Lessons learned by development of UPSat Attitude Determination and Control Subsystem

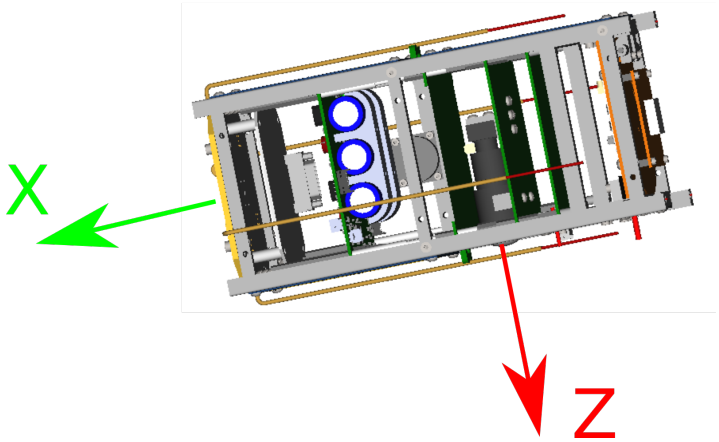
Libre Space Foundation

October 15, 2019

Go/no go Check

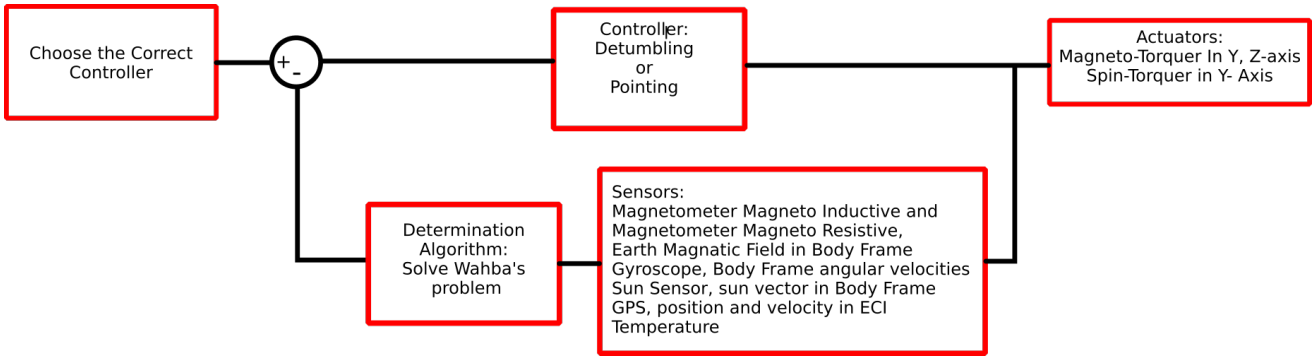
Warning: About my bad English...

System Requirements



- What ADCS does?
- What were the mission requirements?
  - Pointing accuracy: 15°
  - Knowledge accuracy: 5°
  - Recovered from tip-off rates: up to 10°/sec within 2 days
- Note: X roll, Y pitch, Z yaw

System Architecture

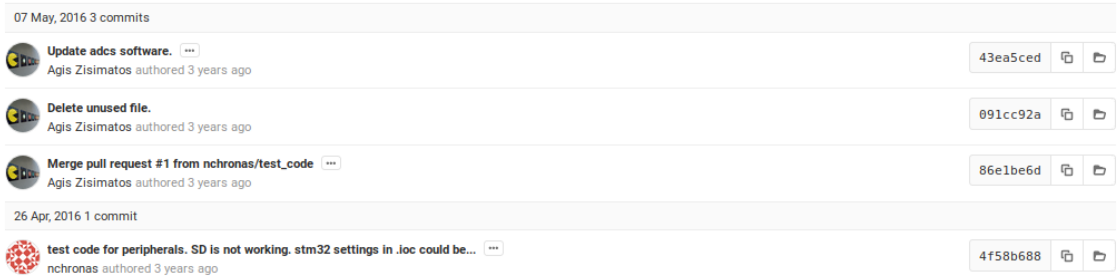


- Control Loop: 1s, 68ms for determination algorithm and control (actuators are OFF) and then the actuators are ON
- Switching controller condition, angular velocities $<0.3^\circ/\text{sec}$
- Power consumption, total 1740mW:

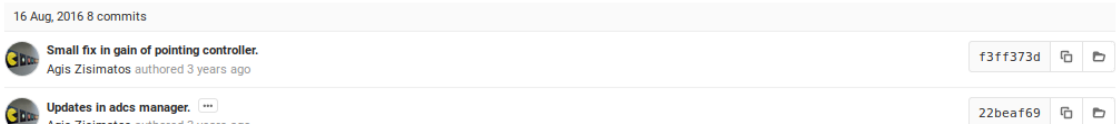
Module	Power
Actuators	180mA @ 5V, 20mA @ 3.3V
MCU - Sensors	73mA @ 3.3V, Clock Speed 168MHz
GPS	100mA @ 5V

Known Issues Before flight

- Limited time for Development and Testing
  - First commit

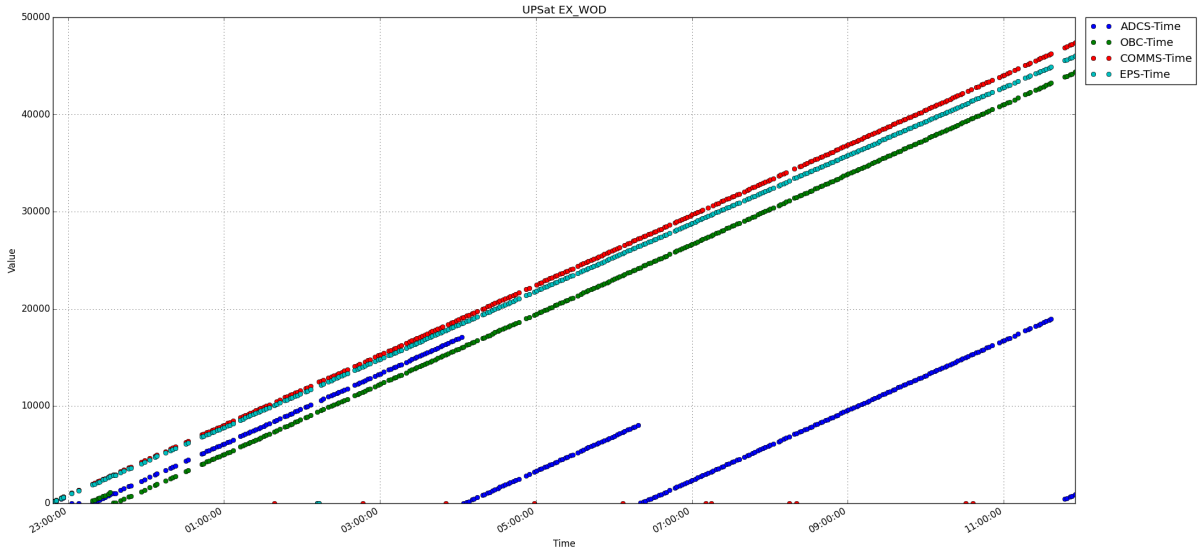


  - Last commit

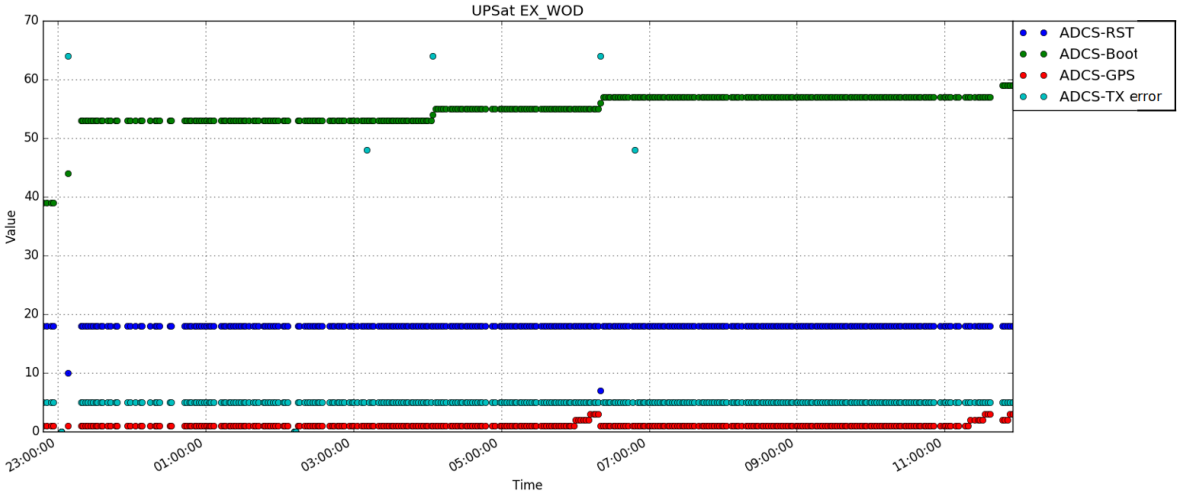


Known Issues Before flight

- 4 total resets in overnight test, 12 hours



Known Issues Before flight



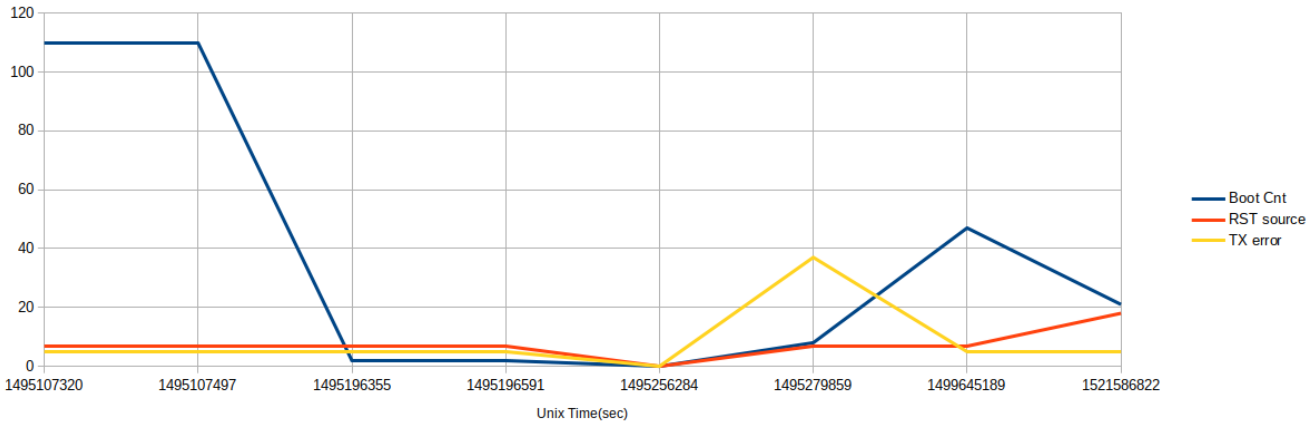
- TX ERROR 48, 64, means I2C bus is blocking
- TX ERROR 5, means no error in ADCS
- TX ERROR 37, means no sync time with OBC
- RST 7, means that ADCS is closed from EPS
- RST 18, means that ADCS is closed from WDT

Known Issues Before flight

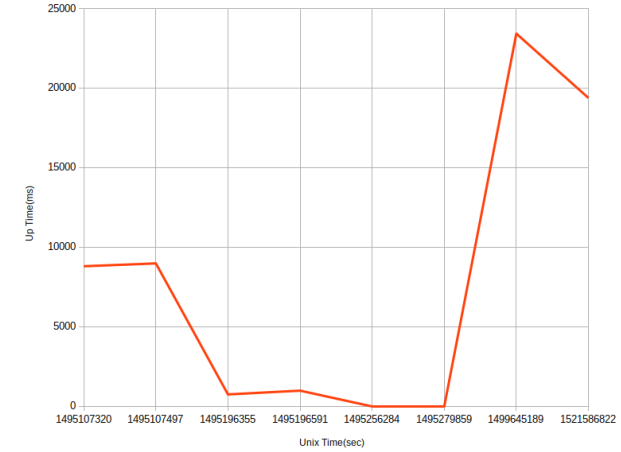
- GPS Fix, Never got Fix Position in test campaign
- I2C Bus, Blocking by Spin-Torquer communication
- Flash Memory, Reset Counter is not stored correctly

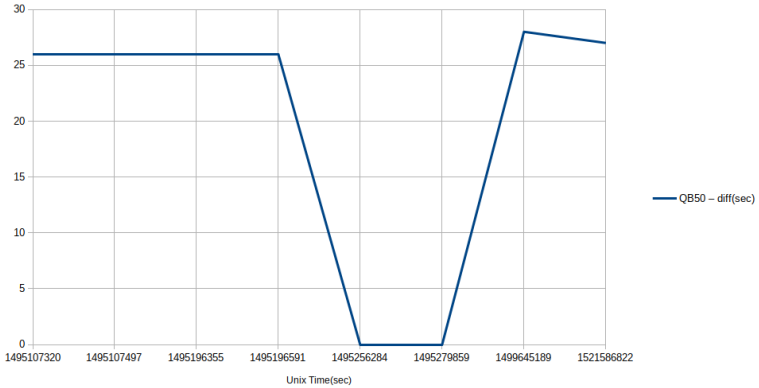
Orbit Life - System Health

- Limited extended Whole Orbit Data (EXWOD) was received (8 packets from almost 200 WOD)
- Time Period: 18/05/2017 (near to lauch day) to 20/03/2018 (dd/mm/yyyy)
- 1 EXWOD packet isn't valid (only zeros) at unix time 1495279859 sec

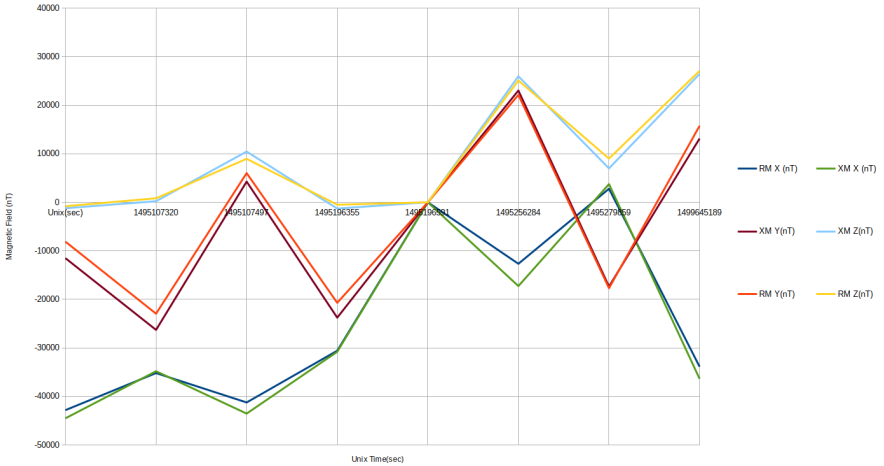


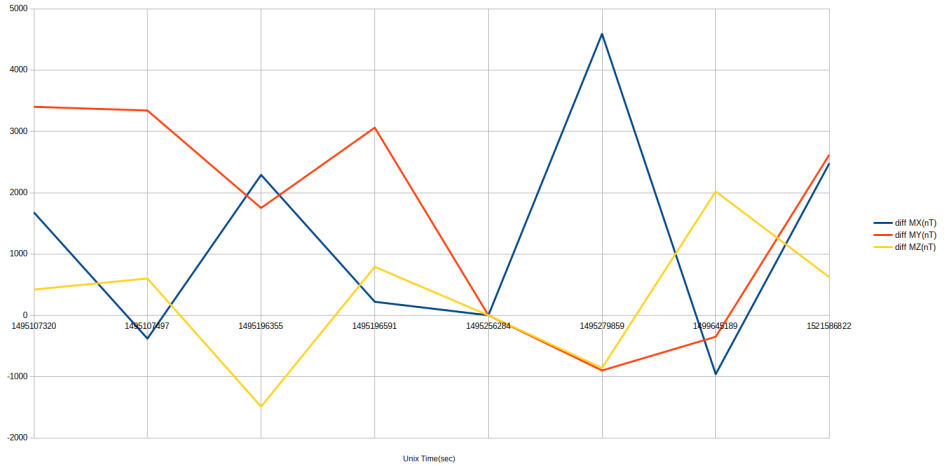
Orbit Life - System Health





Orbit Life - Magnetometers

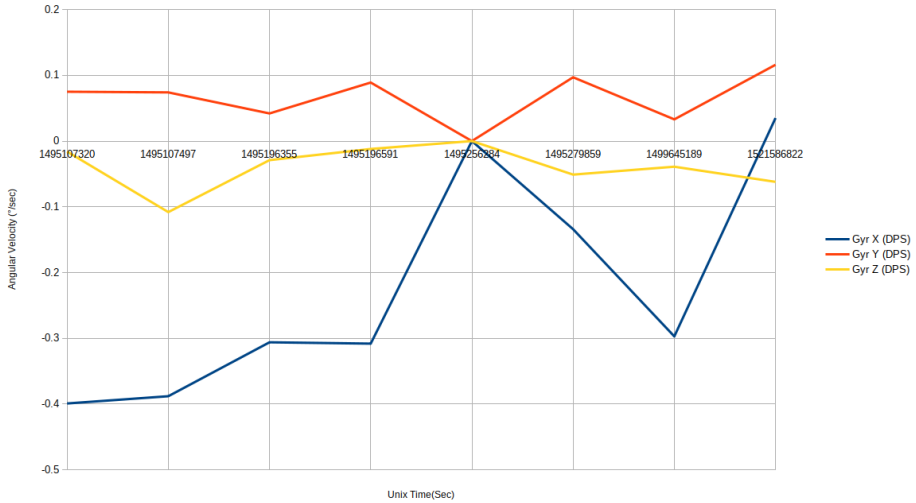


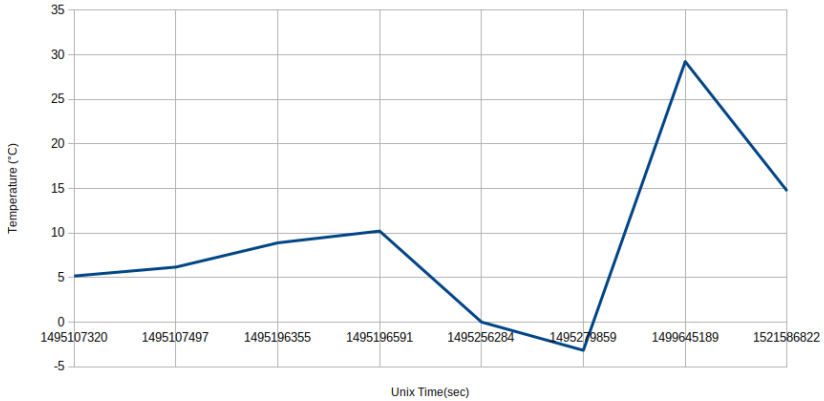


Orbit Life - GPS

Never got Fix position

Orbit Life - Gyroscope, Temperature



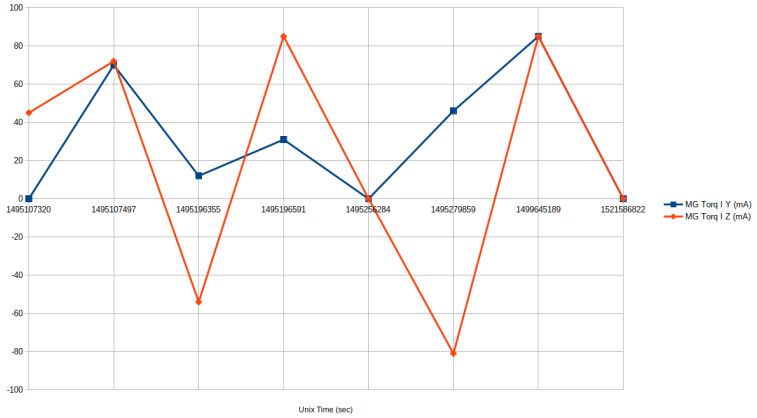


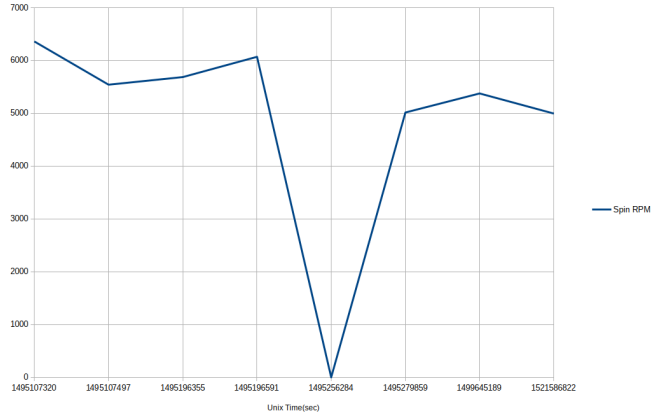
Orbit Life - Sun Sensor

No valid Sun Sensor measurement, due to rotation in X-axis

Orbit Life - Actuators

Spin Torquer constant offset: 5000 RPM





Go/no go - Good Practices

- Change the controller from detumbling mode to pointing with ground command
- Attention to control stategy modes and how they alternate
- Testing the communication with other sub-system
- More time for development, testing and code review
- Feed the satellite with TLE by the ground due to possible issue with GPS
- More data in whole orbit data (WOD) about the health of ADCS (This is an issue in QB50 Mission)

Go/no go - Good Practices

- Use different communication bus for actuators and sensors
- Gyroscope sensor temperature compensation
- Add Current feedback in magneto-torquer control
- Testing of determination algorithm (Open Source Instrumentation - Simulation)
- Testing of control algorithm (Open Source Instrumentation - Simulation)
- 1 Fine sun sensor or Coarse Sun sensor in each sides?

Source Files

Source Files: https://gitlab.com/librespacefoundation/upsat

Thanks!!