Power Management System for a Nano-Satellite

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Background and Objectives

Background

- New Mexico Tech Satellite (NMTSat) is New Mexico Tech's first nano-satellite constructed fully in-house and almost entirely by students.
- NMTSat is a CubeSat (10cm x 10cm x 30cm) project whose primary goals are to monitor space weather in low Earth orbit and correlate this data with results from structural and electrical health monitoring systems.

Objectives

- To design, construct, and test a power management system for NMTSat consisting of three subsystems: solar panels, a power control and monitoring board (PCM), and an electrical power system (EPS).

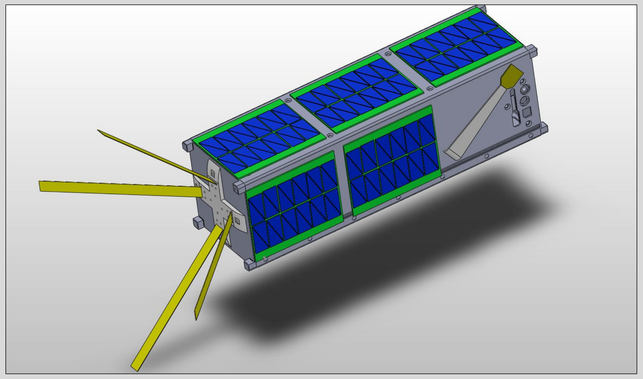


Figure 1: NMTSat Mockup

Design Specifications

Specification	Requirement
Solar Panels	
Power Supplied	1.7W average over whole orbit
Maximum Output Current	2.0A
Maximum Output Voltage	5.5V DC
PCM	
Current Measurement	All satellite subsystems except radio
Power Switching Control	All non-critical subsystems
Current Limiting	All non-critical subsystems
Noise Measurements	All satellite subsystems
EPS	
Voltage Supply Lines	3.3V & 5.0V
Power Supply Capability	>3.0 W
Safeties	• Battery voltage monitoring • Over-voltage shut-off

Selected Design – Solar Panels

- Triangular Advanced Solar Cells (TASCs) from Spectrolab selected
- Blocking diodes implemented to prevent battery discharging
- Panels provide 2.2 Watts over orbit

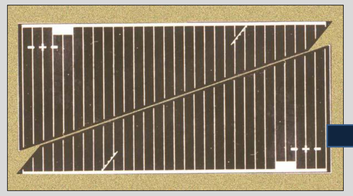


Figure 2: TASCs from Spectrolab
Image courtesy of Spectrolab

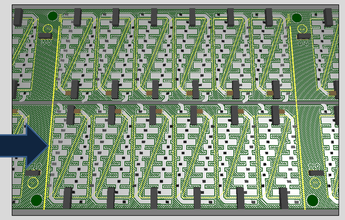


Figure 3: 3D Rendering of Solar Panels

- Structural health monitoring data lines shielded from data loss by ground plane
- Separate locking ribbon cable headers selected for power and data transfer

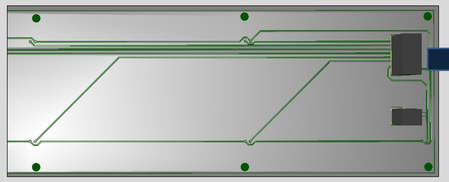


Figure 4: SHM Data Lines

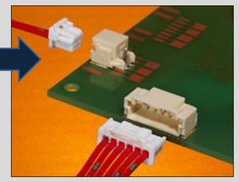


Figure 5: Duraclik Connectors
Image courtesy of Molex

Selected Design – PCM

- Implements hardware and software current limiting
- On command power cycling of noncritical systems
- Current measurements recorded across current sense resistor
- Keeps running average of all current measurements and electrical health monitoring data
- Electrical health monitoring system filters DC component and amplifies AC noise

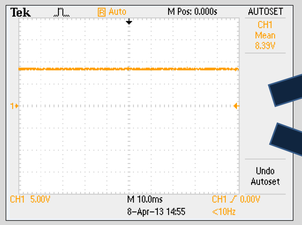
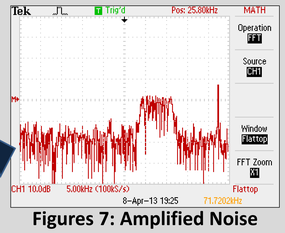
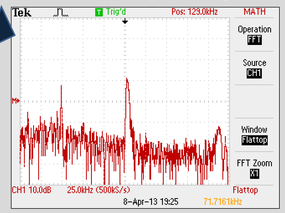


Figure 6: DC Voltage Source



Figures 7: Amplified Noise Spectrum (0-50kHz)



Figures 8: Amplified Noise Spectrum (0-250kHz)

Selected Design – EPS

- Off-the-shelf Gomspace P31u EPS selected
- Onboard Lithium ion battery pack
- Under/over-voltage battery protection
- 3 photovoltaic inputs
- Up to 30W power Conversion
- Three 3.3V & 5V conditioned power outputs
- Raw battery voltage access
- I2C interface
- CubeSat kit compatible
- Remove-before-flight pin interface

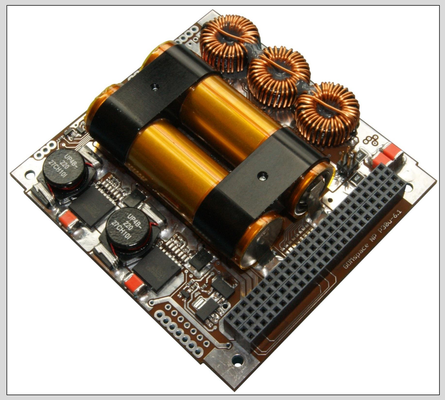


Figure 9: Gomspace P31u EPS
Image courtesy of Gomspace

Project Status

Solar Panel Results – Design complete and materials ordered
PCM Results – Design complete and materials ordered
EPS Results – Gomspace P31u selected and ordered

Future Work

May 2013

- Manufacturing and testing of solar panels and PCM

Summer and Fall 2013

- Testing of EPS upon arrival
- Full system integration

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References

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