Stacking Power MOSFETs
NMOS Configuration

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Test 1

- NMOS Configuration; 5 Stack MOSFET
- MOSFET:
  – STP8NM60 , VDS = 600 V, RDS(on) = 0.9 Ohms
- Calculated Capacitance Values:
  – 160pF, 320pF, 480pF, 640pF
- Diode:
  – BZX84C15L
- Max Voltage:
  – 2500 V

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Test 1 – Calculations

Cgs   = 700 pF   Vd   = 500 V
Cgd   = 100 pF   Vgs   = 20 V
Czener   = 110 pF   Av   = 25

C'gs   = Cgs + Av * Cgd + Czener
         = 700 pF + 25 * 100 pF + 110 pF
         = 3310 pF

Vgs   = Vd * C2 / (C2 + C'gs)   *Solve for C2*
C2   = [(Vgs / Vd) * C'gs] / [1 − (Vgs / Vd)]
   = [(20 / 500) * 3310p] / [1 − (20 / 500)]
         = 138 pF
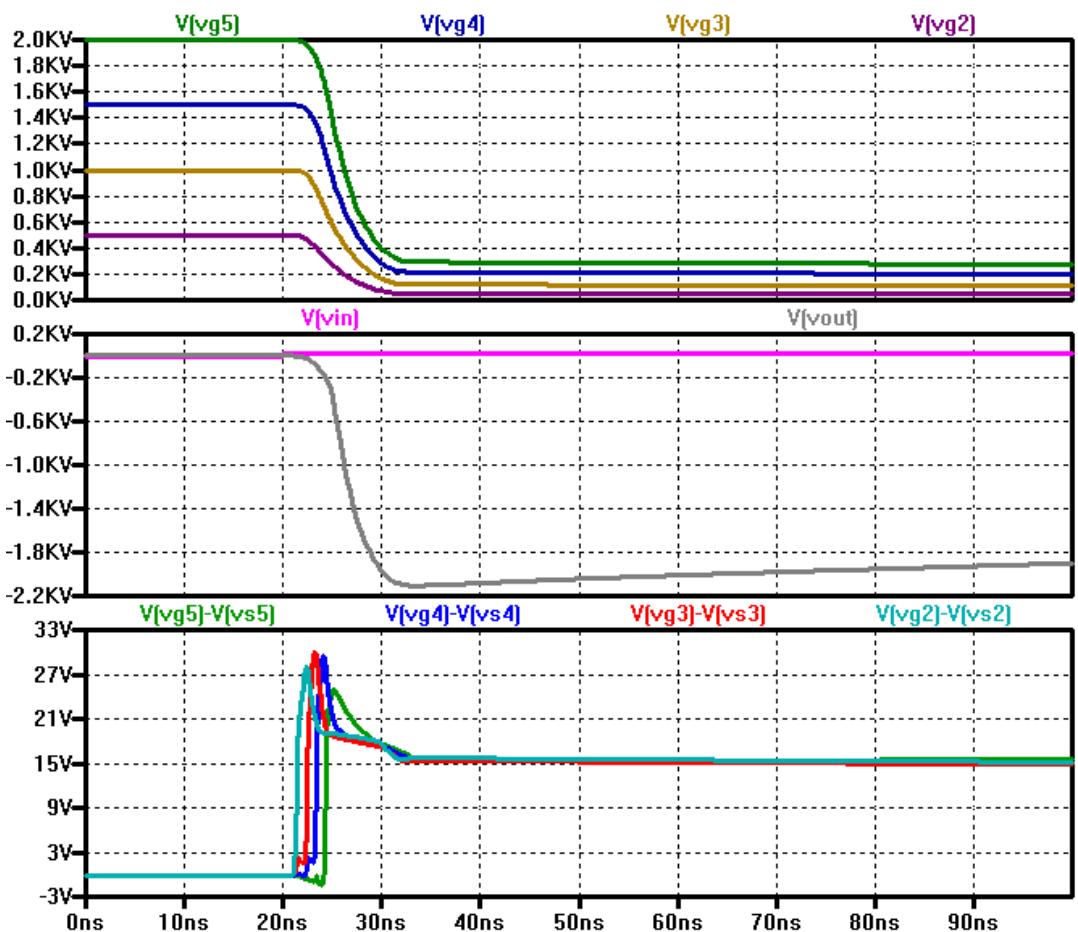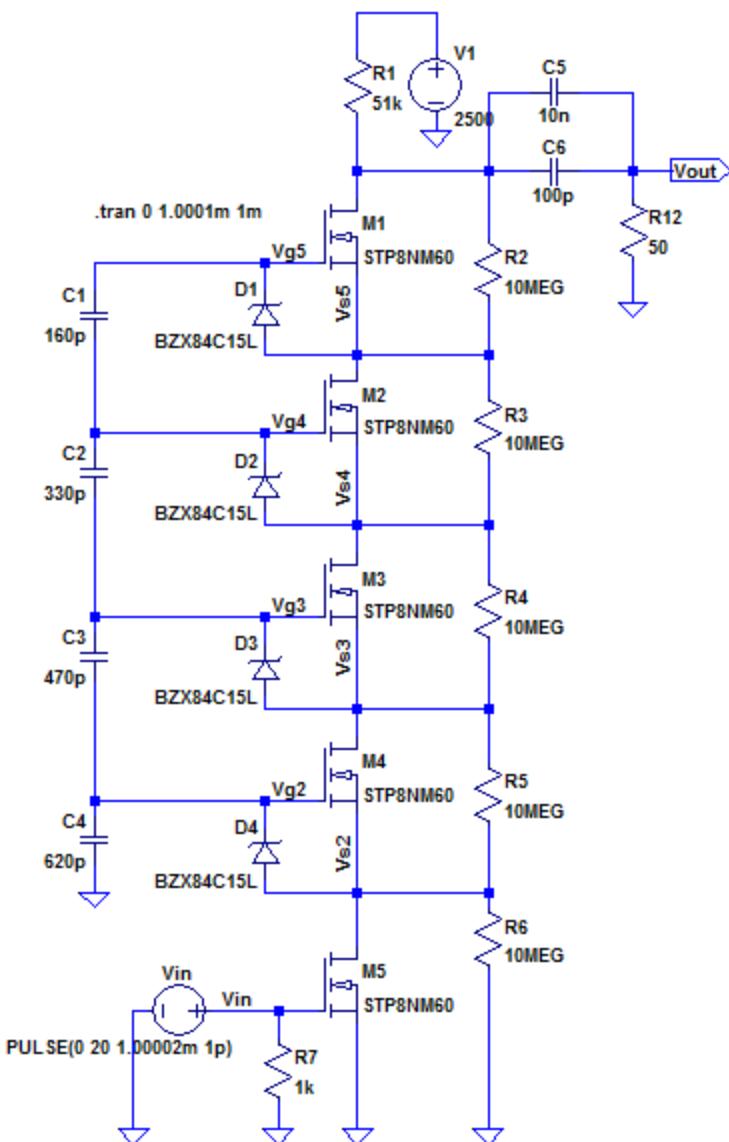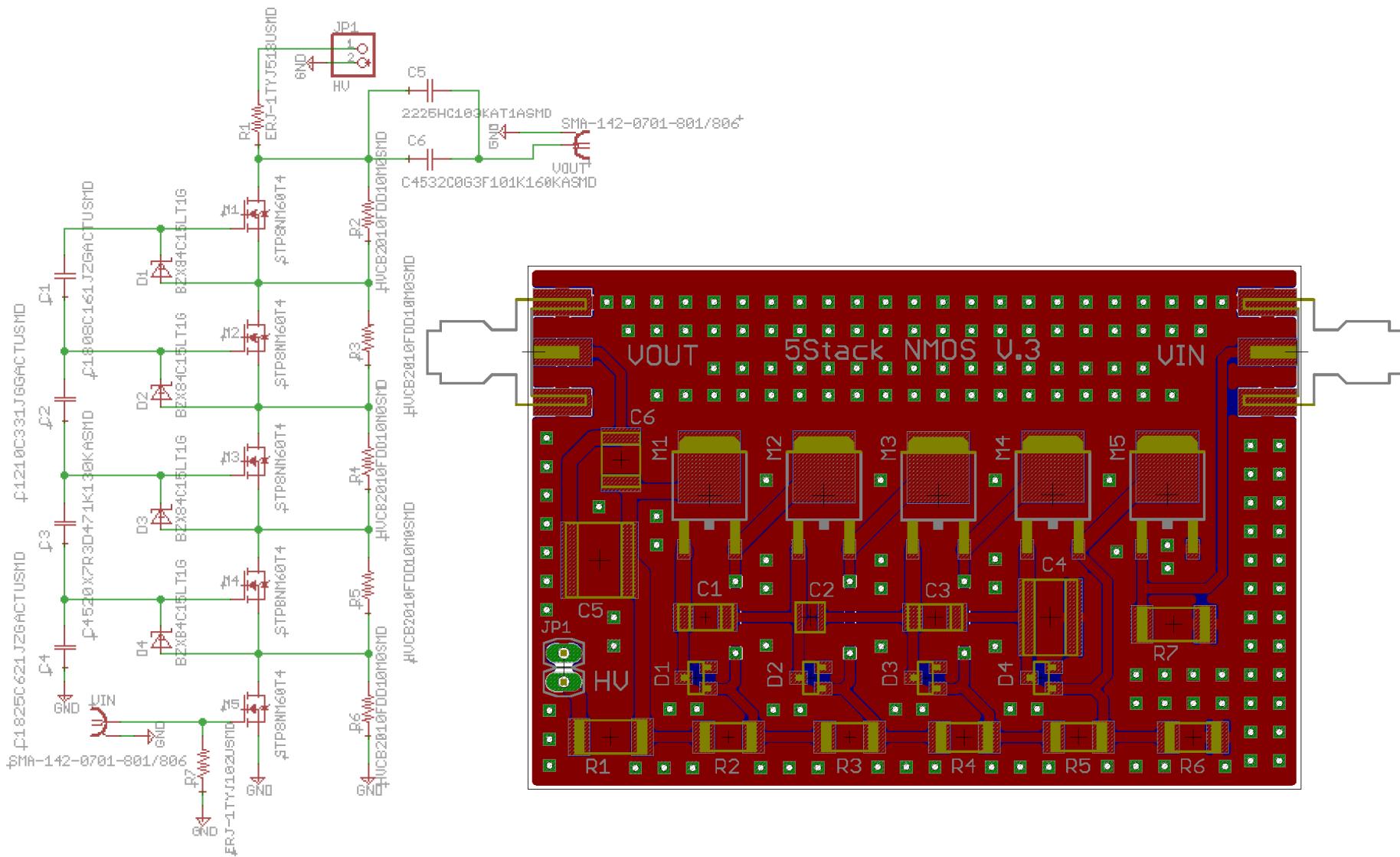
*To ensure the MOSFETs turn on, increase C2 to **160 pF***

Test 1 – Simulation & Values
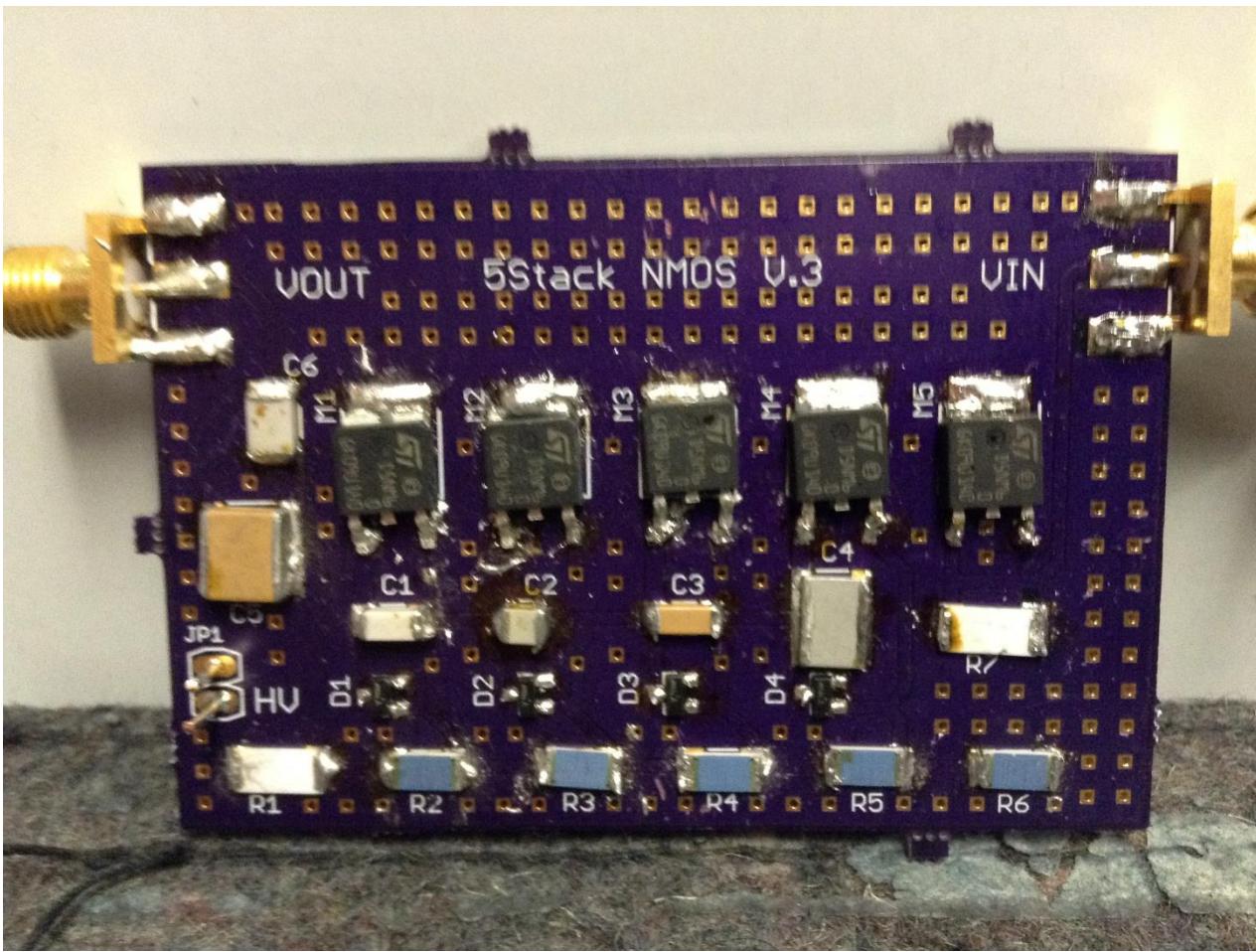
*Values reflect components available

Test 1 – PCB Layout

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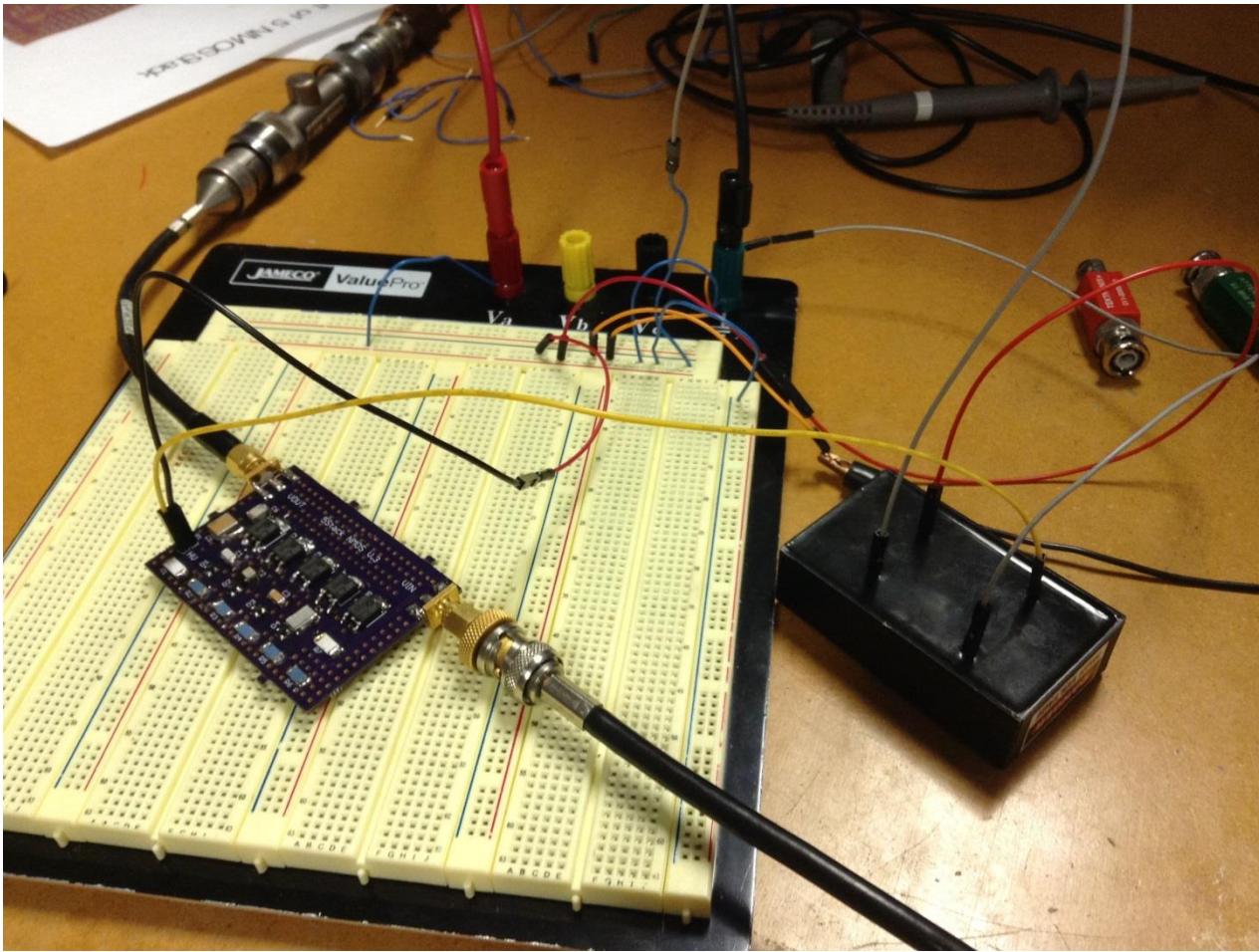
Test 1 – Chip
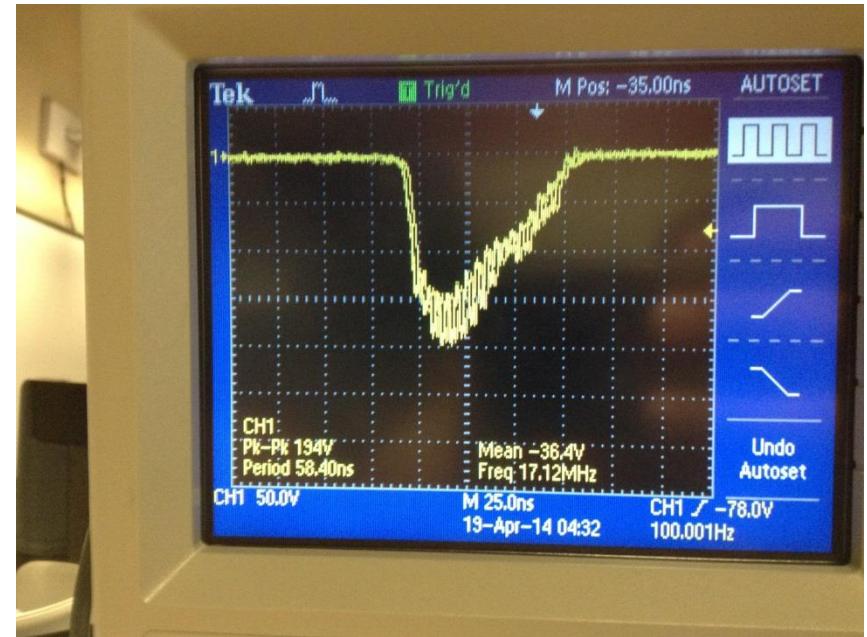
# Test 1 – Setup
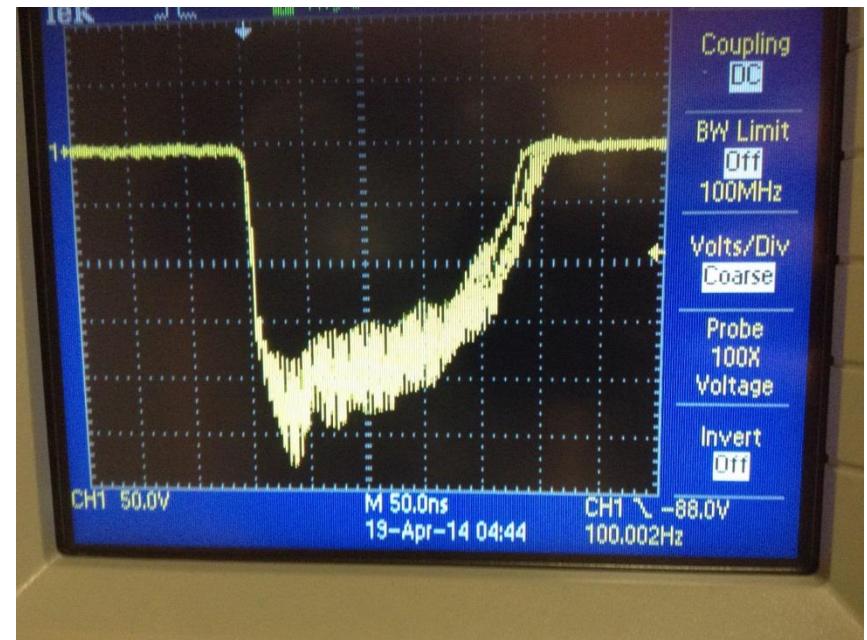
# Test 1 – Sample 1 Results

- Vin = 525 V

- Switching = 200 V, or 38.1%

- Voltages Across (Difference):

  - M1: 520 V (-5)

  - M2: 246 V (-274)

  - M3: 177 V (-69)

  - M4: 76 V (-101)

  - M5: 19 V (-57)

- The waveform oscillates both when switching from and returning to zero volts

- The noise may be caused by the Zener diodes as they are not reacting fast when the voltage switches

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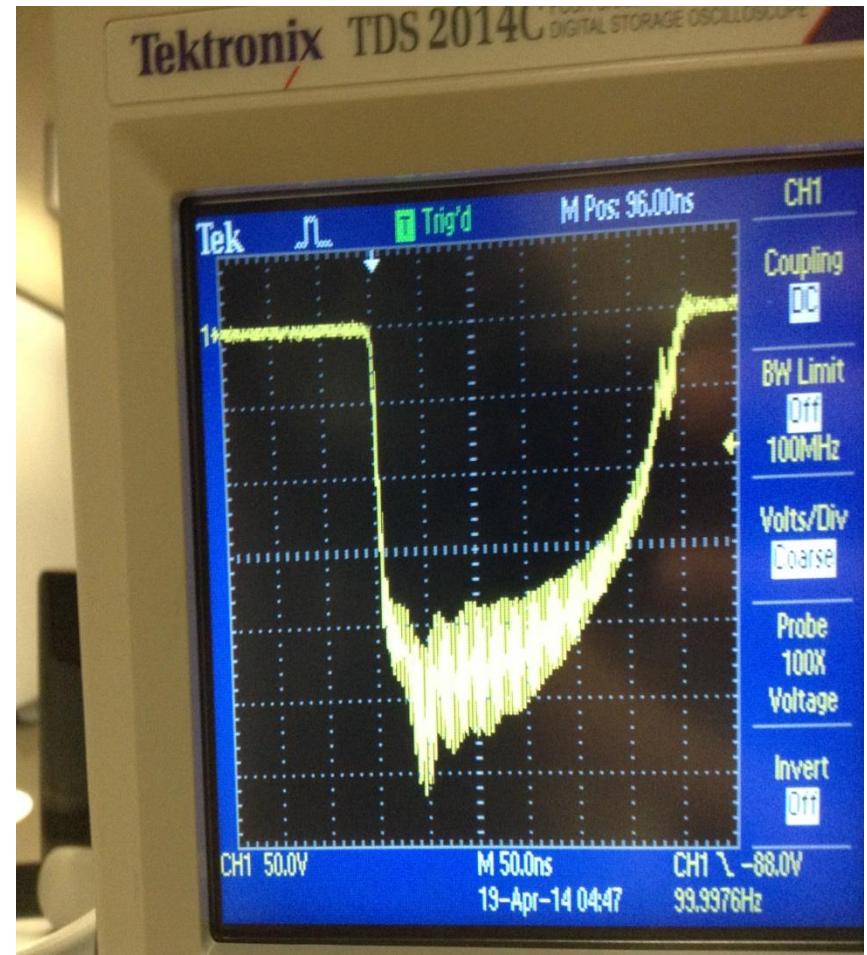
Test 1 – Sample 2 Results

- Vin = 747 V

- Switching = 275 V, or 36.8%

- Voltage Across (Difference):

  - M1: 730 V (-17)

  - M2: 440 V (-290)

  - M3: 303 V (-137)

  - M4: 156 V (-147)

 - M5: 25 V (-131)

- Similar results to the previous sample

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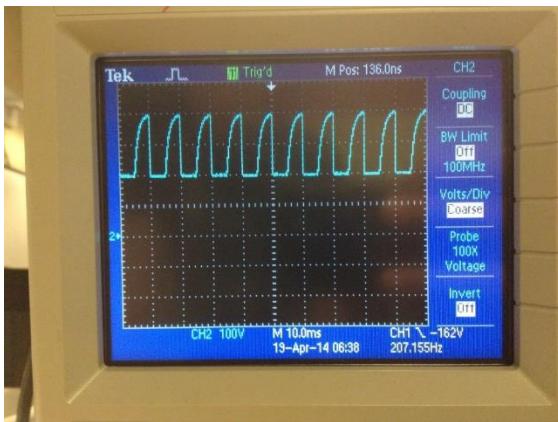
Test 1 – Sample 3 Results

- Vin = 1.008 kV

- Switching = 320 V, or 31.7%

- Voltage Across (Difference):

  - M1: 990 V (-18)

  - M2: 579 V (-411)

  - M3: 398 V (-181)

  - M4: 258 V (-140)

  - M5: 39 V (-219)

- Results were consistent, but the percentage of switching progressively got worse
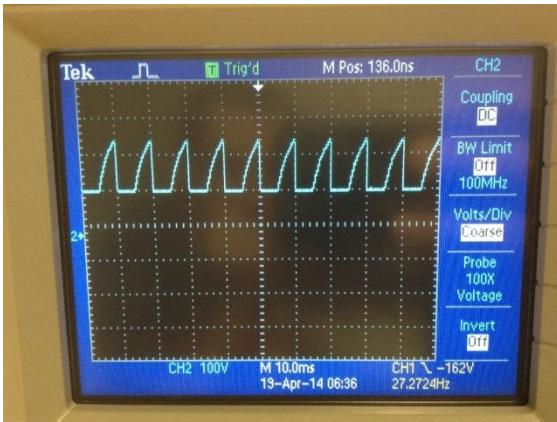
Test 1 – Sample 1 Gate Probing
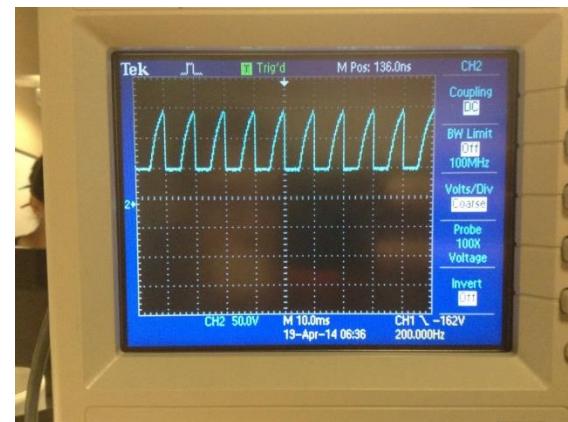
MOSFET 1
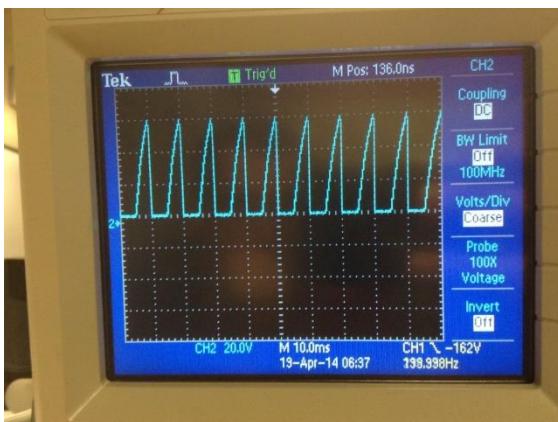

MOSFET 2
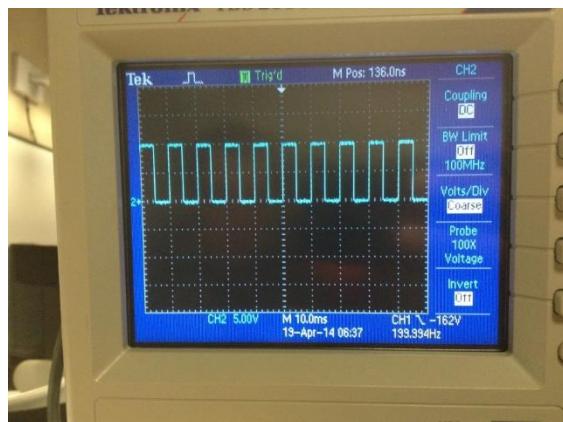
MOSFET 3

MOSFET 4

MOSFET 5

- Peak Voltages:
  - M1: 200 V
  - M2: 140 V
  - M3: 100 V
  - M4: 60 V
  - M5: 10 V

Test 1 – Conclusion

- In short, the Test 1 results were far from expected results

- As discussed, the Zener diodes may be the source of the distorted wave form

- To fix the problem, we will test by using 10K Ohm resistors in place of the Zener diodes