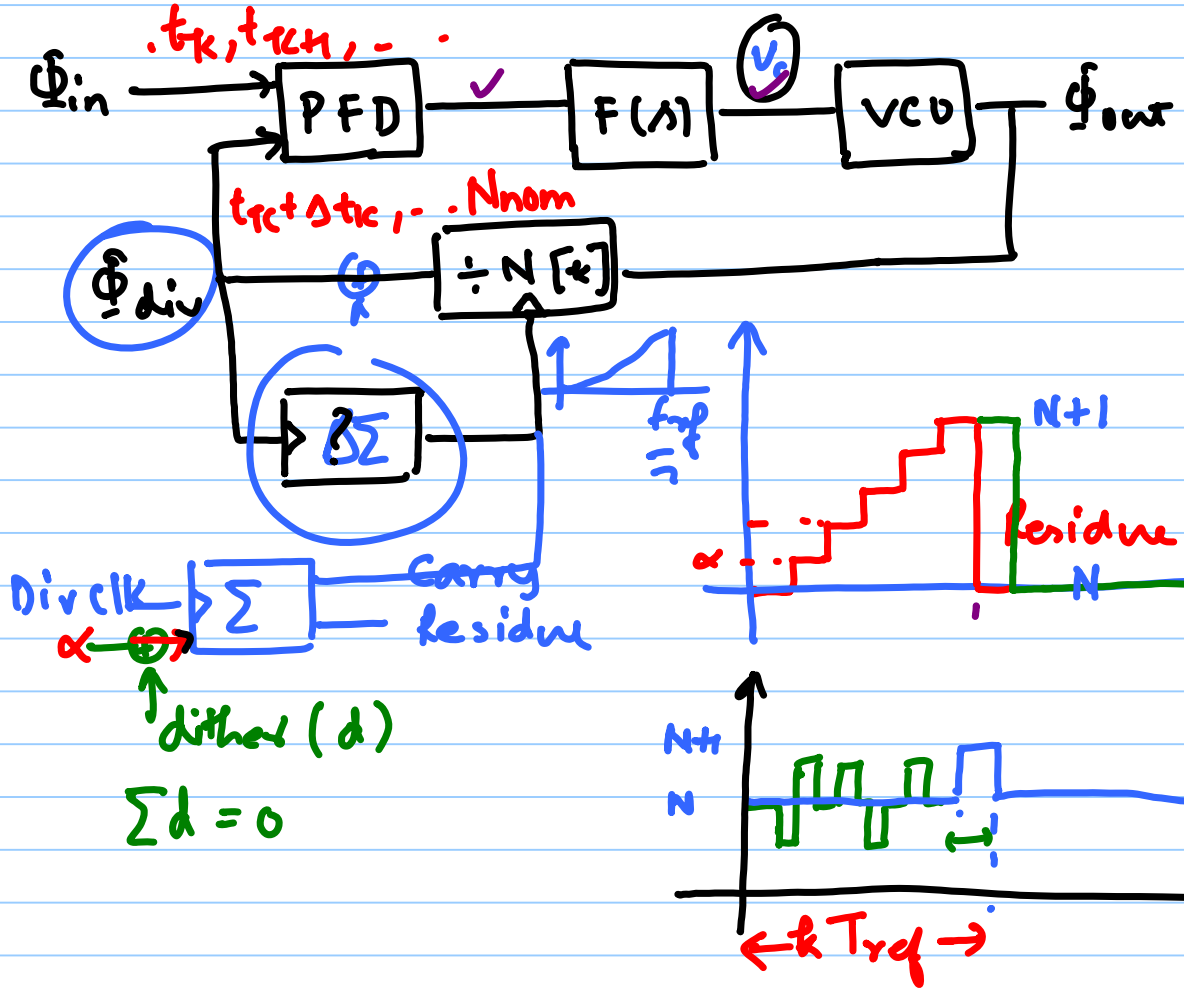
Lecture # 48

Note Title 02-11-2017

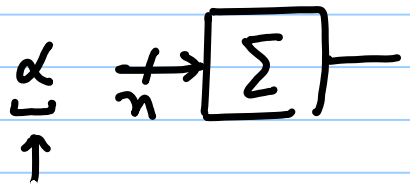
Fractional - N PLL



$$f_{out} = (N+\alpha) f_{ref} = N_{nom} f_{ref}$$

$$0 < \alpha < 1$$

$$N_{div} \in [N-1, N, N+1]$$



$f_{ref} = 40\ MHz$, $f_{out} = (16 + 0.001) \times 40\ MHz$

$= 640\ MHz + \underbrace{0.04\ MHz}_{\alpha}$

3-bit LSB = $\frac{f}{2^3}$ (0, 0.125, 0.25, 0.5, 0.625, 0.75, 0.875)

$\alpha = 0.125$ $n = 3'b001$ — [Σ] — 1bit (Carry) + Residue

$\alpha = 0.001$ $n = 10'b000\ldots1$

fout = N freq

(N+1) freq

Resolution of fractional freq $\propto \frac{1}{\#\text{ of bits in fcw}}$

10-bit — dither — [Σ]

$10'b0000010101$

freq/2^{10}

(u) fcw

· CLK

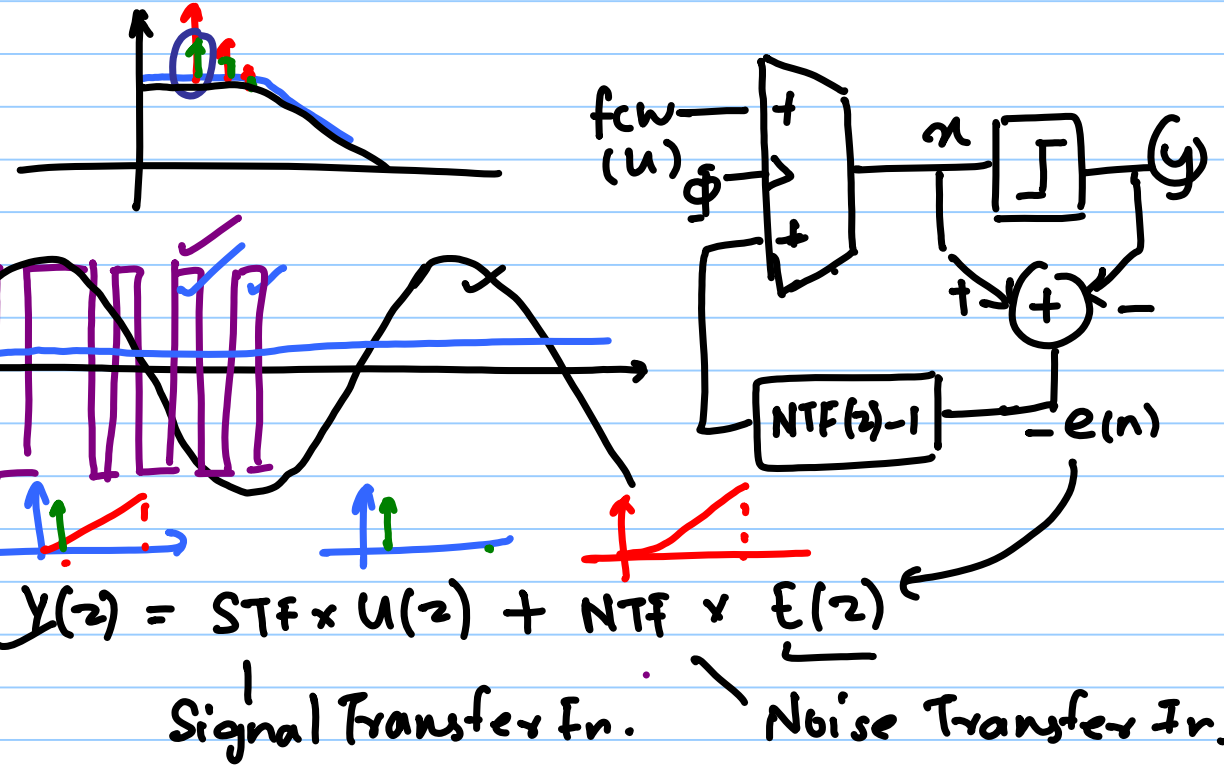
(Divided clock) fdsm

[ΔΣ] — 1bit — y

freq/2

fref ≠ fdsm, int.

$OSR = \frac{f_s}{2f_B}$.

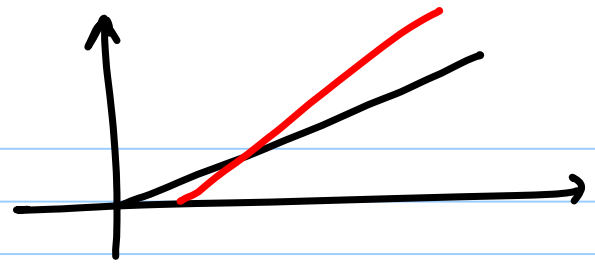


$Y(z) = STF \times U(z) + NTF \times E(z)$

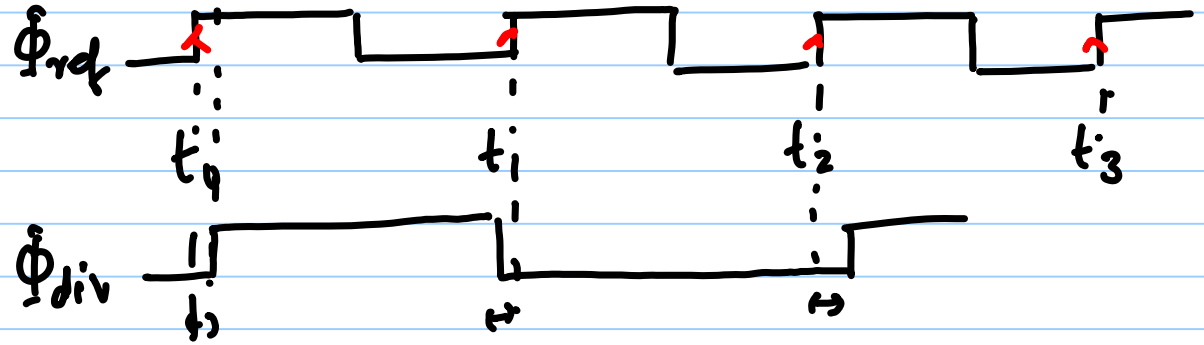
Signal Transfer fn. Noise Transfer fn.

$NTF(z) = (1 - z^{-1})^p$

✓ $NTf(z) = (1 - z^{-1})^2 =$



1.) Ref. clock has rising edge at $t = t_k$, $k \geq 0$



$t_{k+1} - t_k = T$ (ref. period)

Time stamps for divided clock $t_k + \Delta t_k$.

$$\Phi_{err} = \frac{2\pi}{T}(t_k + \Delta t_k - t_k)$$

2) $\Phi_{vco} = 2\pi K_{vco} \int V_{ctrl}\, dt$

$= \underline{2\pi f_{nom} \cdot t} + \Phi_{out}(t)$

$f_{nom} = N_{nom} \cdot f_{ref}$

$(N+\alpha)$

3) Φ_{div} : $t_k + \Delta t_k$ $\qquad$ $t_{k+1} + \Delta t_{k+1}$

$$\Phi_{VCO}(t_{k+1} + \Delta t_{k+1}) - \Phi_{VCO}(t_k + \Delta t_k) = 2\pi N[k]$$

$$= 2\pi f_{nom}(t_{k+1} + \Delta t_{k+1} - t_k - \Delta t_k) + \Phi_{out}(t_{k+1} + \Delta t_{k+1}) - \Phi_{out}(t_k + \Delta t_k)$$

$$= 2\pi f_{nom}(t_{k+1} - t_k) + 2\pi f_{nom}(\Delta t_{k+1} - \Delta t_k)$$

$$+ \Phi_{out}(t_{k+1} + \Delta t_{k+1}) - \Phi_{out}(t_k + \Delta t_k)$$

$$= 2\pi f_{nom} \cdot T +$$

$$2\pi f_{nom}(\Delta t_{k+1} - \Delta t_k) = 2\pi(N[k] - N_{nom}) - (\Phi_{out}(t_{k+1} + \Delta t_{k+1}) - \Phi_{out}(t_k + \Delta t_k))$$