January 29, 2010

ECEN 689: High-Speed Links

Homework #2

Due: 2-5-2010, 9:10AM
Homeworks will not be received after due.
Instructor: Sam Palermo

5 problems from the Dally/Poulton textbook. All problems EXCEPT 3-8 require Spice simulation to verify your hand analysis.

3-2 **Mismatched Terminations:** Section 3.3.3.7 works out the waveforms for an under-terminated transmission line. Find the reflection coefficients for an *over*terminated line, $Z_0 = 50\,\Omega$, $Z_T = 5\,\Omega$, $Z_S = 1\,k\Omega$. Assuming a traversal time of 2 ns, construct the equivalents of Table 3-3 and Figure 3-12. Build a SPICE deck that models this circuit. Perform a transient simulation and compare the results with your hand-constructed solution.

Hint) TL setting in Cadence: TL length 600mm for 2ns delay

3-8 **Bus with Attenuating Probes:** In measuring signals on high-speed lines, it is common practice to use an *attenuating probe*. as illustrated in Figure 3-58. A 50-Ω transmission line with a 950-Ω series resistor taps the signal with a 20:1 attenuation while providing a negligible (1 kΩ) load to the line. Show how such a probe can be used to design a bus that has no reflections from the stubs (as in Exercise 3-7). (Hint: Because the end of the stub toward the bus is clearly mismatched, it must be driven with a source-terminated driver.) Give a formula that relates how the attenuation of the *probe* stubs can be traded off against the attenuation of a signal traveling along the bus.

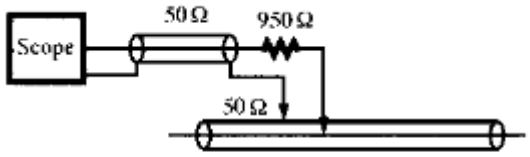

FIGURE 3-58 A Passive Attenuating Probe (for Exercise 3-8)

3-10 **Nonlinear Termination:** Consider the circuit of Figure 3-60. A voltage source with a 10-Ω output impedance drives a transmission line terminated into a pair of diodes (assume these are ideal diodes with no voltage drop) that restrict the range of the signal between 0 and 1 V. Sketch the waveforms that result at both ends of the line in response to a unit step on the voltage source.

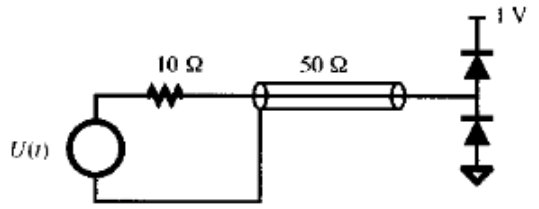

FIGURE 3-60 Nonlinear Termination (for Exercise 3-10)

Hint) Diode model file located at EESUN course folder :cd /home11/courses/689-606/models
diode.m : .MODEL idiode D(IS=1E3 N=0.1) ; diode model name : idiode

3-11 **Frequency-Dependent Termination:** Often a termination includes a reactive element (intentionally or otherwise) that gives it a frequency-dependent impedance. Four frequency-dependent terminations are illustrated in Figure 3-61. In (a) a capacitor has been intentionally added to reduce the DC power dissipation of the termination. A series inductor in (b) models the bond-lead inductance seen by a signal before it arrives at an on-chip termination resistor. The inductance on the side-path in (c) models the lead inductance of an off-chip terminator in a high-inductance (radial-lead, SIP, or DIP) package. The transmission-line stub in (d) models the case in which the termination is placed a small distance from the actual end of the line. For each of these four cases (1) plot the impedance seen by the signal as a function of frequency, and (2) sketch the waveform received (at the right side of the circuit) and reflected (from the left side of the circuit). Assume the termination is at the end of a 50-Ω transmission line. Consider signal rise times of 100 ps and 1 ns.

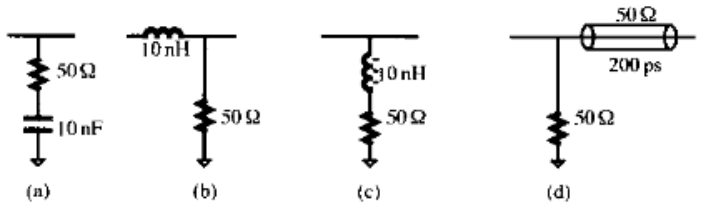

FIGURE 3-61 Frequency-Dependent Terminations (for Exercise 3-11)

Hint) To get Z using source IAC

3-16 **Extracting Parasitics:** Figure 3-63 shows a TDR trace from an unknown circuit. Develop a model circuit composed of ideal transmission lines, inductors, and capacitors that gives the same response. You may find it useful to simulate your model circuit with HSPICE to verify correspondence.

Note: This is a different waveform than in the book!!!!!!!!!

Hint) Using Cadence Spectra

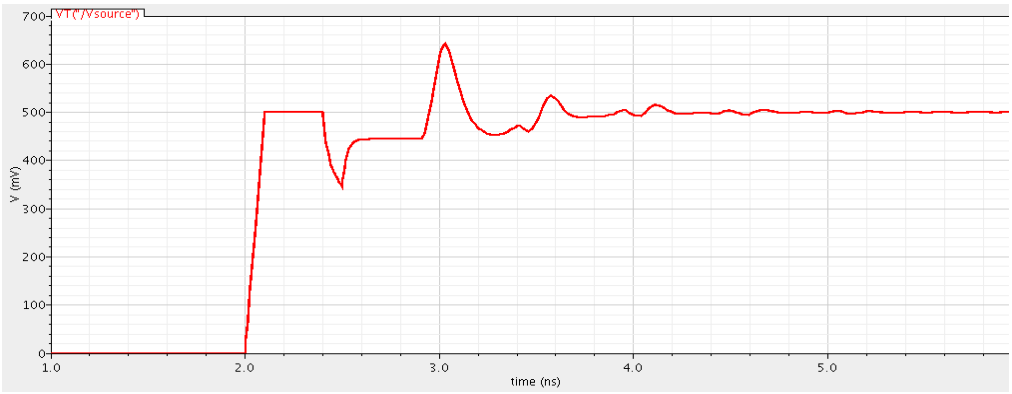

Figure 3-63: TDR trace

- **All Cadence Simulation, we can get components from AnalogLib**