FPGA Auto Correlation Function Simulation Results

**Background**

I have performed fifteen individual tests comparing the Vivado simulation results of the Auto Correlator implementation containing n(i) of size 100, n(i) of size 1000, and finally n(i) of size 10000 samples.

The simulation results have been compared in MATLAB using the following program:

t\_int = 125E-6; %Integration time (Adjusted based on the number of samples desired)

fs = 1E6; %Sampling frequency

n\_int = fs\*t\_int; %Size of n(i) vector

mu = 5;         % Mean

sigma = 2;      % Standard deviation

uniformDist = randi([0,10],1,n\_int); %Generating uniformly distributed numbers from 0 to 10

p = 5;

xmin=0;

xmax=10;

gaussianDist = round(xmin + (xmax - xmin)\*sum(rand(n\_int,p),2)/p); %Generates random integers with Gaussian Distribution

n = gaussianDist; %Generated samples. Can change between uniformDist and gaussianDist

g2 = []

for(delay\_time = logspace(log10(1E-6),log10(125E-6),40)) %Computing Auto Correlation function with logarithmically spaced delay times.

    delta\_n = delay\_time\*fs;

    n\_avg = n\_int - delta\_n;

    numerator = n(1:end-delta\_n+1) .\* n(delta\_n:end);

    numerator\_timeAvg = sum(numerator)/n\_avg;

    denominator = n.^2;

    denominator\_timeAvg = sum(denominator)/n\_int;

    g2(end+1) = numerator\_timeAvg/denominator\_timeAvg;

end

delayt = logspace(log10(1E-6),log10(125E-6),40); %Plotting computed Auto Correlation function

loglog(delayt,g2)

axis([1E-6,1E-4,0,1.1])

Numbers (integers) for the n(i) vector are generated using a Gaussian distribution using MATLAB’s rand() function.

All tests are performed using a 1MHz sampling frequency while varying the integration time to vary the number of samples the n(i) vector will take.

Additionally, the “Observed average percent error” is computed which is the average percent error between the Auto Correlation function computed by MATLAB and the FPGA Simulation for each delay time.

**Auto Correlation Results With 100 Samples ():**

**Test 1**

**A graph of a graph

Description automatically generated**

Observed average percent error: -0.74723%

**Test 2**

**A graph of a graph

Description automatically generated**

Observed average percent error: -1.3008%

**Test 3**

**A graph of a graph with a line

Description automatically generated**

Observed average percent error: -0.53689%

**Test 4**

**A graph of a graph with red and blue lines

Description automatically generated**

Observed average percent error: -0.11439%

**Test 5**

**A graph with red and blue lines

Description automatically generated**

Observed average percent error: -1.2799%

**Auto Correlation Results With 1000 Samples ():**

**Test 1**

**A graph of a graph

Description automatically generated**

Observed average percent error: - 0.12241%

**Test 2**

**A graph of a graph

Description automatically generated**

Observed average percent error: - 0.061677%

**Test 3**

**A graph of a graph

Description automatically generated**

Observed average percent error: -0.12108%

**Test 4**

**A graph of a graph

Description automatically generated**

Observed average percent error: -0.10069%

**Test 5**

**A graph of a graph

Description automatically generated**

Observed average percent error: -0.22629%

**Auto Correlation Results With 10000 Samples ():**

**Test 1**

**A graph of a graph

Description automatically generated**

Observed average percent error: -0.077251%

**Test 2  
A graph of a graph

Description automatically generated**

Observed average percent error: -0.14337%

**Test 3  
A graph of a graph

Description automatically generated**

Observed average percent error: -0.070782%

**Test 4**

**A graph of a graph

Description automatically generated**

Observed average percent error: -0.15419%

**Test 5**

**A graph of a graph

Description automatically generated**

Observed average percent error: -0.094946%