Master of Science in Engineering

Power Electronic Systems

Attestation

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1.1 A

To calculate the duty cycle we can use the volt-second balance. To do so, we have to evaluate the proper mathematical formulation for the active (first) and passive (second) interval.

Active Interval In the active interval the MOSFET is on. Since the inductance is connected to the negative terminal of the source the voltage across the inductance L_1 is the input voltage V_i.

$$V_{L_1} = V_i$$

Passive Interval In the passive interval the diode D is conducting the inductor current to the load and the output capacitor. The capacitor is assumed to be ideal, hence no output voltage ripple is assumed. Therefore, the voltage loop is defined as

$$V_i = V_{L_2} + V_o$$

Using this loop we can obtain the inductors voltage for the passive interval as

$$V_{L_2} = V_i - V_o$$

Volt-Second Balance To calculate the duty cycle we can use the general volt-second balance equation

$$V_{L_1} D + V_{L_2}(1 - D) = 0$$

and rearrange the equation so isolate the duty cycle D. Herefore we can expand the factors to

$$V_{L_1} D + V_{L_2} - V_{L_2} D = 0$$

and separate the sums

$$V_{L_1} D - V_{L_2} D = -V_{L_2}$$

and factorize for

$$D(V_{L_1} - V_{L_2}) = V_{L_2}$$

and finally isolate

$$D = \frac{-V_{L_2}}{V_{L_1} - V_{L_2}}$$

Using the previously obtained expressions for V_{L_1} and V_{L_2} we get

$$D = \frac{-(V_i - V_o)}{V_i - (V_i - V_o)}$$

Expanding this expression leads to

$$D = \frac{-V_i + V_o}{V_i - V_i + V_o} = \frac{-V_i + V_o}{V_o}$$

Results

$$V_{i_1} = 50\,\mathrm{V} \Rightarrow D = \frac{-50\,\mathrm{V} + 200\,\mathrm{V}}{50\,\mathrm{V}} =$$

$$V_{i_1} = 100\,\mathrm{V} \Rightarrow D = \frac{-100\,\mathrm{V} + 200\,\mathrm{V}}{100\,\mathrm{V}} =$$

$$V_{i_1} = 150\,\mathrm{V} \Rightarrow D = \frac{-150\,\mathrm{V} + 200\,\mathrm{V}}{150\,\mathrm{V}} =$$