EMPEL EE252 Project: Zeta Converter

The Zeta converter is a fourth-order DC-DC converter that provides a non-inverting output voltage, making it ideal for applications requiring both step-up and step-down regulation. It ensures continuous output with reduced ripple and its isolated energy transfer via a coupling capacitor makes it effective for noise-sensitive loads.

Basic Relations of the converter:

$\frac{V_o}{V_{\text{in}}} = \frac{D}{1-D} \Rightarrow V_o = V_{\text{in}} \cdot \frac{D}{1-D}$ V_o and V_{in} are the output and input DC voltages respectively

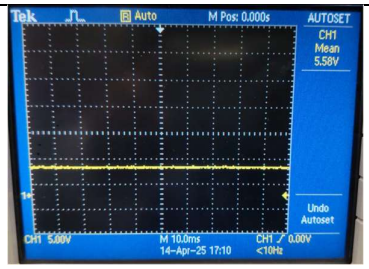
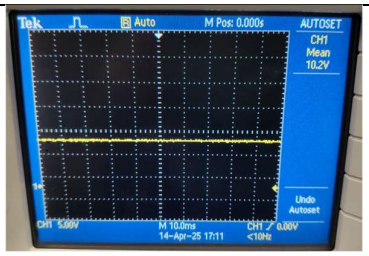
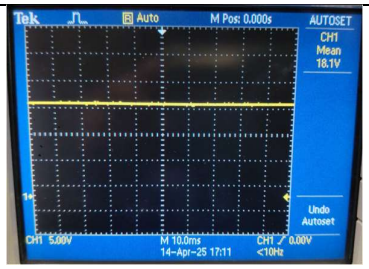
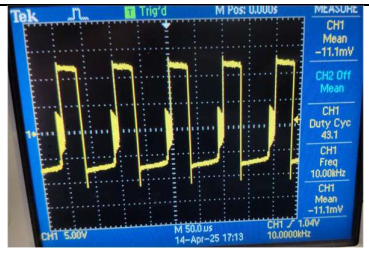
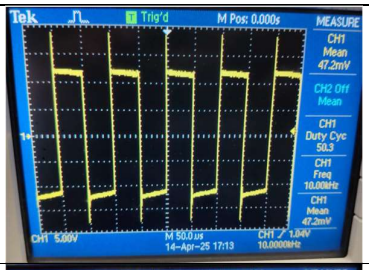
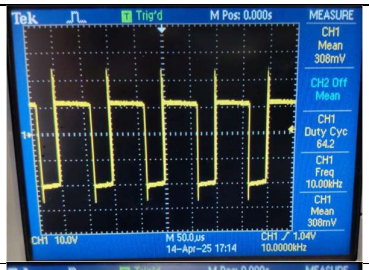
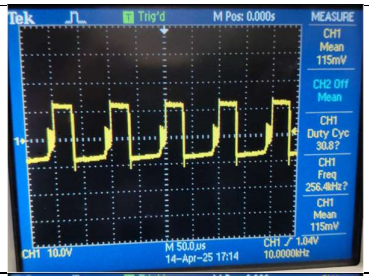
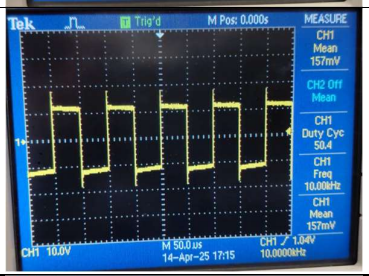
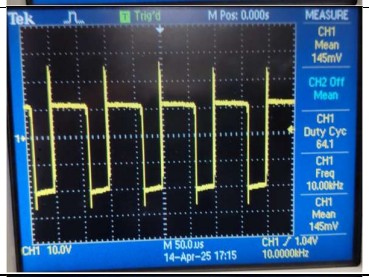
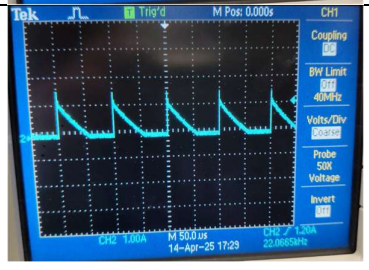
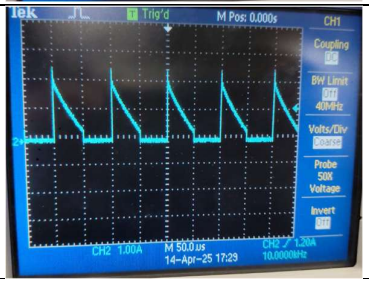
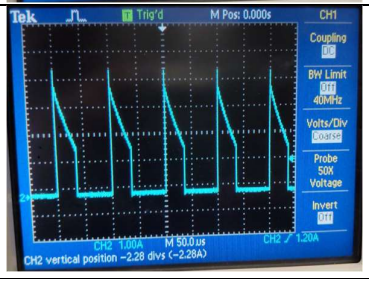
Problem Statement:

a) Specifications: Input 12 V, Output 6-18 V, Switching frequency 10 kHz, Output current

Waveforms of diode current and inductor voltage in CCM.

b) Reduce switching frequency to demonstrate DCM.

Part A: Given V_{in}= 12V, frequency = 10kHz

	D=33%	D = 50%	D = 64%
V_{out}	 5.58V	 10.2V	 18.1V
V_{L1}			
V_{L2}			
I_d			

Part B: Discontinuous Conduction Mode

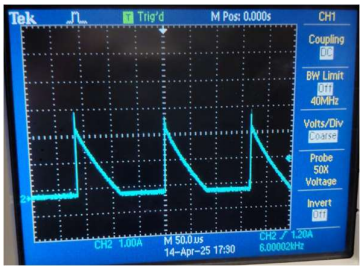
$$\Delta I_{L1} = \frac{V_d \cdot D}{L_1 \cdot f_s};\ now\ I_o = \frac{1}{2} \cdot \Delta I_{L1} \cdot (1-D) = \frac{1}{2} \cdot \frac{V_d \cdot D}{L_1 \cdot f_s} \cdot (1-D)$$

$$\text{taking: } I_o = \frac{V_o}{R_o} \text{ and } V_o = V_d \cdot \frac{D}{1-D}$$

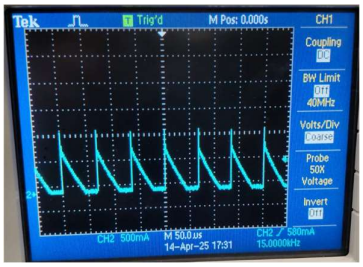
$$\frac{V_d \cdot D}{R_o(1-D)} = \frac{1}{2} \cdot \frac{V_d \cdot D}{L_1 \cdot f_s} \cdot (1-D)$$

Since in DCM ripple should be equal to the average value => $f_{\text{boundary}} = \frac{(1-D)^2 \cdot R_o}{2DL_1}$

Increasing frequency to enter DCM (discontinuous conduction mode) and noting the diode current:

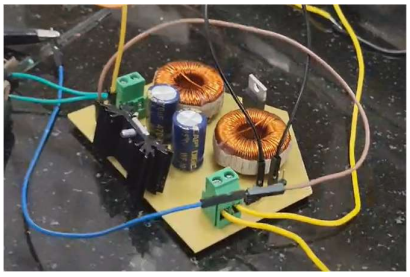
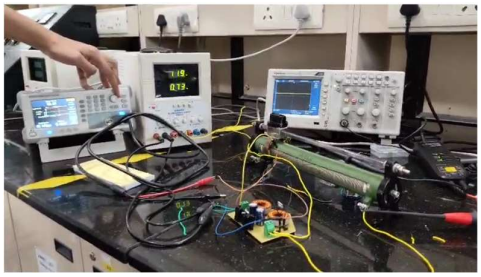


Freq= 6kHz; D =0.33



Freq= 15kHz; D =0.5

Hardware setup


PCB used, the setup and the PWM generating module, respectively.

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