

# EE685: VLSI Broadband Communication Circuits; HW2

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This assignment can be done using macromodels using ideal sources/switches, verilogA blocks, or in octave/matlab. If you simulate “continuous-time” quantities in matlab, you need to use an internal step that is much finer than the symbol period.

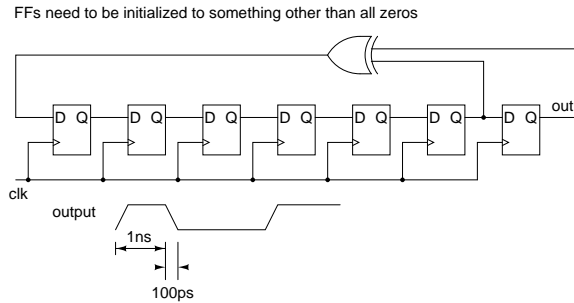


Figure 1: Pseudo random sequence generator

1. Design and simulate the pseudo random bit sequence generator shown in Fig. 1. This will serve as a test pattern generator for your circuits. You can use macromodels of flip flops using switches, or use verilogA to do this in the simulator. Alternatively, you can generate the bit sequence in matlab and use a piecewise linear source to generate the waveform in your circuit simulator. The clock period and rise/fall times should be 1 ns and 100 ps respectively.
2. **Binary data transmission through a bandlimited channel:** Assume a channel of the type  $H_{ch}(s) = 1/(1 + s/\omega_p)^8$ , i.e. 8 poles at  $-\omega_p$ . Pass the random sequence generated

above through the channel and plot the eye diagram with a two symbol period width.

Play around with  $\omega_p$  and note its values for 50% and 10% vertical eye opening. What is the horizontal eye opening in each of these cases? (Do the problems below for each of these cases.)

What is the channel attenuation at  $f_s/2$ ? Plot the channel frequency response.

Plot the response of the channel to a 1 bit wide pulse with 100 ps rise/fall times. Letting the peak be the cursor, determine the sampled response of the channel+transmitter. Ignore ISI less than 1%. Is the eye opening previously determined consistent with the discrete time response that you obtained here?

Design a discrete-time equalizer with as many taps as are in the channel+transmitter response. Determine the coefficients using the two methods discussed in class.

Using the coefficients determined above, construct continuous-time FIR filters as shown in Fig. 2. Plot the eye diagrams at the output of the equalizer. What are the vertical and horizontal eye openings?

3. **PAM4 data transmission through a bandlimited channel:** Use a 4 level symbol at 0.5 Gb/s instead of a two level symbol at 1 Gb/s (Fig. 3). Pass this symbol stream through the channels

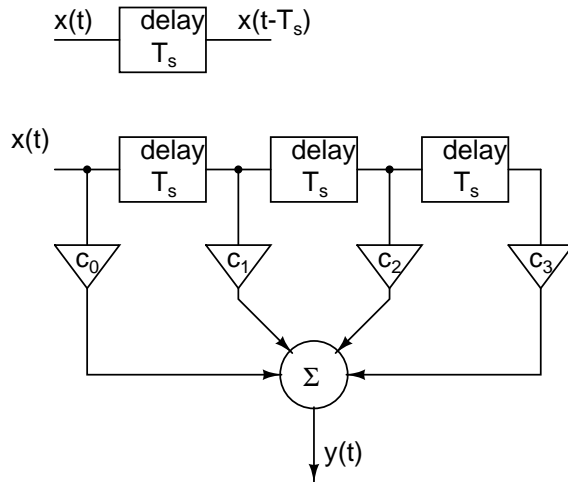


Figure 2: Continuous-time FIR filter

determined above and determine the horizontal and vertical eye opening at the output of the channel.

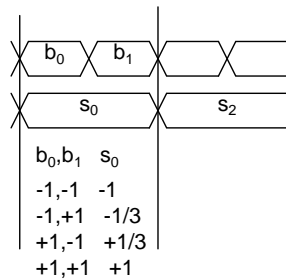


Figure 3: PAM 4 signal generation

Plot the response of the channel to a 1 symbol (2 bit) wide pulse with 100 ps rise/fall times. Letting the peak be the cursor, determine the sampled response of the channel+transmitter. Ignore ISI less than 1%. Is the eye opening previously determined consistent with the discrete time response that you obtained here?

Design a discrete-time equalizer with as many taps as are in the channel+transmitter response. Determine the coefficients using the two methods discussed in class.

Using the coefficients determined above, con-

struct continuous-time FIR filters as shown in Fig. 2. Plot the eye diagrams at the output of the equalizer. What are the vertical and horizontal eye openings?

Compare PAM4 and binary in terms of the eye opening and bit error rate. Which one would you use?