EE 252 EMPEL PROJECT

Design and Analysis of a Boost Converter

Set E2 Batch B2

Team Members:

Vansh Raj Singh: 230002079

Nadimpalli Pranav Varma: 230002045

Sidhant Kumar Mohanty: 230002069

Prashant Narang: 230002056

1. Introduction and Aim

This report presents the design and analysis of a boost converter, a DC-DC converter that steps up the input voltage to a higher output voltage. Applications include power supplies, renewable energy systems, and electric vehicles.

This project aims to demonstrate the boosting action of a DC-DC boost converter, as well as to demonstrate DCM (discontinuous conduction mode) by increasing the load resistance. We attach the pictures of the waveforms of inductor current and switch voltages as required by the problem statement.

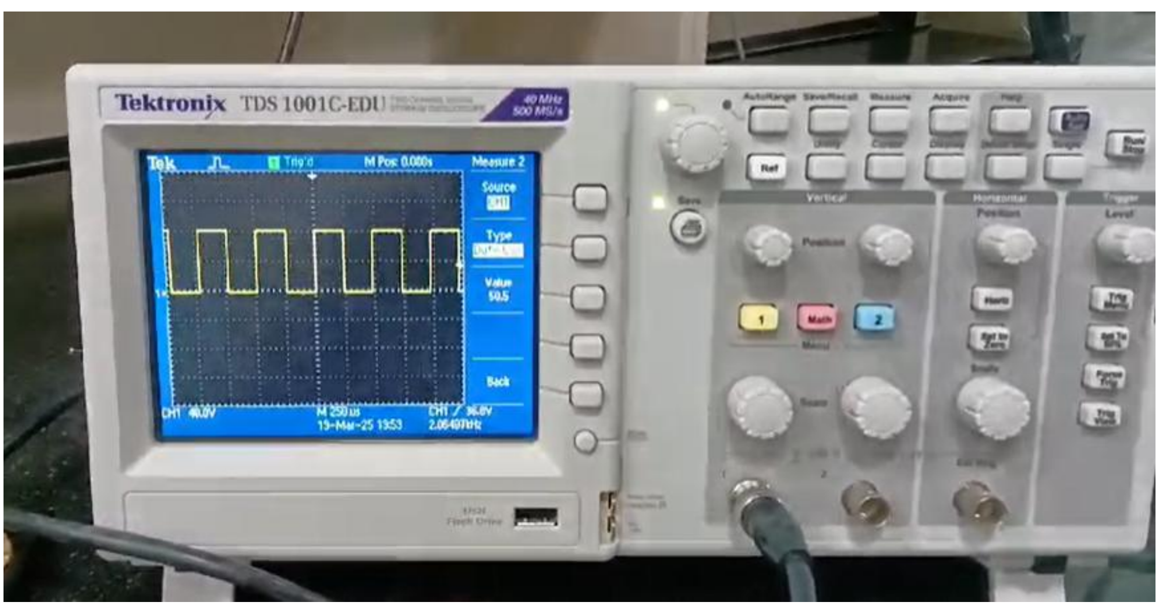
2. Gate Driver Circuit

2.1 Gate Driver PCB

The gate driver circuit was used to generate a square wave PWM signal and provide it to the MOSFET gate.

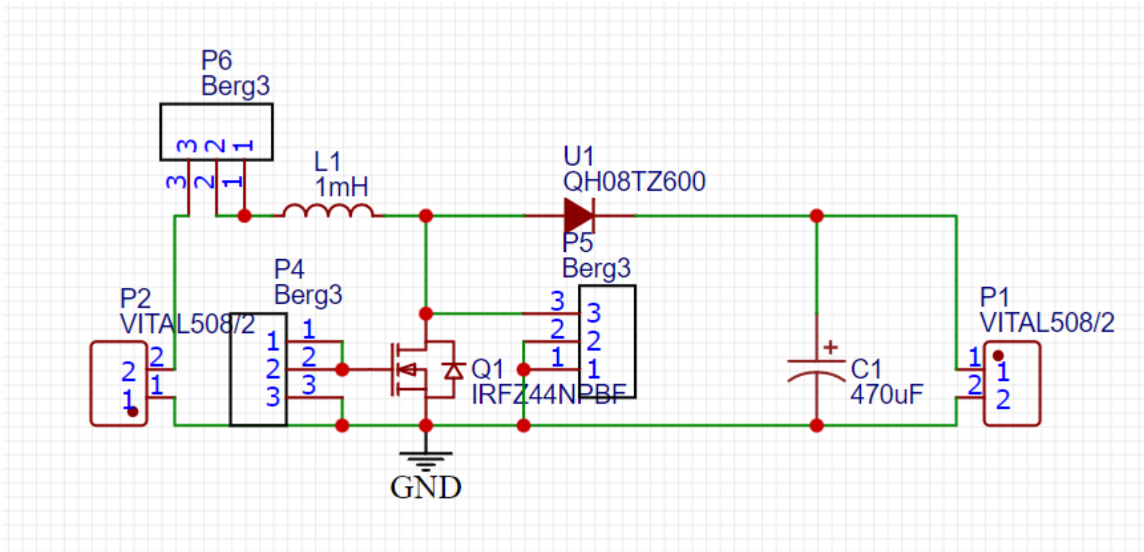
2.2 Gate Driver Output

The output is a square wave PWM signal, observed by varying the Duty cycle and frequency from the gate driver circuit board

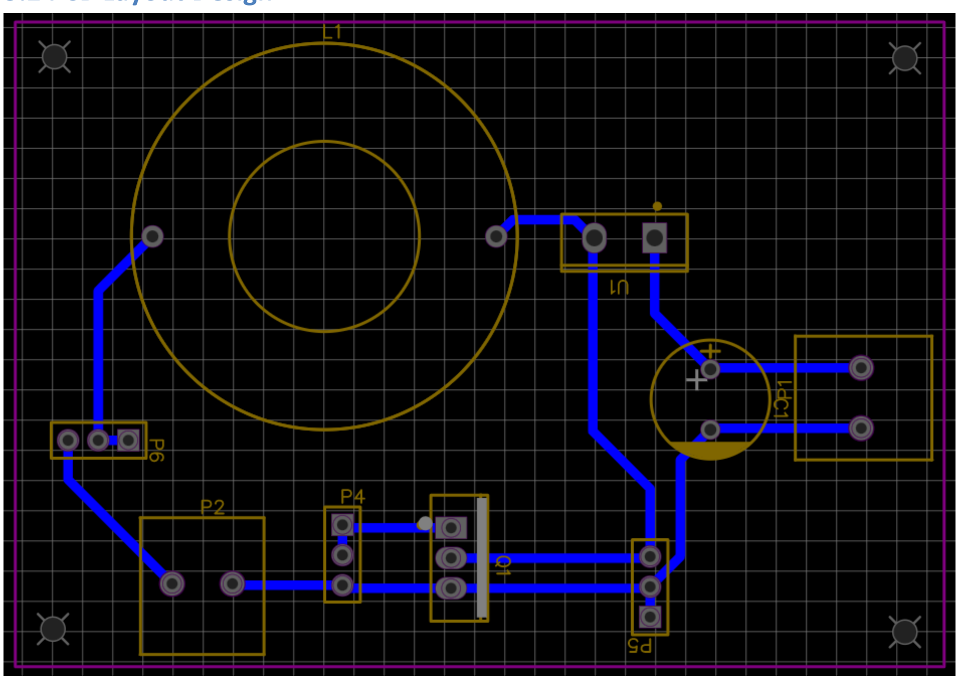


3. Boost Converter PCB

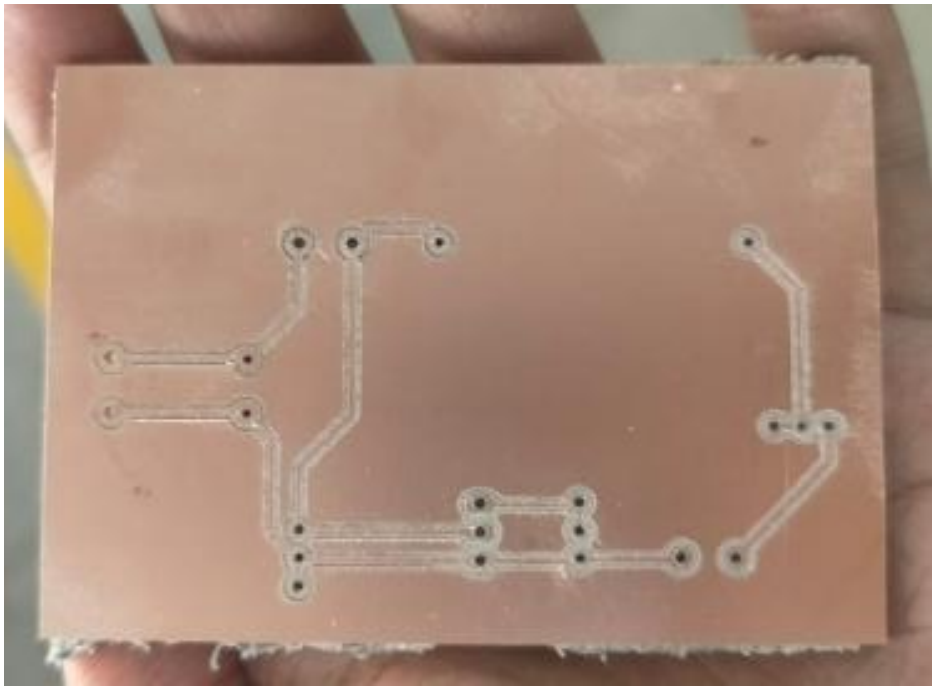
3.1 PCB Schematic Diagram



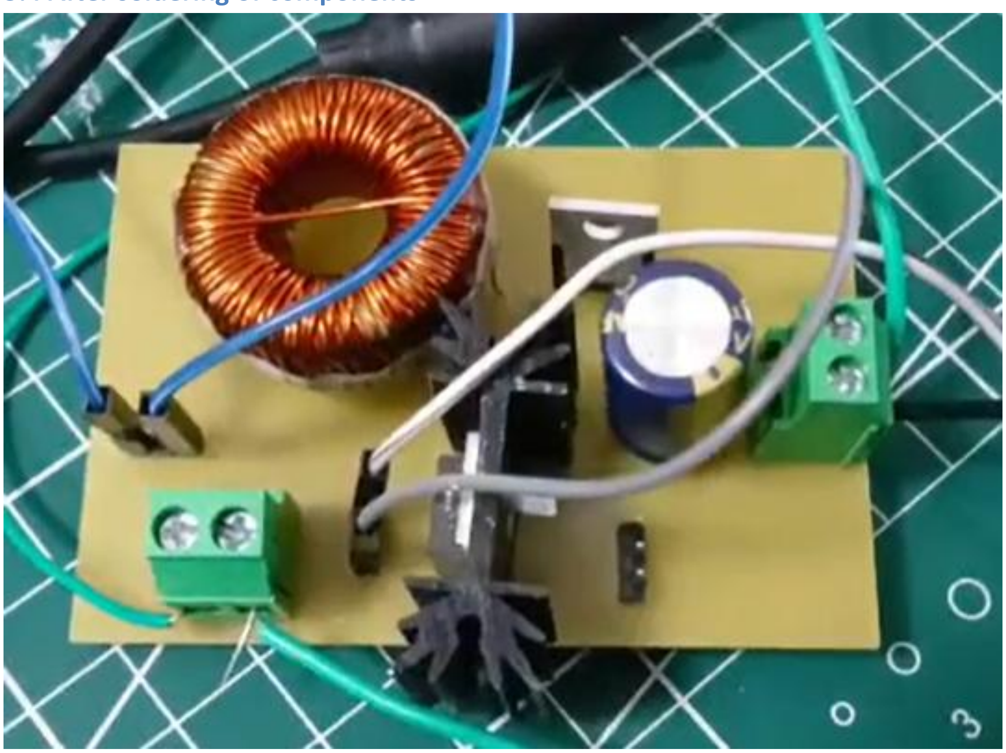
3.2 PCB Layout Design



3.3 Fabricated PCB



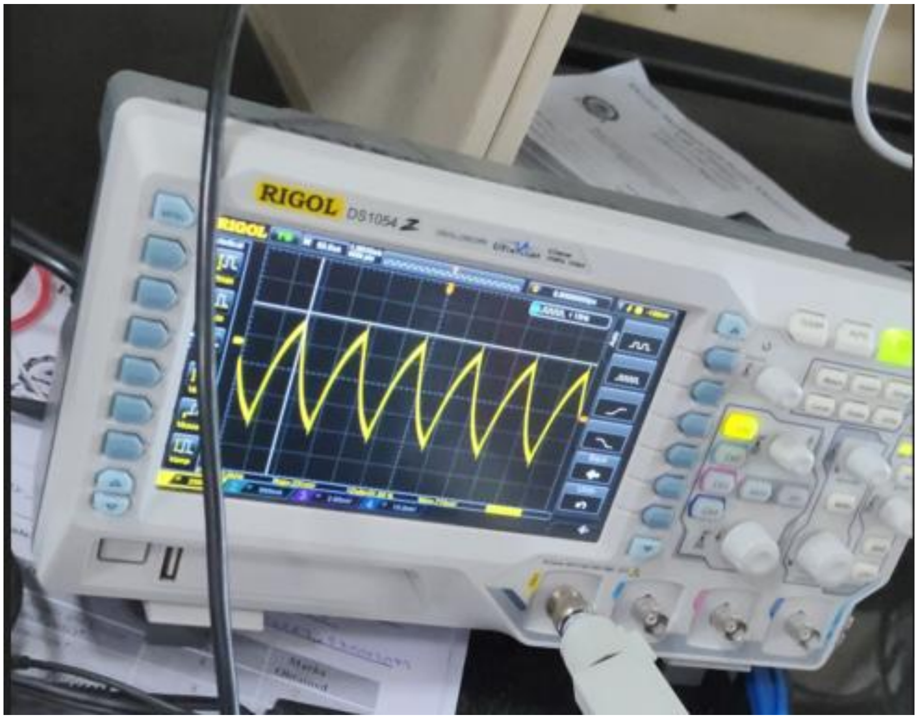
3.4 After soldering of components



4. Continuous Conduction Mode (CCM)

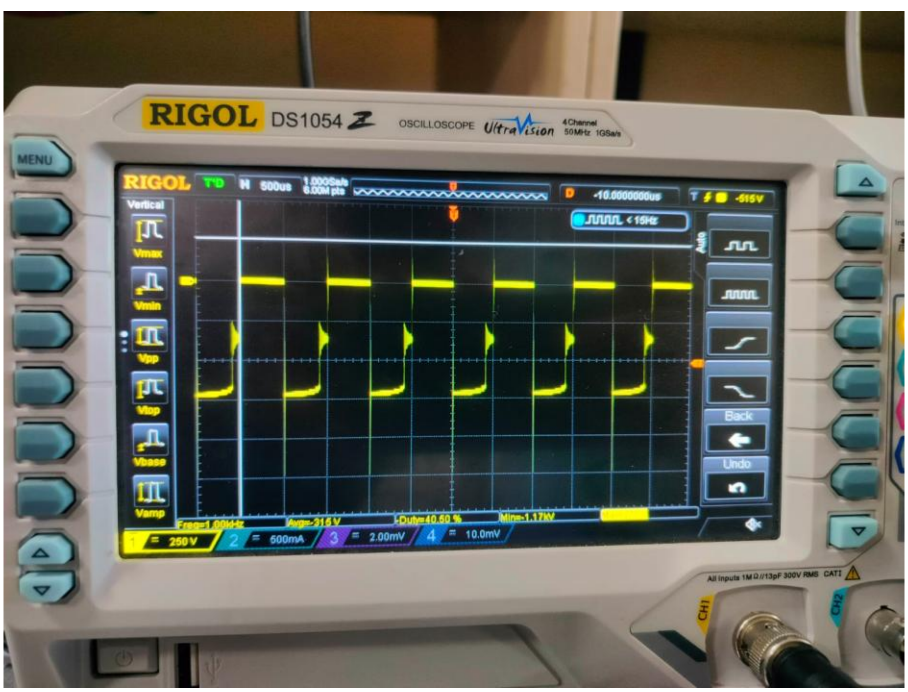
4.1 Inductor Current in CCM

Figure 1: Inductor Current Waveform in CCM



4.2 Switch Voltage in CCM

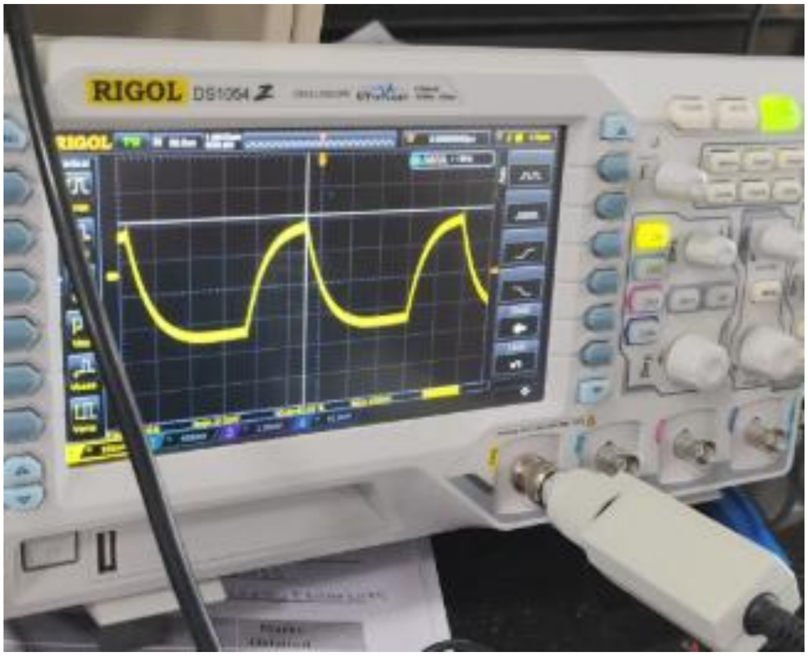
Figure 2: Switch Voltage Waveform in CCM



5. Discontinuous Conduction Mode (DCM)

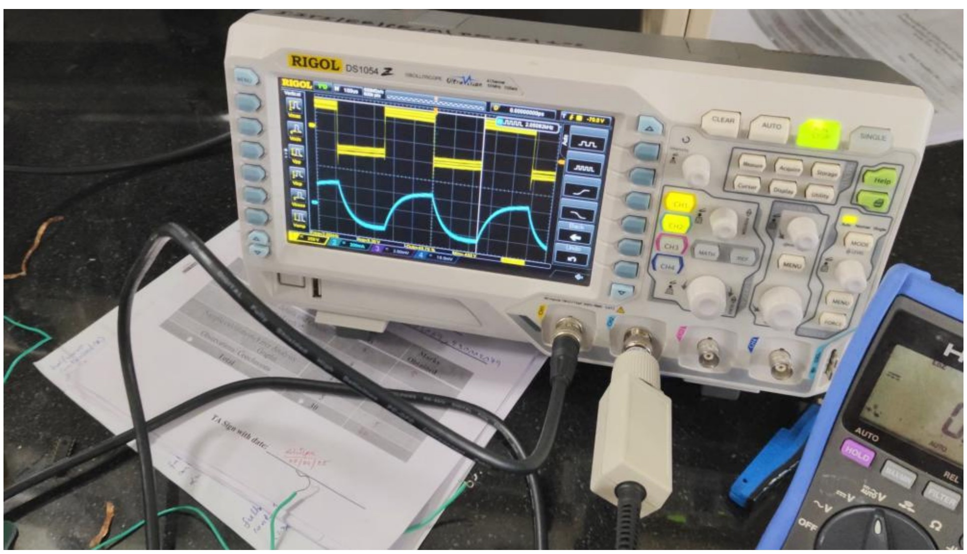
5.1 Inductor Current in DCM

Figure 3: Inductor Current Waveform in DCM



5.2 Switch Voltage and Inductor Current in DCM

Figure 4: Switch Voltage and Inductor Current Waveforms in DCM



6. Theoretical Calculations: Non-Idealities in Boost Converter

To account for non-idealities, we include the MOSFET on-resistance, MOSFET conduction drop, and diode forward voltage. Using volt-second balance on the inductor:

$$\frac{V_O}{V_G} = \frac{\left(1 + D \cdot \frac{V_{DS}}{V_G} - (1-D) \cdot \frac{V_f}{V_G}\right)}{\left[1 - D + \frac{D}{1-D} \cdot \frac{R_{DSON}}{R} + \frac{1}{1-D} \cdot \frac{R_L}{R}\right]}$$

From the datasheets, we have the following values for the variables:

$$D = 0.3, V_G = 14V, V_{DS} = 0.05V, V_f = 1.2V, R_{DSON} = 17.5m\Omega, R = 20\Omega, R_L = 0.3\Omega$$

We thus obtain

$$V_O = 18.25V$$

7. Observations and Conclusion

1. The observed voltage at the above specified conditions was 18V, so the percentage error is 1.36%.
2. The expected output was 20V, and observed output was 18V, so efficiency is 90%.
3. The major voltage drop occurred due to the diode, which was 1.2V according to the datasheet.
4. DCM was observed through the inductor current waveform on increasing the load resistance.
5. We also observed exponential rise and fall in inductor current when the switching time period was comparable to the time constant.