Advanced European Data Conversion Technology

e2v Bringing life to technology

First S-Band Capable Dual 12-bit 1.5GSps ADC in Flip-Chip Hermetic Technology

E. Savasta, N. Chantier, R. Pilard, M. Stackler, G. Wagner,
C. Lambert, O. Boillon, J-P. Amblard, E. Bajat, e2v Semicondutors
F. Malou, CNES

AMICSA 2016

Gothenburg, SWEDEN June 14th 2016

WE PARTNER WITH OUR CUSTOMERS TO IMPROVE, SAVE AND PROTECT PEOPLE'S LIVES

Presentation Outline

e2V Bringing life to technology

- Introduction to market needs
- Product Overview
- Package technology
- Synchronizing Data Converters
- Radiation Hardening
- Measurement Results
- Conclusions

Advanced European Data Conversion Technology

Why investing in this project?

e2V Bringing life to technology

Multiple RF applications needed a new generation of hermetic ADC

	Telecom payload Rx chain	SAR radar Rx chain	MPA TWTA signal processing feedback loops
• Simplification of RF signal chain, less RF mixers.	✓	✓	✓
• More channel integration.	✓	✓	
• Ability to better synchronise channels for beam forming.	✓	✓	
• Performance stability vs temperature.	✓	✓	✓
• Easy export classification.	✓	✓	✓

Presentation Outline

e2v Bringing life to technology

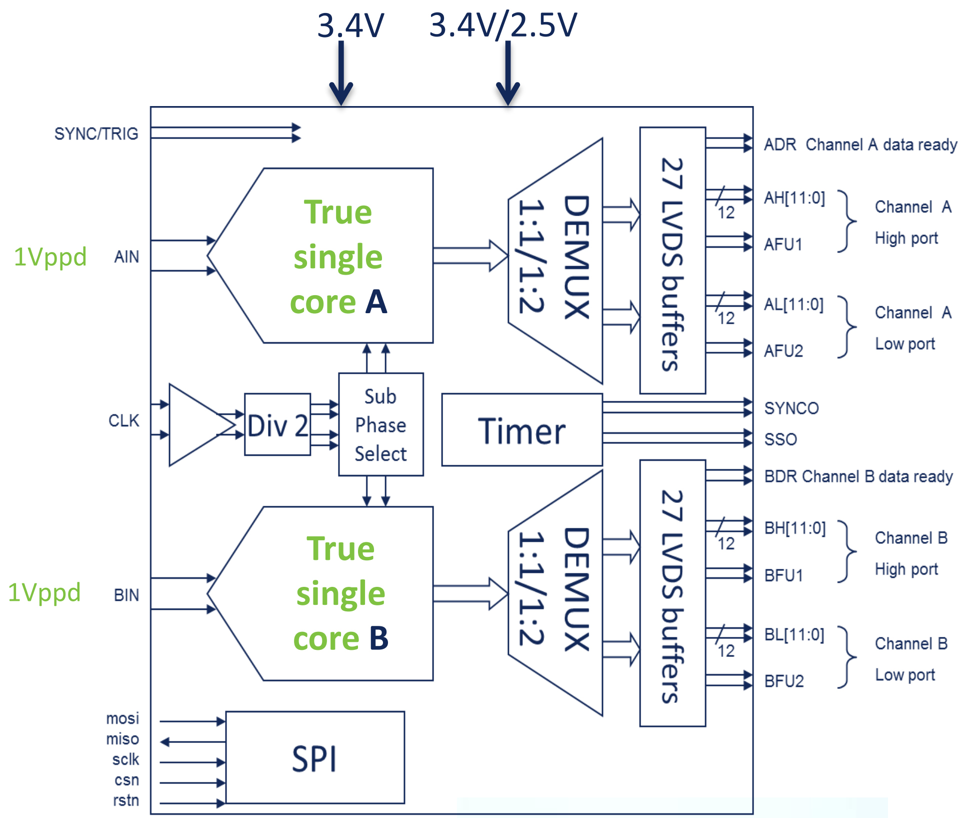
- Introduction to market needs
- Product Overview
- Package technology
- Synchronizing Data Converters
- Radiation Hardening
- Measurement Results
- Conclusions

Advanced European Data Conversion Technology

Product Overview

e2v Bringing life to technology

EV12AD550 : 12 bit 1.5GSps dual channel ADC



Capability for Multi-Nyquist operation :
Above 4GHz bandwidth (-3dB)

Power : 2.3W per channel

SFDR : 70dBc at 100MHz, -3dBFS
68dBc at 1480MHz, -3dBFS
61dBc at 1900MHz, -8dBFS
47dBc at 3730MHz, -8dBFS

NPR : 50dB in 1^{st} Nyquist @LF = -14dB
47dB in 2^{nd} Nyquist @LF = -14dB
46dB in 3^{rd} Nyquist @LF = -14dB

Input Crosstalk isolation : > 80dB up to 5GHz

Features:

Multi-component synchronization
End user calibration free
CCGA323 hermetic package(21x21mm)
Space grade (ESCC9000)

Advanced European Data Conversion Technology

Presentation Outline

e2v Bringing life to technology

- Introduction to market needs
- Product Overview
- Package technology
- Synchronizing Data Converters
- Radiation Hardening
- Measurement Results
- Conclusions

Advanced European Data Conversion Technology

Package technology (1)

e2v Bringing life to technology

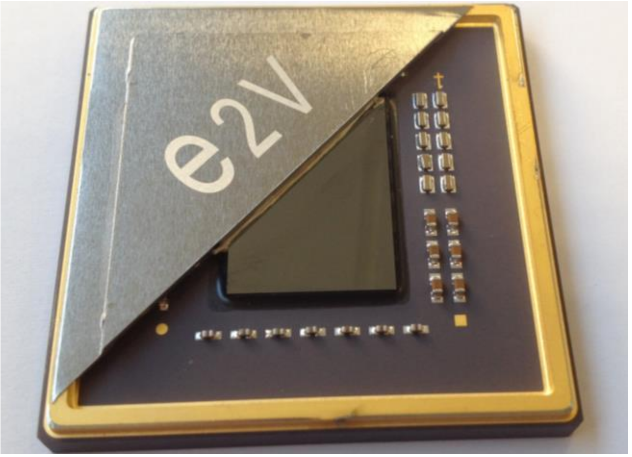
Need of Hermetic Flip CHip

HERMETIC

no potential failure modes linked to moisture / chemicals ingress

Flip Chip advantages :
- Higher pins count capability
- Smaller package size

⇒ RF performance effective
⇒ Power drop optimisation
⇒ Thermal dissipation through top



DEVELOPMENT of PACKAGING TECHNOLOGY FOR HERMETIC FLIP CHIP in e2v Grenoble

&

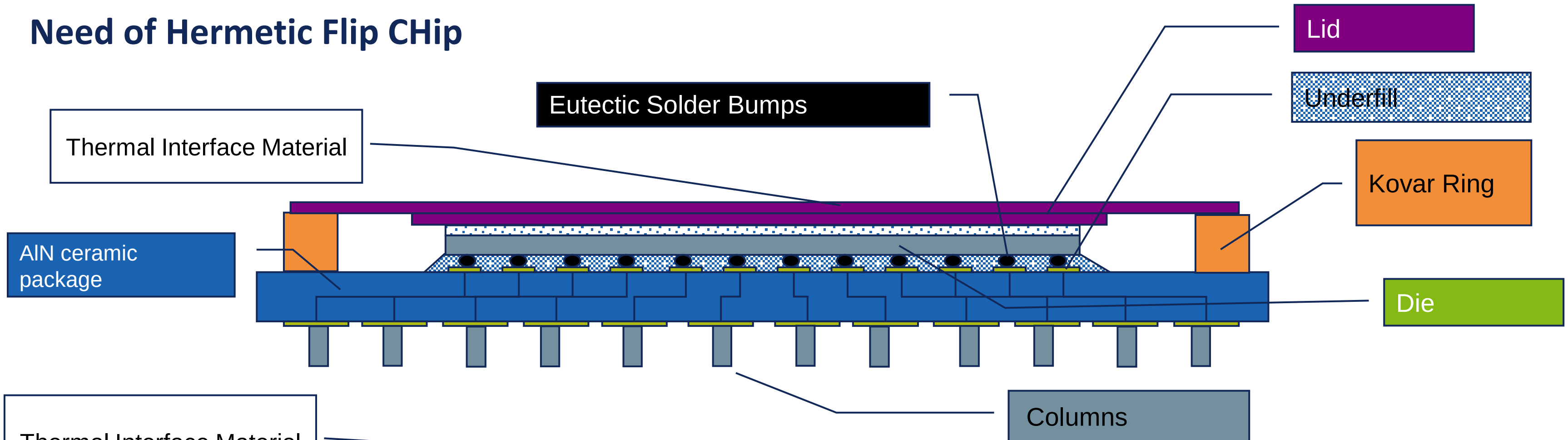
Hermetic Flip Chip recently integrated in ESCC2269000 & ESCC9000 standards

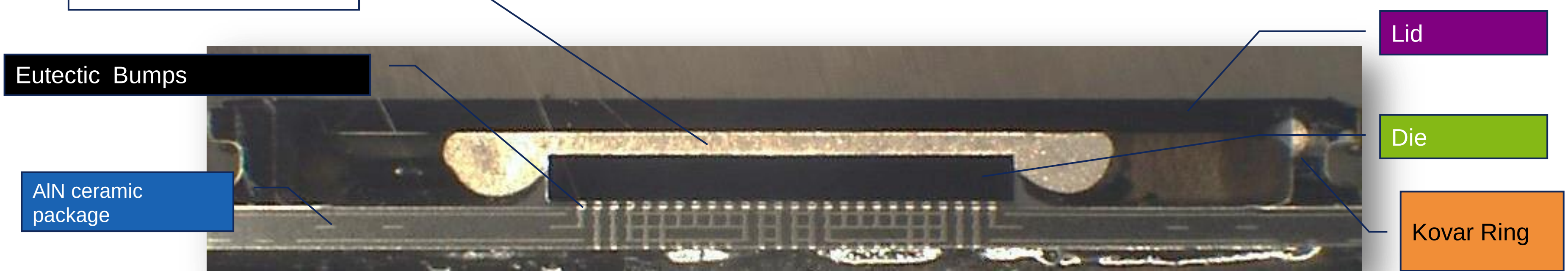
esa bpifrance ThalesAlenia Space AIRBUS DEFENCE & SPACE Atmel

Advanced European Data Conversion Technology

Package technology (2)

Need of Hermetic Flip CHip





Alumine Nitride (from Kyocera) for :

- Better thermal behavior
- CTE close to silicium

Thermal Resistance

- Rth < 4°C/W : junction top of case
- Rth < 4.7°C/W : junction to board

Presentation Outline

e2V Bringing life to technology

- Introduction to market needs
- Product Overview
- Package technology
- Synchronizing Data Converters
- Radiation Hardening
- Measurement Results
- Conclusions

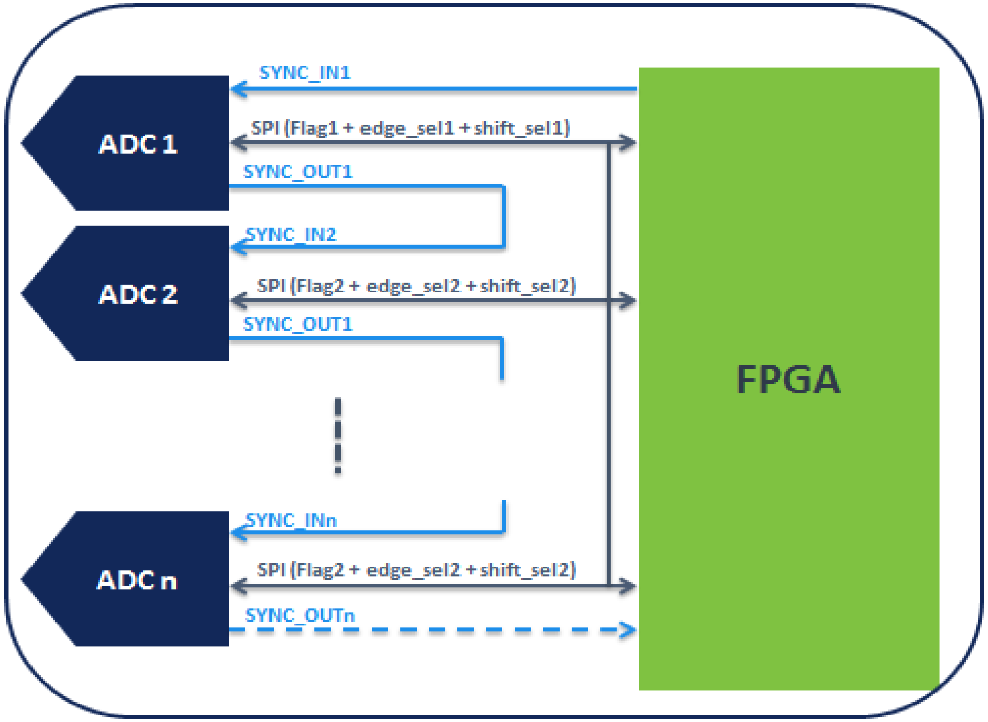
Advanced European Data Conversion Technology

Synchronizing data converters

e2V Bringing life to technology

Overview

- **At system level, Chain ADC using** SYNC_IN & and SYNC_OUT,
- SYNC Pulse propagation between ADC
- Training sequence



- **3 Control bits** (available thru SPI)
  - Flag: indicates meta-stability at the SYNC input
  - Edge selection: configures recovery of SYNC signal on rising or falling edge of clock
  - Shift selection: configures +1 clock cycle delay to the timing restart

Reference :
M. Stackler, et al., *"A novel method to synchronize high-speed ADCs"*, Proceedings of IEEE Radar Conference, 2016

Presentation Outline

e2V Bringing life to technology

- Introduction to market needs
- Product Overview
- Package technology
- Synchronizing Data Converters
- Radiation Hardening
- Measurement Results
- Conclusions

Advanced European Data Conversion Technology

Radiation Hardening (1)

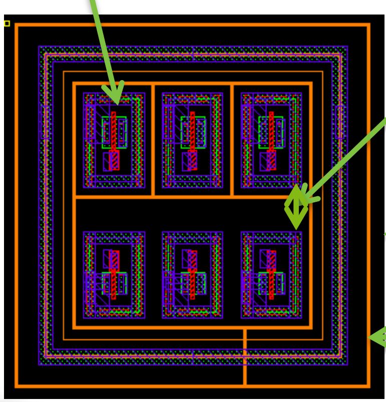
e2V Bringing life to technology

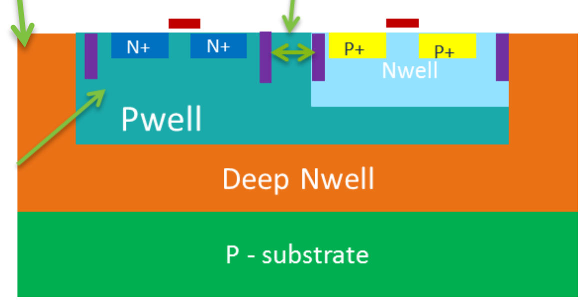
Retained Layout technics

1. **Deep Nwell isolation of analog and digital part**

2. **Guard ring around transistor implementing bulk ties as close as active devices**
   i. limit the ionization leakage current propagation into parasite path
   ii. Maximize energy required to trig parasitic thyristor to prevent from latchup

3. **Modification of standard digital library cells by adding bulk ties**

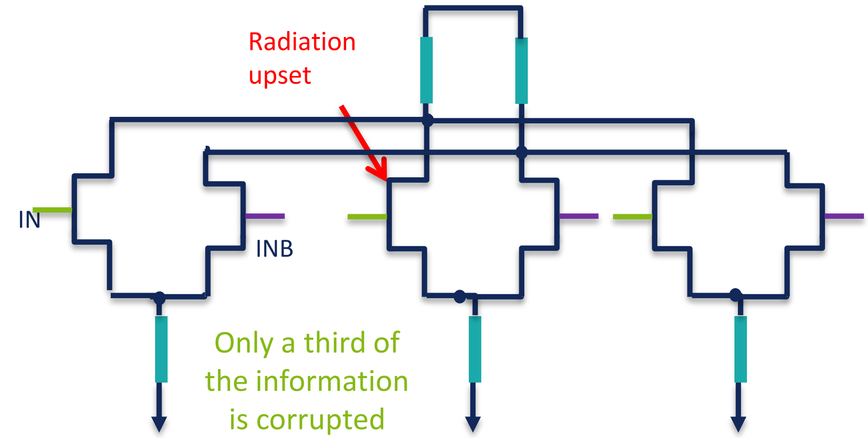




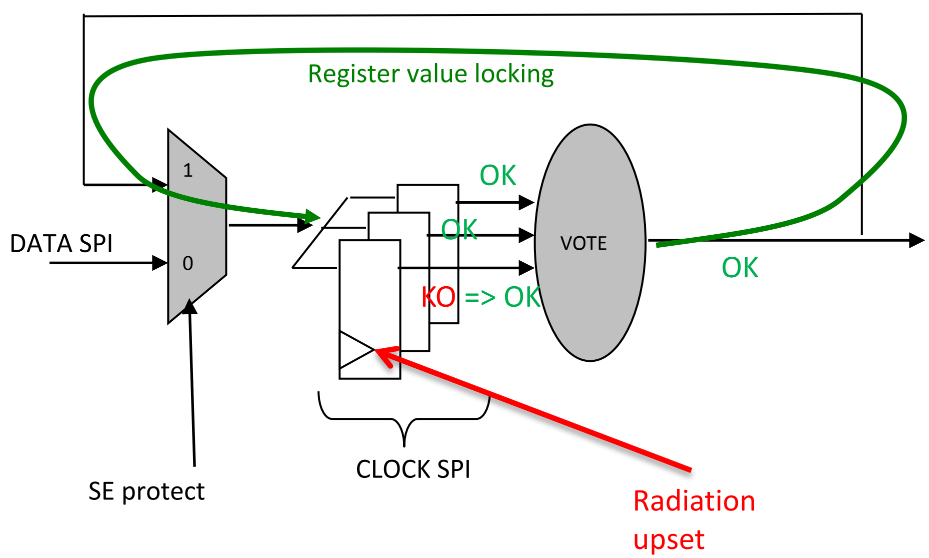
Radiation Hardening (2)

Design consideration

1. **Analog structure**
   i. Filtering using simple RC LPF, Miller cap
   ii. Averaging



2. **Digital technics**
   i. TMV (Tripple Majority Voting)
   ii. Feedback loop to auto correct register value
   iii. SE protect mode thru MUX to prevent from intempestive register writing.



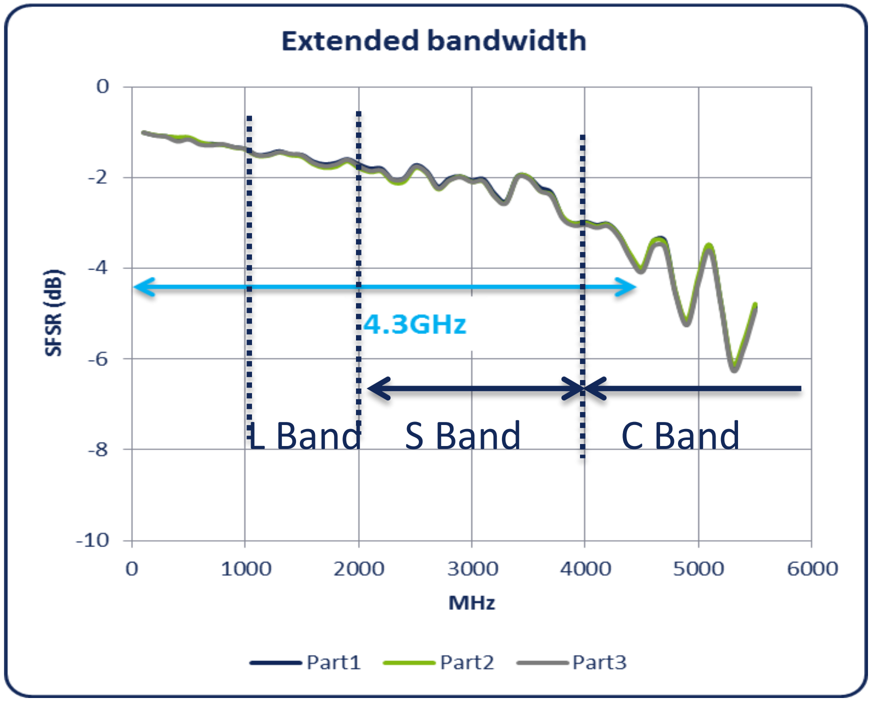
Advanced European Data Conversion Technology

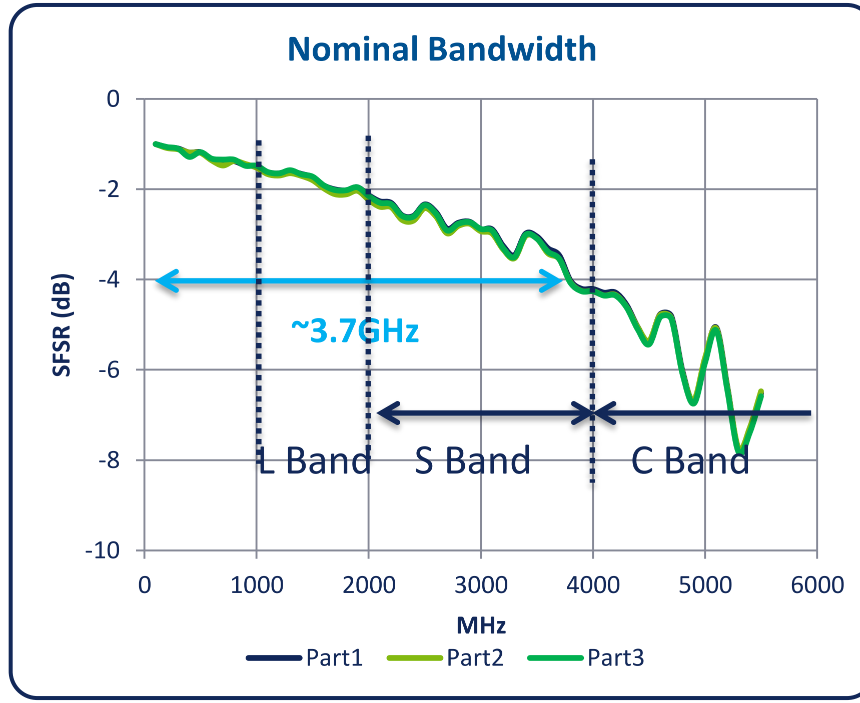
Presentation Outline

- Introduction to market needs
- Product Overview
- Package technology
- Synchronizing Data Converters
- Radiation Hardening
- Measurement Results
- Conclusions

MEASUREMENT RESULTS (1)

Analog Bandwidth



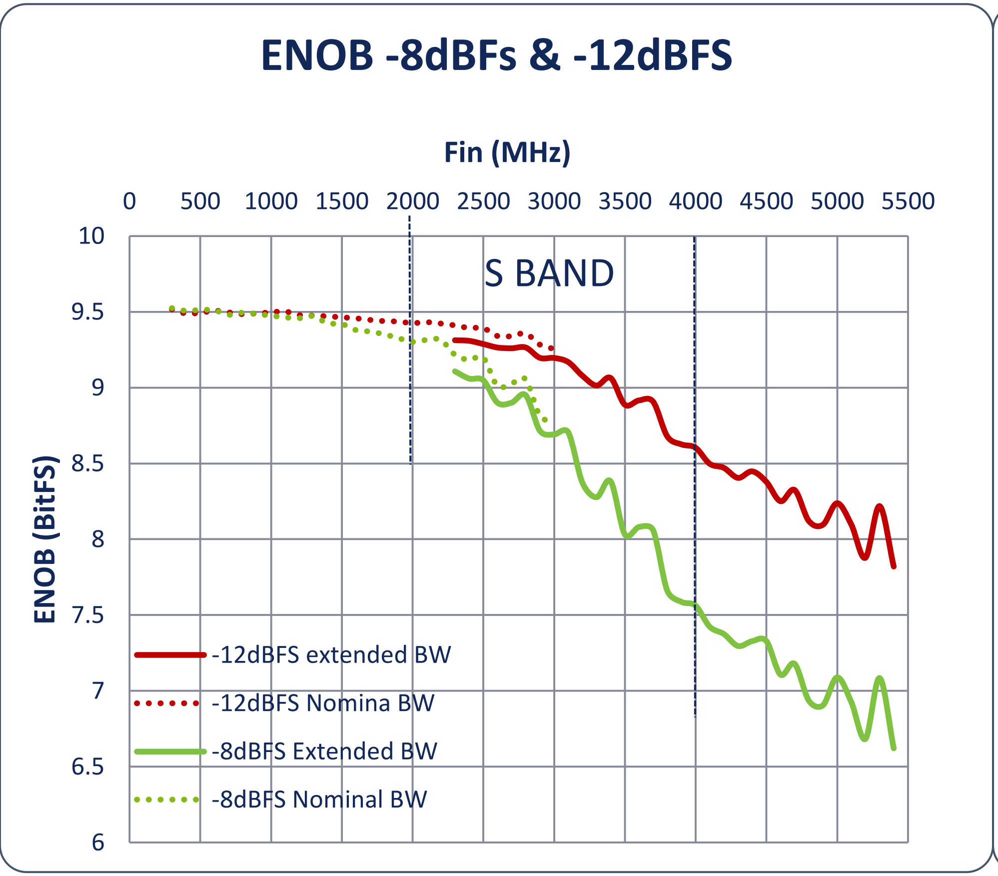


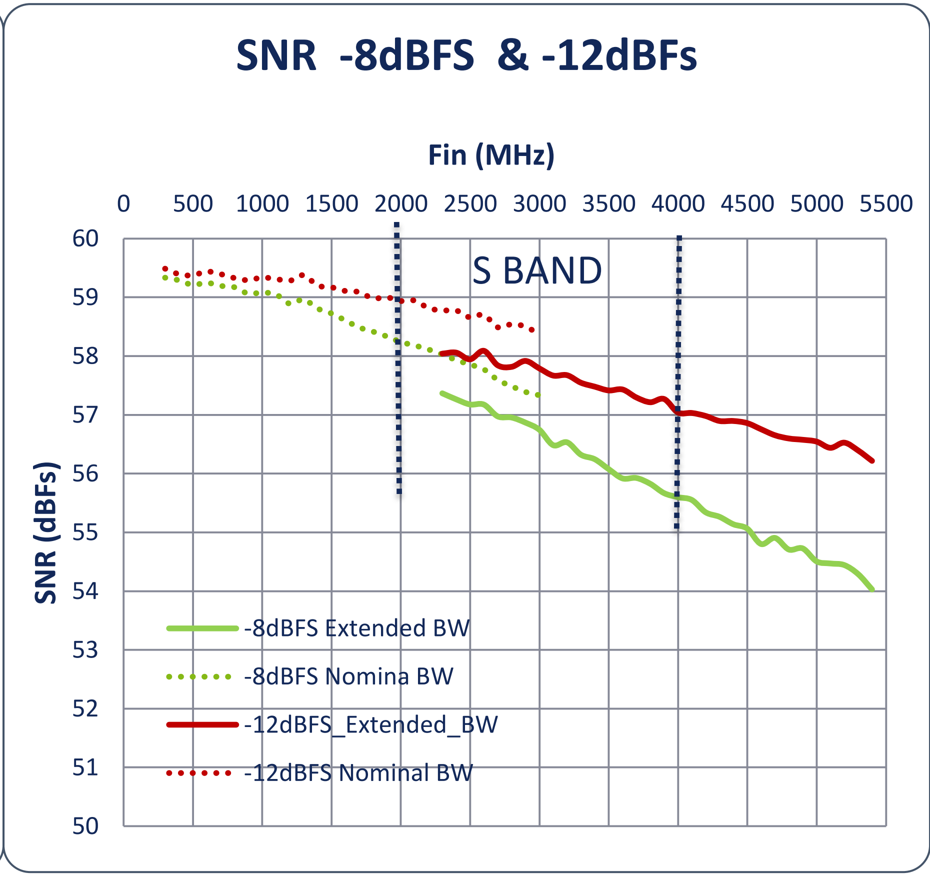
- Performances in L, S Band and even in the beginning of C band

Advanced European Data Conversion Technology

MEASUREMENT RESULTS (2)

SineWaves Performances versus Input Frequency

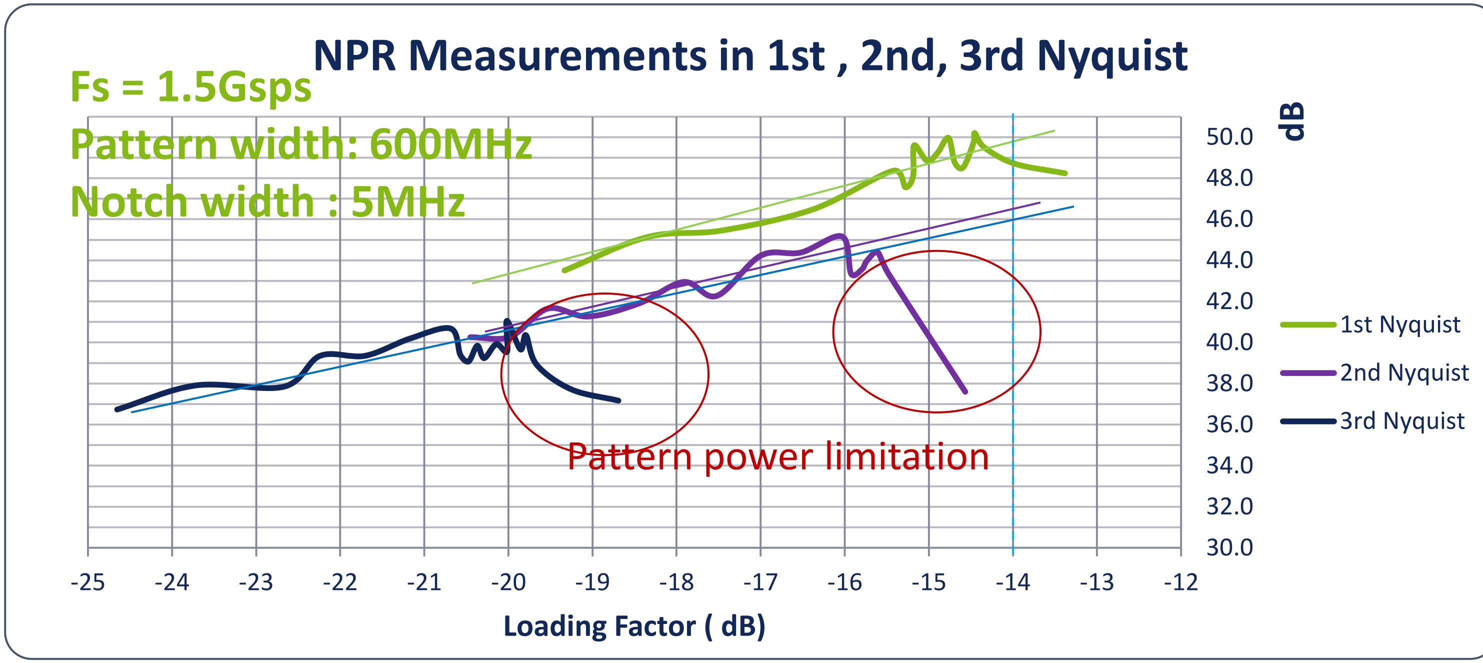




Advanced European Data Conversion Technology

MEASUREMENT RESULTS (3)

Noise Power Ratio

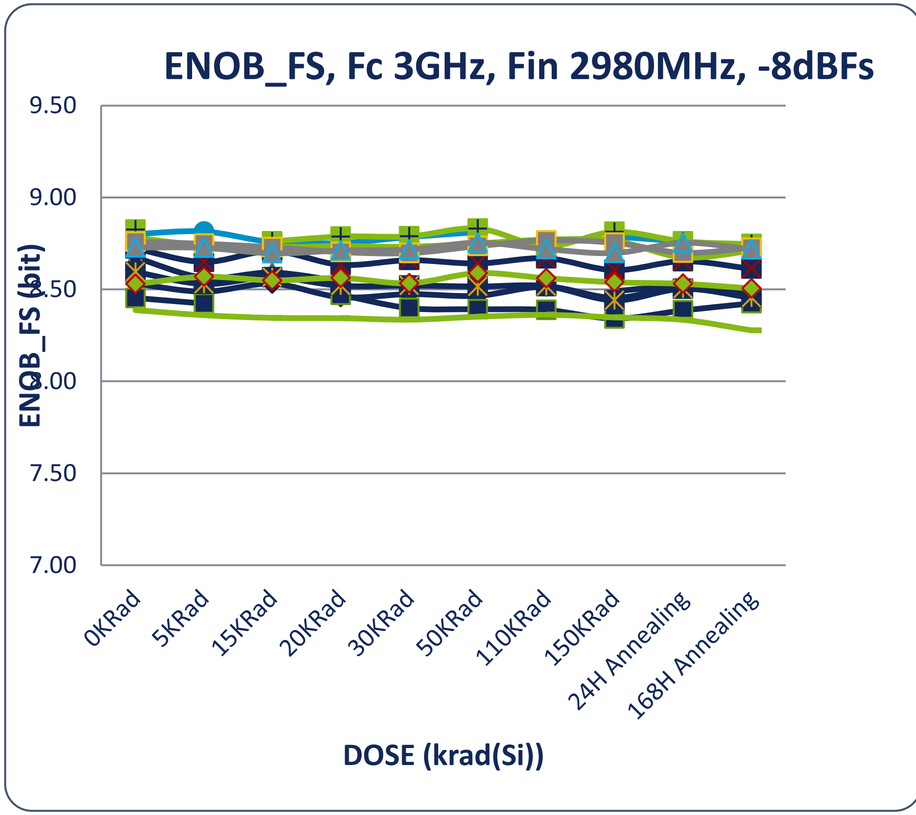


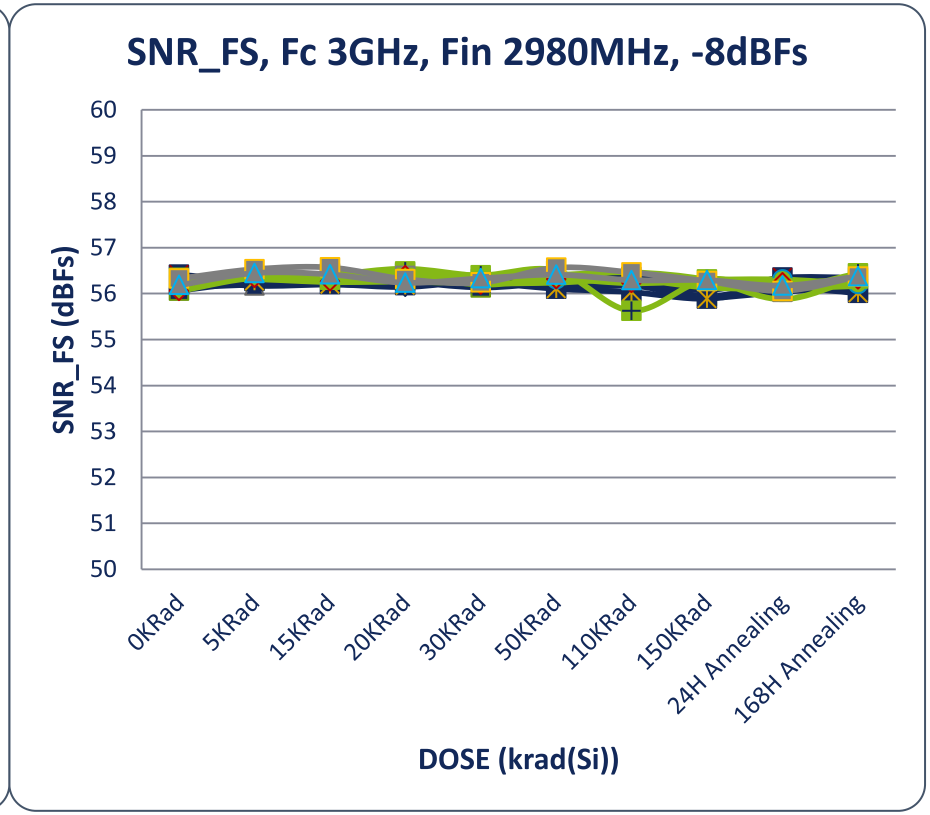
	Measure	Extrapolation from SINAD NPR ~ SINAD @-8dBFS -11dB
1st Nyquist	50dB	49dB
2nd Nyquist	46.5dB (extr) Pattern limitation	47.5dB
3rd Nyquist	46dB (extr) Pattern limitation	47dB

Advanced European Data Conversion Technology

MEASUREMENT RESULTS (5)

IRRADIATION RESULTS : Total Ionization Dose





- No performances deviation up to 150Krad

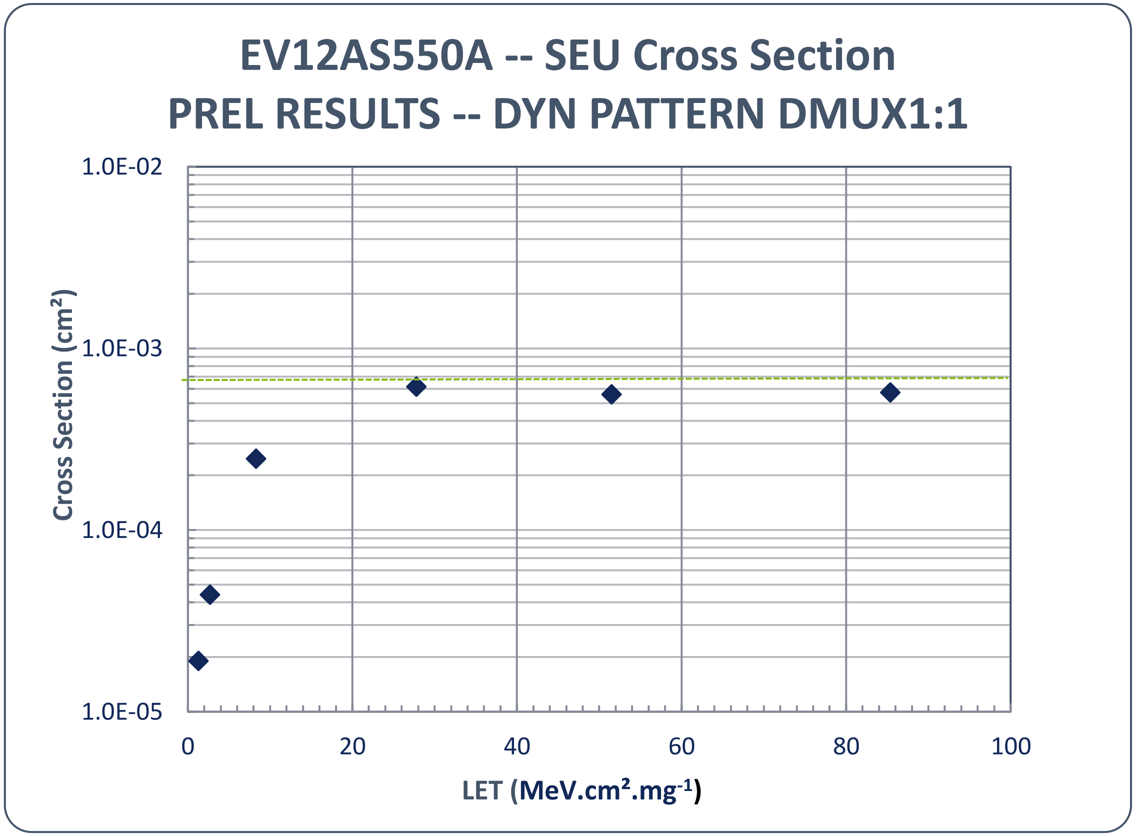
Advanced European Data Conversion Technology

MEASUREMENT RESULTS (5)

IRRADIATION RESULTS : PRELIMINARY Heavy Ions results

PRELIMINARY HIF RESULTS :

- NO SEL @ Tj = 125degC up to 84.5 MeV-cm²/mg



Presentation Outline

e2V Bringing life to technology

- Introduction to market needs
- Product Overview
- Package technology
- Synchronizing Data Converters
- Radiation Hardening
- Measurement Results
- Conclusions

CONCLUSIONS

First S-Band Capable Dual 12-bit 1.5GSps ADC in Flip-Chip Hermetic Technology

- **Samples available**
- ESCC2269000 Evaluation **in progress**
- Preliminary DataSheet available
  http://www.e2v.com/products/ev12ad550

Capability for Multi-Nyquist operation :
Above 4GHz analog input bandwidth

Preliminary Radiation Results:
No perf deviation up to 150Krad
No SEL up to LET 84.5 MeV.cm²/mg

SFDR :
61dBc at 1900MHz, -8dBFS
47dBc at 3730MHz, -8dBFS

NPR : 50dB in 1st Nyquist @LF = -14dB
47dB in 2nd Nyquist @LF = -14dB
46dB in 3rd Nyquist @LF = -14dB

Input Crosstalk : < 80dB up to 5GHz

Features:
Easy synchronization feature
End user calibration free
CCGA323 Flip Chip hermetic package
Space grade (ESCC9000)

Advanced European Data Conversion Technology

Advanced European Data Conversion Technology

e2v Bringing life to technology

Thank you.

Special acknowledgements to:

- **CNES**
- **DGA – French MoD**

e2v Semiconductors
Avenue de Rochepleine
38521 Saint-Egreve
France