



Radiation Tests of Point-of-Load DC-DC Converter and Extended Common Mode LVDS Components

Volodymyr Burkhay⁽¹⁾,
André Roche⁽²⁾

SPACE IC GmbH, Germany

⁽¹⁾v.burkhay@space-ic.com

⁽²⁾a.rocke@space-ic.com

Giorgio Magistrati⁽³⁾, Gianluca
Furano⁽⁴⁾, Farid Guettache⁽⁵⁾

ESA, The Netherlands

⁽³⁾giorgio.magistrati@esa.int

⁽⁴⁾gianluca.furano@esa.int

⁽⁵⁾farid.guettache@esa.int

AMICSA 2014

*5th International Workshop on Analog and Mixed-Signal Integrated
Circuits for Space Applications*

July 1st, 14:00 – 14:20



- Introduction
- Advantages of SOI
- Tested Components
- TID Test Results
- SEE Test Results
- Conclusion & Outlook

Introduction

Until 2013

From 2014

TELEFUNKEN

Semiconductors

Wafer Manufacturing

IC Products

STOP

- Closure of IC product business



SPACE IC

rad-hard
IC products

- SPACE IC takes over development and manufacturing of rad-hard IC products (exclusive license)



TELEFUNKEN Semiconductors

- SOI technologies: 0.35 μm , 0.8 μm
- Robustness: $\leq 200\text{V}$, no latch-up
- Efficiency: LV & HV on die, isolation $\leq 100\text{V}$
- Low power: low leakage, precise currents

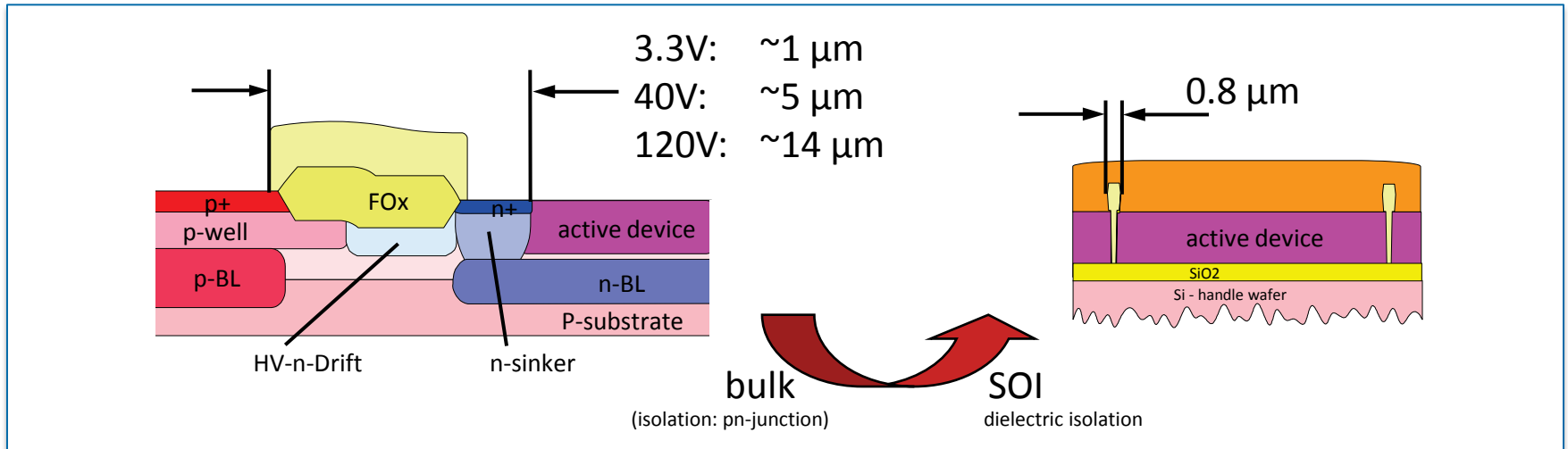


SPACE IC

- ITAR free, high quality, radiation hard integrated circuits from Germany
- Power management and distribution
- Robust interfaces



Advantages of SOI



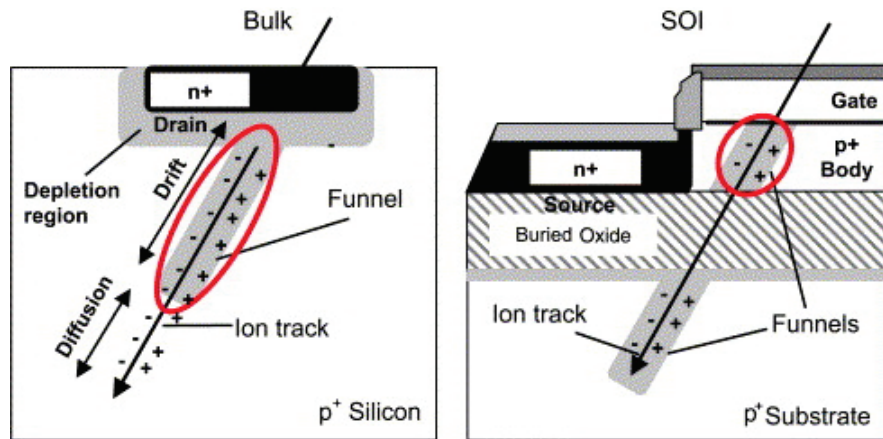
Full dielectric isolation with deep trench

- Enhanced integration density i.e. smaller chip size (more than 50% is possible)
- Superior leakage control
- Inherent prevention of latch-up

Reduced substrate coupling

- Enhanced device performance due to reduced parasitic coupling
- High voltage capability, device stacking and even negative well voltages

Radiation Effects on SOI

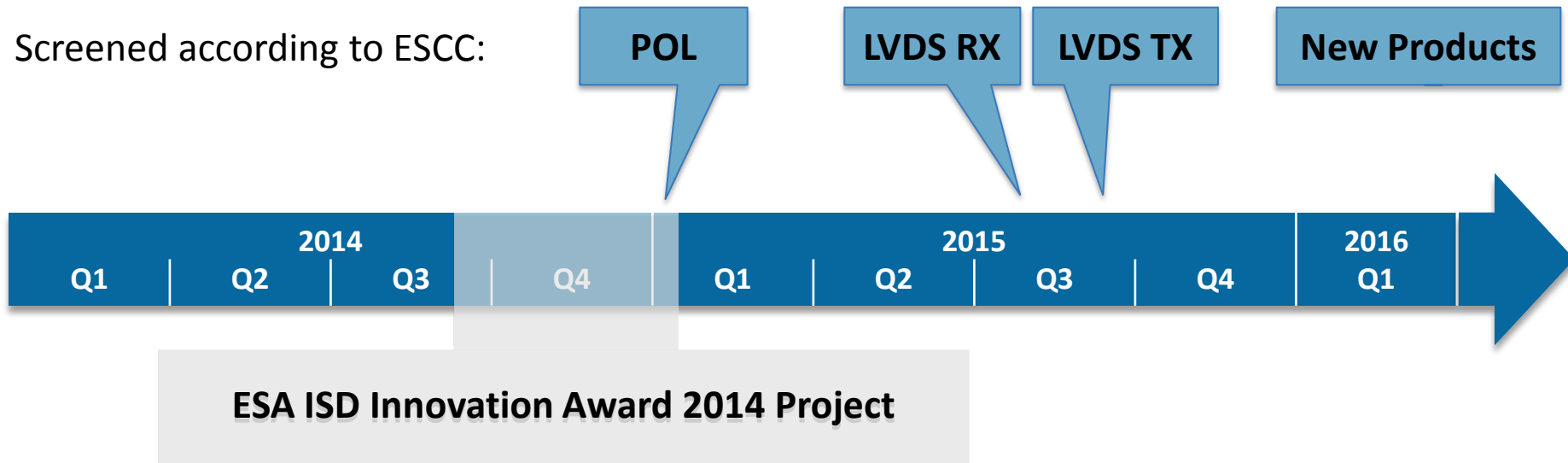


- SOI devices are known to be immune to SEL, which is a typical latch-up event triggered by prompt ionizing particles (ions, protons) entering into silicon.
- Other like SEB, SEGR, SET and others can also be mitigated by the use of SOI due to much smaller charge collection volume compared to bulk devices.
- The body tie improves the single event immunity of SOI by providing the possibility to divert generated charges to the device ground.
- TID effects are mainly relevant to the insulator properties.

Products & Availability

- Point-of-Load (POL) Converter_____ **SPPL12420RH**
- Extended Common Mode LVDS Receiver_____ **SPLVDS032RH**
- Extended Common Mode LVDS Transmitter_____ **SPLVDS031RH**

Screened according to ESCC:

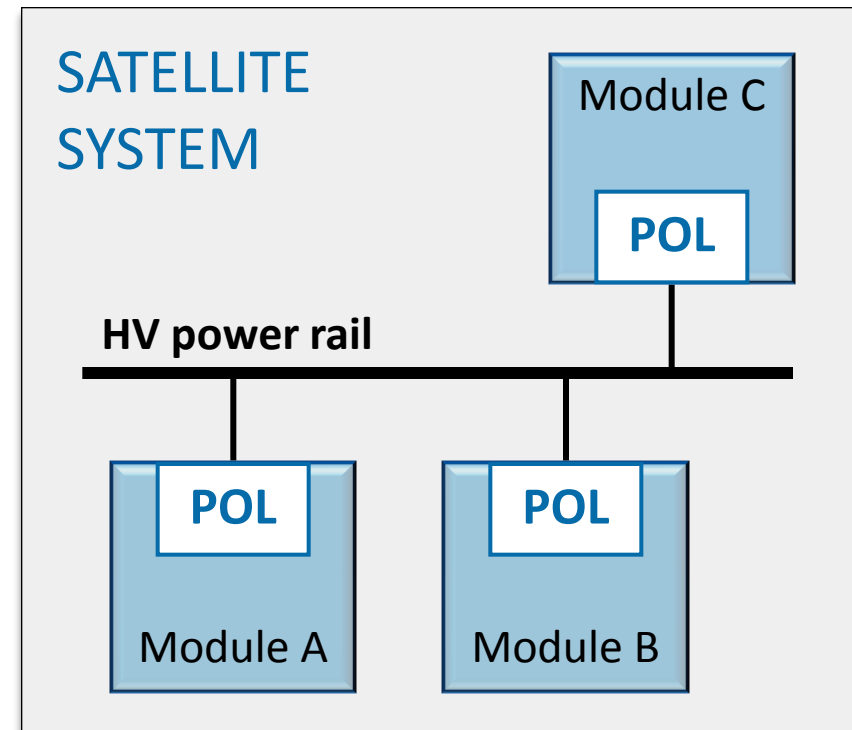


Point-of-Load concept

- Local DC voltages from HV rail to power blocks which are spatially distributed

Advantages

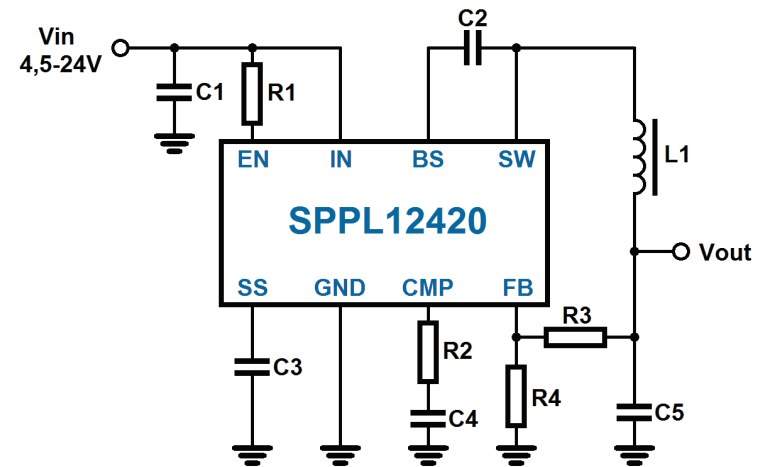
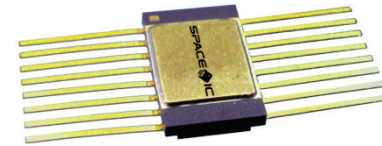
- Simplicity (one HV rail)
- Energy efficiency
- Safety (load decoupling)
- Redundancy



POL Regulator SPPL12420

Features:

- Ceramic hermetic flatpack package
- SOI technology
- 2A output load current
- 4.5V to 24V input voltage
- 0.923V to 21V output voltage
- >90% efficiency
- 340kHz fixed switching frequency
- -55°C to +125°C extended temperature range (target)



SPPL12420

Radiation Tests

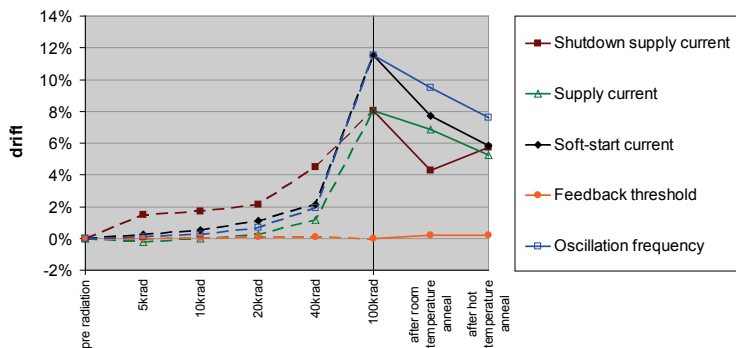
TID

Conditions:

- TID without applied bias
- Dose rate: 75rad/min (^{60}Co source)
- Room temperature annealing
- Hot temperature annealing 100°C for 5h

Results:

- Minor shifts in key data sheet parameters after TID irradiation up to 100krad
- None of the specifications are violated
- All tested parts keep full functionality



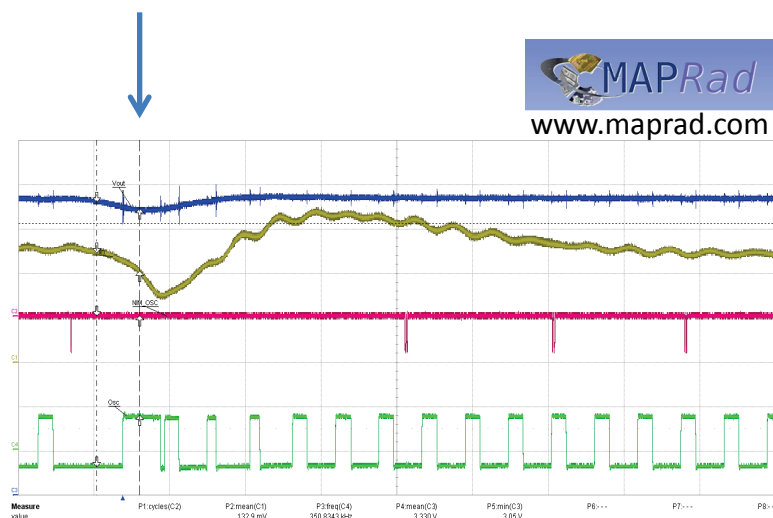
SEE

Conditions:

- $V_{IN} \leq 26\text{V}$, $I_{OUT} \leq 3\text{A}$
- SEE 60.7MeV/(mg/cm²)

Results:

- No fails (SEL, SEGR, SEB)
- SET event – minor output voltage drop



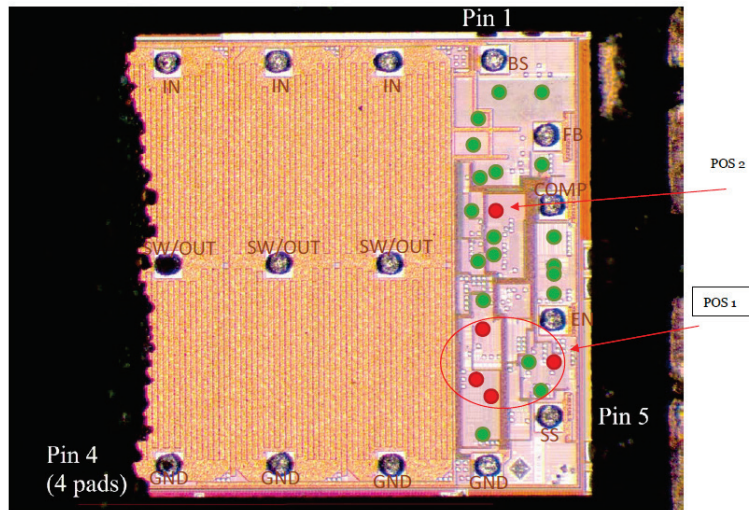
SPPL12420 Laser Tests



Laser

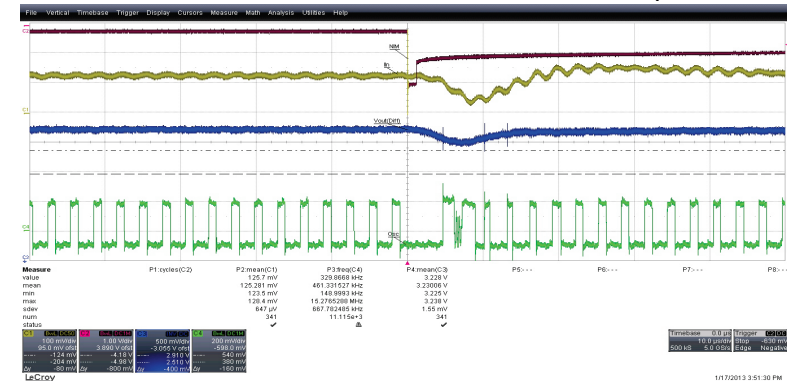
Conditions:

- $V_{IN} \leq 26V$, $I_{OUT} \leq 3A$
- Solid-state laser with 915nm wavelength
- Laser spot 5-10um
- Working distance of about 12mm
- Pulses length of 1us



Results:

- No SELs observed at any chip position
- No permanent functional fails detected
- Lasing on specific spots (red spots) has produced variations in the output amplitude with measurable output voltage drops (amplitude: 150-300mV, width: 5-10us)

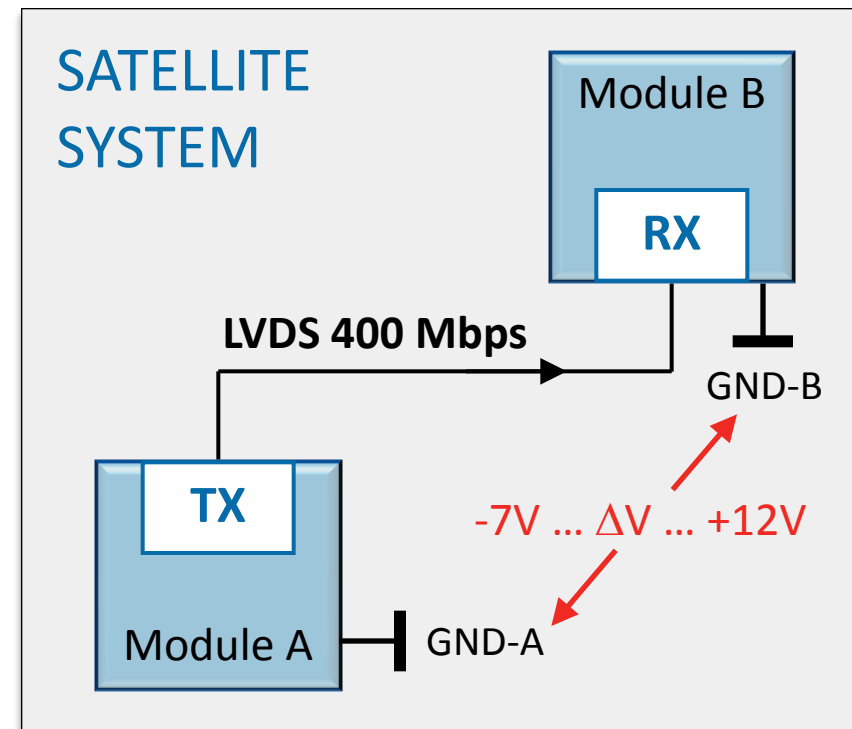


Box-to-box communication

- Fast point-to-point data transfer with exceptional ground noise immunity

Advantages

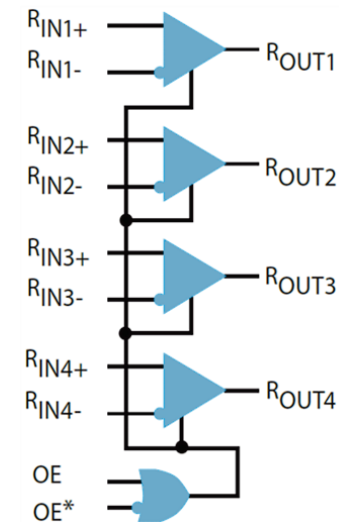
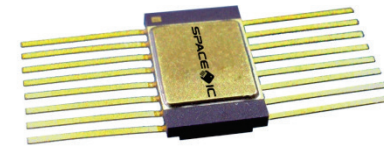
- Compliant to TIA/EIA-644-A
- Extended Common-Mode
- 400Mbps over single wire pair
- High voltage robustness
- Latch-up immunity



LVDS Receiver SPLVDS032

Features:

- Ceramic hermetic flatpack package
- SOI technology
- 400Mbps quad LVDS line receiver
- -7V to +12V extended common mode
- Low skew
- 7mA max supply current
- ESD HBM >8kV
- -55°C to +125°C extended temperature range (target)



SPLVDS032

Radiation Tests



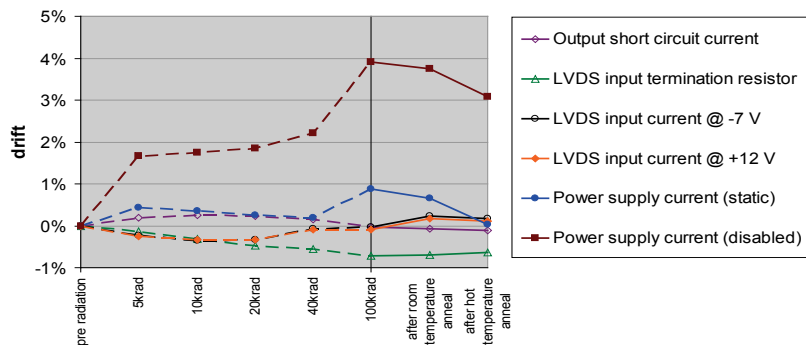
TID

Conditions:

- TID without applied bias
- Dose rate: 75rad/min (^{60}Co source)
- Room temperature annealing
- Hot temperature annealing 100°C for 5h

Results:

- Minor shifts in key data sheet parameters after TID irradiation up to 100krad
- None of the specifications are violated
- All tested parts keep full functionality



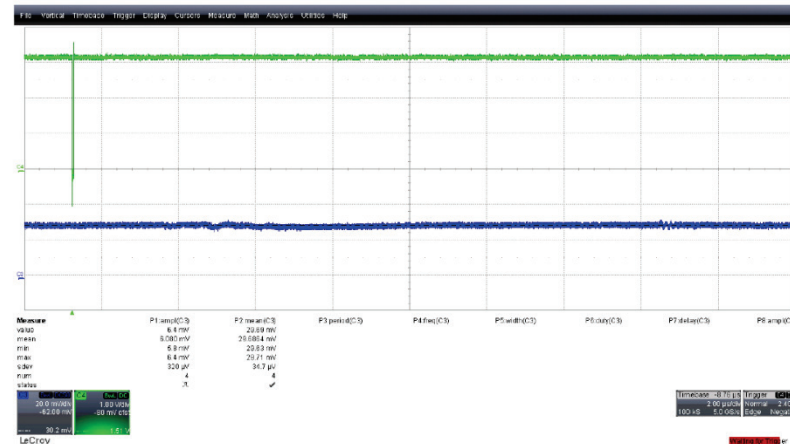
SEE

Conditions:

- Steady-state "1" (external fail-safe NW)
- SEE 60.5MeV/(mg/cm²)

Results:

- No fails (SEL, SEGR, SEB)
- SET event - single bit error



SPLVDS032

Laser Tests

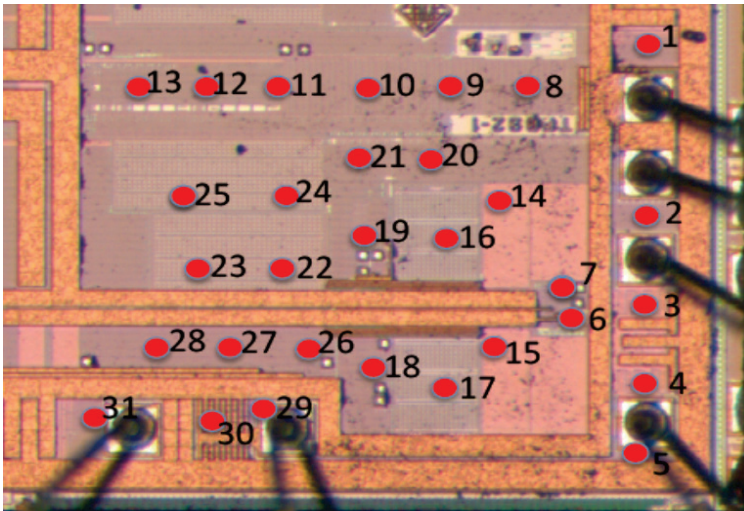
Laser

Conditions:

- Steady-state "1" (external fail-safe NW)
- Solid-state laser with 915nm wavelength
- Laser spot 5-10um
- Working distance of about 12mm
- Pulses length of 1us

Results:

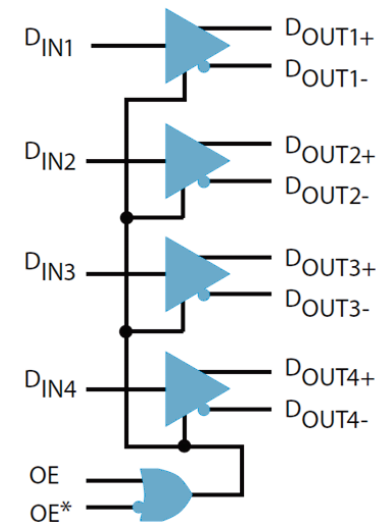
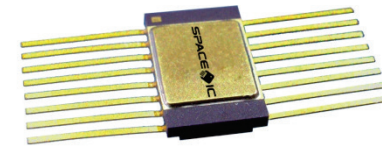
- No effects induced by the laser beam
- Possible reasons:
 1. The suspected sensitive areas (SETs) are covered by a thin metallic layer
 2. The circuit is not sensitive to the used laser pulses



LVDS Driver SPLVDS031

Features:

- Ceramic hermetic flatpack package
- SOI technology
- 400Mbps quad LVDS line driver
- Low skew
- 23mA max supply current (loaded)
- ESD HBM >8kV
- -55°C to +125°C extended temperature range (target)



SPLVDS031

Radiation Tests



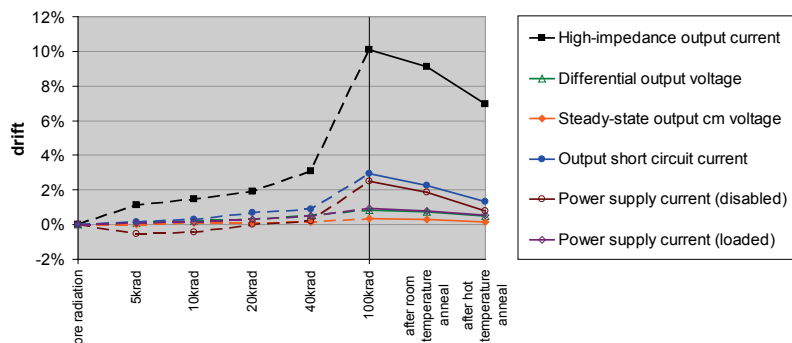
TID

Conditions:

- TID without applied bias
- Dose rate: 75rad/min (^{60}Co source)
- Room temperature annealing
- Hot temperature annealing 100°C for 5h

Results:

- Minor shifts in key data sheet parameters after TID irradiation up to 100krad
- None of the specifications are violated
- All tested parts keep full functionality



SEE

Conditions:

- Steady-state "1"
- SEE 60.5MeV/(mg/cm²)

Results:

- No fails (SEL, SEGR, SEB)
- SET Event - small variation of output magnitude (<100mV, 25ns)





- **Components show good SEE behavior**
 - Laser beam test shows good correlation for POL
- **Improved laser beam test on Extended Common Mode LVDS Rx will follow**
 - Laser beam test didn't show any sensitivity
- **Low dose rate TID test with applied bias will follow**



***Thank you for your
attention!***

www.space-ic.com
info@space-ic.com

