

Front-end electronics based on a $\Sigma\Delta$ ADC for energy

measurements using diamond detectors

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Introduction

In particle detection, diamond shows excellent performances compared to silicon specially when it comes to radiation hardness. The treatment of tumors by a beam of carbon ions or protons is an alternative cancer therapy known as hadron therapy. Ions deposit a large fraction of the dose at the end of their path, in the Bragg peak.

B. Proposed model

SQNR = $6.02N + 1.76 + (20L + 10) \log(OSR) - 10 \log\left(\frac{\pi^{2L}}{2L + 1}\right)$

SPECIFICATIONS OF THE ADC

Values



Comparison between the dose distribution of different particles as a function of penetration depth

INCIDENT RADIATION

PROSPERITIES OF DIAMOND VS SILICON			
Property	Units	Diamond	Silicon
Band Gap Eg	eV	5.47	1.12
Electron mobility μ_e	$cm^2 / V \cdot s$	1700	1420
Hole mobility μ_h	$cm^2/V \cdot s$	2100	470
Saturation velocity	cm / s	2×10^{7}	1.4×10^{7}
Intrinsic carrier density	cm ⁻³	$< 10^{3}$	1.5×10^{10}
e/h pair energy	eV	13	3.6
Displacement energy	eV	37-47	15-20
Density	g cm ⁻³	3.52	2.33
Rad length X ₀	cm	12.2	9.4
Dielectric constant ε_r	(relative)	5.7	11.9
Breakdown E-Field	V/µm	1000	30
Resistivity	Ω/cm	$>10^{15}$	$10^5 - 10^6$

Objectives





The choice of the parameters of the modulator

W	$\sim 40 \; MHz$
SR	10
ilter's order L	4
umber of bits of the modulator N	3
ampling frequency	~ 800 <i>MHz</i>
heoretical SQNR	~ 79.59 dB



Architecture of the proposed CT $\sum \Delta$ modulator

Simulation results

A. Synthesis results

Simulated: SQN(+D)R = 62.2 dB ENOB = 10.0

The SQNR of the simulated ADC

MOD Output Spectral Density

deal LPF @ Fs/(2OSR)

4.0e+07 (Hz

B. Characterization simulation results

DATA BUS

SHAPING

DIGITAL

CONVERSION

The STF and NTF responses of the modulator SQNR for 1000 iterations with 15% error on Coefs

Conclusion

The developed high level model is capable of synthesizing the parameters of the desired $\sum \Delta ADC$ and simulating the effect of the dispersions of these characteristic parameters.

Perspectives

Using the extracted values of parameters to design the building blocks of the $\sum \Delta ADC$ using fast design methodologies : ${}^{g_m}/{}_{I_d}$.