Kumu A’o CubeSat Project
(Source of Learning)

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Agenda

- Kumu A’o Team
- Mission Objectives
- CubeSat Design
- Lessons Learned
Kumu A’o Team

At a Glance

- Created: Summer 2007
- Student Participated: 17
- Students Graduated: 8
- 15 Hawaiian/Pacific Islanders/Other Minorities

This Spring 2009: Our Last Semester!
- Then we work only for love
Mission Objectives

Primary:
- Develop Standard Cubesat Bus
- Build, Launch, and Operate Cubesat
- Provide opportunity for Native Hawaiian engineering students
- Accelerate next-gen mission development

Secondary:
- Evaluate Pumpkin Inc. “CubeSatKit” (CSK)
Quick Specs

■ **C&DH**
  ○ CubeSatKit FM430 Module (MSP430F1612)
  ○ Pumpkin’s Salvo RTOS
  ○ Manages complete satellite operation

■ **Thermal Sensors**
  ○ Measuring temperatures inside and out

■ **Structural**
  ○ CubeSatKit 1U Skeletonized Structure
  ○ Antenna deployment by melting fishing line
Telecommunications

- **Radio**: Yaesu VX-3R
  - 100mW or 1W RF Output, 70cm Band
  - ~30% Efficient

- **TNC (Modem)**: Byonics TinyTrak4
  - 1200bps AFSK

- **Morse Code Generator (FM430:TimerB0)**

- **Custom Protocol**
  - Addresses unreliable link due to spinning
  - Connectionless messaging
  - Out of sequence file transfer
TNC

- Custom built TinyTrak4 Based TNC
- Audio In/Out to PC104 via MHX DSR/CTS Pins

Figure 7a: CubeSatKit FM430

Figure 7b: MHX Radio Slot TNC
Radio

Figure 8b: Yaesu VX-3R Radio on Shared Board (CSK Slot 1)

- Switched Power
- Operating State Feedback
- Power Button
- Speaker
- Mic
- TX Power Control
Power Generation

- Spectrolab UTJ Cells (24.3% to 28% Eff.)
  - 2 Cells on Each Face Except Front
- Considering Front TASC Cells

Figure 9a: Spectrolab UTJ Cells

Figure 9b: Kumu A’o CubeSat Rendering
“Simple” MPPT System

- Redundant power, solar & battery
- MSP430F1612 Based
  - Low power idle
- Battery Charger Current Control
- >70% Efficient – Preliminary Results
  - Estimated Generation (1 Side): 24 WHr/Day
  - Normal Consumption: 10 WHr/Day
- Harvests direct and albedo energy
Simple MPPT System

Figure 11: Simple MPPT Method

1. Power Generated
2. Power Boosted from ~4V to 5V
3. Power Sensed by MPPT, Increases Charge Current
4. Power Extracted from Array
5. MPPT Control Loop Maximizes Power
Lessons Learned

- Leadership
- Learning Curve
- Requires Commitment
- Data Sharing
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