UNIVERSITÄT BONN

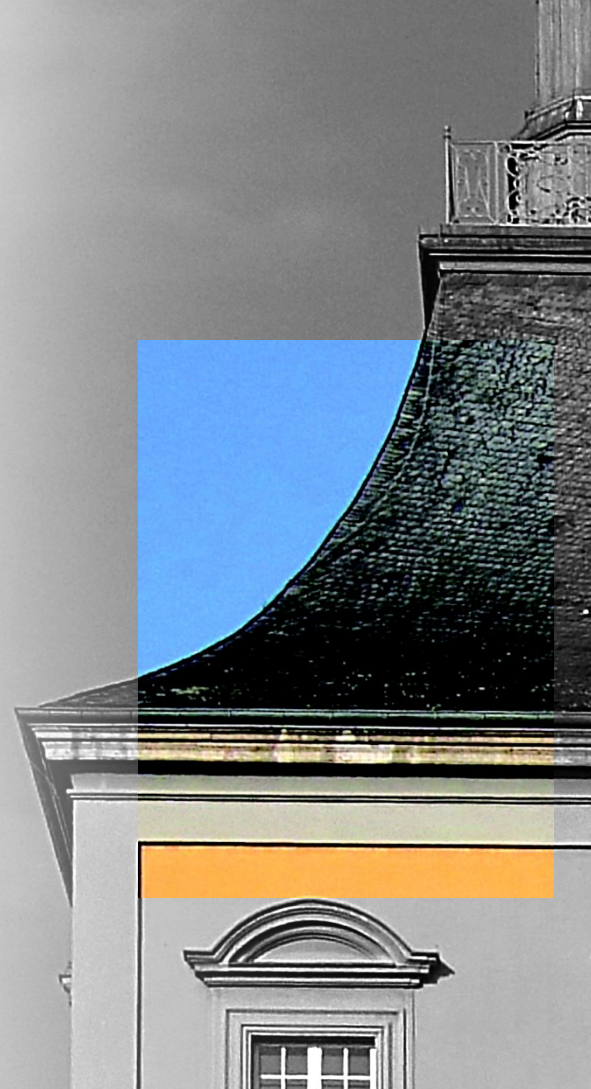
Physikalisches Institut

SI LAB Silizium Labor Bonn

FAST SHUTDOWN STATUS

PXD Workshop

16.05.2022



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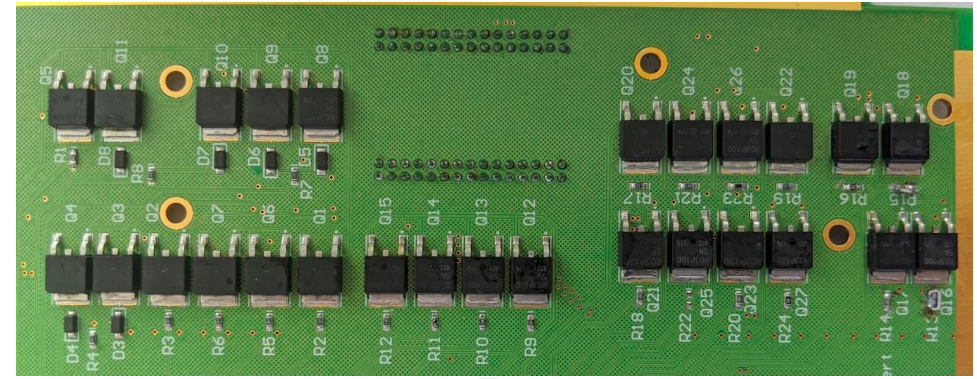
FAST SHUTDOWN MODIFICATION MAMI 2021

- Board shorts all voltage to their respective ground with multiple FETs
- Usage of fast shutdown board did result in comparable damage of switchers in the past

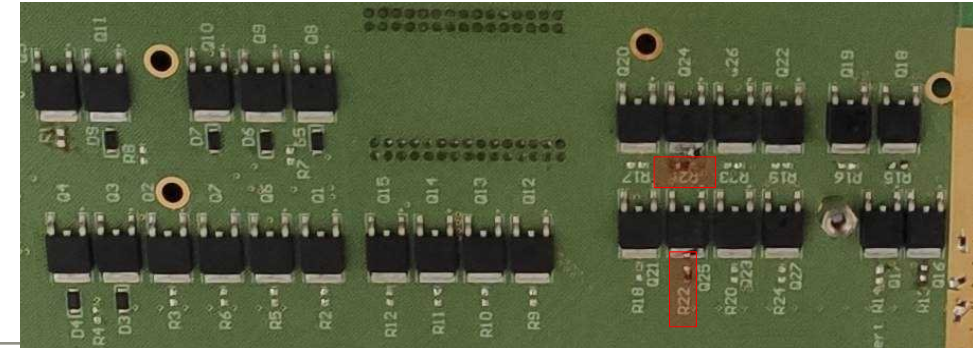
→ Voltage dependencies during fast shutdown unclear

→ Restrict active pulldown to clear-on / clear-off by removing all resistors but R21 & R22

→ $V_{clear\text{-}on}$ & $V_{clear\text{-}off}$ shorted to STEER-GND in case of shutdown



Modification



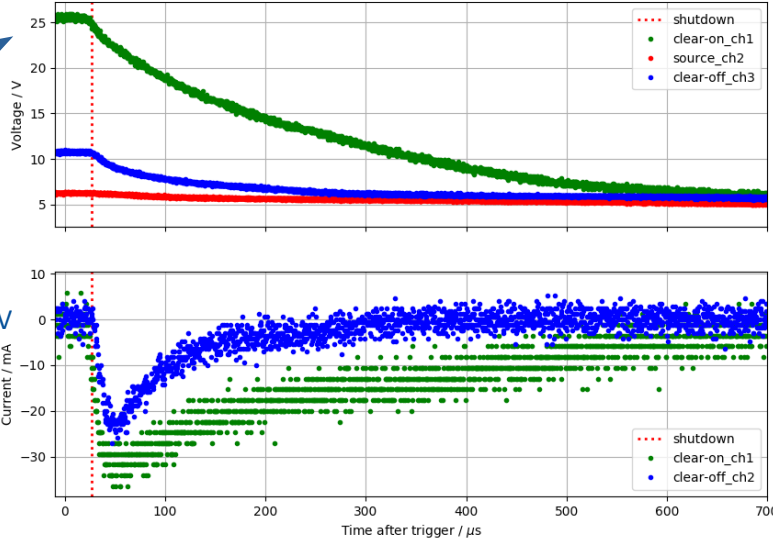
FAST SHUTDOWN LAB TEST

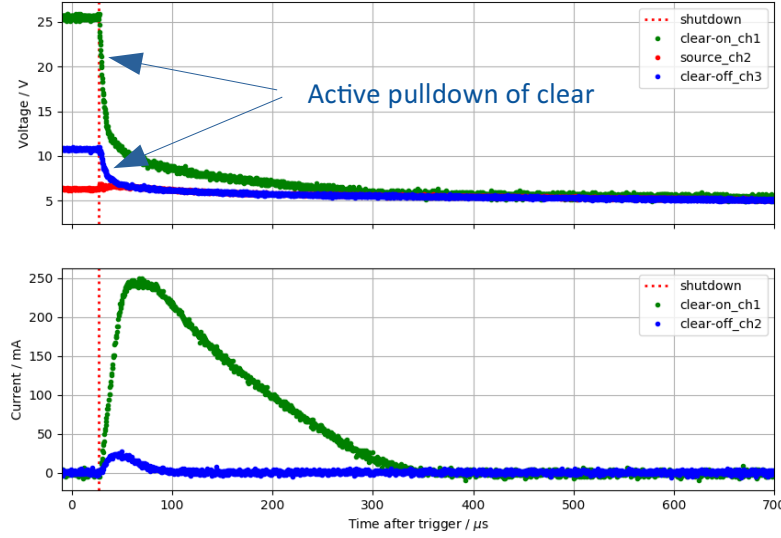
Slow shutdown

Fast shutdown $R_{clear\text{-}on}$ = 10Ω , $R_{clear\text{-}off}$ = 10Ω

Single-ended voltage measurement, referenced to GND instead of Source (6V)

→ Vclear-on = 19V + 6V





All measurements done with Hybrid5 PCB without ASICS&matrix, but all SMD components

→ Active pulldown significantly decreases shutdown time

→ Low voltage levels already at O(10us) instead of O(100us)

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Other Observations

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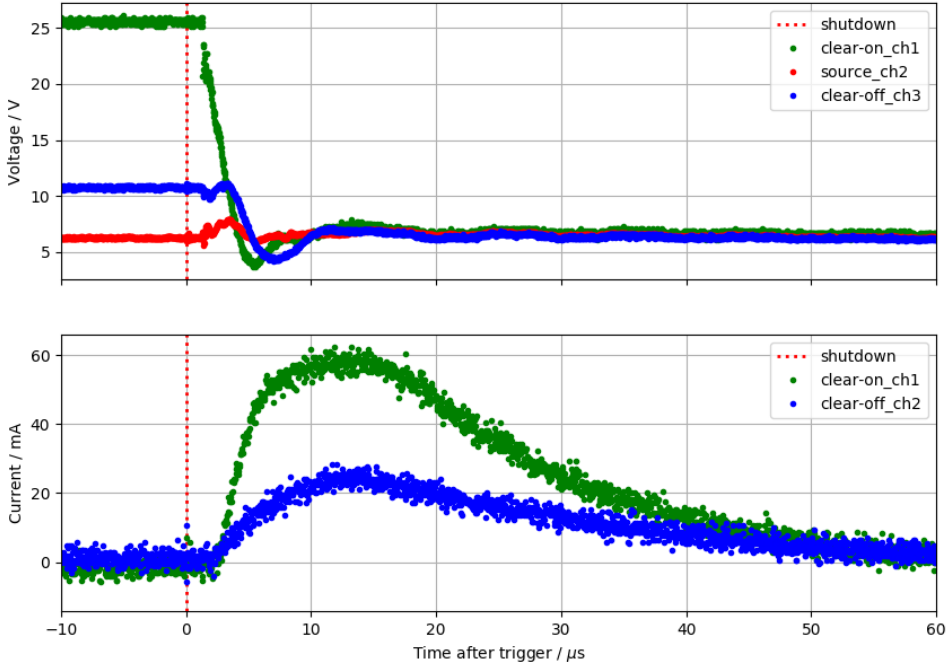
FAST SHUTDOWN LAB TEST 08

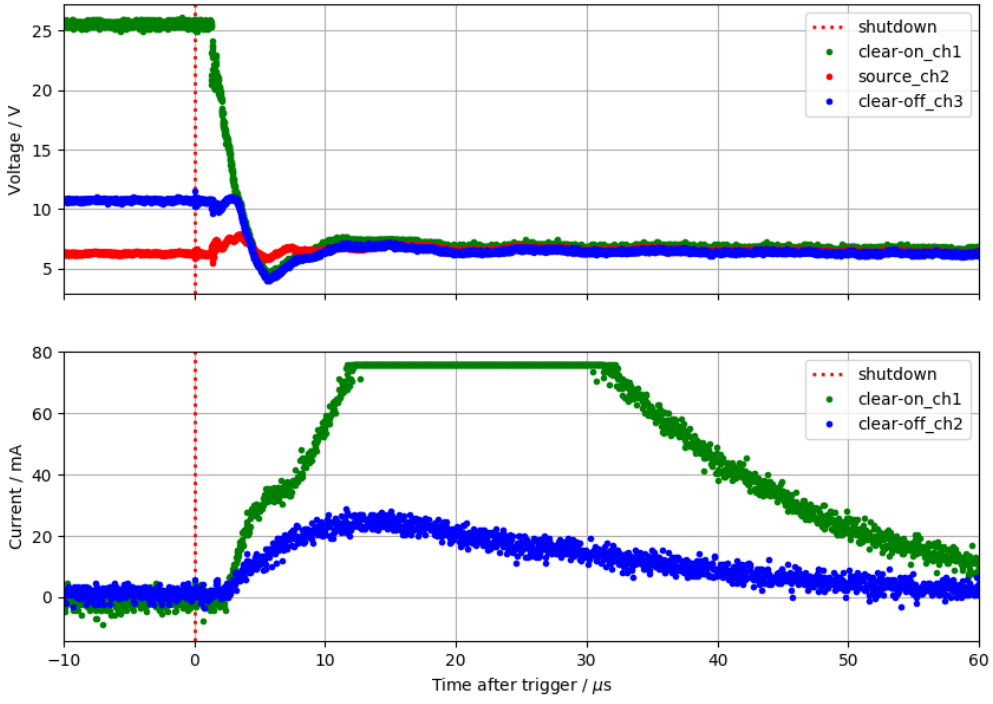


$R_{clear\text{-}on}$ = 0 Ω, $R_{clear\text{-}off}$ = 0 Ω

→ Even higher speed up with low voltage levels after ~5µs

→ Clear-on voltage drops below clear-off voltage before swingback

FAST SHUTDOWN LAB TEST 09



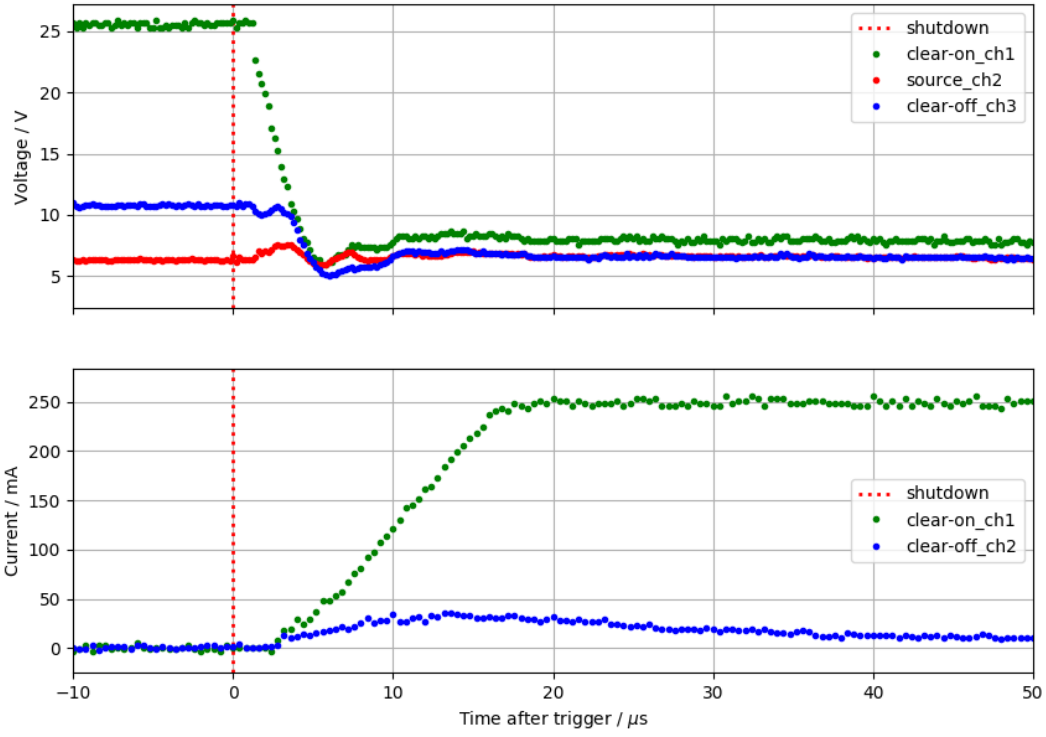
Shottky diode SB140 between clear-on and clear-off

$R_{clear\text{-}on} = 0\ \Omega$, $R_{clear\text{-}off} = 0\ \Omega$

→ Clear-on current spike factor 2 higher and slightly longer
(cutoff due to wrong oscilloscope range)

→ **BUT:** clear-on voltage does not drop below clear-off anymore

FAST SHUTDOWN LAB TEST 11



Shottky diode SB140 between clear-on and clear-off

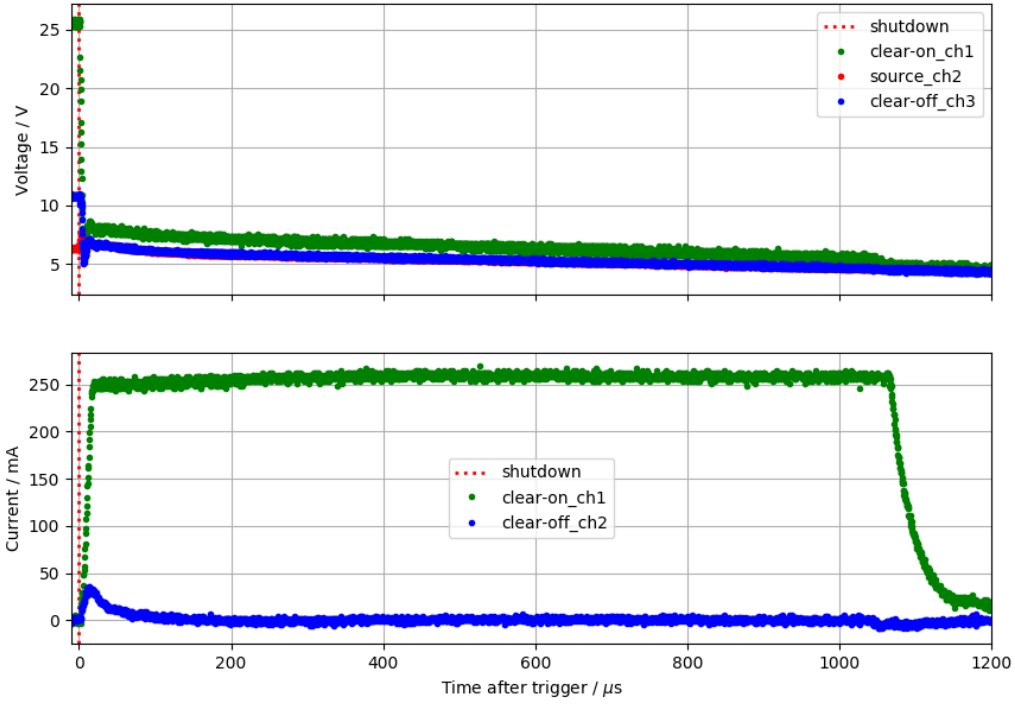
$R_{clear\text{-}on}$ = 1 Ω, $R_{clear\text{-}off}$ = 0 Ω

→ Clear-on current goes into current limit for ~1.1 ms

(Clear-on DCDC converter limited to 8W @ 30V → I_{max} = 266mA)

→ Clear-on voltage seems shifted positive, drops after ~1.1 ms (time until regular shutdown?)

FAST SHUTDOWN LAB TEST 11



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CONCLUSION

- Found configuration of pull-down resistors $R_{clear\text{-}on}$ = 10 Ω, $R_{clear\text{-}off}$ = 10 Ω where voltage dependencies are still fulfilled while decreasing shutdown time

  → Performed 25 test shutdowns before MAMI → Safe to use on hybrid5

  → **BUT:** still not fast enough to protect Switchers (see MAMI2021 slides)

- Still many open questions from shutdown lab tests

- Crucial to understand shutdown behaviour & PS limitations to find optimal configuration of pull-down resistors

→ Simulation ?