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DESIGN AND DEVELOPMENT OF A RELIABLE ADCS AND INDIGENOUS BUS ARCHITECTURE FOR NANOSATELLITES: ITU PSAT II

Abstract

In this paper, we present the design and the development of the second cubesat/nanosatellite of the Controls and Avionics Laboratory of ITU: ITUpSAT II. The main goal of ITUpSAT II project is to design and implement a reliable and precise Attitude Determination and Control System (ADCS) on standardized but reconfigurable bus architecture which can serve as a standard platform for a variety of space science missions. The configuration is compliant with 3U CubeSat Standards (i.e. 30cmx10cmx10cm) as to enable simple access to space. The key driving force in the development of nanosatellites is their potential for performing valuable missions with minute cost in comparison to larger satellites. Towards this end, in-house space modified commercial off the shelf components are utilized in the design of the ITUpSAT II bus system. The combination of the standardized CubeSatKit Bus and in-house developed Kiss Bus serves as a modular design to achieve not only compatibility with many standardized components but also provide experiment/payload/mission design with faster and reconfigurable data-bus and power lines. In comparison to the existing on-market pico/nano-satellite buses, ITUpSAT II bus provides not only higher computational power and data link capabilities but also precise orbit determination through its GPS receiver. To cope up with precise pointing requirements across a wide range of scientific missions, an indigenous ADCS for precise 3 axis attitude control is developed. Three-layered ADCS hardware is comprised of COTS sensors, miniaturized actuators and indigenous ADCS computer. Embedded within the sensor layer is a set of low cost inertial, magnetic and coarse sun sensors and an in-house developed optional camera/star tracker. A redundant assembly of reaction wheels, together with magnetorquers housed inside solar panels forms the actuator layer. Embedded within the ADCS computer is a suite of attitude determination and controller algorithms with different operation modes as to fulfill the pointing accuracy needs depending on the mission. Specifically, the measurements from sensor suite are fused within an Extended Kalman Filter (EKF) to estimate the nanosatellite attitude. Attitude information is then fed to the dedicated control layer, which supports different operation modes and associated control strategies depending on the actual spacecraft operation mode and the health-status of the individual sensors and the actuators. The complete design is verified within in-house developed software/hardware in the loop system, which includes on-orbit magnetic field emulation, frictionless 1D and 3D tables and direct satellite-bus emulation. ITU pSAT II is expected to be launched in 2013.