MISC 3 – The next generation of 3U CubeSats

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MISC 2 / Colony I (C1B)

• Timeline:
  • Design: Q4 2008
  • Delivery: Q1-Q3 2009
  • First flight: Q4 2010
  • Total: 14 units

• Two configurations:
  • Space dart (QbX1, QbX2)
  • Propeller (Aeneas)

• Capabilities
  • 1500cc payload volume
    (not including radio)
  • 2° attitude knowledge & control
  • MCU-based C&DH and payload processors
  • 8-10W to payload

• Limitations
  • Fixed bus & payload volumes
  • No view of space for ADACS
  • Radio & antennas not integrated
  • Lack of symmetry on sides
  • Volume & mass penalties due to ADACS in middle
  • Limited configuration flexibility
MISC 3 Design Goals

• Power:
  • >15W to payload; improved heat paths; 40Wh battery
  • Variety of solar panel and solar array configurations

• Electronics
  • Support MCU-based customers with PPMs
  • Support Linux-based customers with PC/104 SBCs

• ADCS
  • <0.2º knowledge & control via MAI-400 or BCT XACT
  • Multiple configurations (e.g. nadir, anti-nadir, ram, anti-ram, etc.)

• Structure & Assembly
  • Unique add’tl hard points, cutouts and lengths → Pro chassis
  • Up to five sep switches; minimal harnesses
  • Support for multiple antenna configurations (esp. UHF & S-band)
  • GPS integration

• Comms & Propulsion
  • Accommodate new subsystems from various suppliers
MISC 2 vs MISC 3: Module Stacking

MISC 2
- Payload (140mm)
- BIBO
- ADACS
- Radio/BIBO
- Battery
- EPS
- C&DH

MISC 3
- Payload (up to 175mm with ADACS present)
- C&DH
- Battery
- EPS
- Radio/GPS
- ADACS

Heat generating components

Isolated thermal mass
MISC 3 Bus

- ADCS, Radio, GPS, EPS, BATT, C&DH and panel I/F all tied together in a compact and thermally connected stack
- This stack can “slide” up and down relative to the total 3U length
- CSK electrical bus continues from end of stack (C&DH) into payload volume
- Either end can be used for sep switches, antennas, propulsion and/or solar panel hinges
- Other modules stacks (e.g., PC/104-based) can fit within this envelope, too
MISC 3: Propeller

• Example configuration:
  • 48W in-plane via quad end-hinged spars and winglets
  • 40Wh battery
  • Anti-nadir ADCS (look-down)
  • GPS
  • UHF up / down
  • 1550cc payload volume
MISC 3: Turkey Tail

- Example configuration:
  - 56W in-plane via end-hinged spar and multiple winglets
  - 40Wh battery
  - Anti-nadir ADCS (look-down)
  - GPS
  - UHF up / down (MC3)
  - 1300cc payload volume
MISC 3: 3U w/Wings

- Example configuration:
  - 21W in-plane via fixed and long-edge deployable panels
  - 40Wh battery
  - ADCS (trailing view)
  - GPS
  - VHF up / down
  - 1550cc payload volume
MISC 3: Space Dart

• Example configuration:
  • Aerodynamically stable with quad end-hinged panels
  • 40Wh battery
  • No ADCS
  • Optional GPS
  • Customer-specified radio & antenna
  • ca. 2300cc payload volume
Antenna Tuning

- Configuration flexibility of MISC 3 enables us to optimize antenna placement on a per-user basis
Propulsion

• MISC 3 layout permits integration of propulsive modules on either end of structure or anywhere in-between.

• End locations can take advantage of P-POD’s “hockey puck” extra volume

• (UHF) antennas and thrusters can coexist on same end

*Delta-V / deorbit motor, CAPS unit and data courtesy of DSSP*
Conclusion

• MISC 3 has all of the features that made MISC 2 so user-friendly, including:
  • Open architecture
  • Highly modular
  • Rapid delivery (<90 days from receipt of order)
  • Pumpkin quality & affordability

• MISC 3 adds:
  • Basic user customization included in price
  • >20W to the payload, and enough power to run Linux SBCs
  • CubeSat Kit Pro chassis structure
  • More accurate ADACS
  • Bigger / better battery
  • Integrated basic UHF comms, or optional higher-performance comms
  • Easy GPS integration
  • Multiple ADACS, radio, antenna, propulsion and other subsystem choices
  • Multitude of different configurations possible to suit mission requirements
Q&A Session

Thank you for attending this Pumpkin presentation at the 2013 CubeSat Developers’ Summer Workshop!
Notice

This presentation is available online at:

Appendix

• Speaker information
  ▪ Dr. Kalman is Pumpkin’s president and chief technology architect. He entered the embedded programming world in the mid-1980's. After co-founding Euphonix, Inc – the pioneering Silicon Valley high-tech pro-audio company – he founded Pumpkin, Inc. to explore the feasibility of applying high-level programming paradigms to severely memory-constrained embedded architectures. He is the creator of the Salvo RTOS and the CubeSat Kit. He holds several United States patents. He is a consulting professor in the Department of Aeronautics & Astronautics at Stanford University and directs the department’s Space Systems Development Laboratory (SSDL). Contact Andrew at aek@pumpkininc.com.

• Acknowledgements
  ▪ Pumpkin’s Salvo, CubeSat Kit and MISC customers, whose real-world experience with our products helps us continually improve and innovate.

• CubeSat Kit information
  ▪ More information on Pumpkin’s CubeSat Kit can be found at http://www.cubesatkit.com/. Patented and Patents pending.

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