Development and Operation of the PocketQube T-LogoQube

Kevin Zack
Sonoma State University
11th Annual CubeSat Developers' Workshop
**T-LogoQube Team**

**Lead Science Mentor**
Dr. Garrett Jernigan (LHR)

**Lead Engineering Mentor**
Prof. Robert Tigges (MSU)

**Science Mentor**
Prof. Lynn Cominsky (SSU)

**Science Mentor**
Prof. Benamin Malphrus (MSU)

**Software Mentor**
Brian Silverman (PICO)

**Software Mentor**
Barry Silverman (DiSUS)

**Engineering Mentor**
Dr. John Doty (NA)

**Engineering Mentor**
Jeffrey Kruth (MSU)

**Engineering Mentor**
Steve Anderson (SSU)

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**Overall Student Team Leader**
Kevin Zack (SSU)

**MSU Student Team Leaders**
Sean McNeil and Will Roach (MSU)

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**SSU Student Team**

- Cunningham, Ben
- Gill, Amandeep
- Goldsmith, Corbin (LHR)
- Loudermilks, Lauryn
- McCowan, Anna
- Mills, Hunter
- Owen, Aaron
- Pacheco, Aaron (SRJC)
- Torke, Max

**MSU Student Team**

- Adams, Garret
- Fitzpatrick, John
- Glaser-Garbrick, Dan
- Grindrod, Jennafer
- Healea, Jordan
- Lawson, Eric
- Mabry, Hannah
- Mays, David

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**Institutions**

- SSU (Sonoma State University)
- MSU (Morehead State University)
- LHR (Little H-Bar Ranch)
- NA (Noqsi Aerospace)
- PICO (Playful Invention Company)
- DiSUS

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**Acknowledgements:**

Chantal Cappelletti and the UniSat-5 team; Prof. Kevin Brown, Tyler Rose, Lance Simms, Luke Lim, Bob Kroll, Eric Thomas, Mike Combs and the entire CXBN team; 50 Dollar Team: Stuart Robinson, Michael Kirkhart, Howie DeFelice, Charlie Cantrill, Bo Lowery; also Eric Tapio, Greg Sprehn, David McCall, Kamal Prasad, John Collins, Laura Chase, Aurore Simonne and Haider Khaleel.
T-LogoQube

Primary Goals:
• uLogo on Orbit
• Down-link Telemetry
• Up-link Commands with Response
• Magnetometer Data Spin Rate by Fourier Transform

Secondary Goals
• Torque Coil
• Radio Configuration Change
• $50sat Relay Packets (Same Transceiver)

• 3P 5 cm x 5 cm x 15 cm
• Launched November 21 2013
• Sun-Synchronous Polar Orbit
• 8 Weeks of Operation

• Uses uLogo for Language
• Re-Programmable Over Transceiver
Instrumentation

- Magnetometer
  - 3-Axis
  - Field measurement range +/-1100uT
  - Resolution as low as 0.015uT

- Temperature Sensor
  - Solar Cell and Torque Coil
  - Microprocessor
  - Battery

- Torque Coil
  - 150 turns 32 gauge
  - 21 ohm coil
  - 157mA
  - 29 sq cm Area
RFM22B Transceiver

- 437.465 MHz
- 100 mW
- Max Range Receive: 2700 km
- Max Range Transmit: ~1500 km
  w/ 50W transmitter 7element Yagi

2x ~17 cm Foldable Dipole Antenna Elements
Development - FlatSat
Testing & Rapid (~4 hrs) Prototyping

Total Time 4 hours
TLQ Revisions ~10
Final Assembly
## Cost

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<th>Description</th>
<th>Quantity</th>
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**Grand Total:** $42.54

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**Grand Total:** $119.98

**Items not purchased**
- 3P PocketQube Frame
- 4 Solar Panels
- Antenna w/ drag cover

**Flight Board** $119.98
**Doty Circuit** $42.54

**Total Flight Hardware Cost:** $162.52
First Packets

Launch on November 21
First Decoded Packet November 23
First Packets prior to accurate NORAD TLE
First Commands

T00 – Beacon Packets
T01 – Checksum Packets
T03 – Magnetometer Packets
T04 – Flag Packets

Example Sequence Beacon Packets
Data of Satellite Temp

Temperature vs Time

Microprocessor
Solar
Battery

Day
Night

Spacecraft Time (Seconds)

Temperature (Kehln)

NIGHT  DAY  NIGHT  DAY
Spin of TLQ from Mag Dump

Time: $128 \times \frac{1}{4}$ samples = 32 sec

Proportional to Earth's Magnetic Field
Demonstration of TLQ Fourier Transform with Flight Code

- Change in Spin rate
- 128 ½ Second Samples
- Total Time 64 Seconds
- Comparison Plots Show Frequency Shift