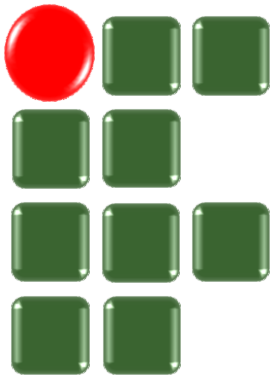
28º SIMPÓSIO SUL DE MICROELETRÔNICA

Porto Alegre, 29 de abril a 3 de maio de 2013

ANALOG ACQUISITION USING MULTILEVEL STATISTICAL SAMPLING



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Abstract

- Presentation of a systematic approach to the design of over-sampled stochastic ADCs with inherent tolerance to parametric variations and faults
- Usage of low cost blocks
- Theoretical analysis
- Practical implementation and validation

Introduction

- A designer dealing with CMOS technology must take into account high parametric variations on the electric features of the system

- Self-configuration and redundant components available are an attractive solution

  - Digital modeling of analog problems in ADCs

  - Provide a tradeoff between area and resolution

Introduction

- Some architectures design requires

- Use of low-cost blocks
- Highly digital design
- Meet a large application area
- Be tolerant to faults

Introduction

- Working with stochastic converters

- Dealing with similar concepts

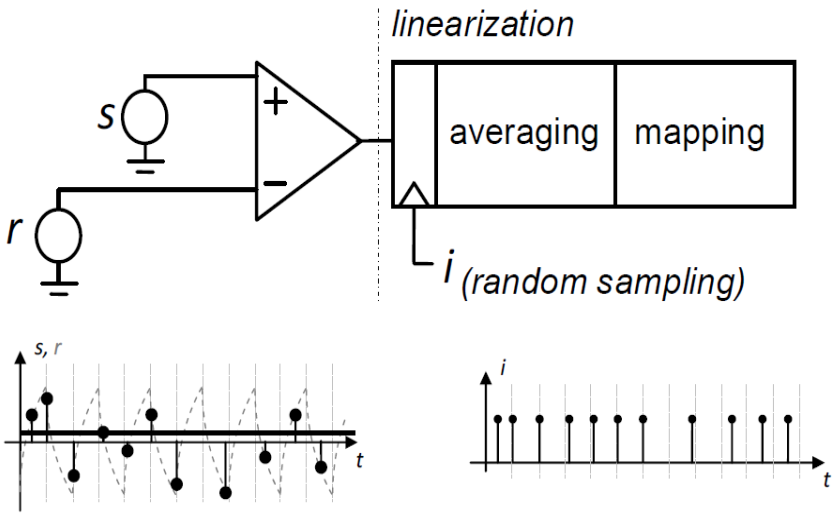
- There is a need for a reference signal with a uniform probability distribution

- very low bandwidth due to bit-stream digital input

Basic Concepts

- Statistical Sampling

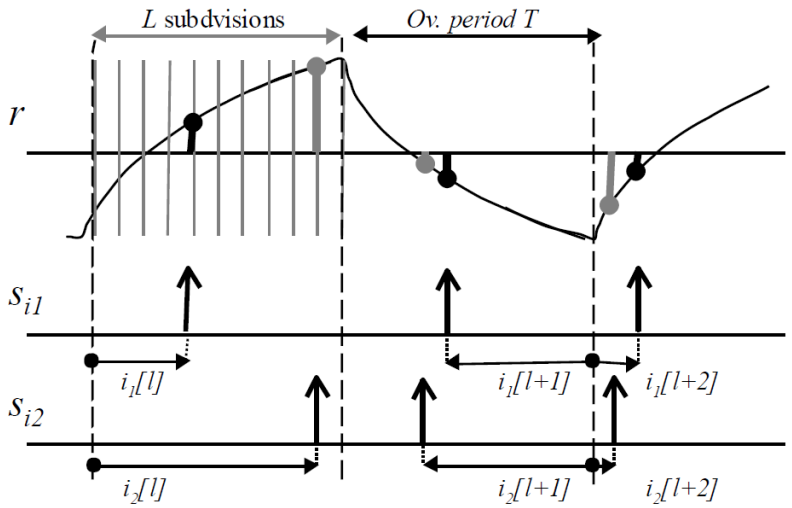
- A reference signal well known provides an bit-stream on the output with probability of a high level known



- From the statistics of the output signal, it is possible calculate the statistics of the input signal

Basic Concepts

- The reference signal is generated from a capacitor charge and discharge
- The samples are taken at random time instants



- The probability distribution of the reference signal discretized remains the same

Basic Concepts

- Relationship between output average and input average

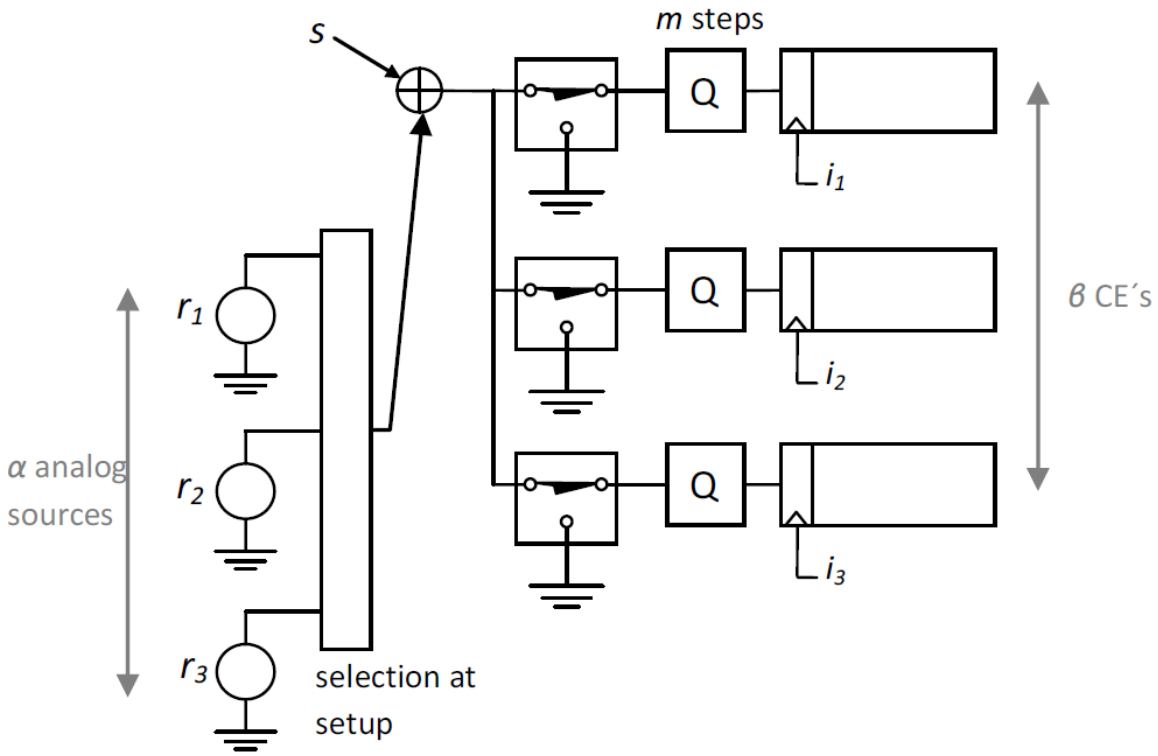
$$\mu(s) = E\{o_+\} - \frac{1}{2}$$

- Resolution is determined by the deviation of the moving average of the output

$$\sigma_o \propto \frac{1}{\sqrt{N}}$$

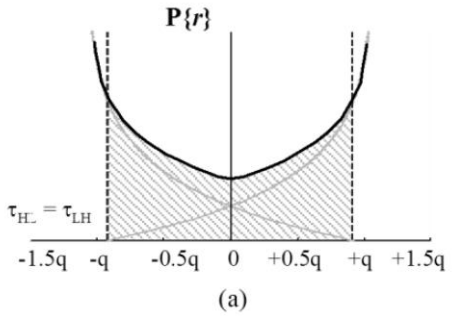
Basic Concepts

- With the PSS (Parallel Statistical Sampling) the relationship between the number of samples and the resolution is improved

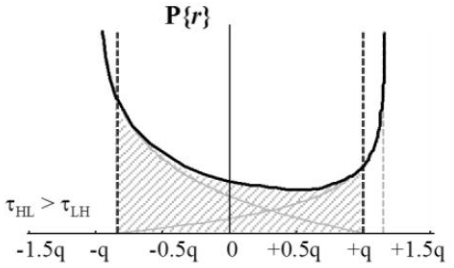


Basic Concepts

- As the reference signal is charge discharge capacitor signal, the probability distribution will not be uniformly distributed

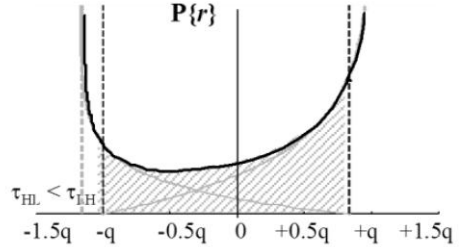


(a)



(b)

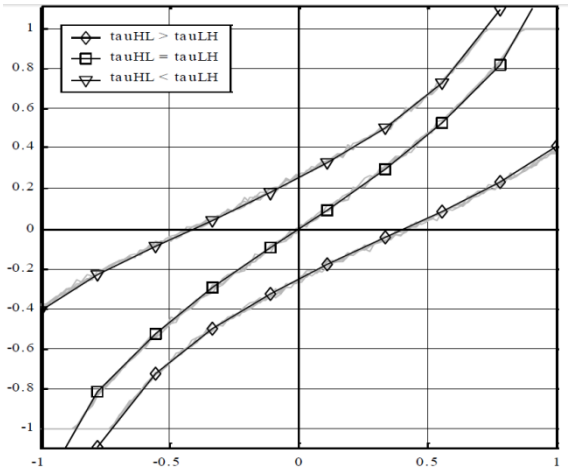
- The mapping approach has shown good results at higher acquisition frequencies



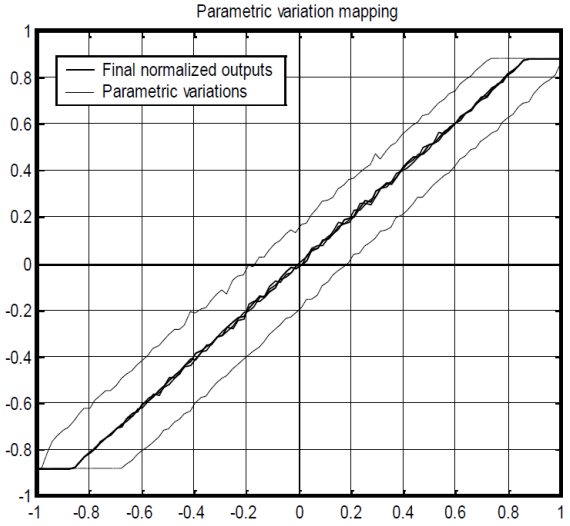
(c)

Basic Concepts

- Due to the output of the comparator having an offset, the dynamic range is not entirely covered



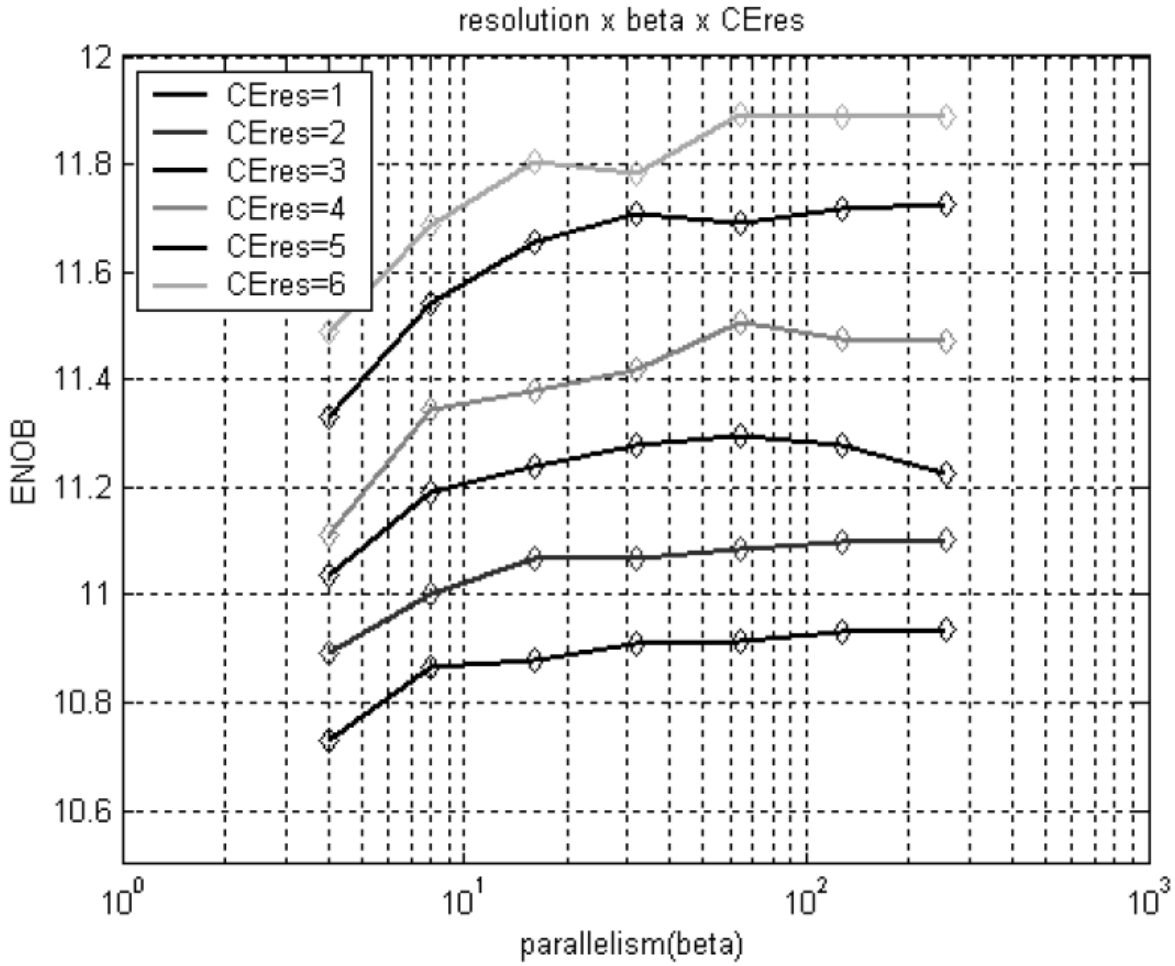
- With the mapping approach, one can obtain a good linear relation between input to output



Practical Results

Maximum DNL variation with RC parameters (5 bits, 10^5p-histogram)			
	Values for τ_{LH}		
Values for τ_{HL}	$\tau_{LH} = 0.45$	$\tau_{LH} = 0.5$	$\tau_{LH} = 0.55$
0.45	0.0082	0.0079	0.0077
0.5	0.0080	0.0077	0.0075
0.55	0.0078	0.0076	0.0071

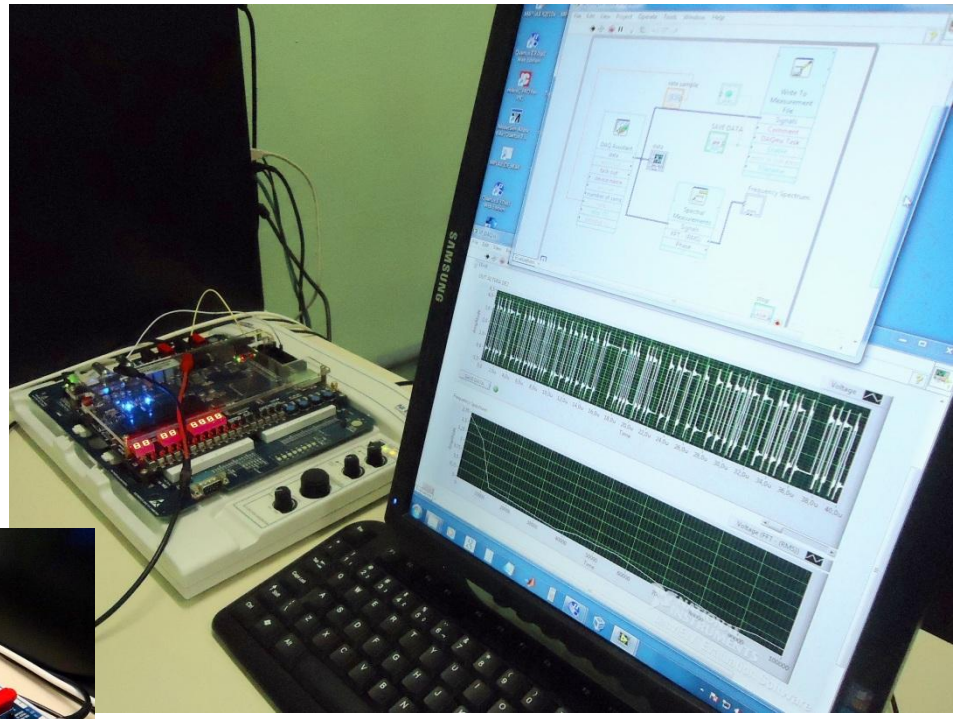
Practical Results

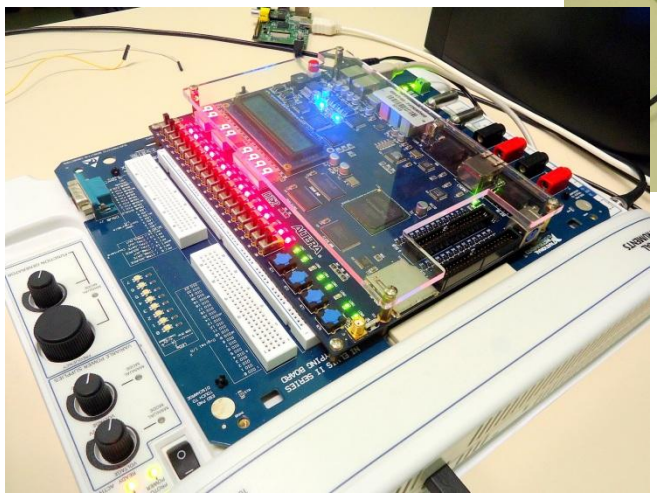


Conclusion and Future Work

- For instance previous results show that applications for multiple fault-tolerance may require quantizer blocks with lower resolution
- Multi-bit quantizer blocks can help applications where high frequency is required
- As the system can detect faults and self-configure, in future researches, digital signals will be tested as reference signals

Conclusion and Future Work





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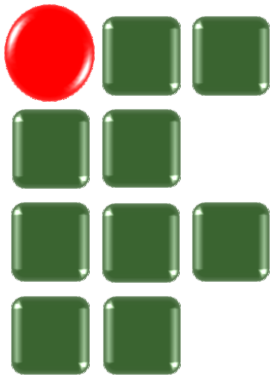

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