INDUCTOR VOLT-SECOND BALANCE (IVSB)

For steady state operation of an inductor in a DC-DC Converter, net inductor voltage in a switching period must be zero. $\langle v_L \rangle_{T_s} = 0$

CAPACITOR AMPERE-SECOND BALANCE (CASB)

For steady state operation of a capacitor in a DC-DC Converter, net capacitor current in a switching period must be zero. $\langle i_C \rangle_{T_s} = 0$

CONTINUOUS CONDUCTION MODE (CCM)

Inductor current is continuous, never reaches to zero and can be assumed as DC. For CCM operating converters, there are two time intervals in a switching period.

- $D\,T_S$: Mosfet is ON, Diode is OFF.
- $(1-D)\,T_S = D'T_S$: Mosfet is OFF, Diode is ON.

To calculate voltage conversion ratio, two sub-circuits must be sketched for $D\,T_S$ and $(1-D)\,T_S$ time intervals, inductor voltage values $V_{L(DT_S)}$ and $V_{L(D'T_S)}$ are taken from two sub-circuits and IVSB is applied to inductor.

$$IVSB \quad \rightarrow \quad V_{L(DT_S)} \cdot DT_S + V_{L(D'T_S)} \cdot D'T_S = 0$$

To calculate current conversion ratio, two sub-circuits must be sketched for $D\,T_S$ and $(1-D)\,T_S$ time intervals, capacitor current values $I_{C(DT_S)}$ and $I_{C(D'T_S)}$ are taken from two sub-circuits and CASB is applied to capacitor.

$$CASB \quad \rightarrow \quad I_{C(DT_S)} \cdot DT_S + I_{C(D'T_S)} \cdot D'T_S = 0$$

For all CCM operating DC-DC Converters, peak-to-peak inductor current Δi_L is less than average inductor current I_L. This is the critical point of CCM operating converters.

Δi_L is independent from output resistor (or output power) of the converter. Increasing or decreasing the power of the converter doesn't change peak-to-peak inductor current.

However, I_L is dependent to output resistor (or output power) of the converter. Average inductor current increases by increasing output power, and decreases by decreasing the output power.