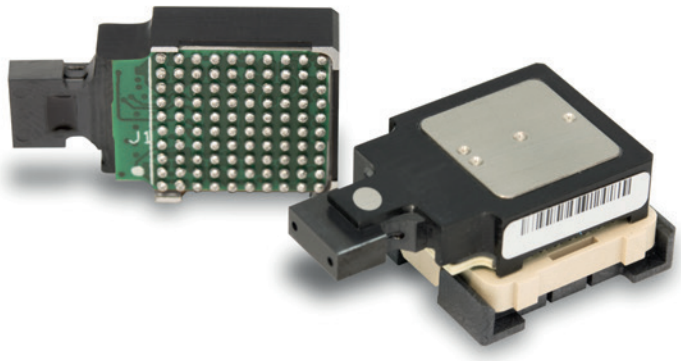
REFLEXPHOTONICS®

Optical interconnect within space vehicles in low-earth orbit



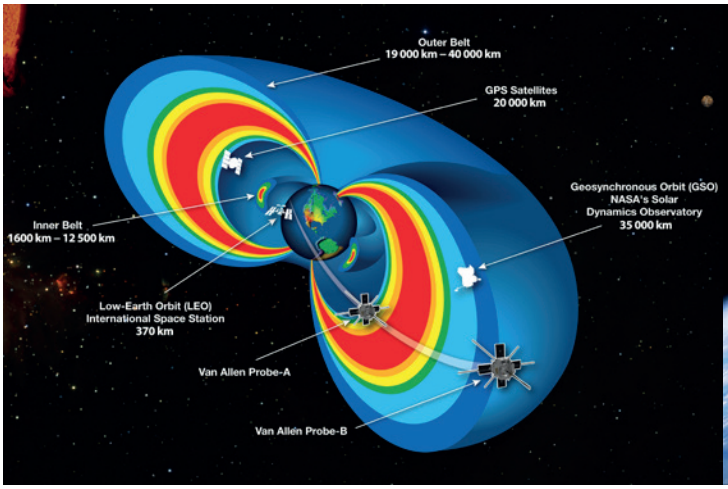
Radiation hardened

Benefits of using Reflex Photonics optical space-grade optical solutions

- Meet highest level SWaP requirement.
- Smallest transceiver on the market, low weight.
- Heavy-ion tested.
- Gamma rays tested.
- High and low energy protons tested.
- ECSS process and lot acceptance tests.
- 12-lane parallel optical transceiver.
- Up to 12.5 Gbps/lane from −40 °C to 100 °C.
- BER: As low as 10^{-15}.
- Sensitivity: as high as −12 dBm.

Leveraging its expertise in embedded optical communication modules for defense and aerospace, Reflex Photonics is offering radiation-hardened optical transceivers aimed at the space market with the introduction of the *Light*SPACE™ and *Space*CONEX™ “radiation hardened” line of products.

Description of the application



Van Allen belts representation.

Satellite can use optical transceivers extensively.

When components, like embedded optical transceivers are deployed in space on a satellite or on a space vehicle, they are exposed to both protons and heavy ions from cosmic rays and solar flares.

This is why, unlike most electronic equipment designed for terrestrial use, hardware deployed at LEO (low earth orbit: altitudes between 500 and 2000 km), must be radiation hardened.

The charged particles are concentrated by the earth magnetic field into two principal zones called the Val Allen belts. The inner belt ranges from 500 to 6000 km in altitude and overlap the LEO zone where most satellites discussed by this application will be located.

Shielding is not the solution

Systems with increased shield thickness, see a reduction in low-energy proton fluence, while the fluence of protons with energy greater than 50 MeV is hardly affected. Although shielding is effective at reducing the fluence of low-energy protons, secondary radiation is generated as a result of protons interacting with the shielding material.

This radiation takes the form of gamma rays, neutrons, protons, electrons, alpha particles, and heavier nuclei. This is why *Light*SPACE and the *Space*CONEX radiation-hardened optical transceivers, with their intrinsic radiation resistance, are well suited to provide optical interconnect within space vehicles in low-earth orbit.

*Light*SPACE radiation hardened optical transceivers

We are taking all these environmental threats seriously when it comes to qualifying our radiation hardened modules and this is why we have placed so much effort on testing for heavy ions, protons and gamma rays. Reflex Photonics' radiation hardened or "Space-grade" transceivers are engineered to withstand radiation doses >100 krad.

Furthermore, all our devices are tested following ECSS process and lot acceptance testing, and component pre-screening is done for every batch of transceivers sold for this application.

Radiation tests summary

Radiation Test #1

Proton testing: Total Non-Ionizing Dose (TNID).

Testing was done at KVI – University of Groningen, The Netherlands.

Radiation Test #2

Heavy ion testing: Single Event Effect & Latch-up (SEE and SEL).

Testing was done at Texas A&M University, USA.

Radiation Test #3

Gamma Ray using Cobalt-60: Total Ionizing Dose (TID) (MIL-STD-883G, method 1019.7).

Testing was done at TRAD in Toulouse, France.

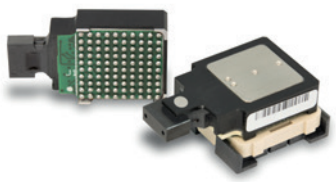
*Light*SPACE™ also passed standard *Light*ABLE™ qualifications

- **Vibration** tests per MIL-STD-883, Method 2007.3.
- **Mechanical shock** tests per MIL-STD-883, Method 2002.4.
- **Thermal shock** tests per MIL-STD-883, Method 1011.9.
- **Damp heat** tests per MIL-STD-202, Method 103B.
- **Cold storage** tests per MIL-STD-810, Method 502.5.
- **Thermal cycling** tests per MIL-STD-883, Method 1010.8.

References

Stephen Buchner, Paul Marshall, Scott Kniffin and Ken LaBel. "Proton testing guidelines", NASA/Goddard Space Flight Center, 2002.

Doug Sinclair and Jonathan Dyer. "Radiation Effects and COTS Parts in SmallSats", SSC, 2013.



Transceiver used in this application

The *Light*SPACE module that was used as the base reference module for the experiments was the SMX04P518432101 *Light*SPACE SR4 4-lane transceiver.

THE ***Light*** on Board® Company

www.reflexphotonics.com

Reflex Photonics Inc.

16771, Chemin Ste-Marie
Kirkland, QC
H9H 5H3, Canada

For information on Reflex Photonics products, contact:

sales@reflexphotonics.com
+1.514.842.5179 (Montreal)
+1.408.715.1781 (USA)

Reflex Photonics is certified to ISO 9001

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