SPACE SYSTEMS SYMPOSIUM (D1)
Training, Achievements, and Lessons Learned in Space Systems (5)

Author: Dr. Joon Wayn Cheong
University of New South Wales, Australia, cjwayn@unsw.edu.au

Mr. Ben Southwell
University of New South Wales, Australia, benjsouthwell@gmail.com
Mr. Chung Lam
University of New South Wales, Australia, john.lam128@gmail.com
Mr. James Bultitude
University of New South Wales, Australia, james.bultitude@gmail.com
Mr. William Andrew
UNSW Australia, Australia, w.andrew@unsw.edu.au
Mr. Shannon Green
University of New South Wales, Australia, shannon@shannon.green
Dr. Barnaby Osborne
University of New South Wales, Australia, barnaby.osborne@gmail.com
Dr. Andrew G. Dempster
University of New South Wales, Australia, a.dempster@unsw.edu.au
Dr. Elias Aboutanios
University of New South Wales, Australia, elias@ieee.org
Mr. William Crowe
Australia, crowe.william.james@gmail.com

DESIGN AND DEVELOPMENT OF THE UNSW QB50 CUBESAT - EC0

Abstract

The Australian Centre for Space Engineering Research (ACSER) at the University of New South Wales has developed a 2U Cubesat named 'Educational Cubesat 0 (EC0)' to participate in the QB50 project. QB50 is a constellation of 50 Cubesats developed by various universities to perform in-situ scientific experiments in the largely unexplored thermosphere. The Cubesats will be launched to the International Space Station (ISS) for deployment in mid 2016. This paper details the software and hardware integration and testing of EC0. The findings cover the functionality of the system, as well as a discussion of testing methods selected for subsystem verification and the lessons learnt in developing and integrating ACSER's first CubeSat.

The primary payload of EC0 is the INMS (Ion/Neutral Mass Spectrometer), which will measure the mass of ions and neutral atoms. In addition, EC0 features four other UNSW experiments; the Kea GPS Board for navigation and remote sensing experiments, the seL4 board for testing of its formally verified microkernel experiment, the RUSH FPGA for testing a radiation tolerant FPGA to mitigate SEU failures, and finally, RAMSES, a rapidly manufactured Cubesat structure using selective laser sintering of high temperature 3D-printing.

The EC0 was developed by a diverse team that integrated the payloads, support structures and core subsystems. An Electrical Ground Support Equipment (EGSE) was implemented, allowing for core subsystems and payload integration testing with the On-Board Computer (OBC) in the loop. The EGSE allows the OBC to be controlled and programmed, with each satellite resource accessible. Various

electrical power conditions can be simulated. The EGSE can be accessed remotely to facilitate off-site code development and testing work. The development of EC0 follows the agile methodology and strict version control via the use of a GIT repository.

A magnetically actuated, Attitude Determination and Control System (ADCS) was designed and implemented to provide de-tumbling and pointing capabilities for EC0. Attitude determination utilises a sun sensor, an earth sensor, a 3 axis gyroscope and a 3 axis magnetometer. A simple B dot controller was implemented for detumbling and for pointing, an Extended Kalman Filter (EKF) was implemented to determine attitude. Then PD controller is used for magnetorquer actuation. The implemented ADCS is modular, allowing for easy adaptation by another Cubesat that featuring a subset of EC0's sensors.