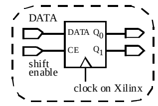
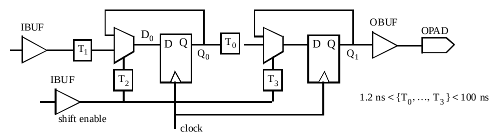
1 XILINX IO TIMING AND SYNCHRONIZATION

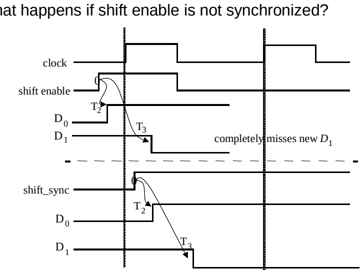
1.1 Synchronization of External and Internal Timing





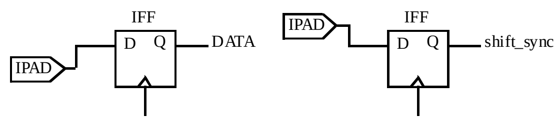
1 XILINX IO TIMING AND SYNCHRONIZATION (cont.)

What happens if shift enable is not synchronized?

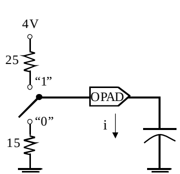


1 XILINX IO TIMING AND SYNCHRONIZATION (cont.)

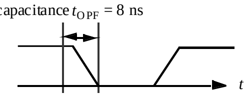
Fix: Use IFF



2 EXTERNAL WIRING AND GROUND BOUNCE



load capacitance t_{OPF} = 8 ns



2 EXTERNAL WIRING, GROUND BOUNCE

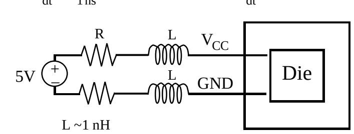
Each output pin loaded with 50 pF

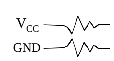
$$i = C\frac{dV}{dt} = (50\times10^{-12}\text{ F})\frac{4\text{V}}{8\times10^{-9}\text{ sec}}$$

$$= \frac{50}{2}\times10^{-3}\text{ amps} = 25\text{ mA}$$

Typical situation – 16 address lines, 8 data lines

$$\frac{di}{dt} = \frac{600\text{ mA}}{1\text{ ns}} = 6\times10^{8}\text{ amps/sec},\ V = L\frac{di}{dt}$$



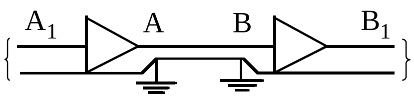


Need good ground connections okay on Xilinx board decoupling caps

$\Rightarrow$ ±0.6 V ground bounce

3 TRANSMISSION LINE

Idealization

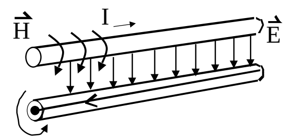


Does $A_1 = B_1$? No! … propagation delay and other stuff
$A = B$?

Velocity factor ~0.2 m/ns
~2/3 c

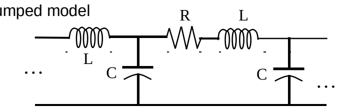
3 TRANSMISSION LINE (cont.)

Wire segment physics



- Resistance
- Capacitance
- Inductance

lumped model



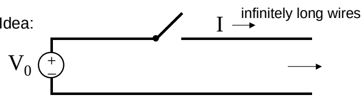
think of slinky ...

3 TRANSMISSION LINE (cont.)

3.1 Characteristic impedance

Recall: $R = \frac{\text{volts}}{\text{amp}} \approx \frac{\text{pressure}}{\text{flow}}$

Idea:



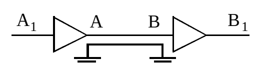
$Z_0 = \frac{V_0}{I} \sim \sqrt{\mu / \varepsilon}$ current even without connection at end:
charging capacitance, $i = C\frac{dV}{dt}$, $V = L\frac{di}{dt}$

☞ Rule of thumb: $\text{length} < (\frac{1}{4}\ \text{rise / fall time}) \cdot \text{speed}$

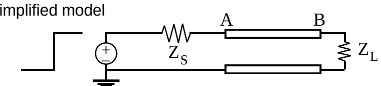
Xilinx (1ns) (0.2 m/s) ~ 0.2m

3 TRANSMISSION LINE (cont.)

3.2 Reflections



simplified model



For PCB, $Z_0 \approx 100\ \Omega$ fiberglass ε

Xilinx $Z_S \approx 20\Omega$ $\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$

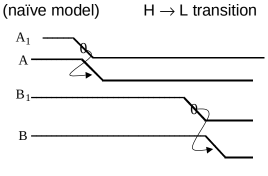
$Z_L \approx 500\text{K}\Omega$ min

$\Gamma_A = \frac{Z_S - Z_0}{Z_S + Z_0} = \frac{-80}{120} \approx -.7,\quad \Gamma_B = \frac{500\text{K} - 100}{500\text{K} + 100} \approx 1$

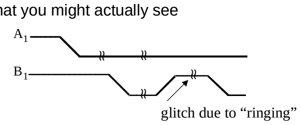
3 TRANSMISSION LINE (cont.)

3.2 Reflections (cont.)

Ideal (naïve model) H → L transition

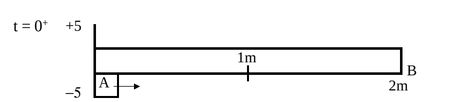


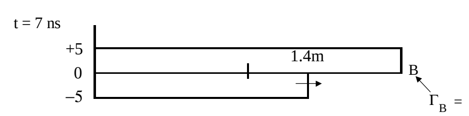
What you might actually see



3 TRANSMISSION LINE (cont.)

3.3 Reflection pictures, V = 0.2 m/ns

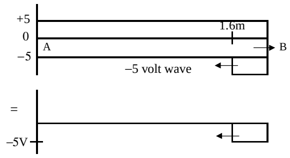




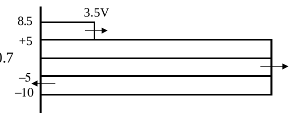
3 TRANSMISSION LINE (cont.)

3.3 Reflection pictures (cont.)

t = 12 ns



t = 22



$\Gamma_A = -0.7$

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3 TRANSMISSION LINE (cont.)

3.3 Reflection pictures (cont.)

vs. time