Low Temperature (30 K) TID Test Results of a Radiation Hardened 128 Channel Serial-to-Parallel Converter.

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James Webb Space Telescope

Electronic Circuit

HV583 COTS
TID at 30 K

- TID Effects (1 μm process) in gate and field oxides.
  - Electrons exit oxide
  - Holes are trapped at generation site
    - $\Delta V_{th}$
    - $\Delta I_{dd}$

TID at 80 K

- Above approximately $3 \times 10^6$ Volts/cm, the holes and protons are mobile.

Proton (63 MeV) Testing

- Both TID and SEE at the same time
- Devices at 30 K during irradiation
- Heavy ion needed for Single Event Dielectric Breakdown (SEDB) test
Proton Test Results (40V)


Proton Test Results (5V)

HV584
Redesigned Part

• Features
  – 1.0 μm, Single Poly/Double Metal, HV CMOS
  – Closed transistors via ion implantation to suppress
    leakage currents in “bird’s beak” region of
    NMOSFETs
  – Gate oxide thickness reduced by 50%
    • 1100 Å for HV transistor (SEGR)
    • 200 Å for LV transistor

• Added Functions
  – Mask to isolate faulty outputs
  – Comparator to measure $V_{out}$

To be presented by Stephen Meyer and Stephen Buchner at Radiation and Its Effects on
Leakage Current via Bird’s Beak


HV584

**TID Test**

- Performed at 30 K in a dewar
  - Eight devices
- Co\(^{60}\) (gamma ray source)
  - Up to 200 krad(Si)
- Dose rate was \(~7\) krad(Si)/hr

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**I\(_{dd}\)(nA) – 5 V Supply**

Total Current Through Eight Devices

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To be tested while irradiated with gamma rays.
$I_{pp}(nA) - 40 \text{ V Supply}$

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Tested While Irradiated with Gamma Rays

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Output Voltage after 200 krad(Si)

Channel Uniformity 200 Krad

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Output Voltage Measurement


V_{\text{out}} \text{ Measured by Comparator}

\[ V_{pp} = 25 \text{ V} \]

Summary and Conclusions

- The original HV583 level shifter – a COTS part - was not suitable for JWST because the supply currents exceeded specs after 20 krad(Si)
- The HV584 – functionally similar to the HV583 – was designed using RHBD approach that reduced the leakage currents to within acceptable levels and had only a small effect on the level-shifted output voltage.