Environmental Test Document

Team #3114

Robotics for Space eXploration (RSX)

Overview

- Thermal test
- Vibration test
- Vaccuum test
- Drop test

Even though the vacuumed test was not able to reach the expected apogee of 700m, changing the code to allow apogee to be reached around the maximum vacuumed (~200 m) still displayed how the cansat would eject once it reaches apogee

Drop Test Configuration

Requirements:

Telemetry must be received before, during, and after the drop test.

Power must not be lost upon dropping the system.

Physical components must not detach upon dropping the CanSat.

Components of the CanSat should not be damaged from the drop test.

The test structure must not be held by hand.

Materials:

61 cm, 5/8" tubular nylon cord

Eyebolt

Scrap wood and Clamps

Winter Jackets (padding)

Setup:

Two 2x4s are placed on the corner of the balcony above Myhal Arena and a large piece of scrap plywood with an eyebolt screwed into the centre and directed towards the ground is placed on top of the 2x4s. The wood is clamped to the rails of the balcony using 4 clamps. The eyebolt of the testing rig is attached via the nylon cord to a second eyebolt screwed into a plywood disk fed through the hole of the parachute and taped to the parachute to ensure it stays centered. Place winter jackets on the ground below the test fixture to act as a safety net for the CanSat if it drops.

Drop Test Procedures

Procedure:

1) Power on CanSat.
2) Verify telemetry is being received.
3) Assemble the testing rig described in the previous slide.
4) Start video recording this testing procedure.
5) Feed the wooden disk with an eyebolt through the hole of the parachute. Use tape to keep the eyebolt in the centre of the hole.
6) Using the tubular nylon, attach these two eyebolts, a distance of 61cm away from each other.
7) Photograph how the CanSat and parachute are fastened to the testing rig.
8) Raise CanSat by the attached cord, so that the attachment points of the cord, on the eye bolt and the parachute, are at the same height.
9) Photograph the CanSat at this point in the procedure.
10) Release the CanSat.
11) Photograph the CanSat after the drop.
12) Verify the CanSat did not lose power.
13) Turn the CanSat off.
14) Inspect for any damage, or detached parts.
15) Verify telemetry is still being received.
16) Stop the video recording.
17) Make this video available to the judges and ensure it does not exceed 5 minutes in length.

Drop Test Results

Video Link:
https://drive.google.com/file/d/1sROrkcR7NDwY3mso1kv6UxrnZrP9bl7X/view?usp=sharing
Result: The cansat was still functioning normally after the drop test, and it was structurally sound, as explain by our mech lead, Arthur in the linked video.

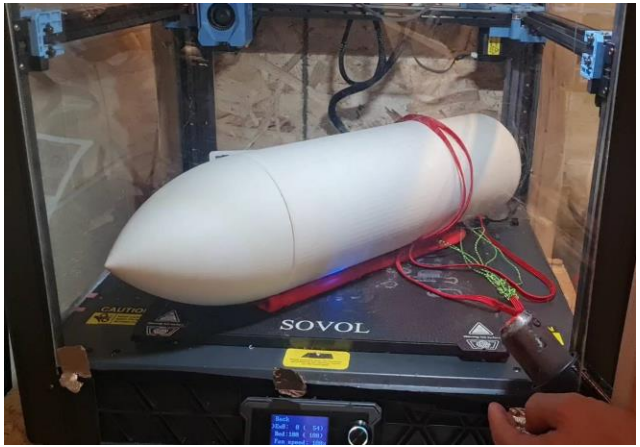
Thermal Test Configuration

Requirements:

Power must not be lost while heating the system.

Components of the CanSat should not be damaged from the Thermal test.

The rubber bands applying the force to lift the rotor joints shall take the same amount of time to deploy the rotors before and after the thermal test.



Materials:

Thermal Chainber (3D printer with heated bed)

Heat Gun

LCD thermometer

Setup:

Set up the heated but to 100 degrees C. This makes the thermal chamber reach 60 degrees C. The thermal chamber loses heat due to imperfections in the chamber. We use

Before putting the cansat in the chamber, put a thermally insulating layer to avoid the cansat direct contact with the 100-degree bed.

Thermal Test Procedures

Procedure:

1) Using a Newton Force Meter Spring Scale, measure the force required to lift a single air foil. Video this process.
2) Clamp one end of the fin down along a distance of 2cms down the fin. Place the mass at the opposite end, and using two rulers, measure the8) Raise CanSat by the attached cord, so that the attachment points of the cord, on the eye bolt and the parachute, are at the same height. distance that the system bends downward. Video tape this process.
3) Place CanSat into a thermal chamber in a secure fashion and video this process.
4) Photograph the manner in which the CanSat is secured.
5) Turn on the CanSat.
6) Close and seal the thermal chamber.
7) Turn on the heat source.
8) Monitor the temperature and turn off the heat source when the internal temperature reaches 60C and turn on the heat source when the temperature drops to 55C.
9) Take a short video highlighting abidence to the above step.
10) Maintain the test conditions for two hours.
11) Turn off the heat source and perform visual inspection and any functional tests to verify the Cansat survived the thermal exposure and can operate as expected. Ensure there is no visible warping or any broken or loose components.
12) Photograph the system.
13) Start a video recording.
14) With the CanSat still hot, remove the CanSat from the chamber.
15) Test any mechanisms and structures to ensure the integrity has not been compromised. Force deployment and ensure the AGDS does not get stuck within the CC due to thermal expansion.
16) Verify through telemetry that the electronics are consistently functional.
17) Turn off the CanSat.
18) Verify epoxy joints and composite materials still maintain their strengths by repeating steps 1) and 2).
19) Stop the video recording
20) Splice together the many short videos into one long video. Ensure this video is less than 5 minutes long.
21) Make this video available to the judges.

Thermal Test Procedures

Procedure:

1) Test the CanSat motor release system is valid. Video tape this process.
2) Place a thermometer inside of the thermal chamber. Place a glove on the layer of the thermal chamber avoid CanSat's direct attachment to the heat bed. Video tape this process.
3) Place CanSat into a thermal chamber in a secure fashion and video this process.
4) Photograph the manner in which the CanSat is secured.
5) Tap the sides of the thermal chamber container and make sure it is properly sealed.
6) Double check if the thermal chamber is properly sealed.
7) Turn on the heat source.
8) Monitor the temperature and turn off the heat source when the internal temperature reaches 60C and turn on the heat source when the temperature drops to 55C.
9) Take a short video highlighting abidence to the above step.
10) Maintain the test conditions for two hours.
11) Turn off the heat source and perform visual inspection and any functional tests to verify the Cansat survived the thermal exposure and can operate as expected. Ensure there is no visible warping or any broken or loose components.
12) Photograph the system.
13) Start a video recording.
14) With the CanSat still hot, remove the CanSat from the chamber.
15) Test any mechanisms and structures to ensure the integrity has not been compromised. Force deployment and ensure the AGDS does not get stuck within the CC due to thermal expansion.
16) Verify through telemetry that the electronics are consistently functional.
17) Turn off the CanSat.
18) Verify epoxy joints and composite materials still maintain their strengths by repeating steps

Thermal Test Results

Video link: https://drive.google.com/file/d/1xN-CH3U1KcelX69eaLlpqZKlPzbh1Y-5/view?usp=drive_link

Result shows that the rotor deployment has not been affected by high temperature around 60 degrees.

Vibration Test Configuration

Requirements:

Accelerometer data must continue to be recorded and sent throughout the entirety of the testing procedure.

The CanSat must be able to withstand the vibrational shock without physical damage.

The Random Orbital Sander must not be held by hand.

Materials:

Random Orbital Sander (GIVE MODEL NUMBER)

Bench Vise

Plywood, Metal Brackets, Screws to fasten, Bolt, Washer, and Nut

Double sided Tape

Setup:

The orbital sander will be secured, downward facing, in the vise bench. A plywood disk the size of the sander's face will be attached using strong double-sided tape to the sander itself. This disk will have two small metal brackets screwed into it, spaced the width of the CC's eyebolt, enabling a bolt to pass through them and the eye bolt of the CC. A washer and nut will be tightened, creating pressure between the two brackets and the eyebolt.

Vibration Test Procedures

Procedure:

1) Power on the CanSat.

2) Verify accelerometer data is being collected.

3) Take a photograph of this setup. Take additional photos highlighting how the CanSat was secured explained in the setup on the previous slide.

4) Start a video recording.

5) Power up the sander.

6) Once the sander is up to full speed, wait 5 seconds.

7) Power down the sander to a full stop.

8) Repeat steps 5) to 7) four more times.

9) Photograph the CanSat.

10) Inspect the CanSat for damage and functionality.

11) Verify accelerometer data is still being collected.

12) Stop the video recording and ensure it is under 5 minutes in length. Make this video available to the judges.

13) Power down CanSat.

Vibration Test Results

- Results show that the cansat is still function and transmitting data after being subjected to 20 to 29 G of vibrations.

- Video Link: https://drive.google.com/file/d/1s6XSHnLbIq4v2N4K2I2q6ZPo6ZZZhTwv/view?usp=drive_link
  - Note: The magnetometer readings are showing 0 Gauss due to the small magnetic fields likely in the decimals and our GUI does not specify further than one full unit
  - Note: The accelerometer readings are only showing up to +-4G due to the original settings of the BNO-085 IMU sensor, however, our orbital saner is creating up to +-25G.

Vacuum Test Configuration

Requirements:

Telemetry must be received before, during, and after the vacuum test.

Telemetry must be exportable as a .csv.

The CanSat must decouple based off the simulated altitude data at 75% of the simulated apogee.

Materials:
IKEA 12-gallon bin

Vacuum

Gray Duct Tape

Clear garbage bag

Setup:

Using the CanSat Container's eyebolt, the system is to be taped to the bin. A towel is placed below the suspended system for padding. A garbage bag was pulled tight over the open side of the bin where the lid would go, and the bag is taped to the bin using the sealant tape. A small hole is cut into the bag and it is pulled over the nozzle of the vacuum. The edges of this tear are taped to the vacuum in order to create an airtight chamber.

Vacuum Test Procedures

Procedure:

1) Start a video recording.
2) Suspend the fully configured and powered CanSat in the vacuum chamber in the manner described in the setup on the previous slide.
3) Take a photograph of this setup.
4) Turn on the vacuum to start generating suction.
5) Monitor the telemetry in simulation mode and stop the vacuum when the peak altitude has been reached.
6) Let the air enter the vacuum chamber slowly and monitor the operation of the CanSat. The air will leak through the vacuum cleaner when off.
7) Ensure the AGDS decouples from the CC at 75% apogee.
8) Stop the video and ensure it shows all mechanisms activated based on altitude changes.
9) Collect the CanSat from the vacuum chamber.
10) Collect and save the telemetry.
11) Power off the CanSat.
12) Make the saved telemetry available for the judges to review.
13) Ensure the video is under 5 minutes long and make it available to the judges.

Vacuum Test Results

- Video link: https://drive.google.com/file/d/1sOdRuyu7-IHa7KviOOJac89K6n2n80d5/view?usp=sharing

- The vacuum test was a success even though the pressure in the enclosure did not reach the expected apogee pressure – the finite state machine was able to be performed as the "Apogee" state was reached when the pressure became constant for a few seconds after rising over a specific threshold.

Summary

- The tests were a success
- For next year, it would be nice to have a more powerful vacuume that allows us to simulate lower pressures similar to that which the cansat will experience at apogee (~700)