Simulation and PCB Designing of Buck Converter

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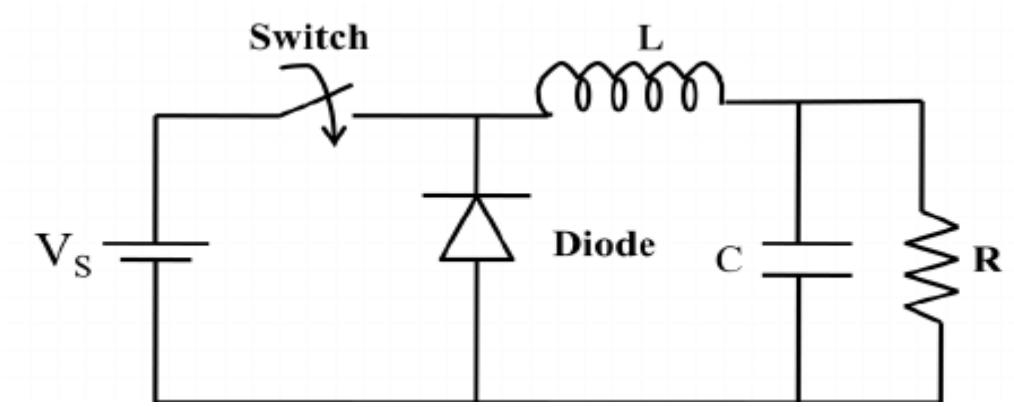
Objective:

The objective of experiment is to familiarize the student with MATLAB/SIMULINK and important simulation settings. For this a buck converter with the following parameter has to be designed and simulated.

Input Voltage	24 V
Output Voltage	12 V
Output power	100 W
Switching Frequency	100 kHz
Ripple in inductor current	25%
Ripple in output voltage	0.1%

Circuit Diagram:



Design Procedure and Calculation Output Voltage:

The value of inductance can be found by using the below expression

$$L=\frac{D(1-D)V_{in}}{\Delta I_L . f_{sw}} \quad (1)$$

$$V_o=D.V_{in} \quad (2)$$

Inductor value comes out to be= 28.8 μH

The capacitance value can be calculated by using the following expression

$$C=\frac{\Delta I\_L}{8 f\_s\_w\ \Delta V\_C} \quad (3)$$

The capacitance value comes out to be approximately= 217 µF.

Transfer Functions of Buck Converter:

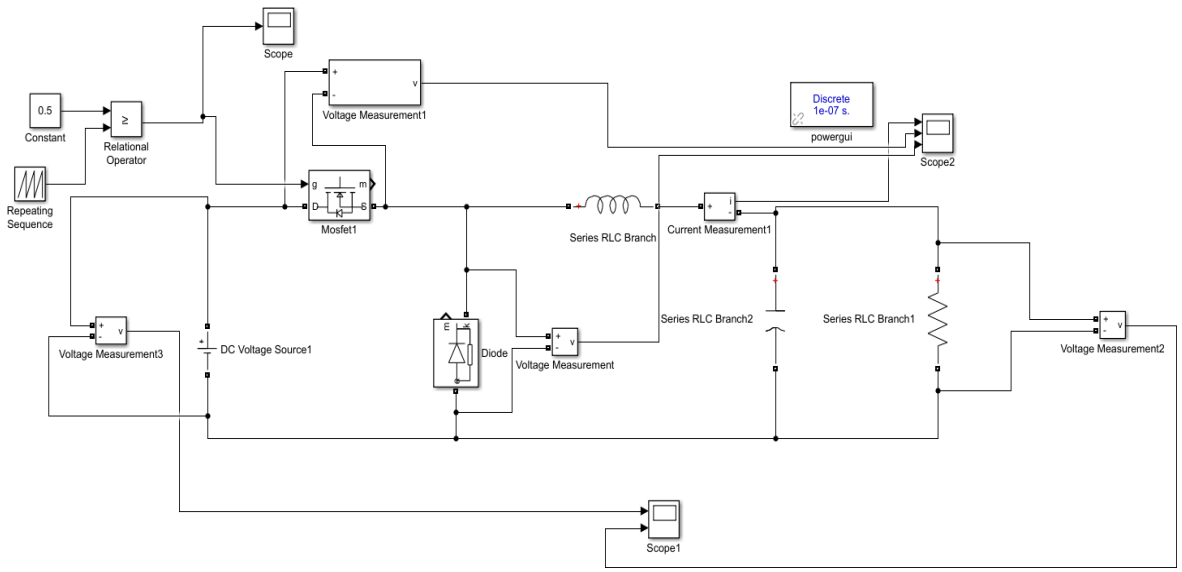
$$\frac{V\_0(s)}{V\_in(s)} = \frac{V\_in}{s\text{^}2\ LC + sL + \frac{L}{R}}$$

$$\frac{V\_0(s)}{d(s)} = \frac{D}{s\text{^}2\ LC + sL + \frac{L}{R}}$$

Code for Bode plot of boost converter:

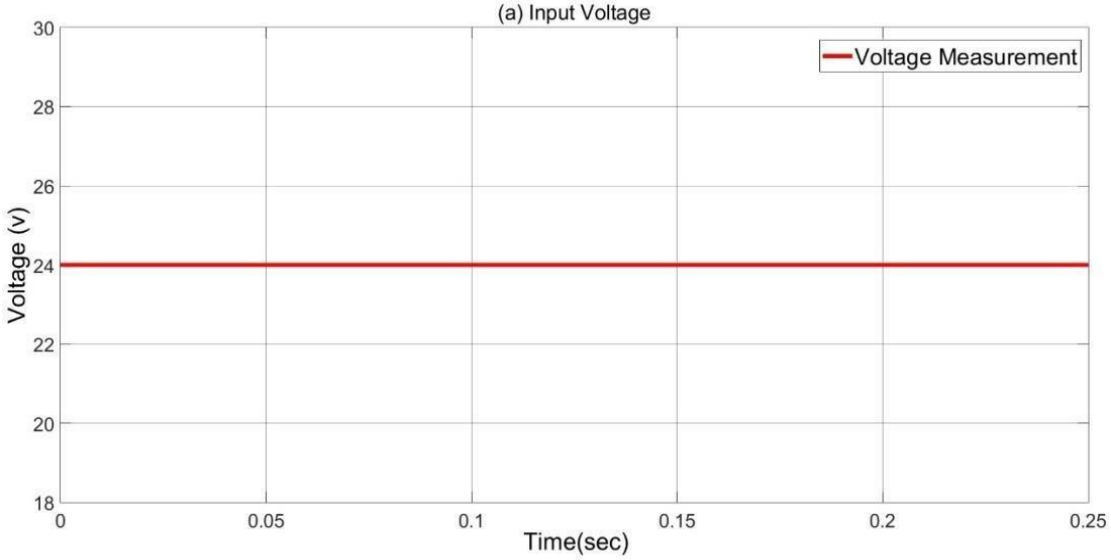
```
vin=48;
D=0.5;
R=5;
fs=50e3;
C=200e-6;
L=0.125e-3;
%H=v0/d% H=tf(vin,[L*C,L/R,1]); display(H);
figure(1) margin(H); bode(H) grid
[Gm,Pm,Wcg,Wcp] = margin(H);
[p,z] = pzmap(H);
%G=vin/vo% G=tf(D,[L*C,L/R,1]);
display(G); figure(2) bode(G) margin(G); grid
[Gm,Pm,Wcg,Wcp] = margin(G);
[p,z] = pzmap(G);
```

MATLAB/SIMULINK SIMULATION

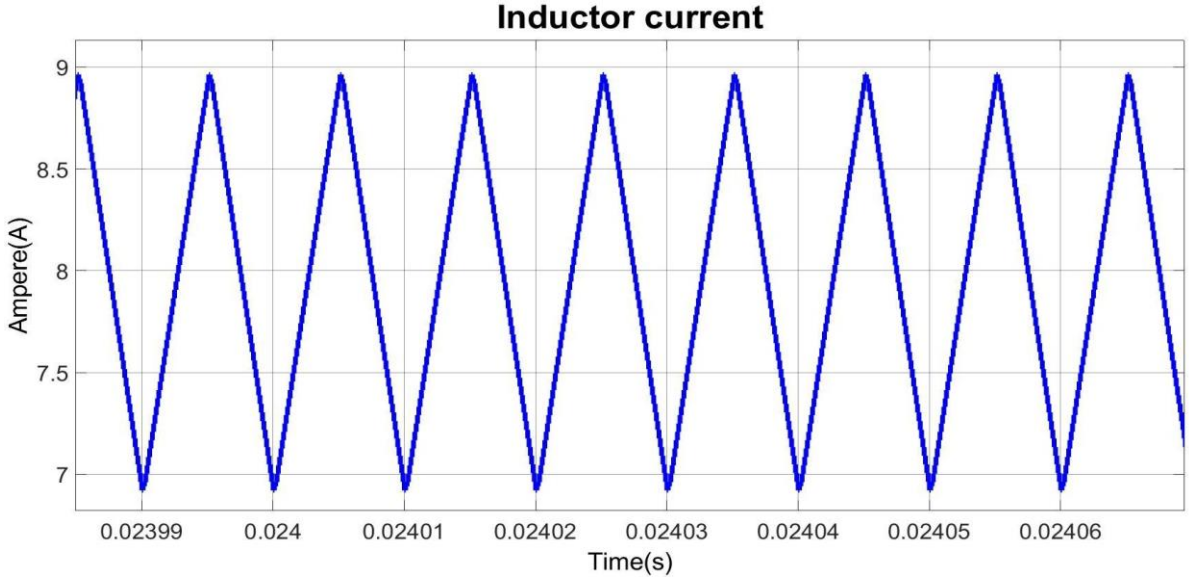


SIMULATED WAVEFORMS:

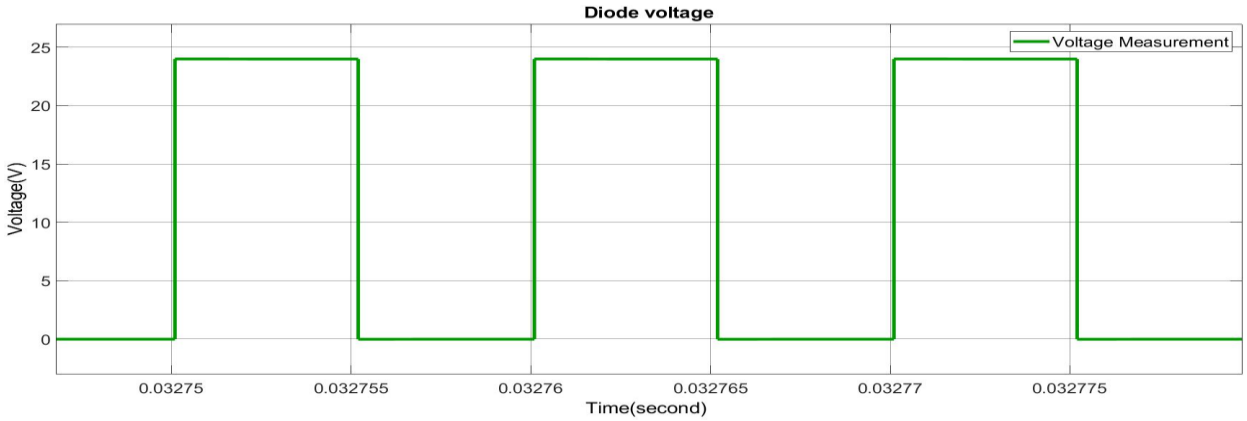
Input Voltage



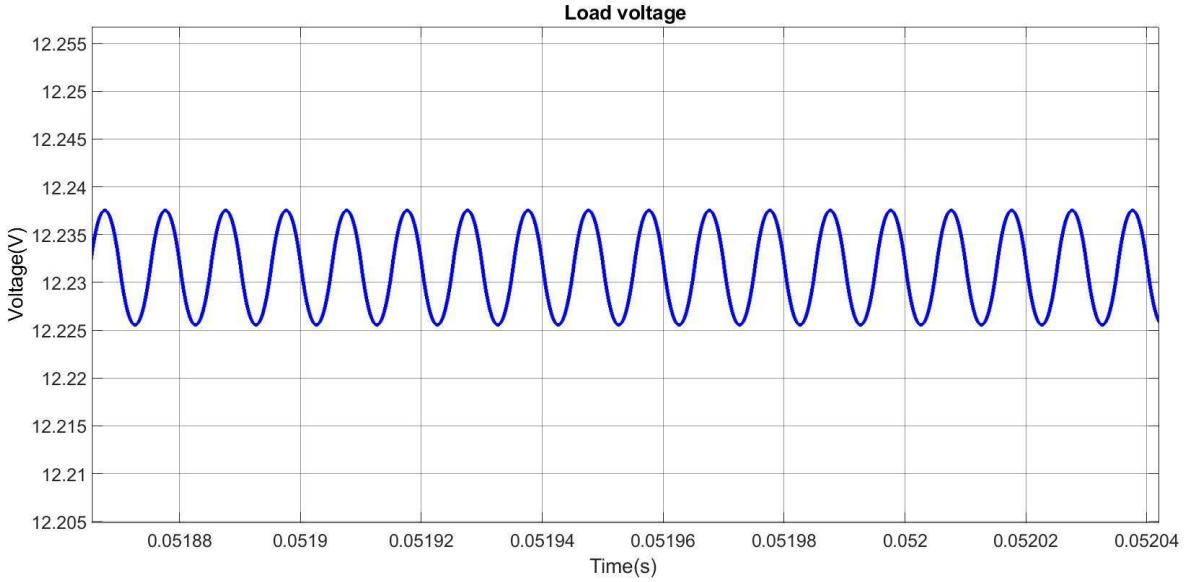
Inductor current



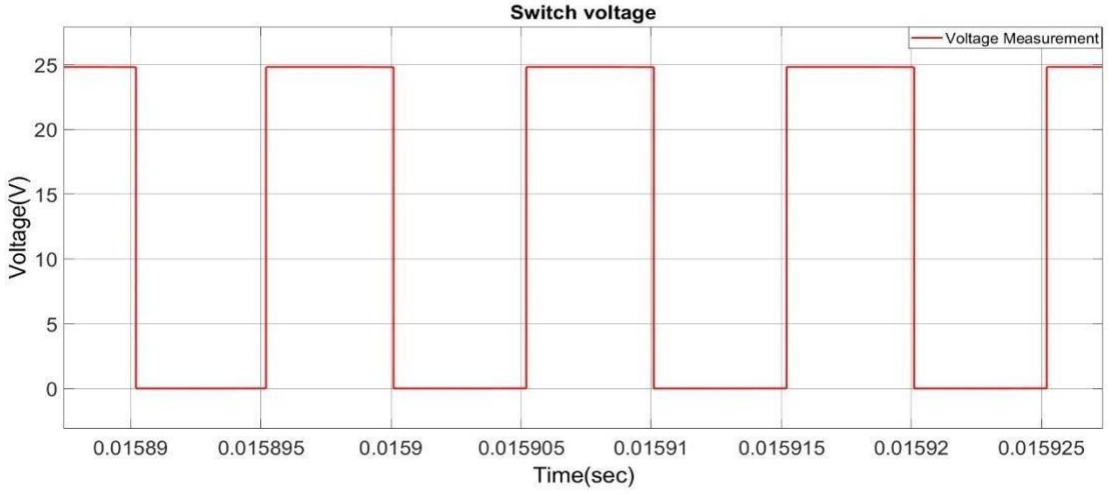
Switching signal



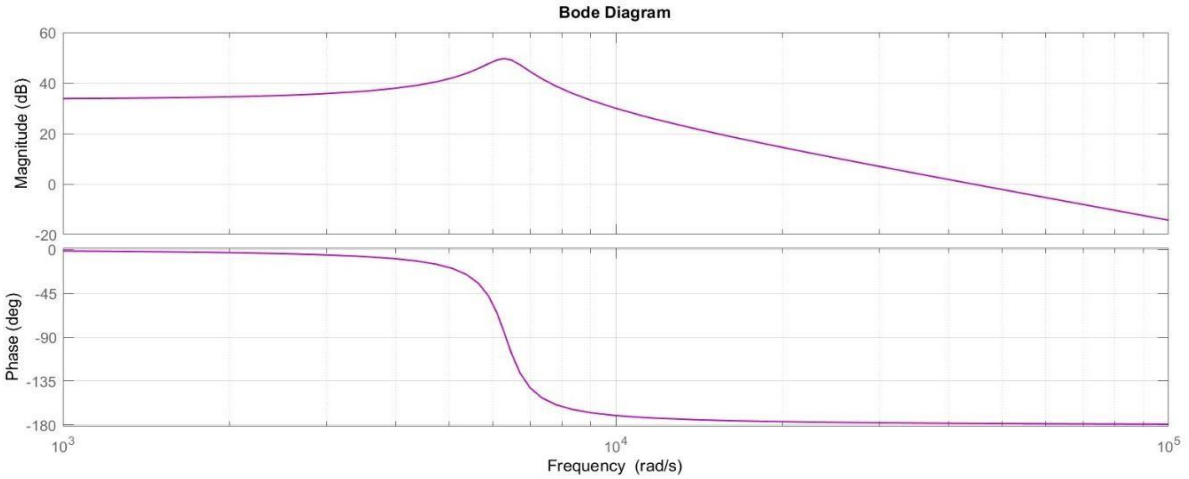
Output Voltage

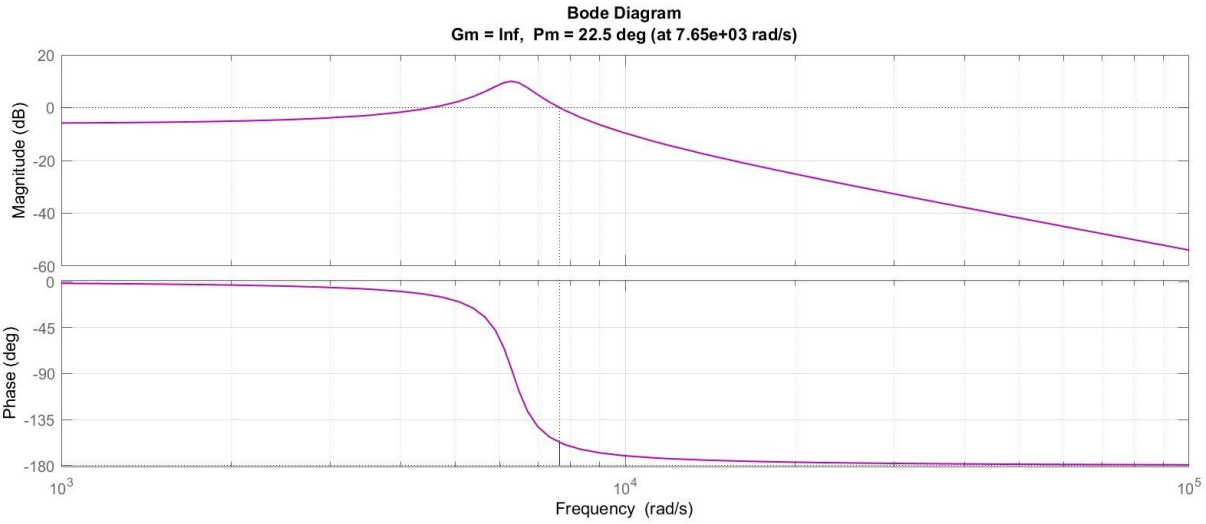


Voltage across switch

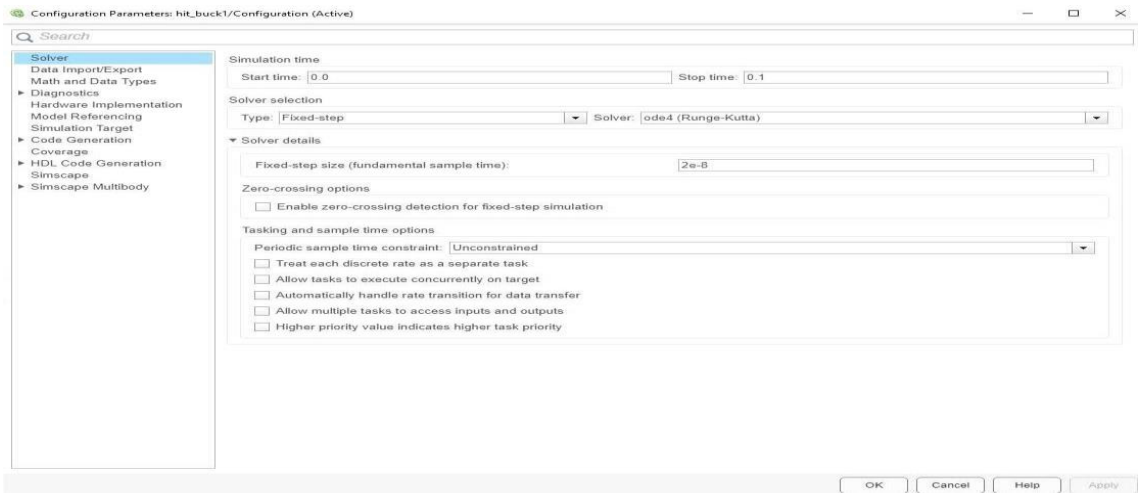


Bode Plots of Buck converter:



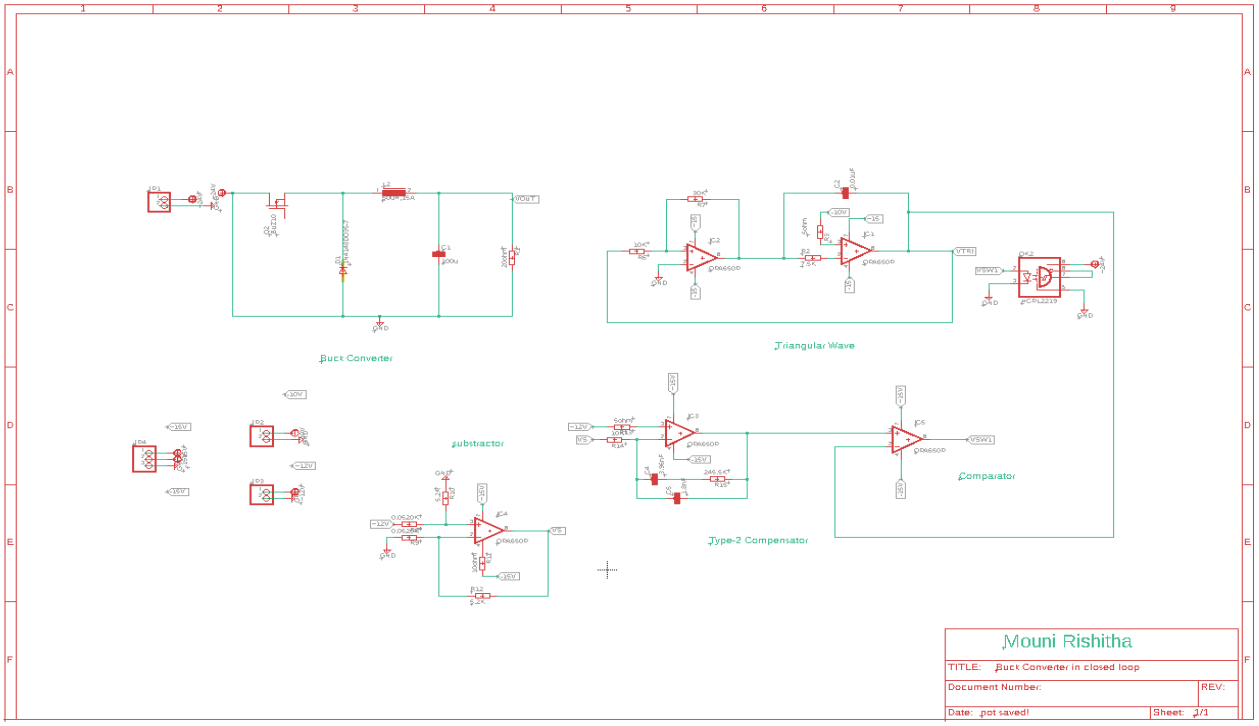


Simulation configuration parameters:

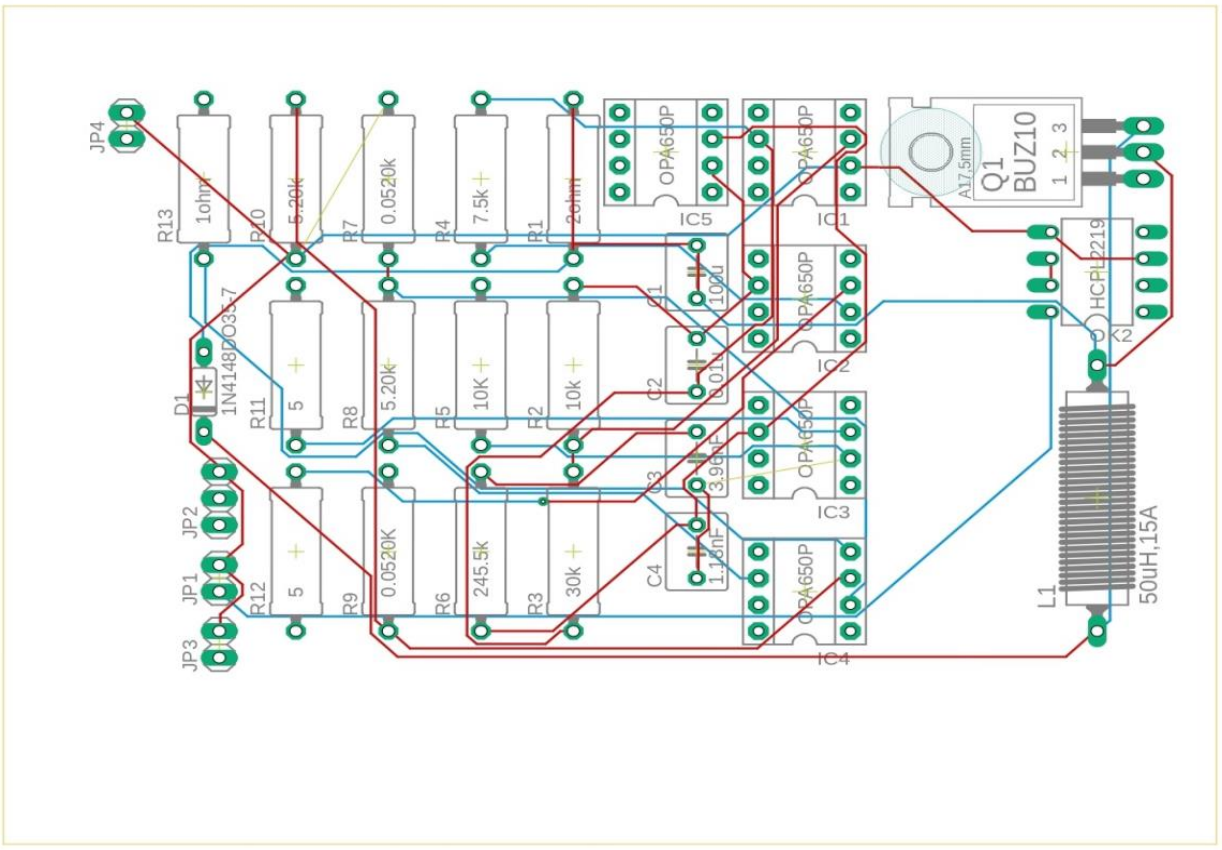


```
>> bodeplotbuck
H =

                  48
  ------------------------------
  2.5e-08 s^2 + 2.5e-05 s + 1

Continuous-time transfer function.
Model Properties

p =

    1.0e+03 *

  -0.5000 + 6.3048i
  -0.5000 - 6.3048i

z =

  0x1 empty double column vector

G =

                 0.5
  ------------------------------
  2.5e-08 s^2 + 2.5e-05 s + 1

Continuous-time transfer function.
Model Properties

p =

    1.0e+03 *

  -0.5000 + 6.3048i
  -0.5000 - 6.3048i

z =

  0x1 empty double column vector

>>
```

PCB Schematic:



PCB Board:



PCB Manufacturing Diagram: