KU LEUVEN

KU Leuven ADCS

Accurate and Agile Attitude Determination and Control for CubeSats

The KU Leuven ADCS offers high-precision attitude determination and control in a compact package. The star tracker with innovative algorithms and the precisionengineered reaction wheels bring unprecedented agility, pointing knowledge and pointing performance to CubeSats.

ADCS Features

Precise Attitude Determination

- 3 Gyroscopes + 6 Photodiodes + 3 Magnetometers + Star Tracker.
- Flexible Extended Kalman Filter.

Agile Attitude Control

- Three reaction wheels and three magnetorquers.
- Fine PID controller, Coarse controller, B-dot, Thomson-spin.

High Autonomy

- SGP4 Orbit propagator.
- Autonomous Nadir, Zenith, Sun, and LLA pointing.
- Autonomous desaturation of reaction wheels.
- Autonomous mode switching possible.

High Robustness

- Extensive test campaign shows high robustness of components.
- Highly robust star tracker algorithms.

- ✓ High accuracy and agility
- ✓ Using COTS hardware
 - Easy interfacing



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Performance

- The star tracker and three reaction wheels offer accurate pointing control.
- A coarse determination (no star tracker) and a coarse pointing mode (only using 1 reaction wheel) increase robustness.
- Extensive ESA-validated simulations were run using a highly representative simulation environment to assess the performance.

Estimation / Control	Pointing acc. Day (deg 1ơ)	Pointing acc. Eclipse (deg 1ơ)	Know. acc. Day (deg 1ơ)	Know. acc. Eclipse (deg 1ơ)
Coa/Coa	6.3	6.4	1.9	3.4
Coa/Fine	1.9	4.9	1.8	4.8
Fine/Coa	3.7	4.1	0.04	0.04
Fine/Fine	0.11	0.11	0.01	0.01

The results in this table were generated based on a 3U CubeSat with a 600km sun-synchronous orbit.



Detumbling: from +60deg/s RW torque: 0.5 mNm RW momentum capacity: 4 mNms nominal, up to 6 possible MTQ mag. Moment: 0.24/0.24/0.13 Am²

Estimation/ Control	Power cons. (mW)
Detumbling	940
Coa/Coa	1000
Coa/Fine	1300
Fine/Coa	1125
Fine/Fine	1400

Budgets

Power Consumption: See table Mass: 715 gram Volume: PC104 format _{Easy to m}

Interface

Power Interface: +5V, +3.3V Data Interface: I2C, CAN







Qualification

The components of the KU Leuven ADCS are vibration tested with loads representing all typical CubeSat launchers. The reaction wheels have undergone accelerated lifetime tests in thermal vacuum, showing a lifetime of 3+ years.

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