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Author: Dr. Anja Kohfeldt
Technische Universität Berlin, Germany, anja.kohfeldt@tu-berlin.de

Mr. Jens Riesselmann
Technische Universität Berlin, Germany, jens.riesselmann@ilr.tu-berlin.de
Mr. Stefan Junk
Technische Universität Berlin, Germany, stefan.junk@tu-berlin.de
Mr. Danilo Költzsch
Technische Universität Berlin, Germany, danilo.koeltzsch@tu-berlin.de
Mr. Frank Baumann
Technische Universität Berlin, Germany, frank.baumann@tu-berlin.de

RADIATION TESTS WITH PARTIALLY OPEN HARDWARE SYSTEM-ON-A-CHIP COMPUTERS FOR APPLICATIONS IN SPACE

Abstract

In the last years the popularity and with that performance of COTS single-board computers and systems-on-a-chip (SoC) with partially open designs and software systems like the Raspberry Pi, Arduino, or BeagleBoard raised significantly. Thanks to their wide availability, low price, and open adaptability they are widely used in broad communities among makers and artists as well as in schools and universities. They can serve as scientific platforms e.g. as interfaces, sensor data handling or distributed computing platforms. Due to the large spread and user number, as well as the accessibility of the design, bugs are likely to be found and patched, leaving a reliable system. A variety of open source operating systems and programs with a multitude of easy to use libraries decreases the complexity in the development of new soft- and hardware. This offers the great opportunity even in space business to use them as an engineering model, to build laboratory breadboards, or as an experimental platform.

Beside the evolution of the boards also the requirements for on-board computers and payload data handling units have increased considerably, even on very small satellites. Computers like the Raspberry Pi or BeagleBone are able to increase computational power and at the same time decreasing size, mass, complexity, and power consumption. They are very well suited for tasks such as image processing, handling of large data, or operation in general. When being able to use them as flight model directly development time and system adaptations can be decreased to a minimum.

We tested both Raspberry Pi and BeagleBone modules. This paper focuses on the characterization and total ionizing dose (TID) test of the smallest board in the BeagleBone family, the PocketBeagle. The PocketBone has a footprint comparable to a matchbox and hosts an 1 GHz ARM processor with 512 MB RAM and integrated power management. Besides the ARM-SoC the PocketBeagle only hosts a SD-card memory slot and a USB interface. We will describe the test setup, parameters, and routines during the test campaign. Further we will present the characterization and discuss the performance during and after the TID test. The TID of this test was equivalent to a 2-years mission in LEO. The PocketBeagle passed the tests.

This paper is a step towards trusting and using open source technology and COTS systems in space.