

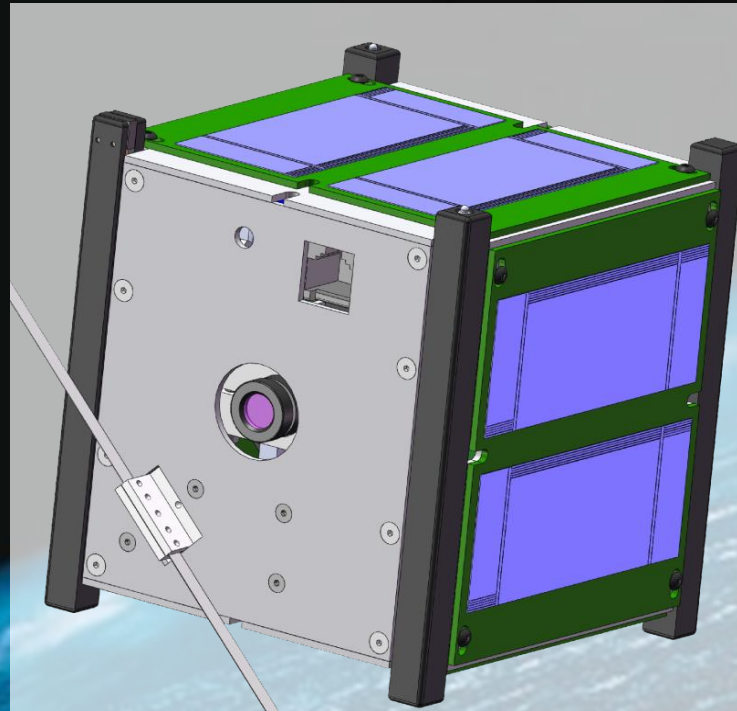
A large, stylized oval frame containing a space-themed illustration. Inside the oval, a satellite with solar panels is shown in the upper right, emitting a bright light. To its left is a full moon, and below that is a view of the Earth from space, showing the Americas. The background of the oval is a dark space filled with stars. The entire oval is set against a larger background of the Earth's horizon from space.

UCISAT

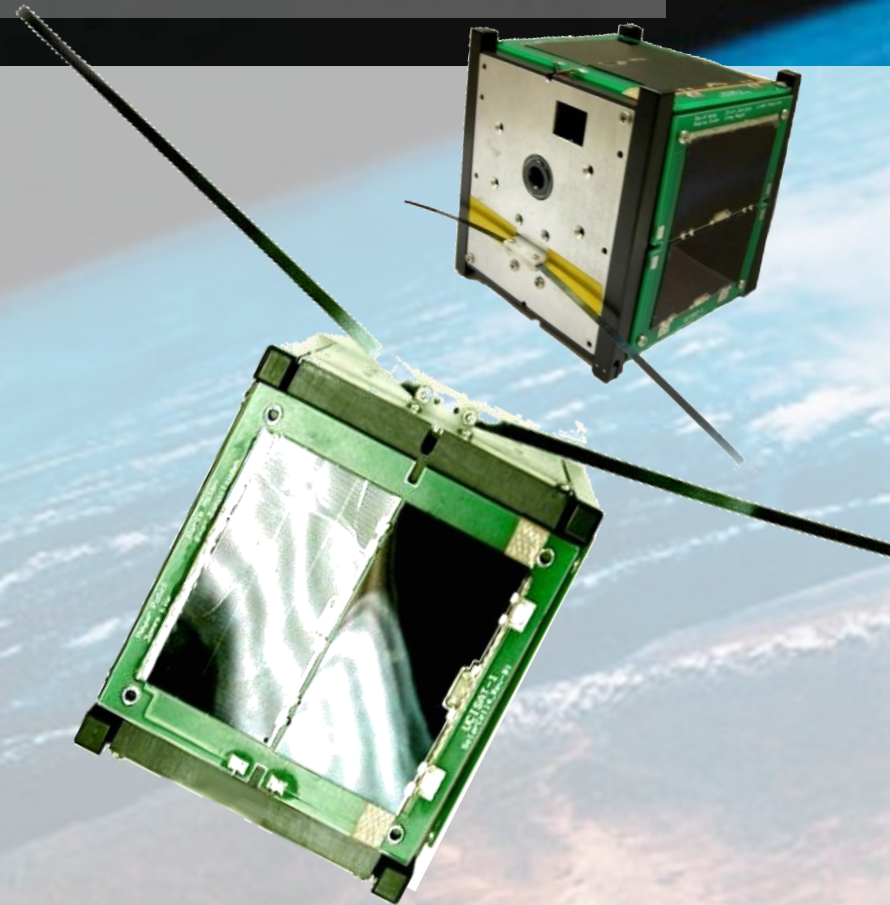
UNIVERSITY OF CALIFORNIA, IRVINE
AOYAMA GAKUIN UNIVERSITY, TOKYO

UCISAT-1

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Current Completed Model

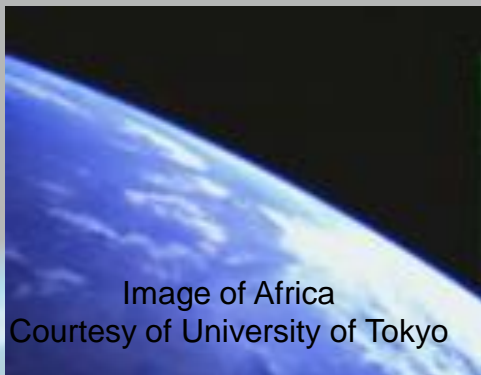


Former Manufactured Prototype

Main Mission Objectives

Primary Mission Objective

Capture an image of Earth from LEO and transmit it to the K6UCI Ground Station on the UCI Campus.



Secondary Mission Objective

Monitor the performance of the passive magnetic stabilization system and compare it with the predictions made in computer simulations.

Extended Mission Objectives

- Record spacecraft telemetry daily in order to analyze solar cell currents, battery voltage and temperature, and subsystem temperature.
- Analyze long-term trends to identify faults and develop design improvements for future UCISAT missions.

UCISAT-1 Special Facts

- UCISAT-1 is an undergraduate managed student project.
- Only University of California as of now to have an undergraduate cube satellite development program.
- K6UCI Ground Station located on UCI campus communicates with UCISAT-1.
- All UCISAT-1 components are in-house designed.



UCISAT-1 Requirements

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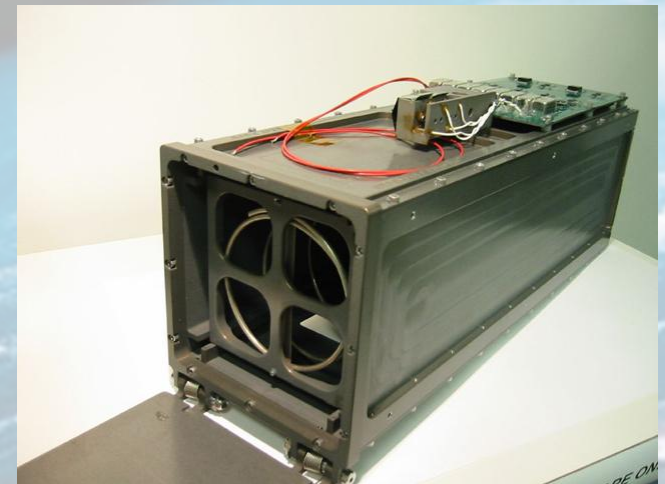
- A classical 1 unit cube satellite design requirement

Structural Requirements:

- Size: 10cm x 10cm x 10cm cube
- Mass: Must not exceed 1kg
- Survive 15g launch forces

Expected Orbit:

- Low Earth Orbit or LEO (600-800Km altitude)
- Launch Costs at least \$40,000 depending on location



Subsystem Breakdown

Structures

To ensure the structural integrity of UCISAT-1.

C&DH

To automate and regulate key functions of the satellite.

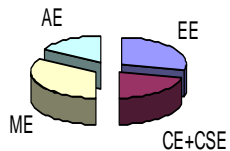
Comm

To respond to an uplink from the ground station and downlink the satellite status and pictures.

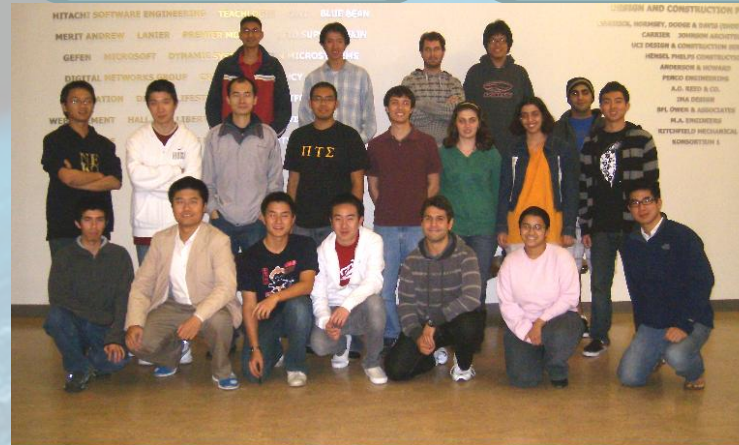
Systems

Monitor the status of the other subsystems.

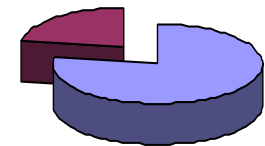
Team Member Major Breakdown



■ EE ■ CE+CSE ■ ME ■ AE



Undergraduate/Graduate Team Composition



■ UNDERGRADUATE ■ GRADUATE

Thermal

To ensure that all the components are within their operating temperature limits.

Power

To manage the power intake and consumption of the satellite.

ADCS

To navigate the satellite on its expected orbit.

Payload

To use the CMOS camera to take pictures of Earth.

Attitude, Determination, and Control

Goal:

To utilize Earth's free magnetic field to de-tumble UCISAT-1 after deployment from the launch vehicle.

How:

12 Hysterisis rods, 1 bar magnet.

Computer Simulations → MATLAB

Materials Used:

Permalloy 78 Hysterisis Rods

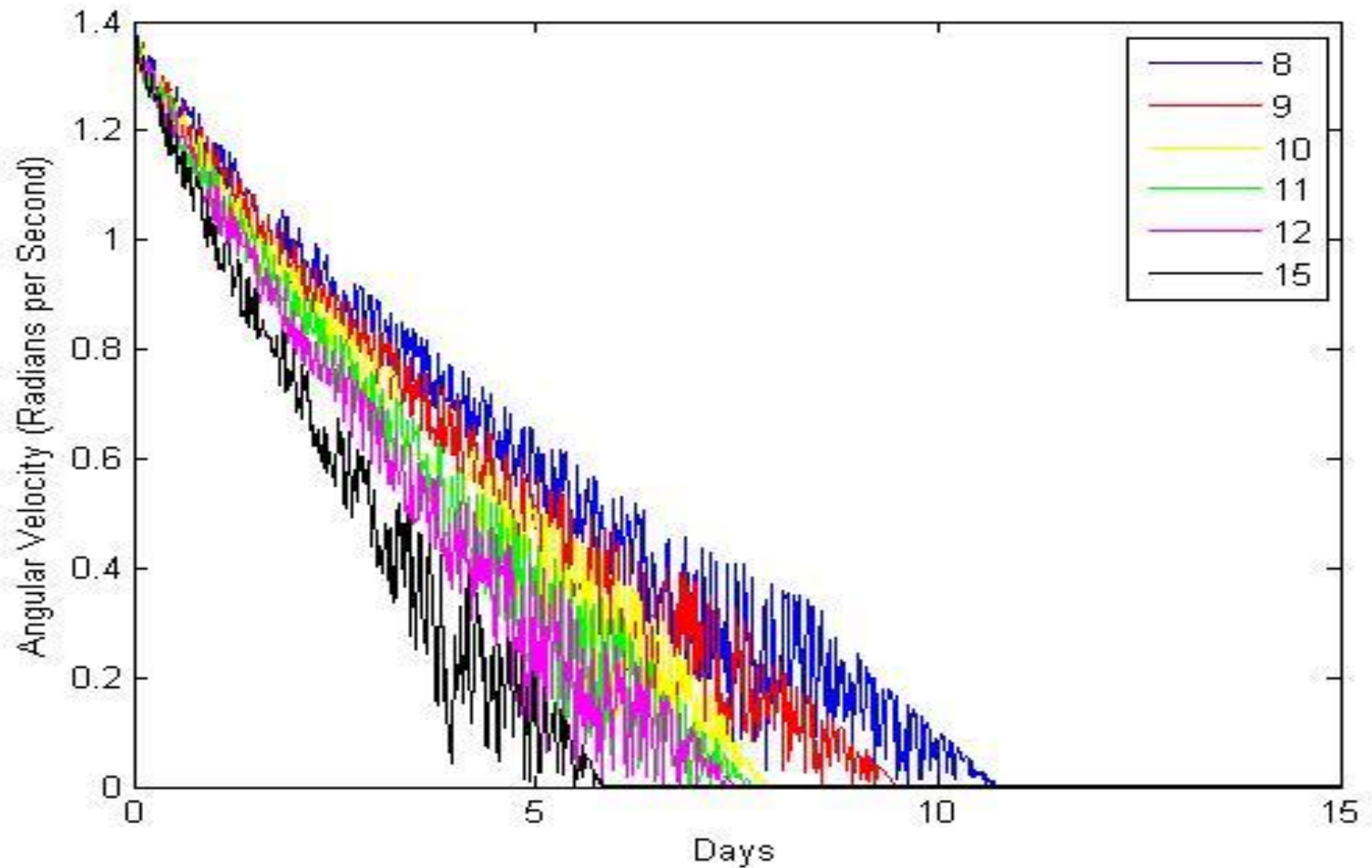


Neodymium Bar Magnet



Attitude, Determination, and Control

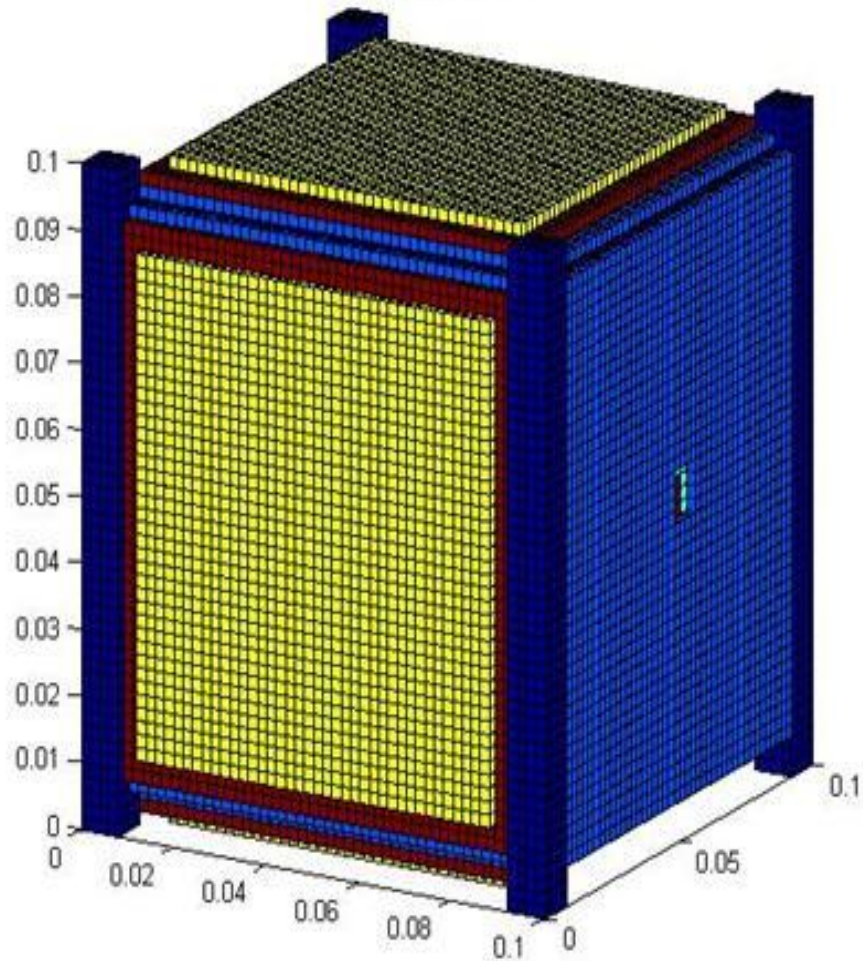
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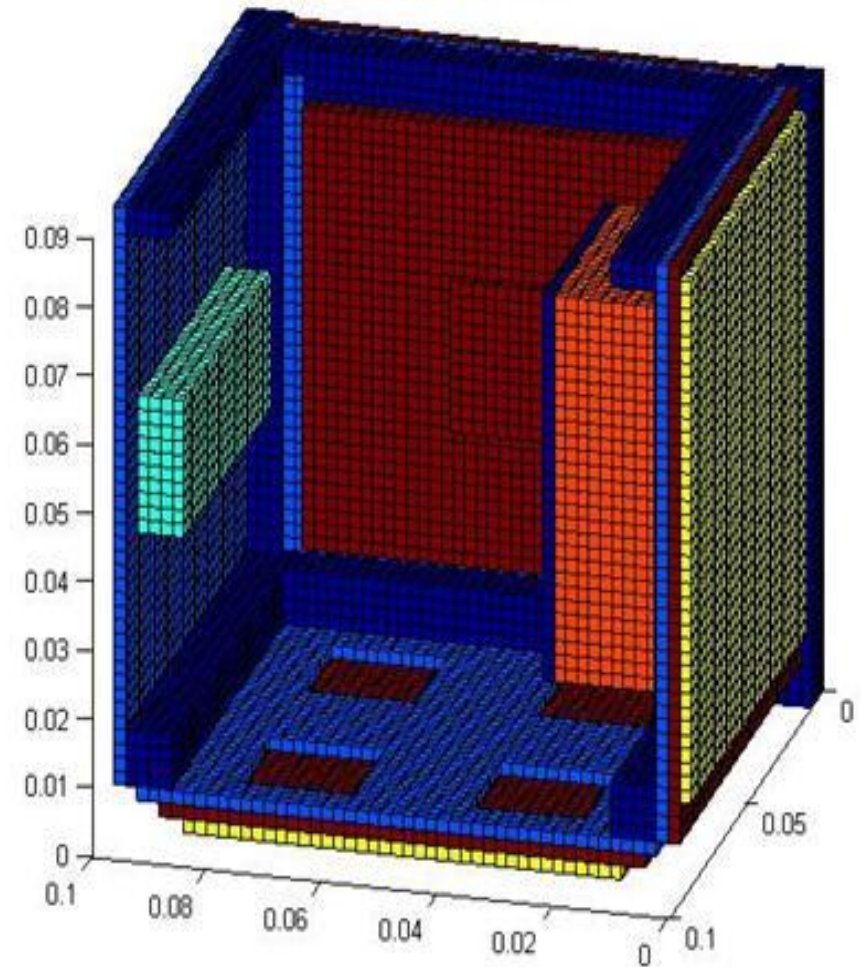
Thermal

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UCIsat structure



UCIsat structure



Structures

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Goal:

To ensure the safety and integrity of all subsystems within a structure that is capable of handling launch stresses and the space environment

How:

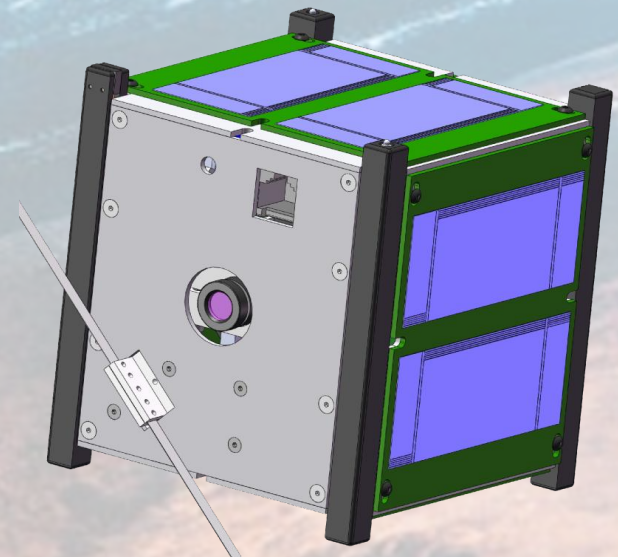
Design, analyze model, draw, and manufacture.

Analysis Parameters: *Maximum stress, deflection, factor of safety, and natural frequency.*

Materials Used:

UCISAT-1 Frames: Al 7075-T7351

UCISAT-1 Panels: Al 6061-T6



Systems

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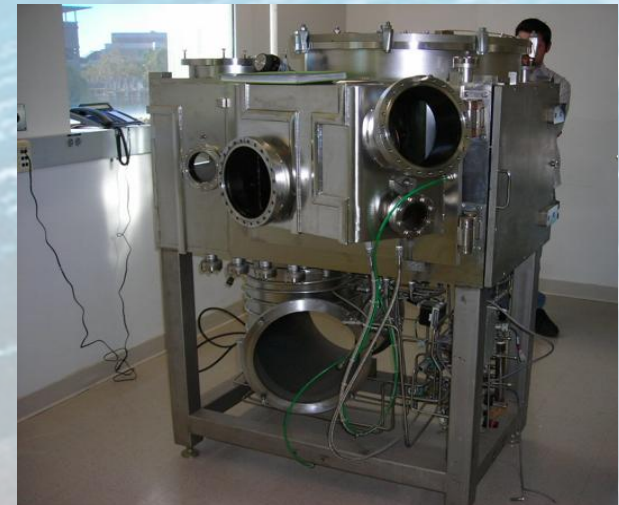
Goal:

To monitor the status, integrate, and test all subsystems within UCISAT-1.

Testing Facilities:

- **Rate Table** (UC Irvine)
- **Test Inertial Measurement Unit**
 - Gyro Sensor (Angular Velocity)
- **Full Scale Test Setup**
 - -100 to +100 degrees per second
 - 10 degrees per second increments
- **Thermal Vacuum Chamber** (UC Irvine)
- **Vibration & Shock Testing** (Cal Poly San Luis Obispo)
 - aka “Shake and Bake”
- **Anechoic Chamber** (7-Layers)

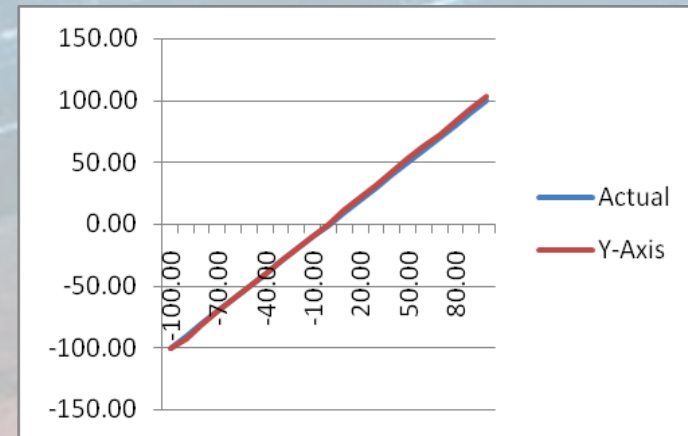
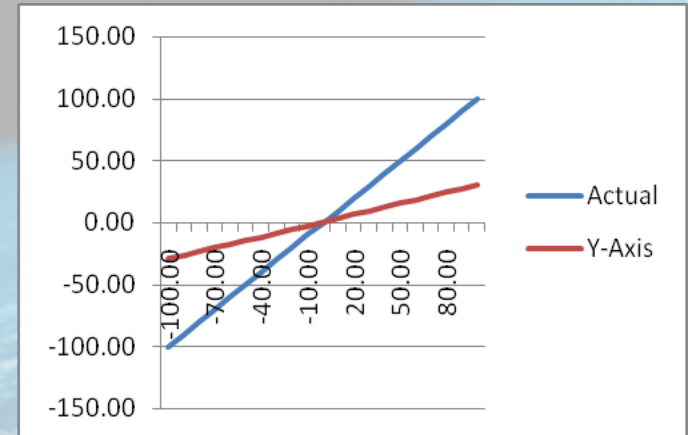
Vacuum Chamber in UCI



Systems

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Rate Table in UCI



Payload

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Goal:

To fulfill UCISAT-1's primary and secondary mission objectives: capture and transmit images and gyro data.

Requirements:

- Imaging Device or Sensor
 - Low Power Consumption
 - Small Image Size
- Inertial Measurement Unit (IMU)
 - Low Power Consumption

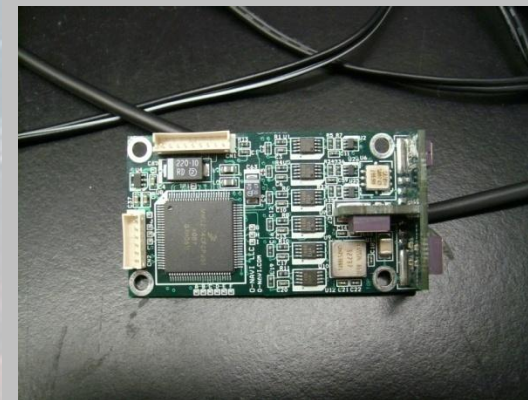
Specifications:

- CMOS Camera Module (C328R)
 - Operating Voltage: 3.0 - 3.6V
 - JPEG Image Compression
- O-NAVI Inertial Measurement Unit
 - Operating Voltage: 5.0V
 - Measures Angular Rate on XYZ-Axis

CMOS Camera



Inertial Sensor



Communications

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Goal:

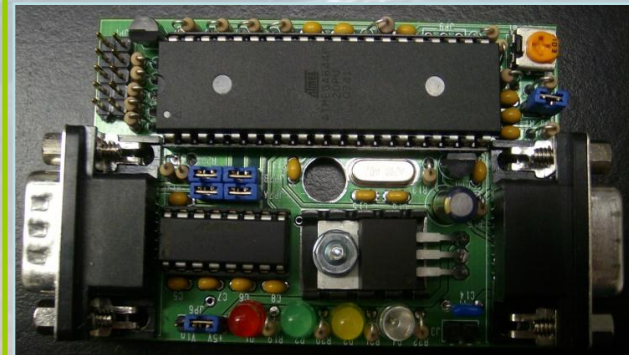
Provide the command and data link between ground operators and UCISAT-1.

Requirements:

- 1) 1 Watt RF output
- 2) Transmits health beacon every orbit
- 3) Transmit image once per day within 5-8 minute pass window

Specifications:

- » 1200 Baud and AX.25 protocol compatible modem (TNC)
- » VX-2R Transceiver with uplink/downlink of 437.405 MHz
- » Half wavelength dipole antenna



Command and Data Handling

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Goal:

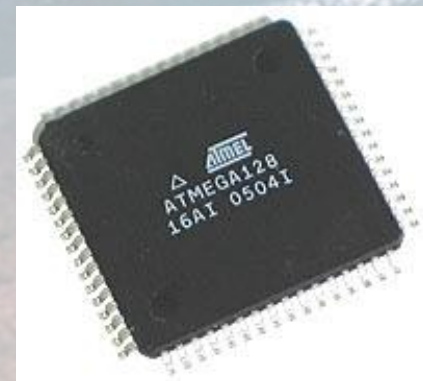
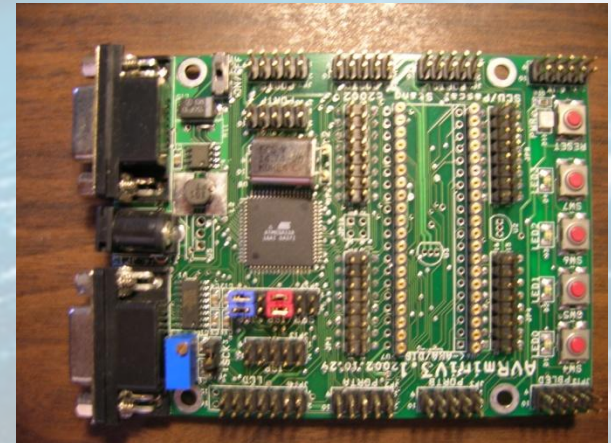
To control UCISAT-1's functions; retrieve, store, and transmit sensor and payload data.

Requirements:

- Low Power Consumption MCU
- Minimum 20 I/O pins, 10 MHz, 8-bit processor

Specifications:

- Atmel Atmega 128 microcontroller
 - 16 MHz
 - 8-bit RISC
 - 128KB Re-programmable Flash
 - I²C, UART, SPI, JTAG Interfaces
 - Programmable Watchdog Timer



Electrical Power System

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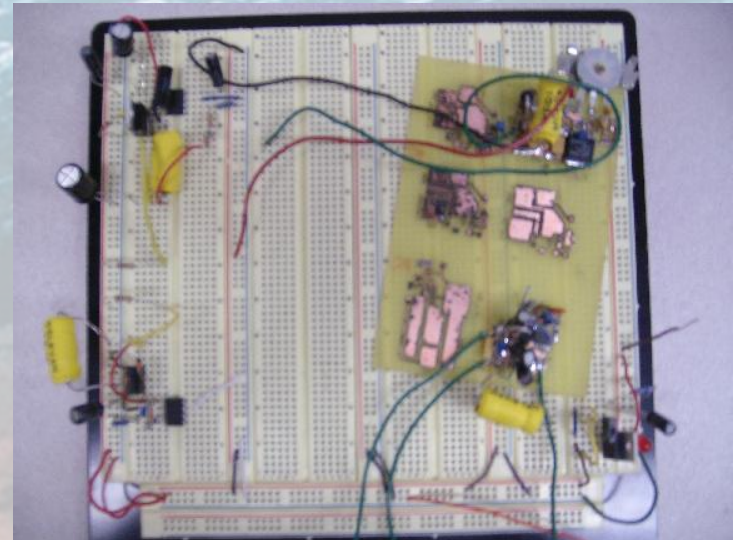
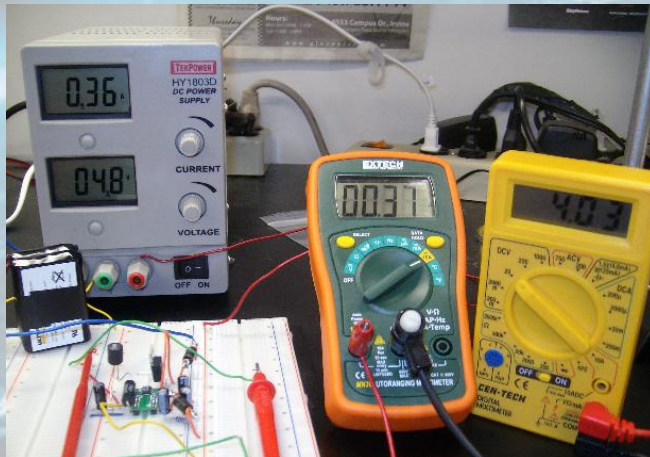
Goal:

To regulate the supply of power to other subsystem components in the satellite.

How:

Calculate power demand of all the subsystems.

Design and specify appropriate switching regulators.



Electrical Power System

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Requirements:

- 1) Supply up to $\sim 5\text{W}$ total power to ensure proper operation of all components and payloads.
- 2) Space-ready components.
- 3) Provide stable voltage rails for critical components.
- 4) Soft-start circuitry for satellite deployment.

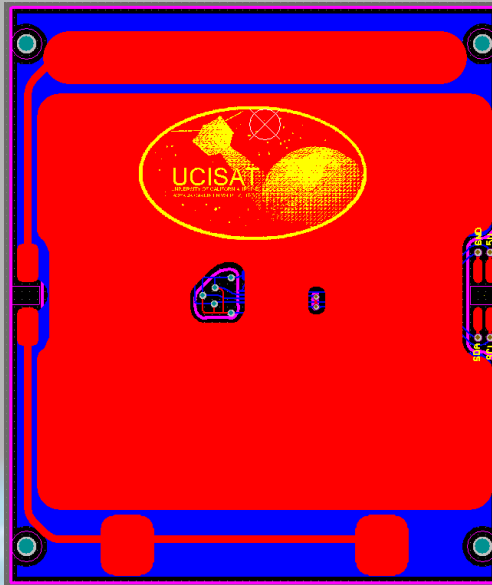
Specifications:

- Triple Junction Solar Cells
 - $\sim 25\%$ Efficiency
- Lithium Ion Batteries
 - 1800mAh Capacity, 3.7V Nominal Voltage
- Step-Up Controllers
 - 5V bus (MAX641)
 - 3.7V bus (LT1370)
- Step-Down Controllers
 - 3.3V bus (MAX1649)
- Battery Charger
 - 4.2V Lithium Ion Charger
- Kill Switch
 - Cherry DH3C-B1AA rated up to 300mA @ 30V

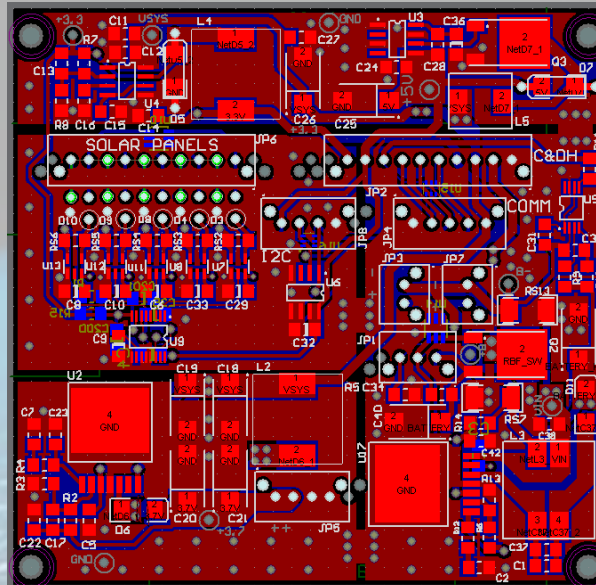
Subsystem PCB's

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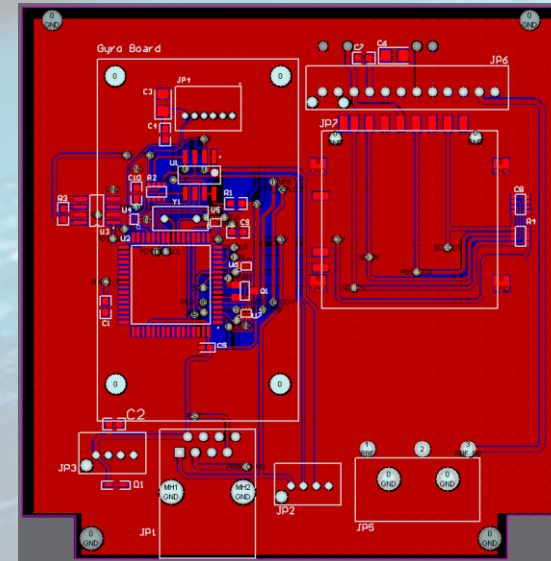
Solar PCB



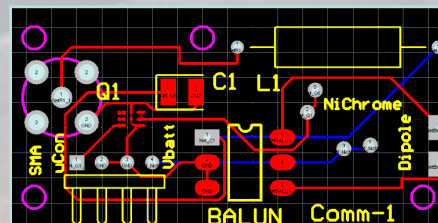
Power PCB



C&DH PCB



Antenna PCB



Mass Allocation

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Subsystem	Allocated Mass (g)
C&DH	80.00
Camera	35.00
Power	65.00
Antenna	15.00
Thermal	25.00
Structures	375.00
Solar Cells	155.00
Comm.	85.00
Battery	115.00
ADCS	50.00
Total	1000.00

UCISAT-1 Financial Budget

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Structures

- Manufacturing: \$4,000 (Includes frames, panels, mounts, etc.)
- Hardware: \$300 (Includes screws, epoxy, frame and panel material)

Subsystem Estimated Total= \$4,300

ADCS

- Permanent magnet: ~\$100 (Includes magnet sizing and EDM sinker charges for holes)
- Hysteresis rods: ~\$235 (Includes heat treatment)

Subsystem Estimated Total = \$335

UCISAT-1 Financial Budget

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C&DH

Parts: \$110 (Includes microcontroller, thermistors, various connectors, resistors, capacitors, and other circuit elements)

Subsystem Estimated Total = \$110

Comm

PCB: \$50

TNC: \$65

Antenna: \$80 (Includes manufacturing for 2 sets of antennas; material and EDM charges)

Subsystem Estimated Total = \$195

UCISAT-1 Financial Budget

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Power

PCB: \$33

Components: \$263 (Includes batteries, IC's, and Passives)

Solar PCB: \$33 each (5 Solar PCB's= \$165)

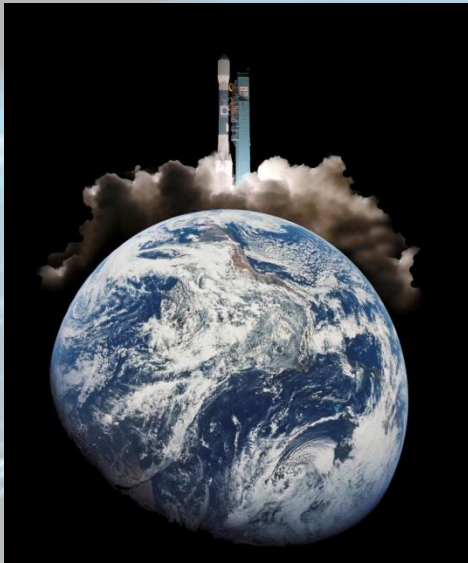
Photovoltaic cells: \$100 each (10 cells = \$1,000)

Subsystem Estimated Total = \$1,461

Total Estimated Cost for UCISAT-1 = \$6,401

Future of UCISAT

- Exploration of launch opportunities for 2010 with funding from The Boeing Company and UC Irvine.
- Gain more experience from operating UCISAT-1 when in orbit.
- Begin funding, design, and development for UCISAT-2



Acknowledgements

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Major Funding Sources:

- UROP (Undergraduate Research Opportunities Program)
- UCI Mechanical & Aerospace Engineering Department
- Team Quarterly Lab Fees
- The Boeing Company



Special Thanks To:

The Boeing Company, Professor Benjamin Villac, Professor Manuel Gamero-Castano, Professor Daniel Mumm, Professor John LaRue, Industrial Metal Supply Co., Hall Machine Service, and Jamie Stewart-March.

UCISAT-1



Questions?

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