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Title

ReFEx: Reusability Flight Experiment - Development of a cold-gas RCS using off-the-shelf components

Authors

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Abstract

The study for future Reusable Launch Vehicles (RLV) at the German Aerospace Center (DLR) currently involves the development of the Reusability Flight Experiment (ReFEx). The experiment is approaching flight-readiness with the launch scheduled in 2024 from the Koonibba Test Range (KTR) in Southern Australia using a VSB-30 sounding rocket. The vehicle flight profile deploys the experiment into the low-pressure thermosphere with an Apogee of approximately 130km. Because of the spin-stabilized rocket and the necessity for attitude control during the re-entry preparation flight phase the deployment of a thruster system is necessary on the experiment [1]. The Guidance and Control (G&C) Subsystem therefore includes a cold-gas Reaction-Control System (RCS) to de-spin and align the vehicle of approx. 400 kg mass.

The development of the custom ReFEx RCS system started in 2018 with the implementation of the preliminary system design as a 1D-simulation model. The EcosimPro ESPSS Library was used for the prediction of the idealized system performance. Further analytical studies were conducted in MATLAB. It was concluded that the system should be fitted with a high-pressure nitrogen tank, eight conical nozzles, as well as two pressure regulators and isolation valves, allowing switching between a 10 bar high-thrust mode for fast maneuvers and a 2.5 bar low-thrust mode for fine pointing. The system performance was initially tested on a Breadboard Model (BBM) in 2019, where the procured Off-the-shelf components (COTS) were assembled and tested in a representative architecture. A functional Structural and Thermal Model (STM) was built in 2020 to test and validate that the system achieves the set requirements with the flight equivalent system setup.

An RCS Proto Flight Model (PFM) will be assembled in 2023 and subjected to further verification and acceptance testing prior to the final assembly and launch of ReFEx. In this paper the RCS development steps, conducted experiments and test results are presented in detail. The different factors impacting the systems (vacuum) performance are discussed.

References

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