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Space systems — Evaluation of radiation effects on Commercial-Off-The-Shelf (COTS) parts for use on low-orbit satellite

Systèmes spatiaux — Évaluation des effets des radiations sur les parties commerciales sur étagère (COTS) destinées aux satellites à orbite basse

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Foreword

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This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document describes methods of evaluating the radiation effects on COTS (Commercial-Off-The-Shelf) parts used in low Earth orbit (LEO) satellites. Many small (<180 kg) and nano/microsatellites (1 kg to 50 kg) are launched to LEO altitudes where space radiation exists but is less than at higher altitudes. As a result, the designers and manufacturers of such satellites are using COTS semiconductor devices for their satellite components and boards. New industries taking advantage of nano/microsatellite and CubeSat [1,33 kg × (1U-3U)] satellite capabilities now include IT ventures, mobile phones, and internet industries along with universities and research institutions.

Satellite manufacturers who prioritize investment efficiency also aim to extend mission lifetimes (up to three, five and ten years) longer than one-year missions that were common for educational and technical demonstrations using nano/microsatellites.

Even with relatively lower space radiation conditions in LEO compared to higher orbits, a longer mission life in LEO poses critical radiation environment constraints for COTS devices onboard small and nano/microsatellites as well as CubeSats.

While there are methods of evaluating the radiation resistance of space parts, there are limited methods for evaluating COTS parts used for LEO satellites and these are often based on legacy parts usage.

This document provides guidance for evaluating radiation tolerance of COTS parts that can help increase confidence levels of longer-term mission lifetimes.

Space systems — Evaluation of radiation effects on Commercial-Off-The-Shelf (COTS) parts for use on low-orbit satellite

1 Scope

This document outlines the evaluation methods for environmental tests that can be conducted on COTS (Commercial-Off-The-Shelf) spacecraft parts intended for use on LEO satellites. The radiation effects considered consist of total dosage, single event, and displacement damage. In addition, this document describes tests that are useful for satellites operating in LEO.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
galactic cosmic rays
GCR
high-energy-charged particle *fluxes* (3.2) penetrating the heliosphere from local interstellar space

Note 1 to entry: Galactic cosmic rays are composed primarily of high-energy protons and atomic nuclei. Upon impact with the Earth's atmosphere, cosmic rays can produce showers of secondary particles that sometimes reach the Earth's surface. There is evidence that a significant fraction of primary cosmic rays originate from stellar supernova explosions and perhaps from active galactic nuclei.

[SOURCE: ISO 15390:2004, 2.1, modified — Note 1 to entry has been added.]

3.2
flux
number of particles passing through a specific unit area per unit time

[SOURCE: ISO 12208:2015, 2.3]

3.3
fluence
time-integrated *flux* (3.2)

Note 1 to entry: Fluence is measured as the flux per unit area per unit time. This is used to express the environment during the operational lifetime of a spacecraft or space instrument. The integrated particles fluence unit is expressed as particles m^{-2}. The energy integral fluence unit is expressed as particles m^{-2} MeV^{-1}. When the directional fluence is included, add per steradian (sr^{-1}).

[SOURCE: ISO 12208:2015, 2.4, modified — Note 1 to entry has been added.]