SPACE POWER SYMPOSIUM (C3)
Small and Very Small Advanced Space Power Systems (4)

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ANALYSIS OF THE ELECTRICAL POWER SYSTEM FOR ESTCUBE-1

Abstract

In this work we will present performance and design analysis of the ESTCube-1 Electrical Power System (EPS). ESTCube-1 is the first Estonian satellite, and it has been designed, assembled, and tested by students from several Estonian universities. Its mission is to test the electric solar wind sail concept in Low Earth Orbit, deploying a thin conductive tether from a rotating satellite, charging it electrically, and measuring how its electrostatic interaction with the plasma in Earth's magnetosphere affects its orbital and attitude parameters. The satellite has been delivered to the launch provider and is scheduled to be launched in April 2013.

The EPS has been built from ground up using Commercial-off-the-Shelf (COTS) components and it uses these components for energy harvesting, storage, distribution and control. Due to the fact that the

satellite has to spin with a speed of up to two rotations per second, energy harvesting systems for solar panels have to adapt as fast as possible to avoid significant efficiency penalties. To achieve this, commercial high frequency perturb-and-observe maximum power point tracking chips have been used that charge batteries through protection circuits. The power is being conditioned and distributed using commercial switching regulators that have been placed in a hot redundant parallel configuration. The control of this system is done through an Atmel AVR microcontroller that has been interfaced to Ferroelectric Random-Access Memories to provide fault-tolerant storage for satellite firmware and important parameters.

To provide precise telemetry information, the EPS has been equipped with 48 analog measurement points, each separately calibrated, allowing precise measurements of all important power parameters inside the satellite, including power production, power consumption per subsystem (and with smaller granularity in case of some systems). This also allows to test system degradation during satellite's lifetime and to provide very precise efficiency measurements, especially measuring the efficiency of energy collection in case of different conditions.

The work includes precise measurements of the satellite's power production and consumption, giving information for power budgets of further satellites and at the same time proving space-worthiness of the components and solutions used to provide relevant design data for future satellite systems, especially about the Maximum Power Point Tracking chip, that could significantly reduce the complexity of future small satellite Electrical Power Systems.