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FORESAIL 1 PLATFORM DESIGN FOR PARTICLE TELESCOPE AND PLASMA BRAKE EXPERIMENT

Abstract

FORESAIL-1 cubesat, scheduled to launch in Q1 2021, is the first in the FORESAIL mission series developed by the Finnish Centre of Excellence for Research in Sustainable Space. The mission objective is to measure radiation belt losses using particle telescope (PATE), demonstrate deorbiting with plasma brake (BP), test an ultra-sensitive magnetometer, and prepare for high radiation missions.

The PATE consists of two telescopes with detectors to measure energy particles and solar ENAs. The requirement is to orient its detector with shorter collimator towards the Sun, while the detector with longer collimator to scan the environment. The BP requires spin control for deploying and maintaining the tension of the tether to demonstrate the deorbiting.

The avionics subsystems of Foresail-1 is designed in house in order to accomplish the payload requirements. The avionic stack is enclosed in an Aluminum vault to protect against the radiation environment. The science and deorbiting experiments impose the requirement on the platform for maintaining desired spin rate around sun pointing reference axis.

The attitude determination control subsystem uses magnetic only attitude control to achieve high spin along the rotation axis. The magnetorquers have been designed using optimization tool and wounded using a 3D printer. The digital and analog sun sensors have been designed for fine and coarse measurements. The electrical power subsystem consists of solar panels, power conditioning distribution unit and battery units. The buck converters have been designed to operate at constant current, constant voltage and maximum power point tracking. The EPS operates in predefined nominal modes for effective battery charging and maintaining the bus voltage equal to battery voltage. The power distribution down converts battery bus voltage to a fixed 3.6V for onward distribution to the platform and payload avionics. The onboard data handling subsystem runs the real time operating system and consist of radiation tolerant

onboard computer, external data storage and custom built RS485 based data handling protocol. The design scheme consists of active and cold redundant units with arbitration logic. The telemetry, tele command communication subsystem consists of radio frequency front end and antennae in ultra-high frequency band for uplink and downlink.

The paper also provides the current design status and test plan for the Foresail-1 satellite. The design philosophy is to build all the subsystems in house. We adopt the Engineering Qualification Model-Flight Model (EQM-FM) which consists of a set of functional and environmental tests for qualification and acceptance.