
Self Project

Output Voltage Regulation of Buck Converter using Type-2 Compensator

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➤ **Objective:**

The objective of this experiment is to design a Type2 compensator for a buck converter to regulate its output voltage.

➤ **Parameters:**

Parameter	Value
Input Voltage	24
Inductor	50μH
Capacitor	100μF
Load resistance	2Ω
Switching frequency	100kHz
Desired gain crossover frequency of compensated system	90 to 120 degrees

➤ **Compensator Design(K factor Method):**

For type2 compensator we have the Transfer function given by

$$G_{c2} = \frac{G_{MB}(1+\frac{w_z}{s})}{(1+\frac{s}{w_p})} \dots\dots\dots(1)$$

where $G_{MB} = \frac{1}{\text{Plant gain at } w_c}$;Absolute gain

$$w_z = \frac{w_c}{k}$$

$$w_p = kw_c$$

$$k = \tan(45 + \text{boost}/2)$$

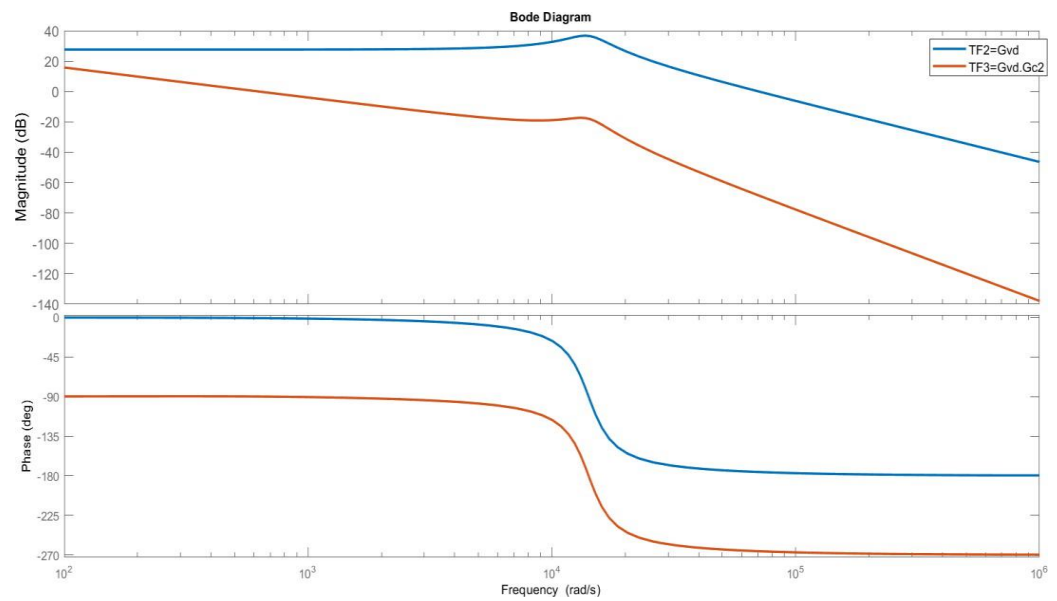
$$G_{vd} = \frac{V_{in}}{s^2 LC + \frac{SL}{R} + 1}$$

After substituting the values we got the following Transfer function

$$G_{c2} = \frac{26.54 s + 16401}{s^2 + 638 s}$$

$$G_{vd} = \frac{24}{5e^{-9}s^2 + 25e^{-6}s + 1}$$

➤ Bode Plot



➤ Stability Margins:

a) Gvd

GainMargin: Inf

GMFrequency: Inf

PhaseMargin: 4.2185

PMFrequency: 7.0620e+04

DelayMargin: 1.0426e-06

DMFrequency: 7.0620e+04

P1=1.0e+04 *(-0.2500 +i1.3919)

P2=1.0e+04 *(-0.2500 -i1.3919)

b) Gc2

GainMargin: 7.8542

GMFrequency: 1.4146e+04

PhaseMargin: 90.0123

PMFrequency: 628.0470

DelayMargin: 0.0025

DMFrequency: 628.0470

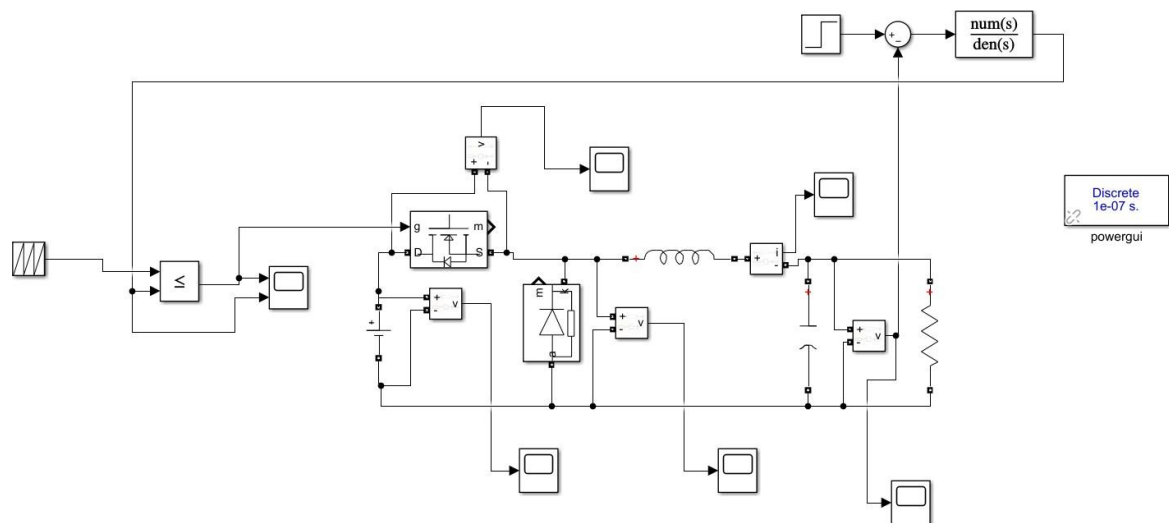
P1= 0.0000 + 0.0000i

P2=-0.2500 + 1.3919i

P3= -0.2500 - 1.3919i

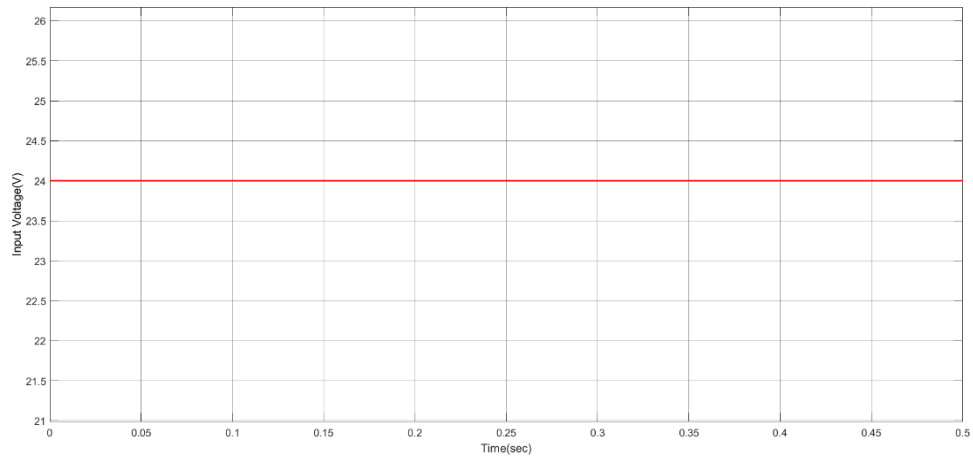
P4=-0.0638 + 0.0000i

➤ MATLAB/SIMULINK SIMULATION

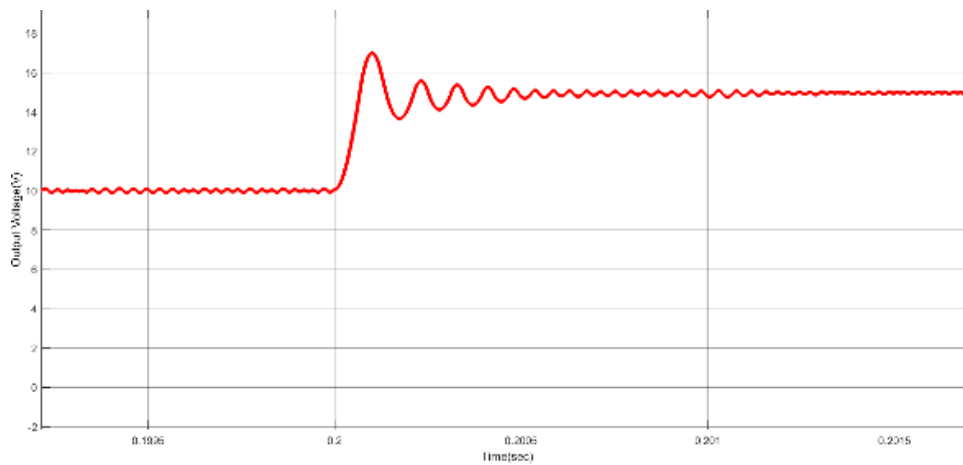


➤ SIMULATED WAVEFORMS

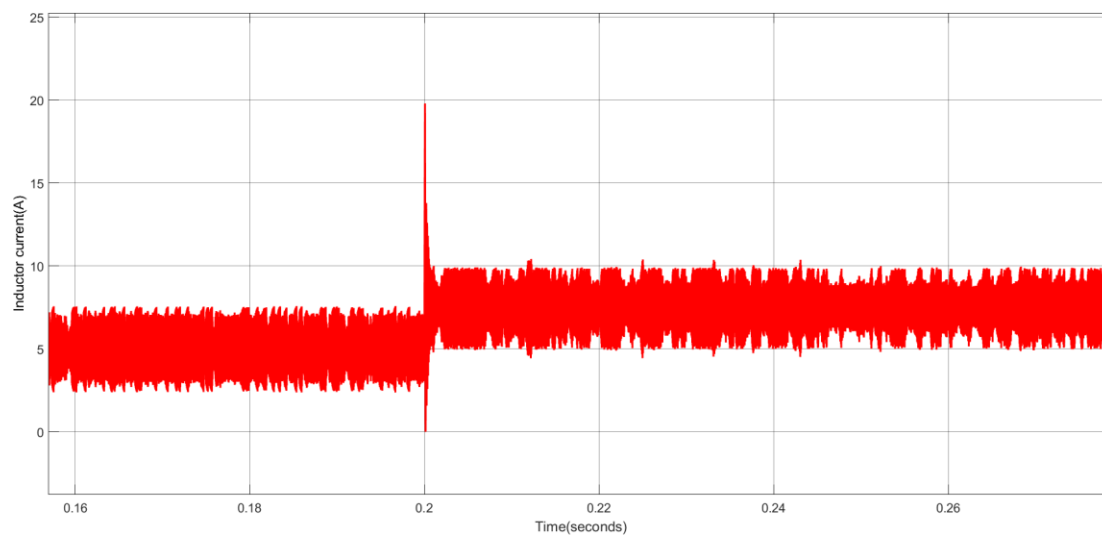
a) Input Voltage



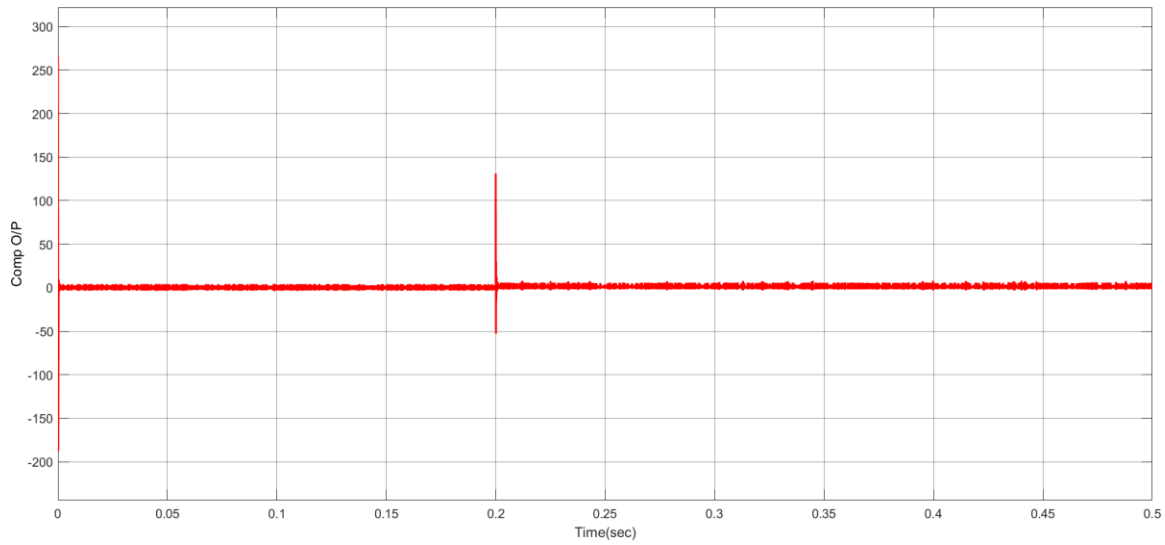
b) Output Voltage



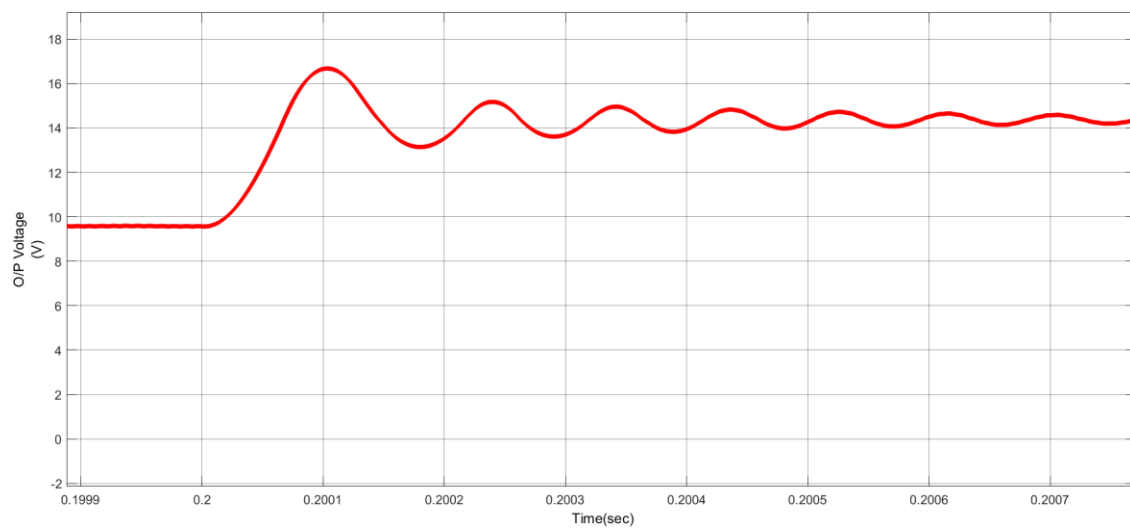
c) Inductor Current



d) Compensator Output



e) Output Voltage without Compensator



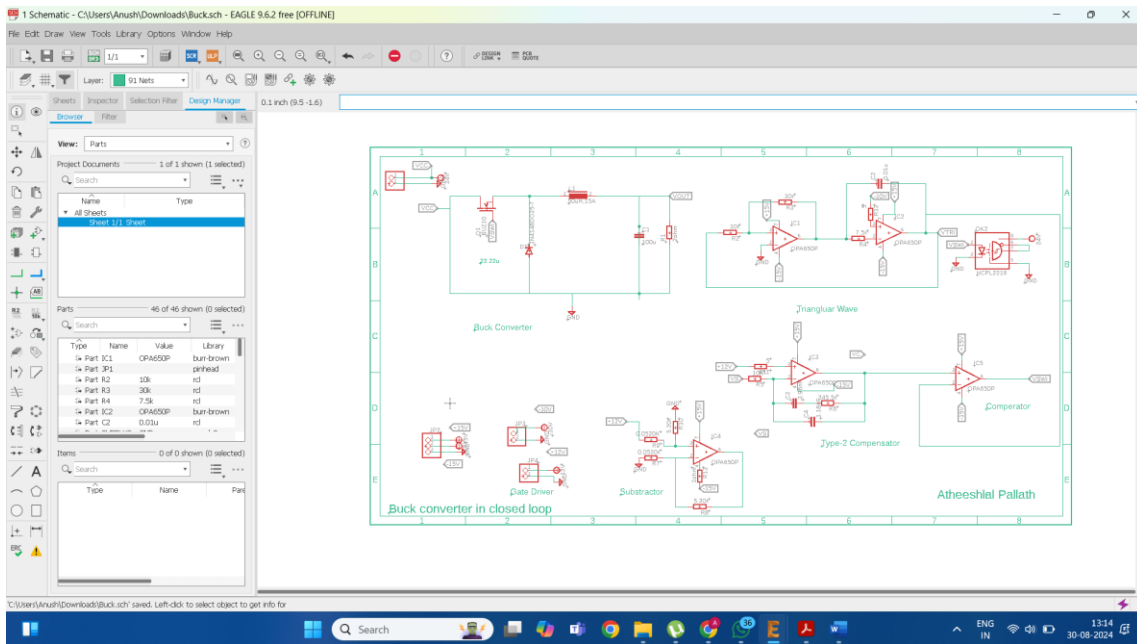
➤ Simulation configuration parameters

The screenshot shows the 'Solver' configuration window in MATLAB/Simulink. The left sidebar lists various settings categories, with 'Solver' selected. The main panel contains the following configuration options:

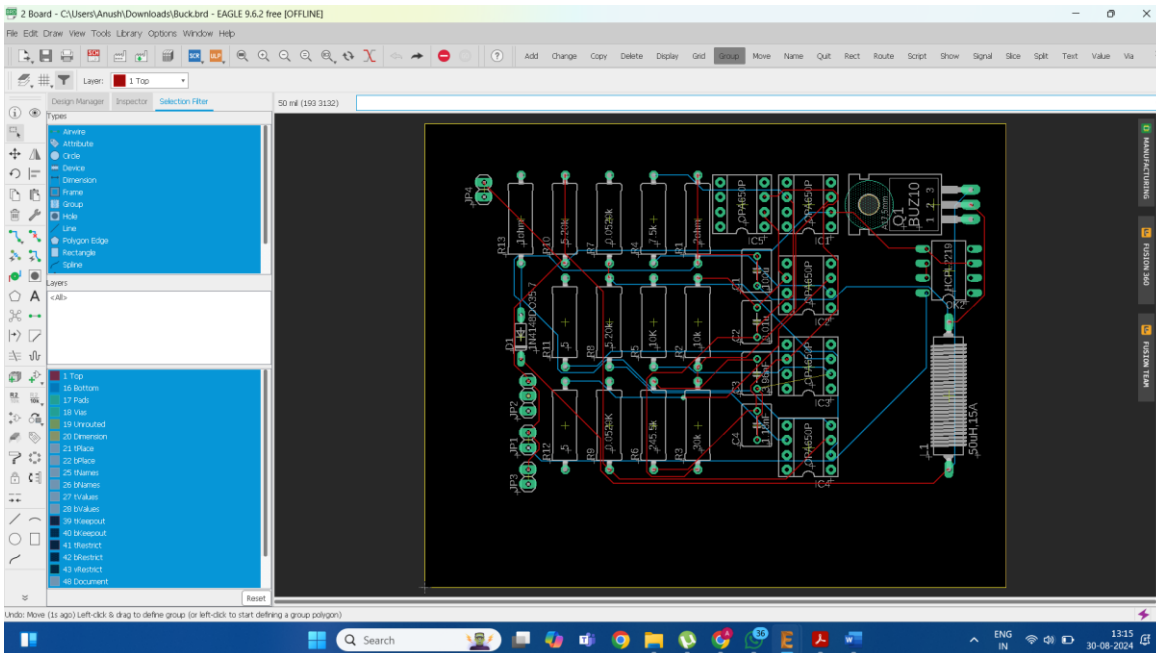
- Simulation time:** Start time: 0.0, Stop time: 0.5.
- Solver selection:** Type: Fixed-step, Solver: ode4 (Runge-Kutta).
- Solver details:** Fixed-step size (fundamental sample time): 1e-7.
- Tasking and sample time options:** Periodic sample time constraint: Unconstrained. Below this are four unchecked checkboxes: 'Treat each discrete rate as a separate task', 'Allow tasks to execute concurrently on target', 'Automatically handle rate transition for data transfer', and 'Higher priority value indicates higher task priority'.

At the bottom right, there are buttons for 'OK', 'Cancel', 'Help', and 'Apply'.

Eagle Schematic:



PCB Design:



➤ Conclusion

In this experiment we designed a type 2 compensator for regulating the output voltage of a buck converter. We used a type 2 compensator to improve the transient response along with stability margins. We can observe that the peak overshoot has also been reduced by using a compensator.

Then the PCB design of the whole system was implemented with the help of Eagle Software.