Experiment #4 Part 2
PV Power Electronics Laboratory

Completed By:
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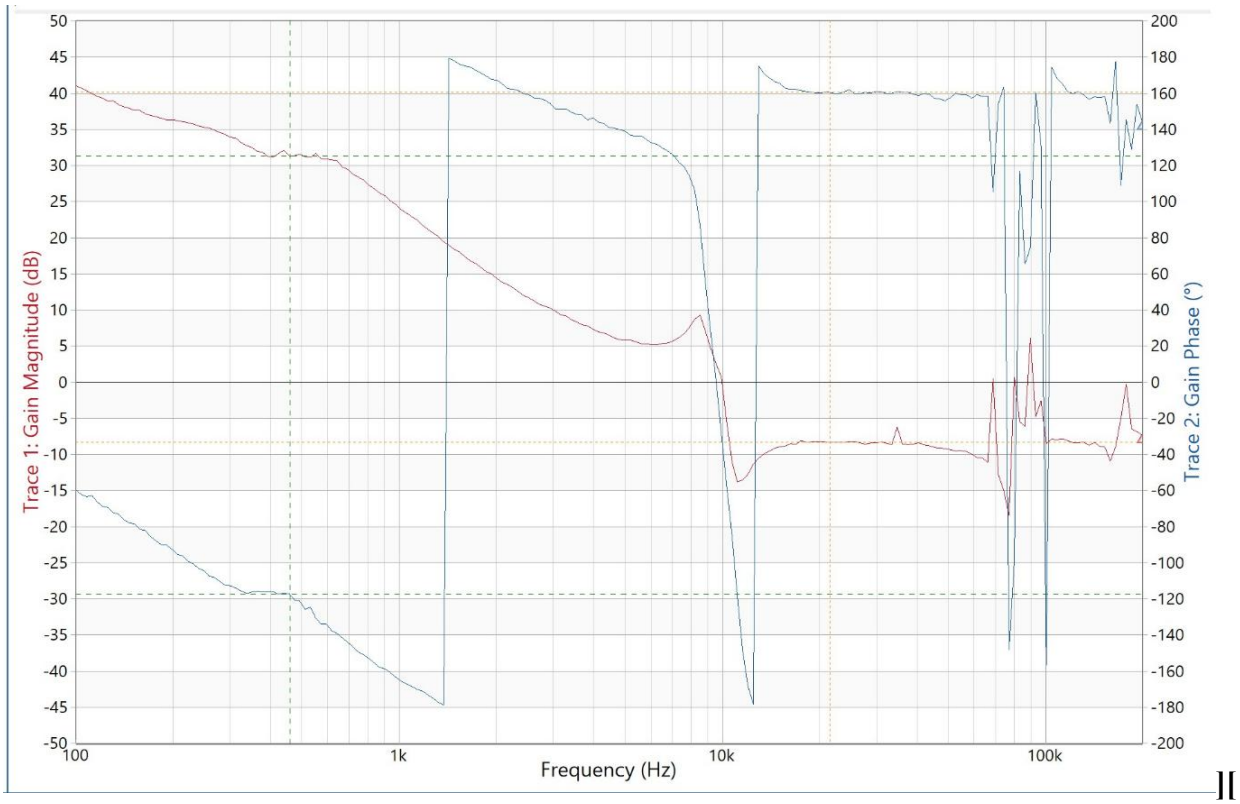
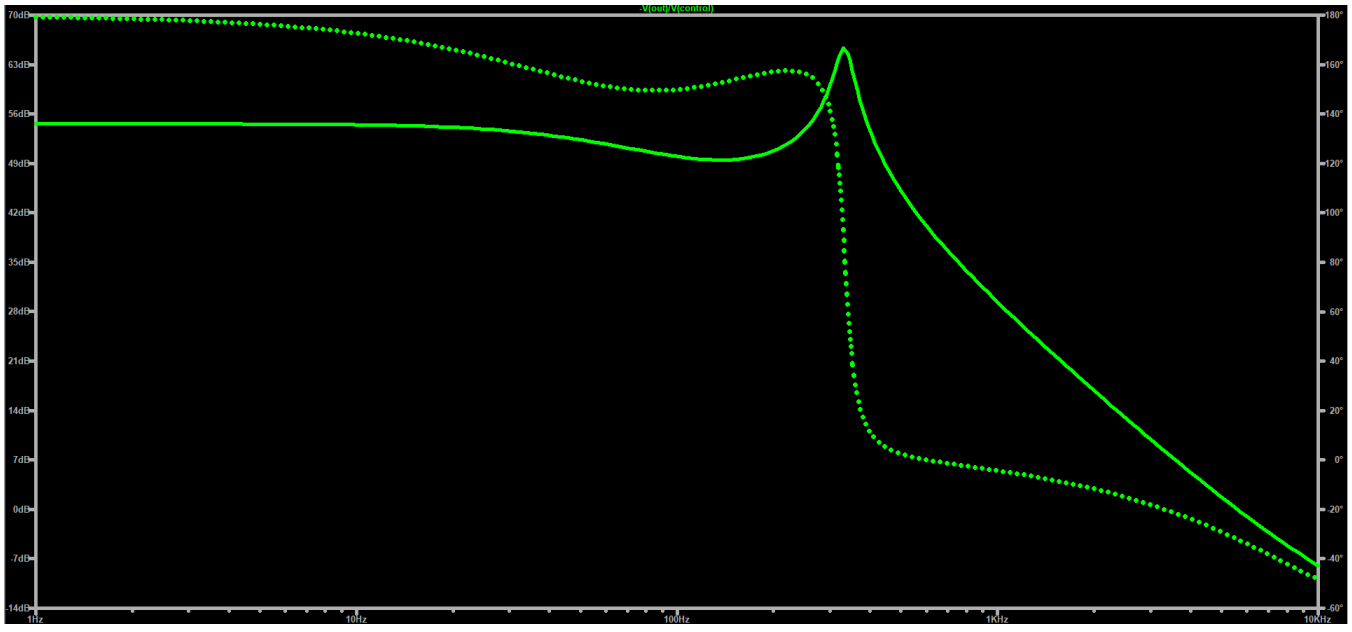
Step 1:

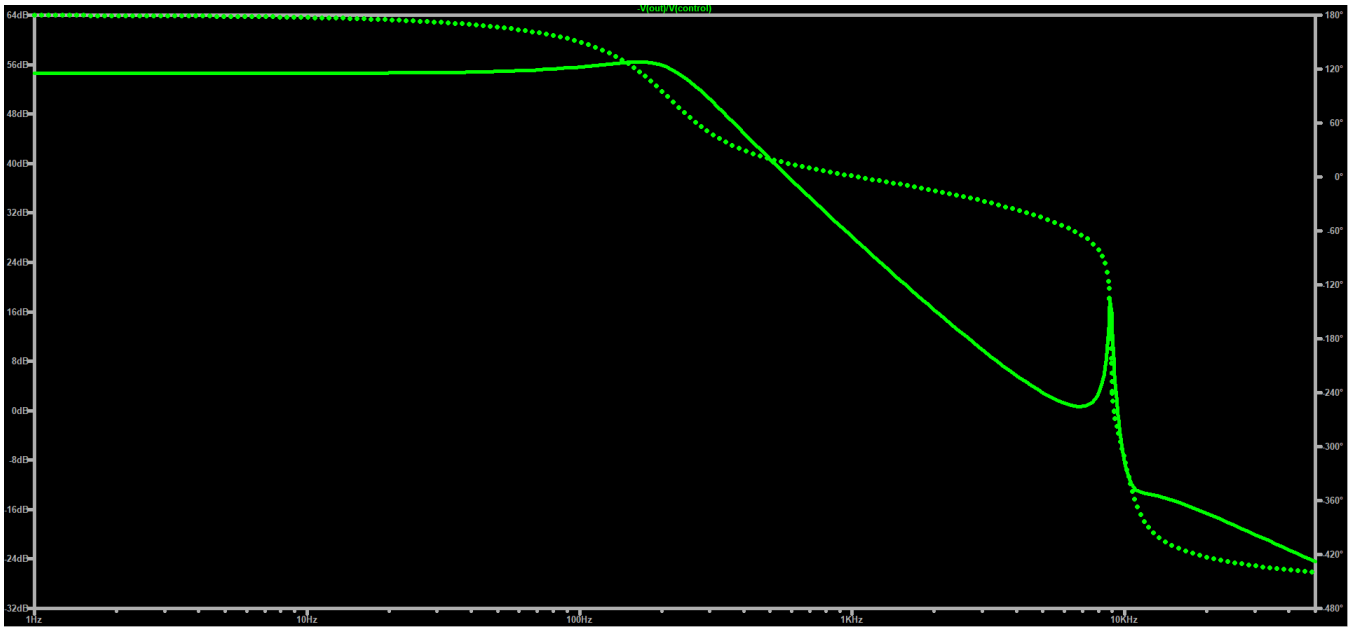


Cascaded Boost Converter Open Transfer Function (Measured)



Cascaded Boost Converter Open Transfer Function (Simulated)

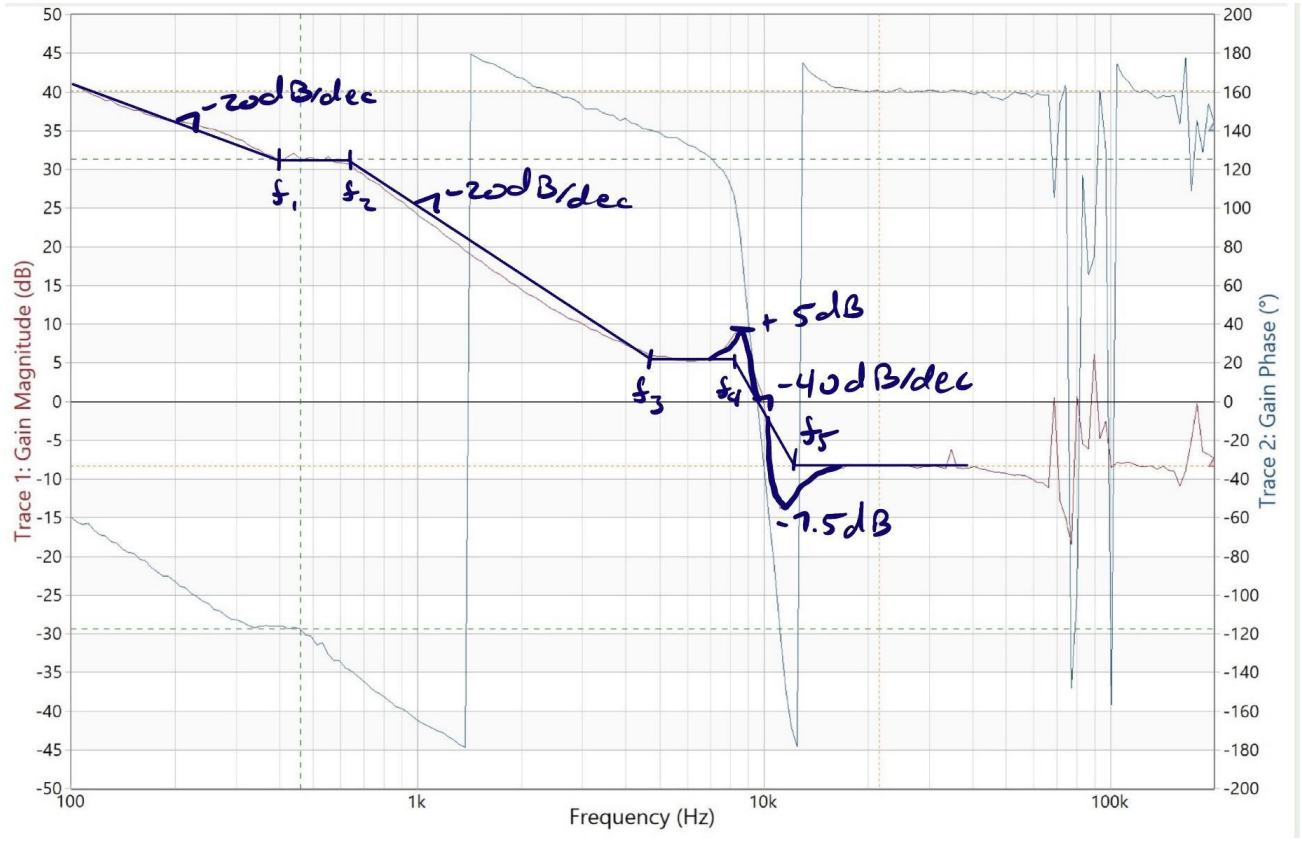
The plots differ in a lot of places, this is entirely due to the fact that the original capacitor we had in for C_2 was 1uF instead of 2200uF. Below is a simulation of what the transfer function looks like when we adjust the value of C_2 to match what was in the circuit.



Cascaded Boost Converter Transfer Function with 1uF C_2 (Simulated)

This looks much closer to what was actually measured. For future parts of this lab, the 1uF C_2 was changed to be the correct value of 2200uF.

Step 2:

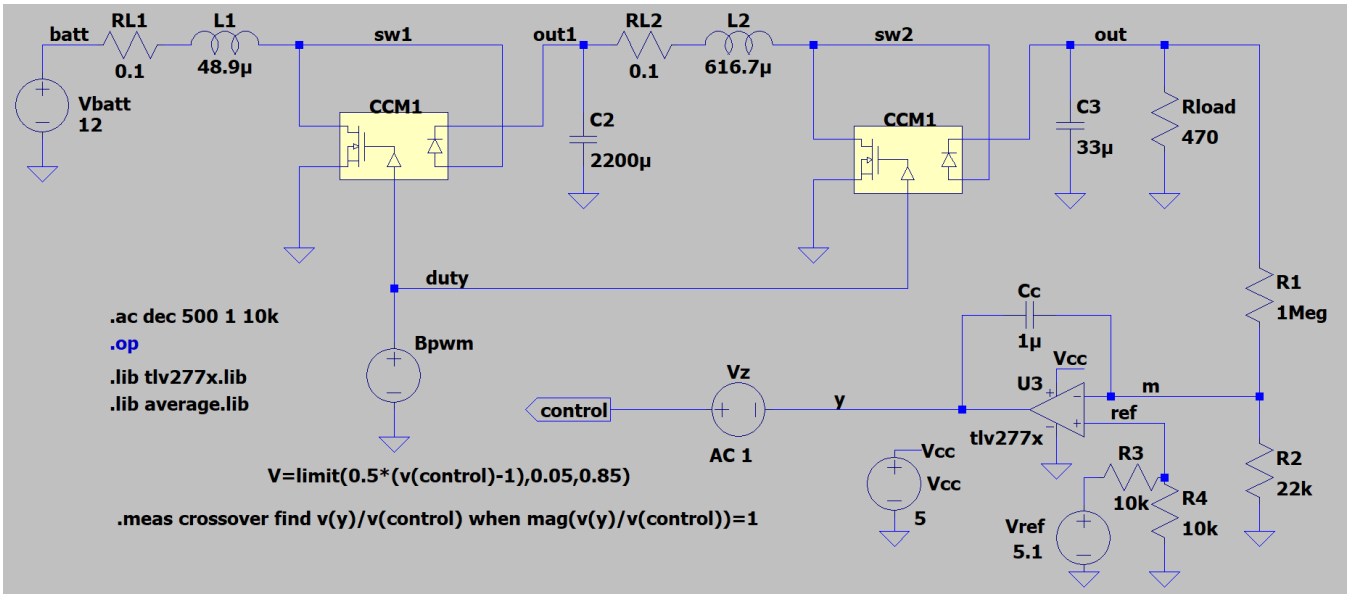


Open Loop Transfer Function Fitted Asymptotes

$$G_{vc}(s) = \frac{(1+\frac{s}{2\pi*400})(1+\frac{s}{2\pi*4.7k})(1+\frac{s}{0.422*2\pi*10k}+(\frac{s}{2\pi*10k})^2)}{(1+\frac{s}{2\pi*100})(1+\frac{s}{2\pi*650})(1+\frac{s}{1.78*2\pi*8.5k}+(\frac{s}{2\pi*8.5k})^2)}$$

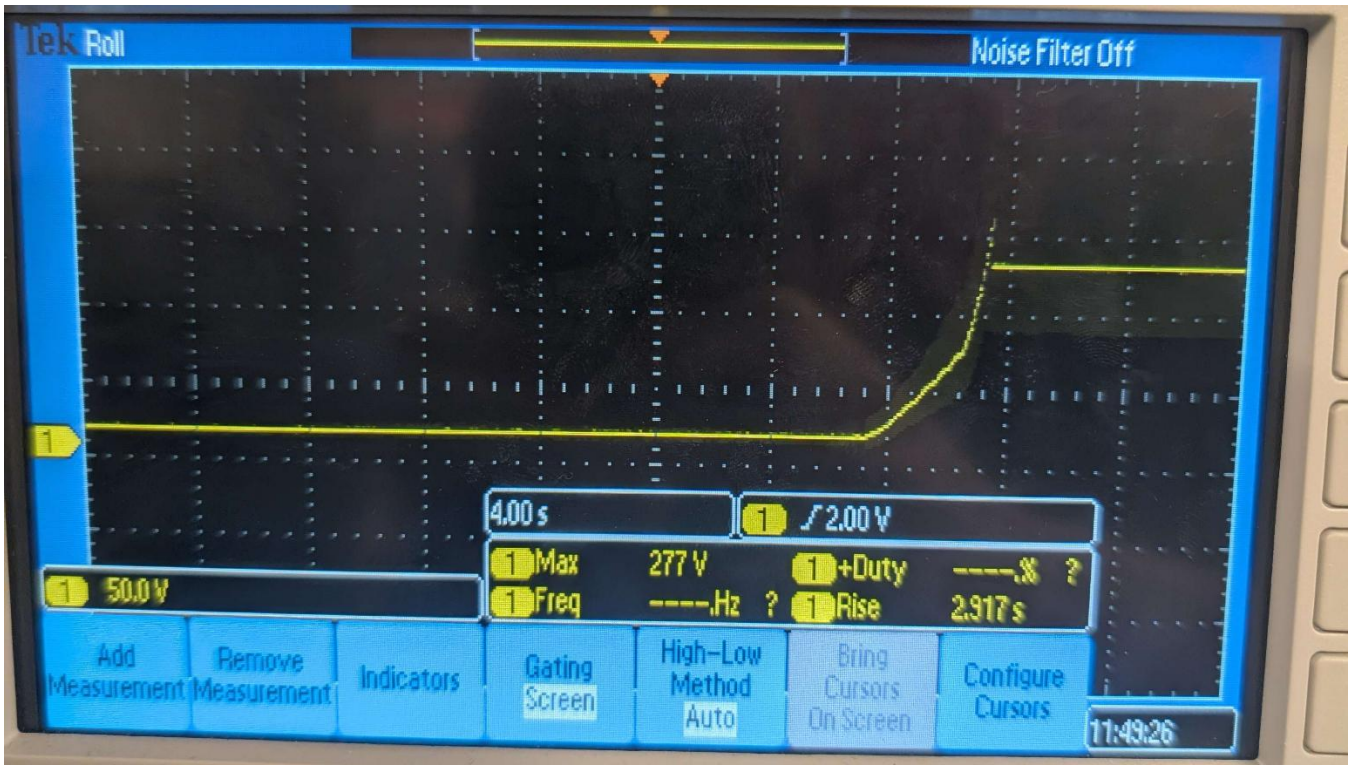
f_0 = 100 Hz (pole)
f_1 = 400 Hz (zero)
f_2 = 650 Hz (pole)
f_3 = 4.7 kHz (zero)
f_4 = 8.5 kHz (complex pole)
f_5 = 10 kHz (complex zero)
$|Q_1|_{dB}$ = 5 dB
$|Q_2|_{dB}$ = -7.5 dB

Step 3:
The integral compensator design needed a few updates to get the stability and compensation correct. After playing around with different resistor values for the boost converter output voltage divider we settled with R_1 = 1 M**Ω** and R_2 = 22 k**Ω**. These values might need to be adjusted for the next lab, but we were satisfied with the results from these.



Detailed Circuit Diagram for Compensator Circuit

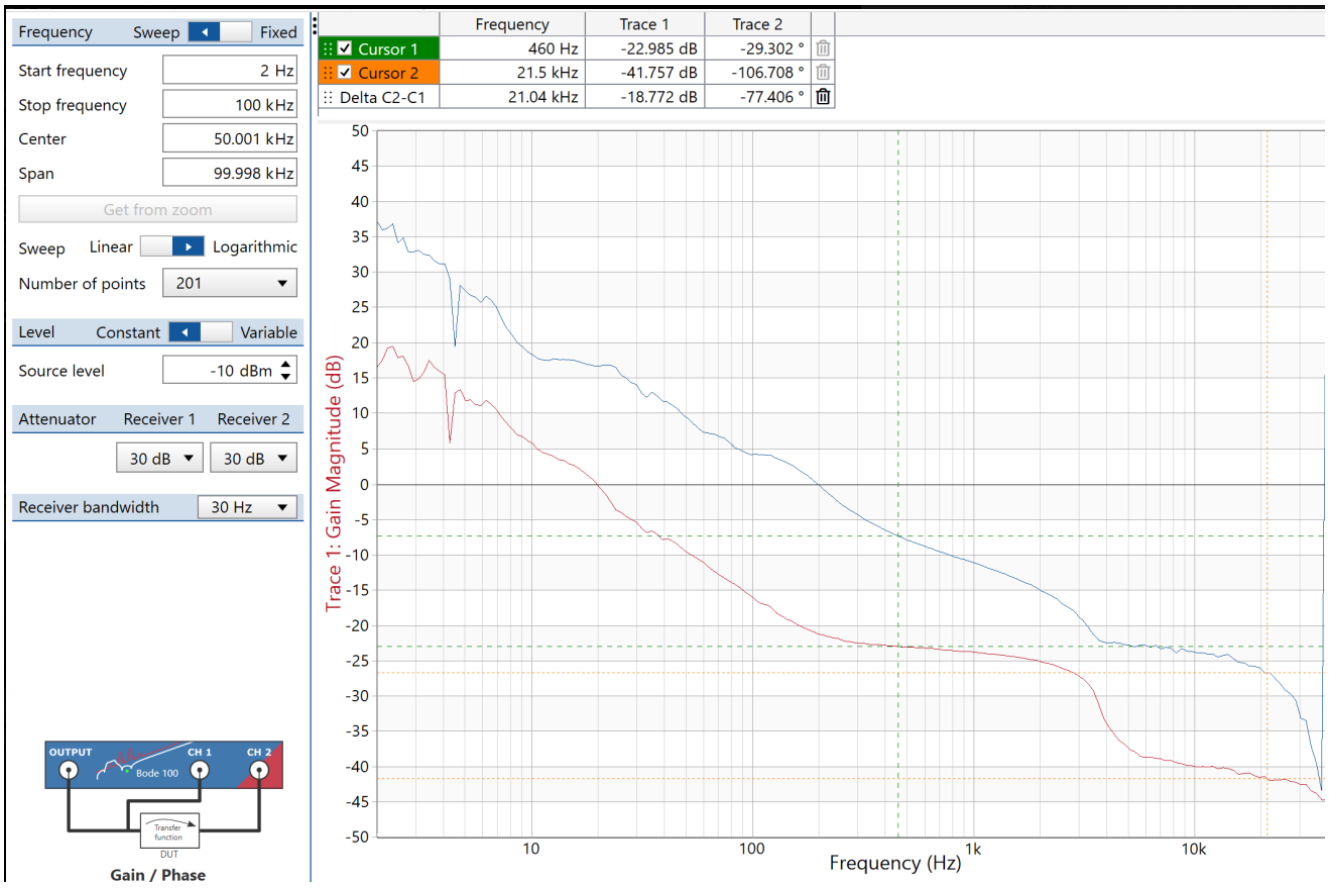
Step 4:
Switching Frequency = **92 kHz**
To measure the maximum duty cycle, we lowered the input voltage to drive the compensator output high. The duty cycle capped at around **88%** which is exactly what we had it set for.



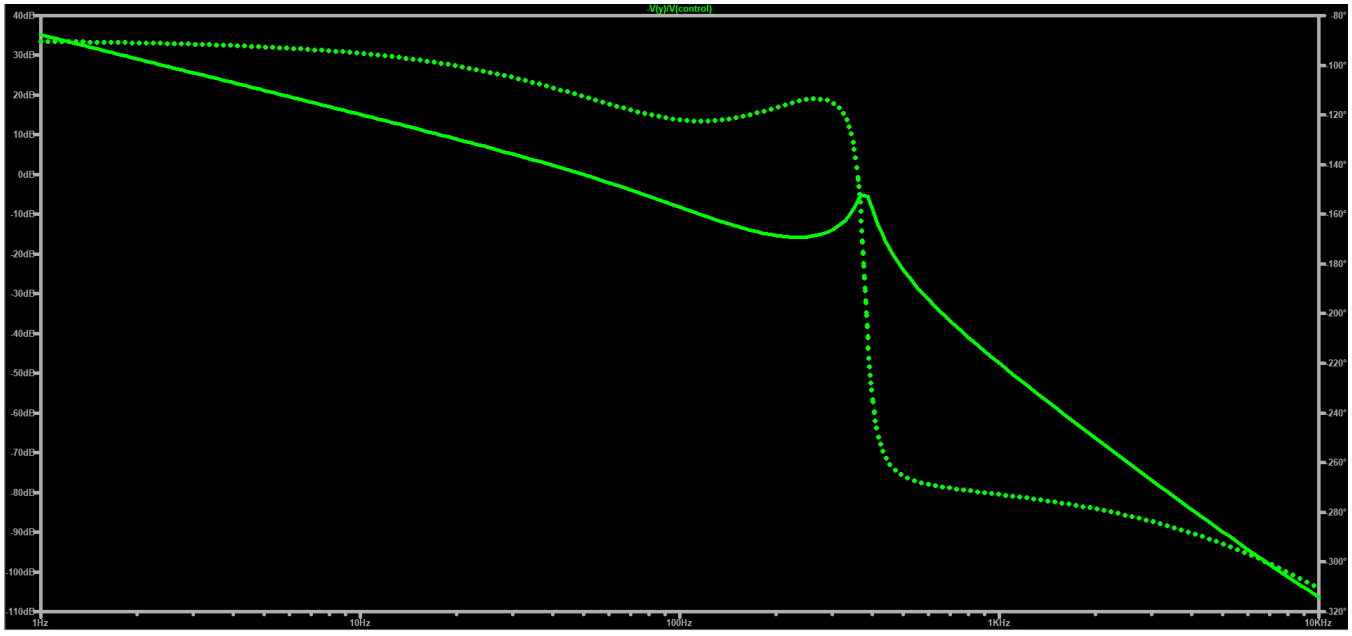
Start-up Output Voltage Transient

Measured start-up time: **2.917 S**

Step 5:



Bode100 Measured Loop Gain Bode Plot



Cascaded Boost Converter Closed Transfer Function (Simulated)

Our measured crossover frequency occurred at 20 Hz with a phase margin of (180°-16°) = 164°

Our crossover frequency indicates that our system would be relatively slower with its voltage regulation although it is very stable. To improve response in our compensator we will test decreasing C_C. Our simulation showed a crossover frequency of around 20 Hz and a similar phase margin to what we measured.

Step 6:

V_{in}	I_{in}	V_{out}	I_{out}	Duty Cycle	N
11V	**3.07A**	**127V**	**261mA**	**80%**	**98.16%**
12V	**2.66A**	**124V**	**251mA**	**78%**	**97.16%**
13V	**2.55A**	**124V**	**260mA**	**75%**	**97.25%**
14V	**2.41A**	**125V**	**265mA**	**72%**	**98.18%**

Regulation:

127V - 124V = 3V

3V/125V = 2.4% Regulation