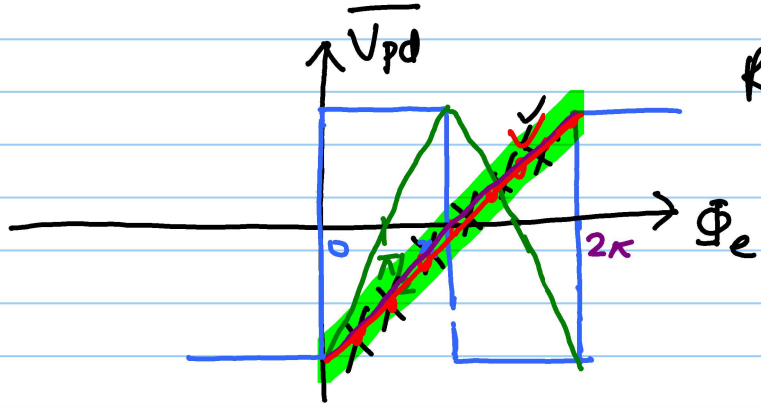
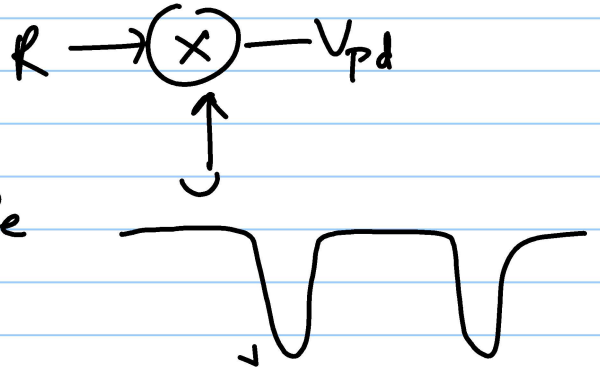
Lecture # 11

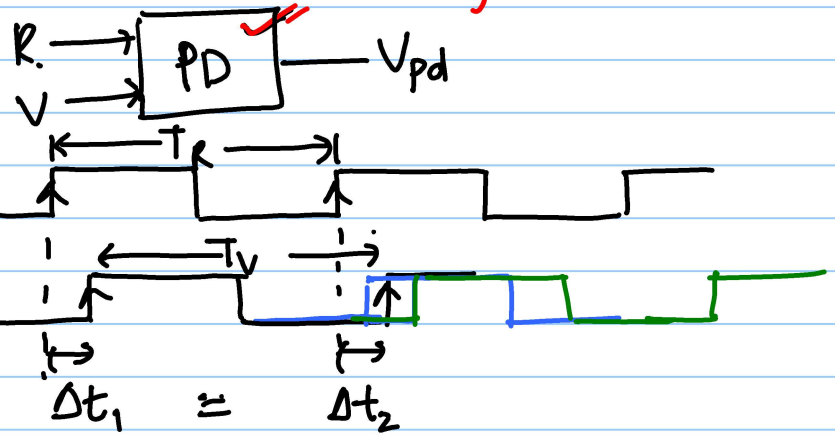
Note Title 21-08-2018

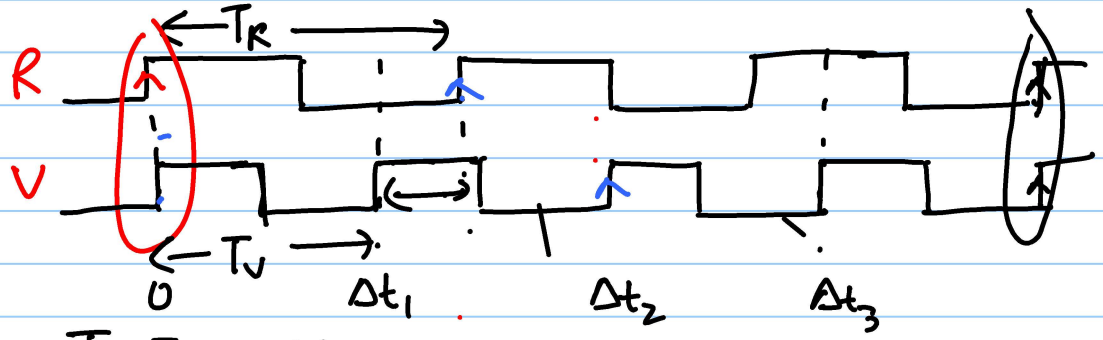
Digital PD

1. XOR-based PD
2. SR-flipflop PD
3. D-flipflop PD





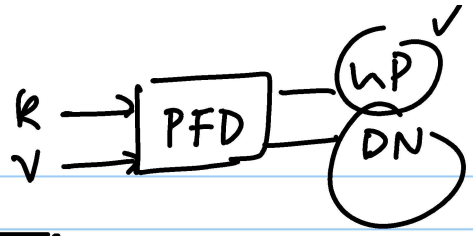


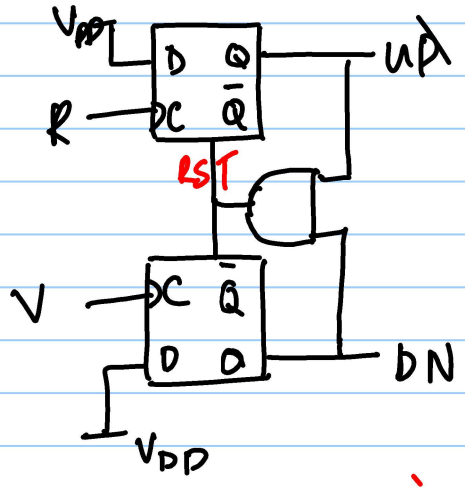


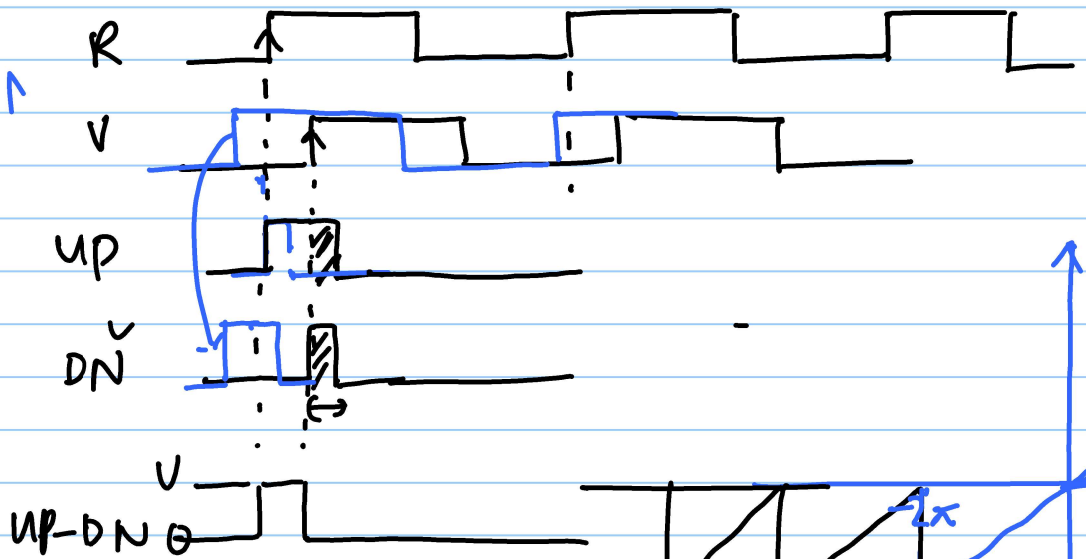
$T_R - T_V = \Delta t$

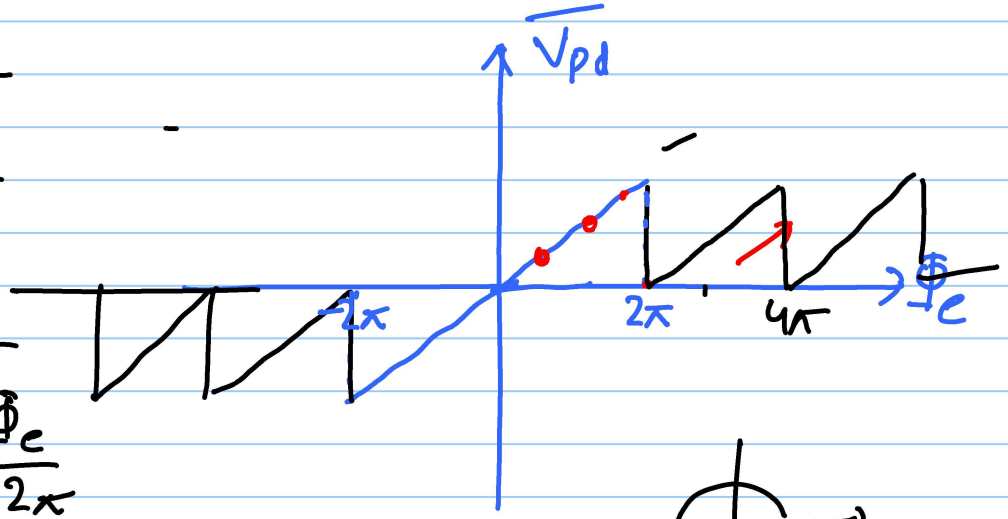
$n \cdot \Delta t = T_V$

Phase Frequency Detector. (PFD)

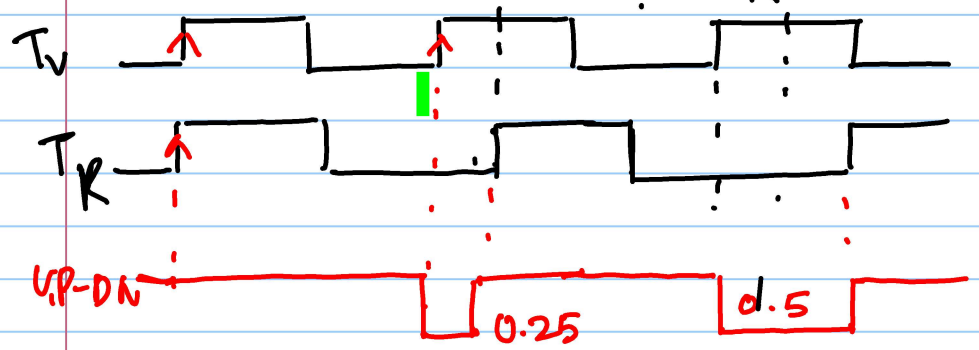




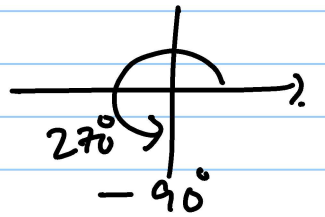


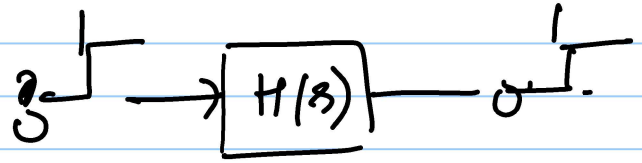


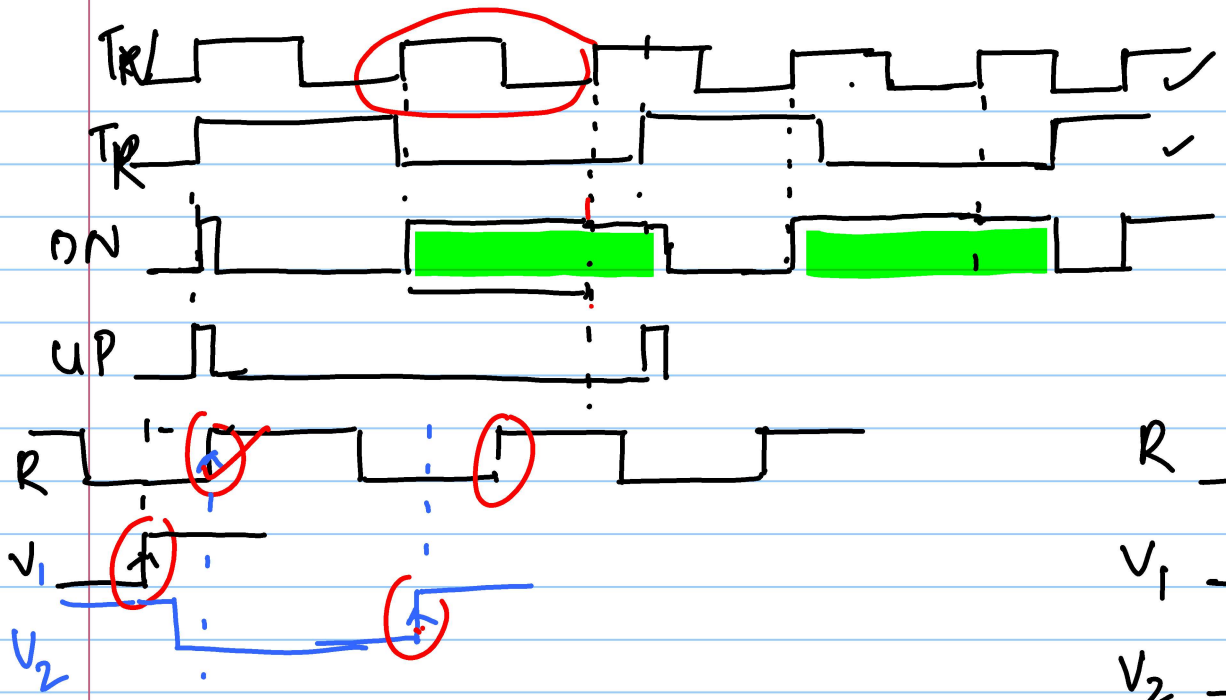
$$\overline{V_{PD}} = \overline{UP-DN} = \frac{\Delta t}{T_R} \times V = V \times \frac{\Phi_e}{2\pi}$$



$$T_R = 1.25\,T_V$$

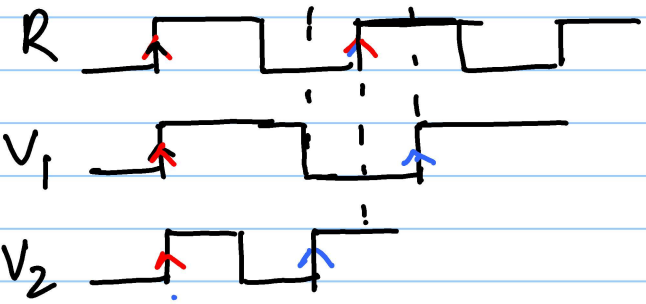


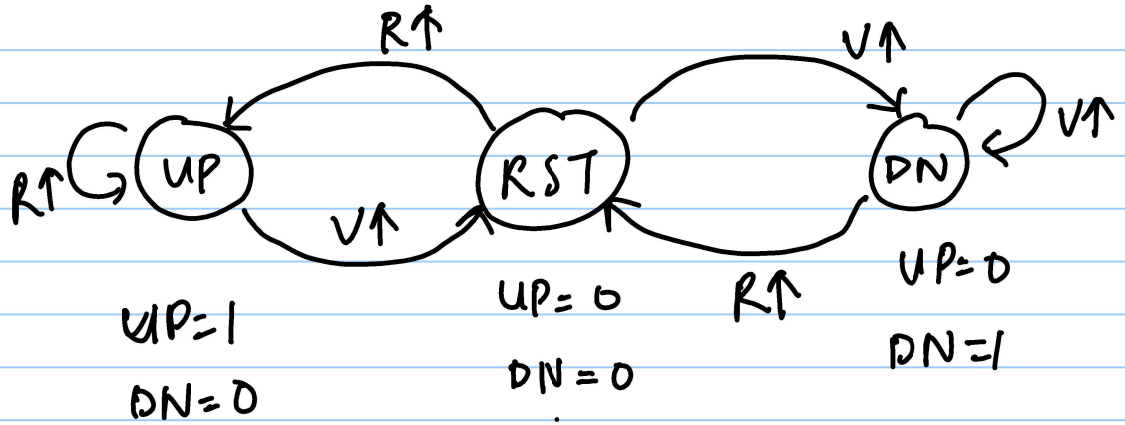


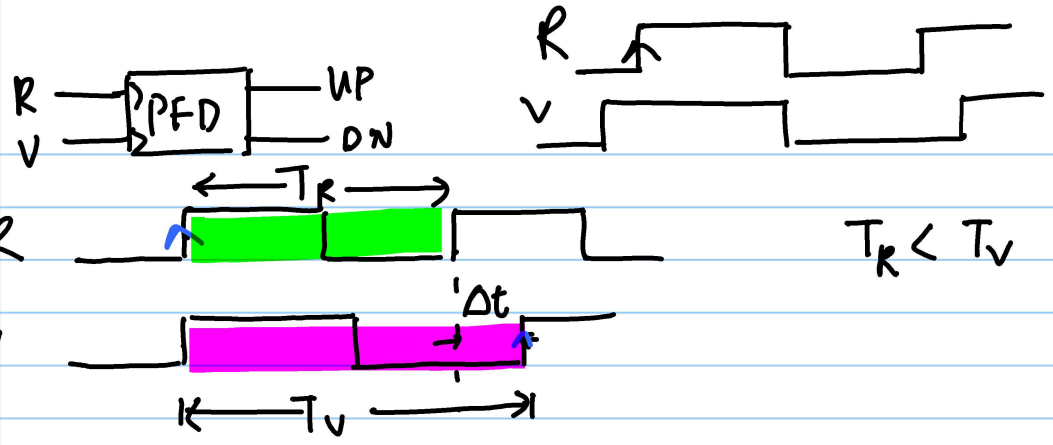


$T_R = 2.25\,T_V = \frac{9}{4}\,T_V$

$4T_R = 9T_V$







$T_R < T_V$

$\Delta T = T_V - T_R$

	$t=0$	T_R	$2T_R$	-	-	-
Phase Error (Δt)	0	ΔT	$2\Delta T$	-	-	$(N-1)\Delta T$

$$V_{up-dn} = \frac{0 + \Delta T + \dots + (N-1)\Delta T}{N}$$

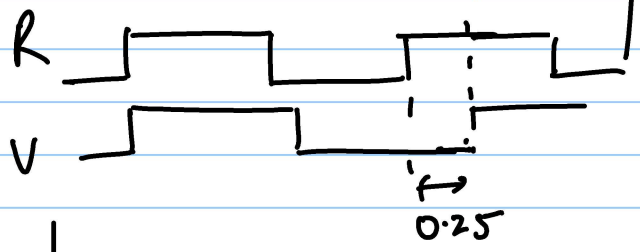
$$= \frac{(N-1)N.(\Delta T)}{2 \cdot N(T_R)}$$

$$= \frac{1}{2}\left(\frac{N-1}{N}\right)$$

$$\Delta F = \frac{1}{T_R} - \frac{1}{T_V} = f_R - f_V$$

$$T_V = 1.25\, T_R = \frac{5}{4} T_R$$

$$4T_V = 5T_R$$



$$\Delta T = T_V - T_R$$

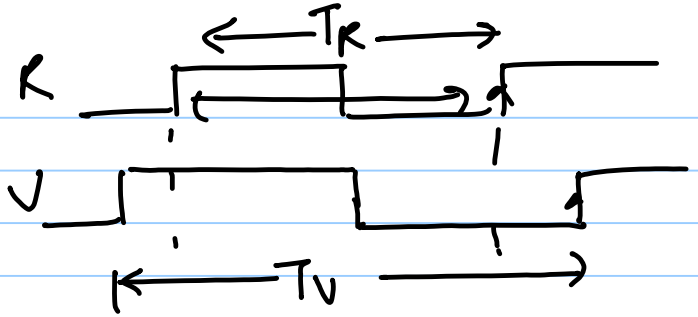
$$= \frac{5}{4} T_R$$

$$= 0.25 T_R$$

$$N(\Delta T) = T_R$$

$$N(0.25\, T_R) = T_R$$

$$N = 4$$



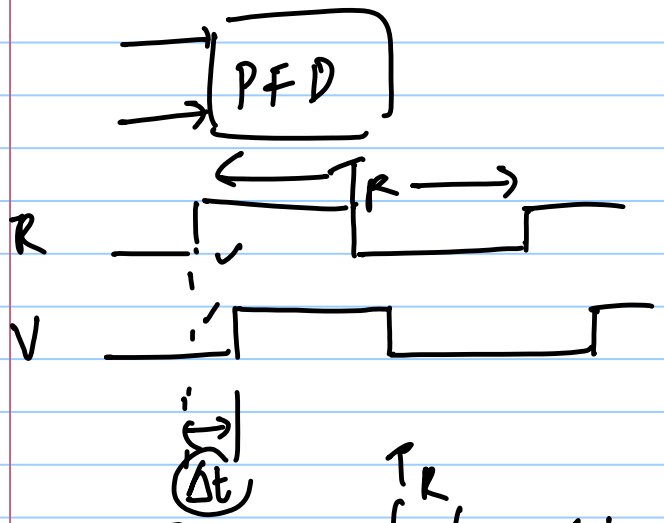
$$P(V\uparrow \text{ in } T_R \text{ time period}) = \frac{T_R}{T_V} \quad V$$

$$P(\text{no } V\uparrow \text{ in } T_R \text{ period}) = 1 - \frac{T_R}{T_V}$$

$$\overline{V_{up-dn}} = P(V\uparrow) \times V_{up-dn}\Big|_{V\uparrow} + P(\text{no } V\uparrow) \times V_{up-dn}\Big|_{\text{no } V\uparrow}$$

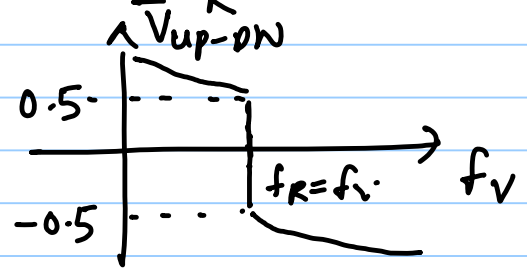
$$= \frac{T_R}{T_V} \times 0.5 + 1 - \frac{T_R}{T_V}$$

$$\therefore 1 - 0.5\frac{T_R}{T_V} = 1 - 0.5\frac{f_V}{f_R} \qquad (f_R > f_V)$$



$$\overline{V_{up-dn}} = \int_0^{T_R} \frac{1}{T_R} \frac{\Delta t}{T_R} \cdot d(\Delta t) = \frac{1}{2}$$

$$\overline{V_{up-dn}} = 1$$



$$f_V > f_R : \quad \overline{V_{up-dn}} = 0.5\frac{f_R}{f_V} - 1$$