Flex cable from SHWS 1

Baumer Flex cable from SHWS 2

SHWS BOARD

Baumer Flex Cable

Headers

MOTHERBOARD

12 V

XBEE

SUPPORT BOARD

BAUMER CAMERA

Power (12V)

GigE

Chassis