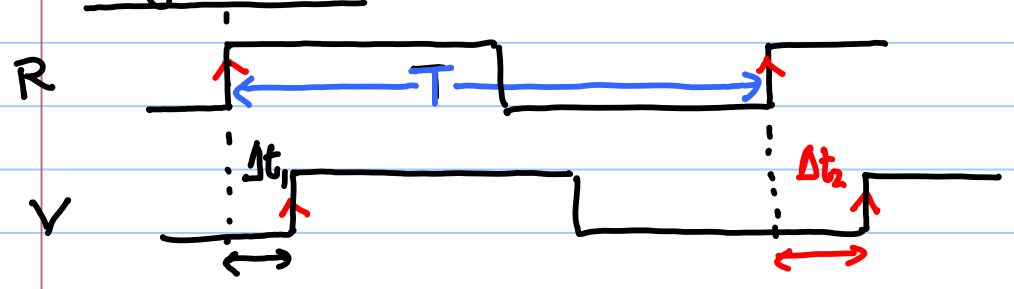
Note Title 28-09-2020

Lecture #12

Digital PD

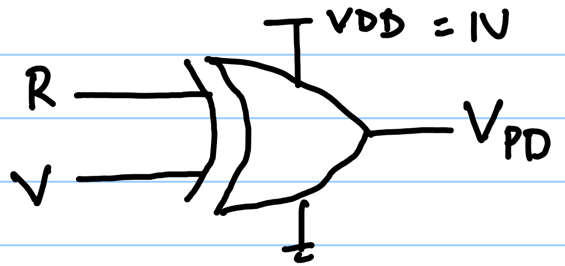


$$\phi_{er}(kT) = 2\pi \cdot \frac{\Delta t_{k+1}}{T}$$

$$\phi_{er}(0) = 2\pi \cdot \frac{\Delta t_1}{T}$$

$$\phi_{er}(1 \cdot T) = 2\pi \cdot \frac{\Delta t_2}{T}$$

Exclusive-OR based PD



$$\overline{V_{PD}} = 1 \times \frac{\Delta t_1}{T/2} = 2 \cdot \frac{\Delta t_1}{T}$$

$$= \frac{2}{2\pi} \cdot 2\pi \cdot \frac{\Delta t_1}{T} = \frac{1}{\pi}\,\phi_{er}$$

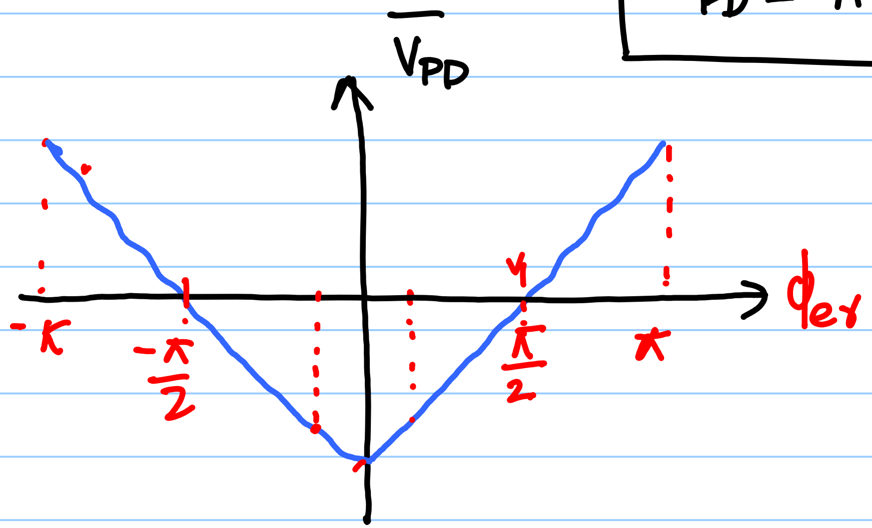
$\overline{V}_{PD} = \frac{1}{\pi}\phi_{er}$

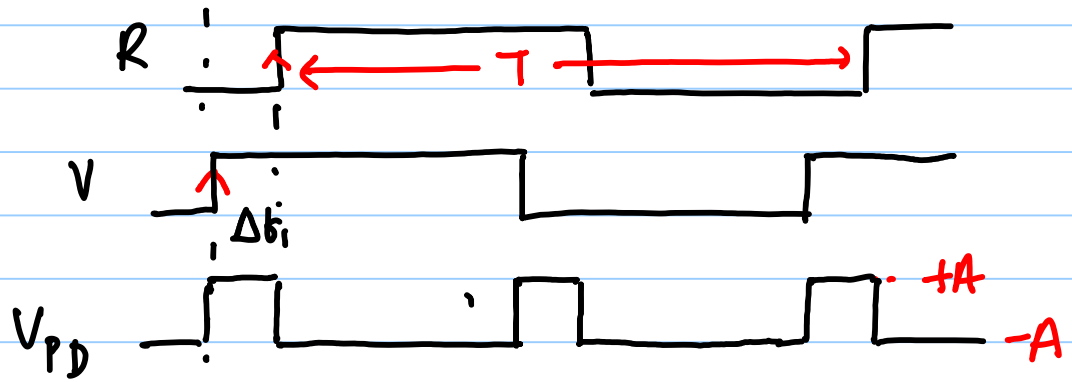
$$\overline{V}_{PD} = \frac{\Delta t_1 \cdot A - (\frac{T}{2} - \Delta t_1) A}{T/2}$$

$$= \frac{2A}{T}\left(2\Delta t_1 - T/2\right) = A\left(4 \cdot \frac{\Delta t_1}{T} - 1\right)$$

$$= A\left(\frac{2}{\pi} \quad 2\pi \cdot \frac{\Delta t_1}{T} - 1\right)$$

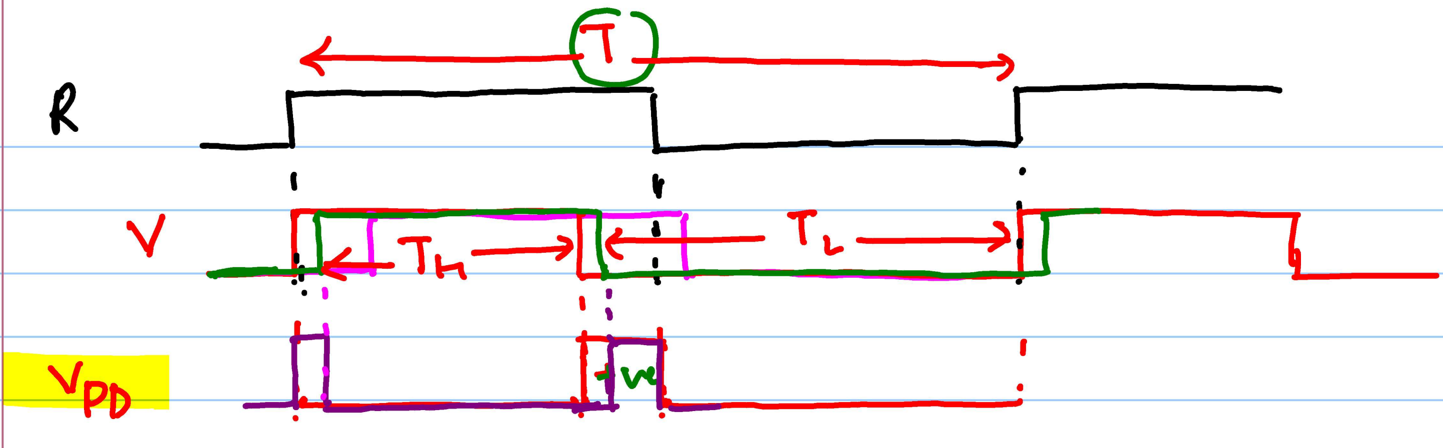
$$\boxed{\overline{V}_{PD} = A\left(\frac{2}{\pi}\phi_{er} - 1\right)}$$ ✓



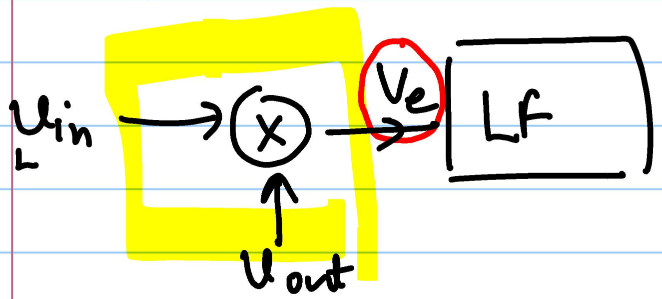


$\overline{V}_{PD}$ is a linear fn. of $\phi_{er} \in [0, \pi]$

$$\frac{d\overline{V}_{PD}}{d\phi_{er}} = \frac{2A}{\pi}$$



$$D = \frac{T_H}{T_H + T_L} = \frac{T_H}{T}$$

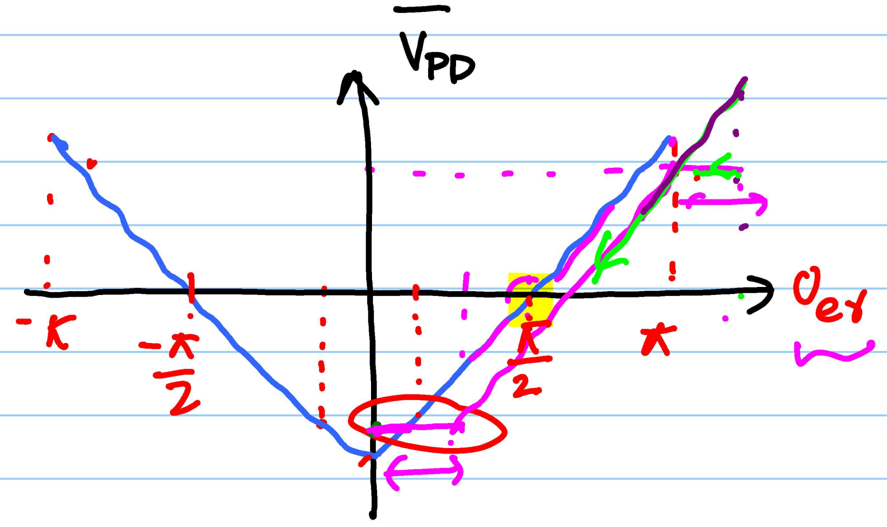


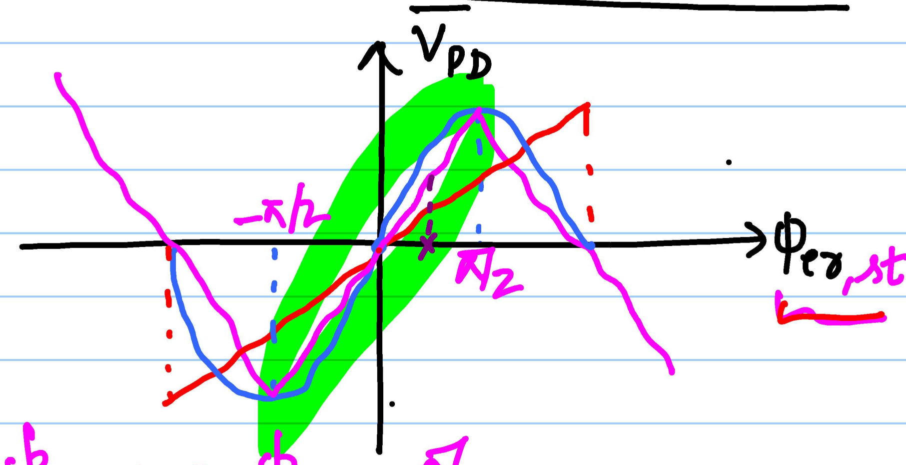
$v_{in} = \sin(\omega_0 t)$

$v_{out} = \cos(\omega_0 t - \phi_{er})$

$V_e = \frac{1}{2}\left[\sin(2\omega_0 t - \phi_{er}) + \sin(\phi_{er})\right]$

$V_e = 0 \Rightarrow \sin(\phi_{er}) = 0$

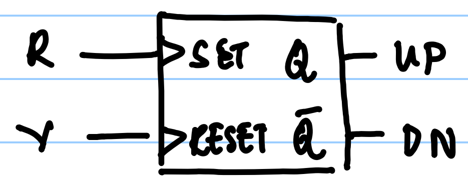


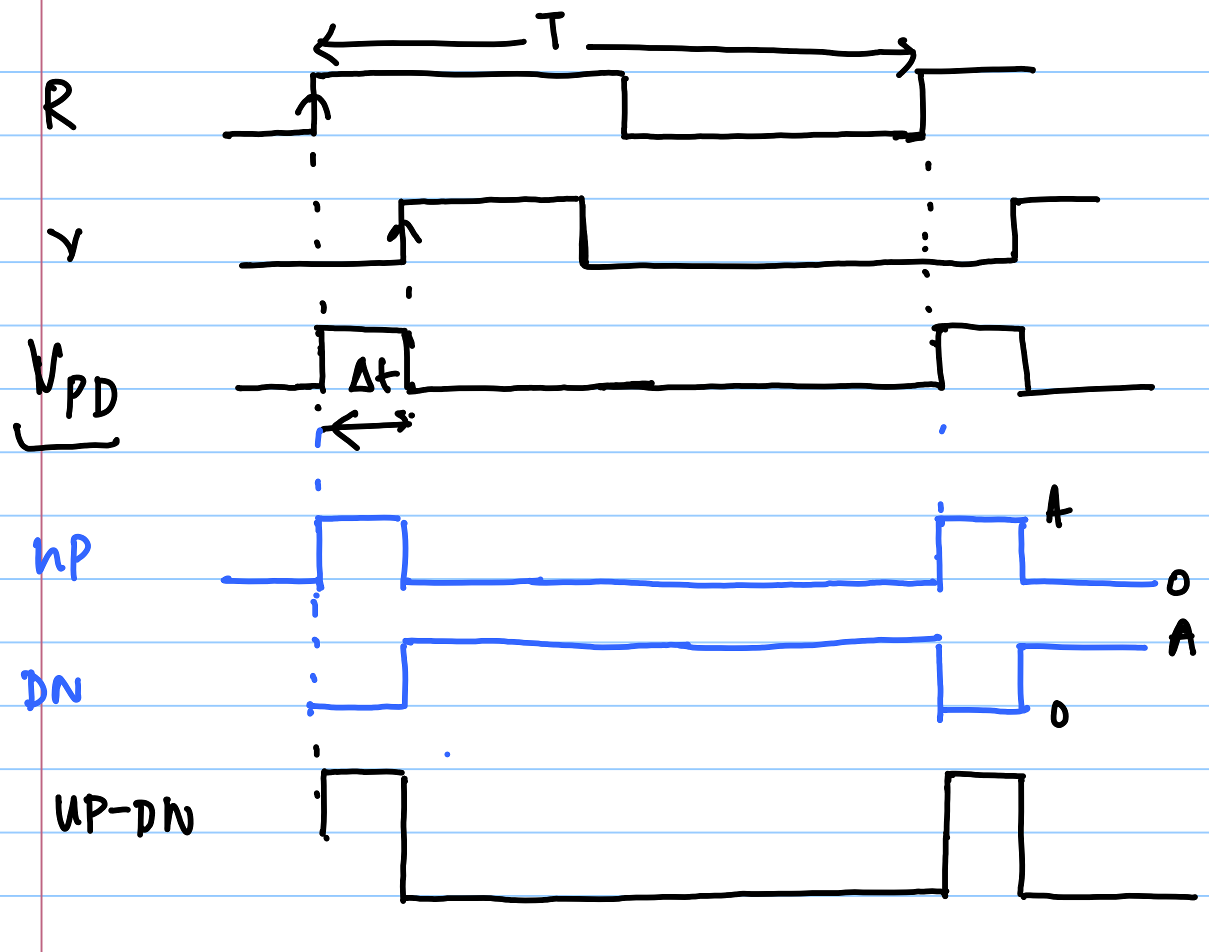


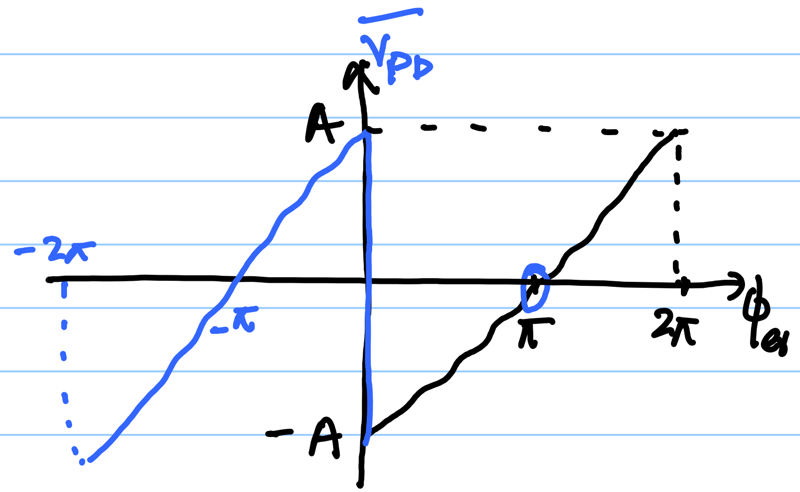
$\phi_{er,st} = \phi_{er} - \pi/2$

2-state Phase Detector.

S-R flip-flop.







$$\overline{V_{PD}} = \overline{UP-DN} = \frac{\Delta t \cdot A - (T-\Delta t)\cdot A}{T}$$

$$= A\left(\frac{2\Delta t}{T} - 1\right)$$

$$\overline{V_{PD}} = A\left(\frac{1}{\pi}\phi_{er} - 1\right)$$

$$\text{Gain} = \frac{d\overline{V_{PD}}}{d\phi_{er}} = \frac{A}{\pi}$$