Radiation Evaluation of the CS5508 (20-BIT ADC from Crystal Sem.)

Amira Omerbegoviæ

Space Research Institute SRI in Graz
in co-operation with the
European Space Agency ESA and TU Graz

November, 1999

Outline

- ❶ **Introduction**
- ❷ **Measurements and Testing**
  - ➢ **Total Ionising Dose Test**
  - ➢ **Single Event Effect Test**
- ❸ **Summary**

International ROSETTA Mission

Flux Gate Magnetometer / RPC MAG

- Purpose of the ROSETTA mission: Rendezvous with Comet 46P/ Wirtanen
- Launch: January 2003, Ariane-5, from Kourou, French Guiana
- Requirements: - small dimension
  - low power consumption (600mW)
  - maximum bit rate 1027 bits/secs
  - in flight calibration
  - total ionising dose rate 10krad

CS5508 A/D Converter Characteristics

- High Resolution: 20 Bits
- Very Low Power Consumption:
  Single Supply + 5V operation: 1,7 mW
  Dual Supply ±5V operation: 3,2 mW
- Output Update rates up to 100 Hz
- On chip self Calibration Circuitry
- Extended Temperature Range (-55 to +125°C)
- Radiationhardness unknown

Measuring and Quantifying Performance

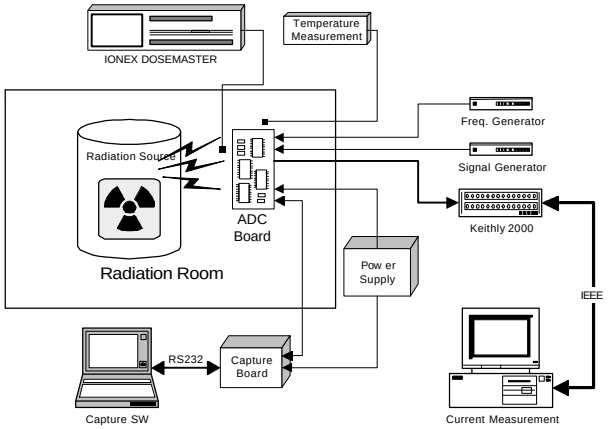
- **Histograms for static performances**
  1. Offset Errors — μ = Offset Error
  2. RMS Noise — σ = RMS Noise
  3. Peak to Peak Noise — $6{,}6 \cdot \sigma$
- **Fast Fourier Transforms (FFTs) for dynamic performances**
  1. Signal-to-Noise Ratio (SNR)
  2. Signal-to-Noise and Distortion (SINAD)
  3. Signal-to-Distortion (SDR)
  4. Signal-to-Peak Noise

Total Ionising Dose (TID) Test

- Purpose: to Determine the Total Tolerant Dose
- Gamma Radiation Test Facility (Co^{60}) at ESTEC was used
- 5 A/D Converters were tested under radiation
- Electrical Parameters Monitored:
  1. *Supply Currents*
  2. *Standard Deviation*
  3. *Signal-to-Noise and Distortion Ratio*

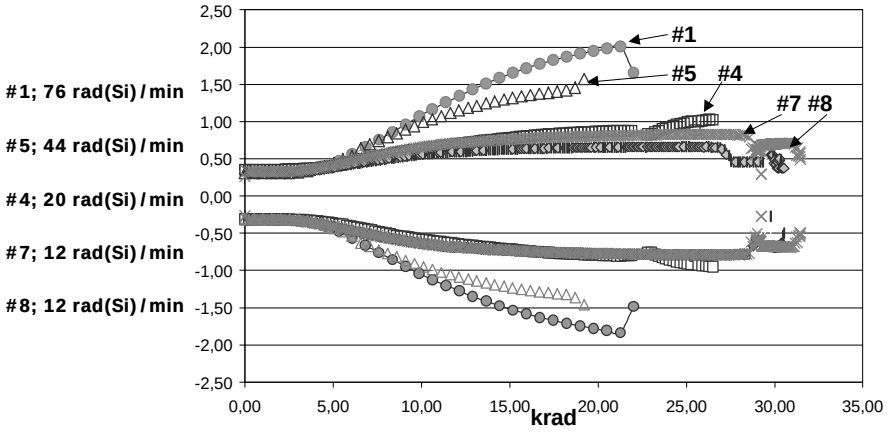
❷ Measurements and Testing -TID

Test Set-Up Equipment for TID test



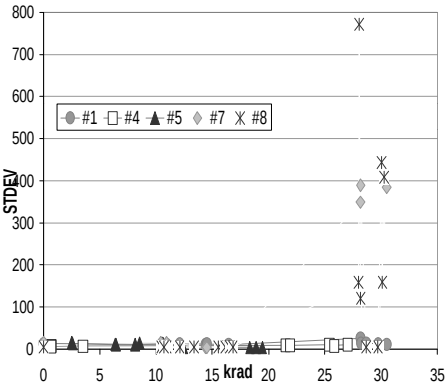
❷ Measurements and Testing - TID

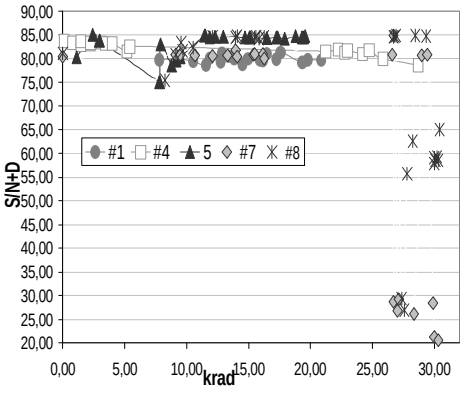
Supply Currents Measurements for TID test



❷ Measurements and Testing - TID

Standard Deviation & Signal-to-Noise Ratio



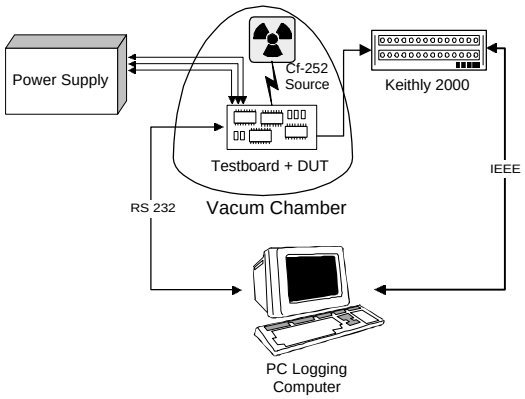


❷ Measurements and Testing - SEE

Single Event Effect (SEE) Test

- Purpose: to Determine the A/D Converter *Susceptibility to Heavy Ions Radiation*
- Heavy Ions Test facility (Cf^{252}) at ESTEC
  - *Linear Energy Transfer (LET) 42 MeV·cm²/mg*
  - *Particle Flux 3,4·10³ particle/cm³/min*
- 3 A/D Converters were tested under radiation
- Measurement:
  1. *Supply Currents*
  2. *Histogram analysis*

Test Set-Up Equipment for SEE test

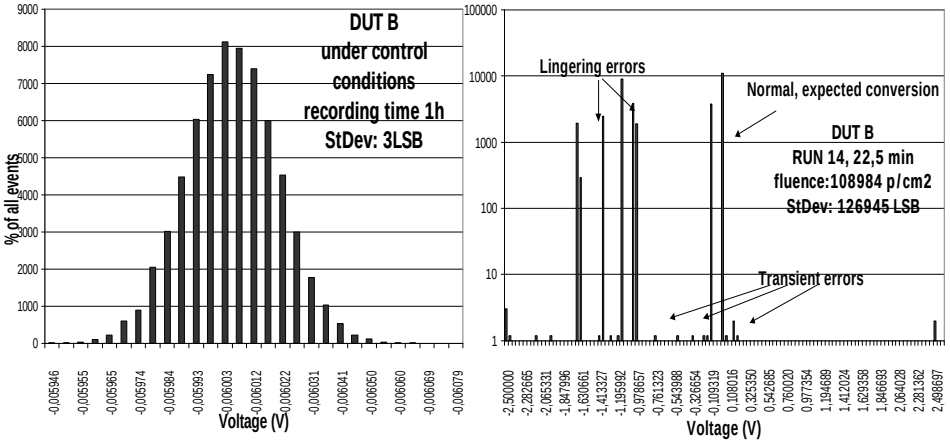


Results / SEE Test

- Single Event Upsets (SEUs)
  - *Transient Upsets*
  - *Lingering Errors*
- Single Events Latch-ups (SELs)
- Single Event Functional Interrupts (SEFIs)

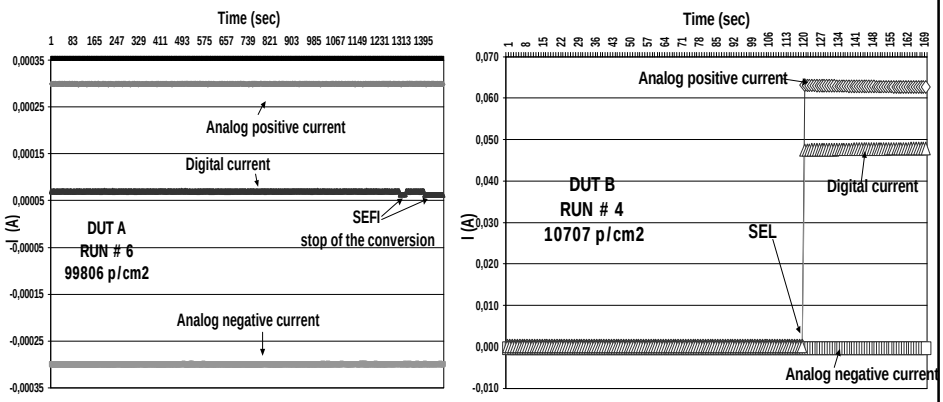
❷ Measurements and Testing -SEE

Single Event Upset (SEU) Errors



❷ Measurements and Testing - SEE

Single Event Functional Interrupt (SEFI)
Single Event Latch-up (SEL)



Summary

- Determined **TID** Tolerance
  low dose rate: *- 27 krad(Si)*
  high dose rate: *- 20 krad(Si)*
  - strong current consumption
  good tendency to recover

- **SEE**: High susceptibility to heavy ion radiation
  further testing recommendable