Radiation hardening of imaging sensors and electronic components.

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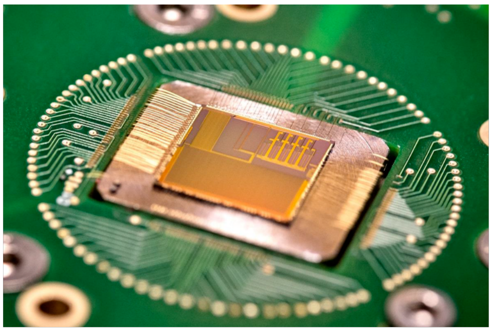

Fully rad-hard & cryo77K readout integrated circuit (ROIC)

Abstract

Imaging sensors in Space need to be functionally "open" to incoming radiation (like light), which means that they can't be shielded and thus also need to be resistant to the damage done by high-energy radiation, like gamma and X-rays, and energetic electrons, protons and neutrons. This is achieved by designing the IC's in a very specific way so as to confine the damage to non-critical areas.

This Belgian technology provider has developed large-scale unshielded area sensors in which the pixels are radiation hard (= radiation resistant); these have applications both in Space and in Earth-bound high-energy environments.

Radiation hard application-specific integrated circuits (ASIC) have also been developed: 180nm process technology with behaviour libraries for analogue-digital-converters (ADC), amplifiers, input-outputs (IO), band-gaps and low-dropout regulators (LDO), etc.

Currently most non-space applications are not radiation hard; though X-ray, nuclear and medical applications need such technology to guarantee correct and long-term functioning of their systems.

Integrators of imaging sensors and integrated circuits are welcomed to collaborate.

Description

Radiation hard technology is not often used outside of space applications. However, non-space applications subjected to radiation can also benefit from technology that is inherently radiation resistant dispensing with the need for any radiation shielding/protection. A sensor in a high-radiation environment suffers radiation damage due to the incoming energy of electrons, X-rays, and even of protons and neutrons.

Alongside radiation hardness of imaging sensor pixels, radiation hard libraries have been developed. These libraries are a collection of 180nm integrated circuitry with implemented behaviour of ADCs, amplifiers, IOs, band gaps and LDOs. The 180 nanometre or 0.180 micron refers to the level of semiconductor process technology.

The Belgian company develops these sensors and libraries in-house: For instance, their mixed analogue digital libraries for several CMOS-IS technologies were hardened for TID (total ionizing dose), TNID (displacement damage), SEU (single event upset) and SEL (single even latch).

Innovations and advantages of the offer

The company has a track record of making radiation hard designs for TID (mostly gamma and X-photons), TNID, SEU & SEL. A significant characterization and benchmarking effort has been performed on these non-protected hardened pixels.

Imaging sensors from this technology provider have the advantage of being robust and rad-hard, as they have been developed for Space. Currently non-space sensors are not generally radiation hard. As a result, in specific earthbound fields, the sensors have to be replaced regularly as damage limits their performance. In current designs, sensors are cooled to increase their life span, but inherent radiation hardness at pixel level will be a clear advantage because expensive cooling processes can be avoided.

The technology provider has demonstrated (and published) that it is feasible to design these radiation hard pixels and periphery, without damaging the pixel and increasing the dark current. The company furthermore has a close working relationship to the foundry technology experts. They have the best (of all published) TID pixels and libraries.

Further Information

The technology provider excels in radiation hard designs for space applications. Its experts have conceived and/or designed

- unshielded X-ray image sensors
- space qualified 8bit and 10bit Flash ADC
- 14bit pipelined ADC for infrared image sensors
- column-wise high-speed 10bit ADC
- radiation tolerant CMOS standard cell library subsets for several CMOS technologies
- very high TID tolerance (mostly to gamma and X-rays)
- pioneering proton and SEU hard pixels

Application

- Medical applications
  - medical diagnostics
  - bone densitometry
  - mammography
  - etc.
- Other X-ray related applications including
  - non-destructive testing (µCT)

- healthcare (dentistry)
    - luggage inspections
    - etc.
- Electron beam microscopy
- Direct electron intensified imaging and very low light imaging in general
- Nuclear environments
- Satellites and space applications

Description of Space Heritage

The heritage of this current project is the result of previous efforts of the technology provider in the development of radiation hard pixels for Space application, and the development of application specific integrated circuits in the frame of an ESA project targeted at infrared sensor signal conditioning for space applications (ESA AO/1-6814/11/NL/AF, Prototype ASIC Development of Large Format NIR/SWIR Detector Array).

Both developments led to a collection of technology solutions for space applications including radiation hard pixels and a generic 0.18µm analogue and digital radiation hard library.

Potential Domain of Application in Space

The technology has been developed for and used in the harsh Space radiation environment.

Comments on the technology by the broker

All technologies suffering from radiation damage (think about computed tomographs and other X-ray devices in medical, nuclear or research applications, or electron beam microscopy applications) can increase performance and lifetime by being radiation resistant, without the need for shielding.