Boost Converter (`PE_boost_2.sqproj`)

Question: For the converter shown in Fig. 1, assume steady state operation. Also assume the components to be ideal, and the inductor current to be always positive and continuous. Let the switching period be denoted by T_s. The voltage V_L is as shown and $T_s = 4\,\mu$s. Find the duty cycle (D) of the switch.

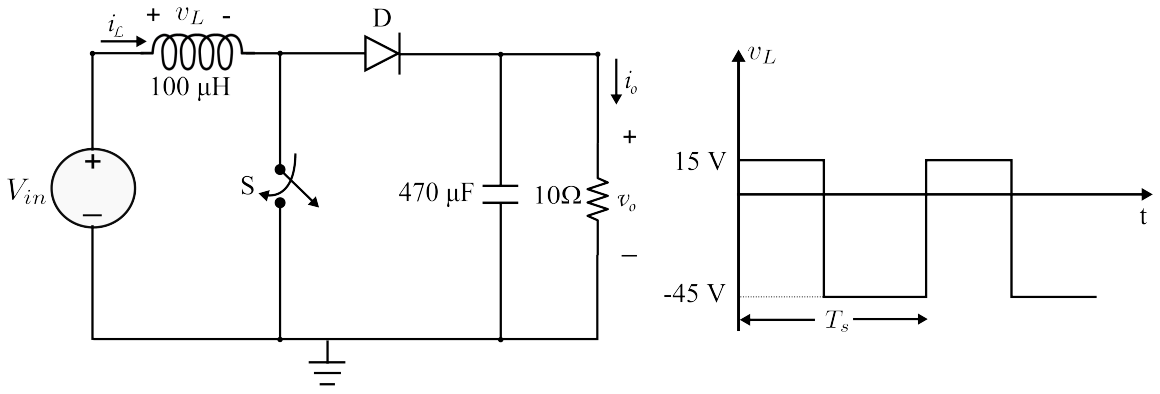

Figure 1: Boost converter

Solution :

Figs. 2 (a) and 2 (b) shows ON and OFF conditions of switch S, respectively.

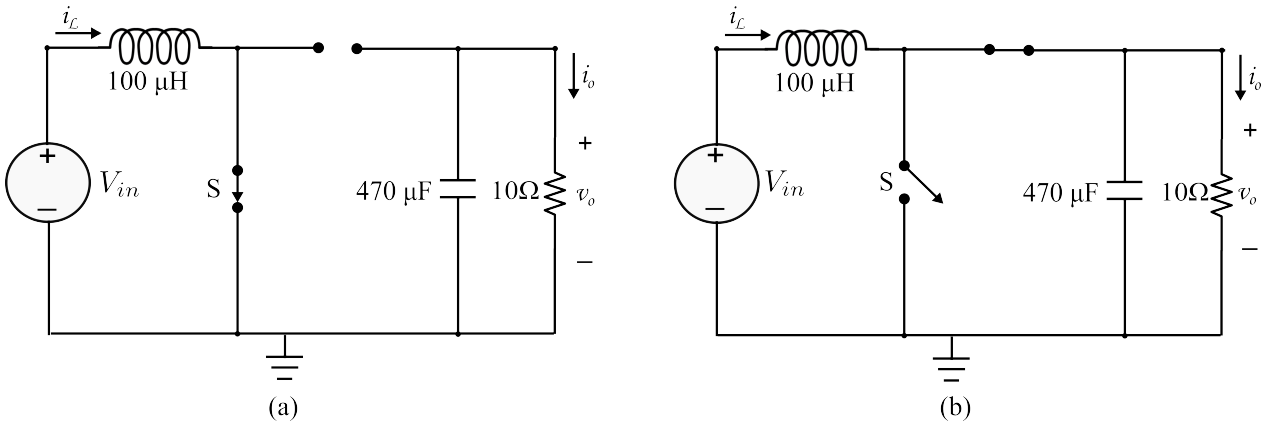

Figure 2: Boost converter circuit. (a) switch is ON, (b) switch is OFF

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Operation : When the switch is ON ($0 < t < DT$), the diode is reverse biased and the inductor stores energy. Alternatively, when the switch is off ($DT < t < T$), the diode is forward biased and the inductor releases energy.

We assume that the circuit is operating under steady state, i.e., the energy stored in the inductor during the ON interval should be released during the OFF interval.

When the switch is ON, applying KVL gives

$$L\,\frac{di_L}{dt} = V_{in} \Longrightarrow V_{in} = 15\,V$$

Similarly, when the switch is OFF, applying KVL gives

$$L\,\frac{di_L}{dt} = V_{in} - v_o(t)$$
$$\therefore V_{in} - V_o = -45\,V \Longrightarrow V_o = 60\,V$$

where, V_o is the average voltage across the load. The voltage across the load is almost constant due to the smoothing capacitor. Hence instantaneous value (v_o) and average value (V_o) are considered as equal.

Applying the volt-sec balance equation,

$$\boxed{V_o = \frac{V_{in}}{1-D}} \qquad \therefore D = 1 - \frac{V_{in}}{V_o} = 0.75$$

SequelApp Exercises:

(1) Find the inductance value which will make the peak-to-peak ripple inductor current (ΔI_L) equal to 3 A. Assume all other circuit parameters to be the same as in Fig. 1. (Take V_{in} and V_o as calculated above.)

Verify your answer using SequelApp.