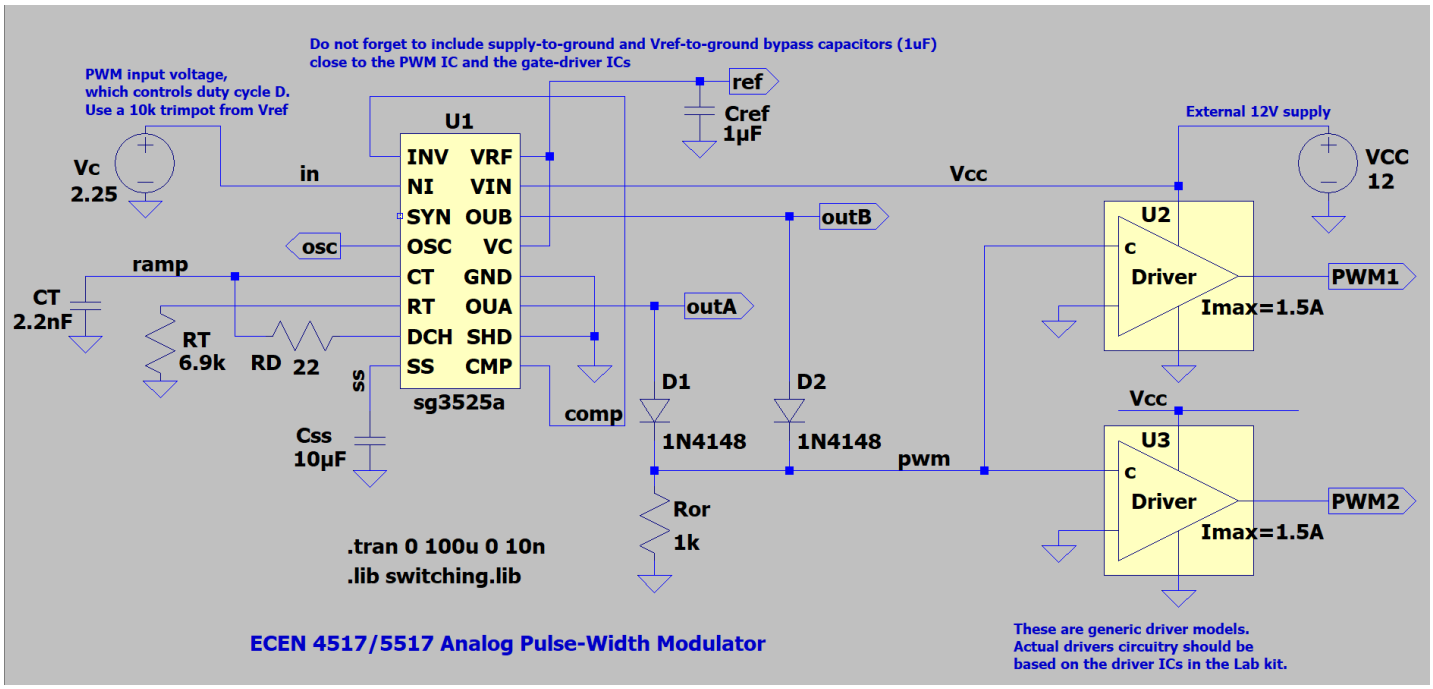
Experiment #4 Part 1
PV Power Electronics Laboratory

Completed By:
Zach Shelton & Shane McCammon

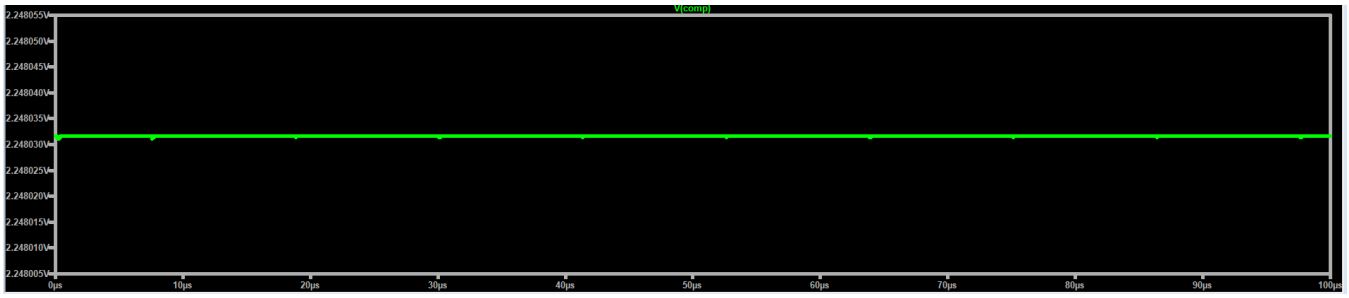
Step 1:

No deliverable

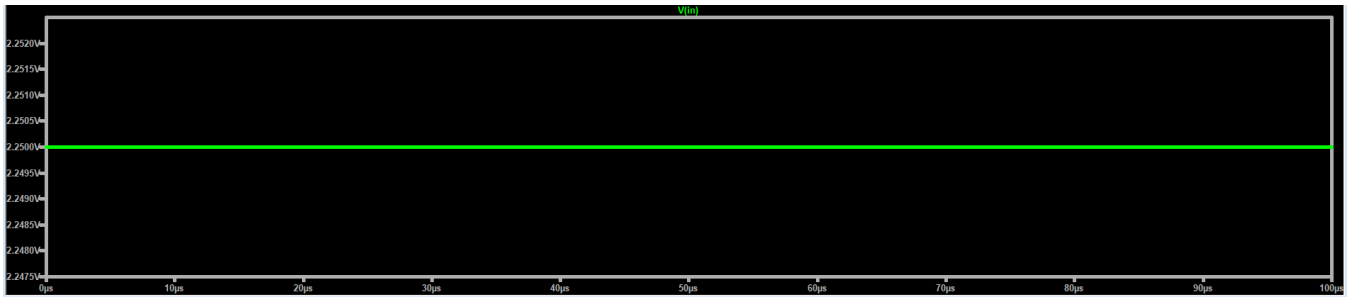
Step 2:



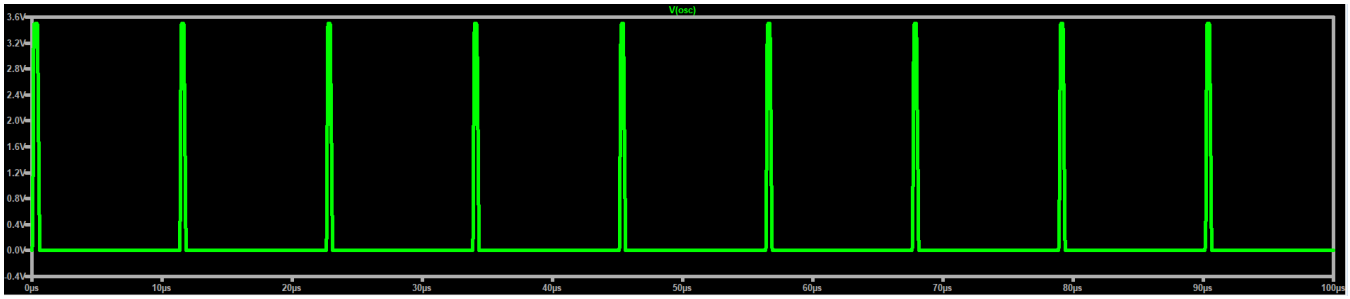
PWM Circuit Schematic



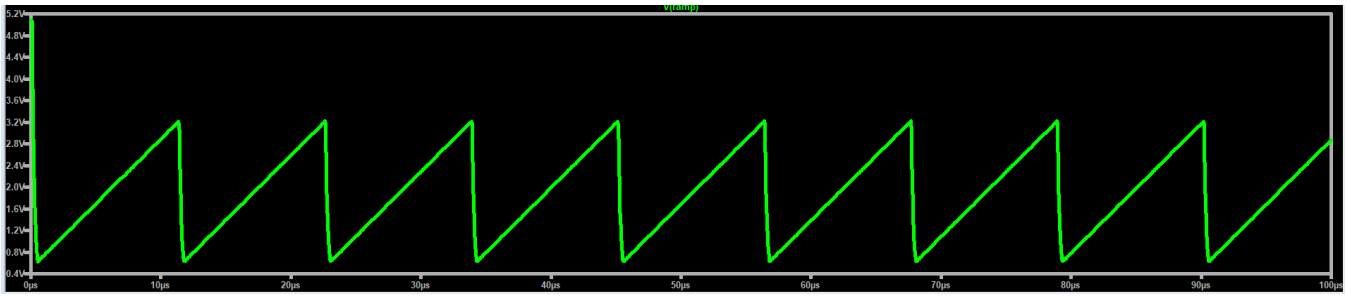
Pin 1 and 9 from Simulation (2.25V)



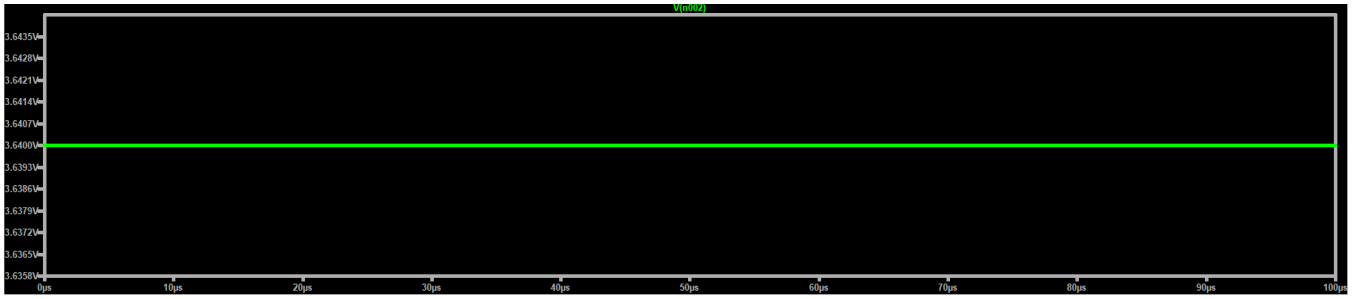
Pin 2 from Simulation (2.25V)



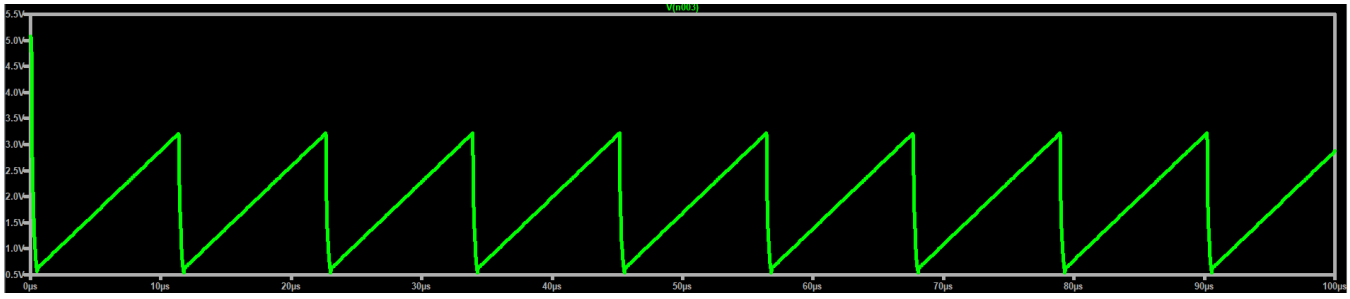
Pin 4 from Simulation (3.6 Vpp)



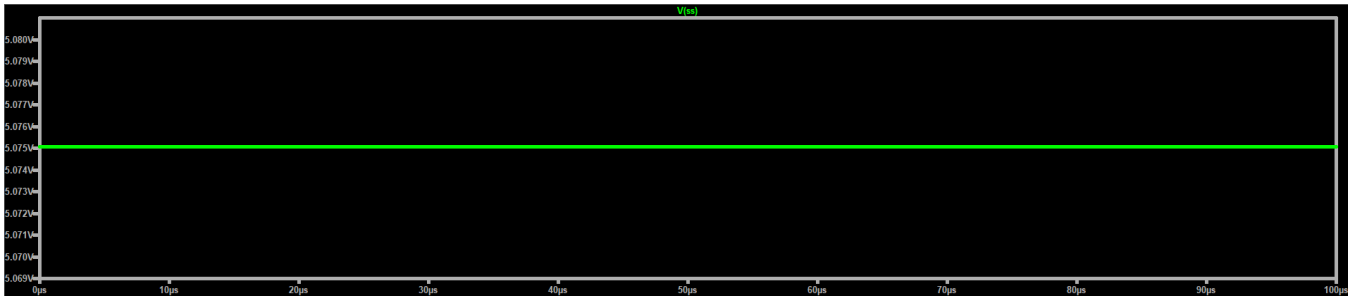
Pin 5 from Simulation (3.2 Vpp)



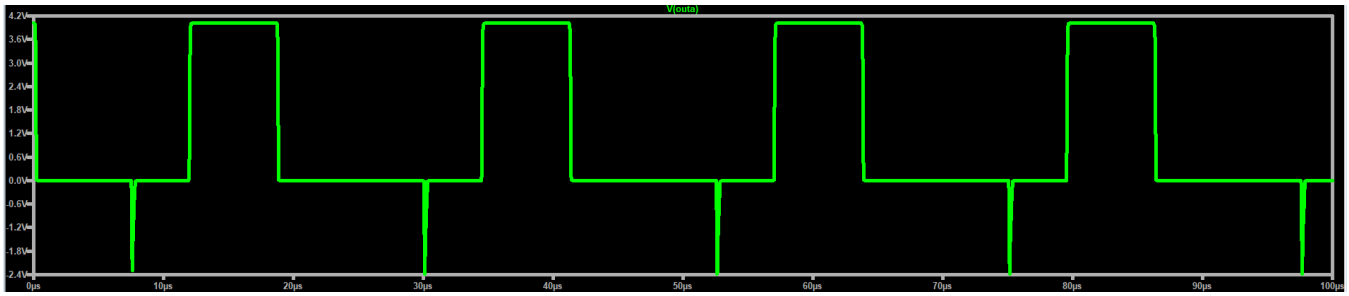
Pin 6 from Simulation (3.64V)



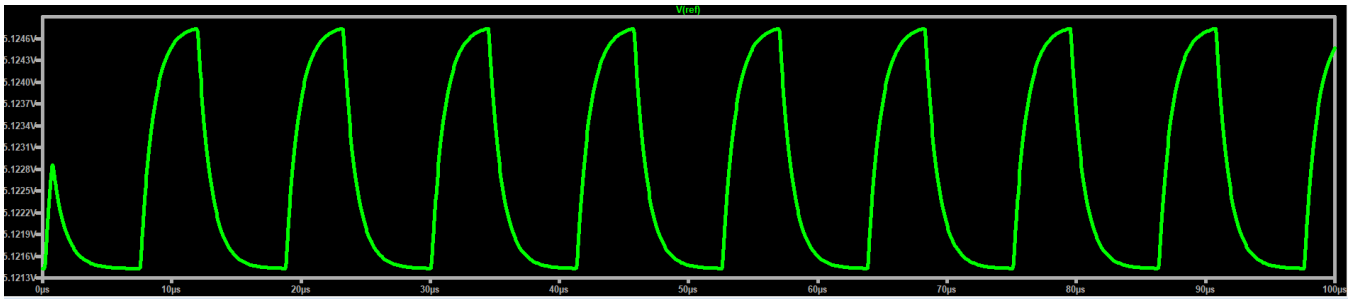
Pin 7 from Simulation (3.2 Vpp)



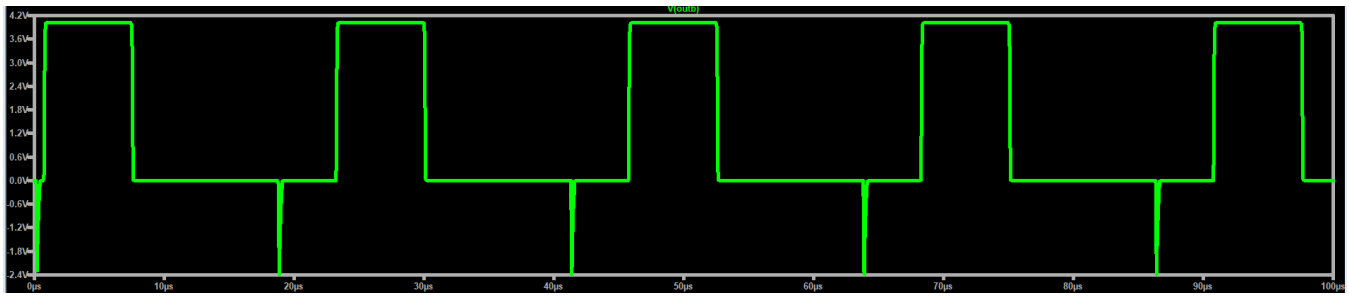
Pin 8 from Simulation (5.075V)



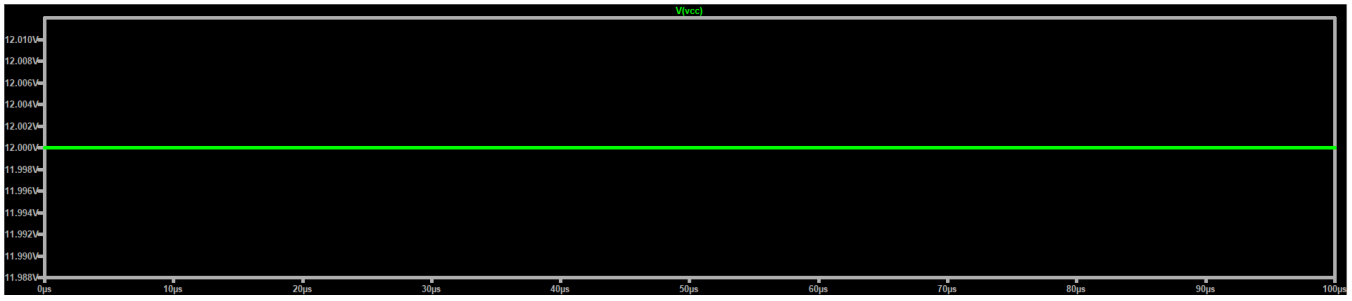
Pin 10 from Simulation (Vmin = -2.4V, Vmax = 4V, D=30%)



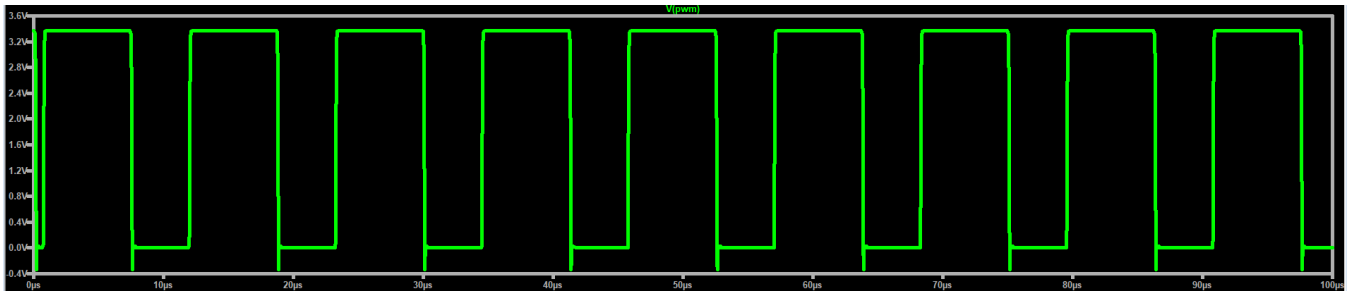
Pin 13 and 16 from Simulation (Oscillating between 5.121V and 5.125V)



Pin 14 from Simulation (Vmin = -2.4V, Vmax = 4V, D=30%)



Pin 15 from Simulation (12V)



Vpwm from Simulation (Vmin = -0.4V, Vmax = 3.3V, D = 60%)

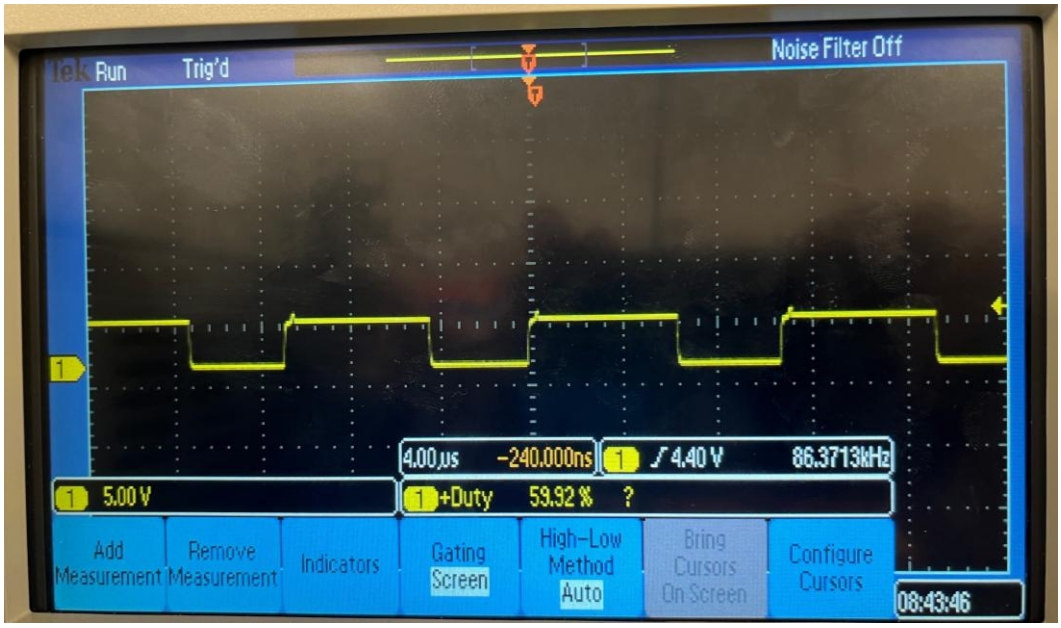
Pin 3, 10 and 12 are all ground

Output A (Measured)

Output B (Measured)

OSC (Measured)

Ramp (Measured)



Vpwm (Measured)

The measured results were very close to the simulated results. This shows that the PWM circuit is working how we expect it to.

Step 3:

Inductor Design:

$L1$: $48.6\,\mu H$, $I_{L_1} = 7.8A$, $\Delta I_{L_1} = 0.25A$

$L2$: $609\,\mu H$, $I_{L_2} = 20A$, $\Delta I_{L_2} = 0.25A$

Using PQ 26/25 core:

$A_c = 1.18$, $B_{max} = 0.3$, $\mu_0 = 4\pi \times 10^{-7}$, n = turns

$L1$: $\frac{(48.6\mu H)(7.8)}{(0.3)(1.18)}(10^4) = \sim 11$ turns

$Wire_{L1}$: $\frac{(0.5)(0.503)}{11} = 22.9 \times 10^{-3} \Rightarrow$ #18 gauge wire

Gap_{L1}: $\frac{\mu_0 A_c n^2}{L} = 3.69$

$L2$: $\frac{(609\mu H)(2.2)}{(0.3)(1.18)}(10^4) = \sim 37$ turns

$Wire_{L2}$: $\frac{(0.5)(0.503)}{37} = 6.8 \times 10^{-3} \Rightarrow$ #23 gauge wire

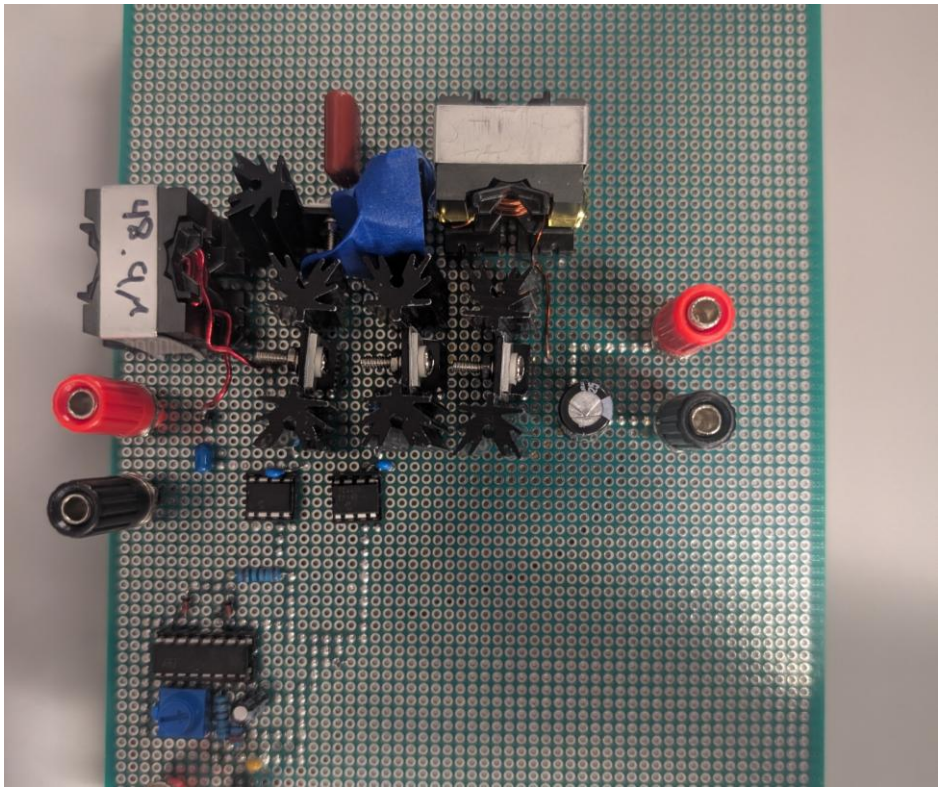
Gap_{L2}: $\frac{\mu_0 A_c n^2}{L} = 3.33$

Measured Inductances:

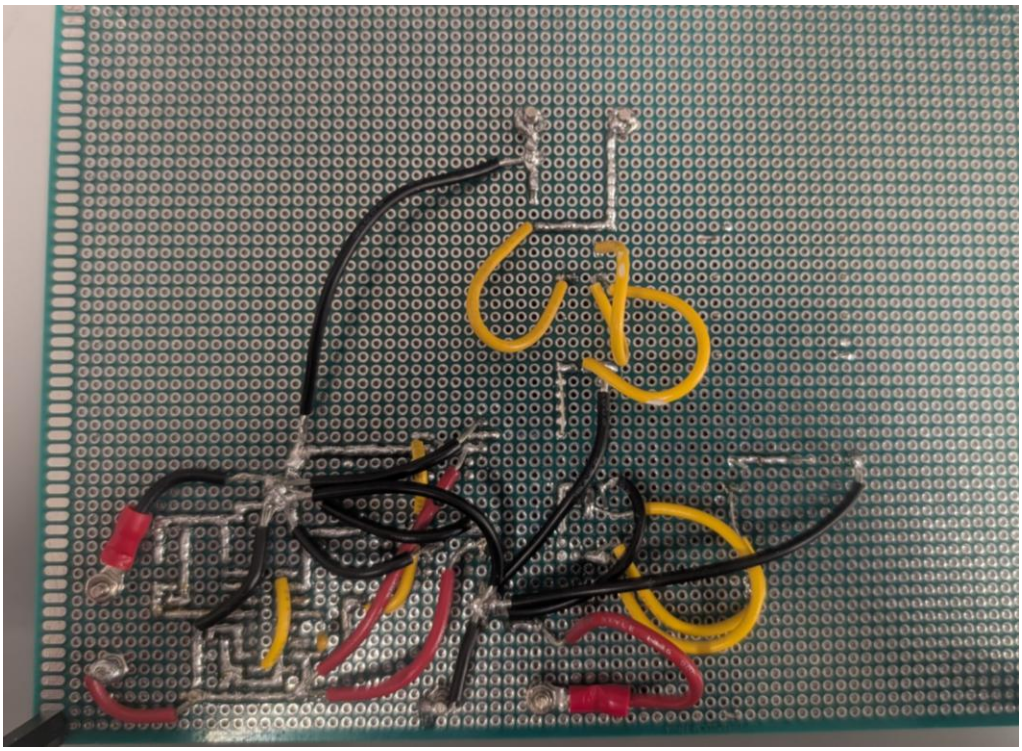
L1: 49uH

L2: 610uH

Step 4:



Top Side of Boost Converter



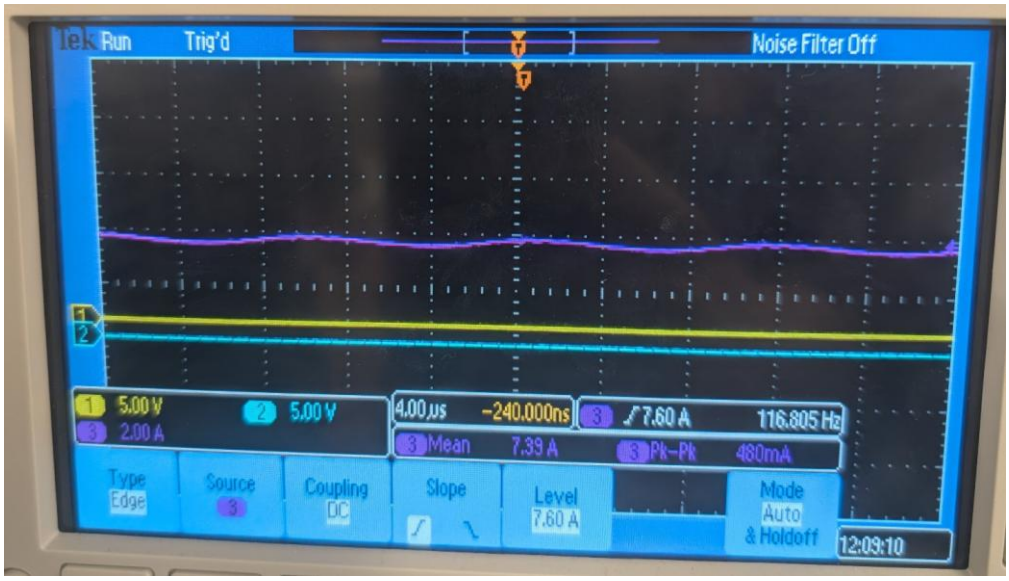
Bottom Side of Boost Converter

Step 5:

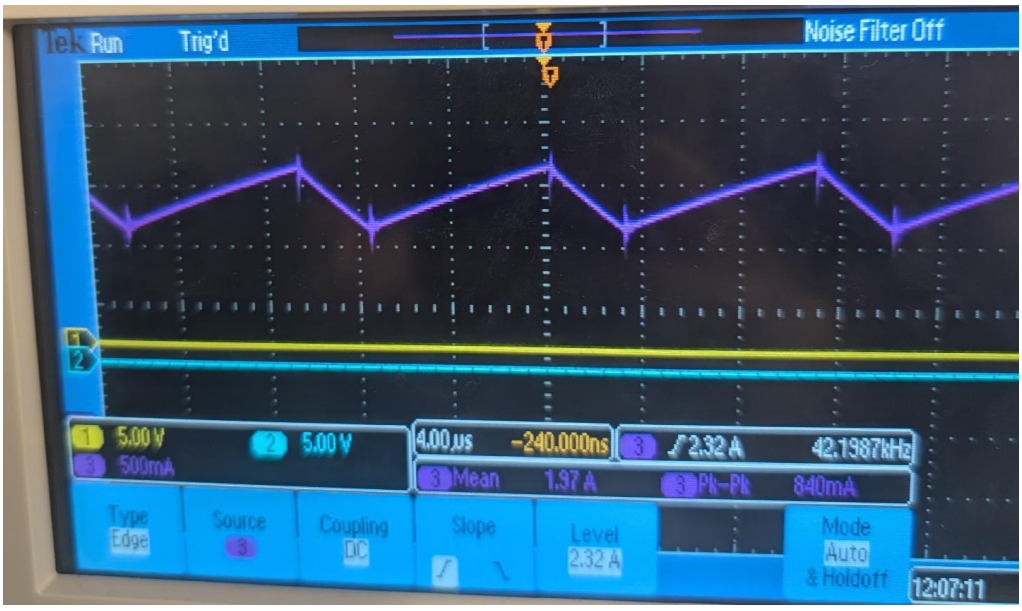
Input Voltage = 13.7V
Input Current = 7.87A
Input Power = 107.819W

Output Voltage = 150V
Output Current = 580mA
Output Power = 87W

Efficiency $\boldsymbol{\eta}$ **= 80.7%**



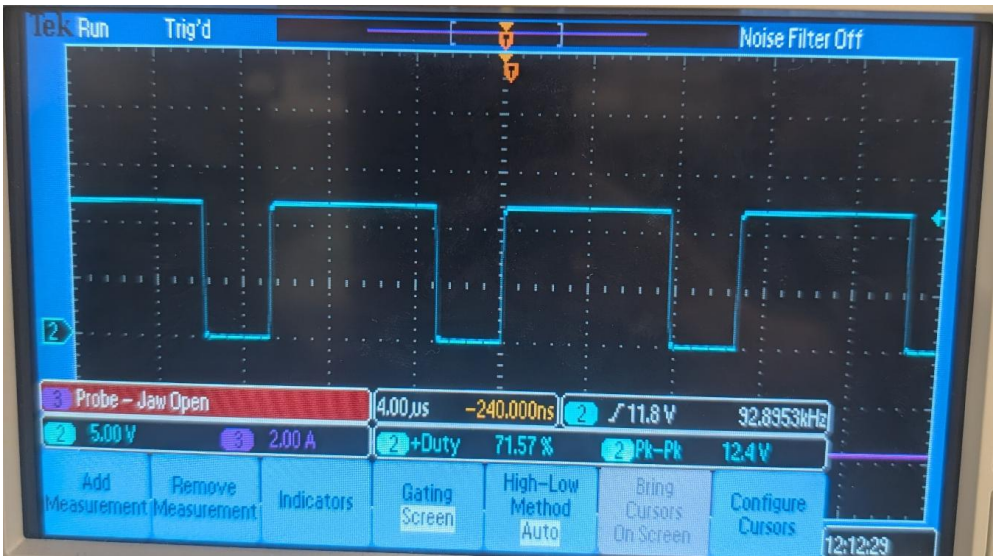
Inductor 1 Current
I_{L1} = 7.4A
ΔI_{L1} = 240mA



Inductor 2 Current

I_{L2} = 2A

ΔI_{L2} = 420mA



MOSFET 1 Drain-to-Source Voltage

Duty cycle = 71.6%

v_{ds1} = 12.4Vpp

MOSFET 2 Drain-to-Source Voltage

Duty cycle = 71.4%

v_{ds2} = 13.4Vpp