TRAPSat
Subsystem Testing Review (STR)
Capitol Technology University
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Nathan Weideman
Zach Richard, Keegan Moore
Michael Strittmatter
Pierce Smith, Chris Murray
1.0 Mission Overview

All
Mission Overview: Mission Statement

TRAPSat will demonstrate the ability of the subsystems on board to work together as a full system. This will prove the system will behave as designed and increase the technology readiness level for use on the CACTUS-1 mission.
Mission Overview

The RockSat-X mission will provide verification for the payload, particularly the following:

Aerogel Support Container
- Protects the aerogel from both the stresses of launch, and the space environment, such that it can still function as a capture medium.

Aerogel Blanketing
- Provides adequate insulation while in a space environment, such that the components remain within their nominal operating temperature.

Hardware and Software
- Provides a hardware and software bus for collecting, storing, and transmitting science data

Imaging and Sensing
- Provides means to collect accurate images of the aerogel and thermal data
Mission Overview

On CACTUS-1, TRAPSat will capture and image debris in LEO to provide scientists with the data needed to begin the parameterization of debris in orbit.

Data from the RockSat-X mission will benefit the design of the next iteration of TRAPSat, which will be the primary scientific payload on CACTUS-1. This payload will be launched into LEO as part of NASA’s CubeSat Launch Initiative in 2018.

This payload will benefit NASA

- Data about micro-debris that is currently too small to be tracked from the ground
- Proof-of-concept of the use of aerogel to remove debris
- Proof-of-concept of the use of aerogel blanketing as an alternative insulation to MLI
Mission Overview

Mission Objectives
• To take images of aerogel
• To collect data from camera and sensors
• To protect aerogel during launch

Minimum Success Criteria
• Aerogel remains secure and intact until reentry
• At least one clear image from the aerogel camera with minimal aberration, collected post timer event 1
• At least one stored temperature data point from each temperature sensor, collected post timer event 1
Mission Overview

Comprehensive Success Criteria

About 18 data sets (Data Set = 2 Images & 4 Temperature Readings)

External Camera damage clause:

The payload includes an external camera that will be unprotected from the forces of launch to see how well it will operate unprotected. If the camera fails prematurely, then our data rate will change slightly, and the internal camera will then produce more images. This camera does not influence the mission minimum success criteria.
Concept of Operations

Continue Data Collection & Transmission

Apogee
$t \approx 180 \text{ seconds}$

$t = +6 \text{ seconds}$
- TE-1 Triggered
- Start Initial Data Transmission
- Continue Data Collection & Transmission

$t = 300 \text{ seconds}$
- Final Data Transmission
- TRAPSat System Halt

$t \approx 330 \text{ seconds}$
- All Payload Power Off

$t = -600 \text{ seconds}$
- Power on Flight Computer
- Collect Initial Data Set

$t \approx 882 \text{ seconds}$
Splash Down

$t = 300 \text{ seconds}$
- Final Data Transmission
- TRAPSat System Halt

$t \approx 330 \text{ seconds}$
- All Payload Power Off
## Concepts of Operations

### Wallops Managed

<table>
<thead>
<tr>
<th>Event</th>
<th>Time On</th>
<th>Dwell Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSE-1</td>
<td>T - 600 seconds</td>
<td>930 seconds</td>
<td>Power On Payload</td>
</tr>
<tr>
<td>TE-1</td>
<td>T + 6 seconds</td>
<td>324 seconds</td>
<td>Launch Indicator</td>
</tr>
</tbody>
</table>

### TRAPSat Managed

<table>
<thead>
<tr>
<th>Event</th>
<th>Time On</th>
<th>Dwell Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Halt</td>
<td>T + 300 seconds</td>
<td>&lt; 30 seconds</td>
<td>Halt System</td>
</tr>
</tbody>
</table>
Payload Location

- Exp5 UPR Bot. Mount
- Exp4 MSU Bot. Mount
- Exp2 Sys2 NNU
- Exp2 Sys1 CTU
- Exp1 Sys1 VHCC
- Exp3 Sys1 VT
- Exp2 Sys2 UNL
- Exp1 Sys2 UNL

UHCC: University of Hawaii Community Colleges
UNL: University of Nebraska Lincoln
CTU: Capitol Technology University
NNU: Northwest Nazarene University
VT: Virginia Tech
CC: Carthage College
MSU: Metro State University
UPR: University of Puerto Rico
2.0 Final Design Description

All
System Changes Since CDR

Custom I/O Board Changes
- FT230XQ-R → FT230XS-R
- ADS1115 RUGT → ADS1115 DGST
- MAX232 Circuit Fix
- 100 ohm LED biasing resistors
System Changes Since CDR

Improve lighting on payload
- To increase the value of the science
- Mylar tent over aerogel

Without tent image

With tent image

Science payload with wings for mylar tent image.
The RASC (Removable Aerogel Support Container) and aerogel will be vibrated before going to Wallops island at NASA Goddard.

The RASC shall be 3D printed due to its complexity and will be coated in RTV on all sides to increase its overall performance as well as reduces the amount of energy that can be transferred to the RASC both thermal and physical from the 6061 aluminum science payload.
Final Design Description: FBD

- **Wallops Telemetry** (37 pin d-sub connector)
- **8-bit Synchronous Parallel**
- **Asynchronous RS-232**
- **Wallops Power** (15 pin d-sub connector)
- **GSE-1 Power**
- **TE-1 Power**

**Flight Computer**
- 4GB eMMC Flash Memory
- **GPIO**

**TRAPSat Custom IO Board**
- **Logic Level Converter**
- **USB to RS-232**
- **Power**
  - Main Power Converter
  - TE-1 Power Converter
- **Camera Selector**
- **4-Channel ADC**

**Cameras**
- Camera 2 (external)
- Camera 1 (internal)
  - LED
  - LED

**Temperature Sensors**
- Therm 0
- Therm 1
- Therm 2
- Therm 3

**Power**
- (0V → +28V)
- (0V → +5V)
- (0V → +3.3V)
- (-12V → +12V)

**Wallops Telemetry** (37 pin d-sub connector) connects to the **Flight Computer** which includes a **4GB eMMC Flash Memory** and **GPIO**.

**TRAPSat Custom IO Board** contains **Logic Level Converter**, **USB to RS-232**, **Power** sections (Main Power Converter and TE-1 Power Converter), and a **Camera Selector**.

**Cameras** include Camera 2 (external) and Camera 1 (internal) with LED indicators.

**Temperature Sensors** include Therm 0, Therm 1, Therm 2, and Therm 3.

**Power** connections include (0V → +28V), (0V → +5V), (0V → +3.3V), and (-12V → +12V).
Mechanical Drawings
Mechanical Drawings
Mechanical Drawings
Mechanical Designs: Computer Flight Box

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>OFF</th>
<th>PART NAME</th>
<th>PART SIZE</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>BOTTOM PLATE</td>
<td>200.0 x 123.2 x 17.7 mm</td>
<td>ALUMINUM 5053</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>WALL</td>
<td>120.0 x 123.2 x 17.7 mm</td>
<td>ALUMINUM 5053</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>FRAME &amp; MOUNTING</td>
<td>196.0 x 193.2 x 17.7 mm</td>
<td>CARBON NUGNITOR</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>SUPPORT PLATE</td>
<td>195.0 x 193.2 x 17.7 mm</td>
<td>ALUMINUM 5053</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>BOTTOM CIRCUIT BOARD</td>
<td>195.0 x 193.2 x 17.7 mm</td>
<td>FIBERGLASS</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>SUPPORT PLATE FOR MOUNT</td>
<td>195.0 x 193.2 x 17.7 mm</td>
<td>ALUMINUM 5053</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>WIRE BUNNY</td>
<td>123.2 x 17.7 mm</td>
<td>WIRE</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>SCREW</td>
<td>123.2 x 17.7 mm</td>
<td>NICKEL</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>SCREW</td>
<td>123.2 x 17.7 mm</td>
<td>NICKEL</td>
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<tr>
<td>10</td>
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<td>123.2 x 17.7 mm</td>
<td>NICKEL</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>SCREW</td>
<td>123.2 x 17.7 mm</td>
<td>NICKEL</td>
</tr>
<tr>
<td>12</td>
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<td>123.2 x 17.7 mm</td>
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</tr>
<tr>
<td>13</td>
<td></td>
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<td>123.2 x 17.7 mm</td>
<td>NICKEL</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>SCREW</td>
<td>123.2 x 17.7 mm</td>
<td>NICKEL</td>
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<tr>
<td>15</td>
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<td>SCREW</td>
<td>123.2 x 17.7 mm</td>
<td>NICKEL</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>SCREW</td>
<td>123.2 x 17.7 mm</td>
<td>NICKEL</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>SCREW</td>
<td>123.2 x 17.7 mm</td>
<td>NICKEL</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>SCREW</td>
<td>123.2 x 17.7 mm</td>
<td>NICKEL</td>
</tr>
</tbody>
</table>

NOTE: PARTS 12 AND 14 ARE ONLY FOR REFERENCE, HARDWARE WILL BE USED.

ISOMETRIC ASSEMBLED VIEW

ISOMETRIC EXPLODED VIEW
INTERIOR PARTS

ISOMETRIC EXPLODED VIEW
EXTERIOR PARTS

ROCKSAT-X COMPUTER FLIGHT BOX
Mechanical Designs: Computer Flight Box
Mechanical Designs: Computer Flight Box
Mechanical Designs: Computer Flight Box

PART 3 - AERO GEL BLANKETING

- PART: COMPUTER FLIGHT BOX
- MATERIAL: CARBON FIBER
- ENVELOPMENT:ady

NOTES:
- PART 3 R: RIBS USED TO SUPPORT THE INTERIOR FIBER MATERIAL BEING USED TO ENCLOSE THE FLIGHT BOX

2016

ROCKSAT-X COMPUTER FLIGHT BOX

STR 71 NO 1

PROF.

STR

23
Mechanical Designs: Computer Flight Box
Mechanical Designs: Computer Flight Box

**PART 5 - BOTTOM CIRCUIT BOARD**

- Dimensions: 120 x 65 x 5.5 mm
- Material: PCB Plastic

**PART 6 - RASPBERRY PI COMPUTE MODULE AND IO BOARD**

- Dimensions: 120 x 60 x 1.6 mm
- Material: PCB Plastic

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**Notes:**

- ROCK SAT-X COMPUTER FLIGHT BOX
- STR: T1 NO. 1
Mechanical Designs: Computer Flight Box

PART 7 - TOP EXTERIOR SPACER
SIZE: 12.74 x 6.35 mm
MATERIAL: ALUMINUM
SCALE: 5:1

PART 8 - MIDDLE EXTERIOR SPACER
SIZE: 19.05 x 6.35 mm
MATERIAL: ALUMINUM
SCALE: 5:1

PART 9 - BOTTOM INTERIOR SPACER
SIZE: 31.75 x 6.35 mm
MATERIAL: NYLON
SCALE: 5:1

PART 10 - MIDDLE INTERIOR SPACER
SIZE: 11.25 x 6.35 mm
MATERIAL: NYLON
SCALE: 5:1

PART 11 - TOP INTERIOR SPACER
SIZE: 28.25 x 6.35 mm
MATERIAL: NYLON
SCALE: 5:1
Mechanical Designs: Science Payload
Mechanical Designs: Science Payload

PART 1 - SCIENTIFIC PAYLOAD BASE
Size: 169.2 x 105.1 x 44.5 mm

SECTION A-A
SCALE 1:1

RocksAT-X SCIENCE PAYLOAD
Mechanical Designs: Science Payload
MECHANICAL DESIGNS: SCIENCE PAYLOAD

PART 4 - RASK SLIDE

Size: 24.4 x 24.4 x 25.71 mm
SCALE: 3:1

SECTION D-D
SCALE 2:1

ACTUAL SIZE
Mechanical Designs: Science Payload
Mechanical Designs: Science Payload
Mechanical Designs: Full Assembly
Mechanical Designs: Full Assembly

PART 1 - DECK PLATE

BOTTOM VIEW

NOTE: THE DIMENSIONED HOLES ARE MEASURED FROM THE DECK PLATE. THE PART COVERS THE DESIGNATED AREA ONLY.
### Detailed Weight Budget

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Total Weight (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Payload</td>
<td>901g = 1.986 lbs</td>
</tr>
<tr>
<td>Computer Payload</td>
<td>1840g = 4.056 lbs</td>
</tr>
<tr>
<td>External Camera</td>
<td>11g = 0.0242 lbs</td>
</tr>
<tr>
<td>RockSat Plate</td>
<td>3.425 lbs</td>
</tr>
<tr>
<td>Ballast Weight</td>
<td>5.509</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15 lbs</strong></td>
</tr>
<tr>
<td><strong>Over/Under</strong></td>
<td><strong>0 lbs</strong></td>
</tr>
</tbody>
</table>
## Detailed Weight Budget

### Electronics Subsystem Approximate Weight: 119.19g

<table>
<thead>
<tr>
<th>Part</th>
<th>Electronic System (Brief Description)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raspberry Pi CM &amp; IO</td>
<td>Computer</td>
<td>62.26g</td>
</tr>
<tr>
<td>Custom IO PCB</td>
<td>--</td>
<td>29.28g</td>
</tr>
<tr>
<td>Adafruit TTL Camera</td>
<td>Camera</td>
<td></td>
</tr>
<tr>
<td>LED (Through Hole)</td>
<td>Camera (LEDs)</td>
<td>0.28g</td>
</tr>
<tr>
<td>Resistor (100ohm, 1/2W, 1%)</td>
<td>Camera (LED resistors)</td>
<td>0.01g</td>
</tr>
<tr>
<td>Dual 4 Line to 1 Line Selector/MUX</td>
<td>Camera (Selector)</td>
<td>0.96g</td>
</tr>
<tr>
<td>ADC (ADS1115 DGS T)</td>
<td>Temperature (ADC)</td>
<td>0.022g</td>
</tr>
<tr>
<td>Resistor (10Kohm, 1/8W, 0.1%)</td>
<td>Temperature (ADC Pull-up Resistors)</td>
<td>0.005g</td>
</tr>
<tr>
<td>Thermistor (10K, -55C to 300C)</td>
<td>Temperature (Thermistors)</td>
<td>0.12g</td>
</tr>
<tr>
<td>Resistor (300kohm, 1/8W, 0.05%)</td>
<td>Temperature (Therm. Bias. Res.)</td>
<td>0.003g</td>
</tr>
<tr>
<td>DC/DC Converter</td>
<td>Power</td>
<td>17.7g</td>
</tr>
<tr>
<td>Inductor (12uH)</td>
<td>Power</td>
<td>0.42g</td>
</tr>
<tr>
<td>Non-Polarized Capacitor (220uF, 63V, 20%)</td>
<td>Power</td>
<td>6.37g</td>
</tr>
<tr>
<td>Non-Polarized Capacitor (2.2uF, 50V, 5%)</td>
<td>Power</td>
<td>0.24g</td>
</tr>
<tr>
<td>USB-Serial Converter (FT230XS SSOP-16)</td>
<td>Async (Logic Converter)</td>
<td>0.084g</td>
</tr>
<tr>
<td>Non-Polarized Capacitor (100nF, 10V, %5)</td>
<td>Async (attached to USB to Serial)</td>
<td>0.013g</td>
</tr>
<tr>
<td>Polarized Capacitor (100nF, 100V, 20%)</td>
<td>Async (attached to RS232 Driver)</td>
<td>0.38g</td>
</tr>
<tr>
<td>RS-232 Driver/Receiver</td>
<td>Async (RS232 Level Converter)</td>
<td>1.05g</td>
</tr>
<tr>
<td>Resistor (1690 ohm, 1/2W, %1)</td>
<td>Power (TE-1)</td>
<td>TBD</td>
</tr>
<tr>
<td>Resistor (3300 ohm, 1/2W, %1)</td>
<td>Power (TE-1)</td>
<td>TBD</td>
</tr>
</tbody>
</table>
# Materials List: Structural

<table>
<thead>
<tr>
<th>Part</th>
<th>Manufacturer</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerogel</td>
<td>Marketech</td>
<td>.04g</td>
</tr>
<tr>
<td>RASC</td>
<td>TRAPSat</td>
<td>40g</td>
</tr>
<tr>
<td>Science Payload</td>
<td>TRAPSat</td>
<td>901g</td>
</tr>
<tr>
<td>Flight Computer Payload</td>
<td>TRAPSat</td>
<td>1840g</td>
</tr>
<tr>
<td>734 RTV</td>
<td>Dow Corning</td>
<td>N/A</td>
</tr>
<tr>
<td>3154 RTV</td>
<td>Dow Corning</td>
<td>N/A</td>
</tr>
<tr>
<td>m3 x 13mm x 6mm DIA Nylon Standoffs</td>
<td>McMaster Carr</td>
<td>TBD</td>
</tr>
<tr>
<td>m3 x 19mm x 6mm DIA Nylon Standoffs</td>
<td>McMaster Carr</td>
<td>TBD</td>
</tr>
<tr>
<td>M2 x .4mm x 8mm Phillips Head Nylon Bolt</td>
<td>McMaster Carr</td>
<td>TBD</td>
</tr>
<tr>
<td>M2 x .42mm x 1.5mm Nylon Nut</td>
<td>McMaster Carr</td>
<td>TBD</td>
</tr>
<tr>
<td>Nylon flat washer M2 Screw Size, 2.2mm ID, 5.0mm OD</td>
<td>McMaster Carr</td>
<td>TBD</td>
</tr>
<tr>
<td>15pin Male - Male DB Connector</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>¼’ - 20 unc 2a 5.5”</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>¼” - 20 unc 2b Lock nut</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>Buttonhead Screws #5 x .5”</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>20 guage stranded core pre treated</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>m2 x .4mm x 2cm</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>Stretched Aluminized Polyester</td>
<td>Coghlan’s</td>
<td>1g</td>
</tr>
<tr>
<td>2mm 2250 Aerogel Insulation</td>
<td>Pacor inc</td>
<td>108g</td>
</tr>
</tbody>
</table>
Electrical Schematics

Power System

TRAPSat RockSat-X 2016

Camera System

Asynchronous Interface

Temperature Measurement Circuit

RPi Pins
## Electrical Parts List

<table>
<thead>
<tr>
<th>Part</th>
<th>System (Brief Description)</th>
<th>Board Labels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raspberry Pi CM &amp; IO</td>
<td>Computer</td>
<td>RPI GPIO &amp; PI_USB</td>
</tr>
<tr>
<td>Adafruit TTL Camera</td>
<td>Camera</td>
<td>CAM0, CAM1</td>
</tr>
<tr>
<td>LED (Through Hole)</td>
<td>Camera (LEDs)</td>
<td>LED1, LED2</td>
</tr>
<tr>
<td>Resistor (100ohm, 1/2W, 1%)</td>
<td>Camera (LED resistors)</td>
<td>R5, R6</td>
</tr>
<tr>
<td>Dual 4 Line to 1 Line Selector/MUX</td>
<td>Camera (Selector)</td>
<td>IC2</td>
</tr>
<tr>
<td>ADC (ADS1115 DGS T)</td>
<td>Temperature (ADC)</td>
<td>U1</td>
</tr>
<tr>
<td>Resistor (10Kohm, 1/8W, 0.1%)</td>
<td>Temperature (ADC Pull-up Resitors)</td>
<td>R9, R10, R11, R12</td>
</tr>
<tr>
<td>Thermistor (10K, -55C to 300C)</td>
<td>Temperature (Thermistors)</td>
<td>THERM0, THERM1, THERM2, THERM3</td>
</tr>
<tr>
<td>Resistor (300kohm, 1/8W, 0.05%)</td>
<td>Temperature (Therm. Bias. Res.)</td>
<td>R1, R2, R3, R4</td>
</tr>
<tr>
<td>DC/DC Converter</td>
<td>Power</td>
<td>DC0, DC1</td>
</tr>
<tr>
<td>Inductor (12uH)</td>
<td>Power</td>
<td>I1, I3</td>
</tr>
<tr>
<td>Non-Polarized Capacitor (220uF, 63V, 20%)</td>
<td>Power</td>
<td>C3, C6</td>
</tr>
<tr>
<td>Non-Polarized Capacitor (2.2uF, 50V, 5%)</td>
<td>Power</td>
<td>C1, C5</td>
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<tr>
<td>USB-Serial Converter (FT230XQ QFN-16)</td>
<td>Async (Logic Converter)</td>
<td>IC1</td>
</tr>
<tr>
<td>USB-Serial Converter (FT230XS SSOP-16)</td>
<td>Async (Logic Converter)</td>
<td>IC1</td>
</tr>
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<td>Non-Polarized Capacitor (100nF, 10V, %5)</td>
<td>Async (attached to USB to Serial)</td>
<td>C9</td>
</tr>
<tr>
<td>Polarized Capacitor (100nF, 100V, 20%)</td>
<td>Async (attached to RS232 Driver)</td>
<td>C2, C4, C7, C8, C10</td>
</tr>
<tr>
<td>RS-232 Driver/Receiver</td>
<td>Async (RS232 Level Converter)</td>
<td>IC0</td>
</tr>
<tr>
<td>Resistor (1690 ohm, 1/2W, %1)</td>
<td>Power (TE-1)</td>
<td>R7</td>
</tr>
<tr>
<td>Resistor (3300 ohm, 1/2W, %1)</td>
<td>Power (TE-1)</td>
<td>R8</td>
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## Updated Power Budget

### TRAPSat (Capitol Technology University) - Power Budget

<table>
<thead>
<tr>
<th>11/25/2015</th>
<th>Subsystem</th>
<th>Voltage (V)</th>
<th>Max Current (A)</th>
<th>Start Time (min)</th>
<th>Time On (min)</th>
<th>Watts</th>
<th>Ah</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GSE-1 Power Converter</td>
<td>28.0</td>
<td>0.73</td>
<td>-10</td>
<td>15.616666667</td>
<td>20.36</td>
<td>0.19</td>
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<tr>
<td></td>
<td>TE-1 Power Converter</td>
<td>28.0</td>
<td>0.73</td>
<td>0.1</td>
<td>5.4</td>
<td>20.36</td>
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<td><strong>Total</strong></td>
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<td><strong>1.45</strong></td>
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<td><strong>40.71</strong></td>
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<td></td>
<td><strong>Total Power Capacity</strong></td>
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<td></td>
<td><strong>Over/Under</strong></td>
<td></td>
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<td><strong>0.25</strong></td>
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<td></td>
<td><strong># of Flights Margin</strong></td>
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<td><strong>3.9</strong></td>
</tr>
</tbody>
</table>
# Pin Assignments: Power

<table>
<thead>
<tr>
<th>Power Connector--Wallops Side</th>
<th>TRAPSat Side</th>
<th>TRAPSat Connection</th>
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</thead>
<tbody>
<tr>
<td>Pin</td>
<td>Function</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>+28 Volts (GSE 1)</td>
<td>Pin 1, DC/DC Converter, +VIN</td>
</tr>
<tr>
<td>2</td>
<td>Timer Event R1 (TE-RA)</td>
<td>unused</td>
</tr>
<tr>
<td>3</td>
<td>Timer Event R2 (TE-RB)</td>
<td>unused</td>
</tr>
<tr>
<td>4</td>
<td>Timer Event 1 (TE-1)</td>
<td>Pin 1, DC1 (DC/DC Converter, +Vin)</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Pin2, DC0/DC1 (DC/DC Converter, -Vin)</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>unused</td>
</tr>
<tr>
<td>7</td>
<td>GND</td>
<td>unused</td>
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<tr>
<td>8</td>
<td>GND</td>
<td>unused</td>
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<tr>
<td>9</td>
<td>+28 Volts (GSE 2)</td>
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<td>10</td>
<td>Timer Event R1 (TE-2)</td>
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<td>11</td>
<td>Timer Event R2 (TE-3)</td>
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<td>13</td>
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<td>14</td>
<td>GND</td>
<td>unused</td>
</tr>
<tr>
<td>15</td>
<td>GND</td>
<td>unused</td>
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</tbody>
</table>
Pin Assignments: Telemetry

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
<th>TRAPSat Connection</th>
<th>Pin</th>
<th>Function</th>
<th>TRAPSat Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Analog 1</td>
<td>Unused</td>
<td>20</td>
<td>Parallel Bit 7</td>
<td>Pin 21, J5, CMIO (GPIO_38)</td>
</tr>
<tr>
<td>2</td>
<td>Analog 2</td>
<td>Unused</td>
<td>21</td>
<td>Parallel Bit 8</td>
<td>Pin 23, J5, CMIO (GPIO_39)</td>
</tr>
<tr>
<td>3</td>
<td>Analog 3</td>
<td>Unused</td>
<td>22</td>
<td>Parallel Bit 9</td>
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<tr>
<td>4</td>
<td>Analog 4</td>
<td>Unused</td>
<td>23</td>
<td>Parallel Bit 10</td>
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<tr>
<td>5</td>
<td>Analog 5</td>
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<td>24</td>
<td>Parallel Bit 11</td>
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<td>6</td>
<td>Analog 6</td>
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<td>25</td>
<td>Parallel Bit 12</td>
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<tr>
<td>7</td>
<td>Analog 7</td>
<td>Unused</td>
<td>26</td>
<td>Parallel Bit 13</td>
<td>Unused</td>
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<tr>
<td>8</td>
<td>Analog 8</td>
<td>Unused</td>
<td>27</td>
<td>Parallel Bit 14</td>
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<tr>
<td>9</td>
<td>Analog 9</td>
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<td>Parallel Bit 15</td>
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<td>Analog 10</td>
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<td>29</td>
<td>Parallel Bit 16</td>
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<td>11</td>
<td>Parallel Bit 1</td>
<td>Pin 09, J5, CMIO (GPIO_32)</td>
<td>30</td>
<td>Parallel Read Strobe</td>
<td>Pin 25, J5, CMIO (GPIO_40)</td>
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<td>12</td>
<td>Parallel Bit 2</td>
<td>Pin 11, J5, CMIO (GPIO_33)</td>
<td>31</td>
<td>N/C</td>
<td>Unused</td>
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<tr>
<td>13</td>
<td>Parallel Bit 3</td>
<td>Pin 13, J5, CMIO (GPIO_34)</td>
<td>32</td>
<td>RS-232 Data (TP-1)</td>
<td>Pin 14, USB to Serial Converter (TX)</td>
</tr>
<tr>
<td>14</td>
<td>Parallel Bit 4</td>
<td>Pin 15, J5, CMIO (GPIO_35)</td>
<td>33</td>
<td>RS-232 GND (TP-2)</td>
<td>Pin 15, USB to Serial Converter (GND)</td>
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<tr>
<td>15</td>
<td>Parallel Bit 5</td>
<td>Pin 17, J5, CMIO (GPIO_36)</td>
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<tr>
<td>16</td>
<td>Parallel Bit 6</td>
<td>Pin 19, J5, CMIO (GPIO_37)</td>
<td>35</td>
<td>N/C</td>
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<tr>
<td>17</td>
<td>N/C</td>
<td>Unused</td>
<td>36</td>
<td>N/C</td>
<td>Unused</td>
</tr>
<tr>
<td>18</td>
<td>GND</td>
<td>Unused</td>
<td>37</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>19</td>
<td>GND</td>
<td>Unused</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
System Overview: Software Flow Chart

1. Power On (T - 600s)
2. Initial State
   a. Software Boot
   b. Camera Capture
   c. Temperature Read
3. Event 1 (T + 6s)
4. Main State
   a. Transmit Data
   b. Camera Capture
   c. Temperature Read
5. Event 2 (T + 300s)
6. Final State
   a. Finish Data Transfers
   b. System Halt
7. Power Off (T + 330s)
Flight Software - core Flight System

- Developed by GSFC NASA
- NASA Open Source Agreement
- Runs on Linux platform
- Custom software added by TRAPSat

### Subsystem Design: Software

**Operating System**

**TRAPSat System Manager**
- Asynchronous [Backup] Comms
- Event Management
- Parallel Comms

**TRAPSat cFS**
- cFS Apps
  - Command Ingest
  - Telemetry Output
- TRAPSat cFS Apps
  - Cameras
  - Temperature Sensors

**cFE Core Apps**
- Event Services
- Executive Services
- File Services
- Message Passing
- Table Services
- Time

**Operating System Abstraction Layer (OSAL)**

**Platform Support Package**

**Key**
- Open Source
- NASA Open Source
- TRAPSat Custom Open Source
Update on Partnerships

Aerogel Testing:

RASC and Aerogel shake testing will be performed with the guidance of Allison Wright from the GSFC. This test will evaluate the integrity of silica aerogel in a 3D printed RASC during simulated launch vibrations.
No descopes or Off Ramps at this current time
Special Requests

No special requests at this time
3.0 Hardware Procurement Status

All
Structural Elements

Things Purchased:
- Mylar Blanketing
- 2mm Aerogel Insulation
- 734 RTV

Things to still be purchased:
- Double Sided Kapton Tape
- Nylon Standoffs/spacers
- ¼”-20 unc -2a x 5.5” countersunk bolts
- ¼”-20 unc 2b lock Nuts
- 3154 Dow Corning RTV

Things to be manufactured:
- Custom Flight Boxes
- 3D printed Silica Aerogel Reusable Aerogel Support Container
Electrical Elements Status Update

- Custom IO Board
  - Quick Status: New Revision Necessary
  - Components acquired
    - ADC
    - Power
    - Serial
    - Camera

Custom IO Board V1.1 (Latest Revision)

Top

Bottom
Electrical Elements Status Update

V1.0

V1.1

Top

Bottom

Designed by Zach Richard and Keegan Moore

Date: December 2015

Date: January 2016

229 μF ND

220 μF ND

2016
Electrical Elements Status Update

Custom IO Board
(Future Revision)

Top

Bottom
Software Elements Status Update

Current Progress Key

- Design
- Development
- Final

Operating System

TRAPSat System Manager
- Asynchronous [Backup] Comms
- Event Management
- Parallel Comms

TRAPSat cFS

cFS Apps
- Command Ingest
- Telemetry Output

TRAPSat cFS Apps
- Cameras
- Temperature Sensors

cFE Core Apps
- Event Services
- Executive Services
- File Services
- Message Passing
- Table Services
- Time

Operating System Abstraction Layer (OSAL)

Platform Support Package
Software Elements Status Update

- cFS
  - compiles and runs
- ADS1115 (ADC to read Thermistor Voltage)
  - working cFS Application, near final version
- VC0706 (Camera)
  - working C++ library prototyped
  - next step is cFS integration
- Event Management
  - in design
- Parallel Output
  - prototyping stage/proof of concept
- Serial Output
  - prototyping stage/proof of concept
- OS Configuration
  - Automated startup of cFS
  - ongoing development
4.0 Subsystem Testing
Status & Results

Ryan Schrenk, Keegan Moore, Zach Richard
Subsystem Testing Results: Structure
Subsystem Testing Results: Structure

Type: Von Mises Stress
Unit: kPa
2/19/2016, 2:44:33 AM
4,068 MPa
Subsystem Testing Results: Structure
Subsystem Testing: Structure
Subsystem Testing Results: Structure

Pyrogel Blanketing 2250
Thickness 0.08 inch (2.0 mm)
Temperature Range -330 – 480º F Continuous (-200 – 250º C)
Color Black
Density 10.7 lb/ft3 (0.17 g/cc)
Hydrophobic* Yes
Thermal Conductivity 0.107 BTU-in/hr-ft2-ºF Mean Temp 100º F (38º C) (15.5 mW/m-K)
Subsystem Testing Results: Structure

2mm Aerogel Insulation
Cryo Test
Subsystem Testing Results: Structure

1 Layer Insulation: Internal vs External

- ambient_temp
- environment_temp
- internal_payload_temp
Subsystem Testing Results: Structure

2 Layer Insulation: Internal vs External

Temperature (°C) vs Time (Seconds)

- Ambient temperature
- Environmental temperature
- Internal payload temperature
Subsystem Testing Results: Structure

Size: 209.55 X 191 x 86.575 mm
Weight: 1764.65g
Subsystem Testing Results: Structure

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>QTY</th>
<th>PART NAME</th>
<th>SIZE</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>BOTTOM PLATE</td>
<td>209.55 x 191 x 4.7625 mm</td>
<td>ALUMINUM 6061</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>WALLS</td>
<td>165.6 x 139.7 x 77.05 mm</td>
<td>ALUMINUM 6061</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>HYBRID BLANKETTING</td>
<td>156.075 x 130.175 x 77.05 mm</td>
<td>CARBON AEROGEL</td>
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<tr>
<td>4</td>
<td>1</td>
<td>TOP PLATE</td>
<td>193.675 x 191 x 4.7625 mm</td>
<td>ALUMINUM 6061</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>BOTTOM CIRCUIT BOARD</td>
<td>105 x 85 x 1.6 mm</td>
<td>PCB PLASTIC</td>
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<tr>
<td>6</td>
<td>1</td>
<td>RASPBERRY PI COMPUTE MODULE AND I/O BOARD</td>
<td>105 x 85 x 6.6 mm</td>
<td>PCB PLASTIC</td>
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<tr>
<td>7</td>
<td>4</td>
<td>BOTTOM EXTERIOR SPACER</td>
<td>12.7 x 4.75 DIA mm</td>
<td>NYLON</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>MIDDLE EXTERIOR SPACER</td>
<td>19.05 x 4.75 DIA mm</td>
<td>NYLON</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>BOTTOM INTERIOR SPACER</td>
<td>12.70 x 6.35 DIA mm</td>
<td>NYLON</td>
</tr>
<tr>
<td>10</td>
<td>4</td>
<td>MIDDLE INTERIOR SPACER</td>
<td>19.05 x 6.35 DIA mm</td>
<td>NYLON</td>
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<tr>
<td>11</td>
<td>2</td>
<td>TOP INTERIOR SPACER</td>
<td>6.35 DIA x 3 mm</td>
<td>NYLON</td>
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<tr>
<td>12</td>
<td>4</td>
<td>EXTERIOR SCREW</td>
<td>M3x0.4 x 63.5 - 4g6g COUNTERSUNK BOLT</td>
<td>NYLON</td>
</tr>
<tr>
<td>13</td>
<td>4</td>
<td>EXTERIOR NUT</td>
<td>M3x0.4 NARROW HEX NUT</td>
<td>NYLON</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>INTERIOR SCREW</td>
<td>M2x0.4 x 69.85 - 4g6g COUNTERSUNK BOLT</td>
<td>NYLON</td>
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<tr>
<td>15</td>
<td>2</td>
<td>DB 15 PIN CONNECTOR</td>
<td>23.75 x 13 54 x 7.87 mm</td>
<td>ALUMINUM 6061 SHELL, COPPER AND STAINLESS STEEL HARDWARE</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>INTERIOR BOARD NUT</td>
<td>M2x0.4 NARROW HEX NUT</td>
<td>NYLON</td>
</tr>
</tbody>
</table>

ISOMETRIC ASSEMBLED VIEW

COMPUTER FLIGHT BOX
SIZE: 209.55 x 191 x 86.575 mm
Subsystem Testing Results: Structure
Subsystem Testing Results: Structure

Size: 149.23 x 114.3 x 63.76 mm
Weight: 900g
Current issues:
- Scientific camera exposed
- Aerogel container’s exact dimensions unknown at the moment
Subsystem Testing Results: Structure

Units: Metric (mm)
Subsystem Testing Results: Structure

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>QTY</th>
<th>PART NAME</th>
<th>SIZE</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>SCIENTIFIC PAYLOAD BASE</td>
<td>149.225 x 114.30 x 44.45 mm</td>
<td>ALUMINUM 6061</td>
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<td>2</td>
<td>1</td>
<td>CAMERA</td>
<td>32 x 26 x 11 mm</td>
<td>PCB BOARD</td>
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<td>3</td>
<td>1</td>
<td>RASK</td>
<td>69.02 x 53.51 x 22.71 mm</td>
<td>ABS PLASTIC</td>
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<tr>
<td>4</td>
<td>1</td>
<td>RASK SLIDE</td>
<td>56.02 x 52.5 x 16.71 mm</td>
<td>ABS PLASTIC</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>AEROGEL</td>
<td>51.5 x 51.5 x 15 mm</td>
<td>AEROGEL</td>
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<tr>
<td>6</td>
<td>2</td>
<td>LED</td>
<td>7.6 x 5.5 DIA mm</td>
<td>APOXY</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>LEFT ARC PLATE</td>
<td>103.19 x 41.27 x 19.85 mm</td>
<td>ALUMINUM 6061</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>RIGHT ARC PLATE</td>
<td>103.19 x 41.27 x 19.85 mm</td>
<td>ALUMINUM 6061</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>MYLAR SHROUD</td>
<td>.01 mm THICKNESS</td>
<td>PET</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>ARC TENT SCREW</td>
<td>#5 - 30 UNC - 2A x 5.08 mm</td>
<td>ALUMINUM 6061</td>
</tr>
</tbody>
</table>
Subsystem Testing Results: Structure

Camera Modules (VC0706):

**Power:**
- 75mA Draw (Manufacturer Spec)
- 3.3-5V (from Computer Board)

**Data:**
- Outputs ~20KB Compressed Images
- Serial Interface to Computer Board

**Mass:** 15g

**Current Issues:**
- Lighting Design is in testing.
- Aerogel blanketing will be being the internal camera

Aerogel (Silica):

**Mass:** 5g

**Current Issues:**
- Very fragile substance. Experimental data needs to be collected to confirm it’s survivability during high vibrations.
Subsystem Testing Results: Structure

TRAPSat just received confirmation that we can perform vibration testing on the aerogel contained in the RASC (Removable Aerogel Support Container) at Goddard space flight center. This will provide confidence in the success of the aerogel survival during the mission.

The date is tentative in March or April based on Goddard’s mission priority.
Subsystem Testing Results: Electronics Bus

Raspberry Pi Compute Module (CM)
- Broadcom BCM2835 700MHz (single core)
- 512 MB memory
- 4 GB eMMC flash storage
- 200-pin DDR2 (1.8V) SO-DIMM form factor

Raspberry Pi CM and Input Output (I/O) Board
- Power: 2000mW (5V)
- Mass: 70g

Subsystem Testing Results: Electronics Bus

Custom I/O Board Overview

- (2x) 28V to 5V DC/DC Converter (20g ea.)
- (1x) USB to Serial Converter
- (1x) 5V to +/-12V Logic Level Converter (RS-232 Driver)
- (1x) 4-Channel Analog to Digital Converter (ADC)
- (1x) Dual 4 Line to 1 Line Multiplexer
- Weight: TBD
Subsystem Testing Results: Electronics Bus

Parallel Telemetry Prototyping / Testing

- Arduino Mega 2560 simulating WFF
- RPi CM read PRS / wrote 8-bit data
Subsystem Testing Results:
Electronics Bus

Custom I/O Board
28V to 5V DC/DC Converter
• Main Power DC/DC Converter
• TE-1 Power DC/DC Converter
• Mfr. Spec. Max Current Draw: 0.73A
• Voltage Output: 5V
• Mfr. Spec. Weight: 17.7g
Subsystem Testing Results: Electronics Bus

Power System Test
Subsystem Testing Results: Electronics Bus

Power System Test Results
- Input 18V → 32V, output remained 4.85V
- Current draw from power supply remained within expected range*

* Current Draw from Power Supply after Pi shutdown: 0.057A
** Current curve estimated.
Subsystem Testing Results: Electronics Bus

Custom I/O Board
USB to Serial Converter
• Asynchronous USB to Serial Converter
• Test Status: Not yet prototyped
  • Waiting of PCB revision
• Weight: 0.084g
Subsystem Testing Results: Electronics Bus

Custom I/O Board
5V to +/-12V Logic Level Converter
- Asynchronous Logic Level Converter
- Test Status: Prototyped (need oscilloscope testing)
- Weight: 1.05g
Subsystem Testing Results: Electronics Bus

Serial Telemetry Prototyping / Testing

- Oscilloscope simulating WFF
- MAX232 successfully inverted and amplified data appropriately
- USB->Serial cable was used in place of FT230XS
Subsystem Testing Results: Electronics Bus

Serial Telemetry Prototyping / Testing

![Graph showing serial telemetry results with voltages and serial types indicated.]

- 8V
- 3V
- 0V
- -8V

RS232 Serial
TTL Serial
Subsystem Testing Results: Electronics Bus

Custom I/O Board
4-Channel Analog to Digital Converter
- Temperature Sensor Reading
- Test Status: Prototyped
- Weight: 0.02g

Temperature Measurement Circuit

[Image of circuit diagram]

[Image of custom I/O board with Texas Instruments ADS1115 chip]
Subsystem Testing Results: Electronics Bus

Custom I/O Board
Thermistor
- Temperature Sensor
- Test Status: Hardware and Software design tested
- Weight: 0.12g
Subsystem Testing Results: Electronics Bus

ADC/Thermistor Results

- ADC Confirmed to work with RPi CM
- Thermistor Tolerance Range in question
Subsystem Testing Results: Electronics Bus

Custom I/O Board
Dual 4 Line to 1 Line Multiplexer
- Camera Selector
- Testing Status: Prototyped
- Mfr. Spec. Weight: 0.96g
Subsystem Testing Results: Electronics Bus

Camera Selector Prototype

Raspberry Pi CM shown with SN74HC253N (mux) and two VC0706 cameras.
Subsystem Testing Results: Electronics Bus
Subsystem Testing Results: Electronics Bus
Subsystem Testing Results: Aerogel Capture System

Custom I/O Board LED
- Aerogel Internal Camera Lighting
- Weight:

Resistors
- Resistance Value: 100 Ohms
- Resistance determines brightness
- Testing showed negligible differences in photo quality between 100 Ohms and 50 Ohms

![LED Diagram]
Subsystem Testing Results: Aerogel Capture System

LED Lighting/Resistor Testing
Subsystem Testing Results: Aerogel Capture System

LED Lighting/Resistor Testing
Subsystem Testing Results: Aerogel Capture System

Purpose of this test:
- Find the right biasing resistance to create acceptable lighting conditions for the camera facing the Aerogel

How did we do this test:
- Used a python script to control a VC0706 camera aimed at a mockup cubesat top
- LEDs were placed in approximately the same placement as they would in our RockSat-X payload design.
- A small piece of Mylar was taped in place to model the same reflection the camera would experience on the mission.
- Control image taken with the camera of the mockup with out lit LEDs
- Images were then taken of the mockup with varying biasing resistances for the LEDs.

Results of this test:
- Tester found that images were sufficiently lit by LEDs with a biasing resistance anywhere in the range of 50 to 100 Ohms without being over exposed
Subsystem Testing Results: Aerogel Capture System

300th Picture

3000th Picture

Camera After 3.5 Hour Cryo Test
Subsystem Testing Results: Software System

cFS Output:
ADS1115 cFS Application successfully added and running.
5.0 Plan for Integrated Subsystem Testing Review (ISTR)

All
Plans for ISTR

February → April
1. Full cFS Integration
2. Telemetry Management
3. Flat-Sat Test
4. HAB Launch

Major Hurdles
- CPU Job Scheduling
- PCB Revisions/Testings
- Telemetry Simulation

Worries
- Serial and Parallel integration conflicts
6.0 Plan for Full Mission Simulation Review (FMSR)

All
FMSR: Mechanical Testing

• There are no deployables on this mission.

• There will be a physical metal inhibit or protective cover placed over the science payload to protect the aerogel from physical damage during integration and testing.
FMSR: Electrical Testing

Closed Box Electrical Plans

- 28V input to DC/DC0 → 5V to Pi (TP-1)
- 28V input to DC/DC1 → 3.3V to Pi (TP-2)
  - After, test data from parallel & serial
- Software System Status → GPIO Pin 41 (TP-3)
FMSR: Software Testing

Software Dependence → Hardware System
- ADC control → ADS1115 + Thermistor
- Serial Output → USB to Serial + RS232 Level Converter
- Parallel Output → Raspberry Pi + Wiring
- Data Collection Sim → Parallel/Serial IO
- VC0706 control → Mux + Cameras

Hurdles
- WFF Data Collection Simulation/Confirmation
- Event Management
FMSR: System Level Testing

Full System Testing Dependencies
- WFF Simulation (w/ Test Point Reader) → Power/TE-1 + Telemetry

Hurdles
- Creating WFF Telemetry Simulation (expected final design ~ April)

Power System Test Steps
1. Power 28V GSE-1 (TP-1)
   i. Wait 10 minutes
2. Power 28V TE-1 (TP-2)
   i. Wait 5.5 minutes
3. Power Off GSE-1 and TE-1

Mission Monitor Test Steps
1. Test Point 1 (TP-1) @ 5V
   i. Test Point 3 (TP-3) Status Flag
2. Test Point 2 (TP-2) @ 3.3V
   i. Read Telemetry 5.5 minutes
3. TP-1 and TP-2 @ 0V
7.0 User Guide Compliance

All
## User Guide Compliance

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center of gravity in 1&quot; plane of plate?</td>
<td>(4mm, 1mm)</td>
</tr>
<tr>
<td>Weight 30.0 +/- 1.0 (15.0 +/- 0.5) lbs?</td>
<td>15 lbs</td>
</tr>
<tr>
<td>Max Height &lt; 10.75” (5.13”)</td>
<td>5 in</td>
</tr>
<tr>
<td>Bottom of deck has flush mount hardware?</td>
<td>compliant</td>
</tr>
<tr>
<td>Within Keep-Out Zone</td>
<td>compliant</td>
</tr>
<tr>
<td>Using &lt; 10 A/D Lines</td>
<td>N/A</td>
</tr>
<tr>
<td>Using/Understand Parallel Line</td>
<td>YES, PRS Frequency at 5000Hz</td>
</tr>
<tr>
<td>Using/Understand Asynchronous Line</td>
<td>YES, at 19200 Baud</td>
</tr>
<tr>
<td>Using X GSE Line(s)</td>
<td>YES, GSE 1</td>
</tr>
<tr>
<td>Using X Non-Redundant PWR Lines (TE-1, TE-2, TE-3)</td>
<td>YES, TE-1</td>
</tr>
<tr>
<td>Using X Redundant Power Lines (TE-R)</td>
<td>NO</td>
</tr>
<tr>
<td>Using &lt; 0.5 Ah</td>
<td>YES, Total at 0.19Ah</td>
</tr>
<tr>
<td>Using &lt;= 28 V</td>
<td>YES</td>
</tr>
<tr>
<td>Using RF (If yes, list frequency and TX Power)</td>
<td>NO</td>
</tr>
<tr>
<td>Using deployable?</td>
<td>NO</td>
</tr>
<tr>
<td>Whole team consists of US Persons</td>
<td>YES</td>
</tr>
<tr>
<td>Using ITAR and/or Export Controlled hardware</td>
<td>NO</td>
</tr>
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8.0 Project Management Update

All
# Updated Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Task</th>
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</thead>
<tbody>
<tr>
<td>2/19/16</td>
<td>STR Presentation</td>
</tr>
<tr>
<td>2/26/16</td>
<td>PCB v1.1 testing complete</td>
</tr>
<tr>
<td>3/4/16</td>
<td>PCB v2 Ordered for printing</td>
</tr>
<tr>
<td>3/?/16</td>
<td>Aerogel Shake testing @ GSFC</td>
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<tr>
<td>3/16/16</td>
<td>RASC Thermal/Vacuum Testing completed</td>
</tr>
<tr>
<td>3/30/16</td>
<td>Flat Sat testing completed</td>
</tr>
<tr>
<td>4/4/16</td>
<td>ISTR Presentation</td>
</tr>
<tr>
<td>4/15/16</td>
<td>Full system software complete</td>
</tr>
<tr>
<td>4/6/16</td>
<td>Final Installment</td>
</tr>
<tr>
<td>5/23/16</td>
<td>FMSR</td>
</tr>
<tr>
<td>6/1/16</td>
<td>Weekly Teleconferences</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/6/16</td>
<td>Integration Reading week</td>
</tr>
<tr>
<td>6/20-26/16</td>
<td>Testing &amp; Environmental Week @ WFF</td>
</tr>
<tr>
<td>7/18/16</td>
<td>LRR</td>
</tr>
<tr>
<td>8/2-8/16</td>
<td>Final Integration @ WFF</td>
</tr>
<tr>
<td>8/9/16</td>
<td>Expected Launch</td>
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</table>
## Budget

<table>
<thead>
<tr>
<th>Parts w/ Redundancy</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerogel</td>
<td>$504.00</td>
</tr>
<tr>
<td>Cameras</td>
<td>$209.25</td>
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<tr>
<td>Space Ready Wires</td>
<td>$200.00</td>
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<tr>
<td>Insulation</td>
<td>$250.00</td>
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<tr>
<td>Raspberry Pi Compute Module</td>
<td>$345.84</td>
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<tr>
<td>Structure</td>
<td>$1,500.00</td>
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<tr>
<td>Custom IO Parts</td>
<td>$657.33</td>
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<tr>
<td>Rocksat Deposit</td>
<td>$2,000</td>
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<tr>
<td>RockSat Berth</td>
<td>$12,000</td>
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<table>
<thead>
<tr>
<th>Travel Expenses</th>
<th># of Students</th>
<th>Cost</th>
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<tbody>
<tr>
<td>June 2016 5 Days</td>
<td>7</td>
<td>$5,341.00</td>
</tr>
<tr>
<td>August 2016 10 Days</td>
<td>3</td>
<td>$3,600.00</td>
</tr>
<tr>
<td>August 2016 4 Days</td>
<td>4</td>
<td>$1,920.00</td>
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</table>

| Total                         |               |        |
| Parts                        |               | $17,666.42|
| Travel/Food                  |               | $10,861.00|
| Contingency                  |               | $400.00 |
| Total                        |               | $28,927.42|

Deposit Status: Deposit and First Installment sent on 2/11/16
Team Available

### Capitol Technology University, Project TRAPSat

**STR RS-X Team Availability Matrix**

<table>
<thead>
<tr>
<th>Feb 15-19</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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<tr>
<td>7:00 AM</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1</td>
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<tr>
<td>8:00 AM</td>
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<td>1</td>
</tr>
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</tr>
<tr>
<td>12:00 PM</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00 PM</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2:00 PM</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3:00 PM</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4:00 PM</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>1</td>
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<td>5:00 PM</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

*PLEASE USE MOUNTAIN TIME ZONE TIMES (MST)*
# Latest Contact Matrix

## TRAPSat / Capitol Technology University

### Fall 2016 RS-X Contact Matrix

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Day Phone</th>
<th>Cell Phone</th>
<th>Receive Texts?</th>
<th>Email</th>
<th>Citizenship</th>
<th>OK to Add to Mailing List?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator/ Lead Engineer</td>
<td>Ryan Schrenk</td>
<td>443-829-8228</td>
<td>443-829-8228</td>
<td>Yes</td>
<td><a href="mailto:rmschrenk@captechu.edu">rmschrenk@captechu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Lead Engineer</td>
<td>Nathan Weideman</td>
<td>-</td>
<td>240-538-1870</td>
<td>Yes</td>
<td><a href="mailto:nathan_weideman@yahoo.com">nathan_weideman@yahoo.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Lead Software Engineer</td>
<td>Keegan Moore</td>
<td>302-542-2293</td>
<td>302-542-2293</td>
<td>Yes</td>
<td><a href="mailto:keeganmoore.km@gmail.com">keeganmoore.km@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Lead Computer Engineer</td>
<td>Zach Richard</td>
<td>302-245-6170</td>
<td>302-245-6170</td>
<td>Yes</td>
<td><a href="mailto:zach.richard94@gmail.com">zach.richard94@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Software Development Specialist</td>
<td>Alex Maricich</td>
<td>443-481-7120</td>
<td>443-481-7120</td>
<td>Yes</td>
<td><a href="mailto:w33tmaricich@gmail.com">w33tmaricich@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>Lead Business Systems Analyst</td>
<td>Michael Strittmatter</td>
<td>609-364-8518</td>
<td>609-364-8518</td>
<td>Yes</td>
<td><a href="mailto:mstrittmatter@captechu.edu">mstrittmatter@captechu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>CAD Specialist</td>
<td>Christopher Murray</td>
<td>724-987-8096</td>
<td>724-987-8096</td>
<td>Yes</td>
<td><a href="mailto:ctmurray@captechu.edu">ctmurray@captechu.edu</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
<tr>
<td>CAD Specialist</td>
<td>Pierce Smith</td>
<td>717-945-3448</td>
<td>717-945-3448</td>
<td>Yes</td>
<td><a href="mailto:piercesmith34@gmail.com">piercesmith34@gmail.com</a></td>
<td>U.S.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Concerns

Concern: aerogel breaks apart during vibration testing.

Outcome: It should not affect any other systems or subsystems on our payload. continue testing without aerogel.

*The manufacturer of the aerogel has warned us that their product has been damaged by shake tables, but it has not been an issue during actual flights and launches. This aerogel manufacturer has manufactured their product for other NASA missions.
Conclusions

Questions
- How much access will we have to the Power/Data lines and Test Points during testing at Wallops?
- Will telemetry simulation be performed at Wallops test flight facilities.