Transient considerations

- $I_{DYN(max)}$ = 4 A
- di/dt = 2.5 A/μs
- V_{OUT} deviation = ±3% for the given transient

Use Equation 8 and Equation 9 to estimate the amount of capacitance needed for a given dynamic load/release.

$$C_{OUT(min\_under)} = \frac{L \times \left(\Delta I_{LOAD(max)}\right)^2 \times \left(\frac{V_{OUT} \times t_{SW}}{V_{IN(min)}} + t_{MIN(off)}\right)}{2 \times \Delta V_{LOAD(insert)} \times \left(\left(\frac{V_{IN(min)} - V_{OUT}}{V_{IN(min)}}\right) \times t_{SW} - t_{MIN(off)}\right) \times V_{OUT}} \quad (8)$$

During load transient when Iout increasing, Vout is decreasing, so Vfb<Vref.

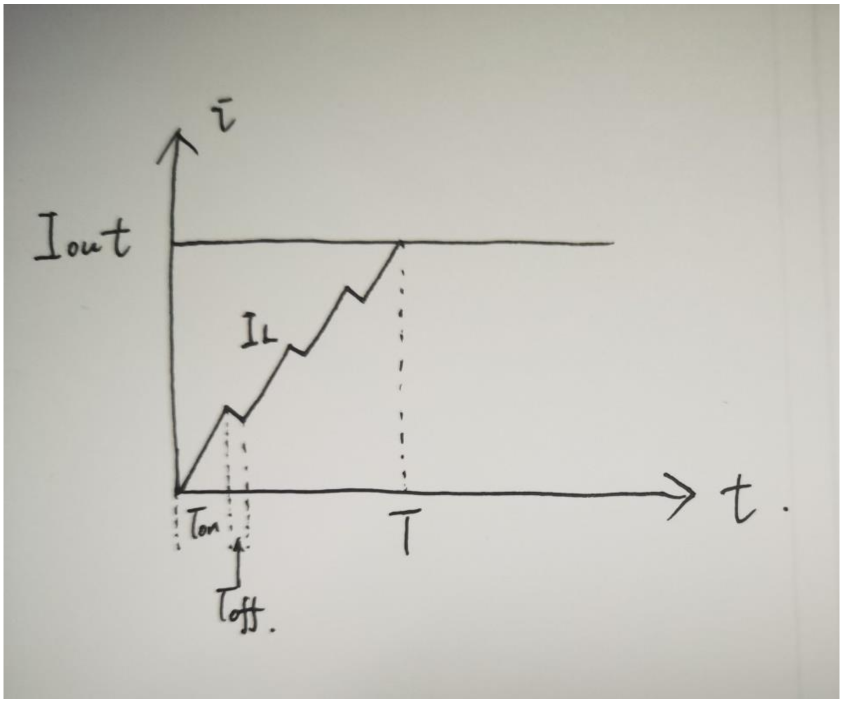
Due to D-CAP3 control mode, while Vfb<Vref, the upper MOS is turned on for Ton time and the lower MOS is turned on for Tmin(off) time.

$$\mathrm{Ton} = \mathrm{Vout}/\mathrm{Vin} * \mathrm{Tsw}$$

Considering the voltage of output capacitor,

$$\Delta \mathrm{Vc} = \Delta \mathrm{Vload} = \frac{1}{C}\int_0^T (IL - Iout)dt$$

Iout = ΔIload is a constant. IL is increasing during Ton and decreasing during Toff as below:



As we know, IL rising slope is (Vin-Vout)/L and falling slope is -Vout/L.

Because inductor current integration is difficult to calculate, it is approximated as a positive proportional function:

$$\mathrm{IL} = \mathrm{kt}$$

$$\mathrm{k} = \frac{\frac{Vin - Vout}{L} * \frac{Vout}{Vin} * Tsw - \frac{Vout}{L} Tmin(off)}{\frac{Vout}{Vin} * Tsw + Tmin(off)} = \frac{Vout}{L} * \frac{\frac{Vout}{Vin} * Tsw - Tmin(off)}{\frac{Vin - Vout}{Vin} * Tsw + Tmin(off)}$$

then

$$\mathrm{T} = \mathrm{Iout/k}$$

$$\Delta\mathrm{Vload} = \frac{1}{C}\int_0^T (IL - Iout)dt = \frac{1}{C}\int_0^T \left(kt - \Delta Iload\right)dt = \frac{1}{C}\left(k\frac{T^2}{2} - \Delta Iload \cdot T\right) = -\frac{\Delta Iload^2}{2kC}$$

So

$$\mathrm{C} = \frac{\Delta Iload^2}{2k\ \Delta Vload} = \frac{L \cdot \Delta Iload^2 \cdot (\frac{Vin - Vout}{Vin} * Tsw + Tmin(off))}{2 \cdot \Delta Vload \cdot (\frac{Vout}{Vin} * Tsw - Tmin(off)) \cdot Vout}$$