EE 252

Electric Machines and Power Electronics Lab (EMPEL)

Group E1-B2

Project Lab Report

DC-DC Boost Converter

Problem Statement :

Simulate the DC-DC converter for the given specifications:

a) Specifications: Input 7.5 V, Output 12.5 V, Switching frequency 12 kHz, Output current 1A.Waveforms of Inductor current and switch voltage in CCM.

b) Increase load resistance to demonstrate DCM.

Submitted by :

Abhijeet Parmar (230002001)

Atharvakant Chandorikar(230002013)

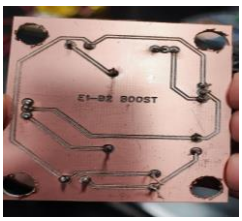
David kumar (230002022)

Kanav Bansal (230002033)

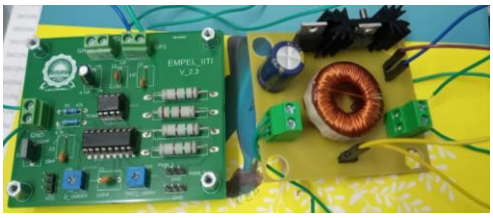
Boost Converter Report

Picture of soldiered Gate Driver and Converter :

Gate Driver(Back)



Converter(Back)



Gate Driver-(left) Converter-(Right) (Front)

Specifications:

- Input Voltage (Vg): 7.5 V
- Output Voltage (Vo): 12.5 V
- Switching Frequency: 12 kHz
- Output Current: 1 A
- Inductance (L): 1 mH
- Inductor Resistance (rL): 0.6 Ω
- Diode Forward Voltage Drop (VD): 1.1 V

Calculations:

1. Theoretical Duty Cycle (D)

Formula: $\frac{V_o}{V_g} = \frac{1}{1-D}$

$$\Rightarrow D = 1 - \frac{V_g}{V_o} = 1 - \frac{7.5}{12.5} = 0.4$$

2. Critical K and K Calculation

Formulas:

$$K\,critical = D(1-D)^2$$

$$K = \frac{2L}{RT_s}$$

Calculation:

$$Ts = 1 / f = 1 / 12000 = 8.33e - 5\ s$$

$$K\_critical = 0.4 * (1 - 0.4)\text{^}2 = 0.4 * 0.36 = 0.144$$

3. Critical Resistance (R_crit)

Formula:

$$R_{crit} = \frac{2L}{K_{critical} T_s}$$

Calculation:

$$R\_crit = (2 * 1e - 3) / (0.144 * 8.33e - 5) = \mathbf{166.66}\ \Omega$$

4. Non-Idealities and Corrected Duty Cycle

Given: R = 166.66 Ω, rL = 0.6 Ω, VD = 1.1 V

Formula:

$$\frac{V_o}{V_g} = \frac{1 - \frac{(1-D)V_D}{V_g}}{(1-D) + \frac{r_L}{(1-D)R}}$$

Final Equation:

$$\frac{12.5}{7.5} = \frac{1 - \frac{(1-D) \cdot 1.1}{7.5}}{(1-D) + \frac{0.6}{(1-D) \cdot 166.66}}$$

Solving numerically: **D = 0.451**

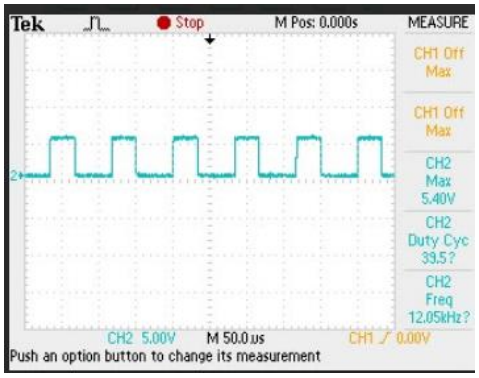
5. Efficiency (η)

Formula:

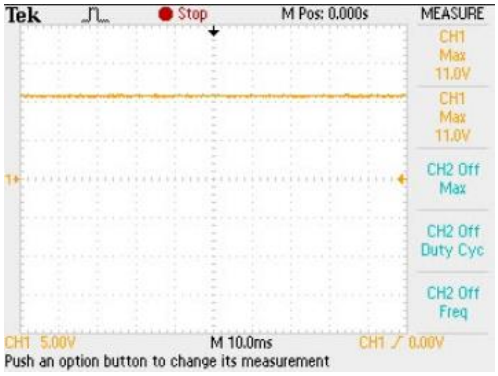
$$\eta = \frac{1 - \frac{V_D \cdot D}{V_g}}{1 + \frac{r_L}{(1-D)^2 R}}$$

Calculation: **η = 0.9339 / 1.011 = 0.9234**

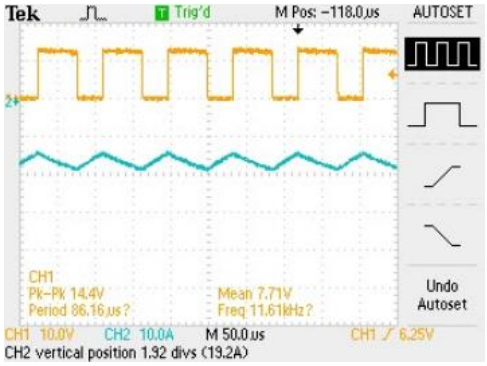
6. Experimental Results



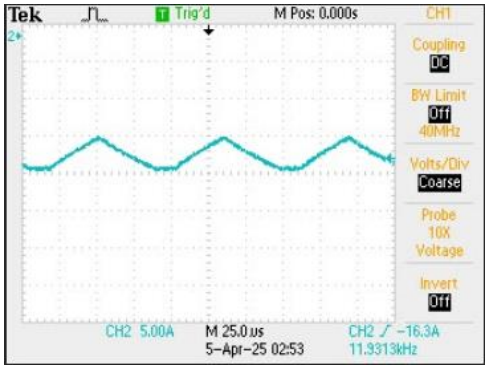
Gate Driver Circuit Output:



Output Voltage (Vout)



Inductor Waveform (Blue) in CCM:



Inductor Waveform in DCM:

Simulation in MATLAB : Boost converter