Create a reflow oven capable of soldering surface mount electronic components to a printed circuit board in the microgravity environment. Create a system that can record accelerometer data occurring in a payload during launch to build a model of the rockets telemetry. Measure and record pressure data along the surface of a launch vehicle using a high frequency pressure transducer.

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1.0 Mission Statement, Requirements, and Expected Results

Reflow Soldering

Create a reflow oven capable of soldering surface mount electronic components to a printed circuit board in the microgravity environment. This will inform the development of a reflow soldering oven to be used on long duration manned space missions. At a minimum, it is expected that the temperature in the oven should match the desired temperature profile. The maximum temperature that needs to be achieved is 220°C.

Accelerometer Filtering

Create a system that can record accelerometer data occurring in a payload during launch to build a model of the rockets telemetry. The system will be inexpensive and will consist of commodity hardware in a small footprint.

Pressure Sensor

The objective of the Pressure Sensor team is to observe aerodynamic phenomena in high-speed vehicles, in particular a boundary layer transition which occurs at high speeds. As the rocket approaches speeds of Mach 4, the flow of air on the outside of the rocket is expected to make a rapid shift from laminar to turbulent flow, manifested as high-frequency oscillations in the range of 100 - 1000 kHz. Using a high-speed data collection unit in conjunction with a custom signal conditioner, the team hopes to collect data from a high-frequency pressure transducer to verify whether or not this phenomenon occurs at the speeds reached by a sounding rocket, and if it does, analyze the frequencies of the oscillations.

2.0 Final Payload Design

Reflow Soldering

The soldering oven was manufactured in the Stevens Machine Shop. The oven is able to isolate the heat from the rest of the canister while also concentrating it towards the board that is being soldered.

A custom circuit board with an Adafruit Feather MO datalogger to collect data and run the PID temperature loop.
Accelerometer Filtering

Physically the accelerometer hardware is nearly identical to last year’s mission. The accelerometer mounts and braces are the same design, but slightly resized.

The material neoprene is being used to test if it has a major effect on the data gathered. The accelerometer board can be seen below.
Pressure Sensor

The pressure sensor data acquisition system consists of a Beaglebone with a PRUDAQ mounted to the top using the pin rails along either side of the board. The signal conditioning board then utilizes the pin rails on the PRUDAQ to mount in a similar manner, creating a 3 board stack with a secure connection between each board and the unit as a whole. Mounting within the canister is done via simple screws. The Beaglebone is bolted onto the side of the oven, and fastened with nylon locking nuts. On top of the PRUDAQ, the signal conditioner board is inserted into the associated rails and press fit together. This forms a rigid, three board stack that is mounted within the canister. The power cables from the batteries are then routed up to the signal conditioner board to provide the necessary voltage to power the Beaglebone, PRUDAQ, and pressure sensor. This power is transmitted to the Beaglebone and PRUDAQ through the attached rails, ensuring a solid connection at all times compared to a soldered connection or clips. Two leads then run off of the signal conditioner board to the pressure sensor.
in the multi-purpose port window. These leads run through the SMA connector and are connected directly to the signal conditioner board which provides power and captures the signal produced, which is acquired and downloaded to a USB memory drive through the Beaglebone.

Custom designed/built signal conditioner board prior to final mounting

3.0 Testing Results

A. Integrated Subsystem Testing Results

Reflow Soldering

Testing was conducted to ensure the oven design in conjunction with the heater selection would meet the 220°C and to stress test the electronics and power systems.

![FLIR Image](image)

The tests confirmed that it was possible to heat the oven to the desired temperature. Running the heaters at maximum rate is dangerous as the thermal expansion of the heater is limited and can caused the heater to
fracture. This result was useful as it identified the weakest link in the design, the heater, and the test also validated the entire power system. It also showed that the e

Accelerometer Filtering
Data able to be written to SD card from sensors, but is currently written as a CSV file (slow). The code will be optimized to increase the sampling speed by using a binary format using some of the techniques developed by the inter project power system team.

Pressure Sensor
The frequency of the GPIO clock has been tested, to confirm a 2MHz clock as set in software. Data has been successfully recorded (as a 400Hz sine wave) and graphed in a real-input test, as noted in the 5/20 update telecom. Further tests will continue for as long as possible, to ensure consistent sampling at different frequencies.

These tests have been run an equal amount of times on both sets of duplicate hardware, to ensure redundancy and mitigate failure prior to launch.

B. Full Mission Simulation Results
As of June 3rd a complete Mission Simulation has yet to be run.

4.0 Launch Readiness

Reflow Soldering
Soldering requires the PID loop to be tuned under launch conditions. This is best achieved during full mission tests.

Accelerometer Filtering
Accelerometer filtering project’s board came in and is waiting on some components coming in on June 5th, mainly headers to connect to the board. Code is in a good state but needs some finishing up.

Pressure Sensor
While the amplifier board is in the final stages of development, the software side of the project is complete. Data has been successfully captured, pre-processed, and rendered in a human-readable graph format, and we are confident the results of recording during launch will be representative of the real-world input. Only minor quality-of-life tweaks remain, such as adjusting the wait time before recording (to minimize wasted data at the beginning) or dumping the unused channel in real time to avoid further processing (as the PRUDAQ reads two channels simultaneously, but the project only requires one).

A. User Guide Compliance
### Center of Gravity in 1" Mid-Can

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status/Reason (if needed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center of gravity in 1&quot; mid-can</td>
<td>Will be (with second payload)</td>
</tr>
<tr>
<td>Contained in can</td>
<td>Yes</td>
</tr>
<tr>
<td>Connected to can by 4 or 5 bulkheads on top and bottom only</td>
<td>Yes</td>
</tr>
<tr>
<td>Mass at 20±0.2lbs</td>
<td>Will be (with second payload)</td>
</tr>
<tr>
<td>Shared canister clearance</td>
<td>Yes</td>
</tr>
<tr>
<td>No voltage on the can</td>
<td>Yes</td>
</tr>
<tr>
<td>No voltage on multipurpose port</td>
<td>Yes</td>
</tr>
<tr>
<td>Activation wires at least 4 ft</td>
<td>Yes</td>
</tr>
<tr>
<td>Activation wire at least 24 gauge</td>
<td>Yes</td>
</tr>
<tr>
<td>Early Activation: current &lt; 1 A</td>
<td>Yes</td>
</tr>
<tr>
<td>T-0 Activation: current &lt; 1 A</td>
<td>Yes</td>
</tr>
<tr>
<td>Battery Type</td>
<td>Lithium Polymer (not charging at Wallops)</td>
</tr>
</tbody>
</table>

### B. Integration Plan and Procedure

Ensure that all data recording devices are blank. Ensure that all soldering oven fail safes are in place. Check with canister partners and begin canister integration. Test for user guide compliance prior to official inspection. If there are areas of non-compliance, make them compliant. Add weights where appropriate to ensure the weight and center of mass requirements are in spec with both canister partners present.

### C. Action Items

Complete electronics assembly (waiting on components coming in on Wednesday June 5th). Full system testing with all final boards will be completed after this is finished. Complete canister assembly anticipate completing June 8th. Run full mission test within canister. Tune PID controller for Soldering Oven. Repeat process until confident the PID values are sound.

### 5.0 Conclusions (0.5 to 1 page)

**Reflow Soldering**

Tuning the PID is a top priority, but the entire system needs to be assembled to tune the the PID. So a number of action items must be tackled first.

**Accelerometer Filtering**

The PCB is in and will be tested as soon as the components come in. The code needs some work to improve the performance, but is manageable. Electrically the...
project could be improved by adding pull-up resistors to the chip-select line on the accelerometer end of the cable instead of the microcontroller, but the current design is workable.

Pressure Sensor
As above, the system appears ready to record data at the required sample rate, and post-processing methods are in place to extract information as soon as the mission concludes. Given the history of this project and the series of previously failed attempts, we are confident this iteration will succeed.

Inter-Project Power System
The inter project power system V1 board is fully operational with all functions working, the V2 board is waiting on some components from the June 5th order but will be finished when those components come in. There are enough components and boards to have two spares.

Overall, the payload appears to be on track in terms of capability, but testing as a whole unit has been lagging somewhat behind. Despite this, we are confident in mission performance, as testing of individual components has thus far shown promise.