21st IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Generic Technologies for Nano/Pico Platforms (6B)

Author: Mr. Sebastian Trowitzsch
Technische Universität Berlin, Germany

Mr. Frank Baumann
Technische Universität Berlin, Germany
Prof. Klaus Brieß
Technische Universität Berlin, Germany

BEESAT-2: A PICOSATELLITE DEMONSTRATING THREE-AXIS ATTITUDE CONTROL USING REACTION WHEELS

Abstract

In 2005, TU Berlin initially started innovative space missions using picosatellites for scientific and educational purposes. In order to widen the field of space applications of picosatellites, the technological need for a three-axis stabilized platform was specifically addressed by the development of miniaturized reaction wheels. The picosatellite BEESAT-1 was designed to provide a reliable platform for technology demonstration in space, and was launched from the Indian space port Sriharikota on September 23, 2009. As a result of the mission, those coin-sized reaction wheels as well as miniaturized sensors for attitude determination could successfully be verified in space.

During more than 3 years of continuing operations of BEESAT-1, valuable telemetry data was retrieved that allowed detailed sensor data evaluation and the derivation of performance characteristics of the platform.

Based on the technological foundation and flight experience of BEESAT-1, the design of its successor BEESAT-2 was slightly improved whilst still keeping the unique and successful approach towards single-point failure tolerance achieved by subsystem redundancy. The satellite was additionally equipped with an exemplary optical payload and a dedicated payload data handling unit. On April, 21st 2013, BEESAT-2 was released into orbit from the Russian satellite BION-M1.

Using reaction wheels and magnetic coils as actuators on the one hand and sun sensors, magnetic field sensors and MEMS gyroscopes for attitude determination on the other, BEESAT-2 is fully equipped to serve as a testbed for implementation and evaluation of different attitude control strategies. An automated ground segment facilitates mission operations and software uploads to the satellite.

The paper presents mission results from testing multi-staged, linear and non-linear quaternion feedback regulators for momentum control with magnetic coils and attitude control with reaction wheels.

The paper concludes with an outlook on the upcoming mission operations of BEESAT-2 and subsumes lessons learned from both the engineering as well as the project management point of view with regard to the boundary conditions specific to university space missions.