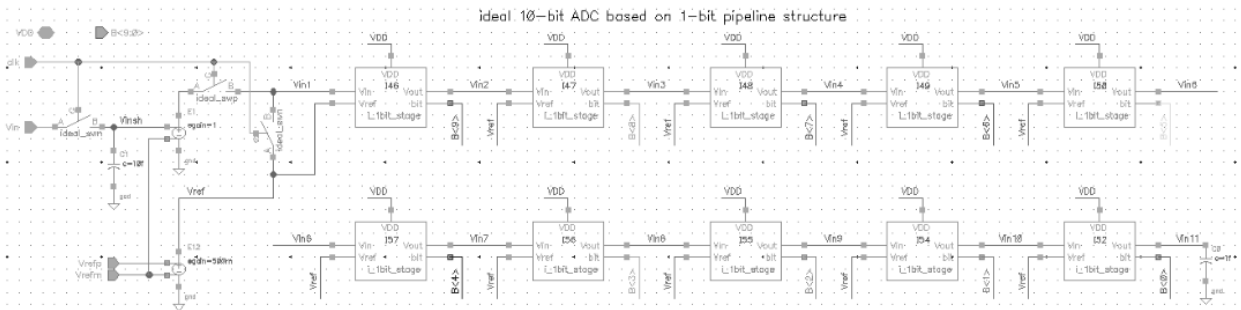
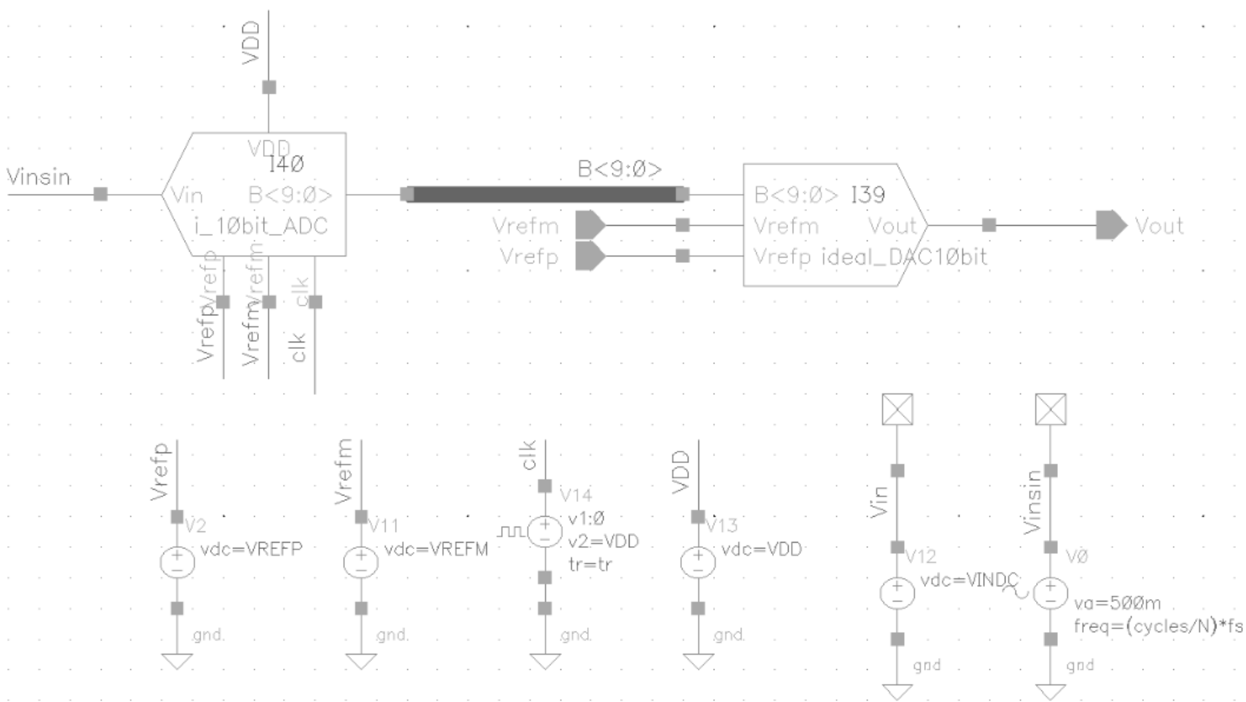
EE288 Homework #1 (5 points) Jan 29, 2018

Due: Feb 12, 2018 6:00PM
Homework will not be received after due.

In this homework, you will build a 10-bit ADC and a 10-bit DAC using ideal components. Use vdc, vpulse, vcvs, switch, res, cap, vccs to construct the 10-bit ADC based on 1-bit per stage pipelined architecture. Below are example schematics you will have to build in Cadence.





Assume the following design constraint.
VDD=1.8V
Vrefp = 1.4V
Vrefm = 0.4V
Input signal range 0.4V ~ 1.4V
Sampling clock pulse, fs = 100 MHz
Input signal frequency at fin = (cycles/N) * fs where cycles=31 and N=64 for 64-point FFT in MATLAB.

The implementation of the ideal ADC consists of an ideal S/H followed by a pipeline ADC as follows:
1. The input signal is sampled and held.
2. This held signal is input to a comparator that compares the input value to a reference voltage.
3. If the input signal is greater than the reference voltage, the output bit is set to a high, and the reference signal is subtracted from the input. The difference is multiplied by two and passed to the next stage.
4. If the input signal is less than the reference voltage, the output bit is set low.
The input signal is multiplied by two and passed to the next stage.
5. The above steps 2, 3, and 4 are repeated 10 times for the 10-bit ADC as you can see in the figure.

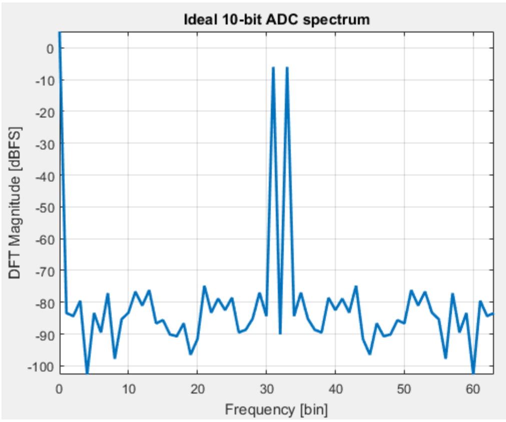
To test the functionality of the ADC, build a 10-bit DAC to convert the 10-bit digital output from the ADC into an analog signal. Building an ideal 10-bit DAC should be straightforward as you just need to create the following equation using vcvs.

$$V_{OUT} = (V_{REF+} - V_{REF-}) \cdot \left(\frac{b_{N-1}}{2^1} + \frac{b_{N-2}}{2^2} + \ldots + \frac{b_1}{2^{N-1}} + \frac{b_0}{2^N} \right) + V_{REF-}$$

You will then analyze the spectrum of the DAC output using MATLAB.

Once you finished building schematics, run a transient simulation for 640ns in Cadence Spectre. Plot the transient waveforms and report the resulting screenshot with white background. Then open Calculator to sample the data points of the transient waveform. Each data point needs to be 10ns apart and you should get 64 data points for FFT analysis in MATLAB. For this, use “sample” function in Calculator to get 64 samples from 9ns, 19ns, 29ns, …. 639ns.

Once you have the data in MATLAB, write a code to run FFT on the loaded samples. Report your result similar to below plot. You should submit your MATLAB code as well as the spectrum plot.



Extra points

1. If you can provide a matching result directly from Cadence DFT result, you will get 1 extra point.
2. If you can provide working Verilog-A codes for each and every block in your design, you will get additional 1 point.

Summary of what you need to submit electronically:

1. Schematics of your design – use white background
2. Transient simulation result
3. MATLAB code for FFT plot
4. FFT plot in MATLAB
5. (Optional) FFT plot directly from Cadence
6. (Optional) VerilogA codes for each and every block of your design