Impact of Decoupling Capacitor Placement and Ground Fills

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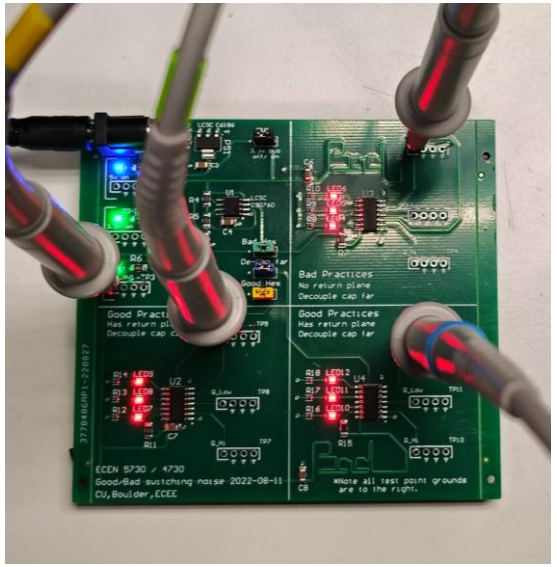
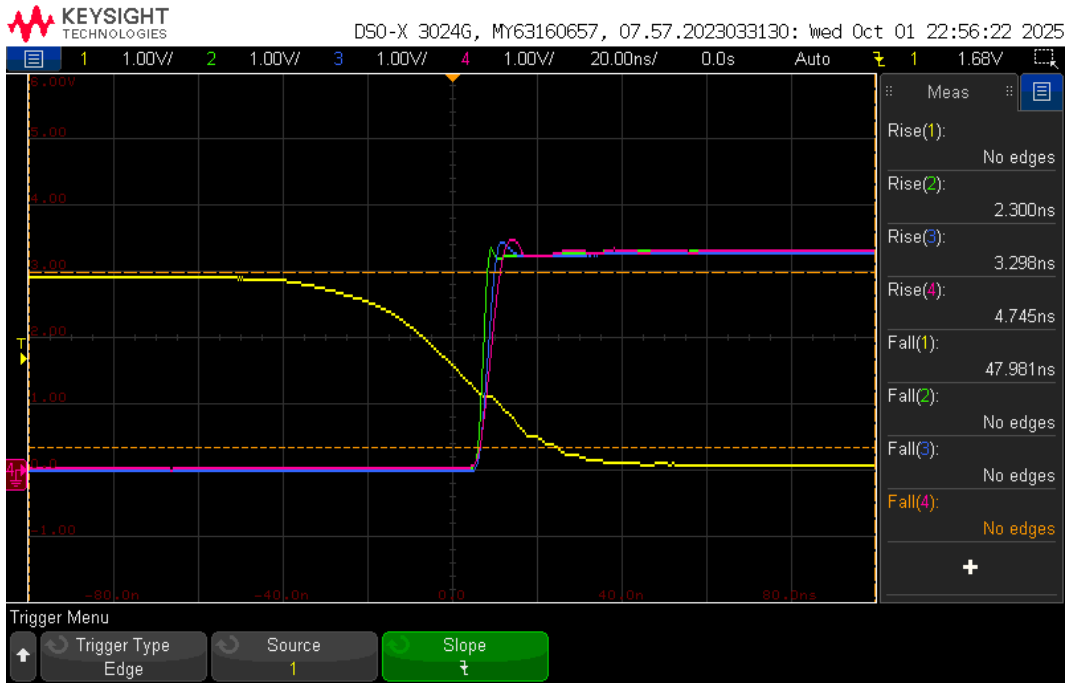
Data Collected 2025-10-01

Report Out 2025-10-06

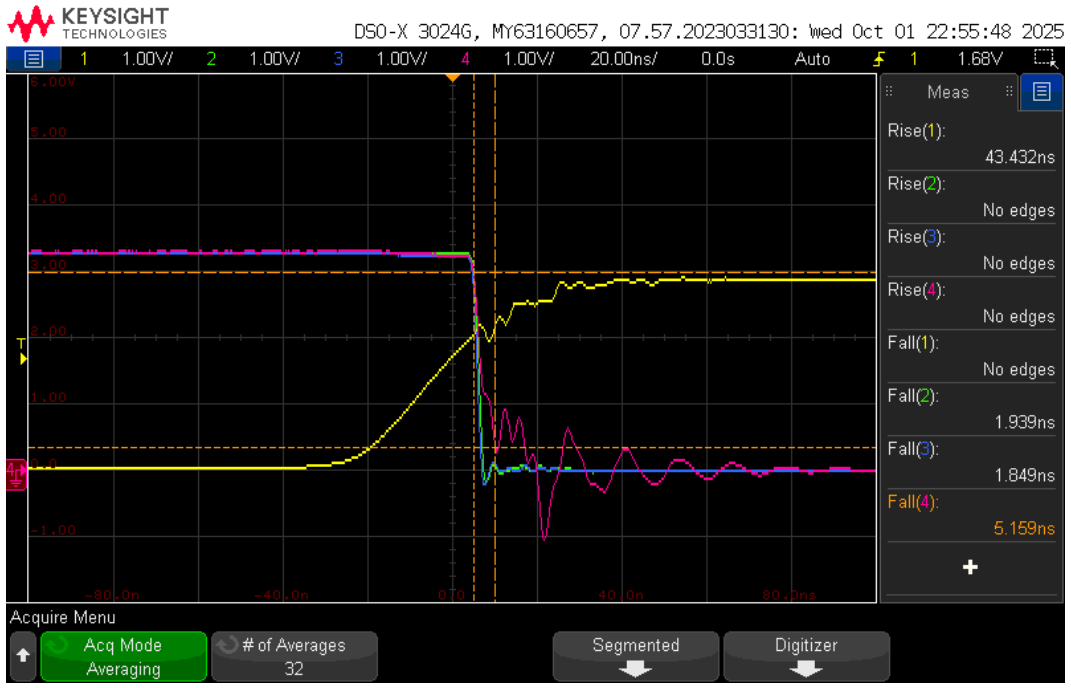
Decoupling capacitor proximity



- Far decoupling capacitors increased rise times by 43% (2.3ns vs 3.3ns)
- Far decoupling capacitors increased overshoot by roughly 60%
- Far decoupling capacitors caused up to 805% increased rail collapse (falling edge of the quiet high)



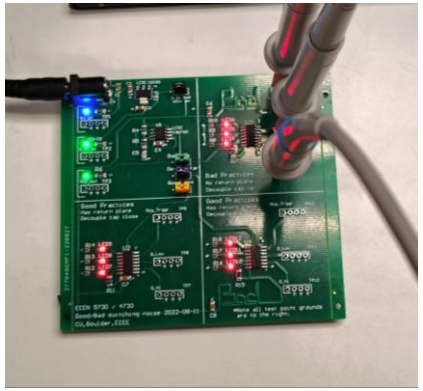
Rise times of all circuits. Good=green, far cap = blue, far cap and no ground fill = purple

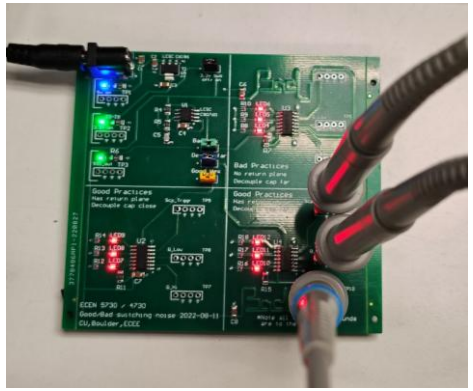


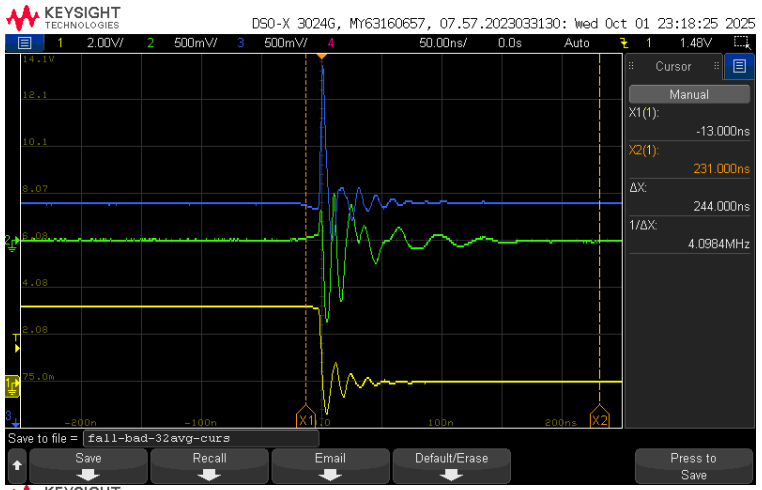
Fall times of all circuits. Good=green, far cap = blue, far cap and no ground fill = purple

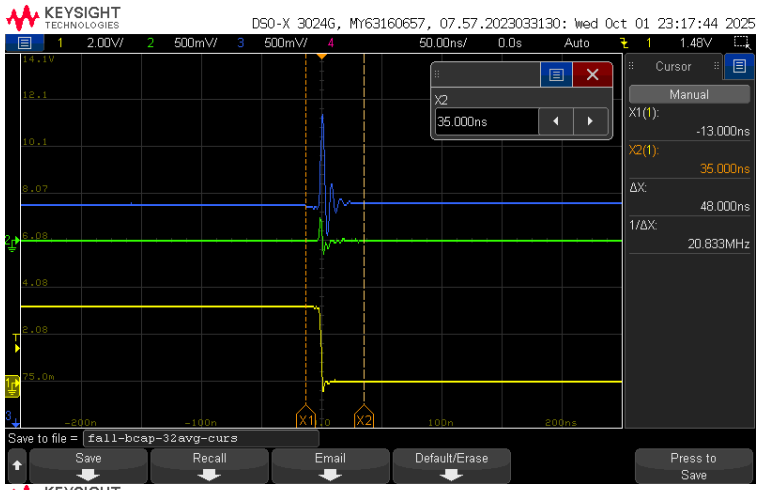
Ground Fill

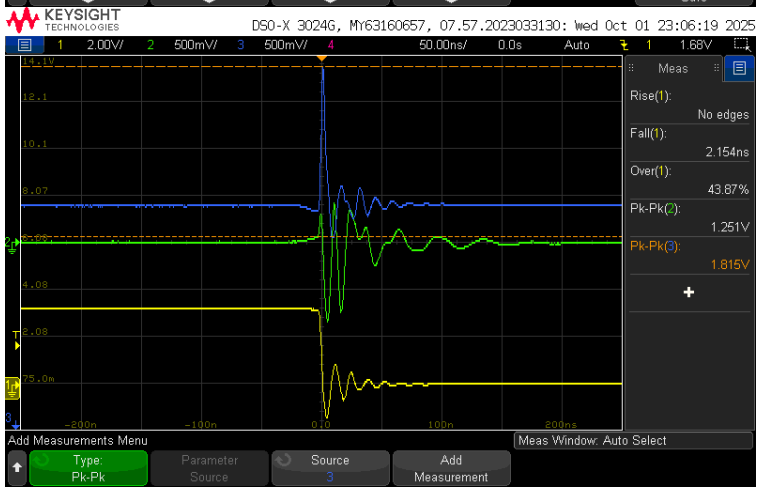
- Ground fill decreased rail settle time on the falling edge by 408% (48ns vs 244ns)
- Ground fill decrease ground bounce on the falling edge by 50% (1.2V vs 1.8V)
- Affects on the rising edge were similar, though less pronounced
- Ground fill increased fall time by 189% (1.8ns vs 5.2 ns, see previous slide)
- Neglecting a ground fill increased rail collapse by about 500%

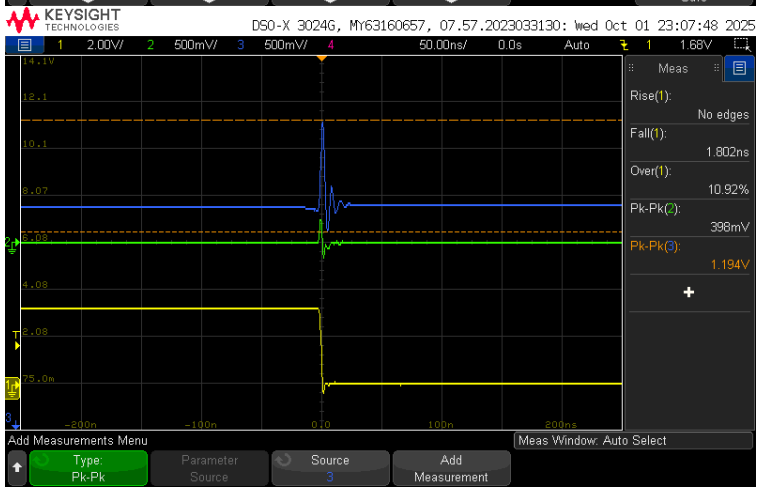












***Left**: Circuit w/o ground fill and far decoupling capacitor*
***Right**: Circuit w/ ground fill and far decoupling capacitor*
***Both**: Yellow = trigger, Blue = quiet high, Green = quiet low*

Overview

- Decoupling capacitor proximity has a significant effect on rise time, overshoot, and on rail collapse on the falling edge.
- Including a ground fill significantly decreases rail collapse and rail settle time. It also decreases overshoot on the falling edge.

	Rise time (ns)	Fall time (ns)	Overshoot (%, Rising Edge)	Overshoot (%, Falling Edge)	Rail Collapse (V, Rising Edge, Quiet High)	Rail Collapse (V, Rising Edge, Quiet Low)	Rail Collapse (V, Falling Edge, Quiet High)	Rail Collapse (V, Falling Edge, Quiet Low)	Rail Settle time (ns, Rising Edge, Quiet Low)	Rail Settle time (ns, Falling Edge, Quiet Low)
Good	2.3	1.939	4.06	6.75	0.254	0.075	0.132	0.187	106	45
Far Cap	3.298	1.849	6.41	10.92	0.633	0.053	1.194	0.398	48	45
Bad	4.745	5.159	6.75	43.87	0.957	0.366	1.815	1.251	244	247
Best	2.3	1.849	4.06	6.75	0.254	0.053	0.132	0.187	48	45
PERCENT DIFFERENCE FROM BEST										
Good	0%	5%	0%	0%	0%	42%	0%	0%	121%	0%
Far Cap	43%	0%	58%	62%	149%	0%	805%	113%	0%	0%
Bad	106%	179%	66%	550%	277%	591%	1275%	569%	408%	449%

Complete results