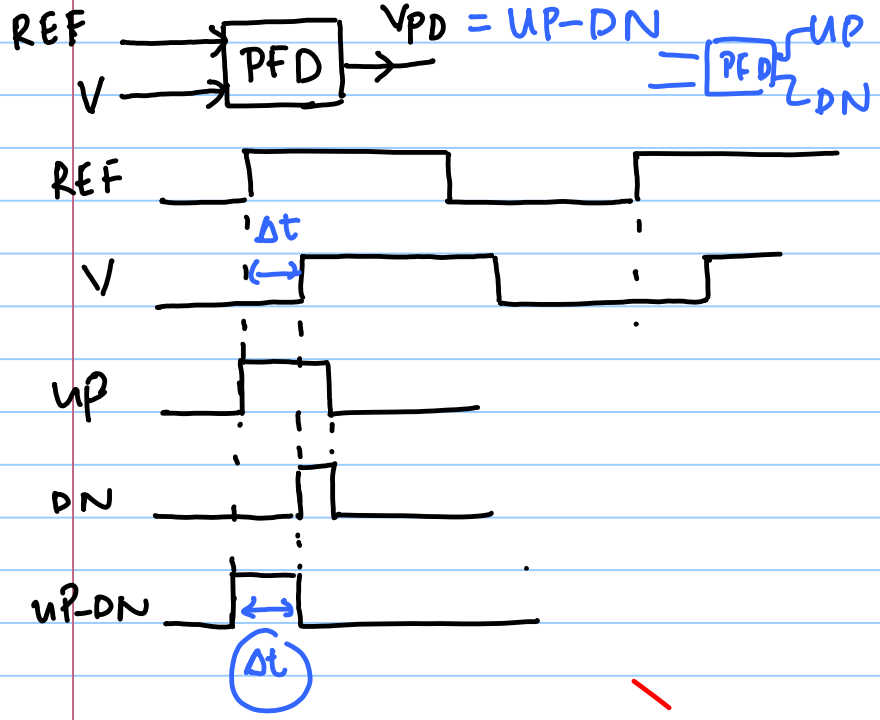
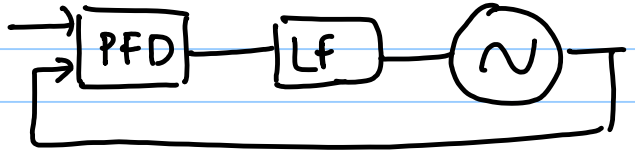
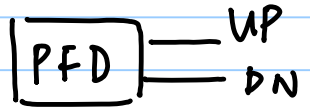
Lecture # 13

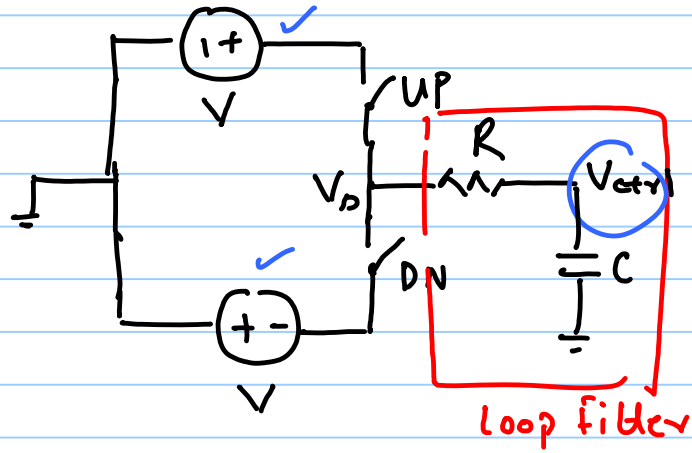
Note Title 29-08-2018

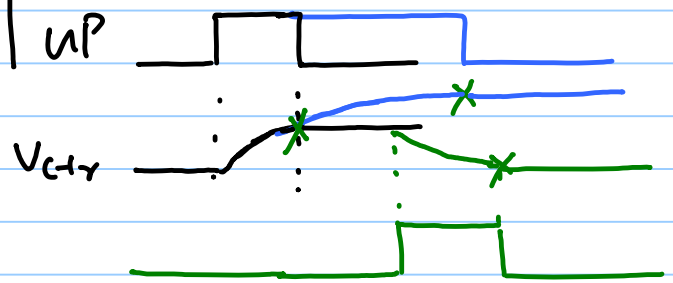




Voltage-base phase error to V_{ctrl}







$$V_{ctrl} = V\left(1 - e^{-t/RC}\right)$$

$$= V\left(1 - e^{-\Delta t/RC}\right)$$

$$\simeq V\left(1 - \left(1 - \frac{\Delta t}{RC}\right)\right) = V \cdot \frac{\Delta t}{RC}$$

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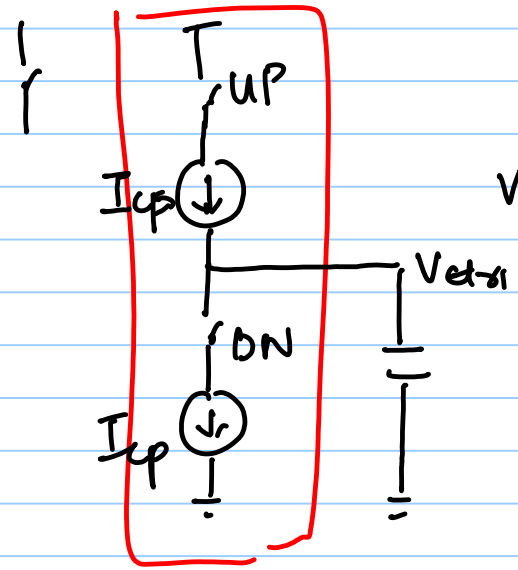
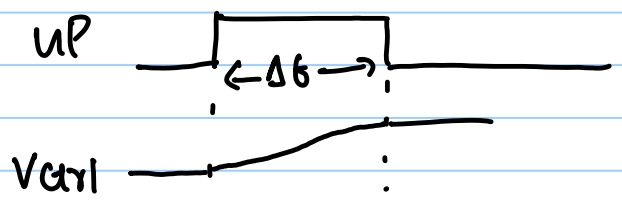
Current-based $\Phi_e \rightarrow V_{ctrl}$





Charge-pump.

T: Ref period

$$V_{ctrl}(\Delta t) = \frac{I_{cp} \cdot \Delta t}{C}$$

$$= \frac{I_{cp}}{C} \frac{T}{2\pi} 2\pi \cdot \frac{\Delta t'}{T}$$

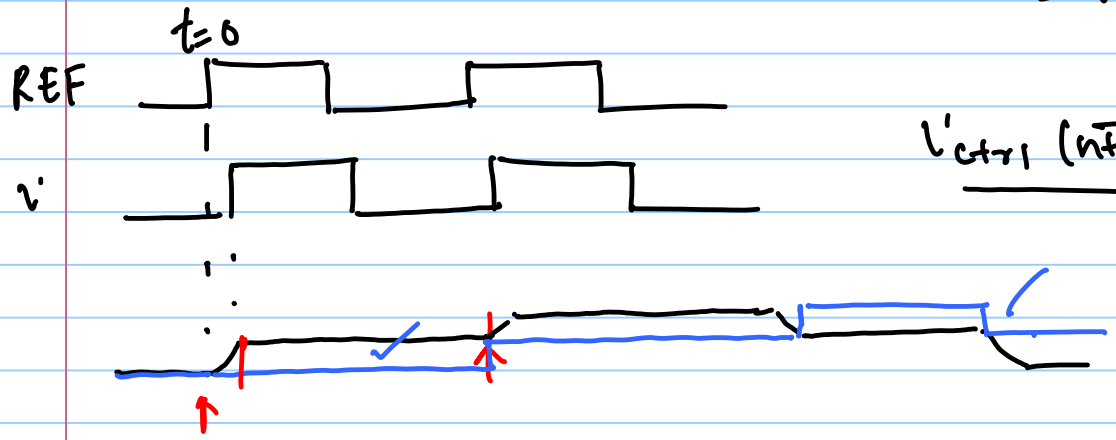
$$= \frac{I_{cp}}{2\pi} \frac{T}{C} \Phi_e$$

$$V_{ctrl}(n+1\,T) = V_{ctrl}(nT) + \frac{I_{cp} \cdot \Delta t(nT)}{C}$$

$$= V_{ctrl}(nT) + \frac{I_{cp}}{2\pi} \frac{T}{C} \Phi_e(nT)$$

$$V_{ctrl}(n+1\,T) - V_{ctrl}(nT) = \frac{I_{cp}}{2\pi} \frac{T}{C} \Phi_e(nT)$$

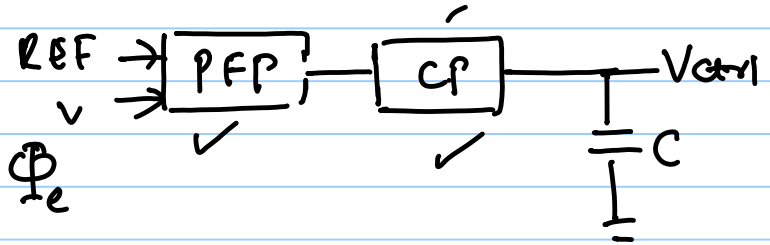
$$V_{ctrl}(z) = \frac{I_{cp}}{2\pi} \frac{T}{C(z-1)} \Phi_e(z)$$

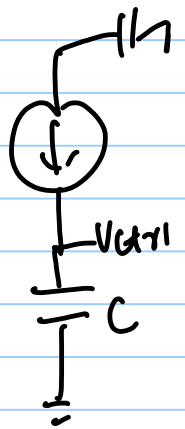


$z = e^{sT}$,

$$V_{ctrl}(s) = \frac{I_{cp}}{2\pi} \frac{T}{C(sT)} \Phi_e(s) \quad ; sT \ll 1$$

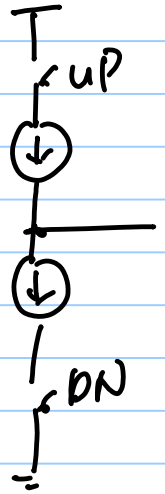
$$\boxed{V_{ctrl}(s) = \frac{I_{cp}}{2\pi} \frac{1}{sC} \Phi_e(s)}$$

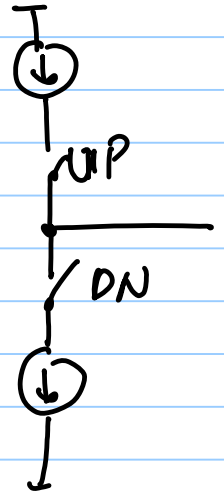


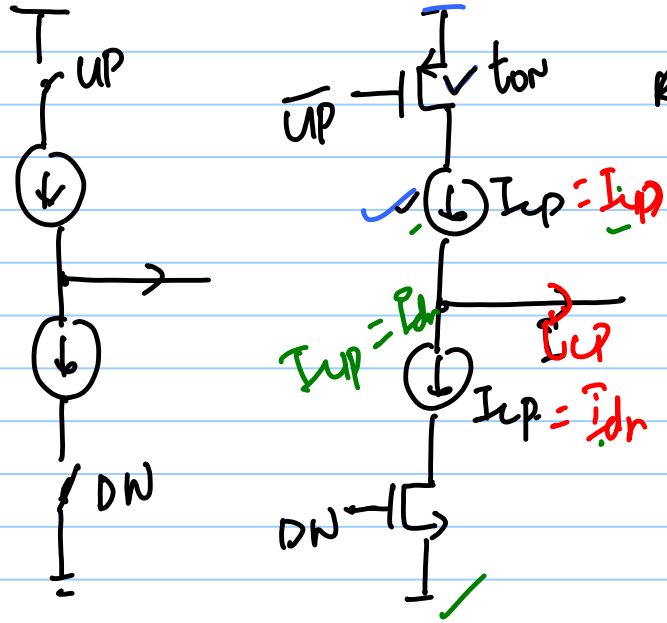


$t=0$, $V_{ctrl} = 0.1V$

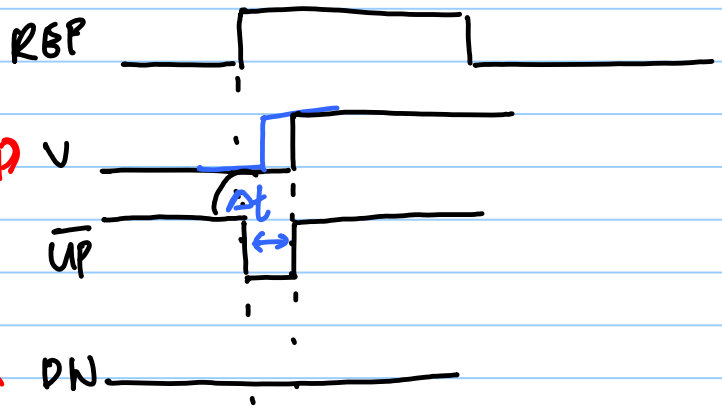
$t=\infty$, V_{ctrl}

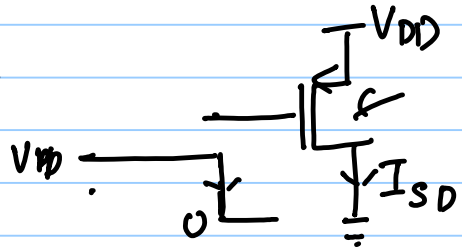


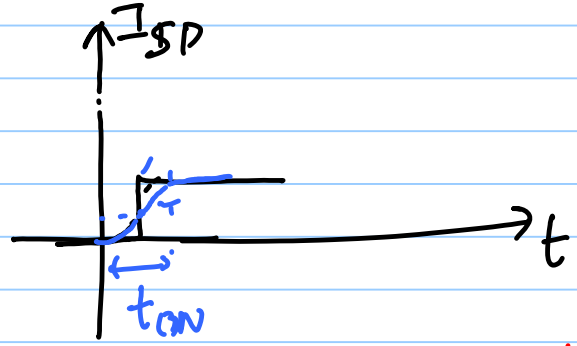


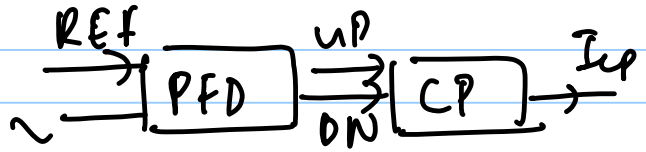

UP
DN

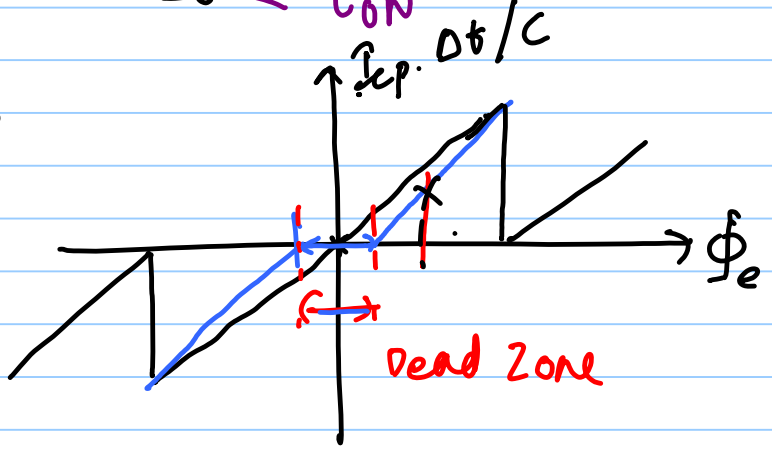
UP
DN

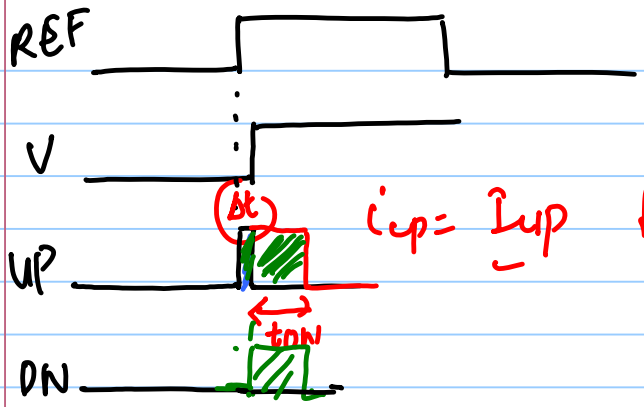

REF
V
UP
DN


VDD
VIN
0

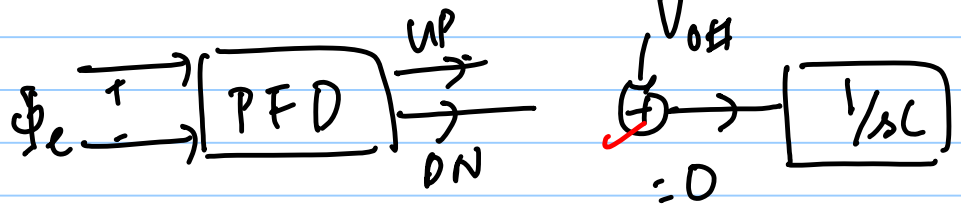

t


REF
PFD
UP
DN
CP


Dead Zone



$i_{cp} = I_{up}$ for $\Delta t + t_{DN}$



$$\Delta V_{ctrl} = \frac{I_{cp} \cdot t_{DN}}{C}$$