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Author: Prof. Craig Underwood

Surrey Space Centre, University of Surrey, United Kingdom, c.underwood@surrey.ac.uk

Dr. Ben Taylor

Surrey Space Centre, University of Surrey, United Kingdom, B.Taylor@surrey.ac.uk

Mr. Alex Dyer

Surrey Space Centre, University of Surrey, United Kingdom, A.Dyer@surrey.ac.uk

Mr. Christopher Ashton

Surrey Space Centre, University of Surrey, United Kingdom, C.Ashton@surrey.ac.uk

MUREM: A MICRO RADIATION ENVIRONMENT AND EFFECTS MONITOR FOR SMALL  
SATELLITES

**Abstract**

The Surrey Space Centre has designed, built and flown a number of space environment monitors over the last 20 years. The MuREM payload is built upon this heritage, but is much smaller in volume and mass, and is comprised of individual internal boards which fit the CubeSat form factor. MuREM is designed to provide in-flight data on Total Ionising Dose, Dose-Rate and the charge deposition spectra of Single Event Effect (SEE) initiating energetic protons and heavy ions, as well as providing radiation effects data on samples of advanced commercial-off-the-shelf (COTS) electronic devices. Its low mass (less than 1 kg) and low power make it suitable in whole or part as a generic radiation environment monitor for routine flight on micro- or nano-satellites. The payload consists of three main boards sized to the PC104 standard to make the board layout consistent with a CubeSat layout, for possible future re-flight. The Total Ionising Dose and Dose-Rate sensor board comprises a C515 microcontroller for CAN communication, two DC-DC converters, a temperature sensor, a solid-state RADFET dosimeter (based on UoSAT-5's Total Dose Experiment) and a dose-rate measuring photodiode circuit (based on GIOVE-A's CEDEX payload). The Heavy Ion and Proton Detector board contains two large area PIN diodes as detectors (with heritage from KITSAT-1's Cosmic-Ray Experiment), along with pulse shaping circuitry, two DC-DC voltage conversion modules and a data handling C515 microcontroller. This board communicates particle linear-energy transfer (LET) spectrum data and radiation effects data using a CAN packet based file-transfer protocol. The radiation effects board consists of a selection of modern COTS electronic components of interest for future spaceflight opportunities. These components are monitored for radiation damage during the mission, with current draw monitored, as well as detection of single event upsets, latch-up and functional interrupt. Data from these devices are delivered to the C515 on the particle detector board. MuREM is currently under construction at the Surrey Space Centre for first flight on Surrey Satellite Technology Ltd's TechDemoSat-1 mission, due for launch in 2012-13.