

A curved horizon of the Earth as seen from space, showing a blue atmosphere and white clouds against a black background.

Cosmic Vision Instrumentation ASIC

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Aim

Provide radiation hard front-end for the Cosmic Vision instrumentation payload

Development phases

Phase I – Develop front-end demonstrator ASIC

Phase II – Radiation characterisation

Phase III – Instrumentation ASIC development

Objective

Reach technology readiness level 5 in 2012

Front-end demonstrator ASIC concept

Configurable analogue front-end

Spacewire digital interface for control and data

Applications

- CCD signal processing

- Radiation detector

- Radiation spectrometer

- ADC

- DAC

- Filter

- Low Noise Amplifier

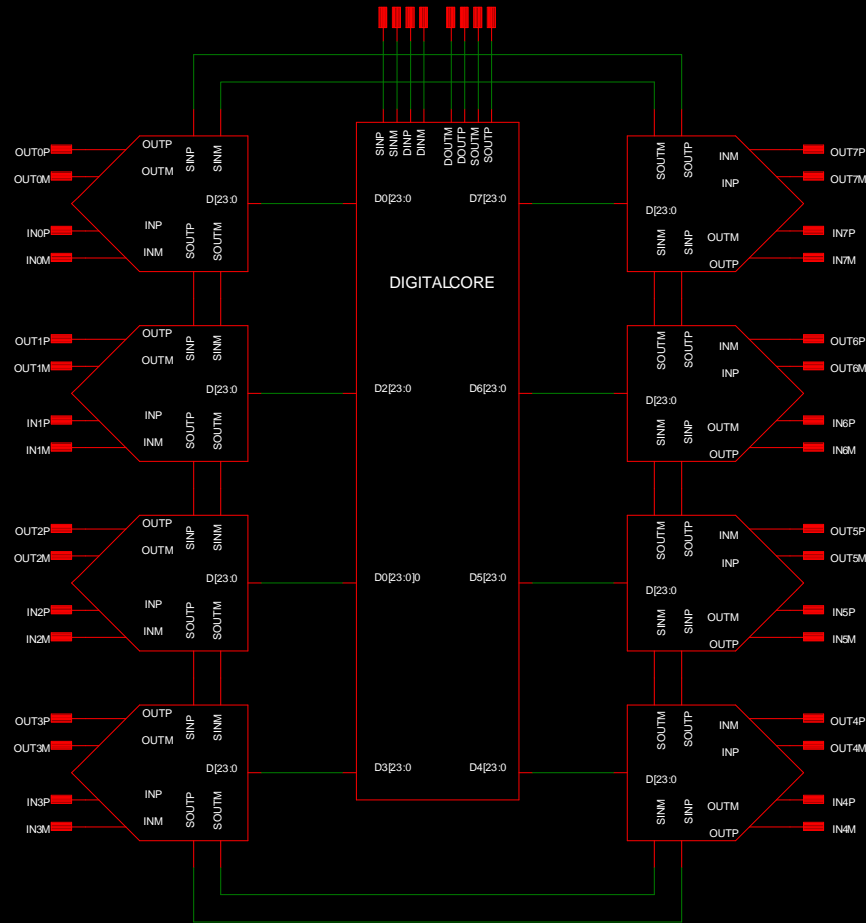
- Power Amplifier

Operating frequency

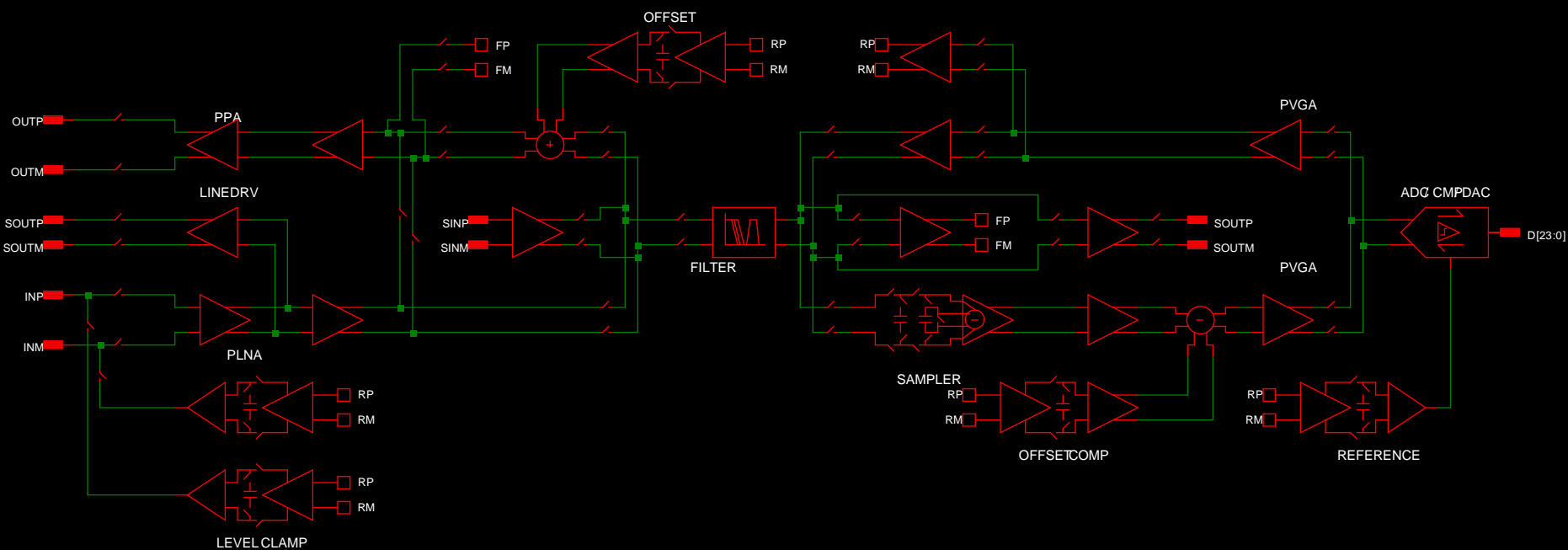
- 100kHz to 10MHz - MF

- 10MHz to 100MHz - HF

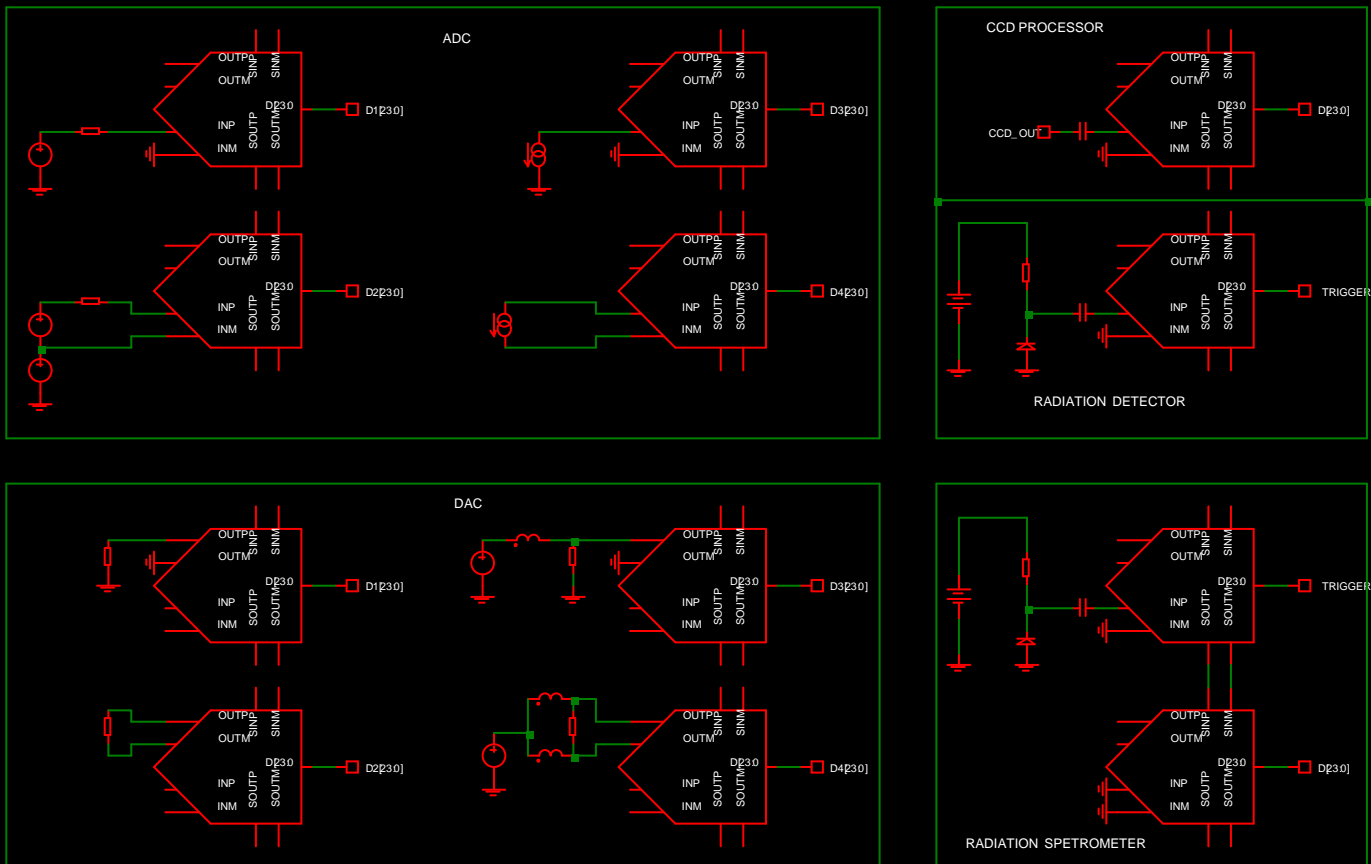
Front-end demonstrator ASIC - Architecture



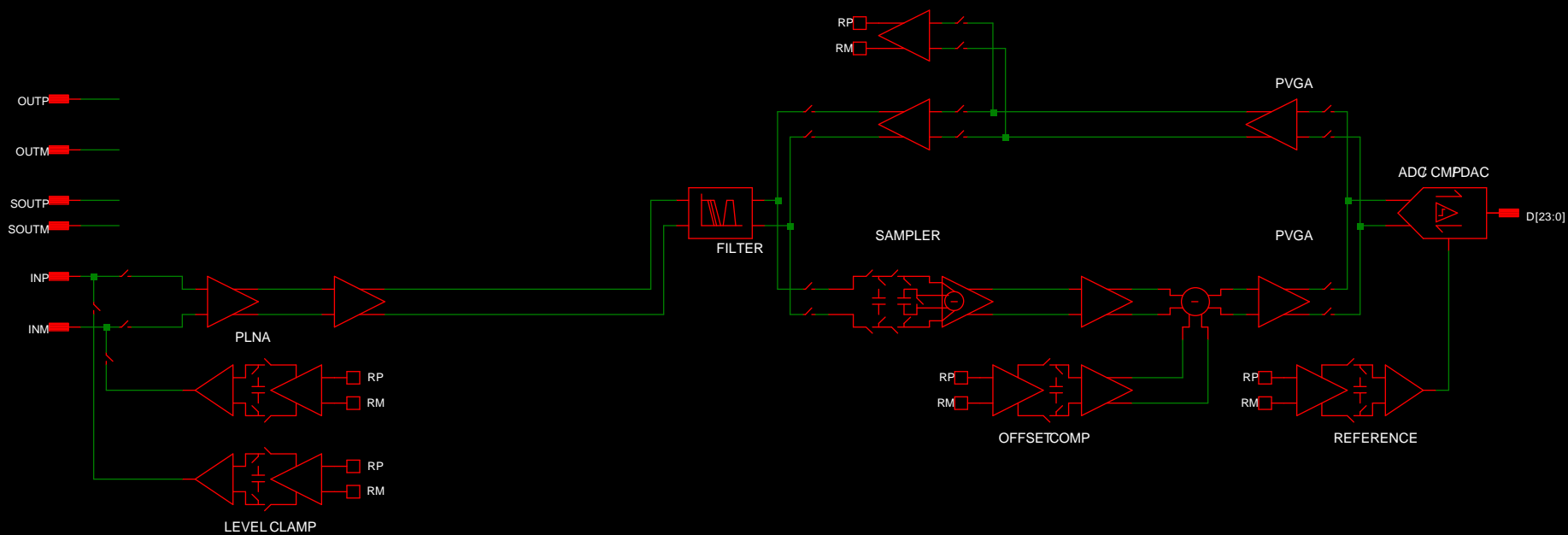
Front-end analogue processing block - Architecture



Front-end demonstrator ASIC - Applications



Front-end analogue processing block - CCD signal processing mode



Phase I Development Outline – Instrumentation teams involvement - 1

Work to date

- Presented MF and HF demonstrator ASIC specification
- Collected feedback from EJSM instrumentation teams
- Refined specification
- Issue ITT for MF and HF demonstrator ASIC development

March 2010

- Select 12 reference front-end target applications
- Select 3 instrumentation team representatives

Phase I Development Outline – Instrumentation teams involvement - 2

2010

- Initiate demonstrator ASIC development

- Review demonstrator ASIC requirements with team representatives

- Present ASIC specification updates (model format)

2011

- Present ASIC development progress

2012

- Validate demonstrator ASIC with team representatives

- Present ASIC validation results

- Distribute

 - Front-end demonstrator ASIC

 - ASIC simulation model

 - Prototype board with PC user interface

Collected feedback from EJSM instrumentation teams

Functionality extension

- Input multiplexer

- Operational amplifier (application schematics needed)

- Low noise amplifier (application schematics needed)

- Low sample rates (<100kHz)

Performance improvement

- ADC accuracy (14bit accuracy at 100MHz)

- Radiation detector and spectrometer ENC

Performance reduction

- Lifetime to 10 years

Performance determination

- Current consumption

Requested reporting on ASIC development

Functionality extension

Input multiplexer

Performance improvement

ADC accuracy (14 bits at 100MHz)

Thanks to

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H. Michaelis

H. L. O'Brien

M. Smit

Configurable front-end – CCD signal processing mode – Specification

No.	Parameter	MF			HF			Unit	Comment
		Min,	Typ.	Max.	Min,	Typ.	Max.		
1	Input level adaptation	1.5		0	1.5		0	V V	Minimum - Single ended Maximum - Single ended
2	Input level adaptation step		100			100		mV	
3	Gain (V/V)	30	0	-30	30	0	-30	dB dB dB	Minimum Nominal Maximum
4	Gain step		1			1		dB	
5	Offset correction	1		50	1		50	μ V min V max	Minimum Maximum
6	Offset corr. step		50			50		μ V	
7	Post Offset corr. Gain (V/V)	30		0	30		0	dB	Minimum Maximum
8	Post Offset corr. Gain step		1			1		dB	
9	Gain flatness			0.2			0.2	dB	
10	Noise			2			2	nV/sqrt(Hz)	
11	Sample rate	10		0.1	100		10	MHz MHz	Minimum Maximum
12	Effective No of bits	19 16 13			13 10				100 kHz 1 MHz 10 MHz 100 MHz
13	Current consumption		27			200		mA	

Configurable front-end – Radiation detection mode - Specification

No.	Parameter	MF			HF			Unit	Comment
		Min,	Typ.	Max.	Min,	Typ.	Max.		
1	ENC		80			50		erms	Input capacitance 50pF/10pF Peaking time 10μs/ 1μs
2	ENC slope		1.6			5.0		erms /pF	Peaking time 10μs
3	Range	200 20000			200 20000			fC fC	Minimum – with 0.2pF feedback cap. Maximum – with 20pF feedback cap.
4	Peaking time for Gaussian shaper	10		0.1	1		0.05	μs μs	Minimum Maximum
5	Peaking time accuracy			5			5	%	For Gaussian shaper
6	Threshold level	1		10	1		10	mV V	Minimum Maximum
7	Threshold step		10			10		mV	
8	Current consumption contribution of LNA and filter		4.5			45		mA	Maximum voltage gain condition at 10μs peaking time

Configurable front-end (MF) – Radiation spectrometer mode - Specification

No.	Parameter	Min.	Typ.	Max.	Unit	Comment
1	ENC		80		irms	Input capacitance 50pF Peaking time 10μs
2	ENC slope		1.6		irms/pF	Peaking time 10μs
3	Range	200 20000			fC fC	Minimum – with 0.2pF feedback cap. Maximum – with 20pF feedback cap.
4	Peaking time for Gaussian shaper	10		0.1	μs μs	Minimum Maximum
5	Peaking time accuracy			5	%	For Gaussian shaper
6	Sample and hold depth	8		1		Minimum Maximum
7	Effective No. of bits	19 16 13				100kHz 1MHz 10MHz
8	Threshold level	1		10	mV V	Minimum Maximum
9	Threshold step		10		mV	
10	Current consumption contribution of LNA and filter		4.5		mA	Maximum voltage gain condition at 10μs peaking time

Configurable front-end – ADC mode - Specification

No.	Parameter	MF			HF			Unit	Comment
		Min,	Typ.	Max.	Min,	Typ.	Max.		
1	Number of bits	21 18 15			15 12				100kHz 1MHz 10MHz 100MHz
2	Sample rate	10		0.1	100		10	MHz MHz	Minimum Maximum
3	Effective No. of bits	19 16 13			13 10				100kHz 1MHz 10MHz 100MHz
4	Input range	2			2			Vd _{pk}	Differential input & nominal gain
5	Gain flatness			0.2			0.2	dB	Over the signal frequency range 50kHz – 5MHz
6	Gain stability			0.1			0.1	dB	Over the temperature range
7	THD	130 110 90			90 70			dB dB dB dB	100kHz 1MHz 10MHz 100MHz
8	SFDR	130 110 90			90 70			dB dB dB dB	100kHz 1MHz 10MHz 100MHz
9	Current consumption contribution of ADC block		1 2 20			20 150		mA mA mA mA	100kHz 1MHz 10MHz 100MHz

Configurable front-end – DAC mode - Specification

No.	Parameter	MF			HF			Unit	Comment
		Min,	Typ.	Max.	Min,	Typ.	Max.		
1	Number of bits	21 18 15			15 12				100kHz (sampling frequency) 1MHz 10MHz 100MHz
2	Sample rate	10		0.1	100		10	MHz MHz	Minimum Maximum
3	Effective No. of bits	19 16 13			13 10				100kHz (sampling frequency) 1MHz 10MHz 100MHz
4	Input range	2			2			V _{dpk}	Differential input & nominal gain
5	Gain flatness			0.2			0.2	dB	Over the signal frequency range 50kHz – 5MHz
6	Gain stability			0.1			0.1	dB	Over the temperature range
7	THD	130 110 90			90 70			dB dB dB dB	100kHz (sampling frequency) 1MHz 10MHz 100MHz
8	SFDR	130 110 90			90 70			dB dB dB dB	100kHz (sampling frequency) 1MHz 10MHz 100MHz
9	Current consumption contribution of DAC block		1 2 20			20 60		mA mA mA mA	100kHz (sampling frequency) 1MHz 10MHz 100MHz

Application selection - Overview

No.	Application	MF	HF
1	CCD processor		
2	Radiation detector		
3	Radiation spectrometer		
4	ADC – current – single ended		
5	ADC – current – differential		
6	ADC – voltage – single ended	16bit @ 10Hz 23bit @ 10kHz 16bit @ 100kHz 14-16bit @ 1MHz	12bit @ 100MHz 14bit @ 100MHz
7	ADC – voltage – differential		
8	DAC – current – single ended	20bit @ 500Hz 16bit @ 10kHz 16bit @ 100kHz	
9	DAC – current – differential		
10	DAC – voltage – single ended		
11	DAC – voltage – differential		
12	Filter		50MHz anti-aliasing filter
13	Low noise amplifier		
14	Power amplifier		
15			

Application selection - Missing

Functionality is not fully exploited yet

No front-end signal conditioning application has been received

No applications concerning

- CCD signal processing

- Radiation detection/spectrometer

- Low noise amplifier/Power amplifier

Call for Applications – Requested information

Application schematic

Signal processing (gain, filtering, correlated sampling, offset cancellation, ...)

Signal

- range and frequency (in band & out of band)

- noise

- source impedance

Performance requirements

Validation requirements

Call for sample orders

Development output

- Front-end demonstrator ASIC

- ASIC simulation model

- Prototype board with PC user interface

Quantities

- Prototype board - 1

- Number of ASICs – no. required

Deadline

- 23 January 2010

User community

- Initiated from the instrumentation team representatives

Milestones

Sample ordering	-	23 January 2010
Application selection	-	20 February 2010
Closing date for ITT	-	22 February 2010
Requirement review	-	June 2010

Information

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