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Author: Mr. Sebastian Grau
Technische Universität Berlin, Germany, sebastian.grau@tu-berlin.de

HIGHLY INTEGRATED COMMUNICATIONS, POWER MANAGEMENT, AND ATTITUDE DETERMINATION AND CONTROL SIDE PANEL FOR CUBESAT STANDARD NANOSATELLITES

Abstract

Recent development in highly integrated side panels for CubeSats has seen the integration of attitude determination and control system (ADCS) components together with components of the electronic power supply (EPS) system. Complemented by the communications system, these three systems form the core of any nanosatellite mission. Their special importance can also be seen in the amount of mass, volume, and electronic power consumption they account for on CubeSat missions. The more precise the ADCS of a CubeSat becomes, the less resources are available for payloads on such satellites. To allow for larger payloads a highly integrated CubeSat side panel was developed at Technische Universität Berlin, Germany. This side panel comprises commercial of the shelf MEMS sensors for attitude determination and housekeeping, space-graded solar cells, a solar antenna, and two attitude actuators. Dual three-axis rate gyroscopes together with dual three-axis magnetic field sensors and a sun sensor based on a position sensitive device are used for attitude determination. The efficiency of the solar cells is increased by using a maximum power point tracking algorithm that is running on a microcontroller which is located on the side panel. A solar cell was combined with a S band patch antenna to form a so-called solar antenna. The solar antenna allows for high datarate downlink while keeping the loss in effective solar cell area on the side panel at a minimum. Coarse attitude control is realized by an electro-magnetic coil that is integrated inside the printed circuit board (PCB) of the side panel. For precise and agile attitude control a newly developed fluid-dynamic actuator for picosatellites is mounted on the side panel. The two actuators together with the sensors and the microcontroller allow for local preprocessing of attitude determination and control, thus freeing the on-board computer from these tasks. The design of the PCB makes it possible to produce different variants of the side panel, for example by subsituting the solar antenna with a larger solar cell and by removing the fluid-dynamic actuator. Significantly larger payloads are enabled by implementing the highly integrated side panel on CubeSat missions.