AUTOMATED GENERATION OF BUILT-IN SELF-TEST AND MEASUREMENT CIRCUITRY FOR MIXED-SIGNAL CIRCUITS AND SYSTEMS

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Overview

- Goals
- Model Design
  - Top Level Architecture
- Program
  - VHDL Generation
  - Example Implementations
- Experimental Results
- Summary

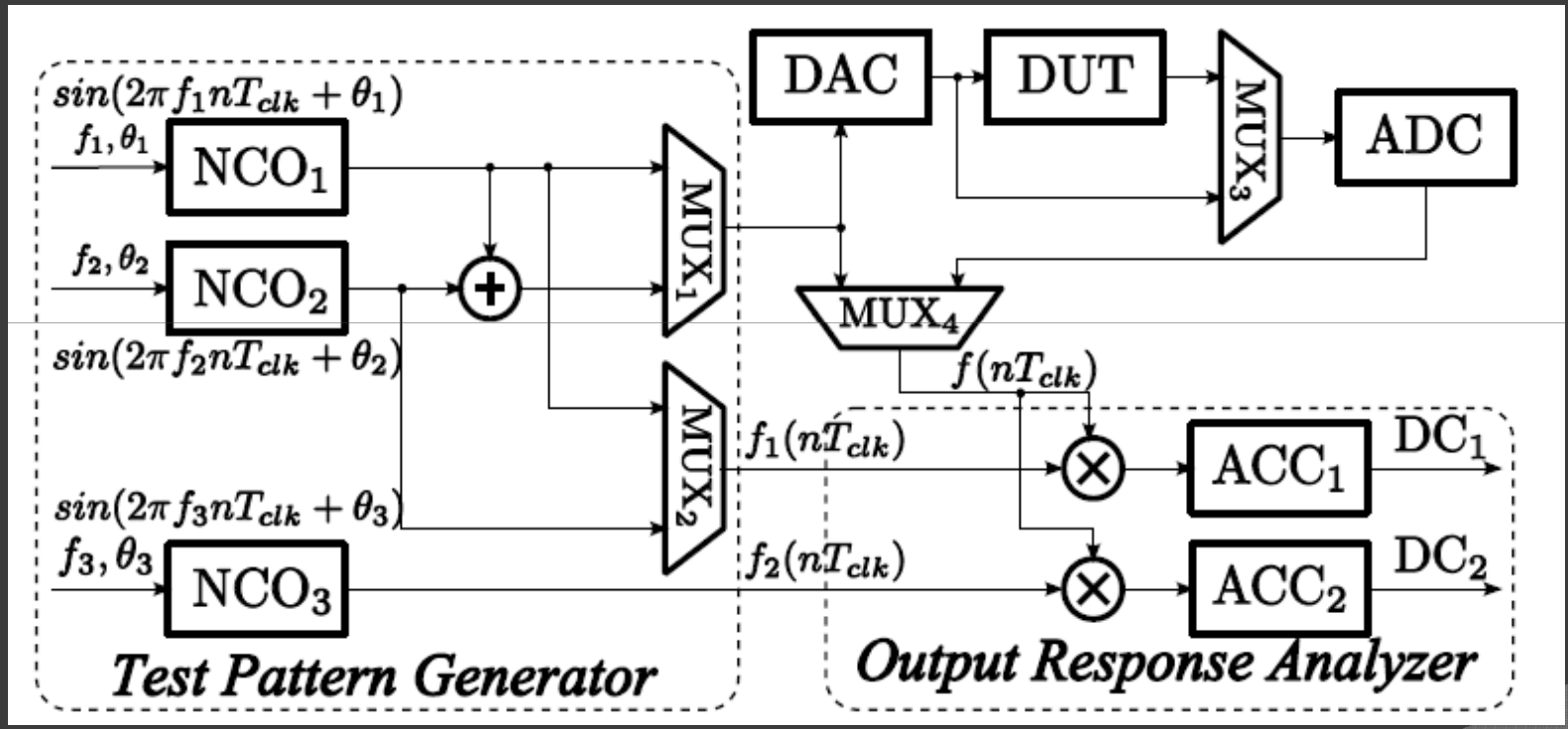
Goals

- Perform on chip calculations of:
  - Linearity
  - Frequency Response
  - Noise Figure

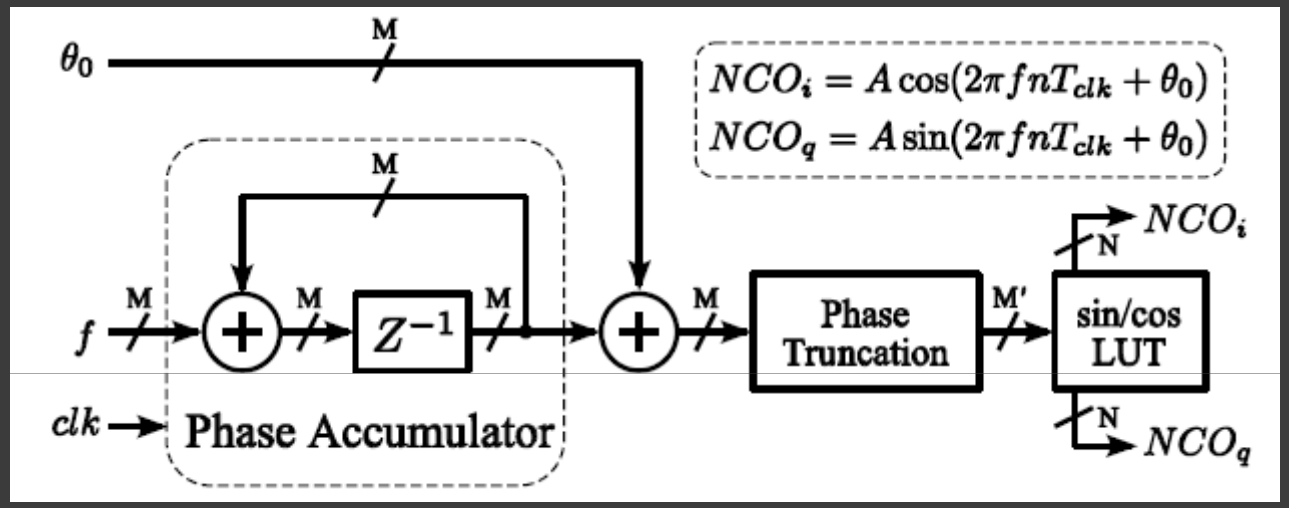
Built-In Self-Test

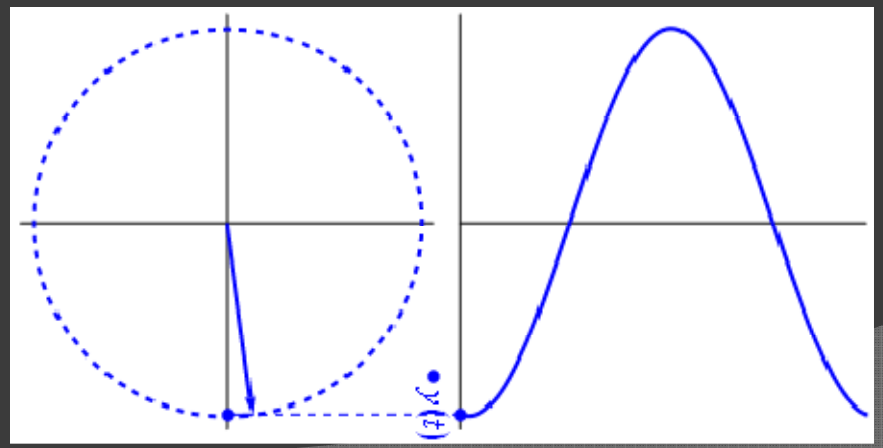
BIST

Top Level Architecture



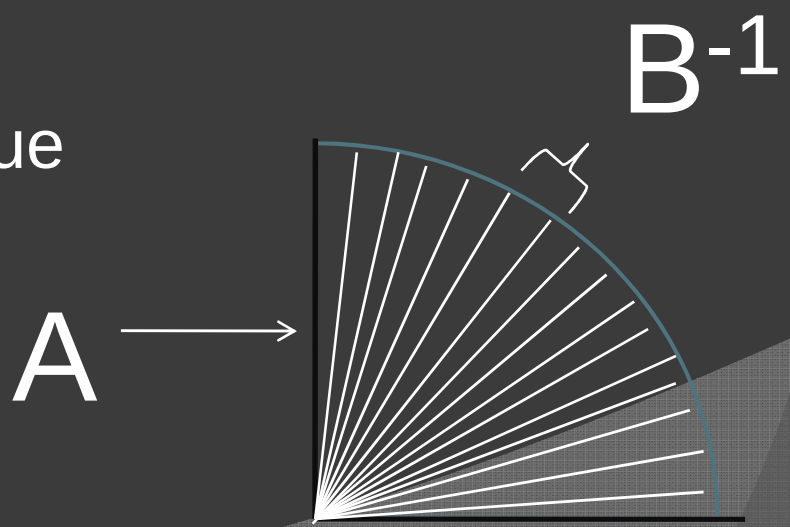
Numerically Controlled Oscillator





Sin/Cos Table Generation

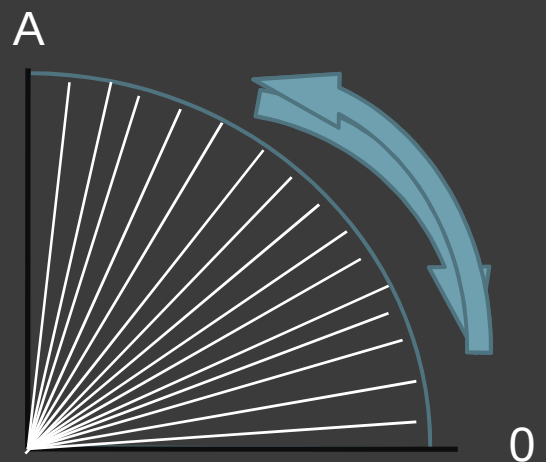
- TableEntry= A*sin(3.141592* I / (2*B))
  - A is the magnitude of the output
    - $A=2^{\#\text{of magnitude bits}}-1$
  - B is the number of entries in the table
    - B=#of table entries
  - I is the table index value

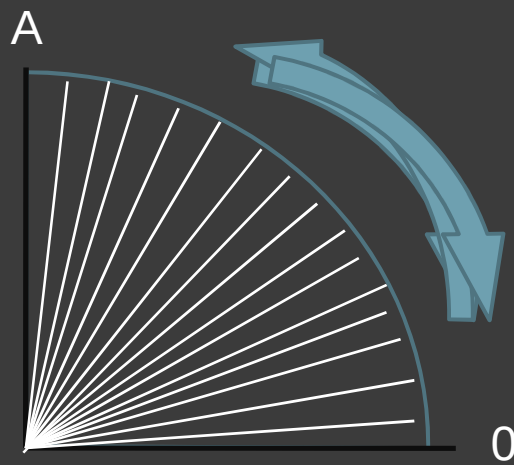


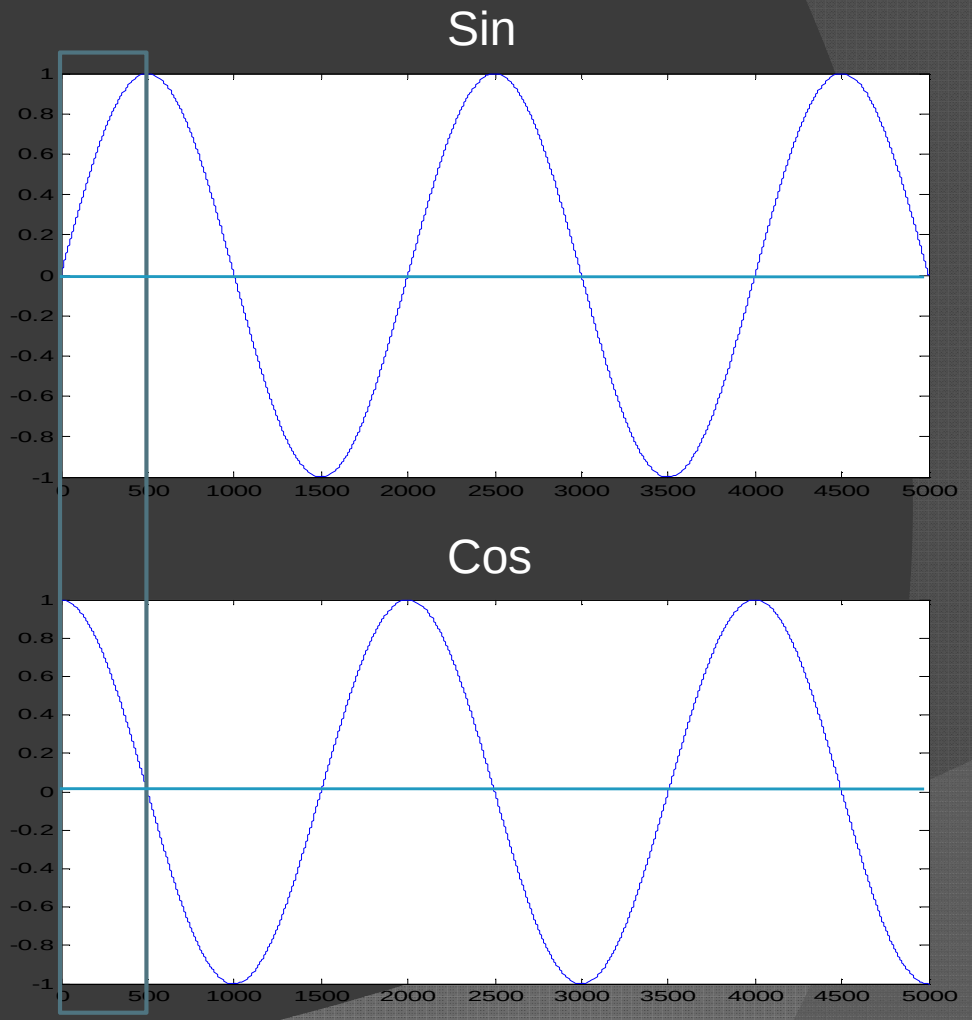
Lookup Table

```
case table_index is
    when 0 =>
        table_value := 0;
    when 1 =>
        table_value := 1304;
    when 2 =>
        table_value := 2401;
    when 3 =>
        table_value := 3001;
    ……
```

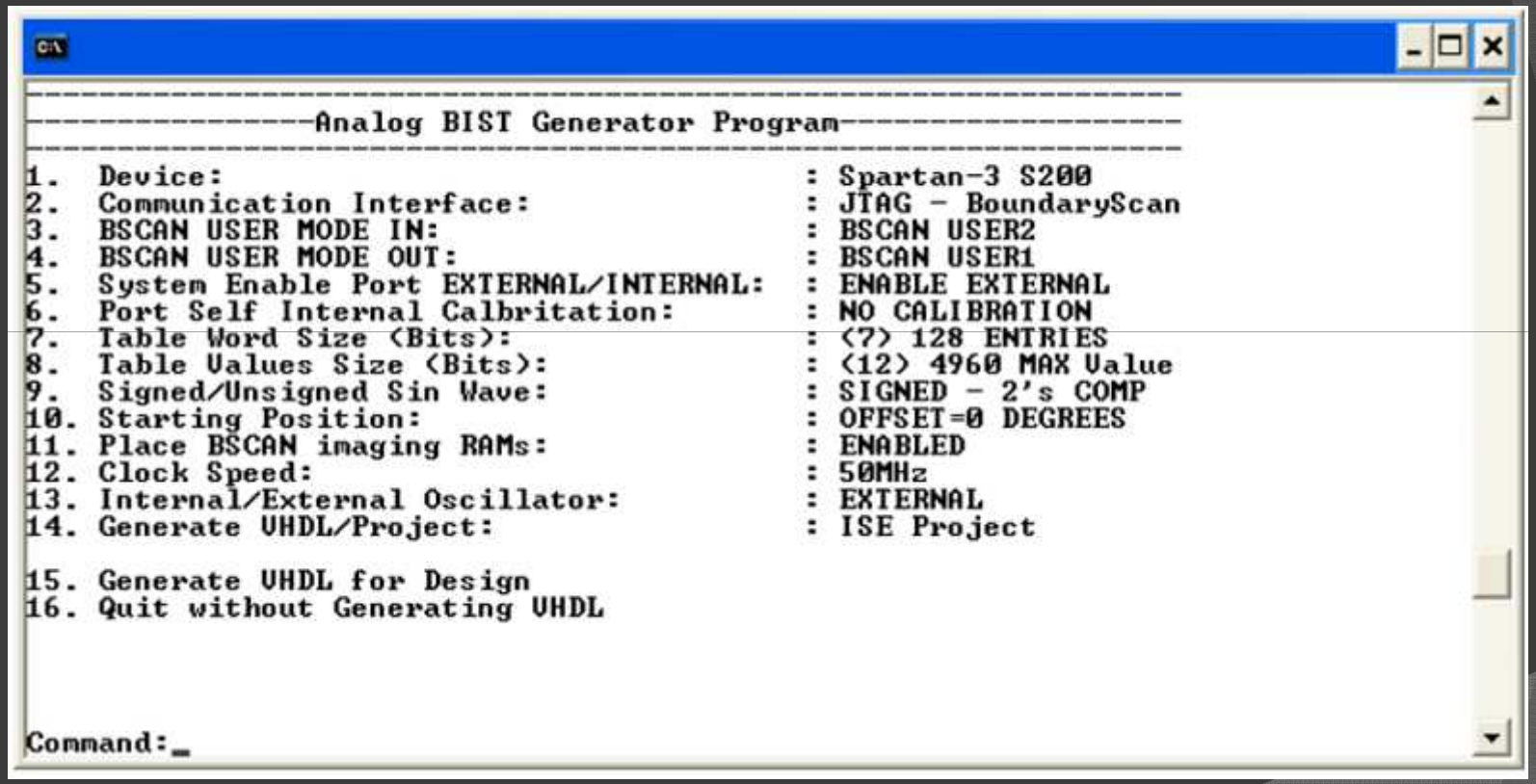
Generating waveforms



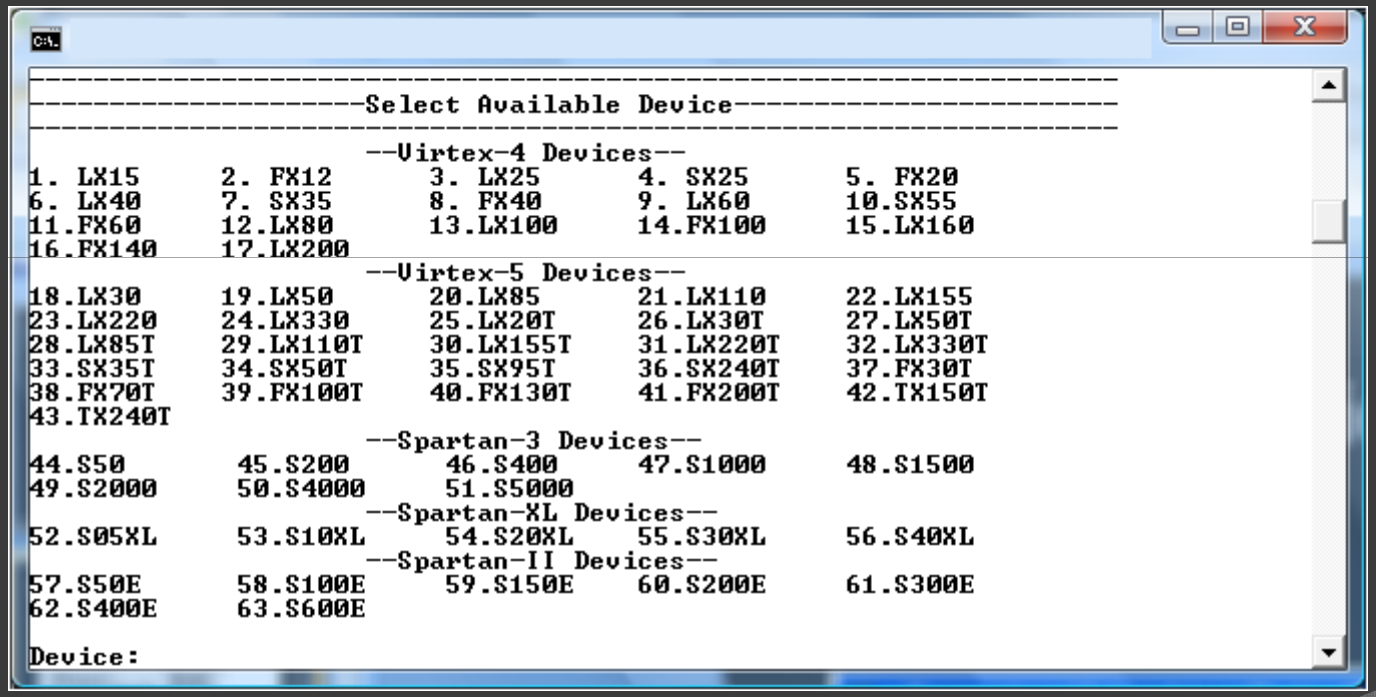




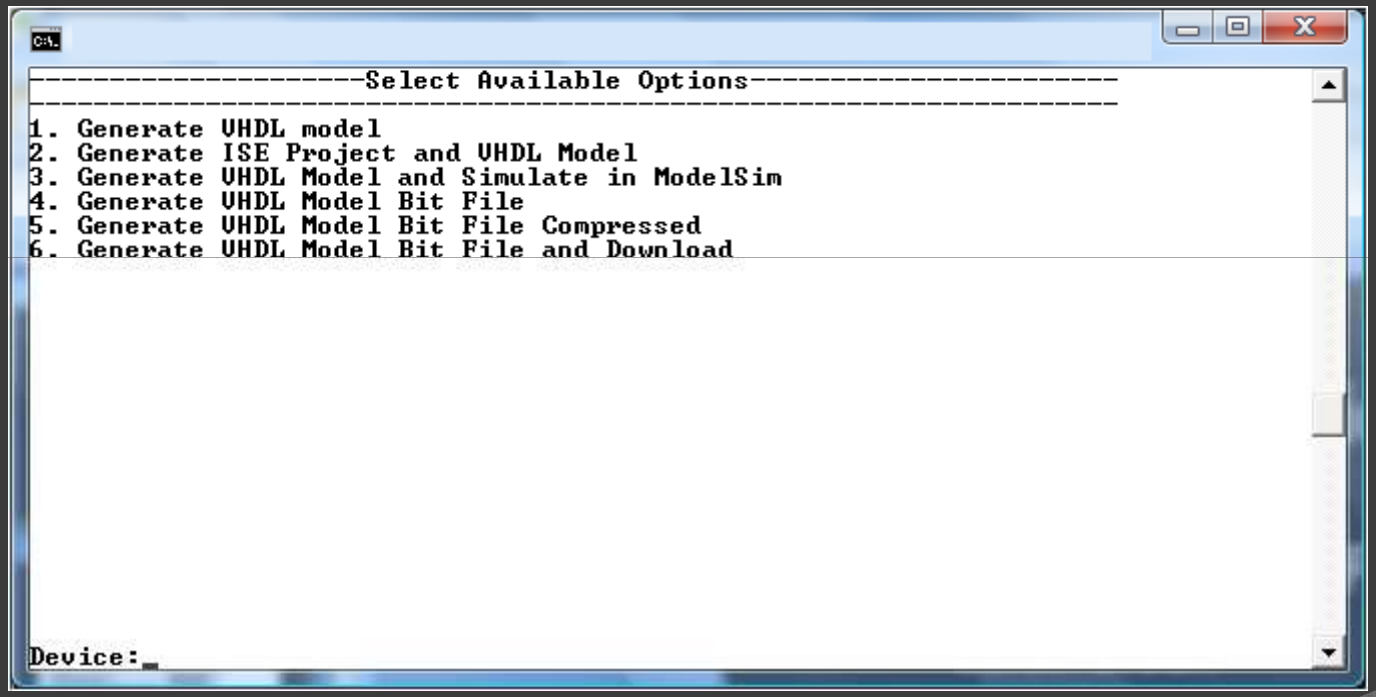
VHDL Generation



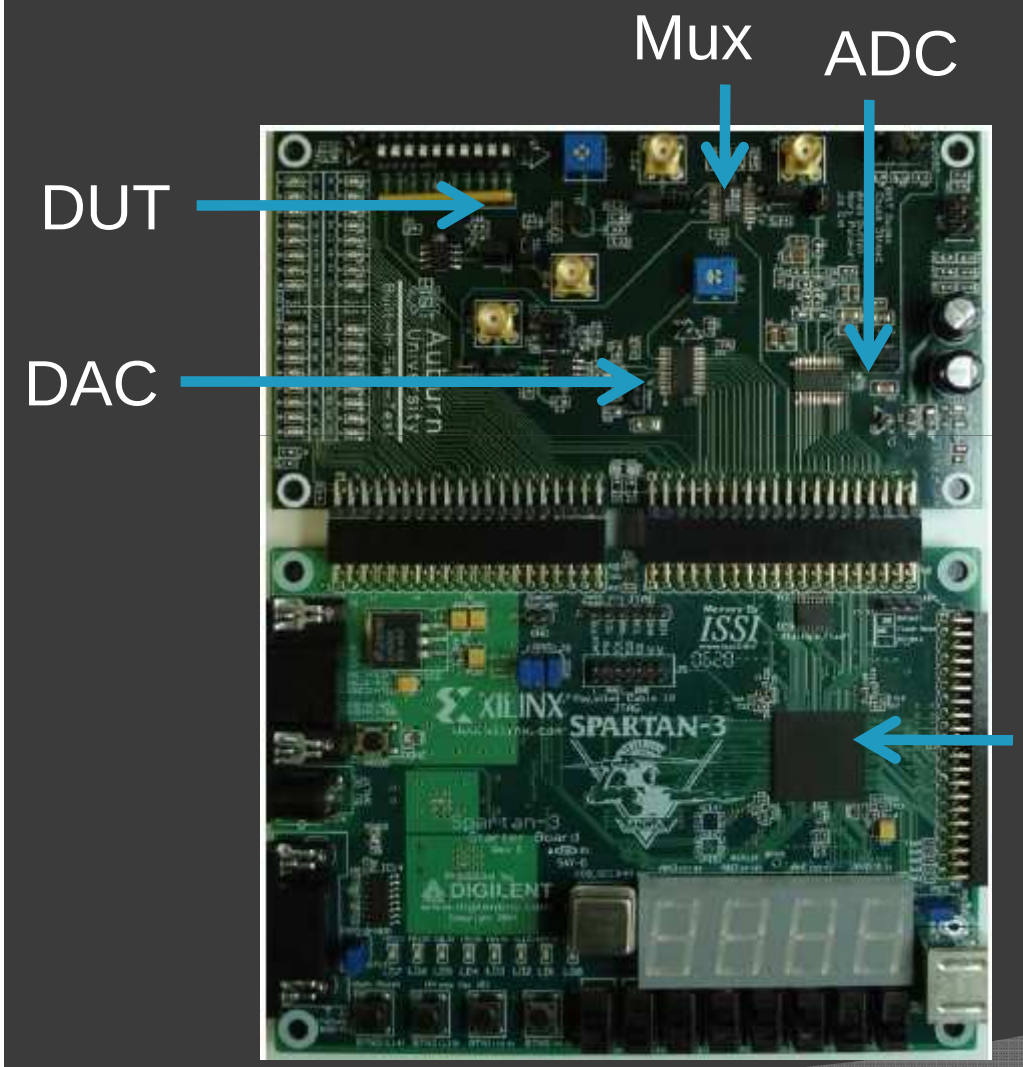
VHDL Generation Options

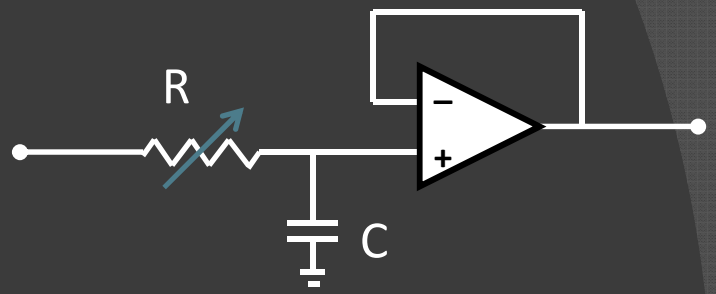


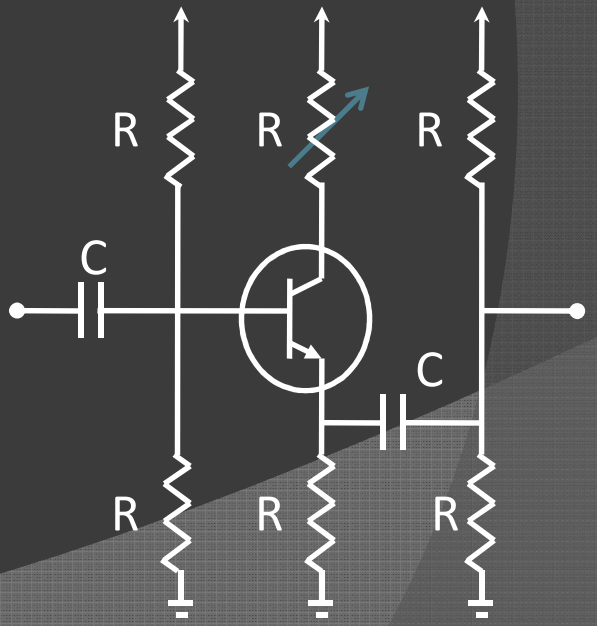
VHDL Generation Options



Example Implementations

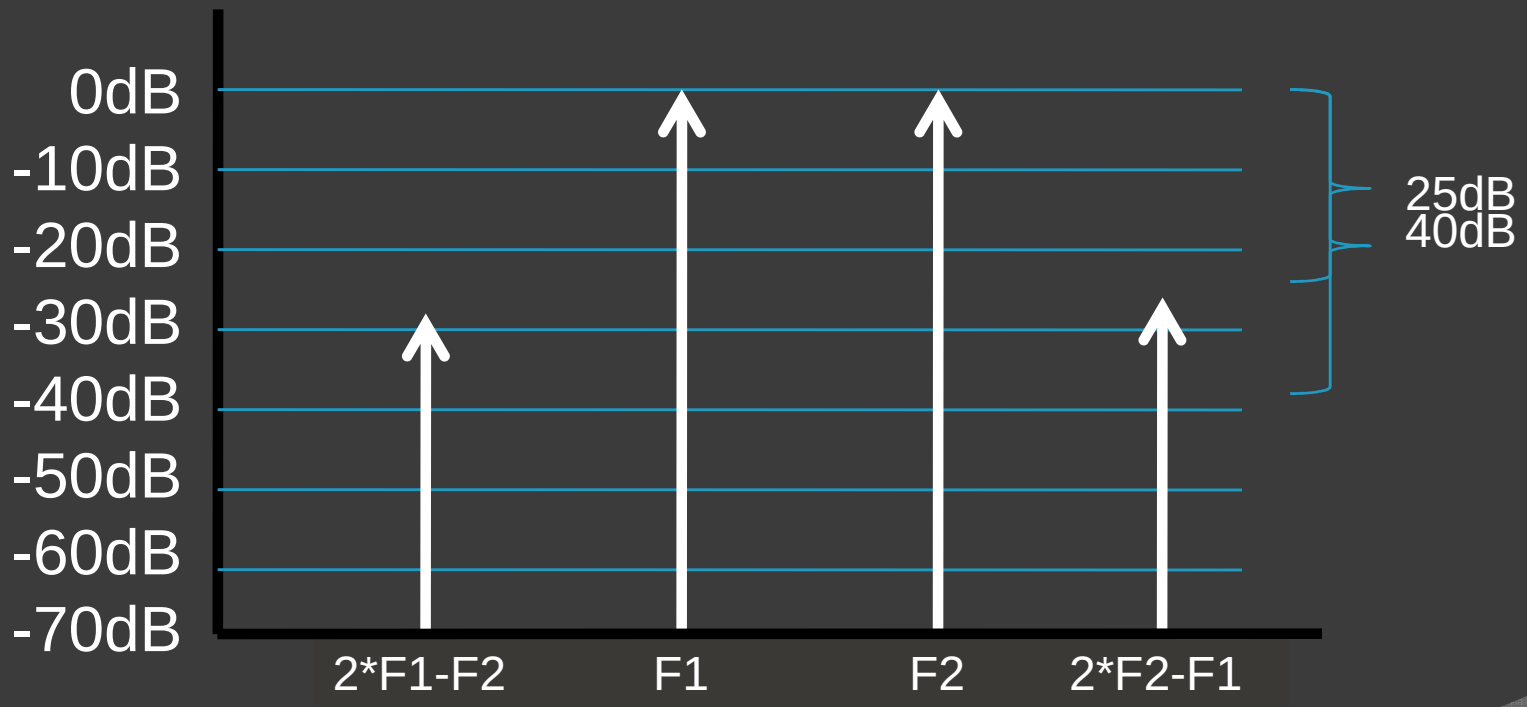




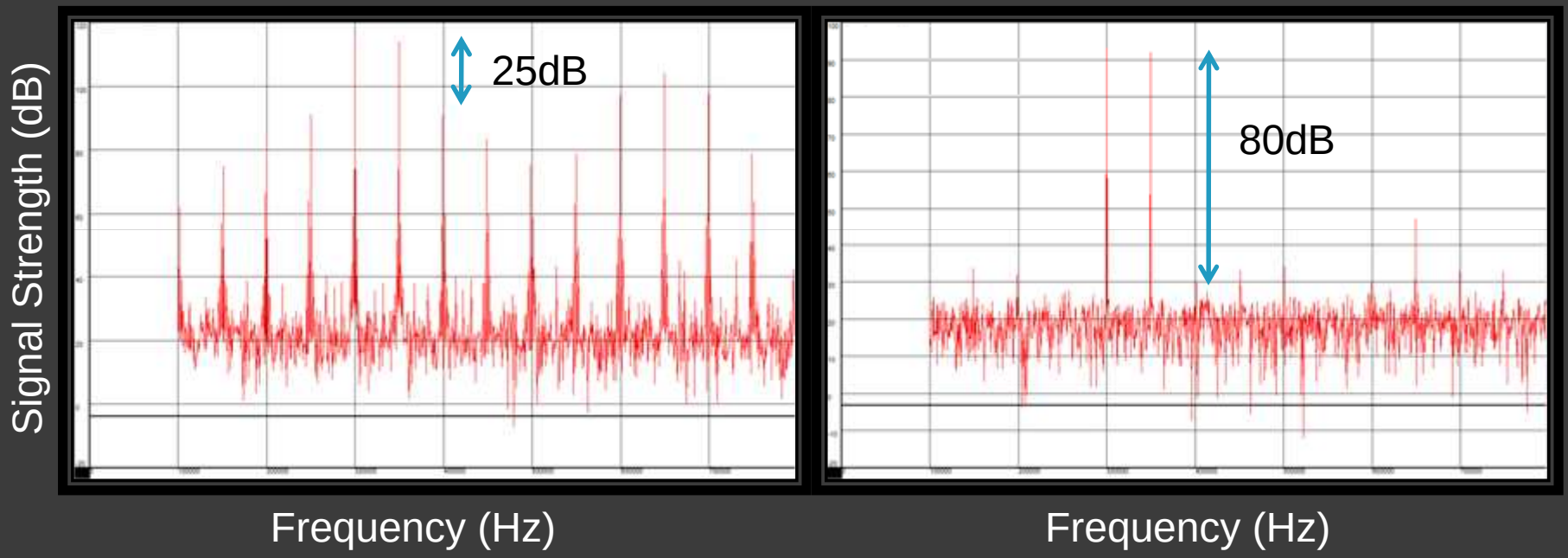


ORA Accumulators

Linearity Measurement



Linearity

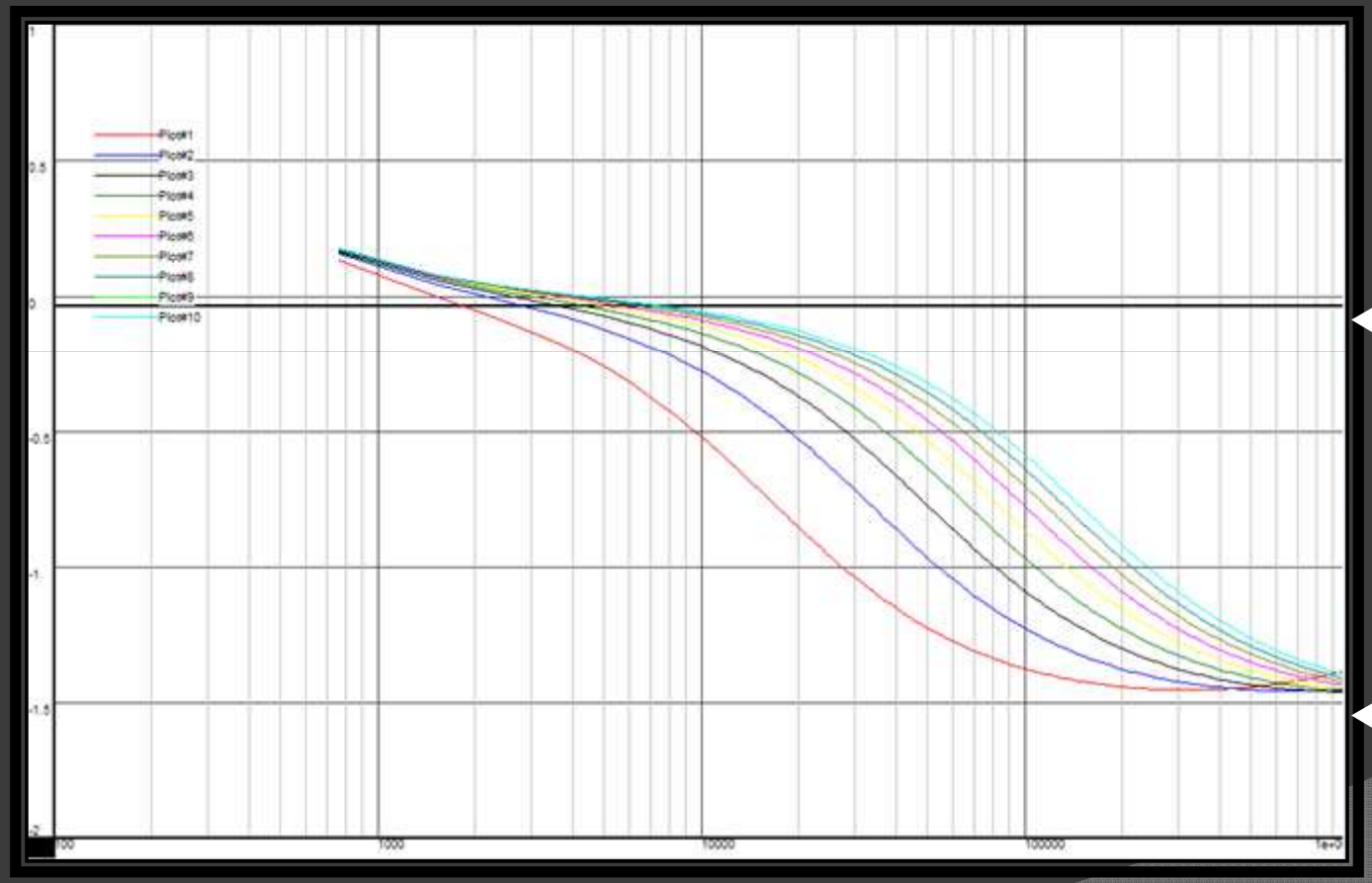


Very Non-Linear System

Linear System

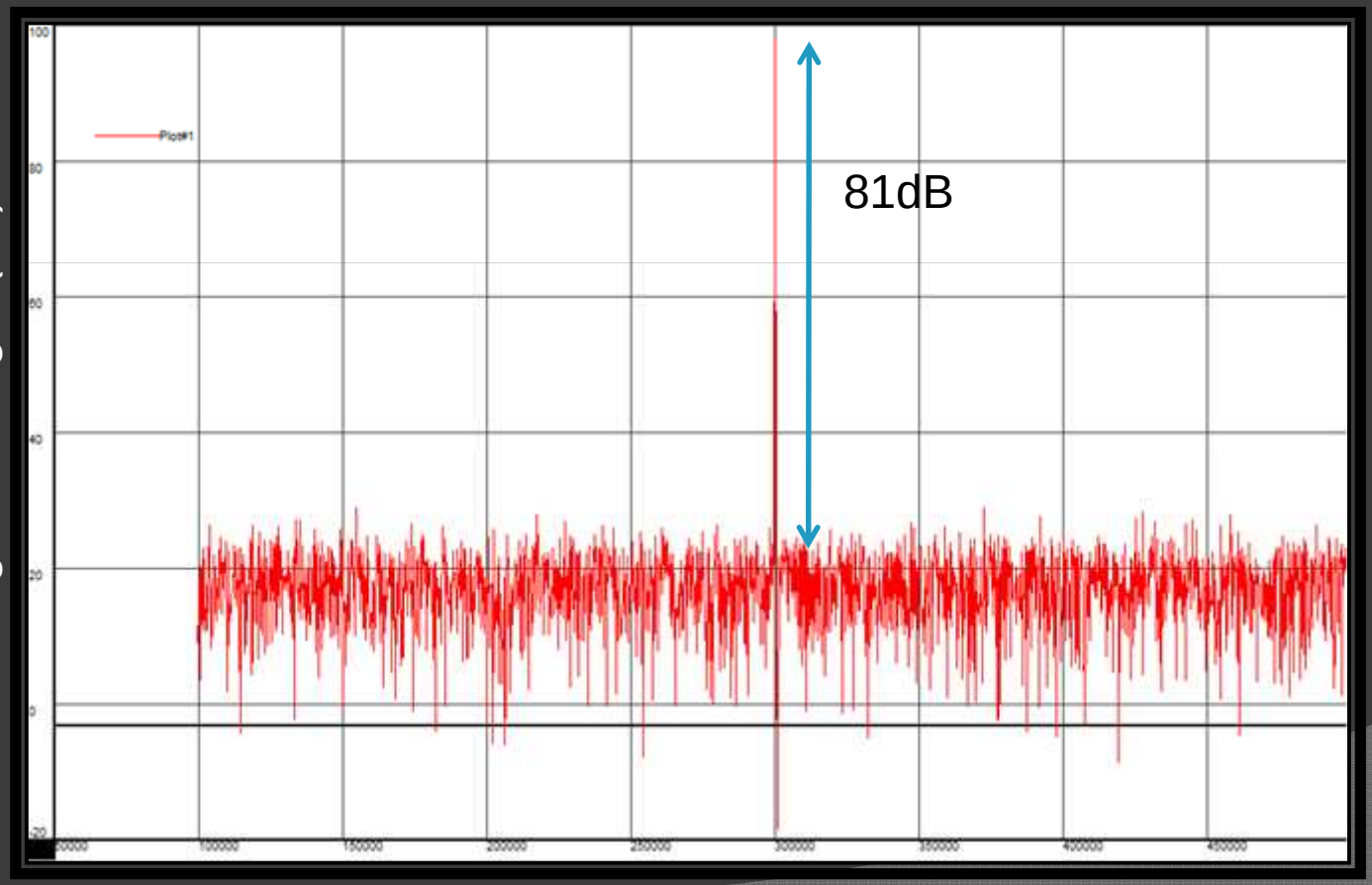
Frequency Response - Gain

Frequency Response -Phase



Noise Figure

$$NoiseFigure = 10 * \log\left(\frac{SNR_{in}}{SNR_{out}}\right) = SNR_{in}(db) - SNR_{out}(db)$$



SNR_{IN} = 109dB
SNR_{OUT} = 81dB
NF = 28dB

RunTime=0.52s

Summary

- Capability to measure
  - Linearity
  - Frequency Response
  - Noise Figure
- Automatic Generation of VHDL
  - Overcome lack of VHDL trigonometric functions
  - Implementation in any mixed-signal system
    - FPGA and ASIC
- Fast & accurate measurements compared to external test equipment

Questions?