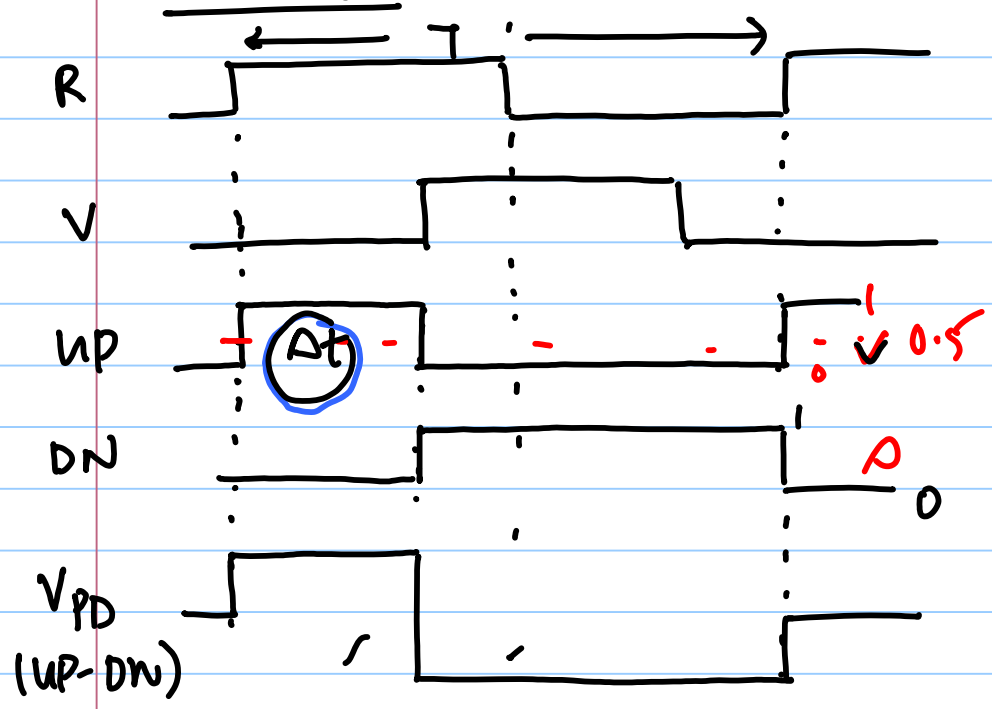
Note Title

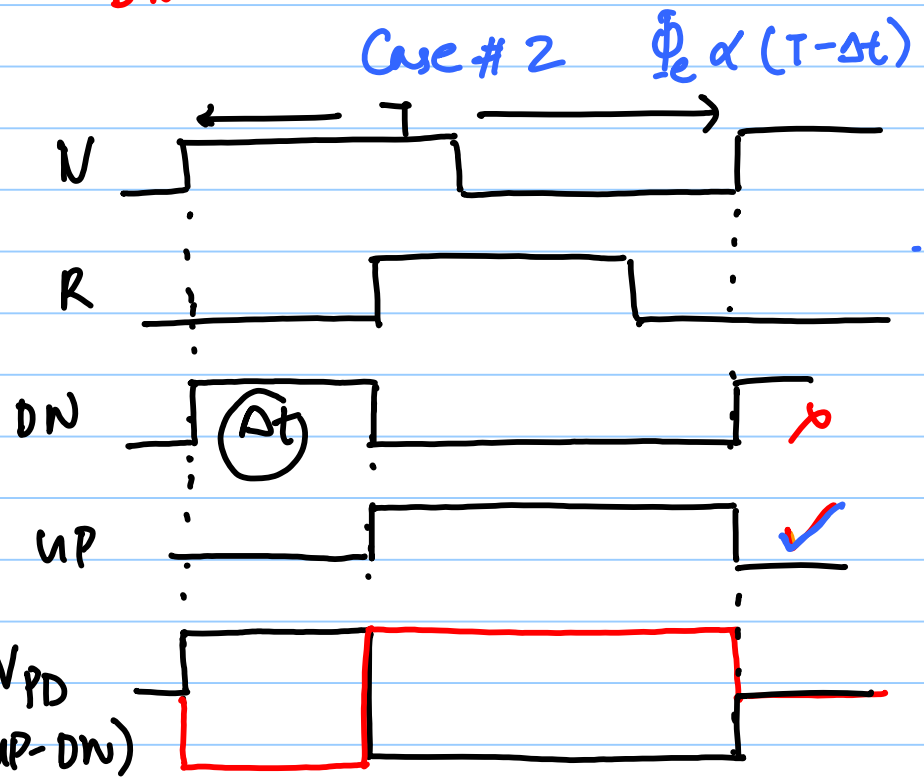
Lecture # 13

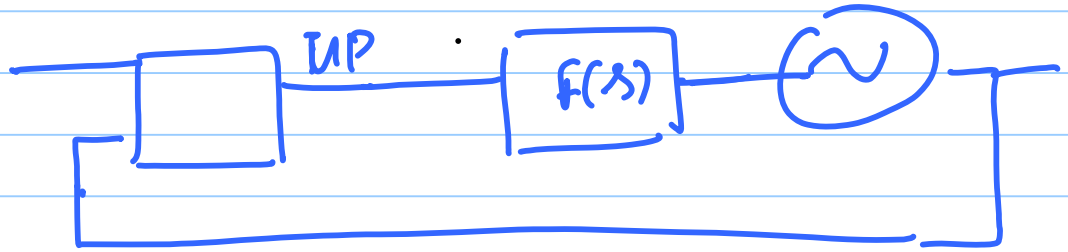
16-06-2020

$\Phi_e \propto +\Delta t$

S-R PD







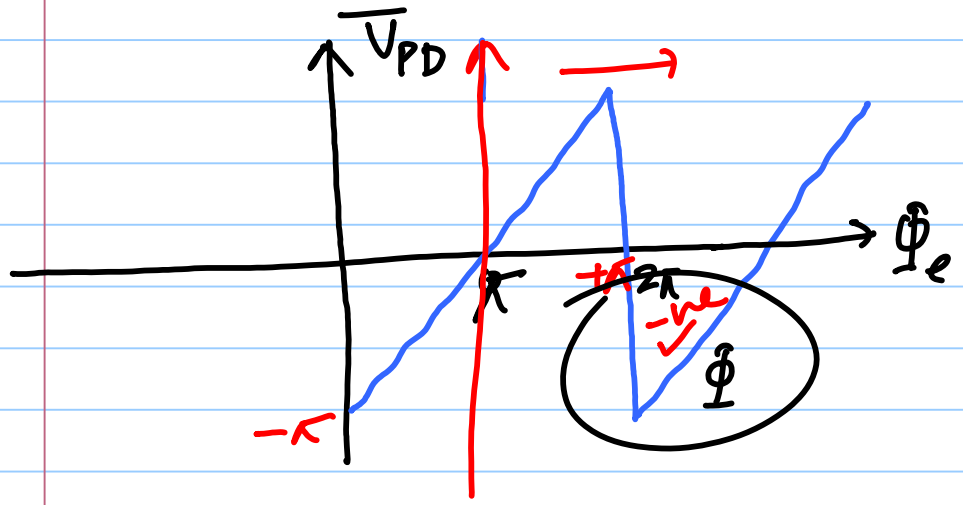
Case #1

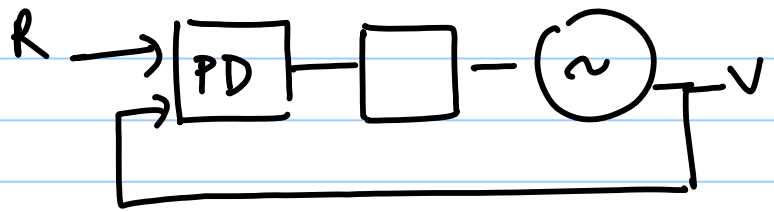
$$\frac{\Delta t - (T-\Delta t)}{T} = \frac{2\Delta t - T}{T}$$

$$= 2\frac{\Delta t}{T} - 1$$

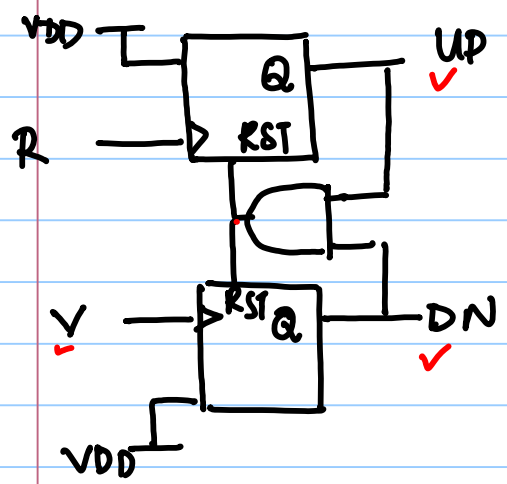
Case #2

$$\frac{-\Delta t + (T-\Delta t)}{T} = \left(\frac{T-2\Delta t}{T}\right)$$

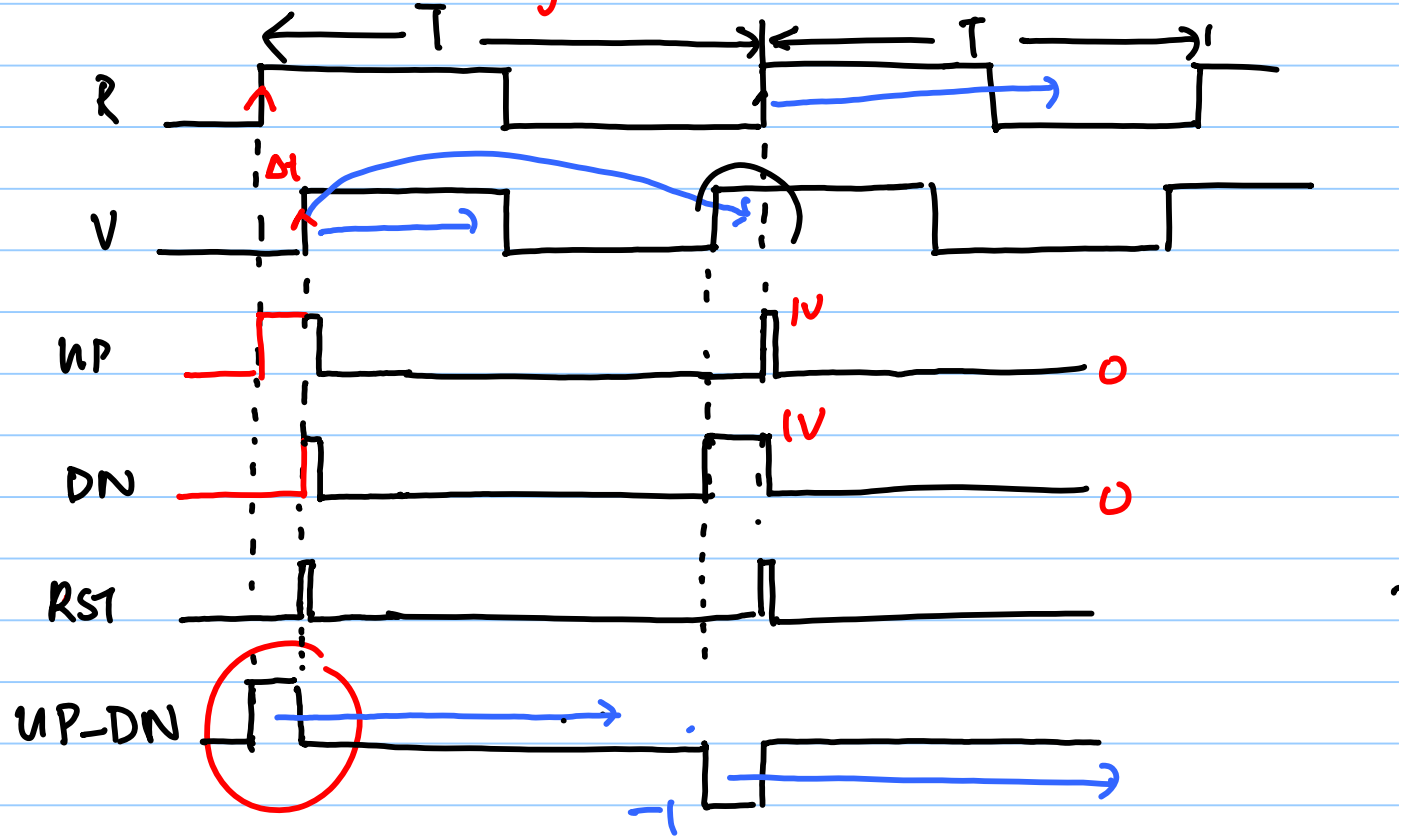




3- state PFD



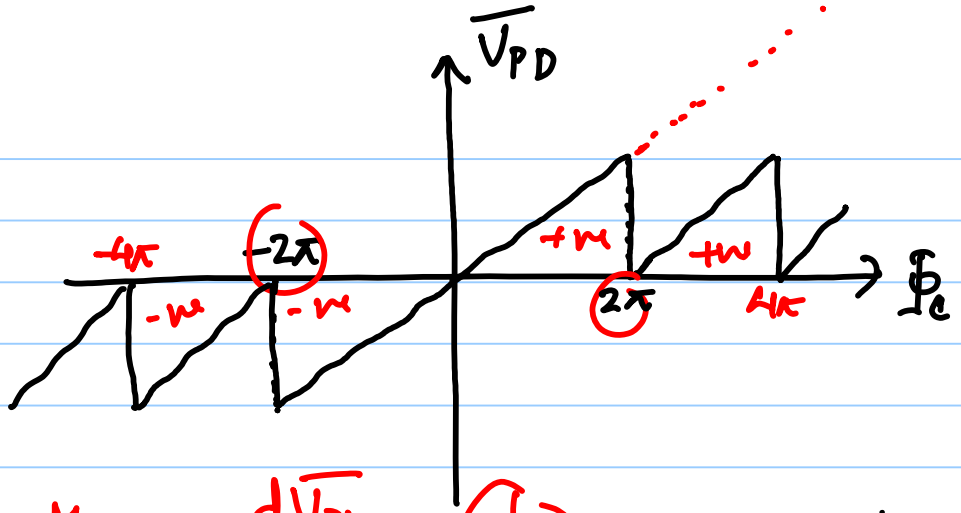
first cycle



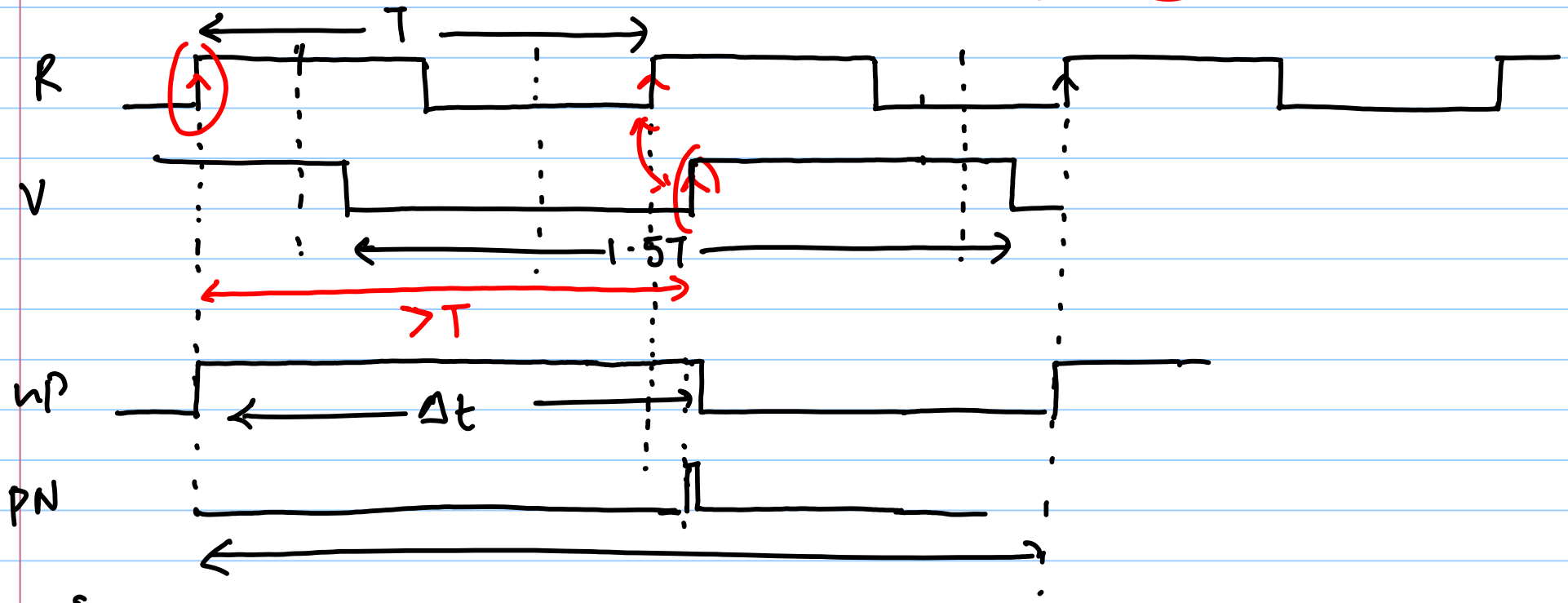
$$\Phi_e = 2\pi \cdot \frac{\Delta t}{T}$$

$$\overline{UP-DN} = \overline{V_{PD}} = \frac{2\pi \cdot \Delta t / T}{2\pi}$$

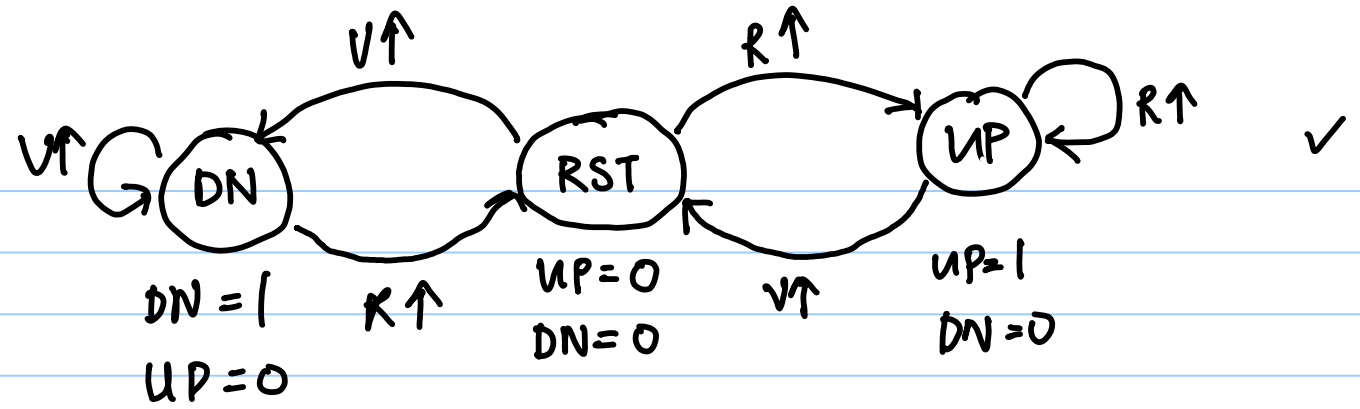
$$\boxed{\overline{V_{PD}} = \frac{\Phi_e}{2\pi}} \checkmark$$



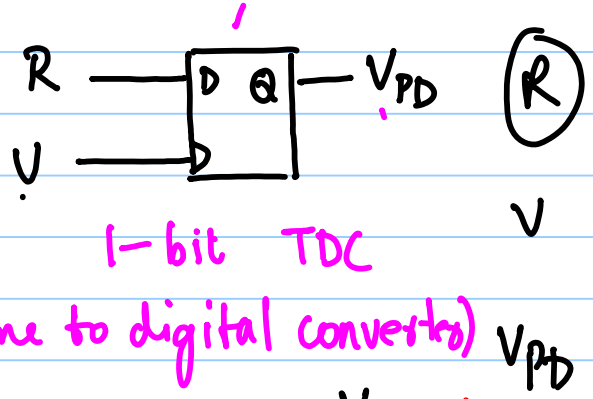
$$K_{PD} = \frac{d\overline{V_{PD}}}{d\Phi_e} = \frac{1}{2\pi}$$



$\Phi_e =$

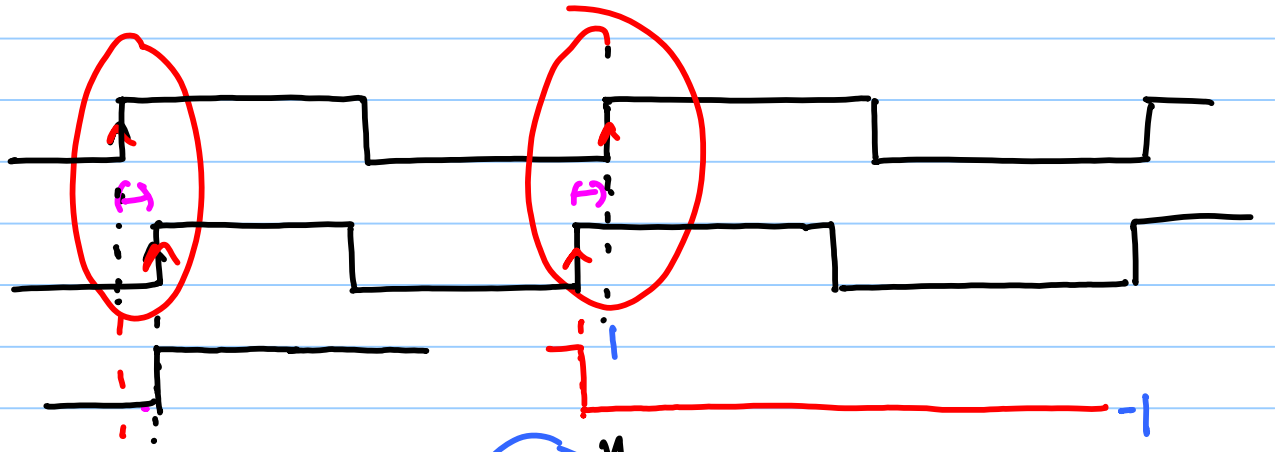


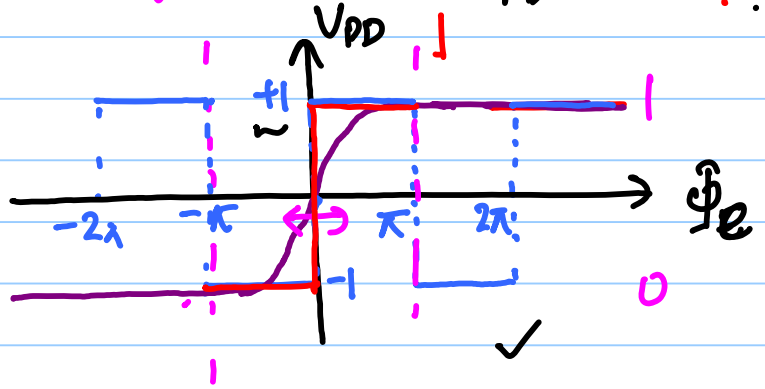
D-Flipflop based PD

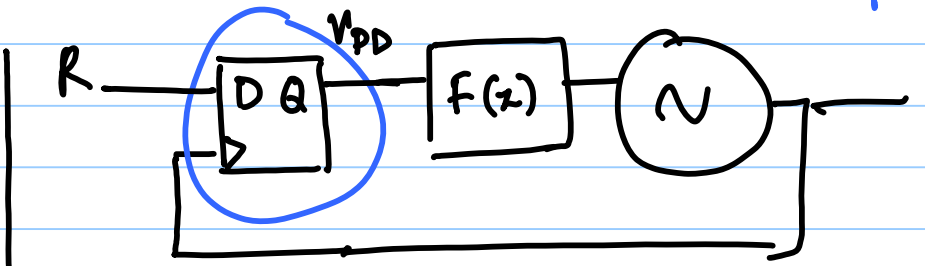


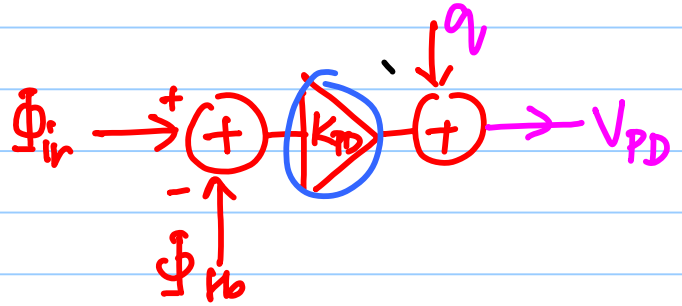
1-bit TDC

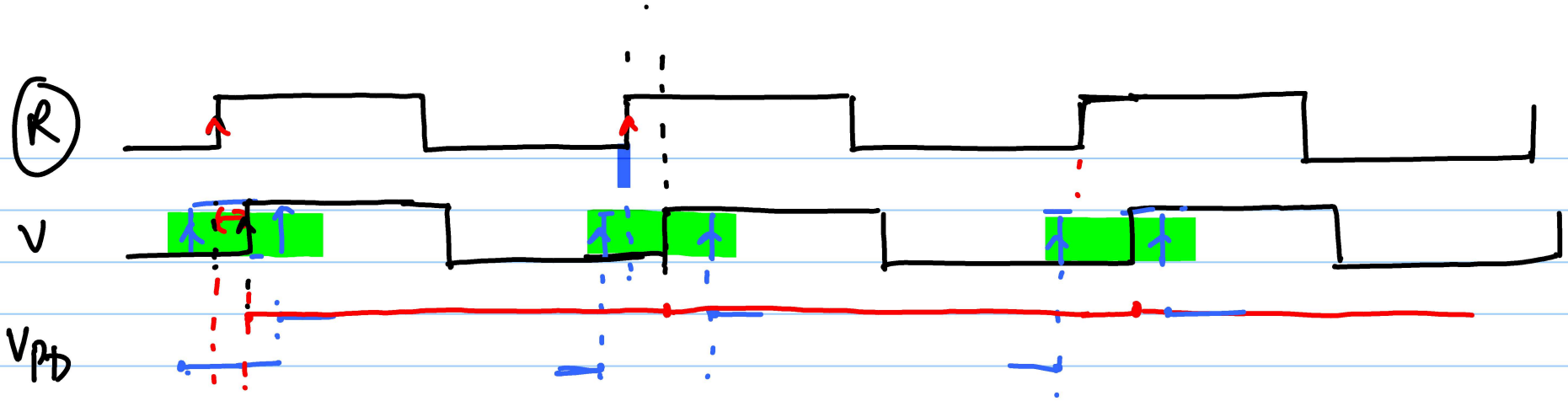
(Time to digital converter)











$$\overline{V_{PD}} = +1\, P(\Delta t + t_j \geq 0) - 1\, P(\Delta t + t_j < 0)$$

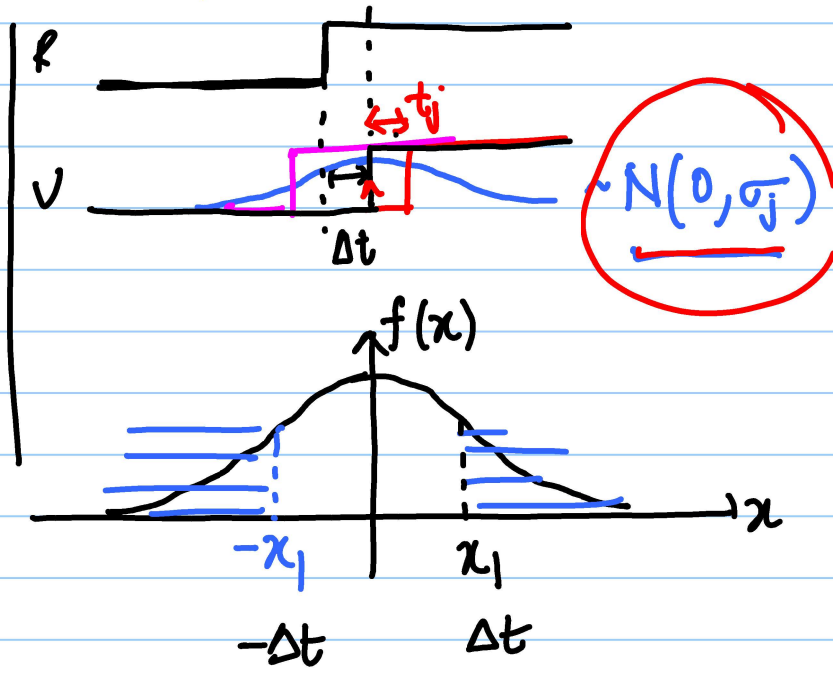
$$= P(t_j \geq -\Delta t) - P(t_j < -\Delta t)$$

$$= 1 - P(t_j \leq -\Delta t) - P(t_j < -\Delta t)$$

$$= 1 - 2P(t_j \leq -\Delta t)$$

$$= 1 - 2P(t_j \geq \Delta t)$$

$$= 1 - 2\int_{\Delta t}^{\infty} \frac{1}{\sqrt{2\pi}} \frac{1}{\sigma_j} \exp\left(-\frac{t_j^2}{2\sigma_j^2}\right) dt_j$$



$$\frac{d\overline{V_{PD}}}{d(\Delta t)} = -2\times \frac{1}{\sqrt{2\pi}}\frac{1}{\sigma_j}\exp\left(\frac{-\Delta t^2}{2\sigma_j^2}\right)\times(0-1)$$

$$= \sqrt{\frac{2}{\pi}}\frac{1}{\sigma_j}\exp\left(\frac{-\Delta t^2}{2\sigma_j^2}\right)$$

$$\boxed{\phi_e = 2\pi\cdot\frac{\Delta t}{T}}$$

$$\frac{d\overline{V_{PD}}}{d\phi_e} = \frac{d\overline{V_{PD}}}{d\Delta t}\cdot\frac{d\Delta t}{d\phi_e}$$

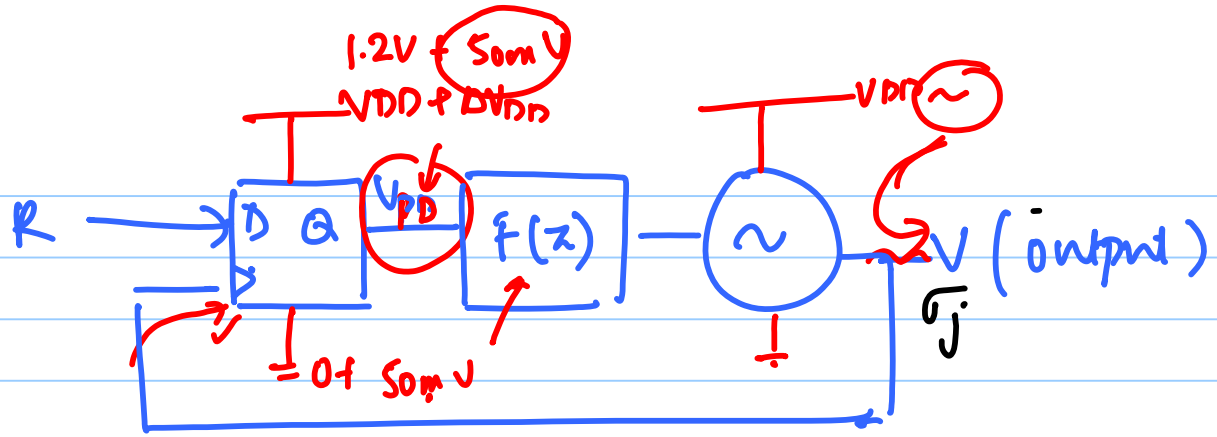
$$\frac{d(\Delta t)}{d\phi_e} = \frac{T}{2\pi}$$

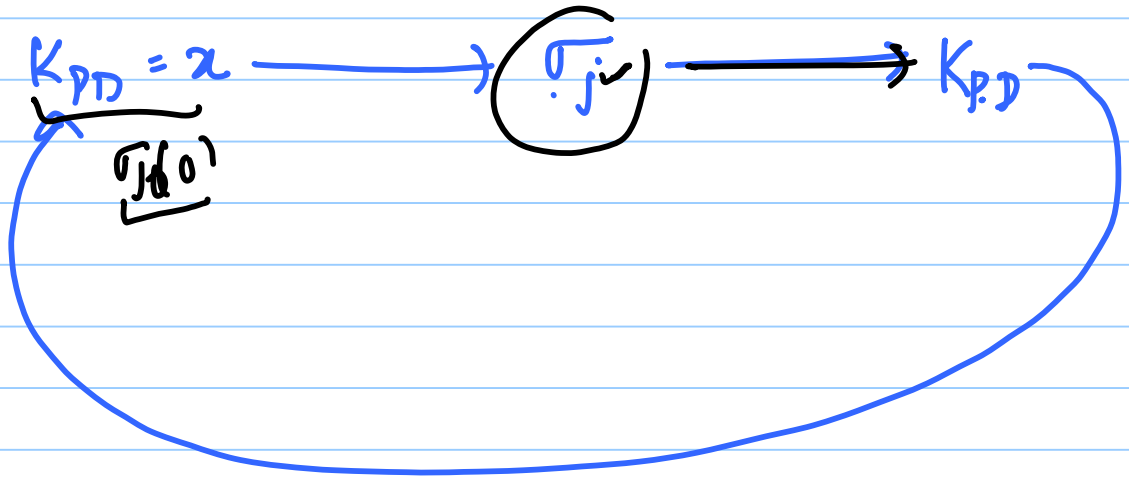
$$= \frac{T}{2\pi}\sqrt{\frac{2}{\pi}}\frac{1}{\sigma_j}\exp\left(\frac{-\Delta t^2}{2\sigma_j^2}\right)$$

$$\frac{d\overline{V_{PD}}}{d(\Delta t)} = \sqrt{\frac{2}{\pi}}\frac{1}{\sigma_j}\checkmark$$

σ_j is seconds.

$$K_{PD} = \frac{d(\overline{V_{PD}})}{d\phi_e} = \frac{T}{2\pi}\sqrt{\frac{2}{\pi}}\frac{1}{\sigma_j}$$





σ_j : Random ✔

- Supply dependent
- Additional Spur.