EE561- PCB Design of closed loop operation of Boost converter

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1 Objective

Aim- Realize a closed loop control of boost converter controlled by analogue PI controller.The specifications for boost converter are given below :Input voltage Vin=96v Vo=200v fsw=20kHz output voltage ripple= 10% Inductor current ripple=20% Po=500w

2 Calculations

1.**Output Current,Input Current**:

$$Po = \frac{Vo^2}{R}$$

$$R = \frac{200^2}{500} = 80ohm$$

$$Io = Imin = \frac{Po}{Vo} = \frac{500}{200} = 2.5amps \qquad Iin = \frac{Po}{Vin} = \frac{500}{96} = 5.21amps$$

2.**Duty Ratio**:

$$Vo = \frac{Vin}{1-D}$$

$$200 = \frac{96}{1-D}$$

$$D = 0.52$$

3.**Inductance**:

$$L = \frac{DVs}{\triangle IL * fs} \quad but\ ; \frac{\triangle I_L}{I_L} = 0.2$$

$$also\ , \quad Is = IL = \frac{Io}{1-D}$$

$$therefore, \qquad L = \frac{0.52 * 96(1 - 0.520}{20 * 10^3 * 0.2 * 2.5} = 2.396mh$$

4.**Capacitance**:

$$C = \frac{D * I_o}{\triangle V_o * f} \quad but\ ; \frac{\triangle V_o}{V_o} = 0.1$$

$$therefore, \qquad C = \frac{0.52 * 2.5}{0.1 * 200 * 20 * 10^3} = 3.25uF$$

5.**Mosfet rating**:

$$V_{ds} = V_d + V_o$$

$$Thus, \quad V_{ds} \approx 200V$$

$$I_d = D * I_{in} = 0.52 * 5.21 \approx 2.7Amp$$

6.**Diode**:

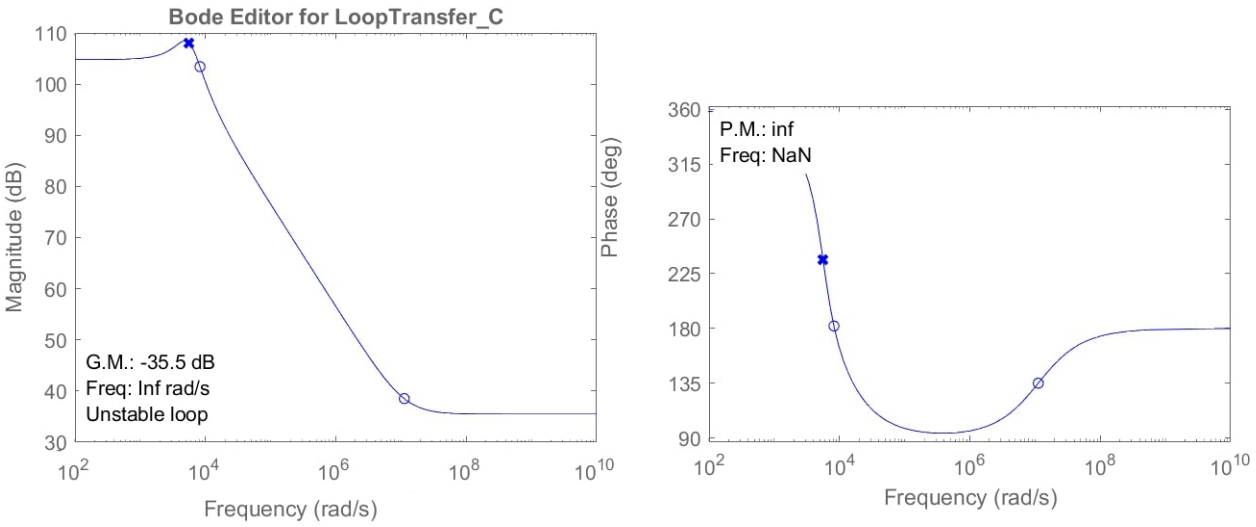
$$V_{RBmax} \approx 200V$$

$$I_d = I_o = 2.5Amp$$

3 Controller Design

3.1 Transfer function

$$\frac{V_o(S)}{D(S)} = \frac{-1.88 * 10^{-6}s^2 - 21.05s + 1.73 * 10^5}{3.155 * 10^{-8}s^2 + 0.000146s + 1}$$



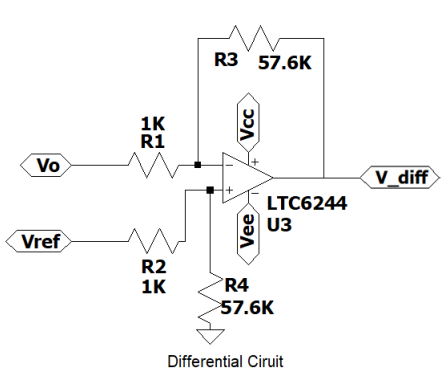
3.2 PI controller

Gain cross-over frequency was found out to be 1.02 kHz.The corresponding PI values were derived using SISO tool.

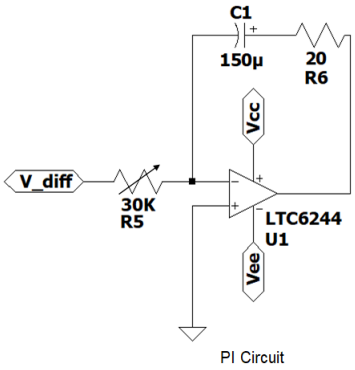
$$K_p \approx 0.0012, K_i \approx 0.3$$

3.2.1 Differential and PI controller

$$V_{cc} = 10V, V_{EE} = -10V$$



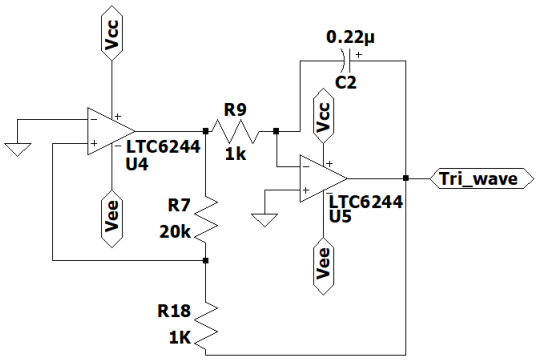
Differential Ciruit



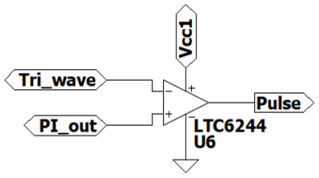
PI Circuit

3.2.2 Triangular Wave Generator and comparator

The output of PI controller is reversed and compared with a triangular wave to generate gate drive signals.



Triangular Wave
Generator (50 kHz)



Comparator

4 Components Selection

Component	Manufacturer ID	Description	Quantity
MOSFET	TK4A60D	V_ds=600V , I_d=4amp	1
Diode	QH03TZ600	V_rrm=600V , I_f=3amp	1
Resistor	1712-HCH335J82RJ-ND	R=82ohm ,wire wound , P_rating=500W	1
Opamp	NJM2122D	Slew rate=2.4V/us , Supply voltage= +/-(10)V	4
Capacitor	200LLE3RMEFC6.3X11	C=3.3uf , V_rated=200V	1
Rheostat	3362P-1-103LF	R=10 kohm and 30 kohm , P=0.5W	2
Inductor	SS28V-25045-CH	L=4.5 mh , I=2.5amp , R=160 mohm	2

5 Spice Model

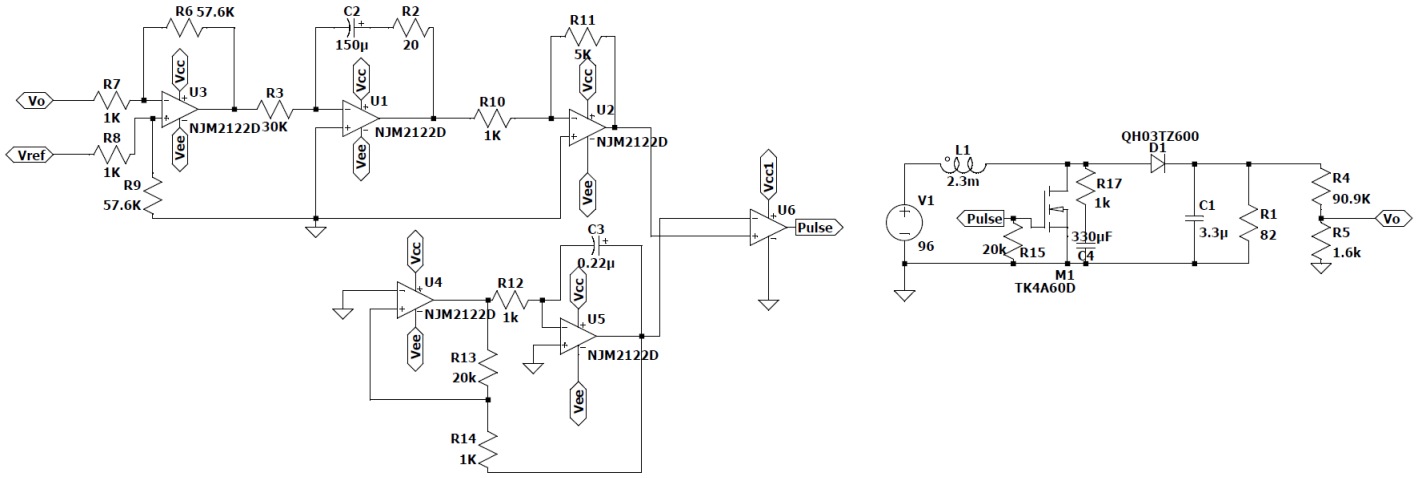


Figure 1: SPICE MODEL

6 PCB Model

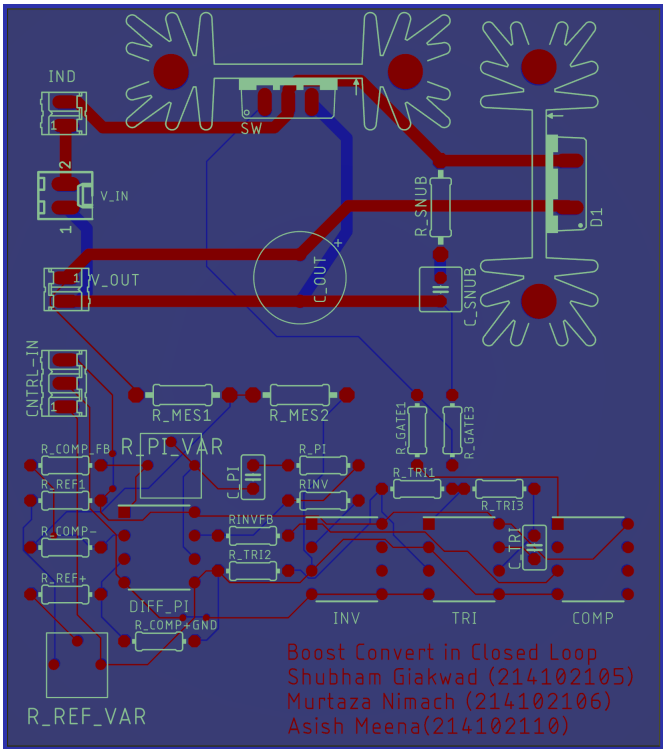


Figure 2: PCB MODEL