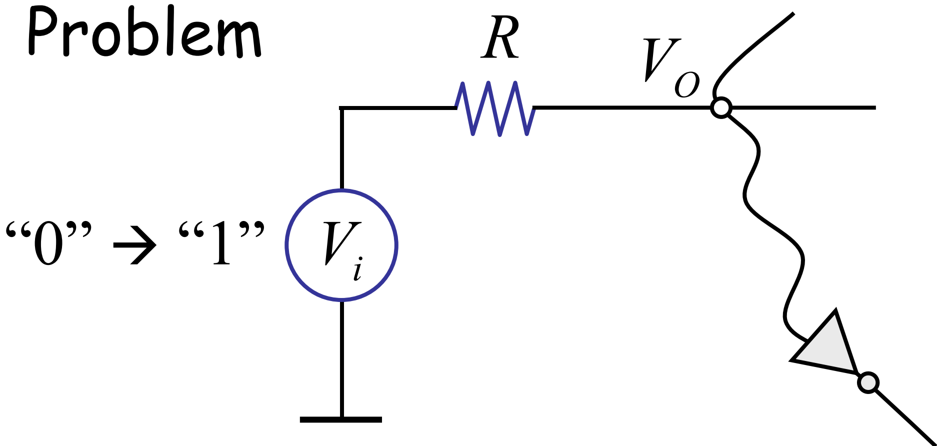
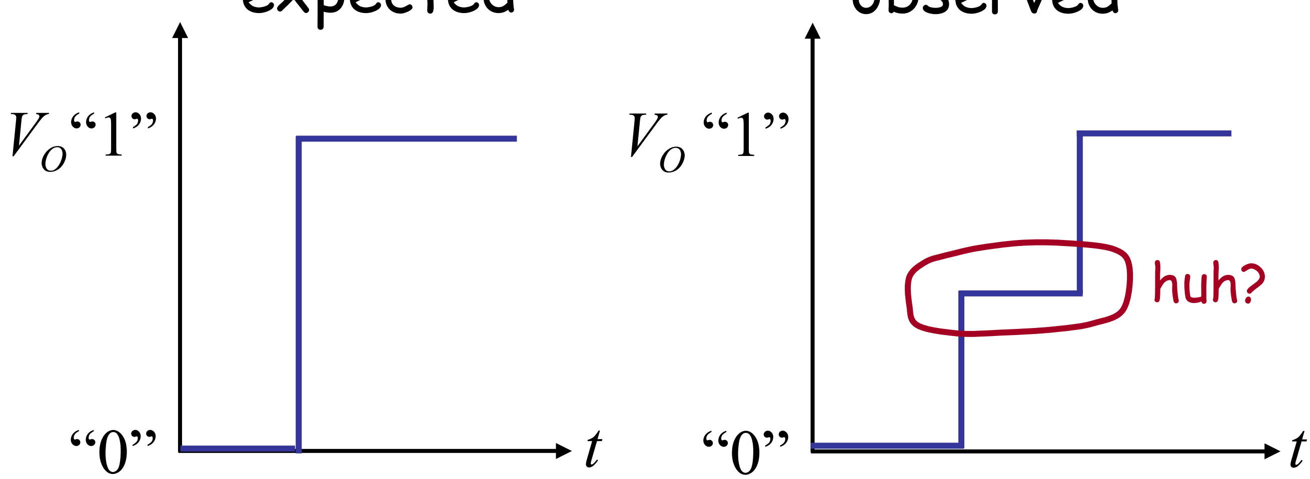
6.002 CIRCUITS AND ELECTRONICS

Violating the Abstraction Barrier

Case 1: The Double Take

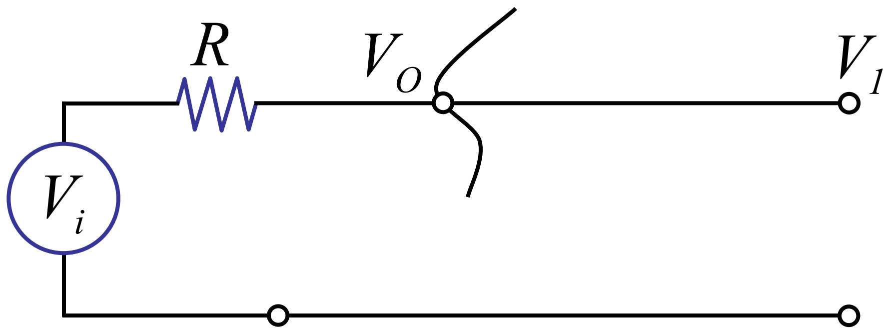
Problem





in forbidden region!

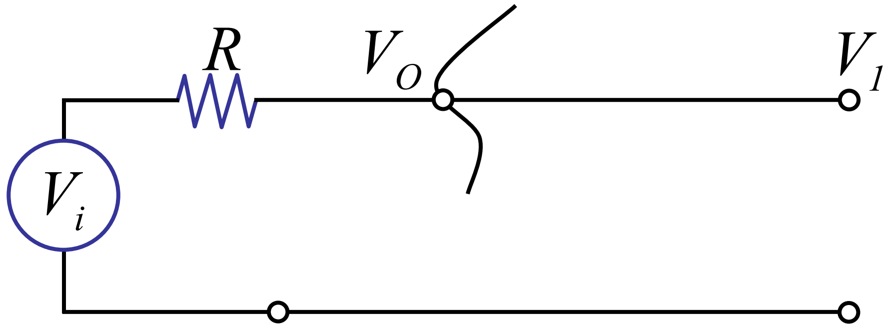
(a) DC case



very high impedance, like open circuit

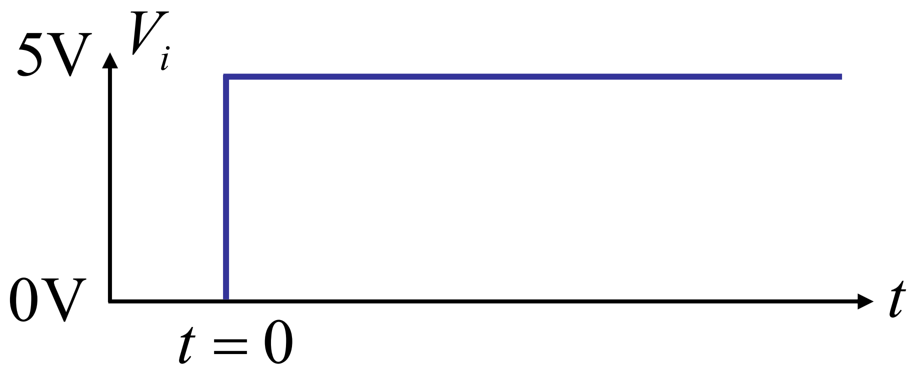
$V_i = 5V\ DC$ $V_O = 5V\ DC$ $V_1 = 5V\ DC \longrightarrow$ OK

(b) Step

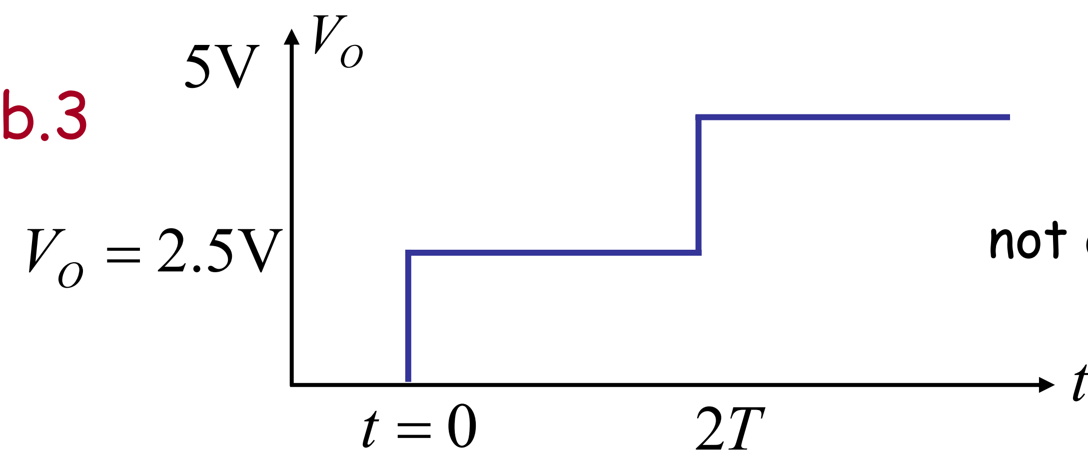


very high impedance, like open circuit

b.1

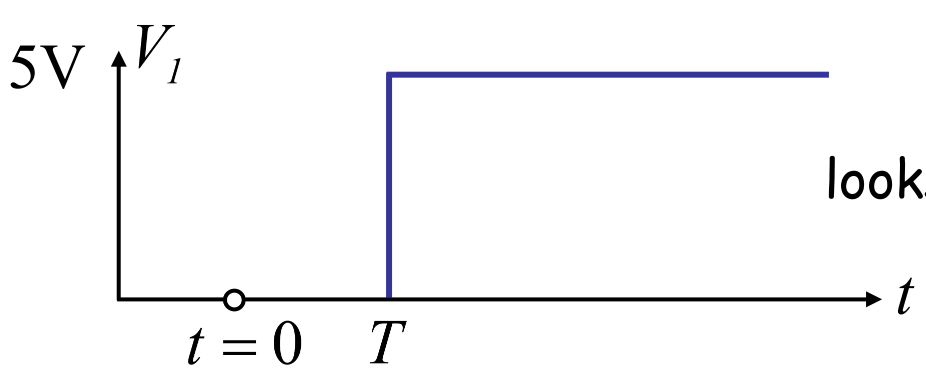


b.3

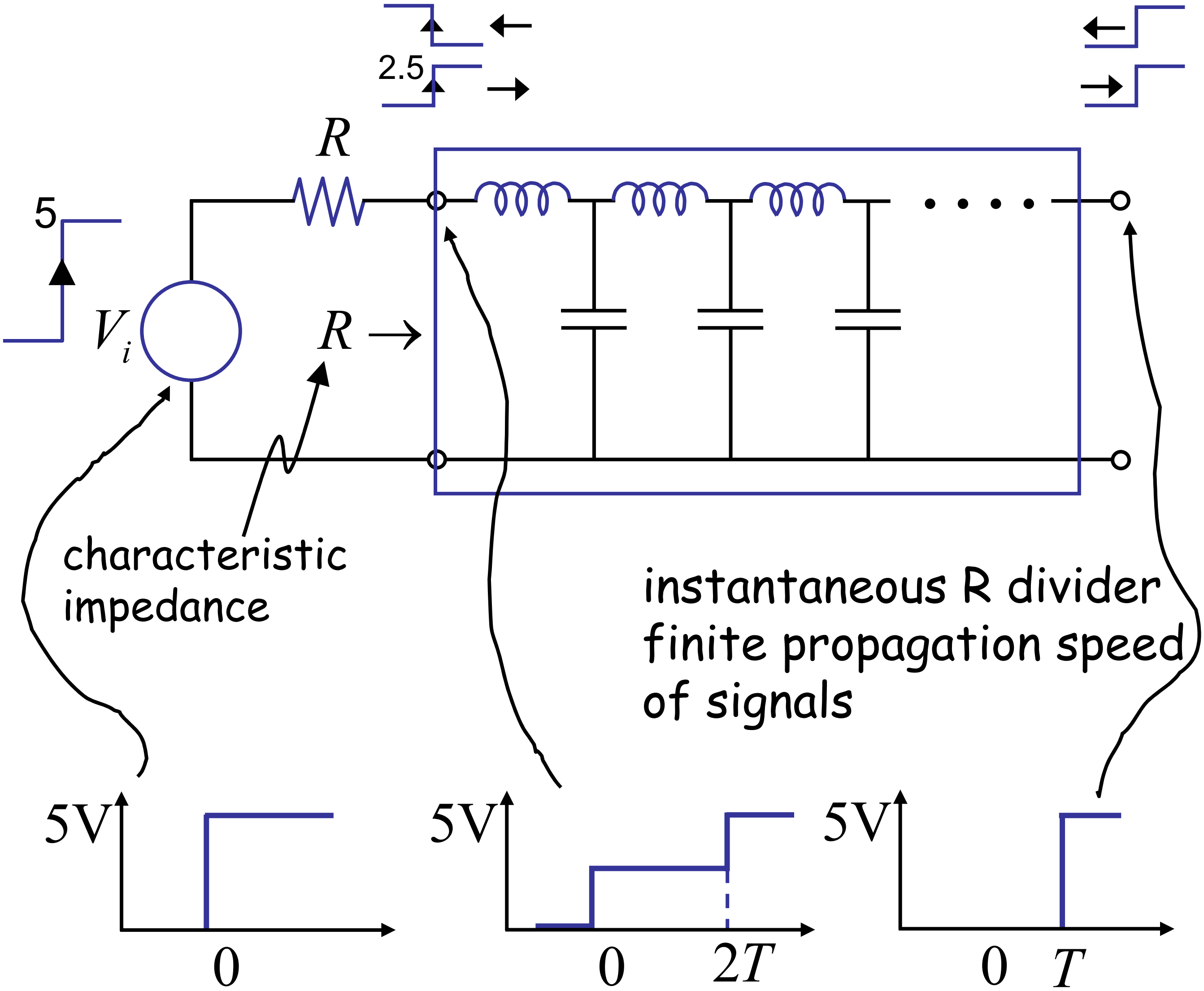


not ok!

b.2

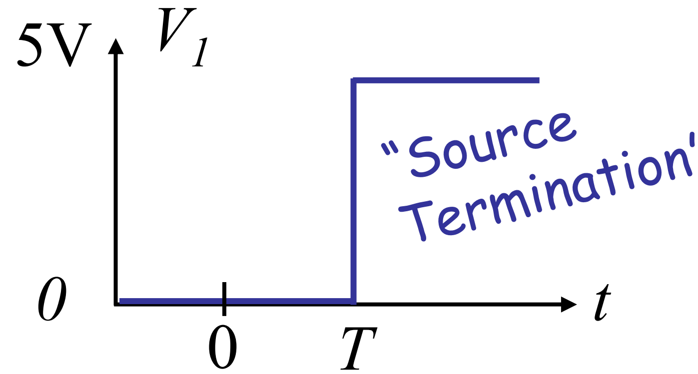


looks ok!



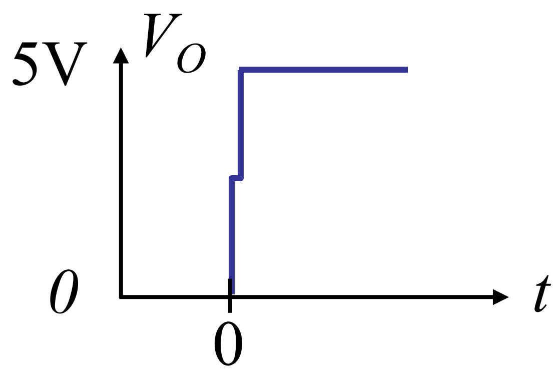
instantaneous R divider
finite propagation speed
of signals

Question: So why did our circuits work?



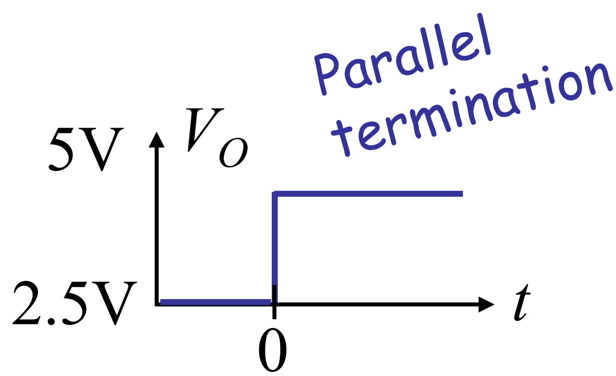
1. Look only at V_1

DEMO



2. Keep wires short

DEMO
use small wire



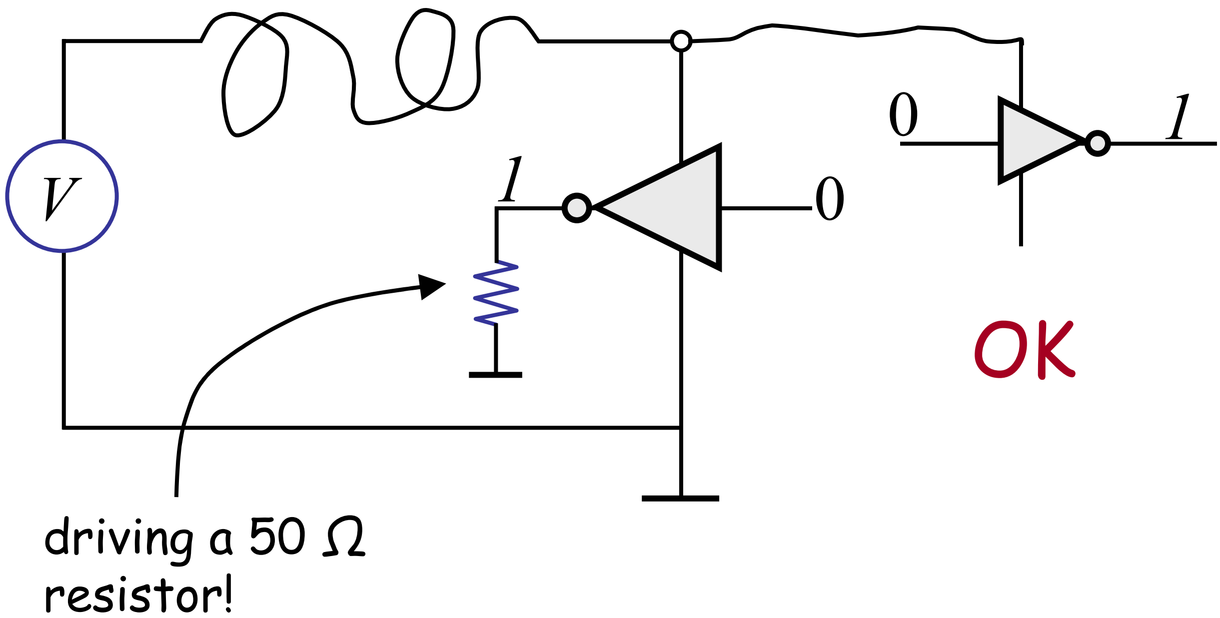
3. Termination

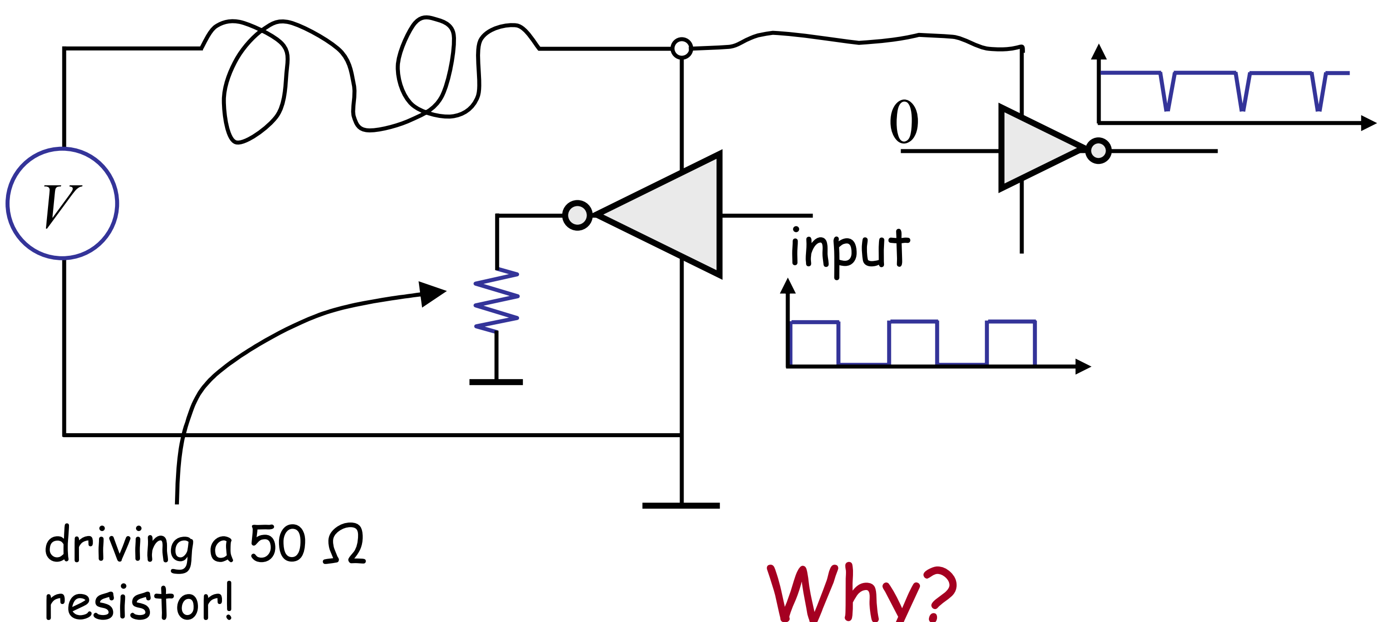
DEMO
add R at the end

More in 6.014

Case 2: The Double Dip

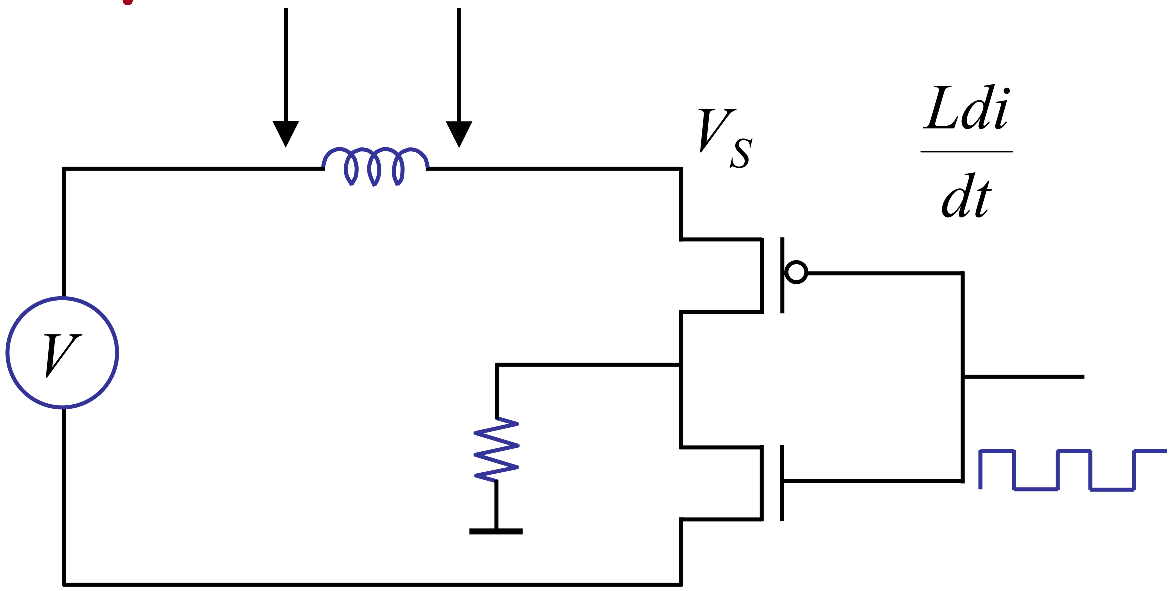
Problem → strange spikes on supply

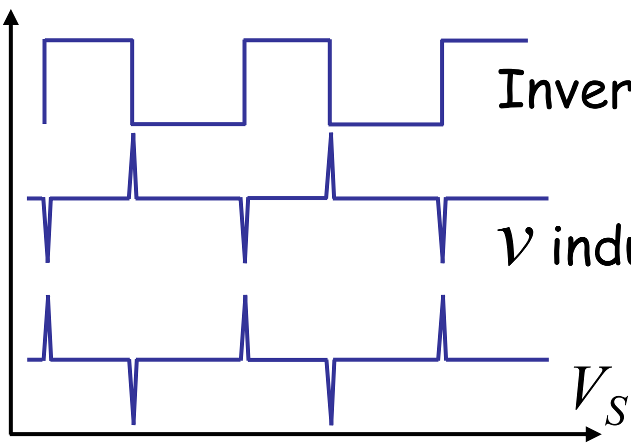




Why?

Drop across inductor

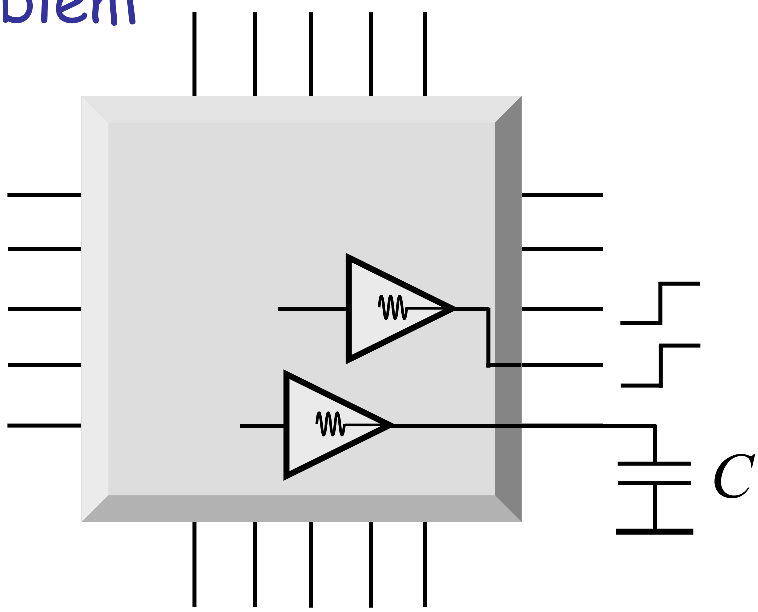




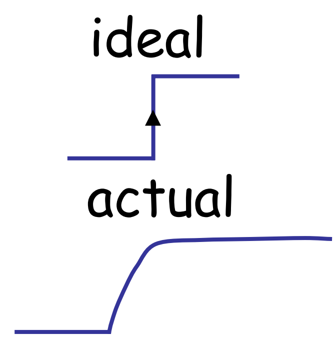
solution
1. short wires
2. low inductance wires
3. avoid big current swings

Case 3: The Double Team, or, Slower may be faster!

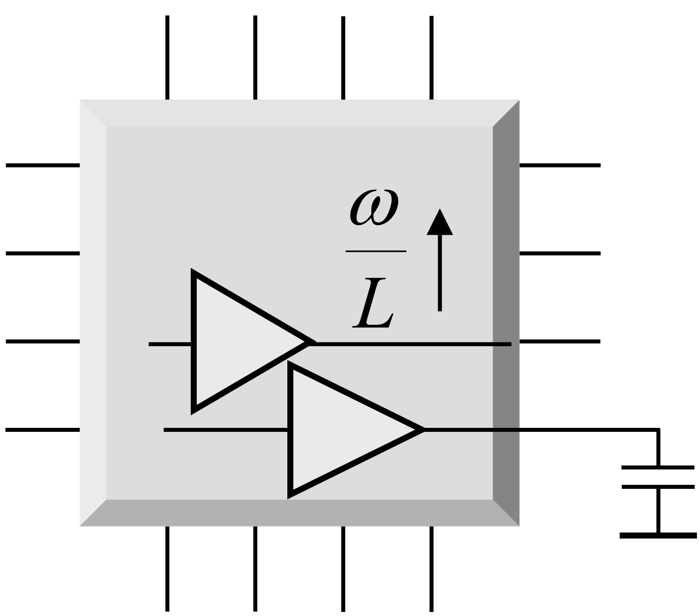
Problem

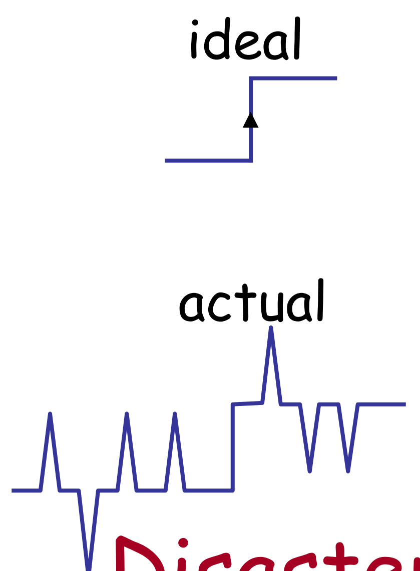


a given chip worked,
but was slow.



Let's try speeding it up by using stronger drivers



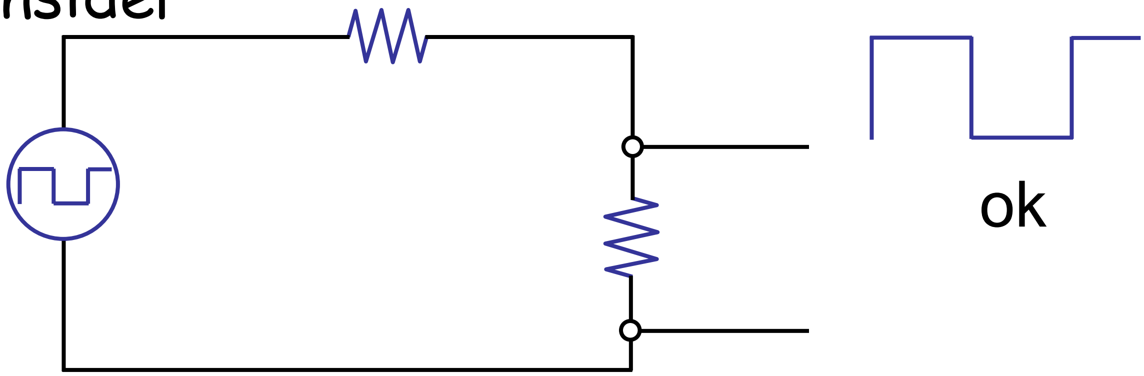


Disaster!

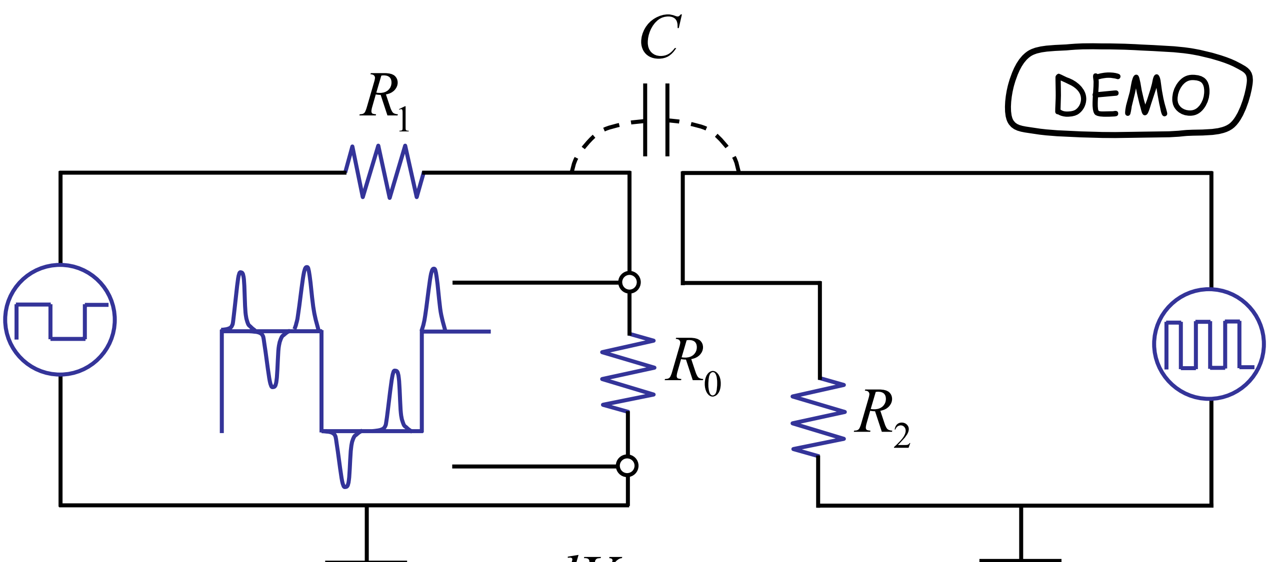
Why?

Consider

DEMO

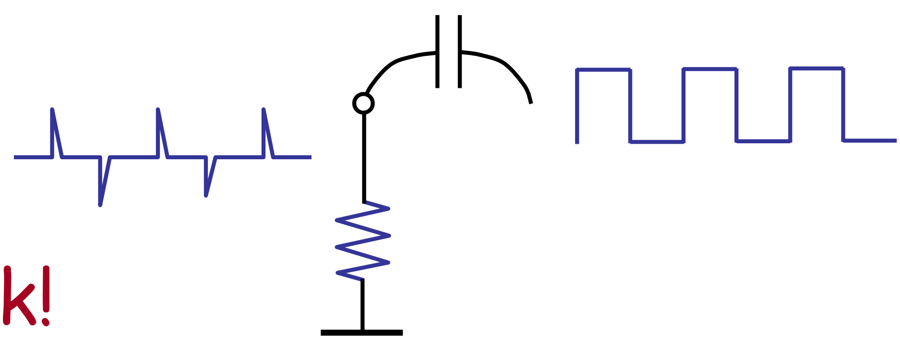


DEMO



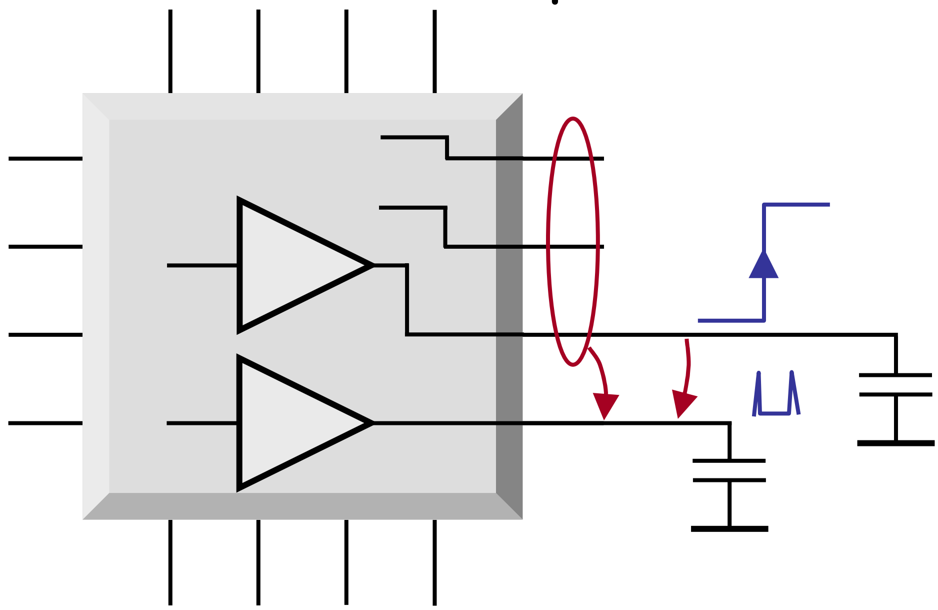
$$\alpha \frac{dV}{dt}$$

$$C \frac{dV}{dt}$$

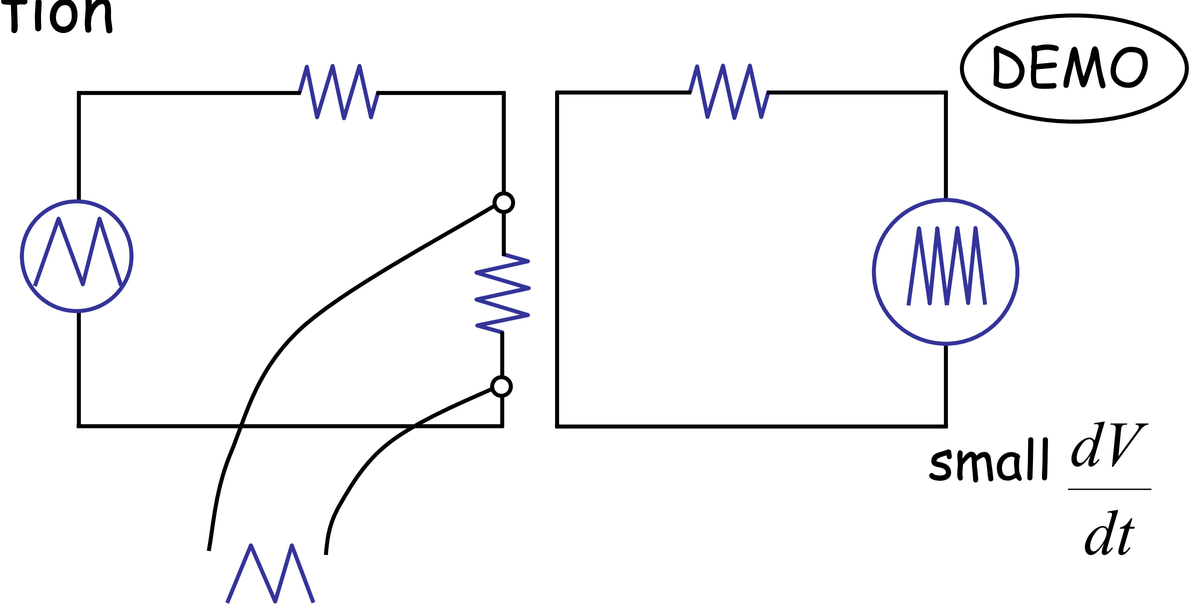


crosstalk!

How does this relate to chip?



Solution

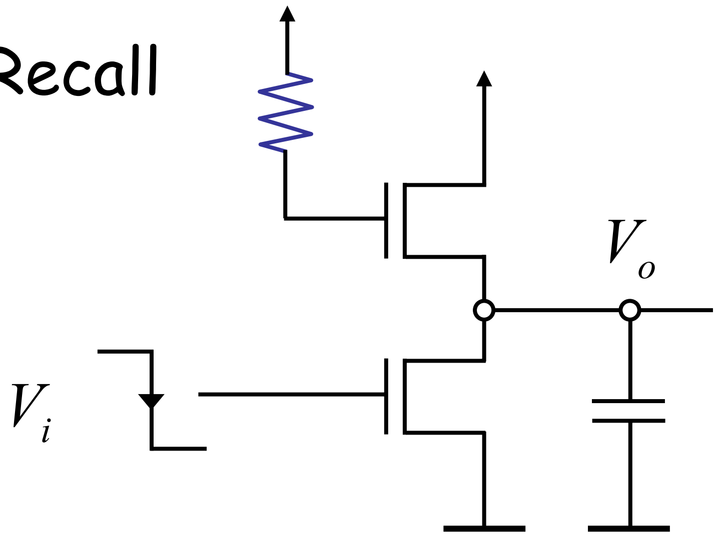


Load output! — put cap on outputs of chip
— jitter edges
— slew edges

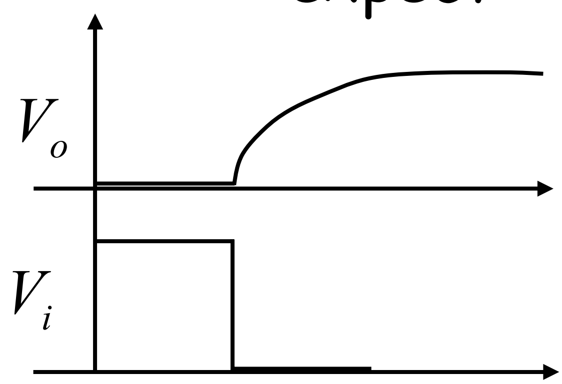
Case 4: The Double Jump

Careful abstraction violation for the better...

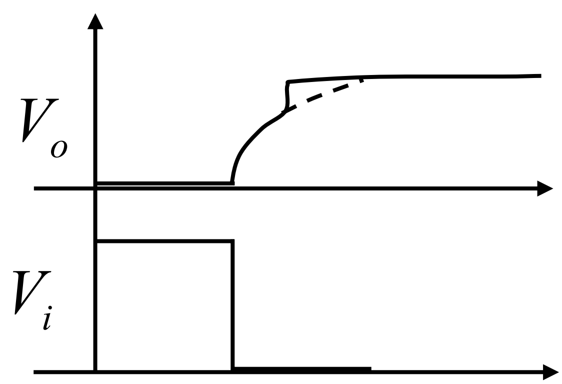
Recall



expect

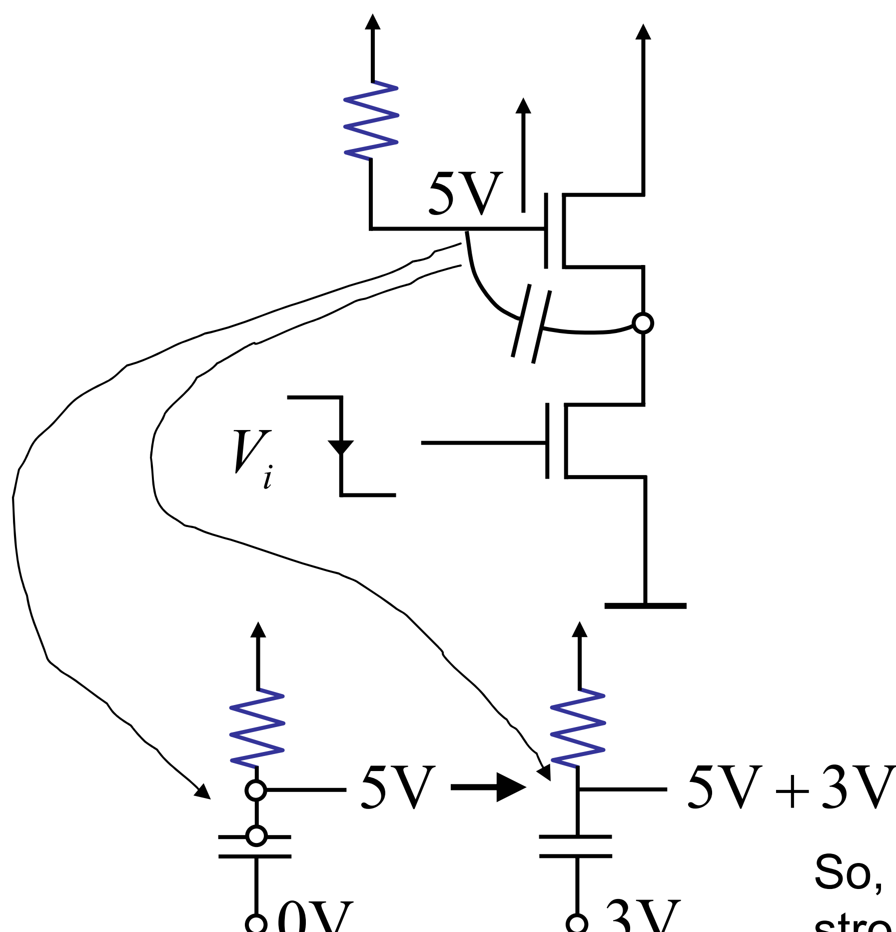


but, observe



Case 4: The Double Jump

Careful abstraction violation for the better…



So, pullup has stronger drive as output rises