

Stacking Power MOSFETs

NMOS Configuration

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Test 2

- NMOS Configuration
- MOSFET:
 - STP8NM60
- Calculated Capacitance Values:
 - 50pF, 100pF, 150pF, 200pF
- Max Voltage:
 - 2500 V
- Changes:
 - Replaced diodes with 10k Resistors
 - Used Cgs and Cgd values according to datasheet instead of behavior model

Test 2 – Calculations

$$C_{gs} = 440 \text{ pF}$$

$$C_{gd} = 10 \text{ pF}$$

$$V_d = 500 \text{ V}$$

$$V_{gs} = 20 \text{ V}$$

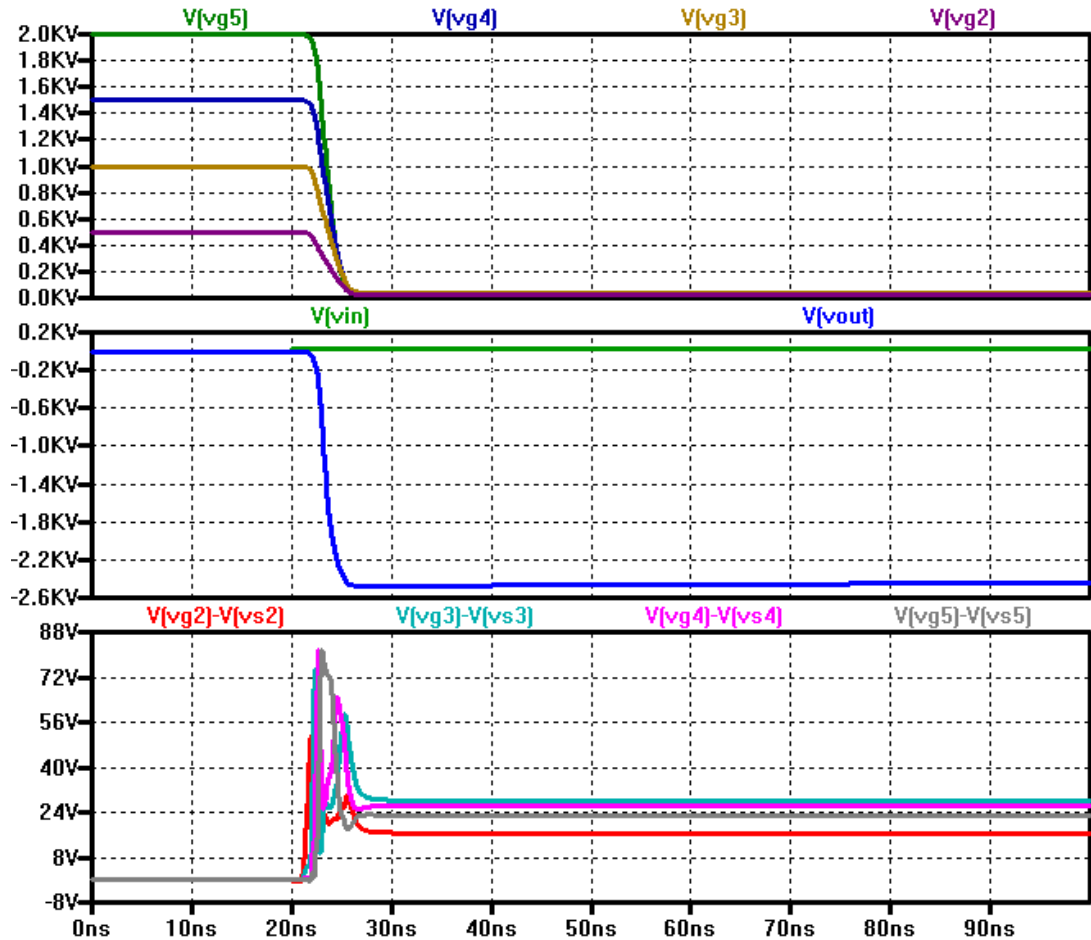
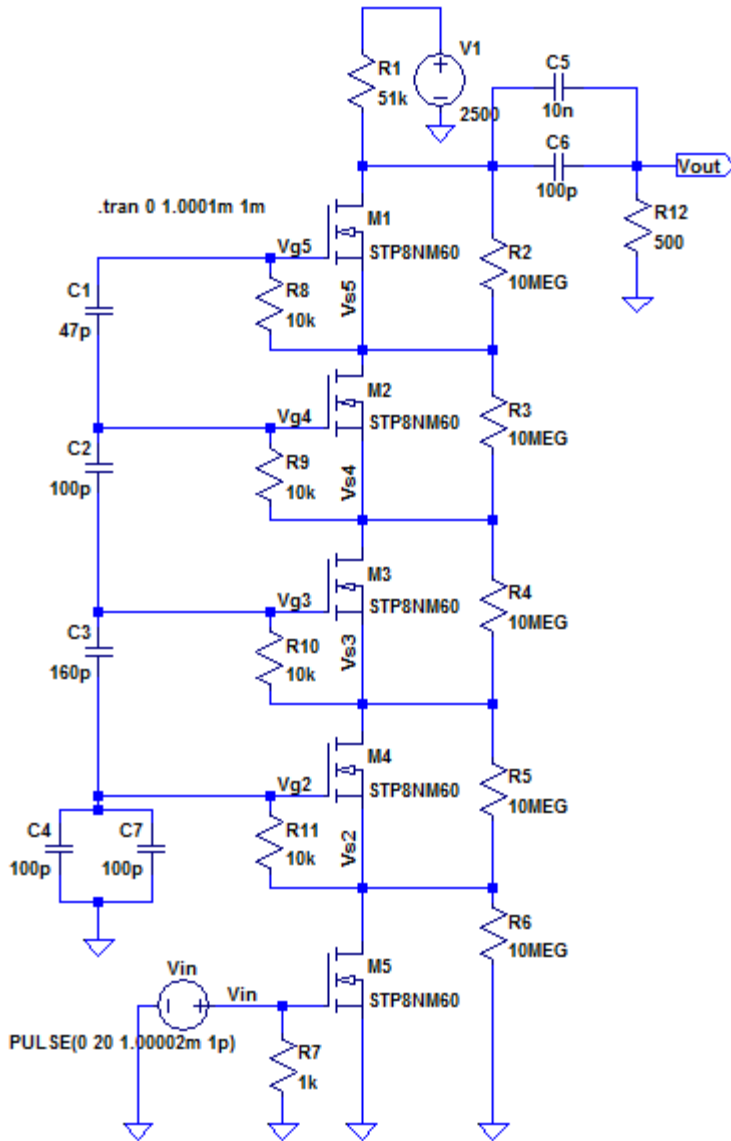
$$A_v = 25$$

$$\begin{aligned} C'_{gs} &= C_{gs} + A_v * C_{gd} \\ &= 440 \text{ pF} + 25 * 10 \text{ pF} \\ &= 690 \text{ pF} \end{aligned}$$

$$\begin{aligned} V_{gs} &= V_d * C_2 / (C_2 + C'_{gs}) \quad \text{Solve for } C_2 \\ C_2 &= [(V_{gs} / V_d) * C'_{gs}] / [1 - (V_{gs} / V_d)] \\ &= [(20 / 500) * 690\text{p}] / [1 - (20 / 500)] \\ &= 28.75 \text{ pF} \end{aligned}$$

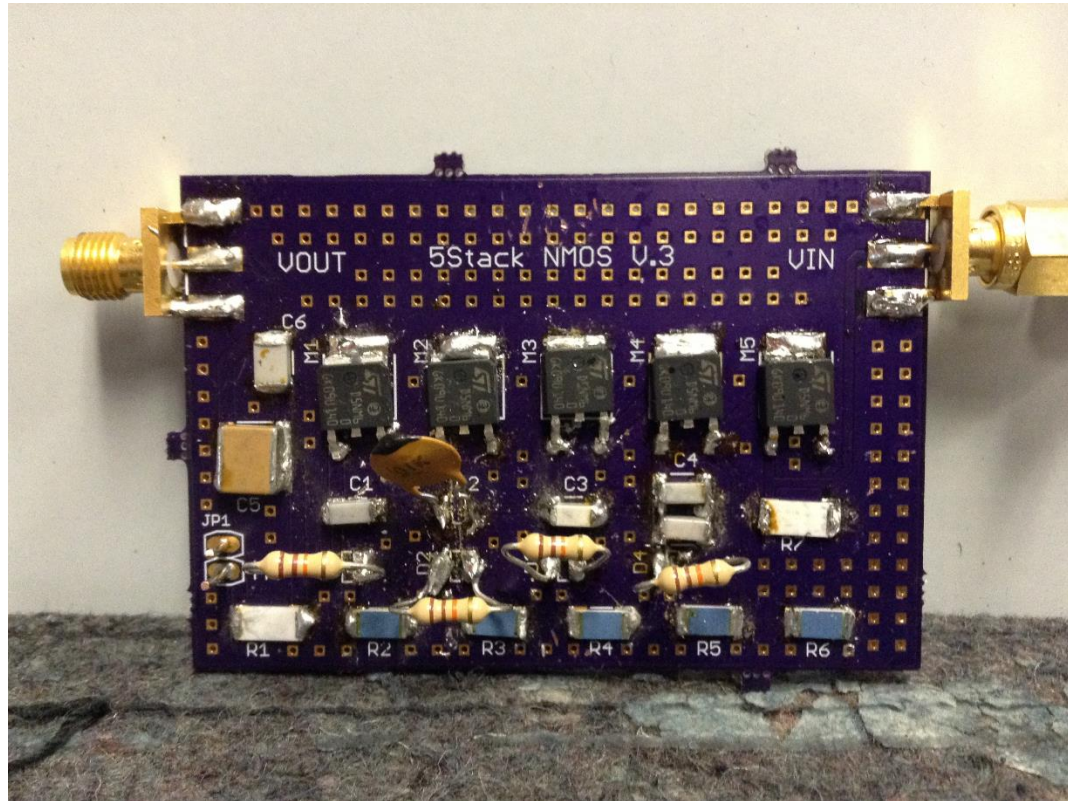
*To ensure the MOSFETs turn on, increase C_2 to **50 pF***

Test 2 – Simulation & Values



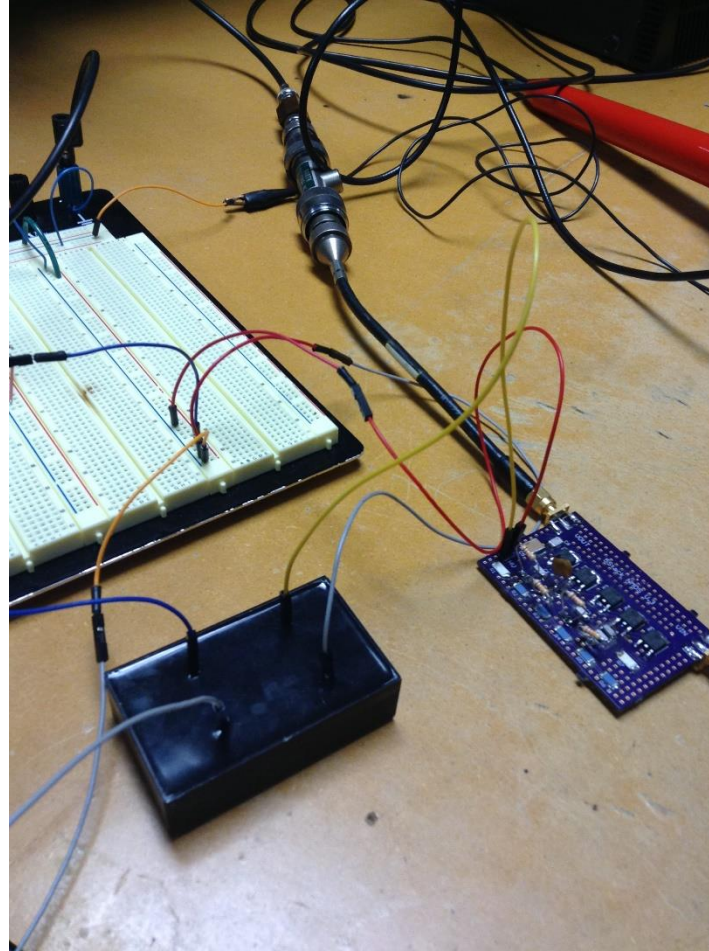
*Values reflect components available

Test 2 – Chip



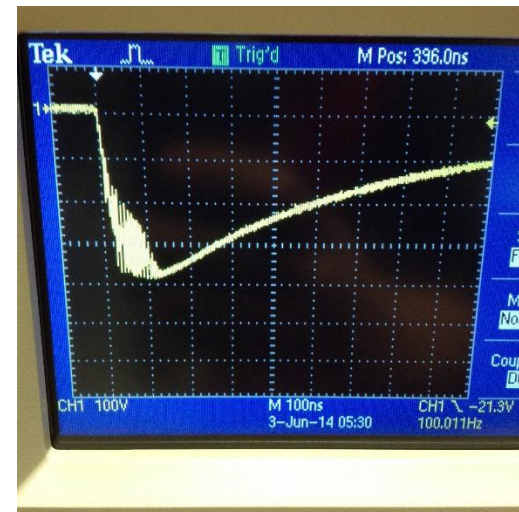
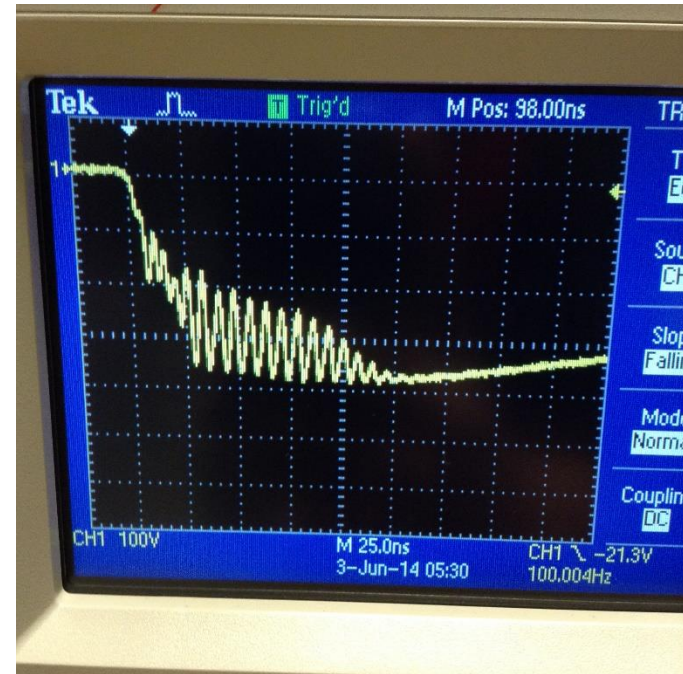
- Use same board as Test 1 Chip
- As a result, axial lead resistors and a radial lead capacitor were used to fit the previous spots

Test 2 – Setup



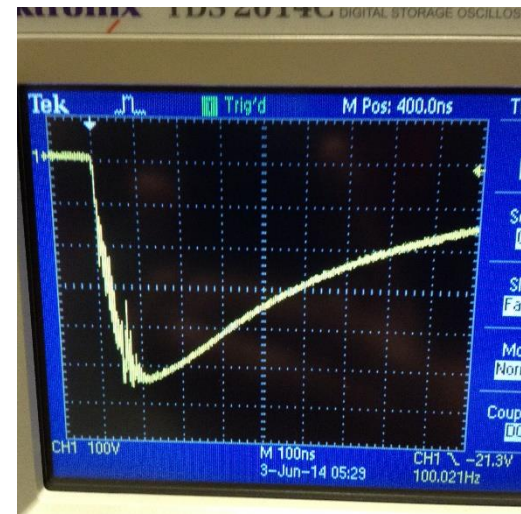
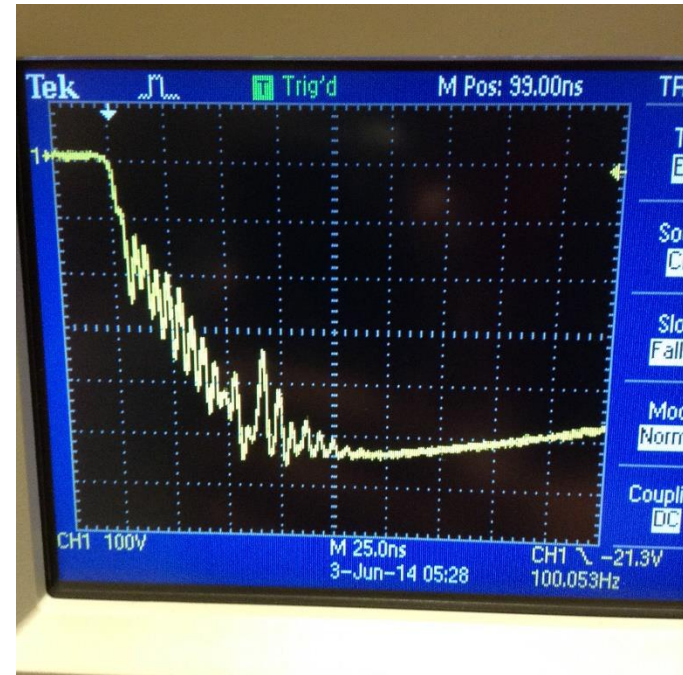
Test 2 – Sample 1 Results

- $V_{in} = 500\text{ V}$
- Switching = 400 V , or 80.0%
- Voltage Across (Difference):
 - M1: 465 V (-45)
 - M2: 343 V (-122)
 - M3: 236 V (-107)
 - M4: 140 V (-96)
 - M5: 49 V (-91)
- The waveform oscillates only from when switching to the high voltage
- The oscillation may be caused by the extra length from the lead resistors



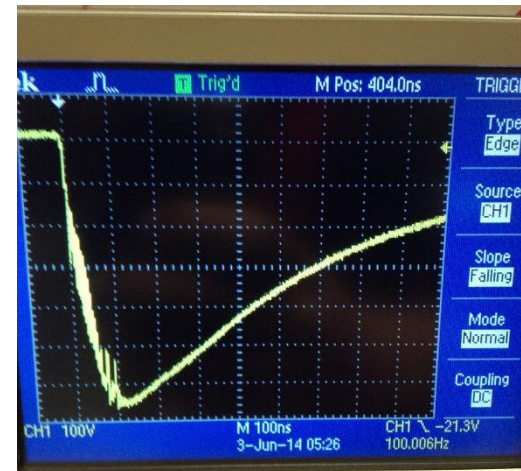
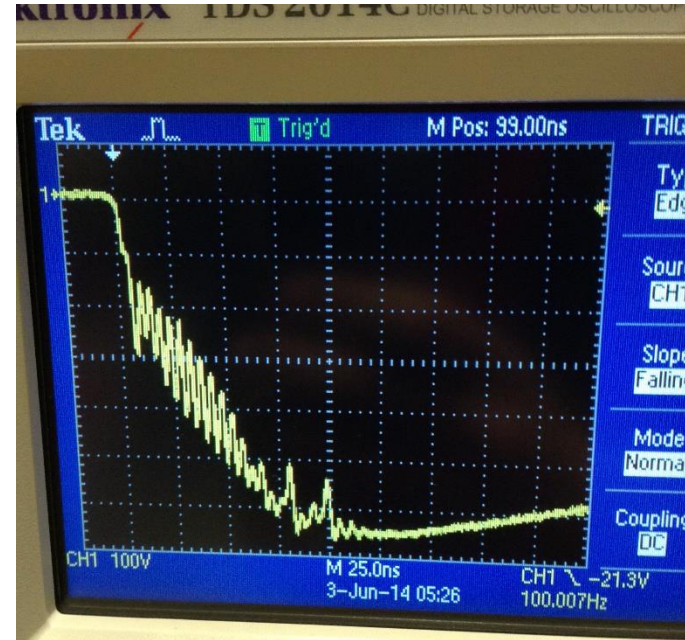
Test 2 – Sample 2 Results

- $V_{in} = 752\text{ V}$
- Switching = 560 V , or 74.5%
- Voltage Across (Difference):
 - M1: 700 V (-52)
 - M2: 515 V (-185)
 - M3: 356 V (-159)
 - M4: 216 V (-140)
 - M5: 82 V (-134)
- The results follow suit of the previous sample
- The initial difference between V_{in} and M1 are larger than the last test



Test 2 – Sample 3 Results

- $V_{in} = 1.001 \text{ kV}$
- Switching = 660 V, 65.5%
- Voltage Across (Difference):
 - M1: 958 V (-43)
 - M2: 698 V (-260)
 - M3: 478 V (-220)
 - M4: 292 V (-186)
 - M5: 115 V (-177)
- As with the last test, the switching voltage got worse, but at a faster rate for this test



Test 2 – Conclusion

- Overall, resistors worked better than the diodes
- As mentioned, the additional length from the lead resistors caused a delay substantial enough to distort the wave
- The problem will be fixed by fabricating a new board with pads for resistors instead of diodes