Bank of Rad-Hard ADCs MPD 2010

SPACE ASICS - DUTH/SRL

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Scope of the Project

Motivation

- ADCs for space applications: highly needed but not available.
- Use of commercial parts compromises system performance.
- Currently available space worthy ADCs are few.
- Large gaps in the availability.

Scope of the Project

- Identify the space worthy ADCs.
- Identify a list of highly wanted / missing ADCs.
- Establish the requirements for the identified ADCs.
- Perform a feasibility and risk analysis on the identified ADCs.

ADC Suppliers

How can someone find an ADC for a space application?

Depending on the application requirements he can choose between

- Commercial ADCs that can meet the mission requirements
  - ESCIES database
  - NASA JPL data base
- Rad-Hard ADCs from a vendor
  - European
  - Non European
  - Non European and not subject to export regulations
- ADCs developed under ESA or other entity contracts

Critical Parameters for ADCs

Areas of concern in ADCs for space applications

- TID Hardness
- SEE Hardness
- Power Consumption
- Suitability of Analog interface

TID

- Some commercial parts hard up to 50KRad (RAD-PAC?)
- 100KRad for typical requirements missions
- 300KRad for most of the missions
- Up to 1MRad for a variety of demanding missions
- Compromises can be made

SEEs

- Many commercial ADCs are sensitive to SEUs and SELs
- In many cases this is a no go situation for commercial parts in many missions
- Rad-Hard ADCs offer a good hardness for most of the missions

Power

- Use in the emerging micro/nano/pico sat. market
- Considerable lack

Analog Front End

On chip AFEND highly required

8 bit ADCs

	Vendor	Smp. Frq MHz	Power Con. mW	TID Krad	SEL MeV/mg/cm^2	Status	E.S	F.H.
ESA	E2V	1500	1500	100	90	In Dev	EU	NA
ADC08D1000	NS	1000	1600	300	120	Ready	NEUNER	NA
ADC1175MW	NS	20	NA	NA	NA	Exp.	NEUNER	NA
JTS8388B	AT	1000	3400	150	NA	Ready	NEUER	NA

12-13 bit ADCs

	Vendor	Smp. Frq MHz	Power Con. mW	TID Krad	SEL MeV/mg/cm^2	Status	E.S	F.H.
C12/275	CY	0.27	20	100	NA	In Dev	NEUNER	NA
ETM	DUTH	100	2.5	NA	NA	In Dev	EU	NA
ADC128S102	NS	1	10	NA	NA	Exp.	NEUNER	NA
ADC124S101	NS	1	NA	100	120	Ready	NEUNER	NA
SPP	AU	5	500	1000	Immune	Ready	EU	NA
RHF1201	STM	50	50	300	120	Ready	EU	NA
RH9225	HN	12	345	300	Immune	Ready	NEUER	NA
AD9042	AD	41	595	100	Immune	Ready	NEUNER	NA
LTC1279	LNT	0.6	60	100	NA	Ready	NEUNER	NASA
LTC1409	LNT	0.8	80	NA	NA	Ready	NEUNER	NASA
NA	ACACIA	80	200	100	NA	Ready	EU	NA

14 bit ADCs

	Vendor	Smp. Frq MHz	Power Con. mW	TID Krad	SEL MeV/mg/cm^2	Status	E.S	F.H.
pSIF	DUTH	0.2	9	1M	NA	EM	EU	NA
ADC14155	NS	155	1000	NA	120	Exp	NEUNER	NA
RHF1401	STM	20	85	300	120	Ready	EU	NA
UT14AD03	AF	3	NA	300	111	Ready	NEUER	NA
AL2	RAY	10	325	300	Immune	Ready	NEUER	NA
AD6645	AD	105	1500	100	Immune	Ready	NEUER	MRO
9240LP	MX	10	355	100	Immune	Ready	NEUER	NA

16+ bit ADCs

	Vendor	Smp. Frq MHz	Power Con. mW	TID Krad	SEL MeV/mg/cm^2	Status	E.S	F.H.
AD977A	AD	0.2	100	NA	80	Ready	NEUNER	OCO
7809LP	MX	0.1	132	100	Immune	Ready	NEUER	NA
5102LP	MX	0.02	130	100	Immune	Ready	NEUER	NA
ADC7714	AD	NA	5	NA	55	Rady	NEUNER	ST7

List of Missing ADCs

Missing ADCs

- Very high resolution (16+ bits), low to medium speed ADCs.
- High resolution (up to 16 bits), moderate to high speed (up to 100 MHz) ADCs.
- Very low power ADCs to accommodate the micro-nano-pico satellite near future need.
- High end ADCs (200-1000MHz) with enhanced low power features.
- Possible areas where ADCs exist but power consumption is high.
- Possible areas where European components do not exist.
- ADCs with mission specific requirements.

List of Selected ADCs and Requirements

ADCs that underwent FRA

Resolution (bits)	Speed (MHz)	Power (mW)	Potential Applications
24	0.01	100	Optics instrumentation, remote sensing, seismic activity monitoring, formation flying applications, etc.
18	10	50	Optics Instrumentation, remote sensing robust control, etc.
16	100	300	Imaging applications, fast waveform capturing, pulse profiling, etc.
14	5	1	Micro/Nano/Pico Satellite market.
12	1	0.1	Micro/Nano/Pico Satellite market.
10	800	400	Modular SOC integration, telecom applications, etc.
10	100	30	SOC integration.

Key Features on all the ADCs

Every ADC needs to include:

Analog Front END (AFEND)

Highly wanted by the space market to offer AFEND or ASP units in the ADCs. The reason is that they are hard to find and in addition including them on chip can enhance performance.

Voltage Reference

- Presence of on chip voltage reference is very crucial.
- Design of a rad hard voltage reference is challenging.
- New techniques in present day technologies can offer solutions.

Challenges and Solutions of the FRA for the above ADCs

Key Challenges

- Requirements specifications on the above ADCs were difficult and time consuming to set since, many competing reqs were coming from potential users.
- Realistic feasibility and risk analysis required:
  - Assessment of various technologies. NDA with these technologies so as to perform realistic simulations.
  - Spice simulation of various design solutions. For high speed cases, layout of critical cells was mandatory since pre and post layout simulations showed significant differences.
  - High level simulations of radiation compensation algorithms to assess their performance.