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RADIATION-HARDENING AND TESTING APPROACH FOR BRINGING A TERRESTRIAL RF TRANSCEIVER TO THE SPACE ENVIRONMENT

Abstract

Present-day space-qualified component performance and flexibility is limited when compared to the capabilities of EEE parts for terrestrial applications. While some component manufacturers provide ranges of products that are radiation-hardened and radiation-tolerant, their computational performances are sometimes limited (as exemplified by the low number of equivalent system gates in rad-hard FPGAs). In other cases, it is even impossible to find high reliability parts that match the required functionality, such as, for instance, RF components for a highly-dynamic Software-Defined Radio (SDR) platform. In fact, when talking about communications, terrestrial technologies are far more advanced than those applied in space. Motivated by the global mobile communications market, permanently seeking new products and development areas, these technologies experience an unparalleled evolution. Then, how can Space benefit from these technological advances on Ground, without sacrificing reliability?

Such challenge was faced in the development of an Inter-Satellite Link (ISL) for the ESA PROBA-3

formation flying mission. The baseline technology was based on a terrestrial software-defined transceiver architecture, relying on state-of-the-art EEE parts. For this reason, and to avoid a design of the ISL data link, the approach selected to handle radiation in the ISL units was threefold: (i) Develop a mechanical design that is able to provide considerable shielding to the electronic components inside, through an increase of thickness. The additional mass is compensated by the miniaturisation levels attained by not using bigger and heavier radiation-hardened components; (ii) Implement design techniques that help to mitigate the single-event effects caused by high-energised particles. Techniques include latch-up protection, voting systems on the processors or Triple Modular Redundancy (TMR); and (iii) Perform radiation testing on selected critical components or assemblies, against the PROBA-3 radiation environment, and devise backup component replacement strategies.

This paper describes in detail the approach followed for the qualification of the PROBA-3 ISL unit, based mostly on commercial EEE parts, and the different challenges faced throughout the process. It covers the three levels described before: mechanical shielding, radiation-hardening design techniques and radiation verification testing, including analysis and test results. Additionally, the paper addresses the benefits and technical and economical viability of this and similar integrated strategies to update the current space-qualified part list, in order to enable better-performing satellite missions and bridge the existing gap between space and terrestrial technology.