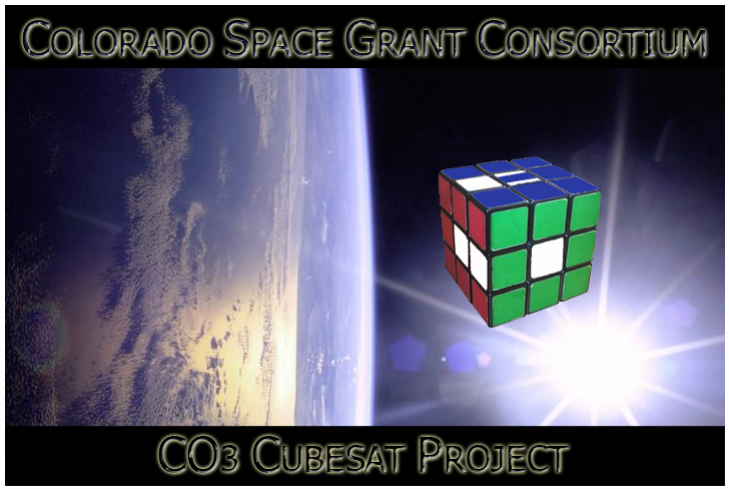
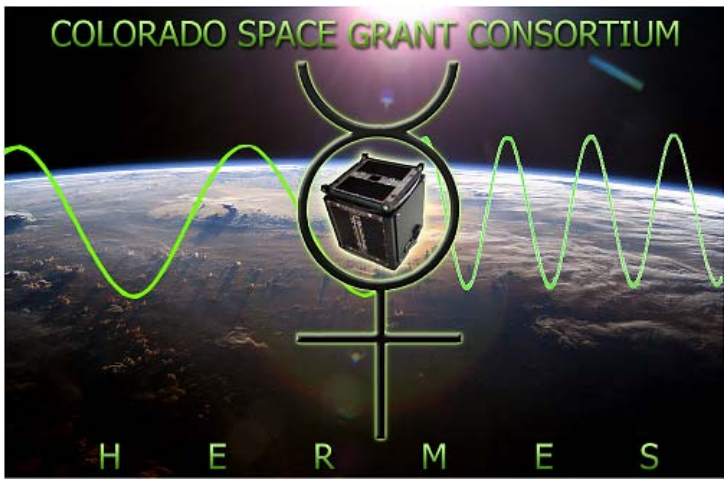




CO^3 Hermes

CubeSat Workshop

Colorado Space Grant Consortium

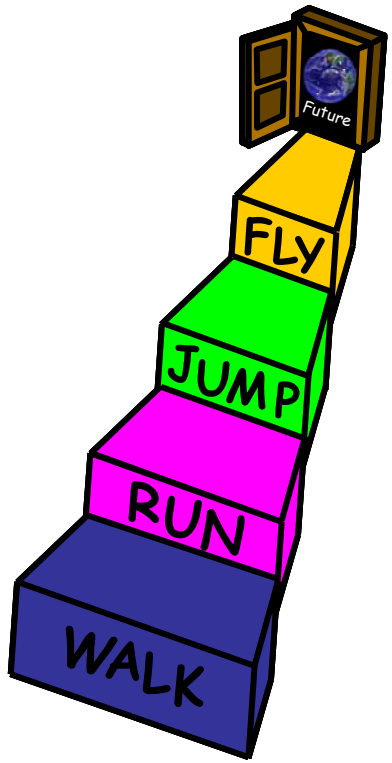
Project Manager: Lee Jasper

Systems Engineer: Phil Holtzman

August 11-12, 2007

Mission Overview

- COSGC's first CubeSat
  - Jump step
  - DemoSat, RocketSat, CubeSat, DANDE
- The Plan:
  - Launch a CubeSat every 18 months
  - Begin a new CubeSat every 18 months
  - Staff Mission Operations center
- The Goal:
  - Build a generic CubeSat capable of communication with ground through UHF/VHF and S-band radio frequencies
  - Provide valuable knowledge and experience to undergraduate students
  - Environmental characterization



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Mission Overview

Outline

- Mission Success: 1 year operations
- Goal: 2 years
- Multidisciplinary undergraduate project

Timeline

- Summer 2006: Project started
- Fall 2006: Conceptual Design
- Spring 2007: Preliminary Design
- Summer 2007: Complete Design
- Fall 2007: FlatSat/DITL Testing
- Spring 2008: Final Integration
- July 2008: Expected Launch

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Communications

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Beacon Mode

- Beacons once every 5 minutes
  - 5 seconds of transmit at 437.425 MHz
  - 30 seconds of receive at 145.980 MHz
  - Short duration due to power restrictions
- If the satellite does not go into receive mode at the correct times, the ground station will not be able to communicate with it
  - After being out of communications with the satellite for a extended period of time, the satellite will re-enter beacon mode
- Real Time Clock
  - Will track time until next communications pass

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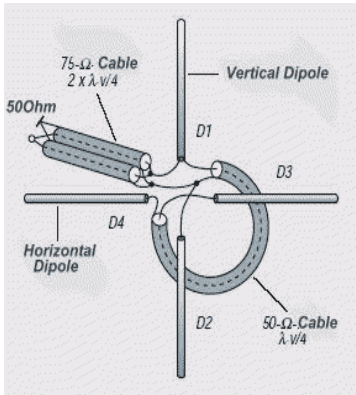
Components

- Full duplex transceiver
  - Capabilities in the UHF, and VHF
- Antenna
  - Crossed Dipole



- Terminal Node Connector
  - Needs to work with the KPC3 plus amateur radio modem
  - AX.25 format

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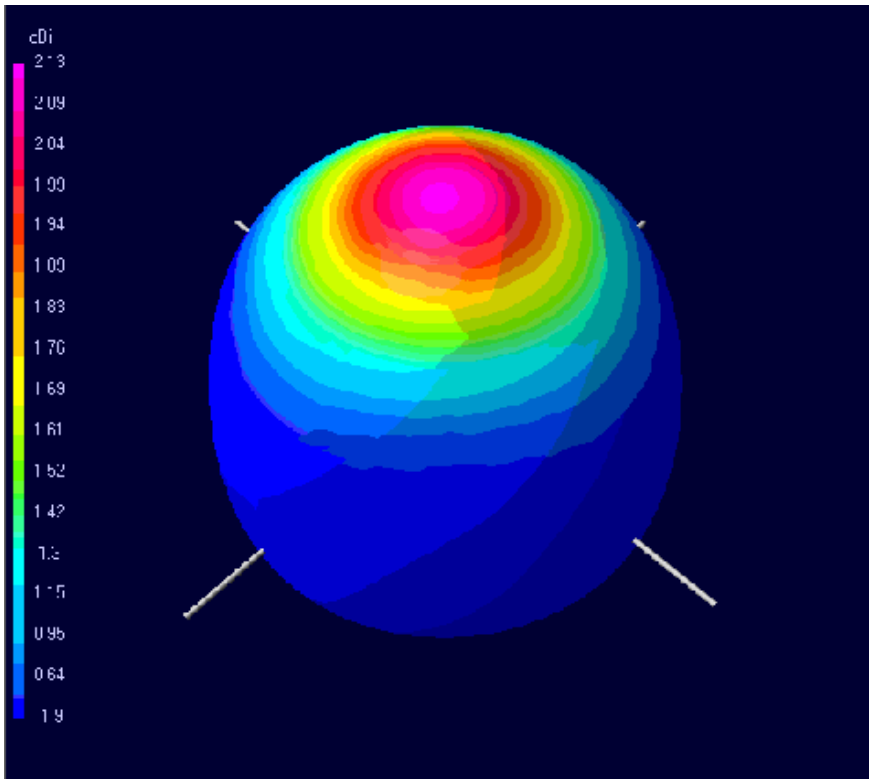
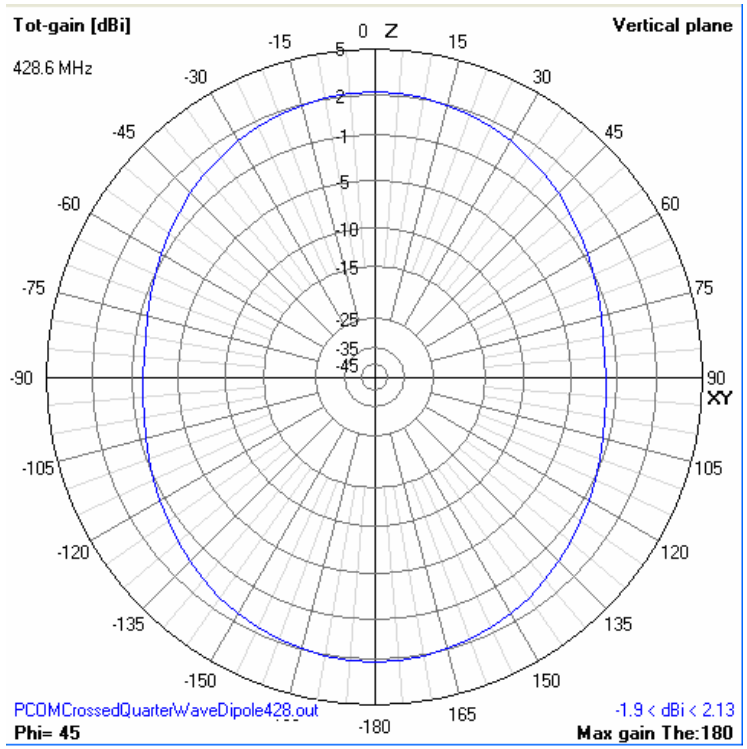
CO^3 Antenna Profile





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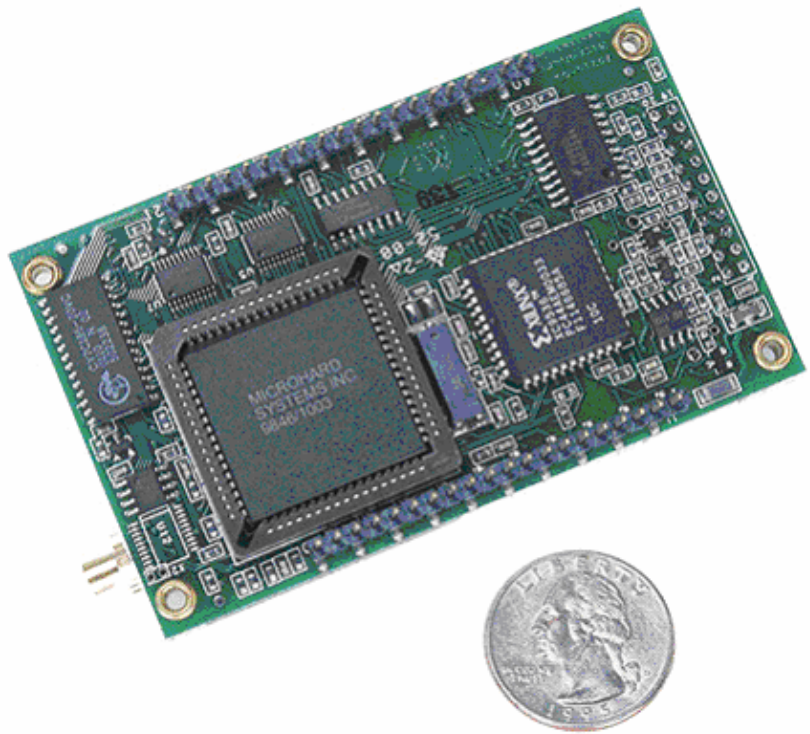
High Speed Modem: MicroHard MHX2400

- Mass: 75g
- Power
  - RF output: 1 W max
  - TX (DC): 2.3 W
  - RX (DC): 1 W
- Frequency hop capable
- +/-30kHz Doppler shift correction
- 115 kbits/sec max data rate
- 1.5m ground station dish w/ 30 dBi gain and 5.8 degrees beam width



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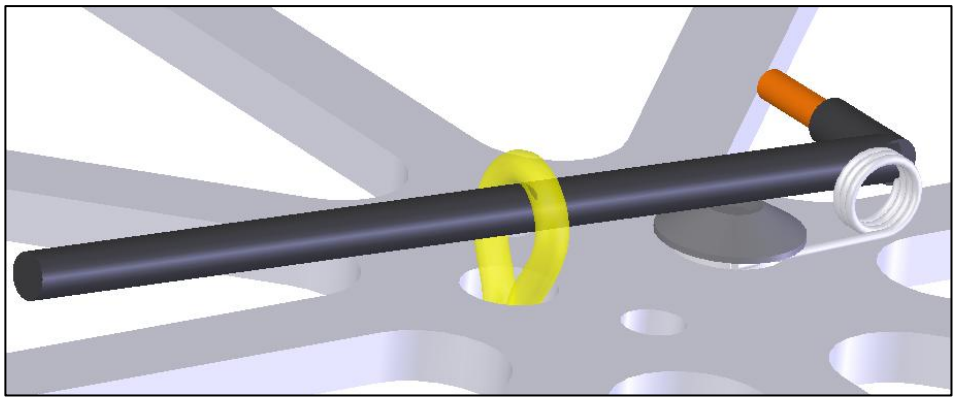
HS Communications Deployment

1



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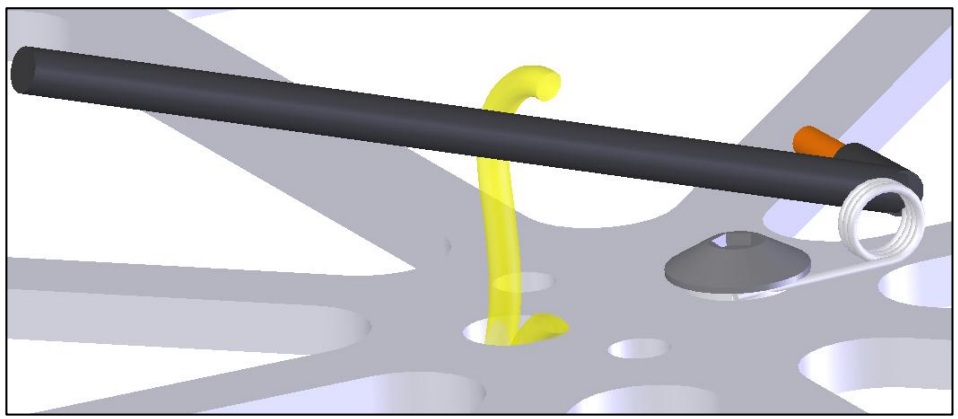

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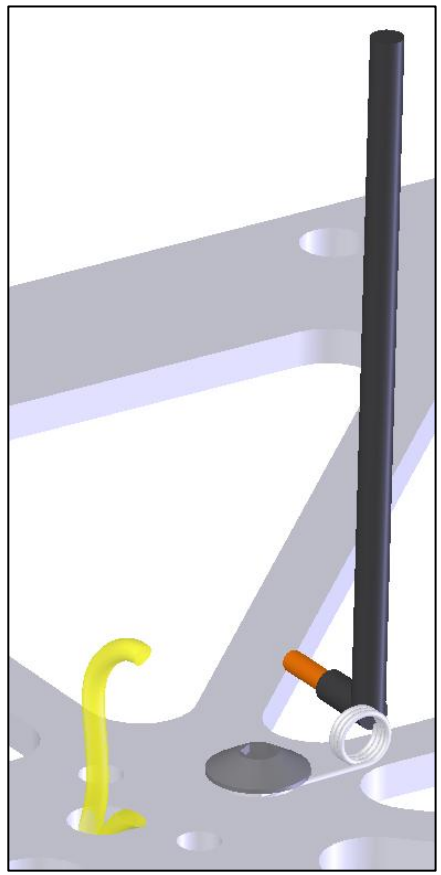

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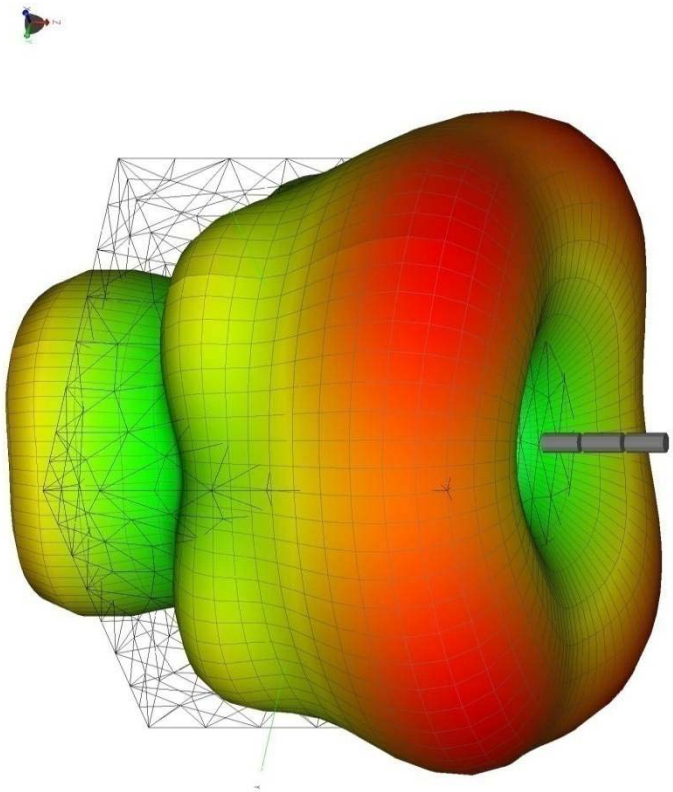
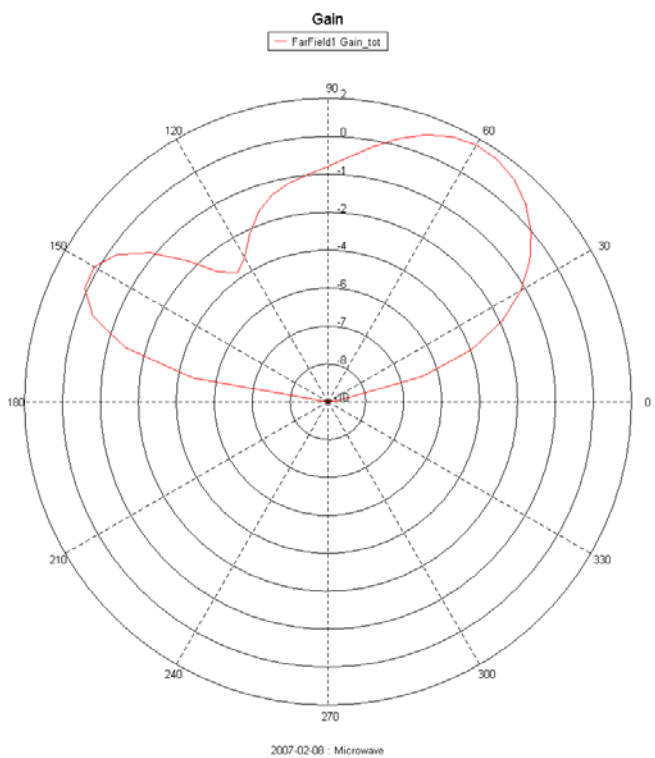
Flight Antenna – Radiation Pattern





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Link

- Based on AMSAT Link budget, STK simulation, consultation with one of our professors

Downlink	
Transmit Power	+30 dBm
Flight Antenna Gain	+1 dBi
Ground Antenna Gain	+30 dBi
Receiver sensitivity	+105 dBm
Path loss (600 km)	-156 dBm
Total Link Margin	**10 dB**

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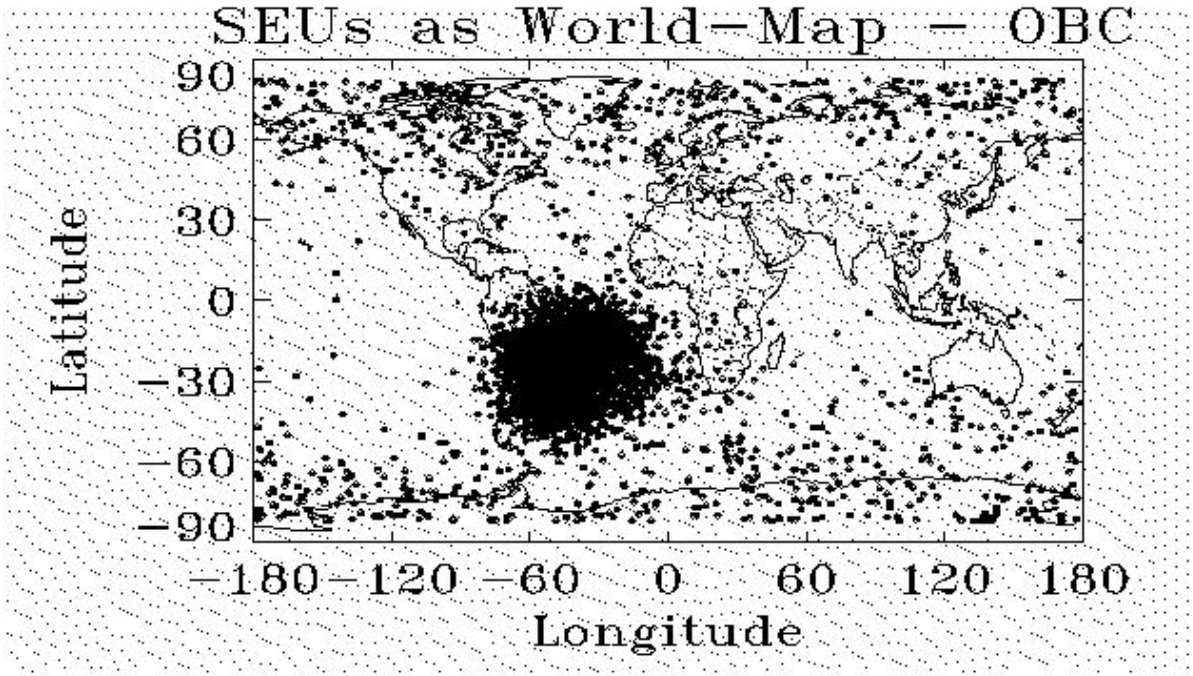
Radiation

Environment

- Solar Min: .5503 krad/year
- Solar Max (more likely): .3557 krad/year



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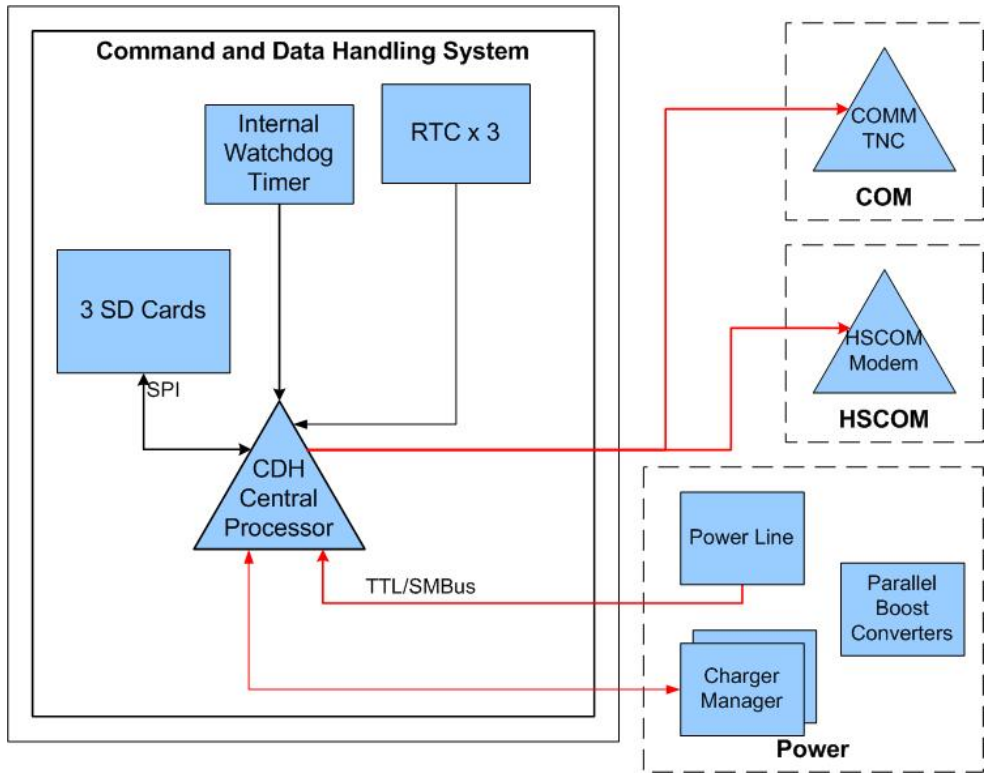
Radiation Mitigation

- Power Cycles
- Voting
- Watchdog



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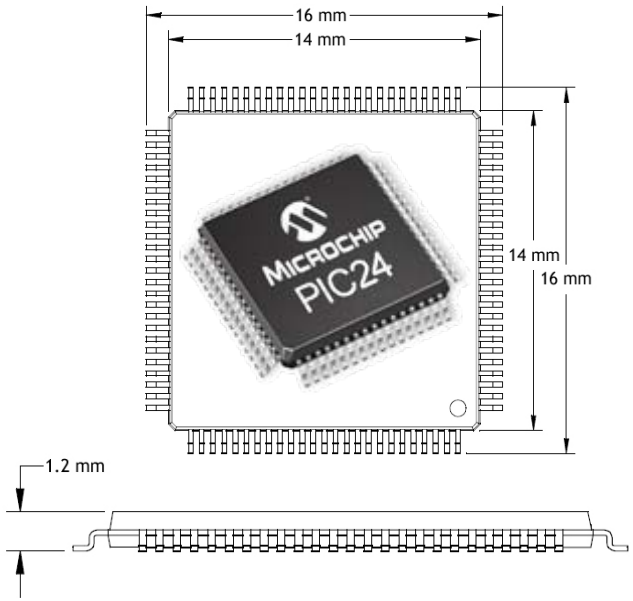
Components

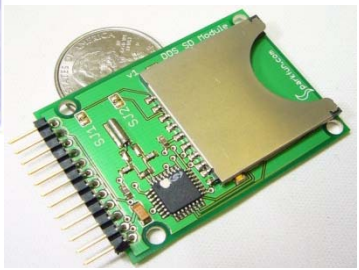
PIC Microcontroller

- Cheap/ small size
- Flexibility and versatility: room for expansion



SD Card

- Easy to use
- Large Storage Space
- Cheap/ small size
- Tolerance to radiation



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Flash Memory Concerns

- SD card used for mass-storage
- TID is not an issue for this mission
- Flash has low susceptibility to SEUs
- Program code triplicated on to 3 SD cards
- Voting scheme used to correct any anomalous bit flips
- Periodically cycle through flash memory with voting algorithm

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SRAM

Concerns:

- SRAM is located onboard the PIC
- Triplication and voting is not an option
- Expecting 15 (max) SEUs per megabyte per day

Proposed Solutions:

- Periodic power cycles (from Power)
- Internal software resets
- Internal watchdog
- All registers (including watchdog) rewritten periodically

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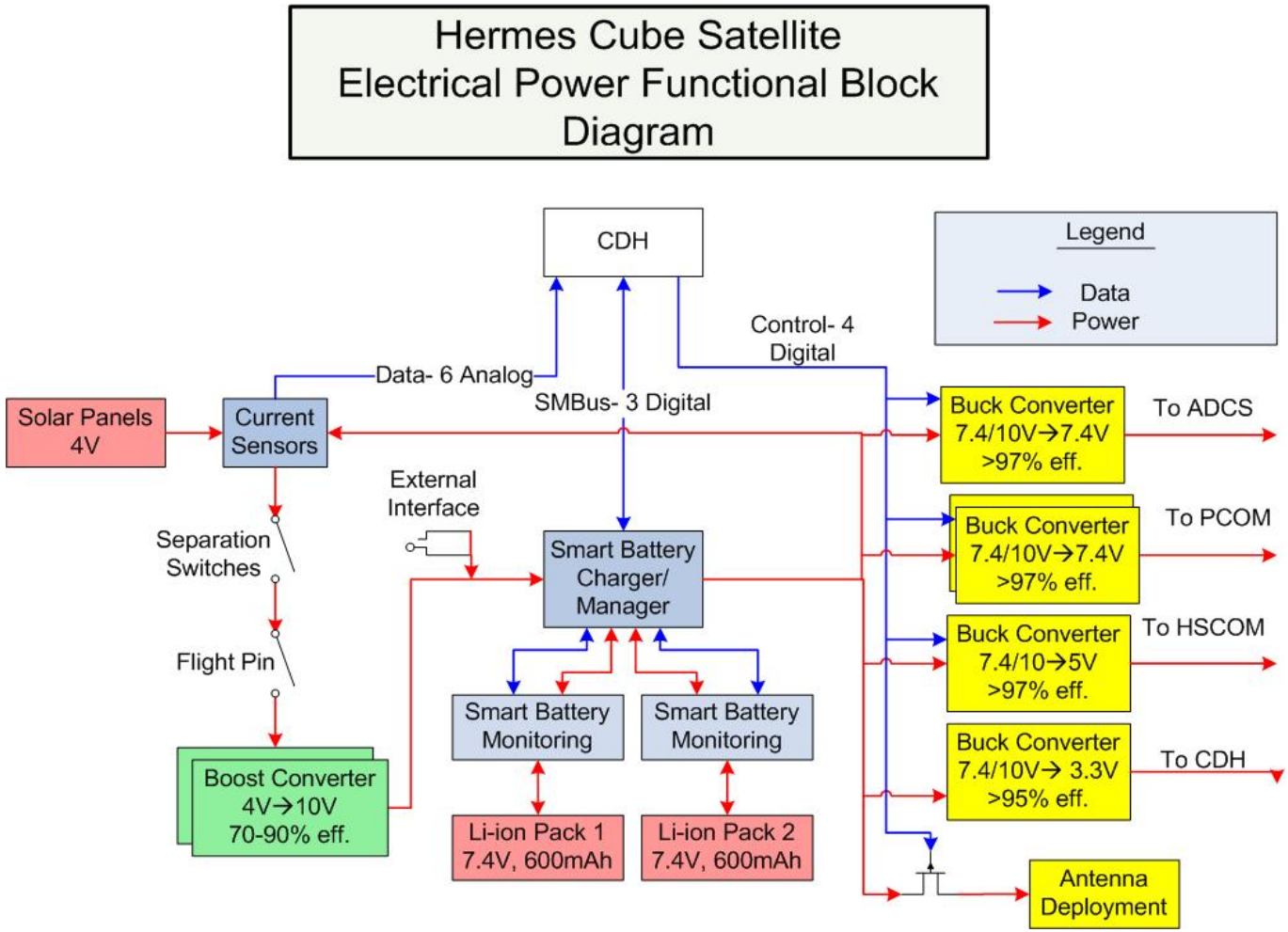
Power

Power Functional Block Diagram



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Power Components

Bidirectional, High Side, Current-Sense Amp

- Characterize solar cell current

DC/DC Boost

- Boost 4V from Solar Panels to 10V for Battery Charger

Dual Battery Manager/Charger

- Smart: charges, stops large discharge, charge level status

2-4 cell Li-Ion Battery Protection AFE

- Protects battery from over-charge/ depth of discharge

Compliant Gas Gauge

- Characterize cycle life and temperature

DC/DC Buck

- CDH subsystem power control
- Converts 7.4V or 10V to numerous other voltages

Triple Junction Solar Cells

- 26% efficiency

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Website

Questions?

http://spacegrant.colorado.edu/co3sat/

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Backup Slides

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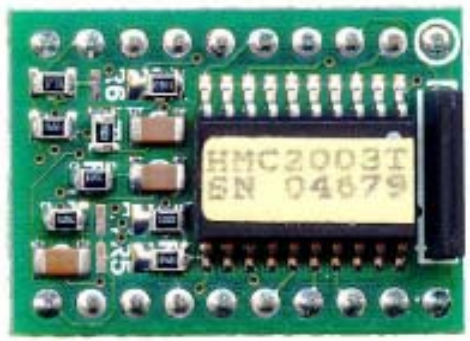
ADCS Components

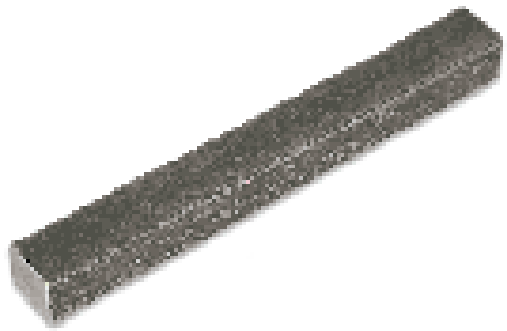
3-Axis Honeywell Magnetometer

- High-sensitivity, 3-axis magnetic sensor hybrid assembly used to measure low magnetic field strengths



Cast AlNiCo Magnets (x2)

- Residual Inductance: 12,500 gauss
- Restorative Torque: 1e-4 Nm



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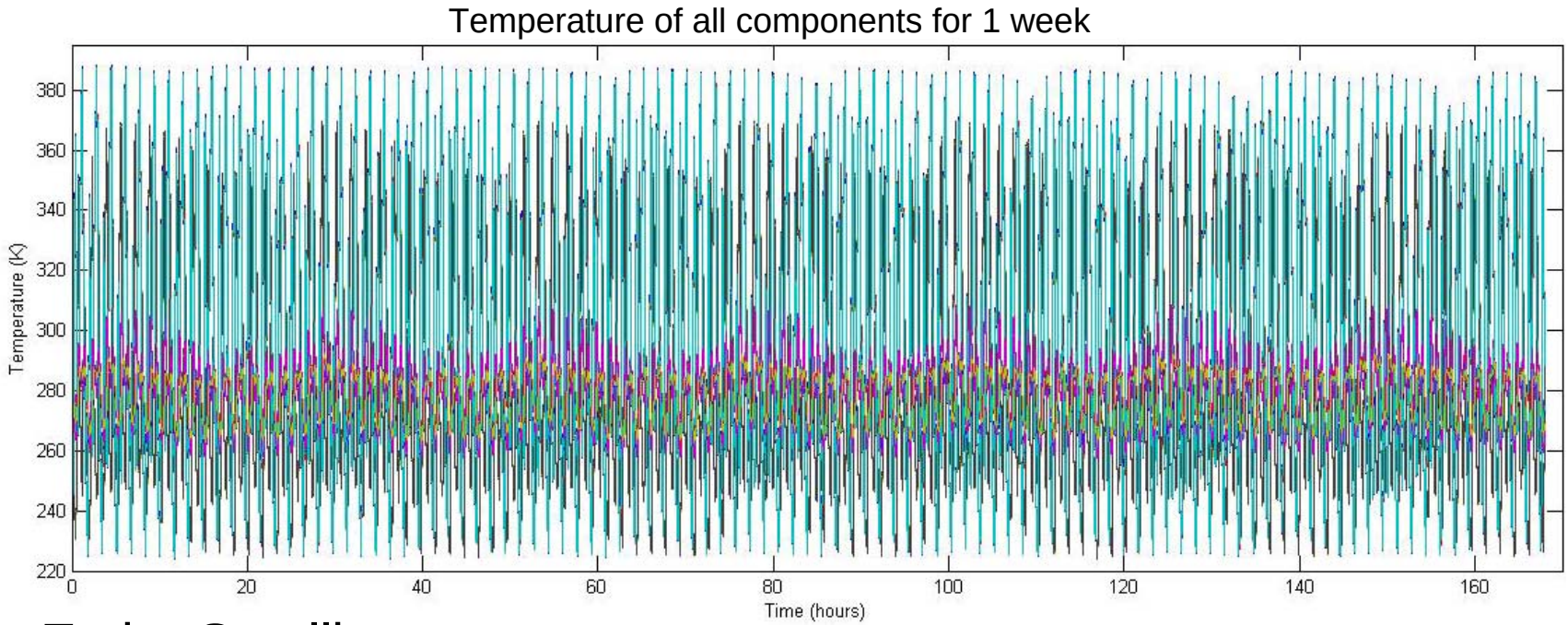
Thermal

Thermal Model - Results



- Entire Satellite
  - Minimum: 224K
  - Maximum: 388K
  - Temperature fluctuates through each orbit, but has a cycle

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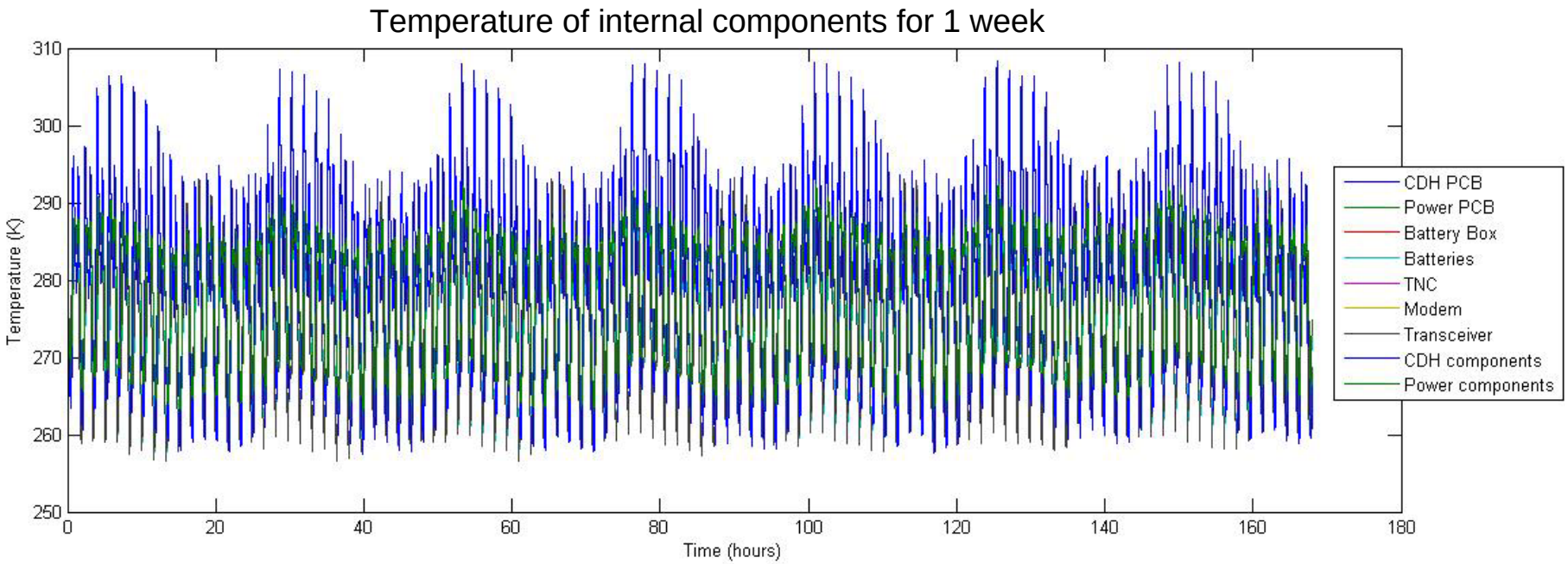
Thermal Model - Results



- Internal Components
  - Minimum: 257K
  - Maximum: 308K

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