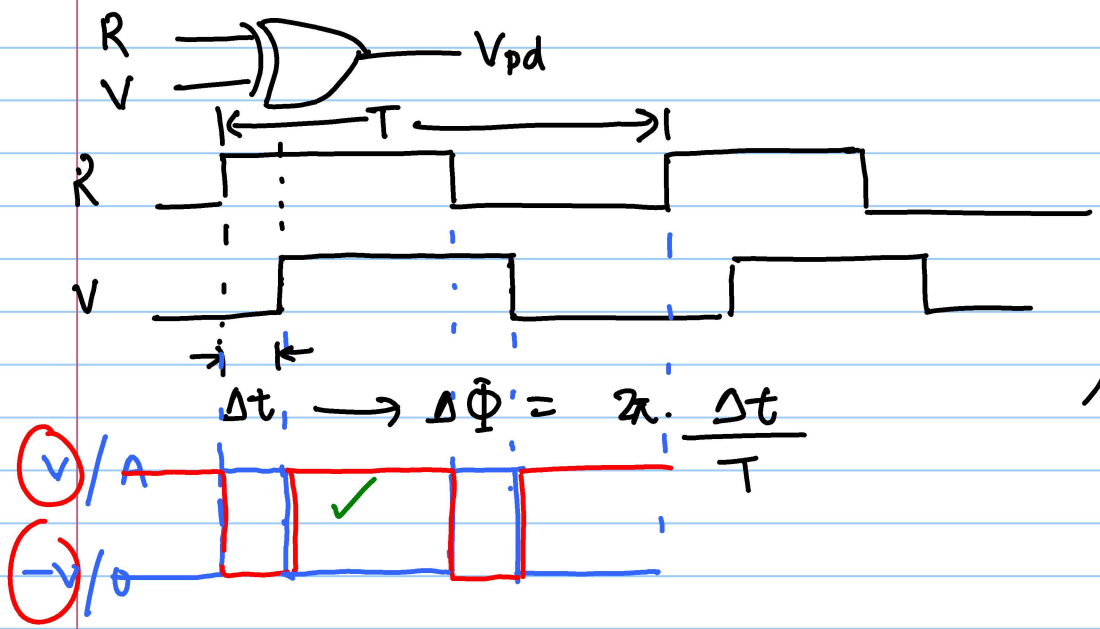
Lecture # 9

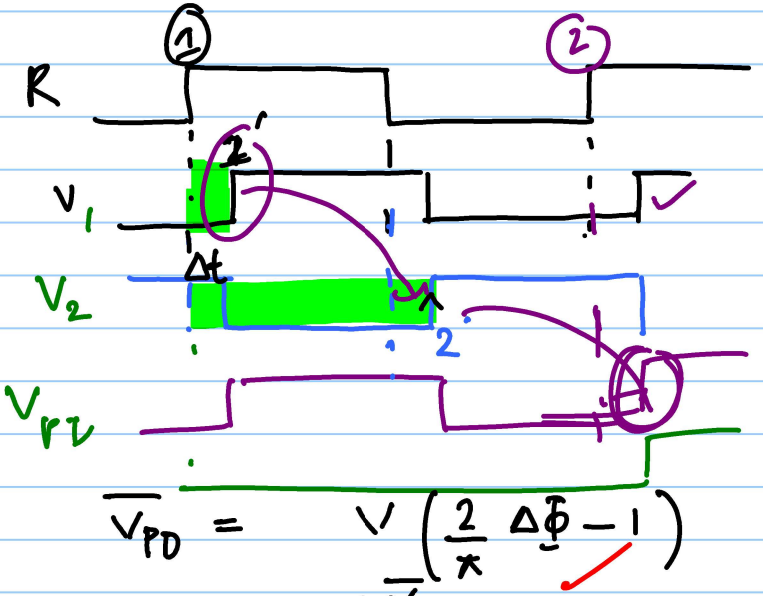
Note Title 16-08-2018

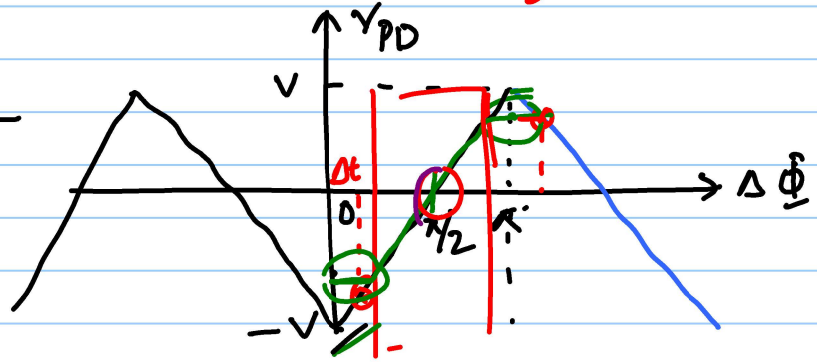
Phase Detectors

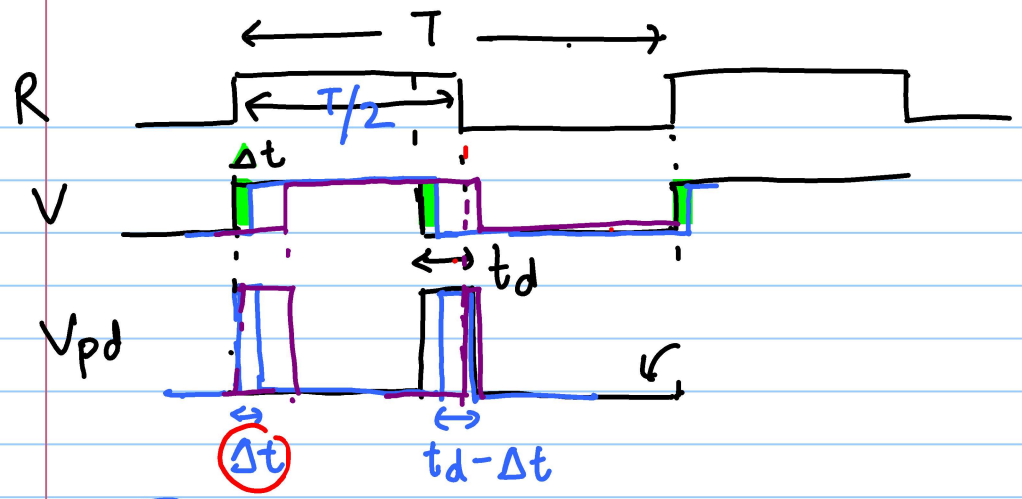
- Analog
  - Multiplier
  - Sampling
- Digital
  - XOR-based

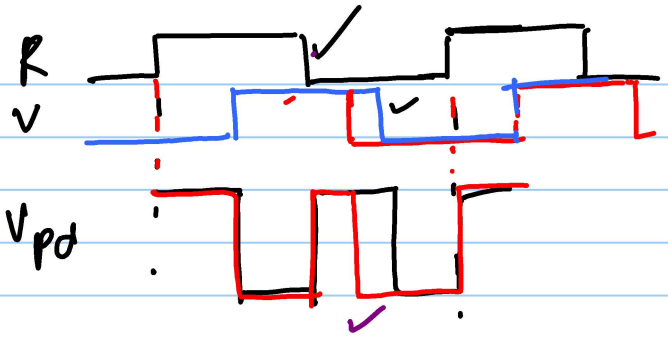
XOR-based PD









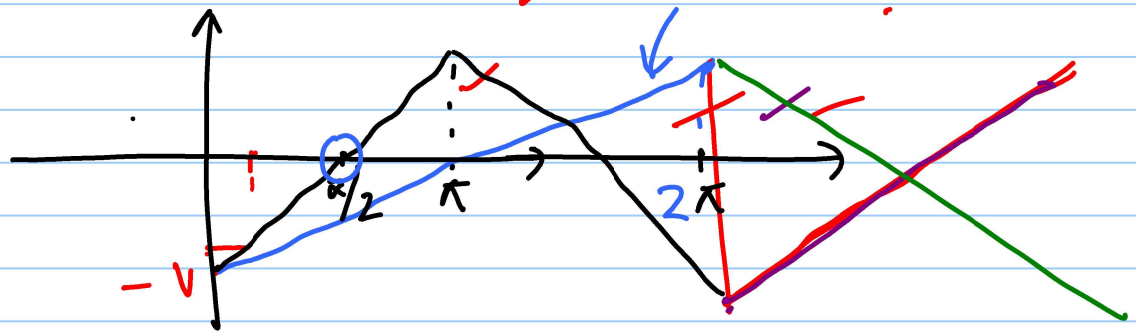


1) $\overline{V_{pd}}\Big|_{\Delta t=0} = \frac{1}{T}\left(V \times t_d - V\,(T-t_d)\right) = \frac{V}{T}\,(2t_d - T) = V\left(\frac{2t_d}{T} - 1\right)$

2) $\overline{V_{pd}}\Big|_{\Delta t < t_d} = \frac{1}{T}\left(V \times \Delta t + V\,(t_d - \Delta t) - V\,(T-t_d)\right) =$

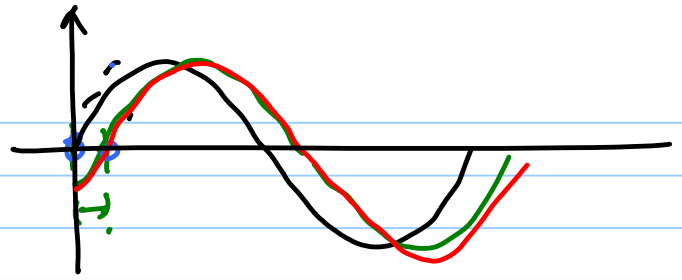
$\frac{2\pi\,\Delta t}{T} < \frac{2\pi\,t_d}{T}$

$\Delta\phi < \Delta\phi_0$.



$V_1 = \sin(\omega_0 t + \Phi_1(0))$

$V_2 = \sin(\omega_0 t + \Phi_2(0))$



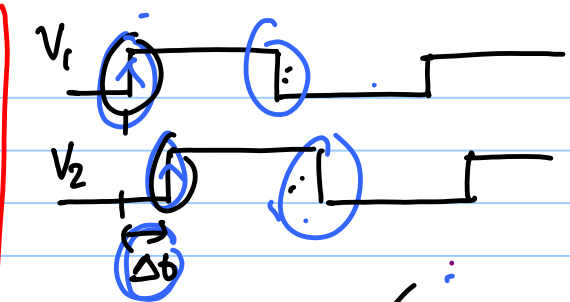
$\Phi_2(0) - \Phi_1(0)$

$\Phi_1(t) = \omega_0 t + \Phi_1(0)$

$\Phi_2(t) = \omega_0 t + \Phi_2(0)$

$\Phi_1(t) - \Phi_2(t) = \Phi_1(0) - \Phi_2(0) = \Phi_{err}(t)$

$= \dfrac{2\pi \cdot \Delta t}{T}$

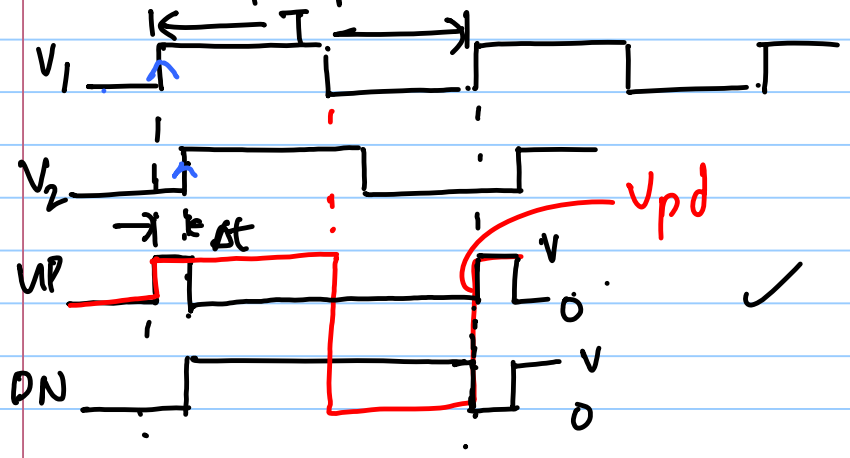


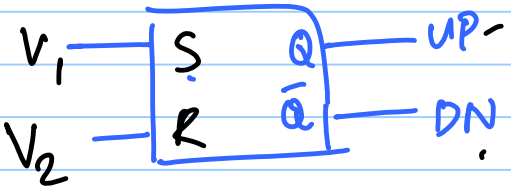
$V_1 = \sum \sin(n\omega_0 t + \Phi_{n_1}(0))$

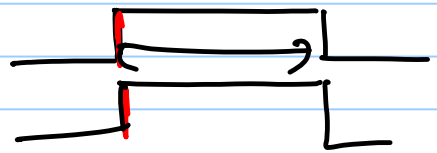
$V_2 = \sum \sin(n\omega_0 t + \Phi_{n_2}(0))$

$\Delta\Phi = \dfrac{2\pi \cdot \Delta t}{T}$

SR-flipflop based PD







$V_{PD} = UP - DN$

$$\overline{V_{PD}} = \overline{UP - DN} = \frac{V \cdot \Delta t - (T - \Delta t) V}{T} = \frac{V}{T}(2 \cdot \Delta t - T) = V\left(2 \cdot \frac{\Delta t}{T} - 1\right)$$

$$= V\left(\frac{\pi}{2\pi} \, 2\pi \cdot \frac{\Delta t}{T} - 1\right) = V\left(\frac{1}{\pi} \Delta\phi - 1\right)$$