Ultra Precise Modular Reaction Wheel Operation for Optical and Radar Satellites

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Introduction

With the new space arena evolving towards serious science and defense missions, the availability of new space avionics with high-end performance is becoming a prerequisite for modern and future satellite missions.

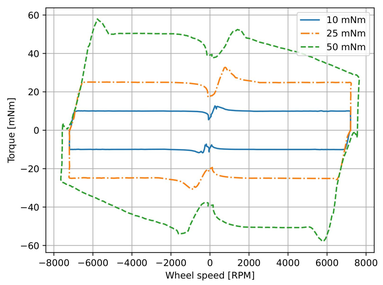
This puts requirements for very accurate speed and torque control of modern reaction wheels used to perform attitude control of modern spacecraft.

- Nearly vibration free operation (optical payloads)
- Extremely trum of frequencies
- Modularity
- Fast delivery
- Scalability

Performance (WHL-500)

Performance:
- Momentum: 500 mNms @ 7.200 RPM
- Max Torque: 50 mNm (impulse up to 100 mNm)

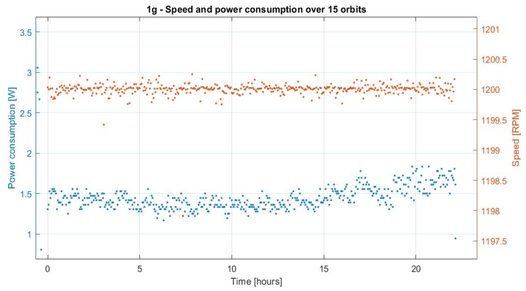
Power Consumption:
- 2 W at 200 mNms
- 6 W at 500 mNms
- 8 W at 175 mNms + 10 mNm
- 14 W at 380 mNms + 10 mNm
- 67 W at 138 mNms + 47 mNm



On-Orbit heritage

Since April 2022, several on-orbit tests have been performed on the WHL-500 to evaluate speed stability, power consumption, and lifetime performance.

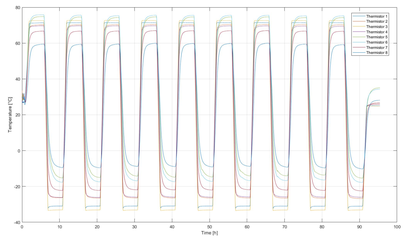
- In space since April 2022
- Speed stability and power consumption unchanged
- 23-hour performance test at 1200 RPM:
  - Speed mean bias of 0.00497 RPM
  - Speed standard deviation of 0.07883 RPM



Robust thermal design

As part of an ongoing effort to fully qualify the WHL-500 for the harshest space conditions, the thermal performance of the reaction wheel was extensively validated.

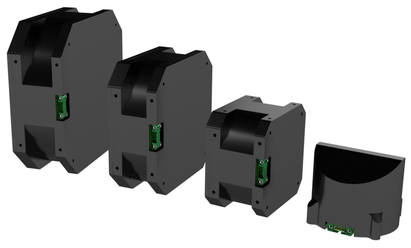
- Robustness in a wide temperature range
  - Min temperature: -20°C
  - Max temperature: +60°C
- Ongoing radiation tests qualification campaign:
  - Total Ionizing Dose (TID)
  - Single Event Effects (SEE).



Design

The presented reaction wheel design is based on a 100% in-house developed permanent magnet synchronous motor with integrated controller and software. Full redundancy provides robustness and long lifetime. Scalability allows for the design to be applied for a broad range of wheel sizes.

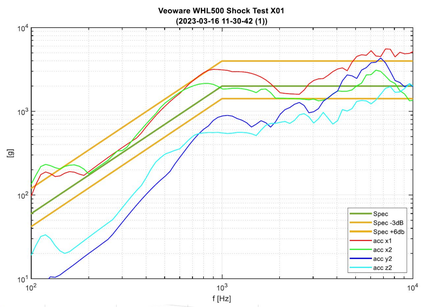
- Redundant CAN bus
- Redundant motor drivers
- Redundant windings
- Scalability: 10 to 250 kg
- Sizes: 100, 200, 500, 1000 mNms

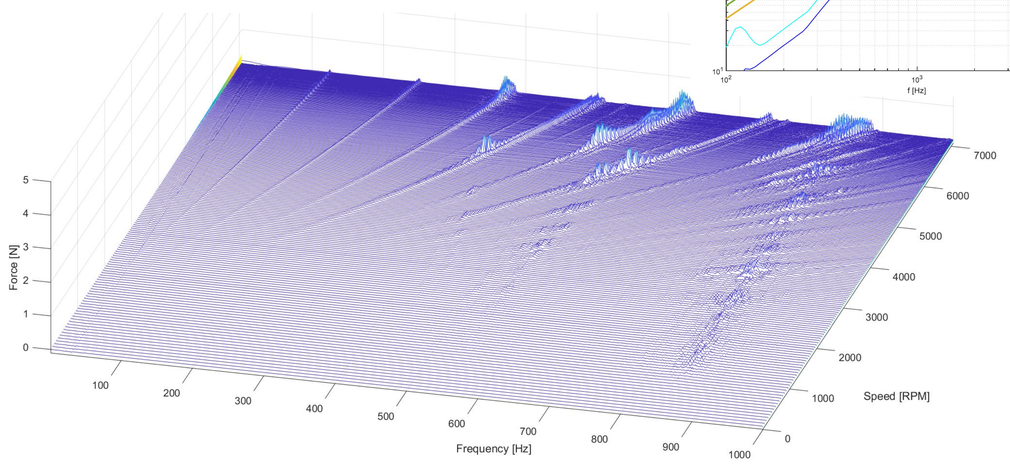


Ultra low microvibrations

Extensive microvibration testing using a high-precision Kistler dynamometer has been performed on the WHL-500 to evaluate its microvibration performance before and after vibration (14.1 GRMS) and shock testing (2000 g).

- No loss of function after the shock test
- Unchanged performance and no dangerous eigenfrequencies vibrations in the critical 1 - 400 Hz
- Post-shock increase of vibrations only after 800 Hz
- Repeatable results for multiple different wheels
- Unbalance grades between G0.1 and G0.4





Summary

In summary, this poster showcases a state-of-the-art reaction wheel designed for small satellites. Extensive testing and analysis have demonstrated:

- Exceptional microvibration performance
- Precise pointing accuracy and stability
- Robustness to extreme thermal conditions

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