Design and Development of AntSat 01's 2U CubeSat Flight Subsystems

UCI Samueli School of Engineering

UCI CUBESAT

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SYSTEMS

Primary focus

- Define the satellites objectives, requirements, and stakeholder needs for the mission
- Enable engineers to design and construct the satellite based on the needs of the mission.

Contributions to the project

- Development of an updated concept of operations document
- Acquisition of updated payload VED requirements

AVIONICS

Primary objective

- Design and develop PCB for the central flight computer (CFC) and attitude determination / control system (ADCS).

Project contributions

- Design and fabrication of PCB, development of sun sensor and GPS module for the mission

Functionality

- A PCB effectively establishes a communication protocol between different subsystems working simultaneously in the cubesat.
- The sun sensors act as "eyes" for the satellite to locate the sun in space and be properly oriented using GPS module to have solar panels facing the sun to charge battery.

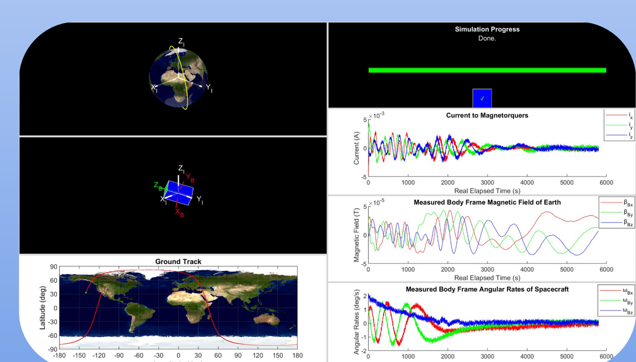

Figure 1: ADCS Bdot simulation

COMMUNICATIONS

Contributions to the project

- Work with the antenna team to set up a notification system that will send notifications to an email list.
  - Design an authentication functionality using a simple token-based system with a refresh token option.
- Work on system to send information to satellite
- Design and develop a pcb to transceive and receive communication from satellite and the ground station

DEVELOPMENT OPERATIONS

Objective

- Take initiatives to ensure software and firmware mission success, and then find ways to make the lives of our developers easier

Initiatives

- Software development, specifically in the context of safety and embedded systems.

PAYLOADS

Variable Emissivity Device

- Changes color and emissivity in response to
- varying voltages. We will test its performance
- under direct solar radiation.
- Similar materials will be used as a method of
- thermal management on future spacecraft.

Figure 2: VED sample

MISSION & RESEARCH SIGNIFICANCE

Mission

- Develop, test, integrate, and launch a 2U CubeSat, AntSat 01, into Low Earth Orbit (LEO)
- Execute and test research experiments in LEO for the payload: Variable Emissivity Device (VED)

Research significance

- Measure the performance of the VED when exposed to orbital conditions to gauge its effectiveness as a cost-effective method of spacecraft thermal regulation.
- Measure and evaluate AntSat 01's performance over the lifetime of its mission. This effort paves the way for our team's future microsatellite iterations.

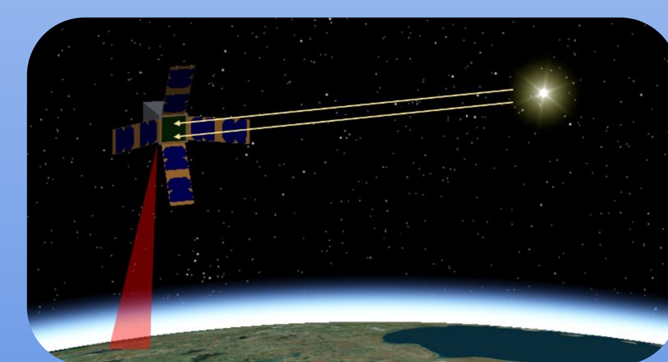

Figure 3: Solar radiation hits VED sample, testings thermal management capabilities.

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SHOUTOUT TO OUR MENTORS!

- **Christian Rodriguez -** Terran Orbital
- **Alec Fuoti -** Terran Orbital
- **Xavier Lian -** Western Digital
- **Shakthivel Rajavelu,** Masters Graduate Student

STRUCTURES

Contributions to the project

- Coordinate with other subsystems to design hardware and plan for systems integration
- Prototype panel and antenna deployment mechanisms, as well as the burn wire system
- Conduct FEA analysis on structural components

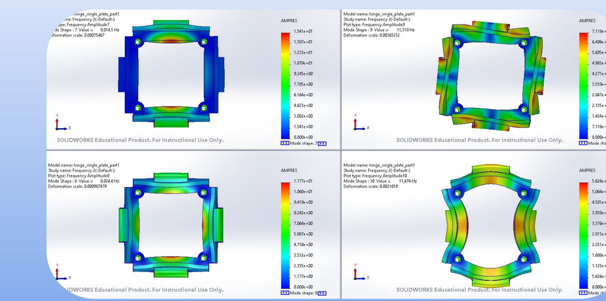


Figure 4: FEA test results

POWER

Purpose

- Provide, store, distribute and control CubeSat electrical power.

Functionality

- Absorb energy from photovoltaic (PV) cells and supply it to the system
- Battery storage system used to feed load when energy produced insufficient and to store excessive energy as possible.
- To select appropriate configuration, mission profile of UPSat is studied to evaluate environmental conditions and energy required

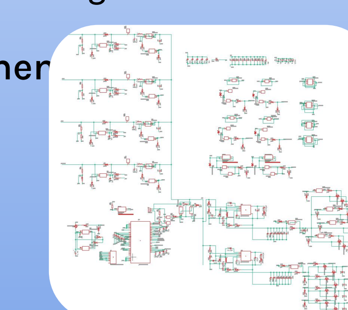
Subteam responsibilities

- Create the PCBs to support mission, select componen ar build the entire design.

Design

- 7 (30%) PV cells in parallel to a battery array through voltage step-up boost converters
- Implement a P&O MPPT algorithm with EPS microcontroller
- Battery Array: 3 Li-Po batteries (3.7V, 4Ah) Variable voltage 6V ~ 8.4V
- MOSFET switches for power distribution

Figure 5: Schematics



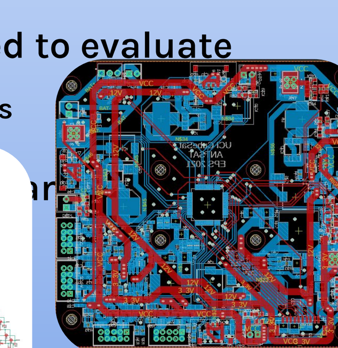


Figure 6: PCB

GROUND STATION COMMUNICATIONS

Objective

- Create a preliminary dashboard for displaying and analyzing log data.

Accomplishments

- Established the database to store logs using a MySQL database
- Created a server (using an Express backend) that will be used to fetch and manage log data
- Designed a frontend that has basic views for the data using React

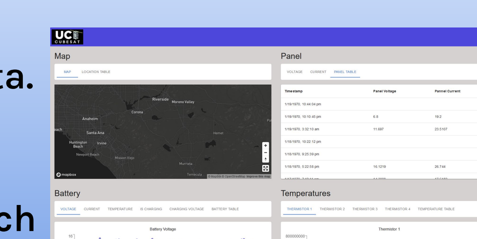


Figure 7: Dashboard

CONCLUSION & FUTURE RECOMMENDATION

Concluding Comments:

- The Cubesat project is a continuously developing project and builds upon previous designs
- Work being done will enable future teams at UCI and other universities around the globe to replicate our results and build upon our open source designs

Recommendations:

- The team will focus on the following quarters on updating designs and consolidating documentation