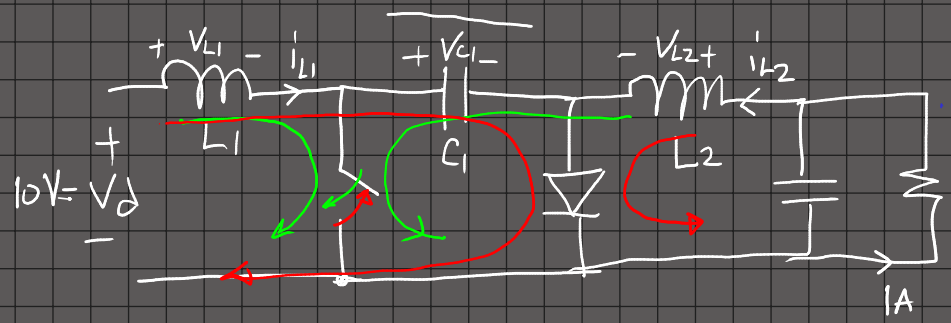
■ ***Example 7-3*** In a Cúk converter operating at 50 kHz, $L_1 = L_2 = 1$ mH and $C_1 = 5$ μF. The output capacitor is sufficiently large to yield an essentially constant output voltage. Here $V_d = 10$ V and the output V_o is regulated to be constant at 5 V. It is supplying 5 W to a load. Assume ideal components.

Calculate the percentage errors in assuming a constant voltage across C_1 or in assuming constant currents i_{L1} and i_{L2}.

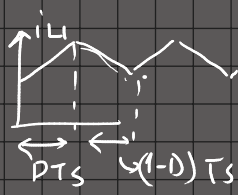


$V_O = V_d \cdot \frac{D}{(1-D)} \Rightarrow \frac{V_o}{V_d} = \frac{5}{10} = \frac{D}{1-D} \Rightarrow D = 1/3 = 0.33\ldots$

$f_s = 50\text{kHz}$

$T_s = \frac{1}{f_s} = 20\,\mu s$

Assume C.C.M



$\Rightarrow \Delta i_{L1} = \frac{V_d \cdot D \cdot T_s}{L_1} = \frac{(V_{C1} - V_d)(1-D)T_s}{L_1}$

$V_{C1} = V_o + V_d$

$= 15\text{V (average)}$

$= \frac{10 \cdot \frac{1}{3} \cdot 20\mu s}{1\text{mH}} = 0{,}067\text{A} = 67\text{mA}$

$\Delta i_{L2} = \frac{V_o}{L_2}(1-D) \cdot T_s = \frac{5}{1m}\left(\frac{2}{3}\right) 20\mu = 0{,}067 = 67\text{mA}$

$\Delta i_{L1} = \Delta i_{L2}$ because $L_1 = L_2$

$i_{L1}(\text{average}) = 0{,}5\text{A}$, $i_{L2}(\text{average}) = 1\text{A}$ } $\Delta i_{L1} \ll i_{L1(av)}$, $\Delta i_{L2} \ll i_{L2(av)}$ } CCM is verified!

inductor currents: $\frac{\Delta i_{L1}}{i_{L1(av)}} = \frac{0{,}067}{0{,}5} \Rightarrow 13{,}4\%$ ripple

$\frac{\Delta i_{L2}}{i_{L2(av)}} = \frac{0{,}067}{1} = 6{,}7\%$ ripple

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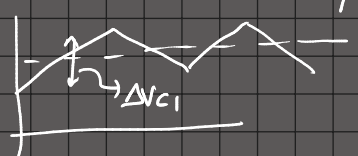
capacitor $i_{L1} \Rightarrow$ Assume constant 0,5A

$\Delta V_{C1} = \frac{0{,}5\,(1-1/3) \cdot 20\mu s}{5\mu F} = 1{,}33\text{V}$

$V_{C1(av)} = 15\text{V}$

$V_{C1}(t) = 15 \pm \frac{1{,}33}{2}$



$\frac{\Delta V_{C1}}{V_{C1(av)}} = \frac{1{,}33}{15} \Rightarrow 8{,}9\%$ ripple