STRATODEVILS ASU ASCEND S23

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GOALS

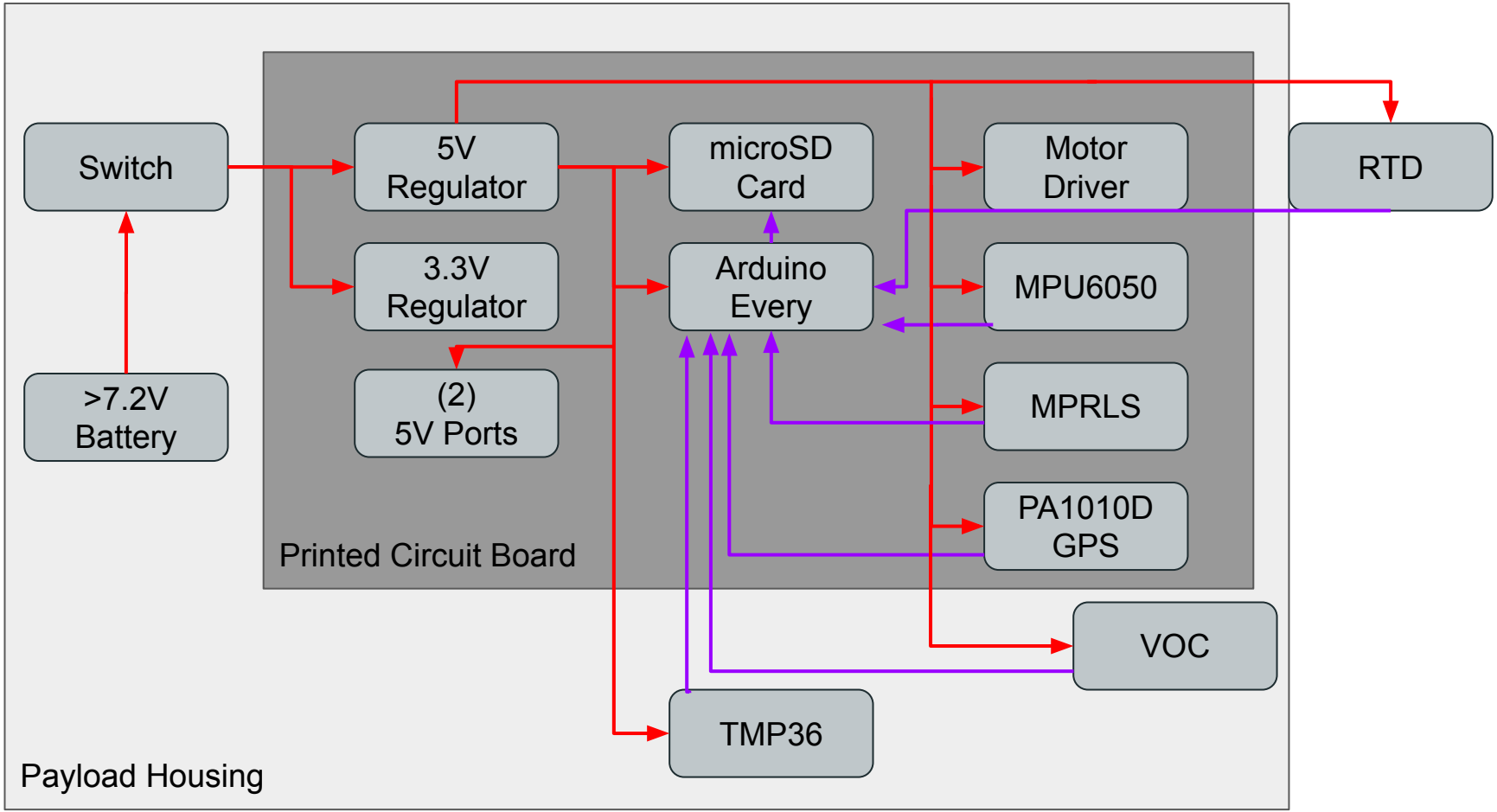
PROFILE THE ATMOSPHERE

SUCCESSFUL LAUNCH AND RETRIEVAL OF PAYLOAD

DETERMINE RADIATION EFFECTS ON LETTUCE SEEDS

ESTABLISH CONNECTION WITH GROUND STATION

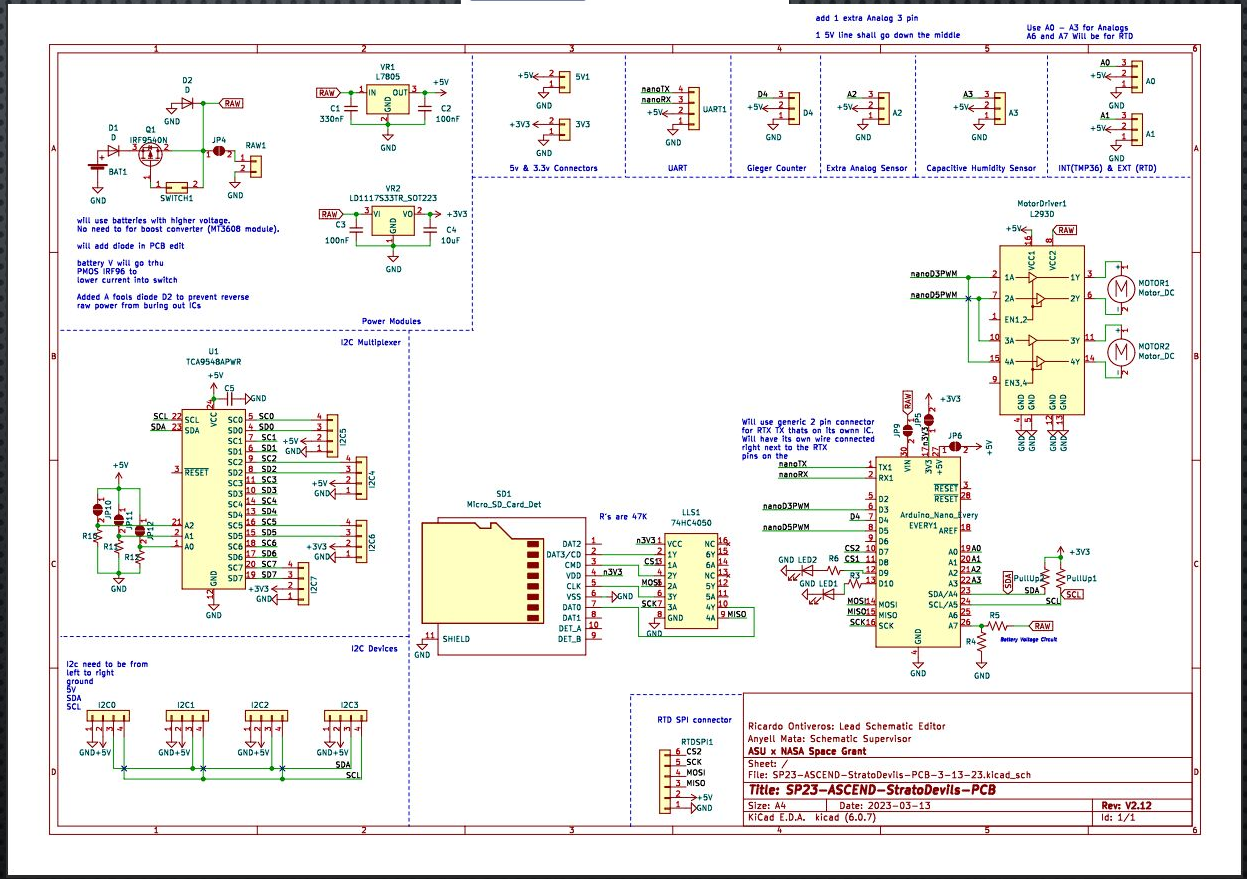
PAYLOAD STABILIZATION USING ADCS


Switch
>7.2V Battery
5V Regulator
3.3V Regulator
(2) 5V Ports
Printed Circuit Board
microSD Card
Arduino Every
TMP36
Payload Housing
Motor Driver
MPU6050
MPRLS
PA1010D GPS
VOC
RTD

SCHEMATIC

Process/ Development

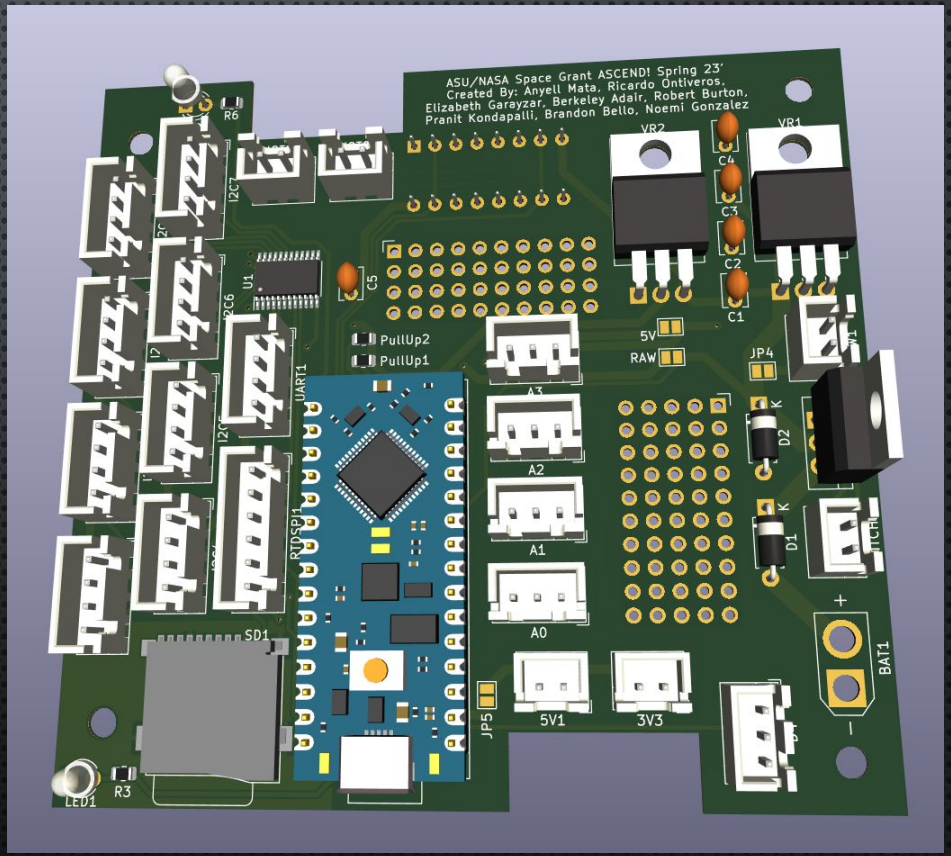
- Universal PCB Schematic was updated this semester
- Updated power systems
- Added PMOS Switch
- Created extra JST connections
- Integrated SD card



PRINTED CIRCUIT BOARD

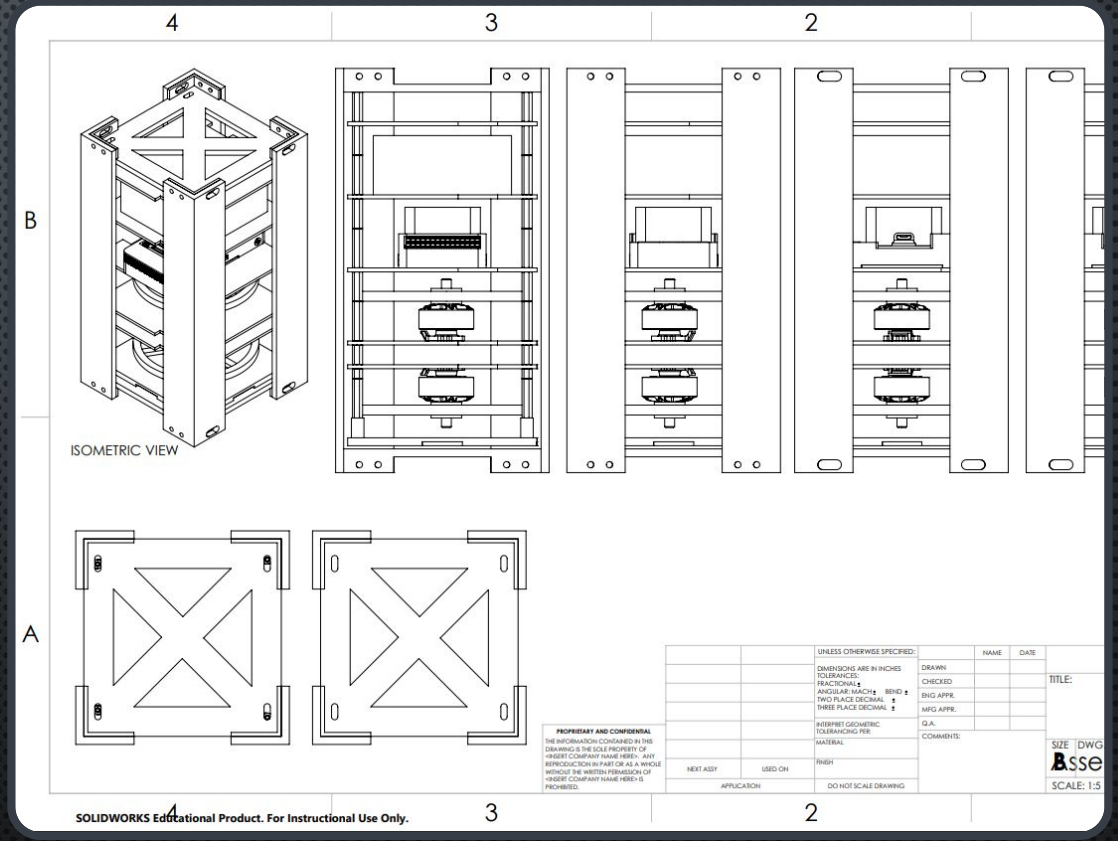
PROCESS/ DEVELOPMENT

- DESIGNED A NEW PCB
- PC104 DESIGN STANDARD FOR 1U CUBESATS
- EXTRA VIAS
- DESIGNED TO BE STACKED IN PAYLOAD HOUSING



HOUSING

- Modular and adaptable for future use
- Aluminum CubeSat Design was too heavy (3.3lbs)
- Outer housing is 2U foam core
- Inner housing is PLA stacks



Housing Analysis

The payload critical components did survive
- PCB
- Motors

The housing of the payload did not survive
- Cracked open
- A couple of PLA failure points

Having better corner beams would have better dealt with the situation.
- Allowing the shock to go through the payload

Key objectives met
- Module design of the payload helped in last minute touches and fixes
- Very simple to take apart and analyze due to the structure
- Created a mock CubeSat which teaches FUNDAMENTALS CubeSat system design

PROGRAMMING

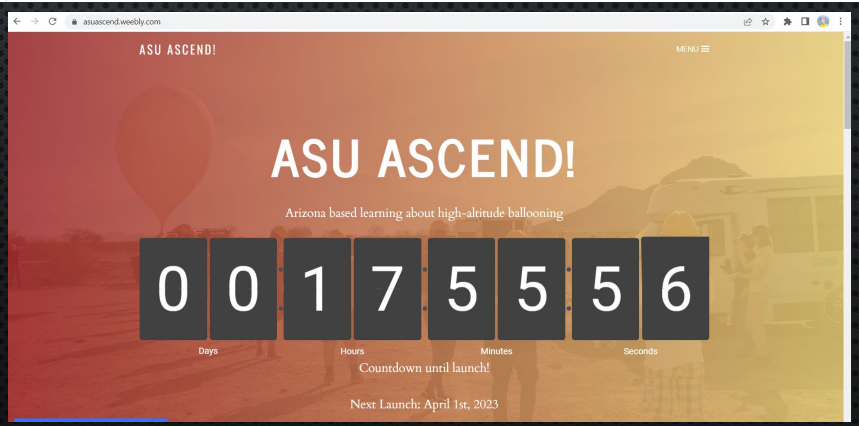
- Implementation of sensor code
- Ensuring sensors function through testing
- Code written Arduino programming
- File sharing through Github
- Data stored in SD as a CSV file
- Website design

StratoDevils_Components_Code_V5 | Arduino 1.8.19

File Edit Sketch Tools Help

StratoDevils_Components_Code_V5

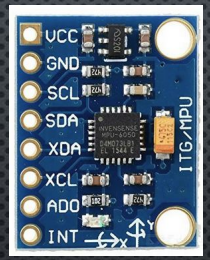
```
    (defined(BUFFER_LENGTH) && BUFFER_LENGTH >= MAXBUF_REQUIREMENT)
#define USE_PRODUCT_INFO
#endif
// You dont *need* a reset and EOC pin for most uses, so we set to -1 and don't connect
#define RESET_PIN  -1  // set to any GPIO pin # to hard-reset on begin()
#define EOC_PIN    -1  // set to any GPIO pin to read end-of-conversion by pin
//************Variables**********************************
Adafruit_MPRLS mpr = Adafruit_MPRLS(RESET_PIN, EOC_PIN);
Adafruit_MPU6050 mpu;
Adafruit_TSL2561_Unified tsl = Adafruit_TSL2561_Unified(TSL2561_ADDR_FLOAT, 12345);
SoftwareSerial ss(RXPIN, TXPIN);
SensirionI2CSen5x sen5x;

unsigned long currentTime = 0;
float sensorVal;
float inTmpV;
//float extTmpV;
boolean groundMode = 0;
// Variable for file name
char logFileName[16];
//Character strings for writing data to memory //
String header = "Time,hp,X,Y,Z,IT,pm1,pm2,pm4,pm10,ambHum,ambTmp,VOCI,Volt3V,latitude,longitude,Alt,lux";
String dataString = ""; //holds the entire data string for each read cycles

```



SENSORS

TMP36
(Temp)

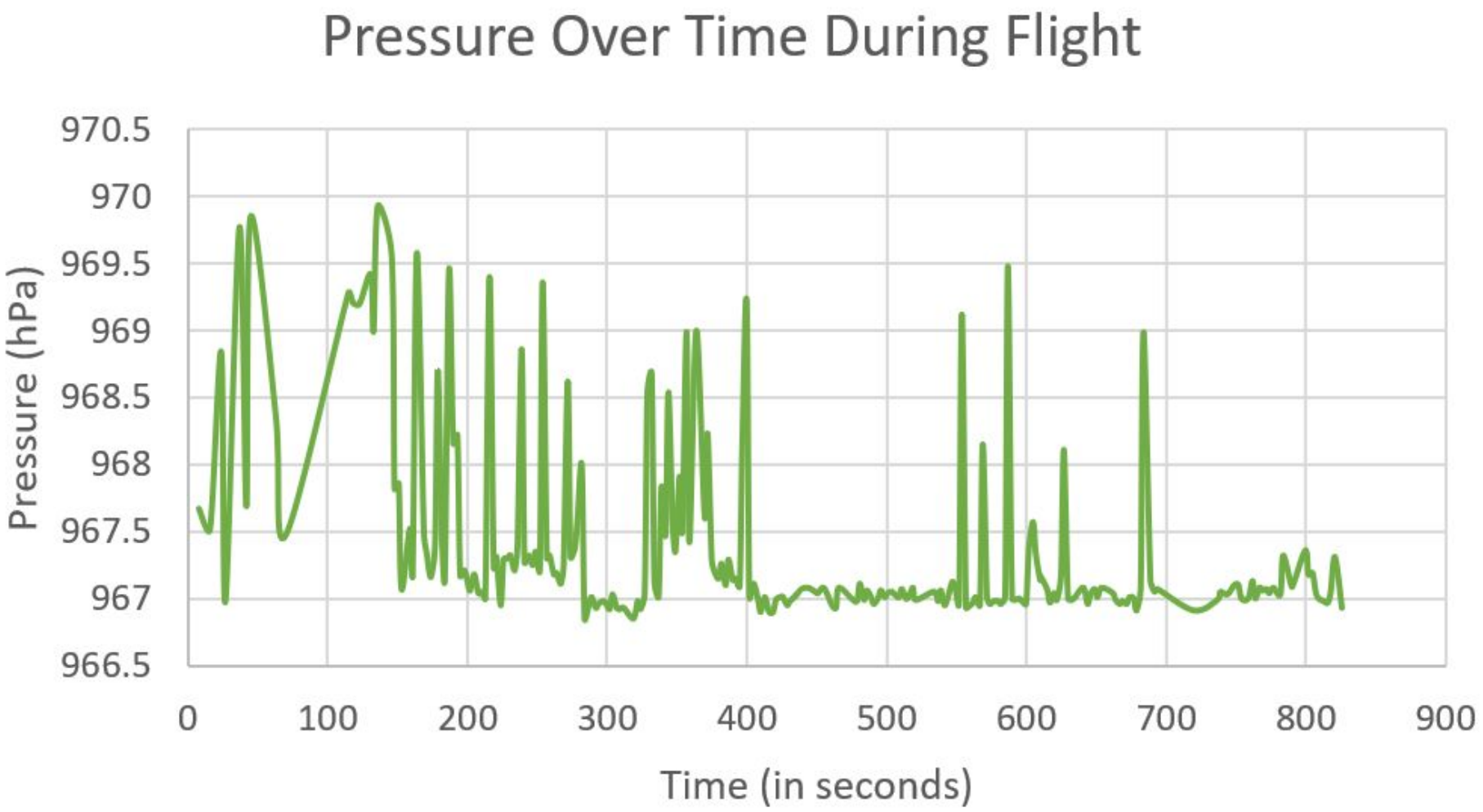
SEN55
(VOC)

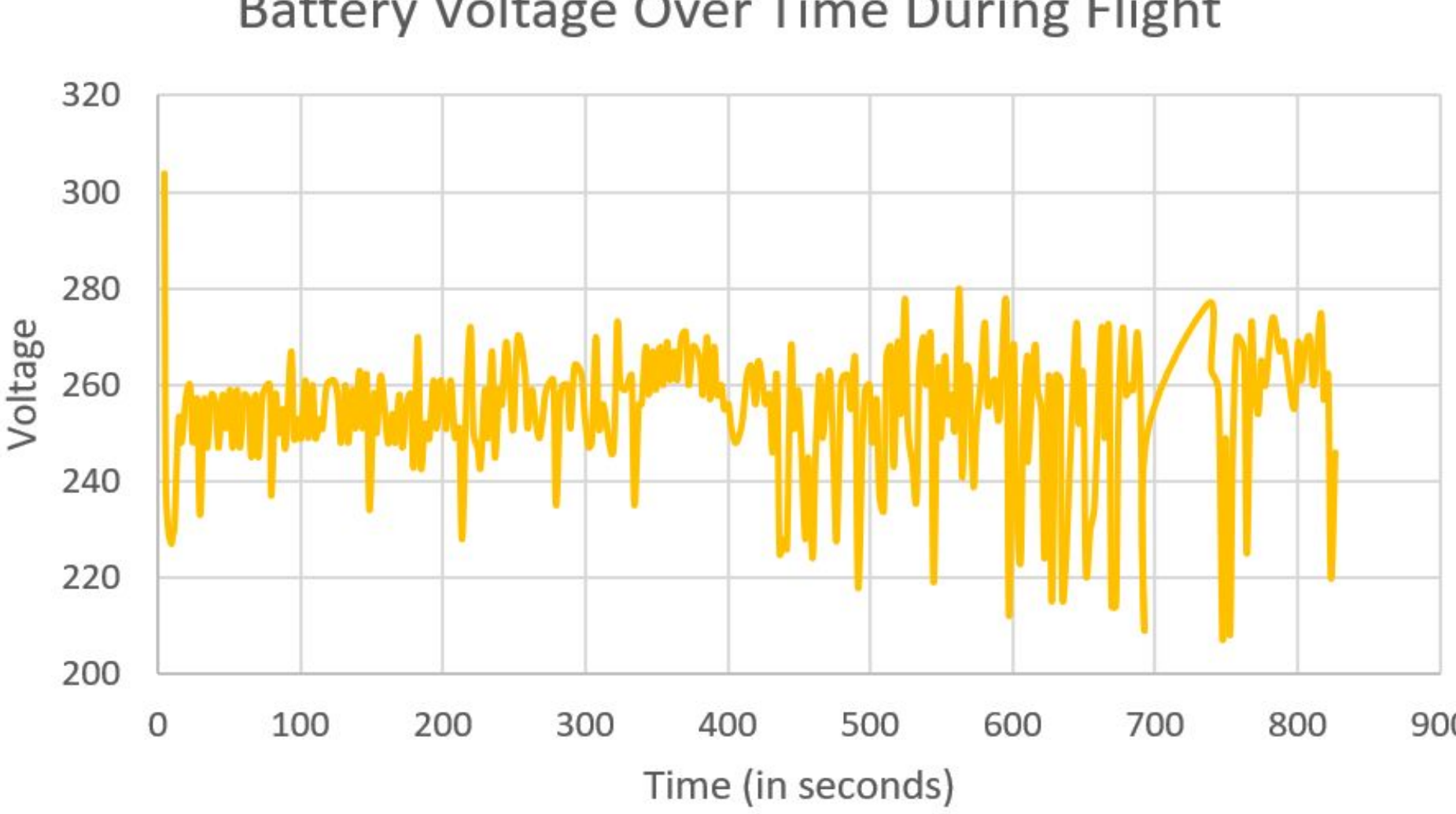


MPU6050
(Accelerometer
and Gyro)

MPRLS
(Pressure)

PA1010D
(GPS)

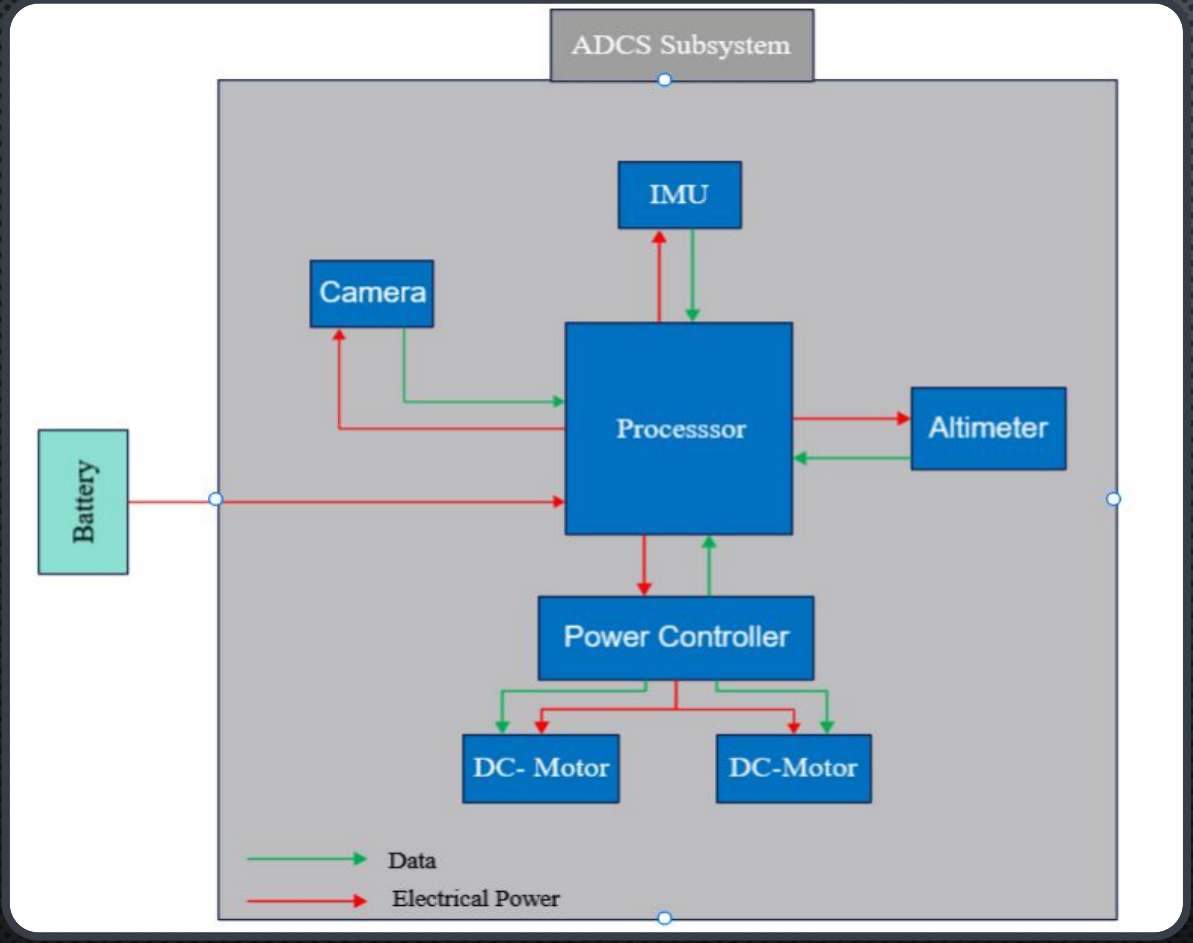

Pressure Over Time During Flight
970.5
970
969.5
969
968.5
968
967.5
967
966.5
Pressure (hPa)
0
100
200
300
400
500
600
700
800
900
Time (in seconds)


Battery Voltage Over Time During Flight
320
300
280
260
240
220
200
Voltage
0
100
200
300
400
500
600
700
800
900
Time (in seconds)

GPS READINGS

- Successfully parsed NMEA sentences
- GPS (Arduino PA1010D) recorded readings that are off by -π/2 radians

GitHub



ADCS SYSTEM BLOCK DIAGRAM

ADCS EXPECTED OUTPUT / DESIGN

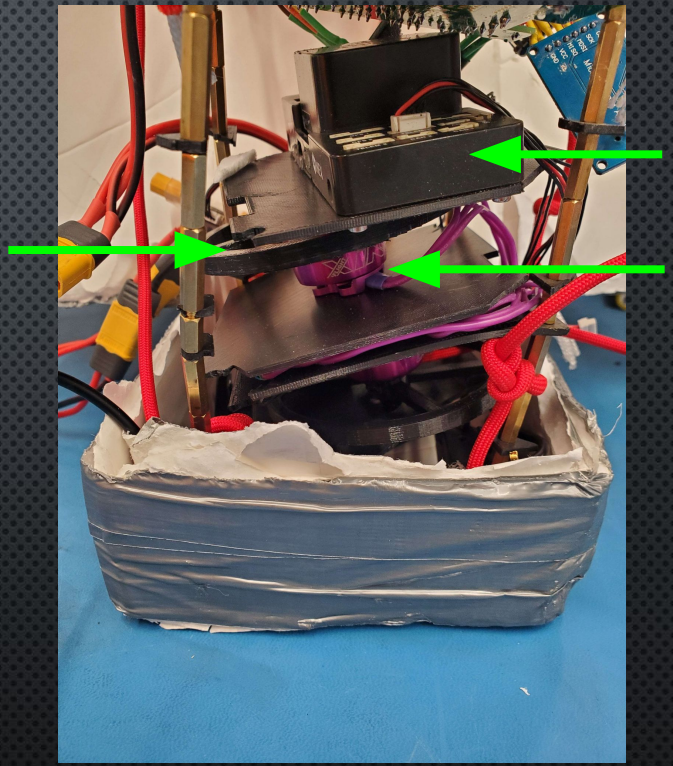
- Reaction Wheels placed vertically
- Motors spin the opposite direction
- the ADCS stabilizes on the Yaw axis

PX4 used as an autopilot to control the motor and stabilize it

- PID controller for the system

ADCS Analysis

- The ADCS successfully armed
- ADCS failed at stabilizing the entire payload
- Disarm protocol at 40,000 ft failed
  - Shortened battery life for others
- Drone controller, motors, flywheels remained intact

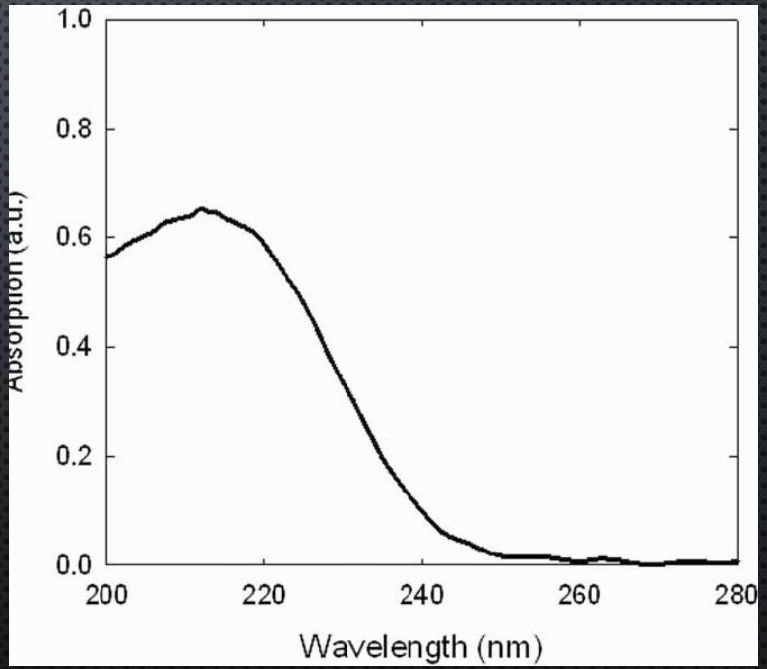


SEED MODULE

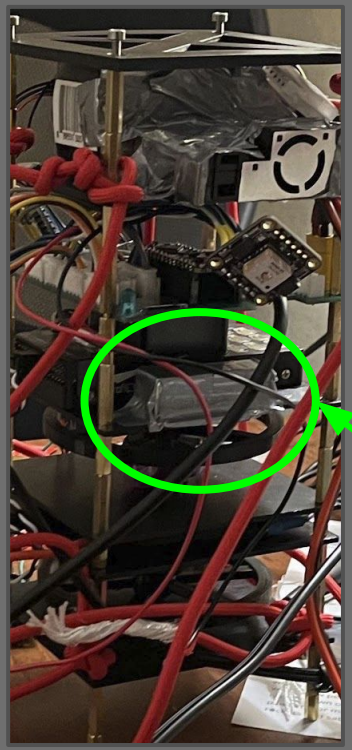
Mission

To determine the irradiating effects of a short near space flight on the germination rate of lettuce seeds

- Little gem lettuce seeds
- Cuvettes (PMMA) permit most of UV-B radiation
- 3 configurations: Shielded, unshielded, control
  - Shielded went inside the payload
  - Unshielded went on top of payload
  - Control did not fly



Seed Module Final Placement



Unshielded seeds on top of the payload

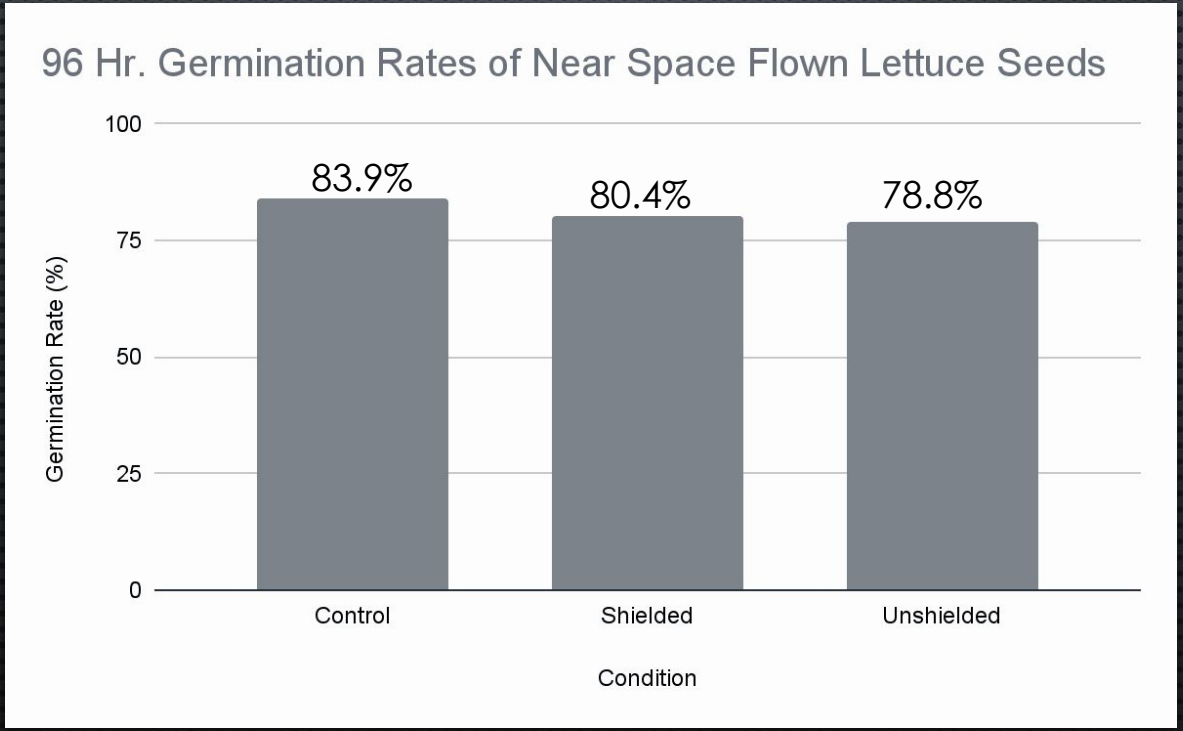
Shielded seeds inside the payload

Methodology

Shielded Germination Test 96 hr.

Unshielded Germination Test 96 hr.

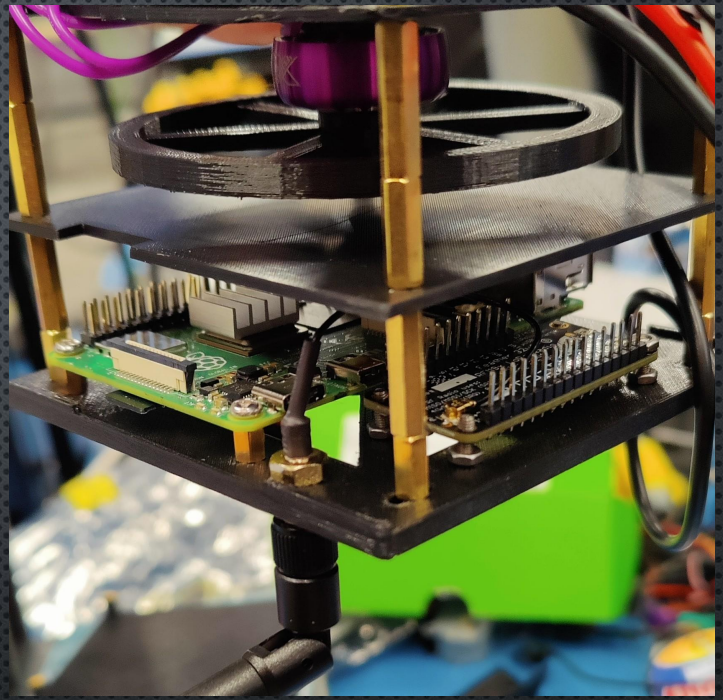
Seed Module Output



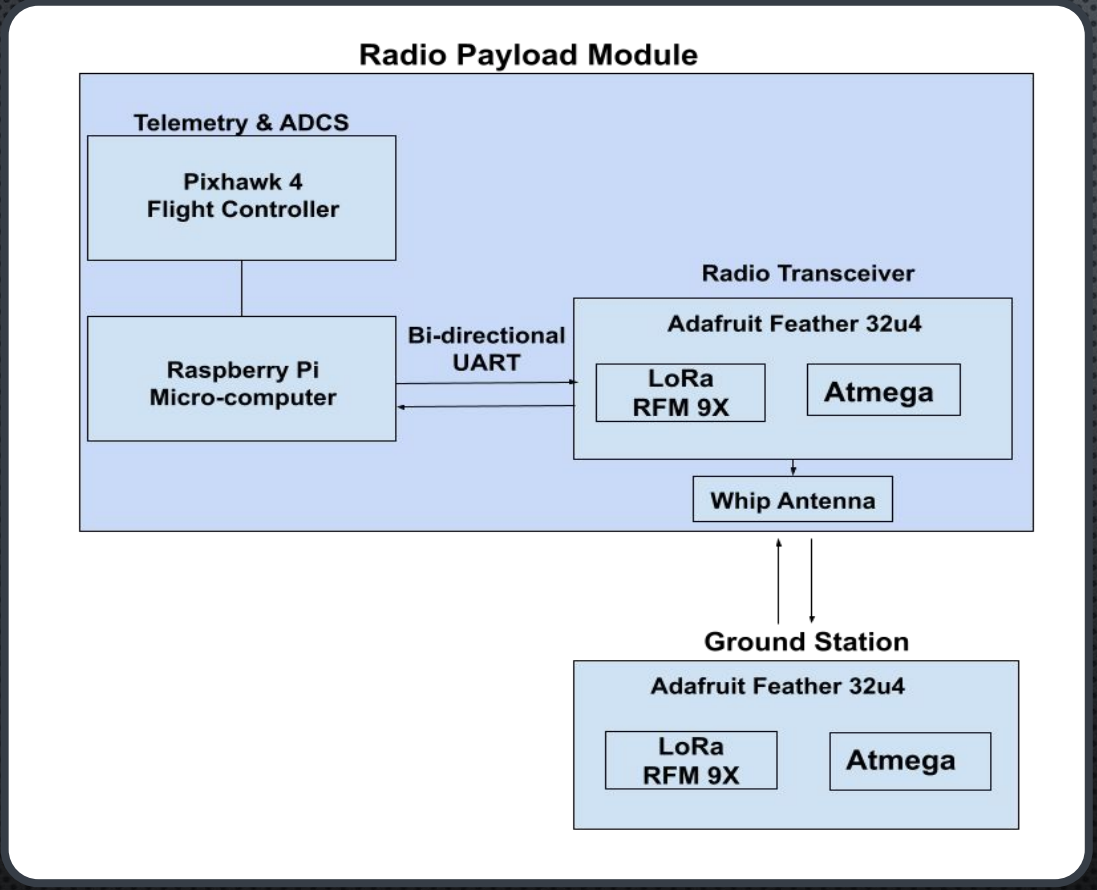
UNSHIELDED RESULTS ARE NOT SIGNIFICANT AT THE 5% SIGNIFICANCE LEVEL

RADIO

- Adafruit Feather 32u4 (RFM9x) with LoRa packet radio transceiver for long range tests
- Pixhawk 4 flight controller used for ADCS and transferring flight telemetry
- Working in 430 MHz Amateur radio band frequency



Radio transceiver codes GitHub->



RADIO SYSTEM BLOCK DIAGRAM

Radio Analysis

- Successful communication established between radio module:
  - Radio successfully received/transmitted telemetry
- High losses experienced:
  - Unstable Communication & receiving frequency decreased
  - low strength antenna caused high loss
  - Solution: Different antenna and increased TX power
- Power connection problem faced:
  - Connecting radio power supply with raspberry pi
  - Solution: integrate RFM9x chip on OBC

```
void loop()
{
  delay(1000);
  Serial.println("Transmitting...");

  char* radiopacket = NULL;
  int bufferSize = 20;
  int packetIndex = 0;

  radiopacket = (char*) malloc(bufferSize * sizeof(char));

  while (MavSerial.available() > 0) {
    char t = MavSerial.read();

    if (packetIndex >= bufferSize - 1) {
      bufferSize += 20;
      radiopacket = (char*) realloc(radiopacket, bufferSize * sizeof(char));
    }

    radiopacket[packetIndex++] = t;
    Serial.print(t);
  }
```

Radio Analysis Continued

Future application:

- LoRa module will be used as payload for Coconut CubeSat

```
Feather LoRa TX Test!
LoRa radio init OK!
Set Freq to: 430.00
Waiting for packet to complete...
Waiting for reply...
Got reply: KK7LTN #     63
RSSI: -54
Waiting for packet to complete...
Waiting for reply...
Got reply: KK7LTN #     64
RSSI: -54
Waiting for packet to complete...
Waiting for reply...
Got reply: KK7LTN #     65
RSSI: -54
Waiting for packet to complete...
```

Data received

Conclusions

Pros

- Cubesat design allowed for compact and modular
- Main code and website is reusable for future semesters
- PCB was versatile and adaptable for future use
- Plant Module contributed to overall understanding of Radiation Effects
- Radio established long range communication

Cons

- Lower structural integrity
- Need more storage or a different board (Raspberry Pi)
- Electrical system needed more testing
- Plant Module Data ultimately inconclusive/ insignificant
- Radio module used was not robust or redundant

CREDITS

Full Name	Position	Subsystem
Jesse Ontiveros	Officer	Electrical
Elizabeth Garayzar	Officer	Electrical
Robert Burton	Member	Electrical
Noemi Gonzalez	Member	Electrical
Pranit Kondapalli	Member	Electrical
Luis Ángel Ruiz	Member	Programming
Muhammed Topiwala	Member	Programming
Brian Lee	Member	Programming
Brandon Bello	Member	Programming
Jessica Maschino	Member	Mechanical
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Vamsy Krishna Nanduri	Graduate Member	ADCS
Naman Tibrewal	Radio Science Director	Radio
Aldrin Inbaraj	Radio	Radio

ASU ASCEND Website