Environmental Test Document

Team 2036
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Overview

- Alignment Measurement & Fit Check
- Drop Test
- Thermal Test & Analysis
- Vibration Test
- Vacuum Test

Alignment Measurement & Fit Check Configuration(1/2)

- Requirements

  1. (S11) All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.
  2. (M4) Spring contacts shall not be used for making electrical connections to batteries. Shock forces can cause momentary disconnects.
  3. (E3) Easily accessible power switch is required
  4. (SN7) The CanSat shall include a video camera pointing horizontally.

- How to set up the alignment measurement & fit check
  - Create a manual containing the necessary parts and assembly sequence.

- Used materials
  - Laptop
  - Assembly sequence manual
  - All parts that make up CanSat

Alignment Measurement & Fit Check Configuration(2/2)

1. Heat Shield 조립

가. 필요 부품

1) UM_HS_UpperHolder : 1개 [3D printed]
2) UM_HS_Base : 1개 [3D printed]
3) UM_HS_LowerHolder : 1개 [3D printed]
4) UM_HS_Arm : 6개 [3D printed]
5) UM_HS_Stretcher : 6개 [3D printed]
6) UM_HS_Fin : 3개 [3D printed]
7) UM_HS_Pin : 6개 [3D printed]
8) 스프링 : 3개 [직접 제작]
9) 카본 파이프 : 3개 [물품 구매] - 외경 8mm
10) 2mm 철사 : EA [물품 구매] - 1m 이상
11) 낙하산 천 : EA [물품 구매] - 30cm*30cm 이상
12) 벨크로 : EA [물품 구매] - 최소 폭 25cm 이상

나. 조립 방법

1) UpperHolder와 Arm을 준비한다.
2) 벨크로를 Arm에 맞게 재단한 후 부착한다.
3) 2mm 철사를 5cm 길이로 잘라 18개를 준비한다.
4) 구멍에 맞추어 Arm과 UpperHolder, Arm과 Stretcher, Stretcher와 LowerHolder를 철사로 체결한다.
5) 카본 파이프를 추어진 길이에 맞추어 잘라 3개를 준비한다.
6) UpperHolder와 Base를 카본 파이프로 연결한다. 이때 접착제를 사용해 고정한다.
7) Fin과 Pin을 UpperHolder와 연결한다.

2. Payload 조립

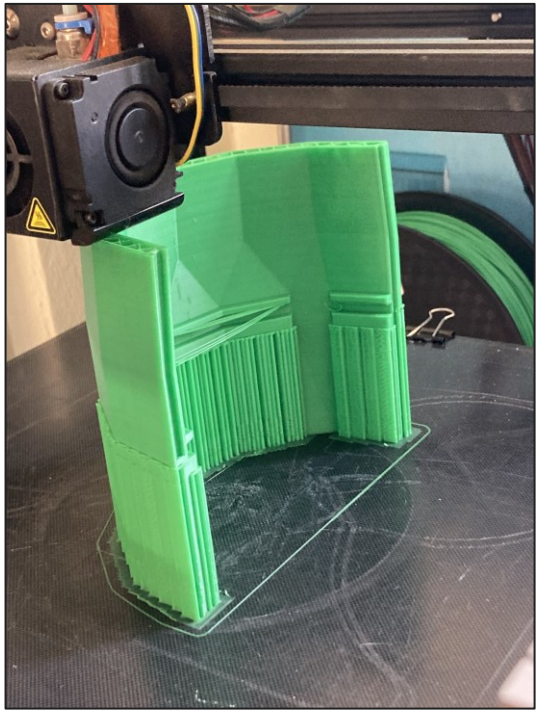
가. 필요 부품

1) UM_PL_BottomPlate : 1개 [3D printed]
2) UM_PL_BottomPlate : 1개 [3D printed]
3) UM_PL_InnerLower : 1개 [3D printed]
4) UM_PL_InnerUpper : 1개 [3D printed]
5) UM_PL_Outer : 1개 [3D printed]
6) 고무 댐퍼 : 8개 [물품 구매]
7) 고무 댐퍼 고정핀 : 8개 [물품 구매]
8) 0.5T아크릴 : EA [물품 구매] - 15cm*30cm 이상
9) 스펀지 : EA [물품 구매] - 충격완화재

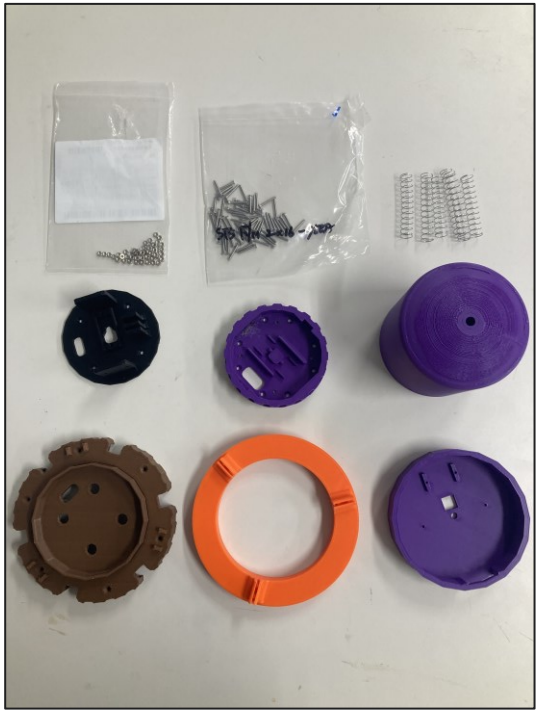
나. 조립 방법

1) BottomPlate와 UpperPlate에 고무 댐퍼를 연결한다.
2) 충분한 길이의 전선을 준비한 후 각 Plate에 고정해 준다.
3) Outer과 각 Plate를 고무 댐퍼로 연결한다. 이때 Outer의 열면과 케이블 구멍이 일치하도록 조립시켜 준다.
4) 고무 댐퍼 고정핀을 이용해 고정해 준다.

Assembly Sequence Manual(Korean ver.)



3D printing the parts



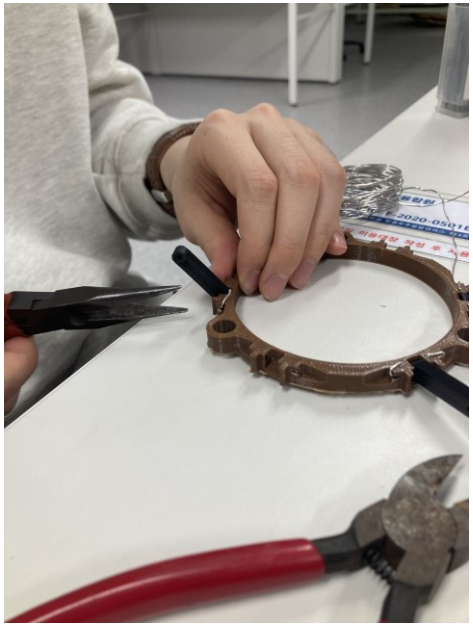
Prepare the necessary parts (partially)

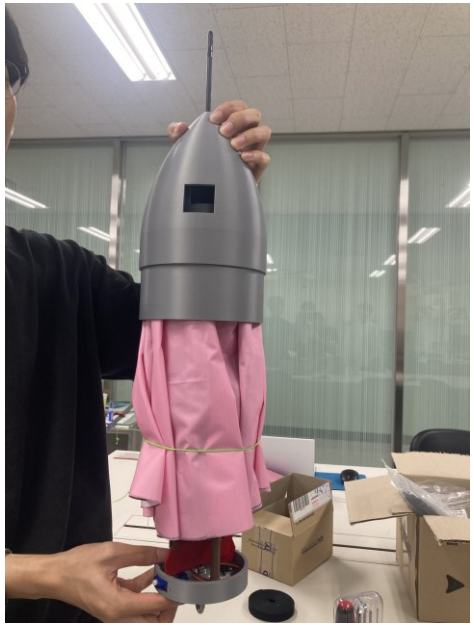
Alignment Measurement & Fit Check Procedures

- Procedure for the alignment test & fit check
  1. Create an assembly sequence manual to meet the requirements.
  2. Assemble the CanSat configuration sections according to the assembly sequence.
     - 2-1 Heat shield
     - 2-2 Payload
     - 2-3 Deployer
     - 2-4 Egg Container
     - 2-5 Rotation Control Unit
     - 2-6 String Parachute Unit
     - 2-7 PCB_Bottom
     - 2-8 PCB_Top
  3. Check that all fastenings meet the regulations and that there are no sharp parts.

Alignment Measurement & Fit Check Results

- Assembly Sequence Manual(Korean ver.)
  https://drive.google.com/file/d/1ONjQVolw4CqZDaJs7o2bAXhBqmf6E_KV/view?usp=sharing





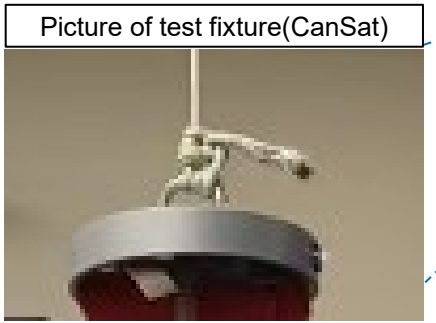
All parts were securely fixed according to the manual and satisfied the size regulations of the mission guide.

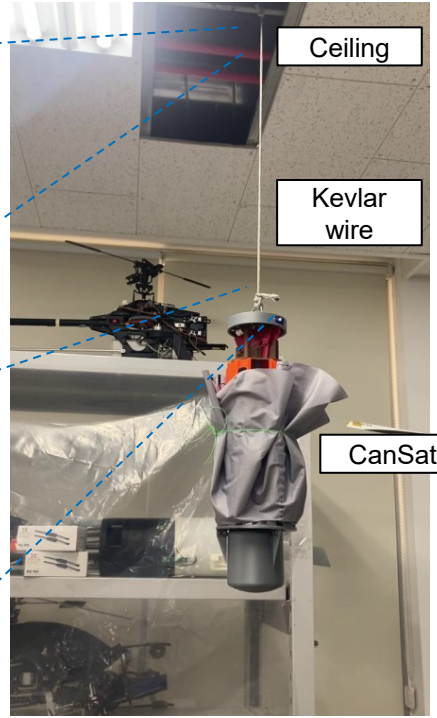
Drop Test Configuration(1/2)

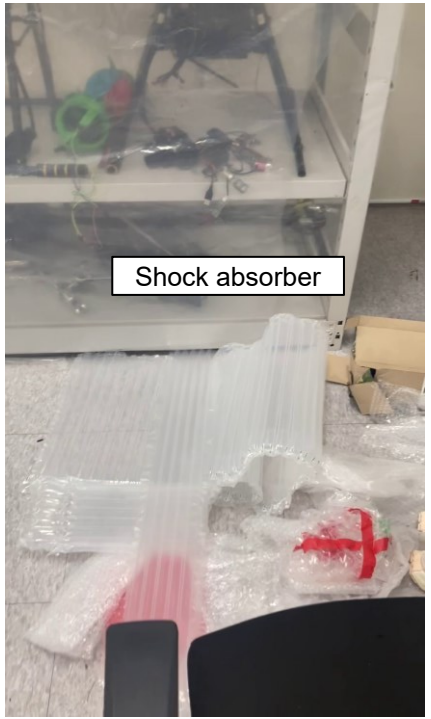
- Requirements
  1. (M3) All mechanisms shall be capable of maintaining their configuration or states under all forces.
  2. (S7) Cansat shall survive 30 G shock.
  3. (S11) All electronics and mechanical components shall be hard mounted using proper mounts such as standoffs, screws, or high performance adhesives.
  4. Telemetry is received well.

- Used materials
  - 61 cm non-stretching 1/8 thick kevlar cord
  - Shock absorber

Drop Test Configuration(2/2)







All parts were securely fixed according to the manual and satisfied the size regulations of the mission guide.

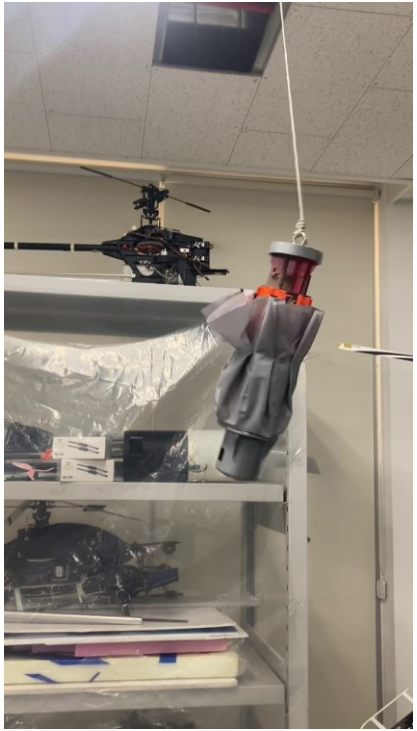
Drop Test Procedures

- Procedure for the drop test
  1. Power on CanSat.
  2. Verify telemetry is being received.
  3. 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.
  4. Release the CanSat.
  5. Verify the CanSat did not lose power.
  6. Inspect for any damage or detached parts.
  7. Verify telemetry is still being received.

Drop Test Results(1/2)

Just before drop

Dropping



Just after drop

Drop Test Results(2/2)

- After Drop Test,
  - CanSat survived.
  - Power loss, reset, battery disconnection is not occurred.
  - Any structures or mechanisms, electronics are not failed.
  - Telemetry is received well.

- Functional test is included in the video.
- Drop Test Video:

  https://drive.google.com/file/d/16w8Q6bTZcJE-h3OB3aRjbfRtgrX3IIIv/view?usp=sharing
- Telemetry:

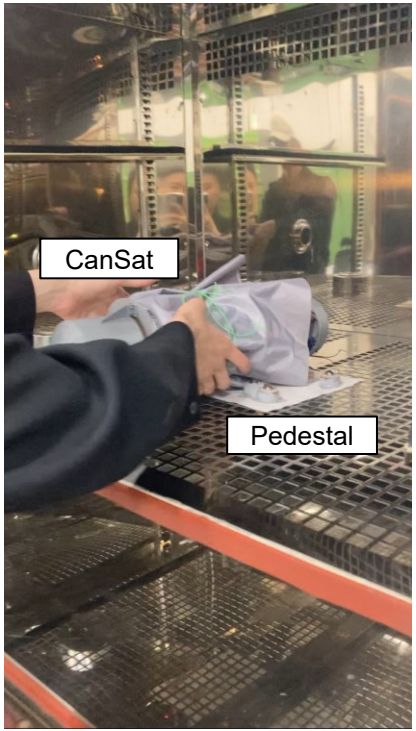
  https://drive.google.com/file/d/1ntX87TBvbUtJBWoV2EJHUEpoZiViRwQ7/view?usp=sharing

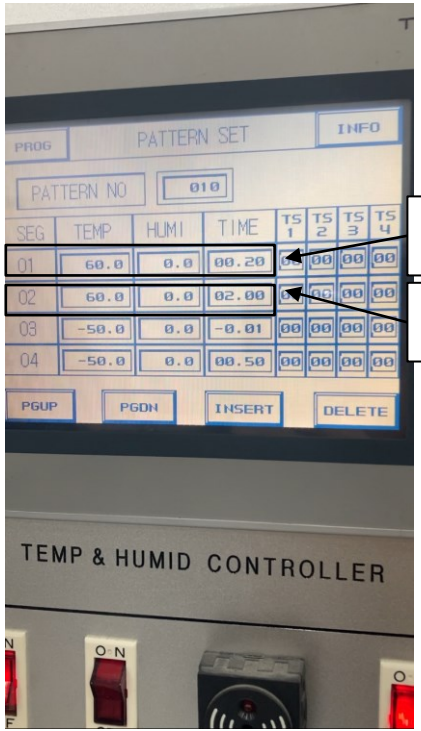
Thermal Test Configuration(1/2)

- Requirements
  1. CanSat can operate at a temperature of 60C for a period of 2 hours.
  2. The CanSat must not fail to function or change characteristics at temperatures up to 35°C.
  3. With the CanSat still hot, test any mechanisms and structures to make sure the integrity has not been compromised.
  4. Telemetry is received well.

- Used materials
  - Heat chamber

Thermal Test Configuration(2/2)





Initial heating(20m)

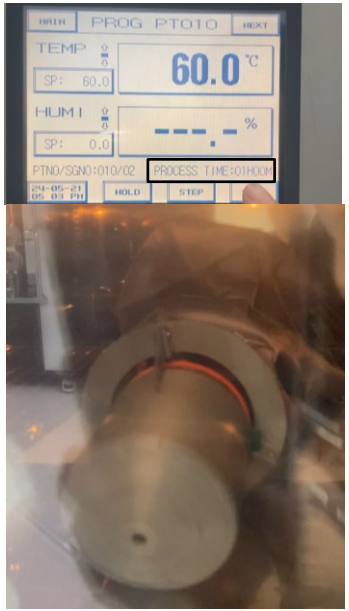
Heating for thermal test(2h)

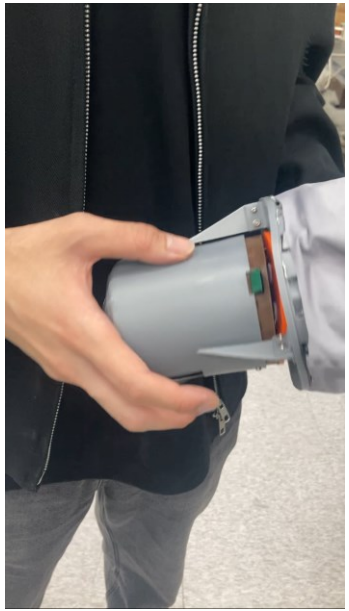
Place the CanSat on the pedestal and start heating according to the pattern of last picture.

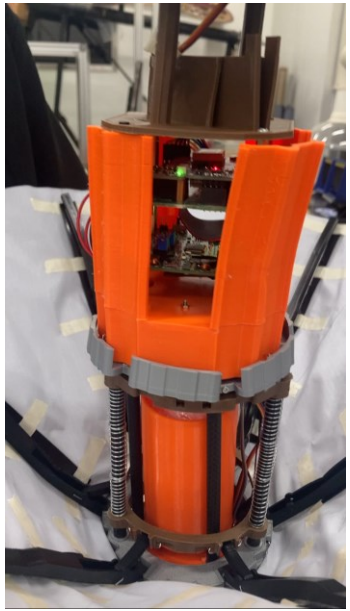
Thermal Test Procedures

- Procedure for the drop test
  1. Place CanSat into a thermal chamber.
  2. Turn on the CanSat.
  3. Close and seal the thermal chamber.
  4. Turn on the heat source.
  5. 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 55°C.
  6. Maintain the test conditions for two hours.
  7. 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.
  8. With the CanSat still hot, test any mechanisms and structures to make sure the integrity has not been compromised.
  9. Take precautions to avoid injury. Verify epoxy joints and composite materials still maintain their strengths.

Thermal Test Results(1/2)







Just before thermal test

1 hour after thermal test

Just after thermal test(nosecone unit, internal unit, parachute unit)

Thermal Test Results(2/2)

- During Thermal Test,
  - Because the heat chamber cannot stop at the correct temperature, the thermometer rose from 25.1ºC to 67.7ºC.
  - Telemetry is received well.

- After Thermal Test,
  - The major mechanical structure is not melted or destroyed, but a little bending occurred.
  - Payload Thermometer temperature was in range of 62.5ºC~67ºC.
  - Telemetry is received well.

- Functional test is included in the video.
- Thermal Test Video :
  https://drive.google.com/file/d/1f0RbZOexOEktNQanu3f7hv6ktyLujV10/view?usp=sharing
- Telemetry:
  https://drive.google.com/file/d/1VLSMCZYU1wshtfYHOkKsFK7tPhK4vPu8/view?usp=sharing

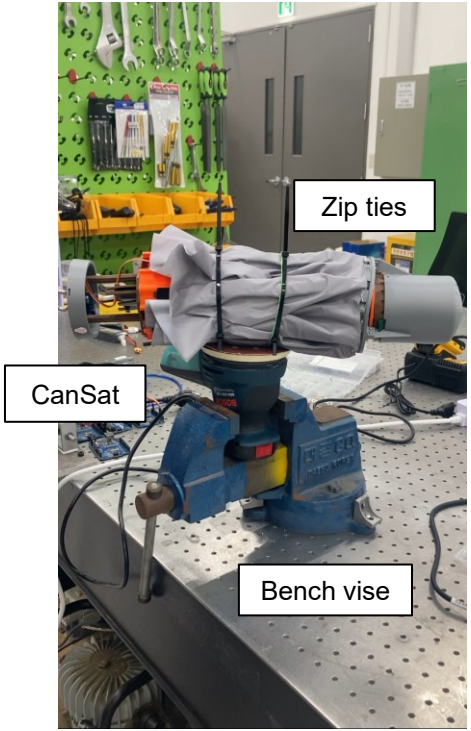
Vibration Test Configuration(1/2)

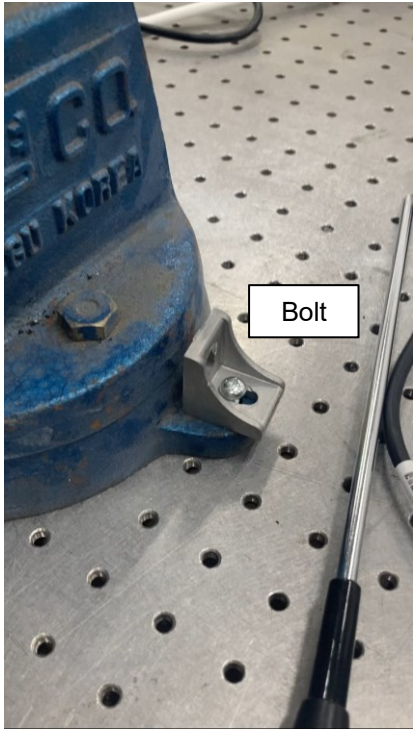
- Requirements
  1. All structures shall be built to survive 15 Gs of launch acceleration.
  2. All structures shall be built to survive 30 Gs of shock.
  3. All mechanisms shall be capable of maintaining their configuration or states under all forces.

- Used materials
  - Random orbital sander
  - Bench vise
  - Bolts for mounting vise
  - Zip ties for holding CanSat

- Random orbital sander information
  - BOSCH GEX 125-1 AE
  - Power Consumption: 250W
  - Weight: 1.3kg
  - Rotational Speed: 7,500 ~ 12,000rpm
  - Sanding Paper Diameter: 125mm

Vibration Test Configuration(2/2)

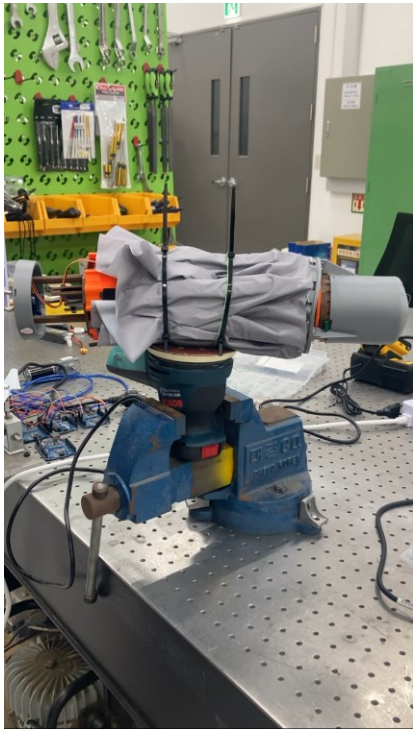




Vibration Test Procedures

- Procedure for the vibration test
  1. Power on the CanSat.
  2. Verify accelerometer data is being collected.
  3. Power up the sander.
  4. Once the sander is up to full speed, wait 5 seconds.
  5. Power down the sander to a full stop.
  6. Repeat steps 3 to 5 four more times.
  7. Inspect the CanSat for damage and functionality.
  8. Verify accelerometer data is still being collected.
  9. Power down CanSat

Vibration Test Results(1/2)



Just before drop

Spinning at full speed

Just after drop

Vibration Test Results(2/2)

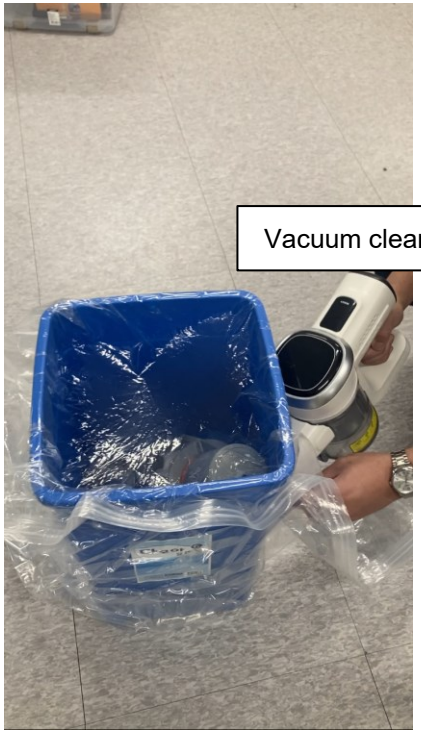
- During vibration test,
  - Accelerometer value(TILT X, TILT Y, Rot Z) is received well.
  - It is well fixed with no parts popping out during rotation.
- After vibration test,
  - Major mechanical structure is not broken/twisted.
  - Electronics/Power/Battery is alive.
  - Sensor data for rotation are received reliably.
- Functional test is included in the video
- Vibration Test Video:
  https://drive.google.com/file/d/1oOK7FqkG8Bfd8woIsYHxDeIOecm_IJTP/view?usp=sharing

Vacuum Test Configuration(1/2)

- Requirements
  1. CanSat launched to altitude up to 725 meters and shall ensure operation in low air pressure at high altitude.
  2. CanSat shall calculate altitude by pressure.

- Used materials
  - Big trash bin
  - Vinyl vacuum bag
  - Vacuum cleaner

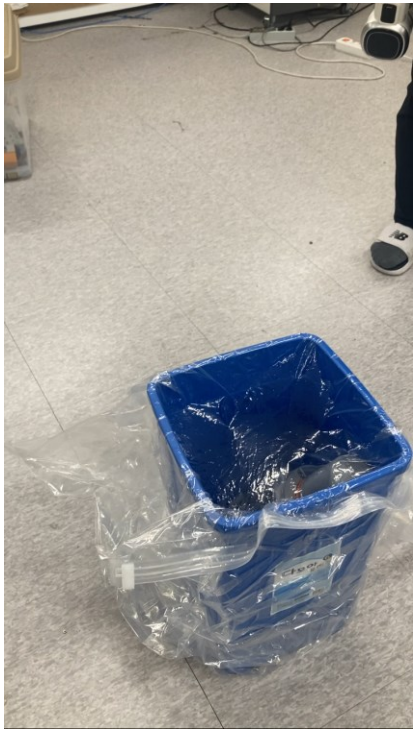
Vacuum Test Configuration(2/2)



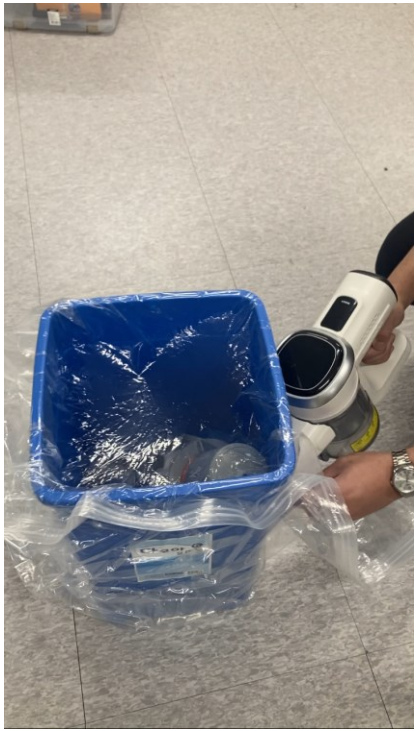
Vacuum Test Procedures

- Procedure for the vacuum test
  1. Suspend the fully configured and powered Cansat in the vacuum chamber.
  2. Turn on the vacuum to start pulling a vacuum.
  3. Monitor the telemetry and stop the vacuum when the peak altitude has been reached.
  4. Let the air enter the vacuum chamber slowly and monitor the operation of the Cansat.
  5. Collect and save telemetry Make the saved telemetry available for the judges to review.

Vacuum Test Results(1/2)

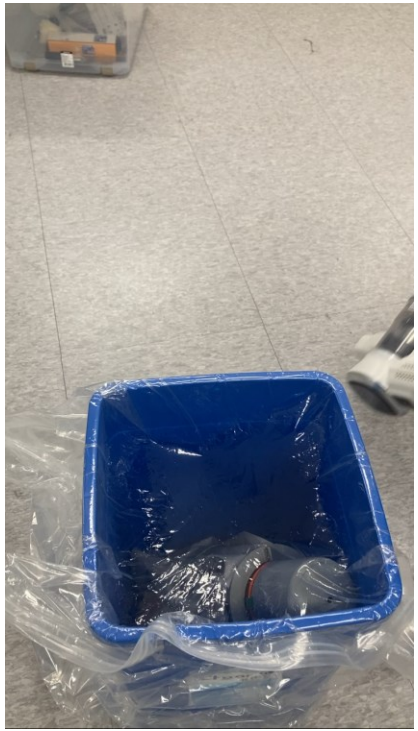


Just before vacuum



Pulling vacuum

Vacuum state at peak altitude



Just after vacuum

Vacuum Test Results(2/2)

- During vacuum test,
  - Telemetry is received well.
  - Altitude changes due to air intake are calculated stably.

- After vacuum test,
  - All components are well secured.
  - Telemetry is received stably.
  - The calculated data is displayed as a graph and saved as a CSV file.

- Vacuum Test Video:
  https://drive.google.com/file/d/1ZW7LCfHzHx2CtKcta8e2vtYICKOIP0JJ/view?usp=sharing
- Telemetry:
  https://drive.google.com/file/d/1rXRCqHqII2PMLqPZQ9IvBo6e1OsOyeFI/view?usp=sharing

Summary

- The Mechanical, Electronical components and Power or Battery had not failed in Environmental Tests.
- FSW worked well & did not reset.
- It is necessary to use highly heat-resistant carbon fiber filament to minimize bending due to heat.
- Use of self-locking nuts to reliably fasten all parts.