EE658: VLSI Data Conversion Circuits; HW1

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1. Simulate one cycle of a full scale sinewave passing through a 8 bit quantizer with a range of 2 V. Plot the histogram(with a total of 10000 points, and dividing each quantization step into 50 steps) of the quantization error. How does the simulated distribution compare to the uniform distribution that is commonly assumed?

2. Do the following simulations using a full scale sinewave for 4, 8, and 10 bit quantizers.

   Plot the spectrum of a sampled quantized sinewave(The number of points in the DFT should be an integer power of 2; use a log-y axis). The input frequency must be near $f_s/4$. Compute rms quantization error and compare it to the theoretical value. Is the spectral density of quantization error constant over the frequency band? How large is the largest tone relative to the signal? Are there frequencies missing from the output spectrum? Why?

   Compare the spectrum of the quantized signal before sampling[1] and after sampling.

3. DAC jitter: A DAC is designed to give half width rectangular output pulses. Compute the output spectrum of the DAC in terms of the spectrum of the digital input sequence $D_{in}[n]$. Compare this to the spectrum of a DAC with full width output pulses.

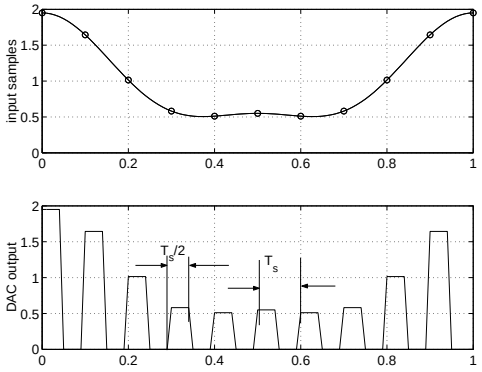

Figure 1: DAC with half width output pulses

   Describe the effect of jitter on the output of this DAC. Is it different from that in a DAC with full width output pulses? (Hint: compute the error due to jitter for a dc signal)

4. Calculate the offset, gain error, INL, and DNL (for both endpoint and least mean squared error fitting) of the 2 DACs whose output voltages are given in `dac1.dat` and `dac2.dat` . Simulate the output spectrum of the DAC with a full scale digital sinewave input near $f_s/4$. Plot the input and the output spectrum of the 2 DACs[2]. Compute SFDR, SNDR, and SNR for each case[3]. What can you say about the first DAC?

[1] This is a continuous-time signal. You need to approximate this by using a much higher sampling rate.

[2] Ignore the first order hold effect. Simply consider the output samples

[3] Ignore dc for all these cases. Assume that everything other than the largest spurious tone is noise.