- A Sepic converter has an input voltage of $15\ V$ and an output voltage of $6\ V$. The load resistance is $2\ \Omega$, and the switching frequency is $250\ kHz$.
- a) Determine values of L_1 and L_2 such that the variation in each inductor current is 40% of its inductor current average value.
- b) Determine values of C_1 and C_2 such that the variation in each capacitor voltage is 2% of its capacitor voltage average value.

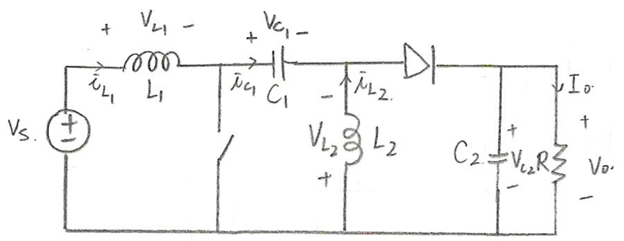
Sepic Converter

$V_i = 15\ V.$

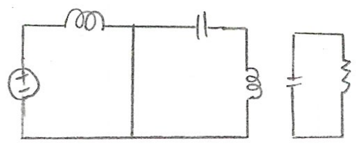
$V_o = 6\ V.$

$R = 2\Omega.$

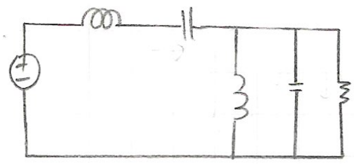
$f = 250\ kHz.$

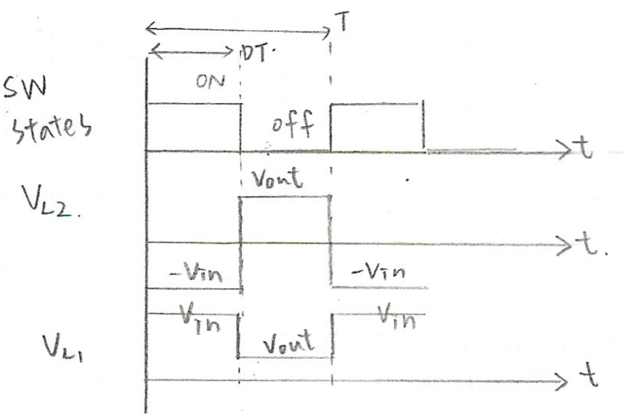


① ON.



② OFF





(a)

$\Delta i_{L_1} = 40\% \, I_{L_1}$

$\Delta i_{L2} = 40\% \, I_{L2}.$

$I_{L_1} = I_i$

$I_{L_2} = I_{out}$

$$\frac{I_i}{I_o} = \frac{V_o}{V_S} \Rightarrow I_i = \frac{V_o}{V_S} \cdot I_o = \frac{6}{15} \cdot 3 = 1.2 \text{ A}$$

$$I_{out} = \frac{V_o}{R} = 3. \text{ A}$$

$$V_{L_1} = L \frac{\Delta i_{L1}}{\Delta t} \rightarrow \Delta i_{L_1} = \frac{V_{L_1}}{L} DT = \frac{V_{L_1} D}{L_1 f} = \frac{V_{in} D}{L_1 f}$$

$$\Delta i_{L_2} = \frac{V_{L2}}{L} DT = \frac{V_{L_2} D}{L_2 f} = \frac{V_{in} D}{L_2 f}$$

$$\frac{V_o}{V_S} = \frac{D}{1-D} = \frac{6}{15} = 0.4 \Rightarrow D = 0.2857$$

$$\Rightarrow \Delta i_{L_1} = \frac{15 \cdot 0.2857}{L_1 \cdot 250 \times 10^3} = 0.4 \times 1.2$$

$$\Rightarrow \underline{\underline{L_1 = 3.571 \times 10^{-5} \text{ H}}}$$

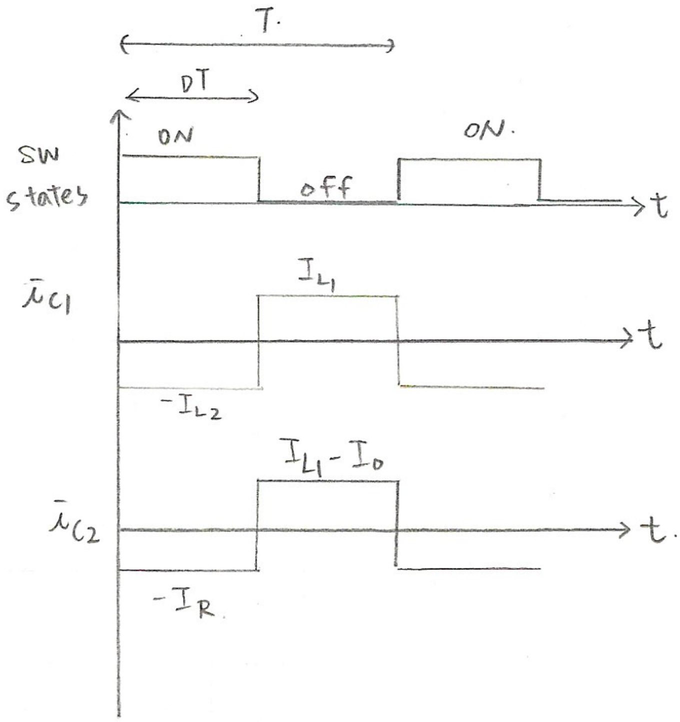
$$\Rightarrow \Delta i_{L2} = \frac{15 \times 0.2857}{L_2 \cdot 250 \times 10^3} = 0.4 \times 3$$

$$\Rightarrow \underline{\underline{L_2 = 1.429 \times 10^{-5} \text{ H}}}$$

(b)

$\Delta V_{c_1} = 2\% \; V_{c_1 \, avg}.$

$\Delta V_{c_2} = 2\% \; V_{c_2 \, avg}.$



$V_{c_1} \, avg = V_s. = 15 \text{ V}$

$V_{c_2} \, avg = V_o. = 6\text{V}.$

$$I_c = C \frac{\Delta V_c}{\Delta t} \Rightarrow \Delta V_c = \frac{I_c}{C} \Delta t = \frac{I_c \, D}{C \cdot f}$$

$$\Delta V_{c_1} = \frac{I_{L2} \cdot D}{C_1 \, f} = \frac{3 \cdot 0.2857}{C_1 \cdot 250 \cdot 10^3} = 15 \times 2\%$$

$$\Rightarrow \underline{\underline{C_1 = 1.1428 \times 10^{-5} \text{ F}}}$$

$$\Delta V_{c_2} = \frac{I_R \cdot D}{C_2 \, f} = \frac{3 \cdot 0.2857}{C_2 \cdot 250 \times 10^3} = 6 \times 2\%$$

$$\Rightarrow \underline{\underline{C_2 = 2.857 \times 10^{-5} \text{ F}}}$$

(c)

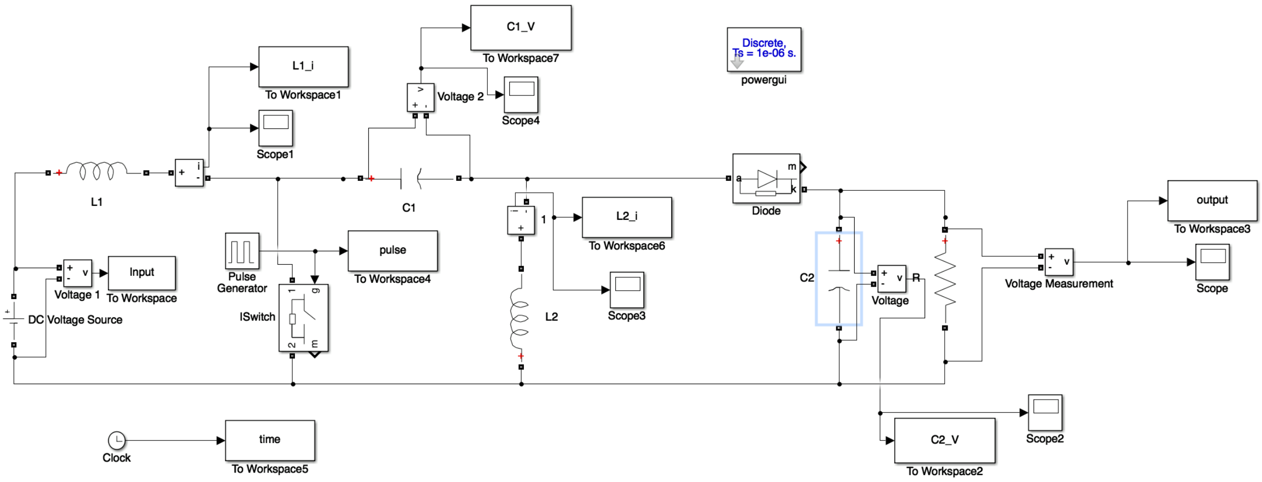


Figure 3-1 Simulated configuration for Sepic converter.

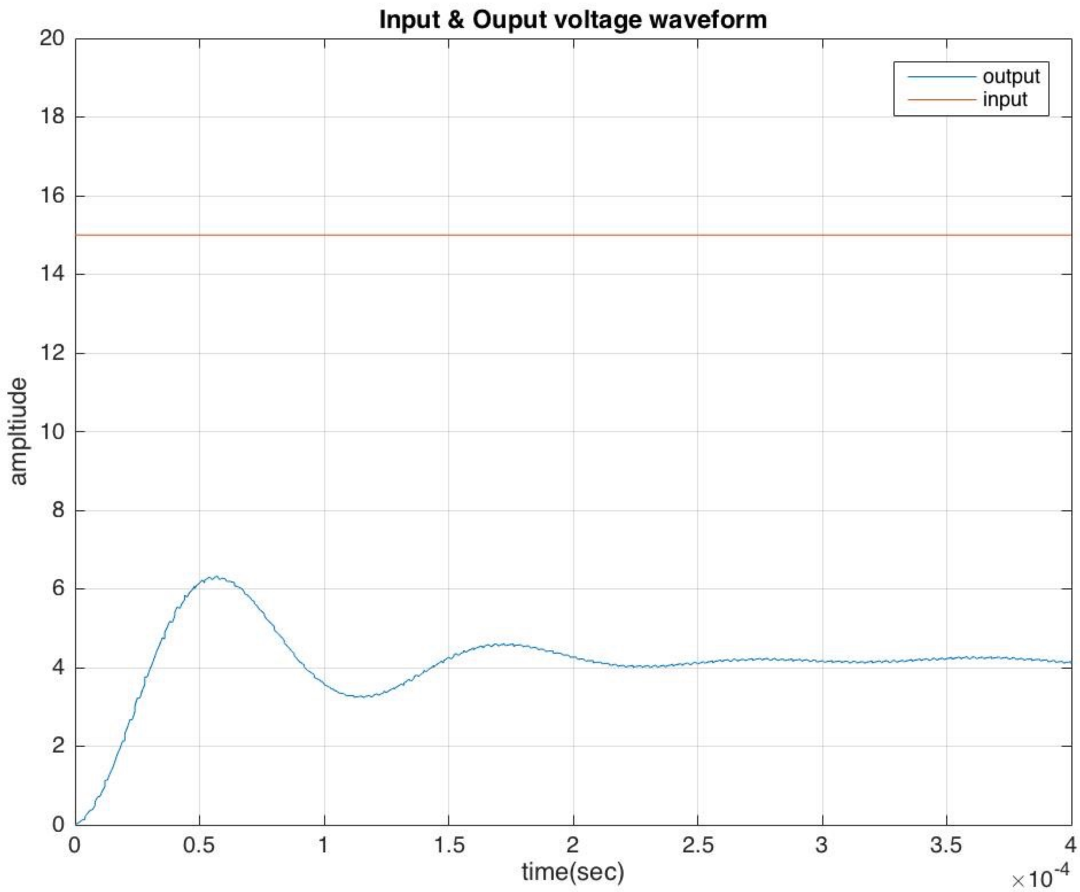


Figure 3-2 Input and output voltage waveform.

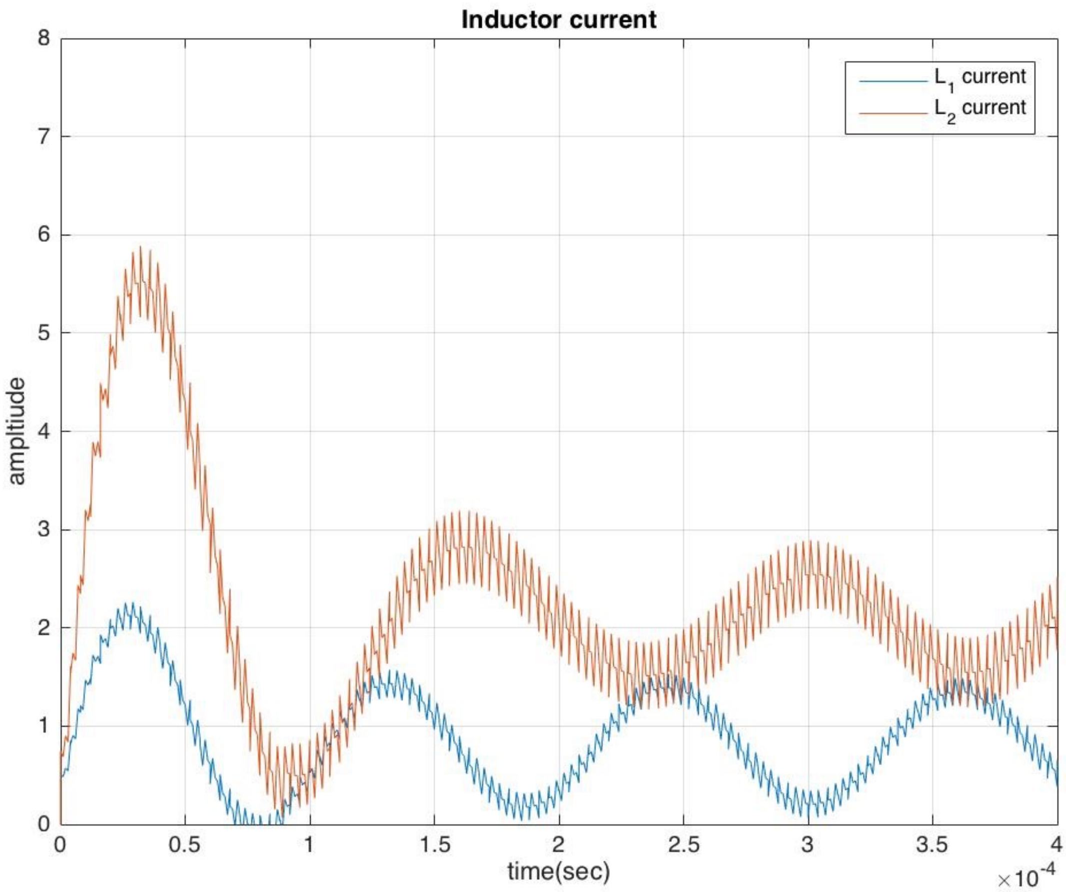


Figure 3-3 Inductor current waveform.

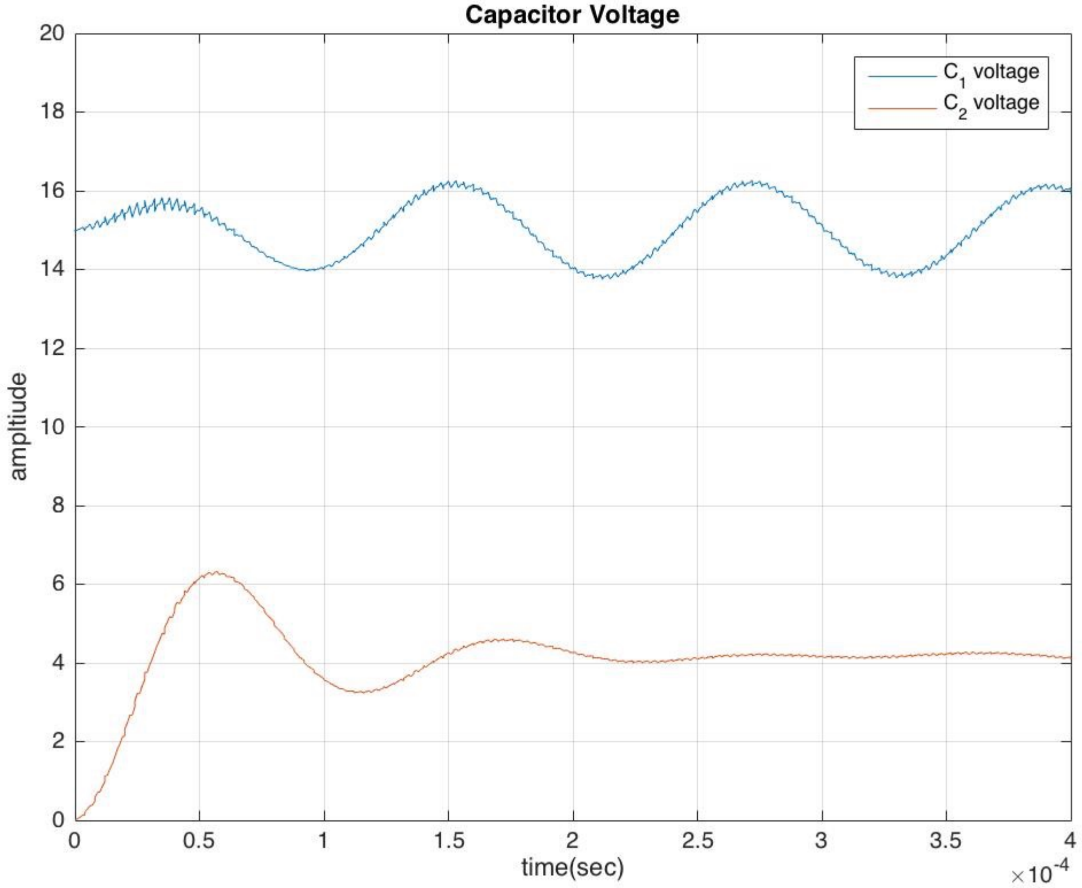


Figure 3-4 Capacitor voltage waveform.