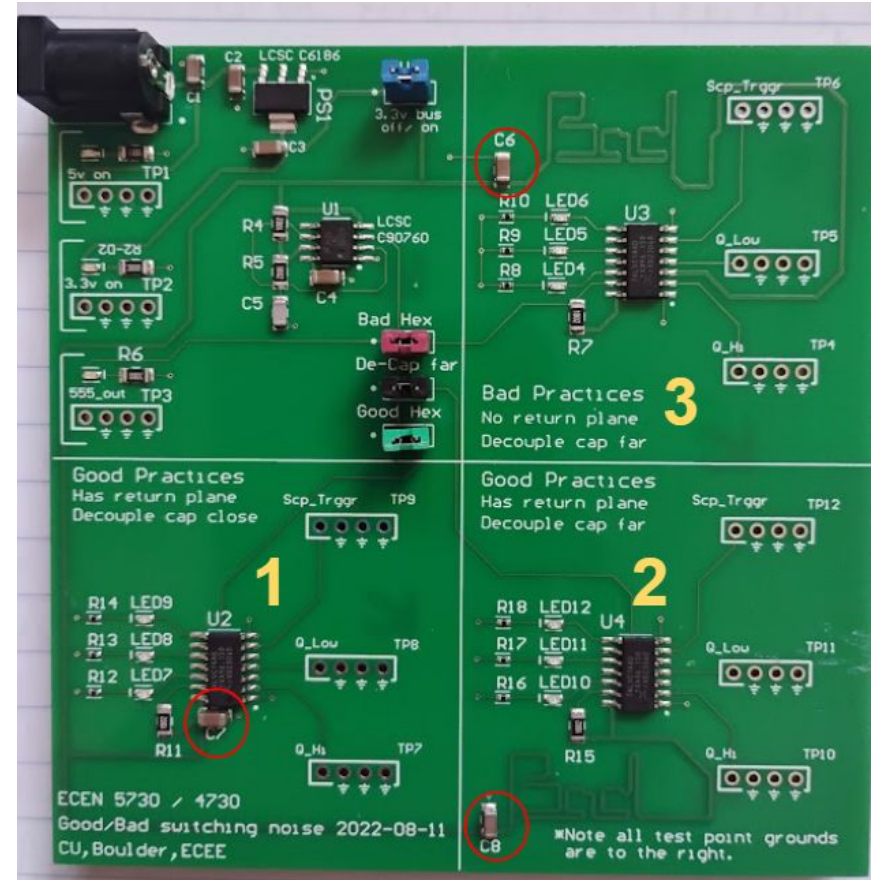# Lab 15

Measuring Performance Impacts of General PCB Design Practices

Julia DiTomas

Objective

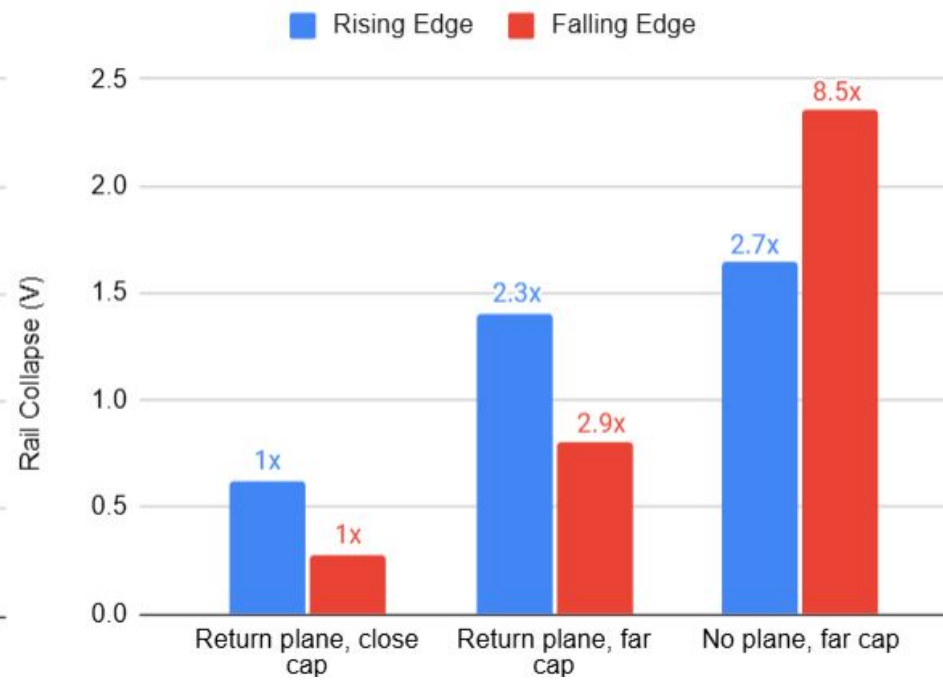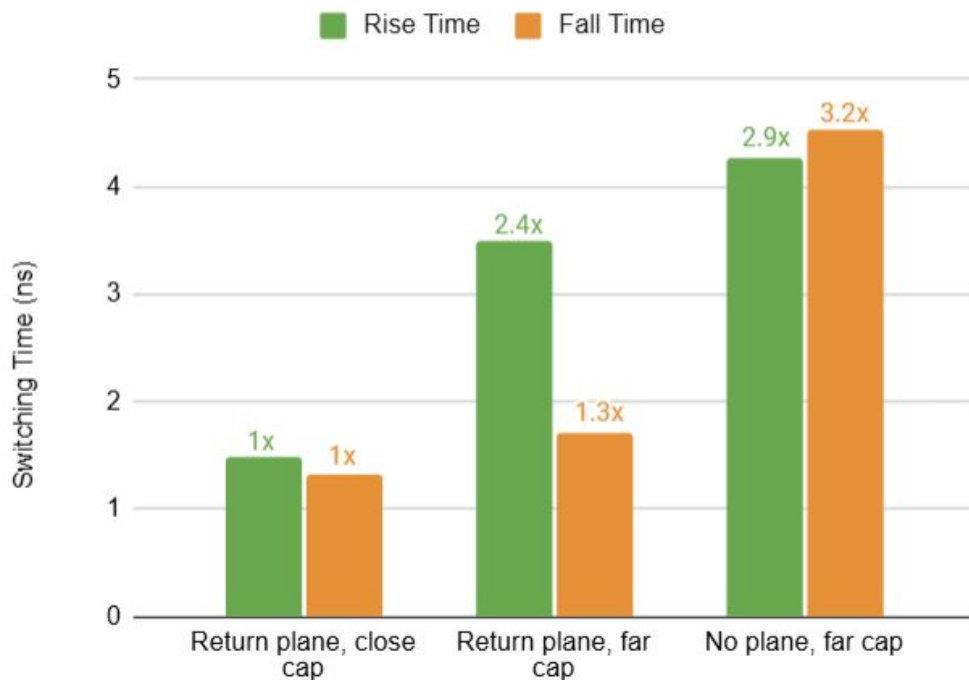Compare the rail collapse and the rise and fall times of 3 hex inverter circuits driven by a 555 timer.

- Circuit 1: Decoupling capacitor close to IC, has ground plane
- Circuit 2: Decoupling capacitor far from IC, has ground plane
- Circuit 3: Decoupling capacitor even further from IC, no ground plane

PCB under test.

Results

Switching Time for Various PCB Design Practices

Rise Time — Fall Time

	Return plane, close cap	Return plane, far cap	No plane, far cap
Rise Time	1x	2.4x	2.9x
Fall Time	1x	1.3x	3.2x

Rail Collapse for Various PCB Design Practices

Rising Edge — Falling Edge

|	Return plane, close cap	Return plane, far cap	No plane, far cap
Rising Edge	1x	2.3x	2.7x
Falling Edge	1x	2.9x	8.5x

Conclusions and Lessons

For otherwise identical circuits, performance was significantly affected by placement of decoupling capacitor and inclusion of ground plane.

Best practices include utilizing a solid ground plane and placing decoupling capacitors close to all ICs.

On another note, scope screenshots for direct comparison should be taken on the same scale. (Notice the mistake to the right in which these saved displays had different horizontal scales.)
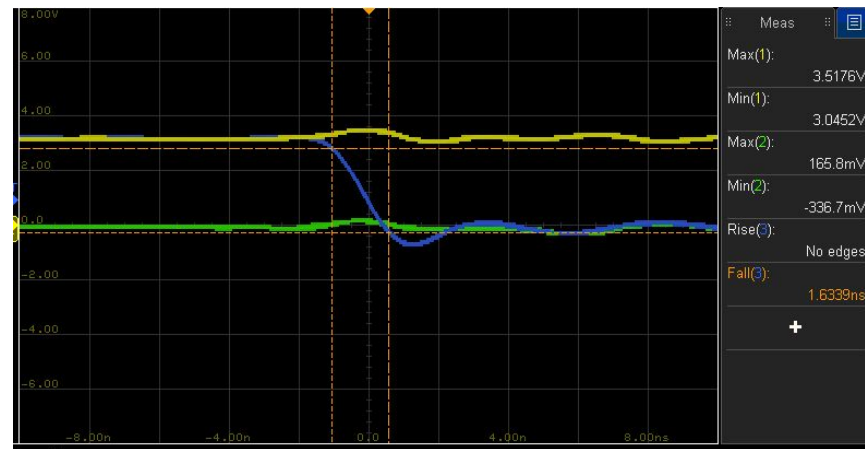
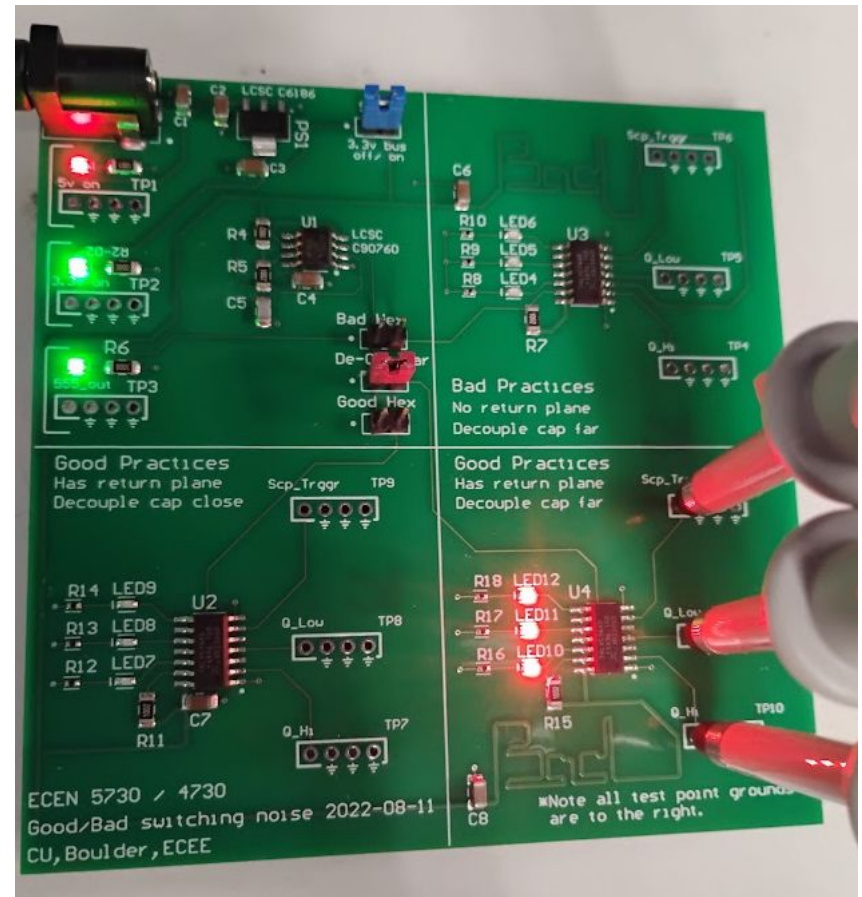Falling edge for Circuit #1.
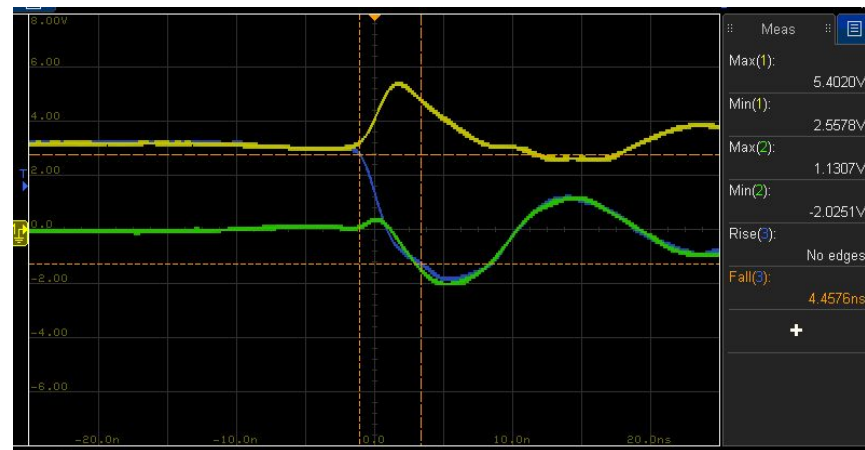
Falling edge for Circuit #3.

Auxiliary Slides

Measurement Details (1/2)

After verifying the rail voltages and the 555 timer output (test points in the upper-left box), each hex inverter circuit was switched on independently.

Measurements were three outputs of the hex inverter:

- Scope trigger (555 timer input, open output)
- Quiet low
- Quiet high

Test setup for Circuit #2.

Measurement Details (2/2)

For each circuit and each edge type, recorded switching time and maximum instantaneous rail compression.

The yellow trace is the quiet high, the green trace is the quiet low, and the blue trace is the scope trigger.

In this example, maximum rail compression occurs ~14 ns after the falling edge

Scope screenshot for falling edge, no ground plane, far decoupling capacitor.

Aggregated Data

	Rising Edge		Falling Edge	
	Rail collapse (V)	Rise time (ns)	Rail collapse (V)	Fall time (ns)
Return plane, close cap	0.62	1.48	0.277	1.32
Return plane, far cap	1.4	3.5	0.8	1.7
No plane, far cap	1.65	4.27	2.36	4.53