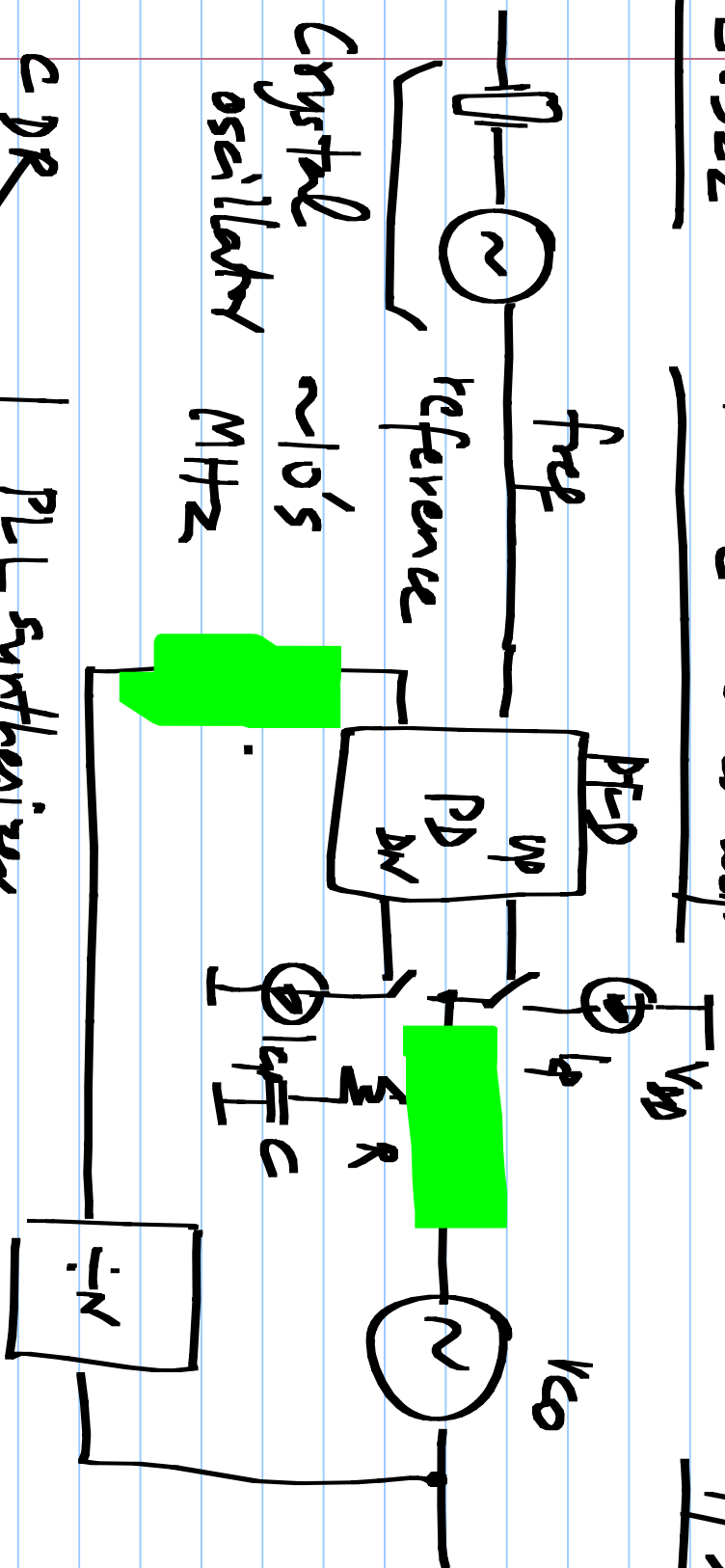


EECS222

Phase-locked loop

14/3/2018



Crystal oscillator
reference
 ~ 10 's MHz

CDR

PLL synthesizer

Random data
@ $1/p$ freq.

Periodic reference
@ $1/n \cdot 1/p$ freq.

Edge sensitive PD preferred

Phase detectors:

$$\text{Average} \sim \sin(\phi - \theta)$$

Multiplexer:

$$\cos(\omega_1 t + \phi) \cdot \sin(\omega_2 t + \theta)$$

XOR gate:

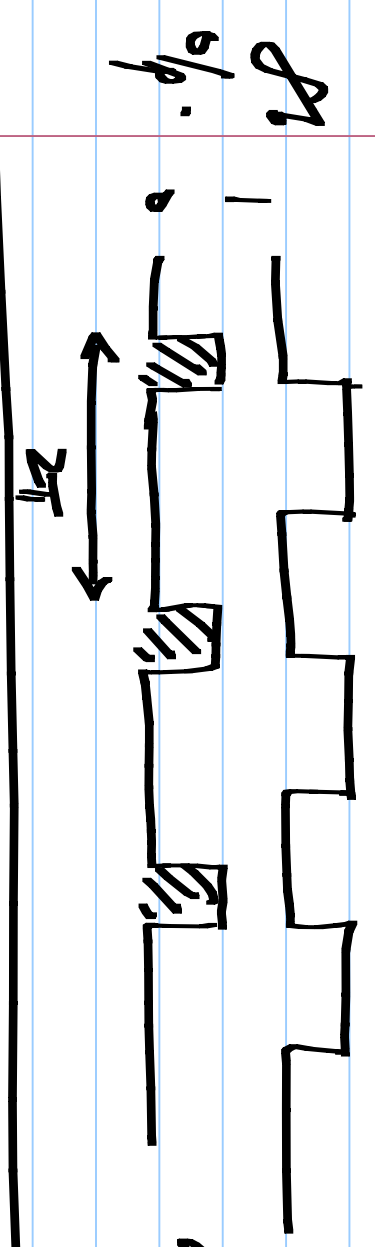
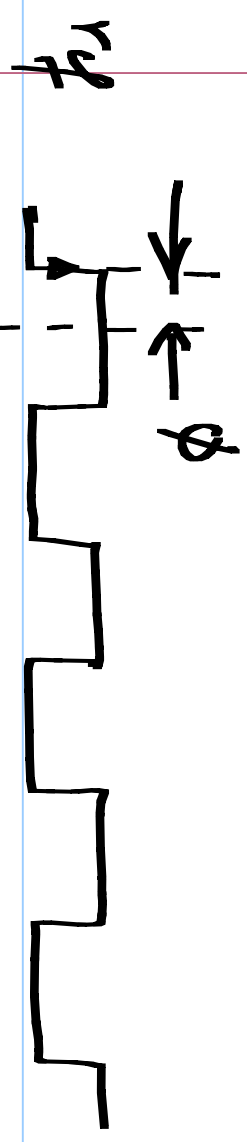
$$\text{sgn}[\cos(\omega_1 t + \phi)] \cdot \text{sgn}[\sin(\omega_2 t + \theta)]$$

-1: low
+1: high

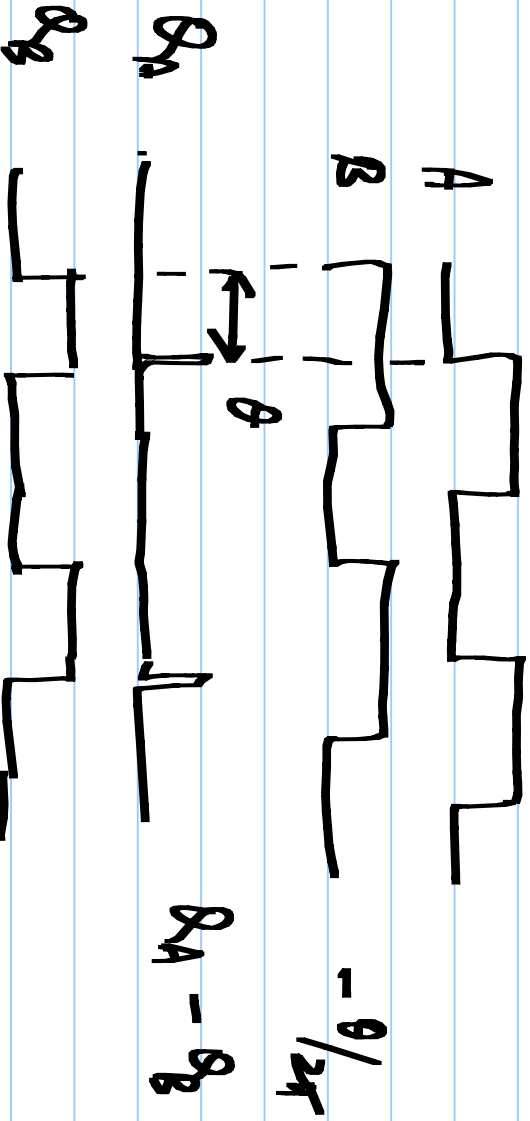
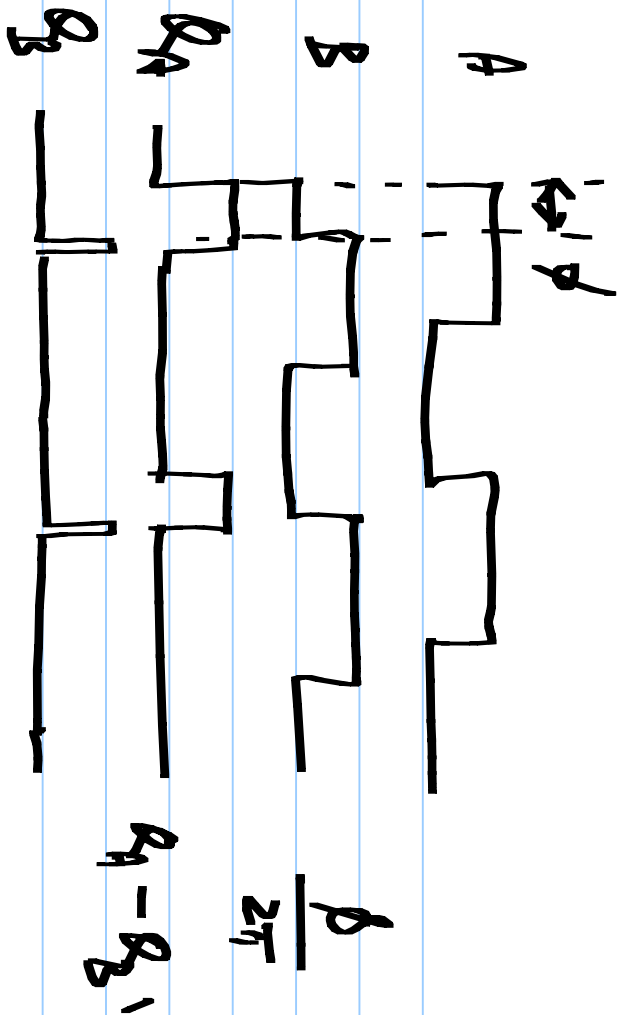
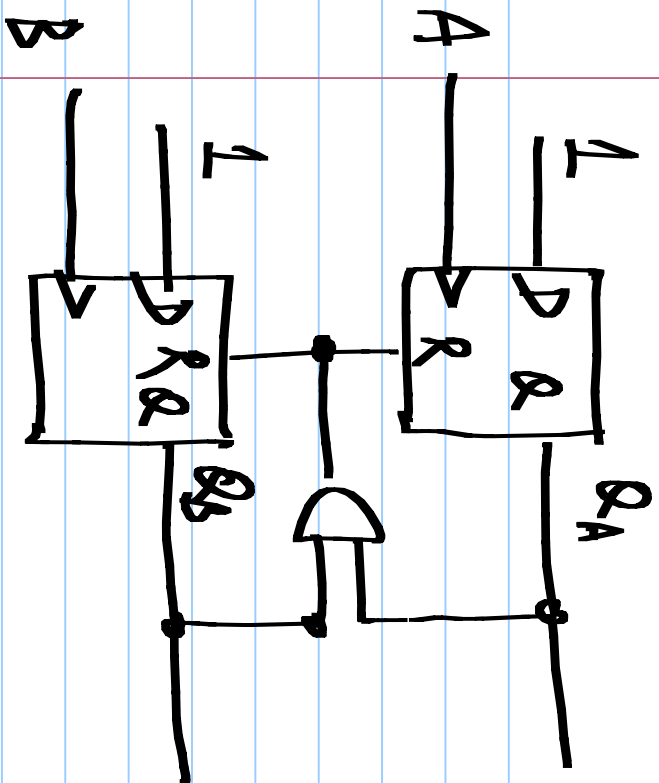
$$\text{Average} \sim \phi - \theta$$

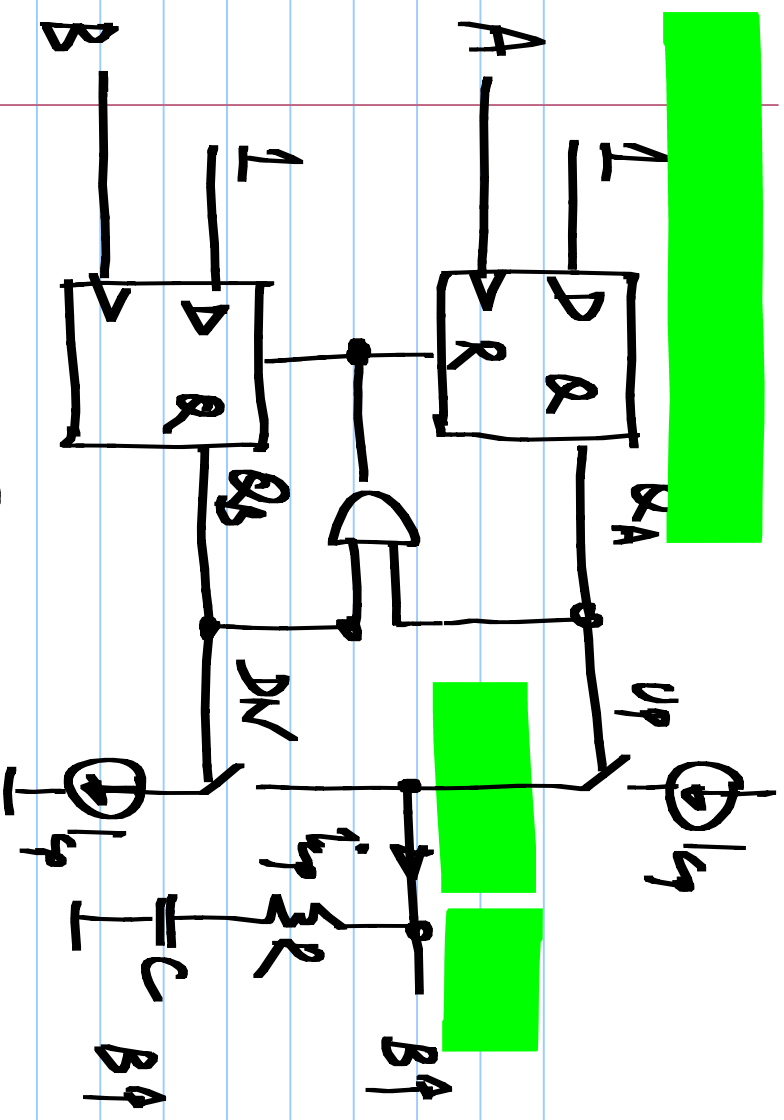
Sensitive to waveform shape.

e.g. XOR of α & $\phi - \theta$ if its inputs have 50% duty cycle



average value = $\frac{\phi}{2\pi}$

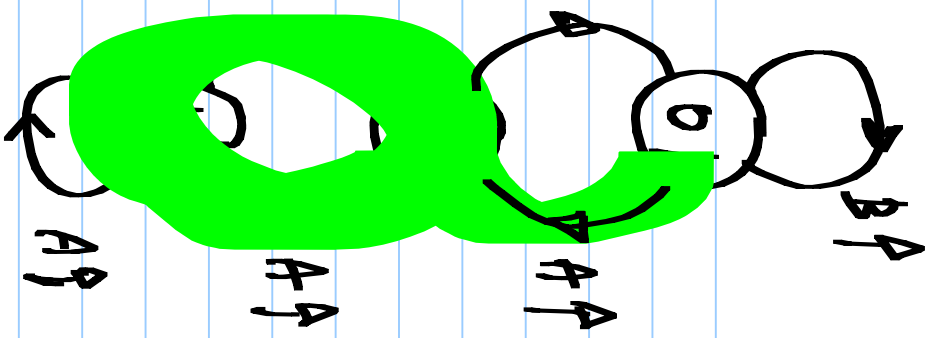




A, B: inputs @ same frequency

Can cycle between states 00 & 10

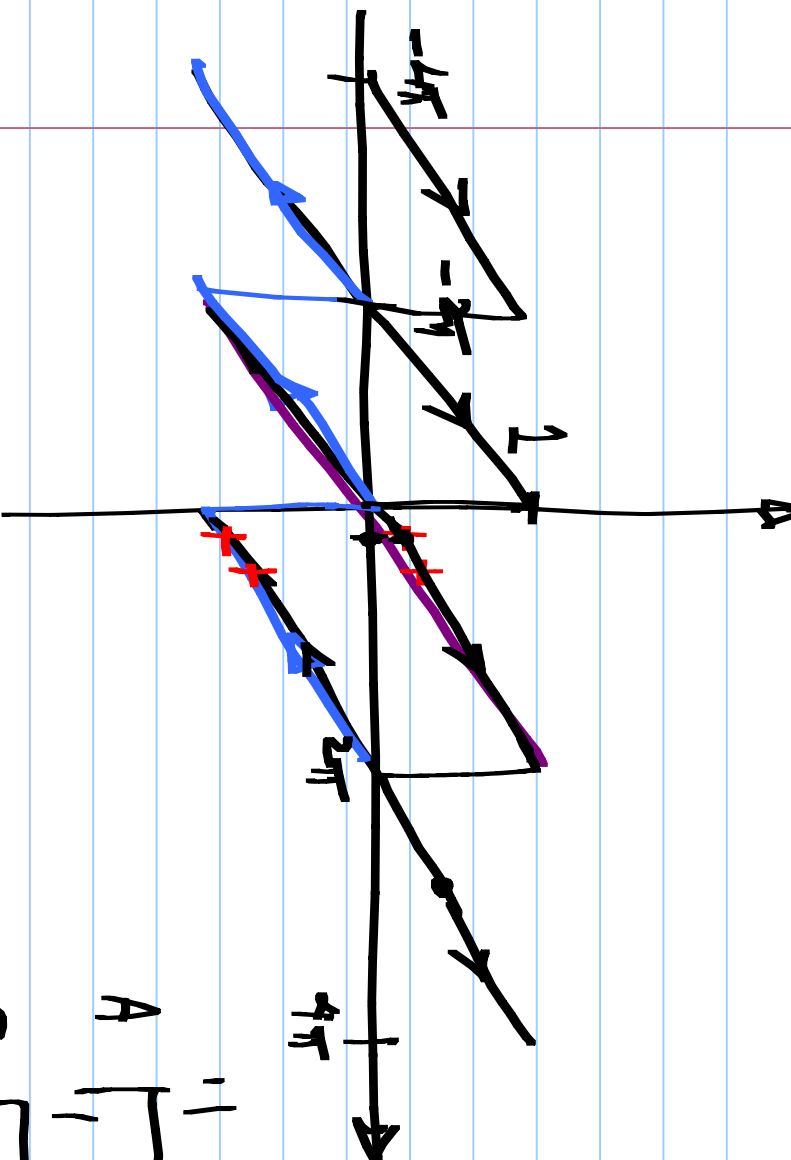
or " 00 & 01



QA QB: state:

Average $f_{vp} = \frac{1}{2T} \cdot \phi$

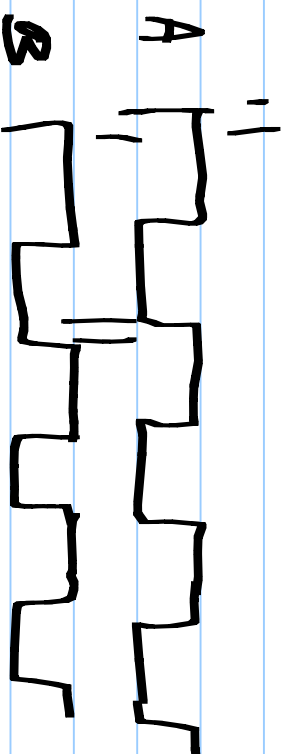
Arg ($\alpha_1 - \alpha_3$)

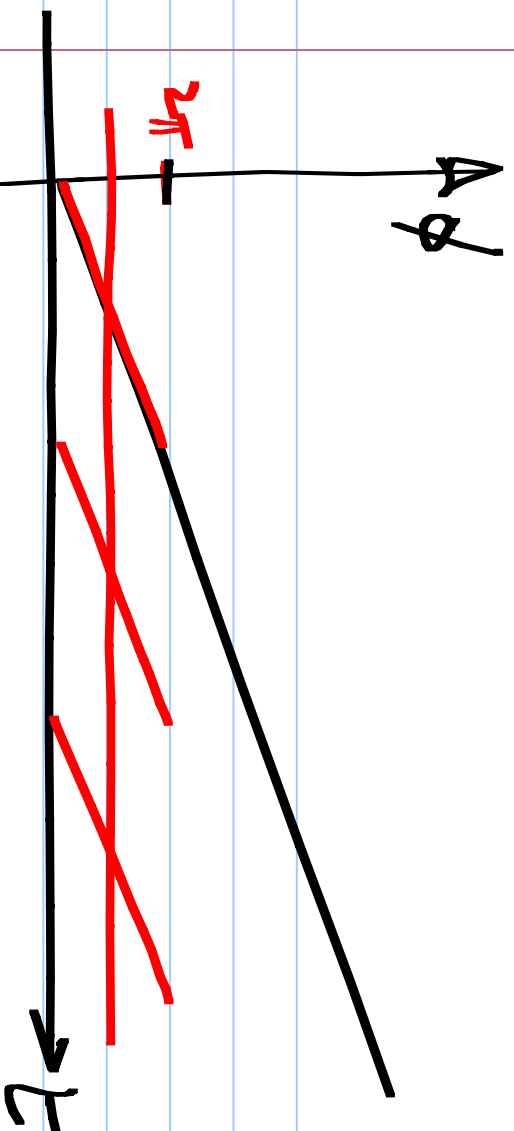


B lags A by ϕ
cycling between ∞ & 10

0 - 4π

ϕ





Average ($\omega_A - \omega_B$) = $\frac{1}{2}$ if $f_A > f_B$

= $-\frac{1}{2}$ if $f_A < f_B$

3-state phase frequency detector