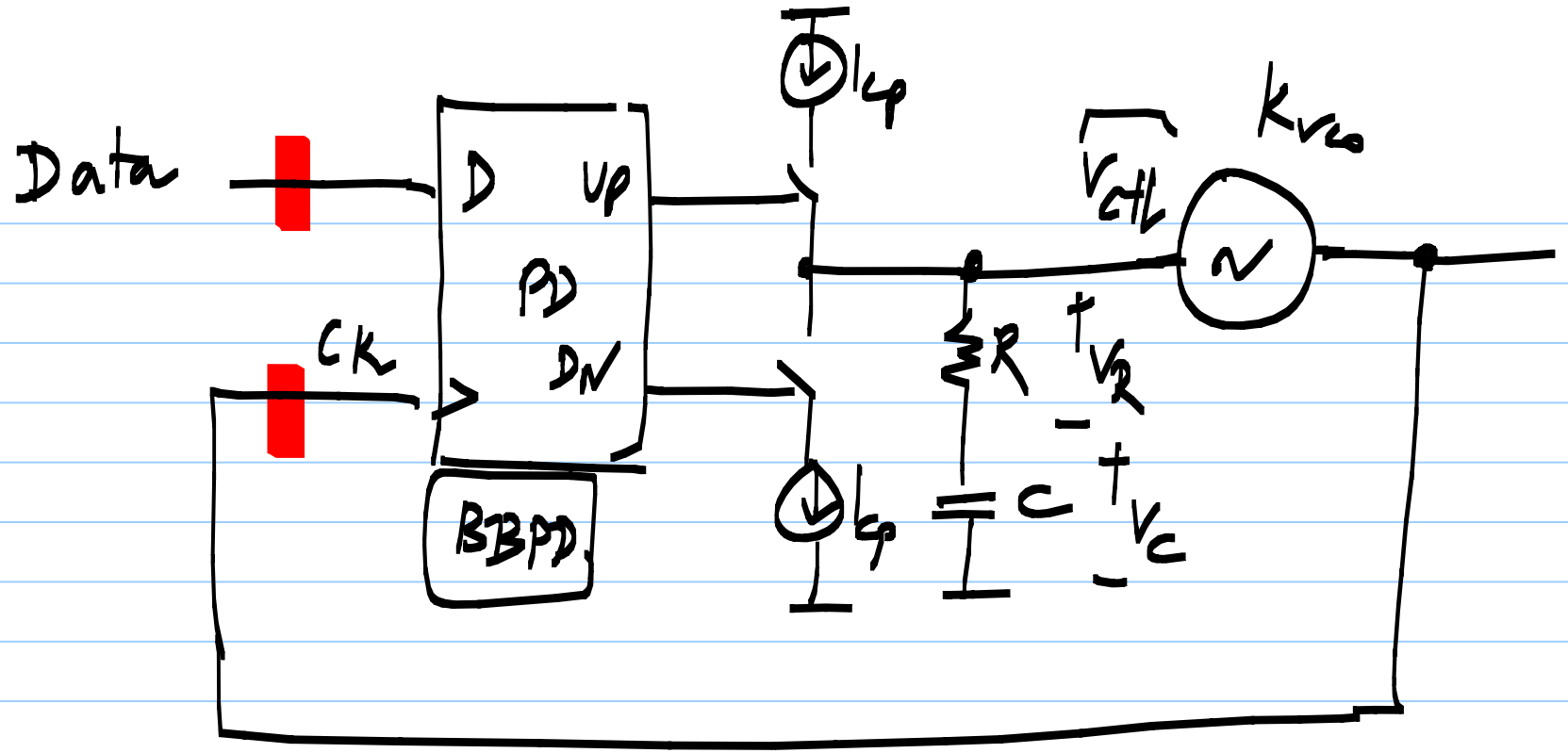
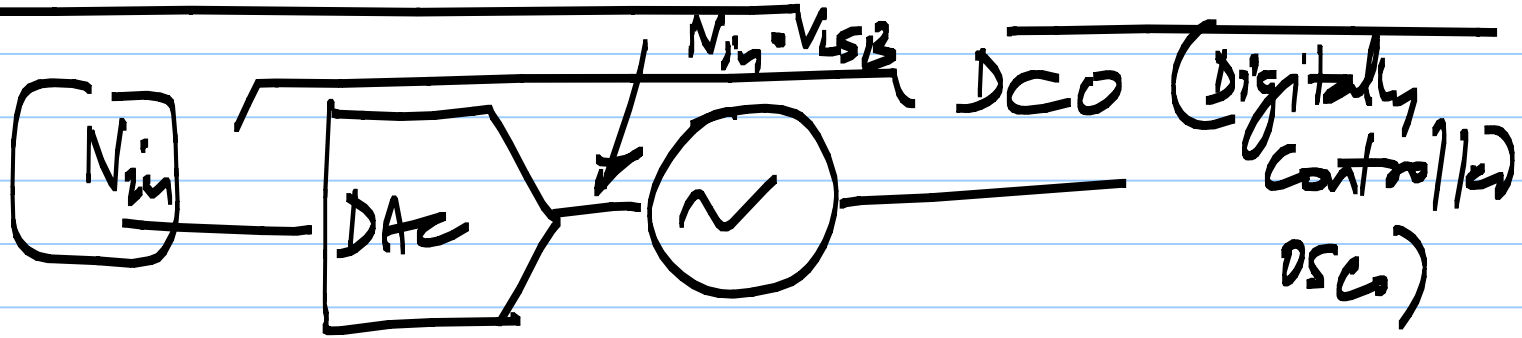
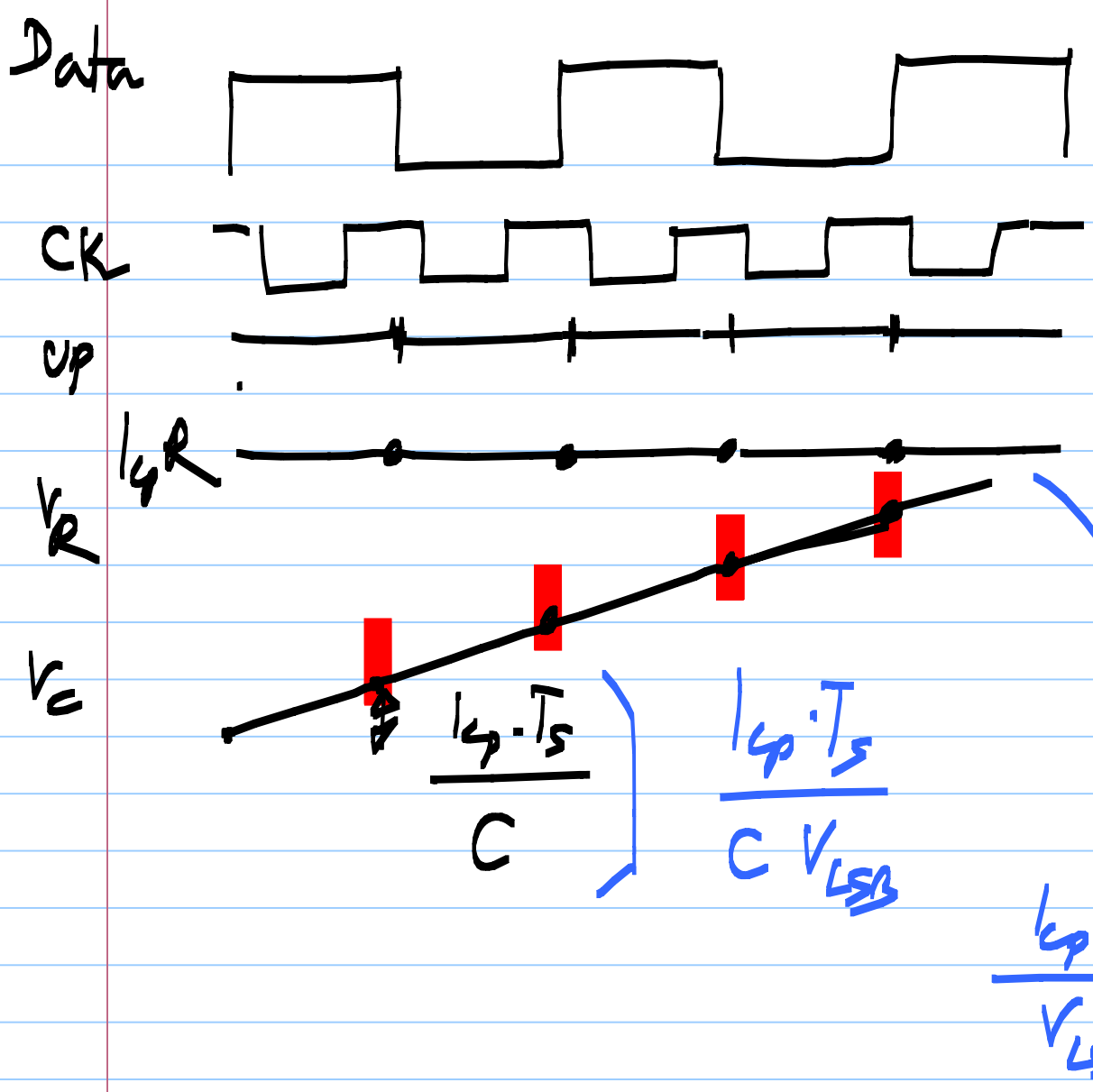


Reduce the jitter generated: → $R \downarrow$ $I_{cp} \uparrow$ $C \uparrow$





V_R : $0, \pm I_p R$

V_C change in every cycle:

$0, \pm \frac{I_p T_s}{C}$

up=1 DN=0.

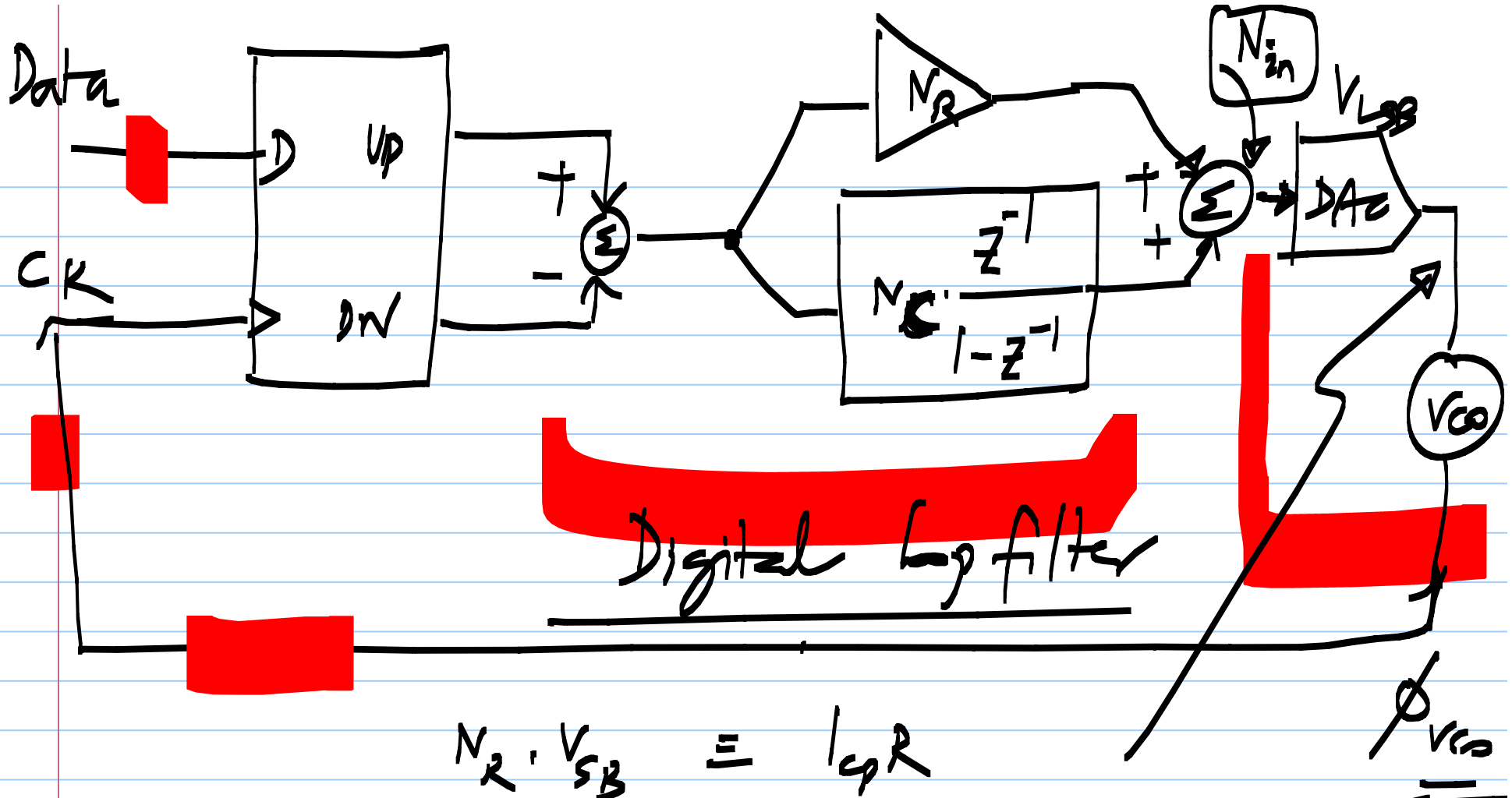
Input N_{in} of the digitally controlled oscillator:

$$N_{in}(z) = (UP-DN)\left[\frac{I_{cp}R}{V_{LSB}}\right] + (UP-DN)\left[\frac{I_{cp}T_s}{CV_{LSB}}\right]\frac{z^{-1}}{1-z^{-1}}$$

$\pm 1, 0$ — Integer N_R — Integer N_C

Resistor — Capacitor

$$V_{CH}(s) = I_{CH}(s) \cdot \left(R + \frac{1}{sC} \right)$$



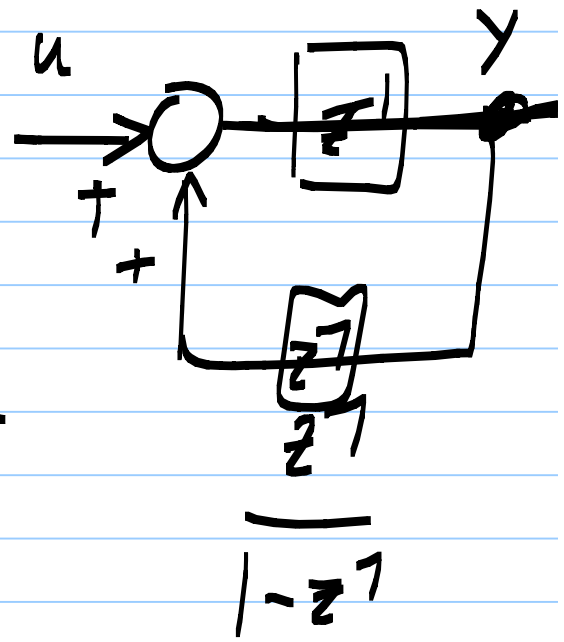
$$N_R \cdot V_{LSB} \equiv I_{CP} R$$

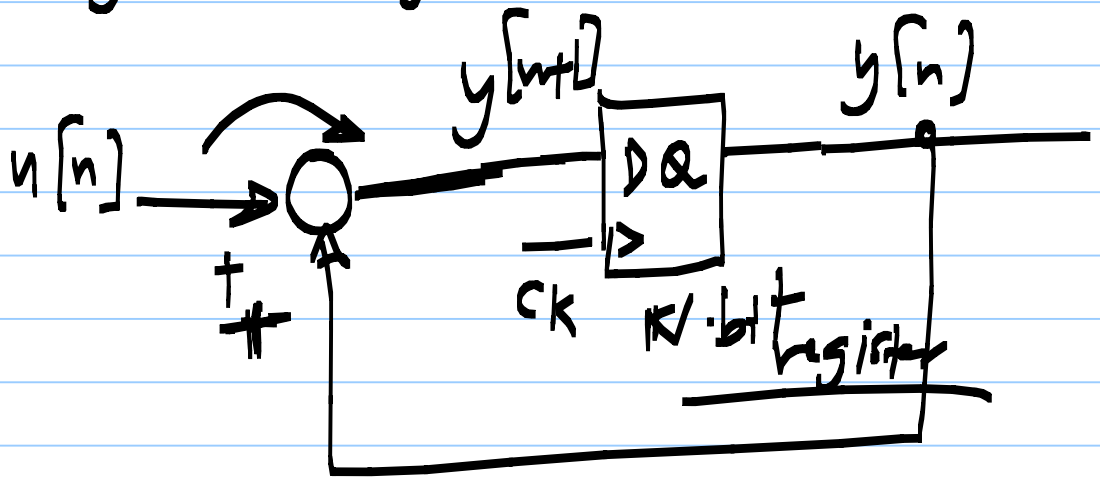
$$N_C \cdot V_{LSB} \equiv \frac{I_{CP} \cdot T_S}{C}$$

$$Y(z) = U(z) \cdot \frac{z^{-1}}{1 - z^{-1}}$$

$$y[n] - y[n-1] = u[n-1]$$

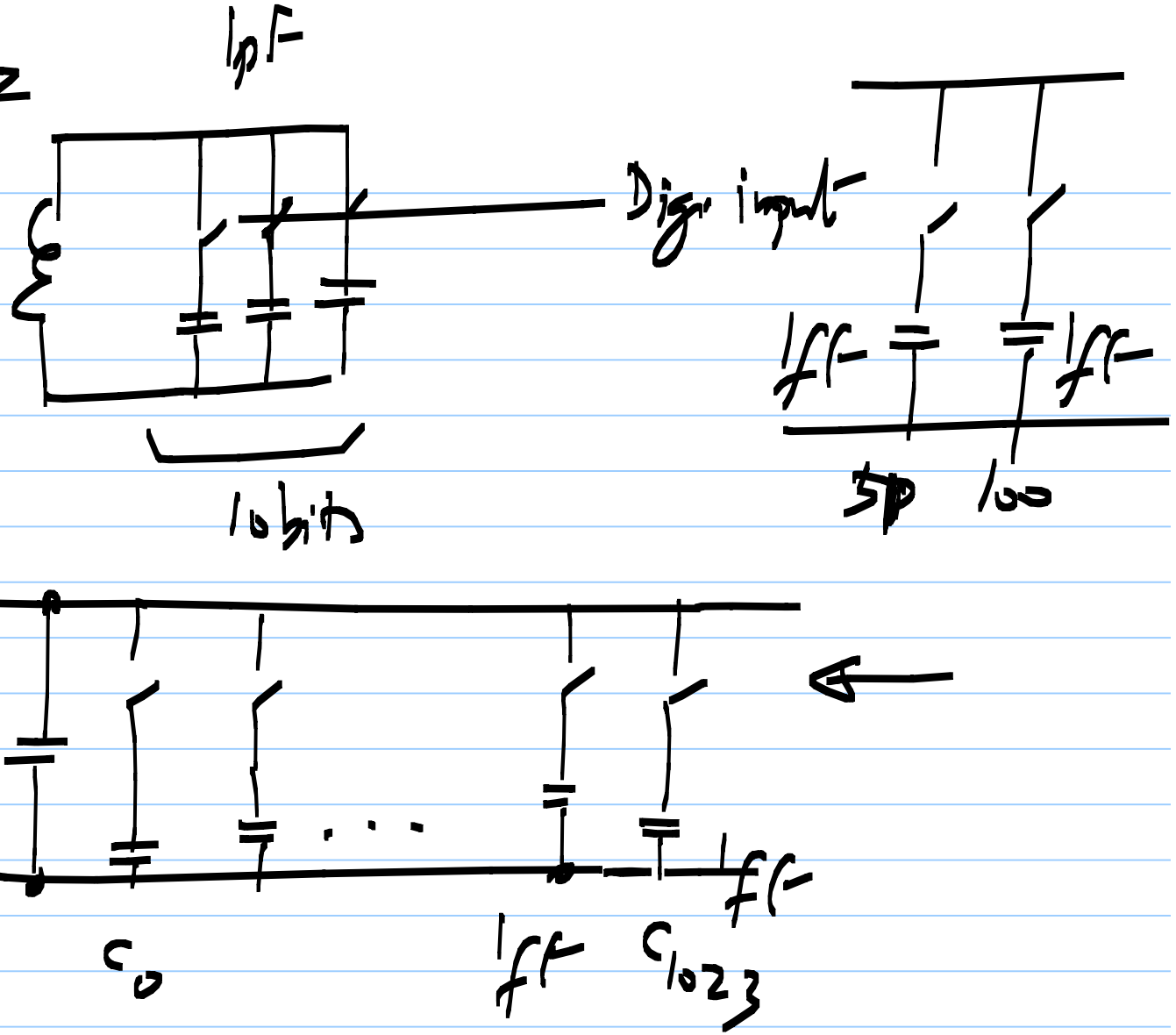
$$y[n] = y[n-1] + u[n-1]$$



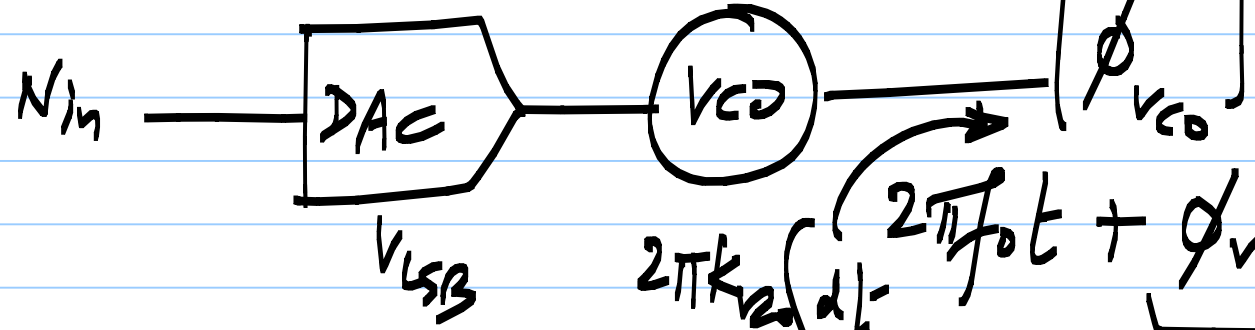


1nH, 1pF ~ 5GHz

200pF 200fF 25MHz



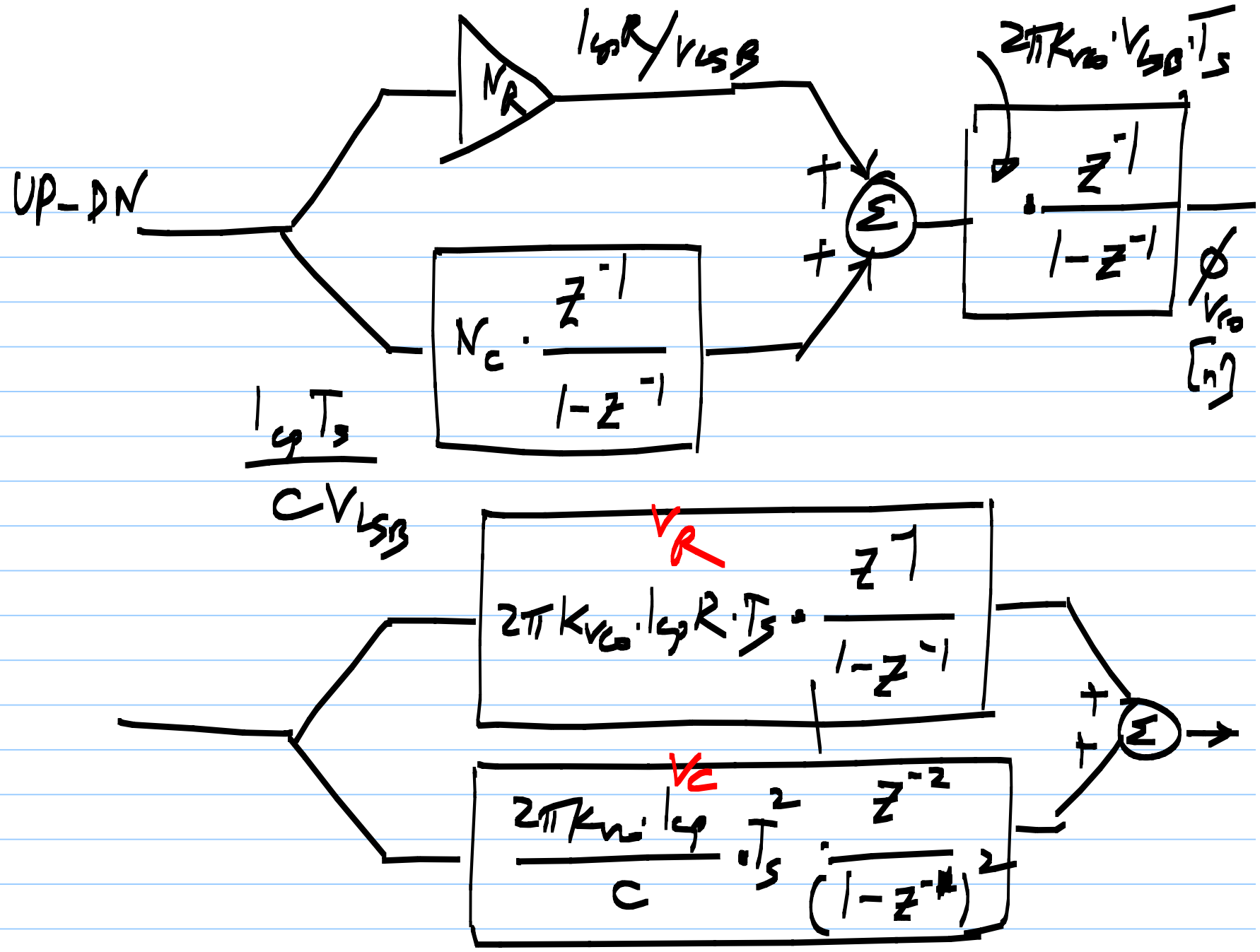
$N_{in} \rightarrow \phi_{vco}$?

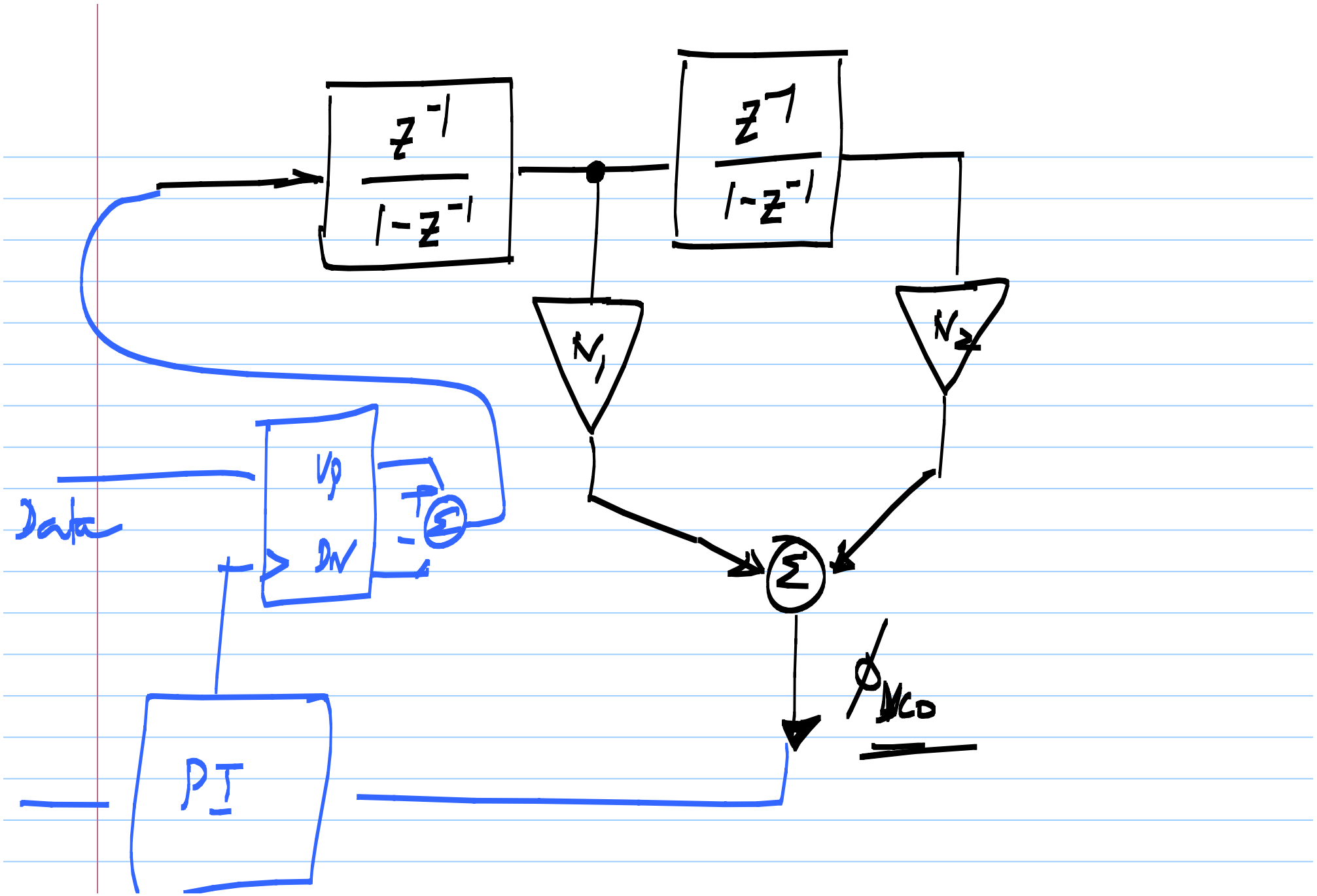


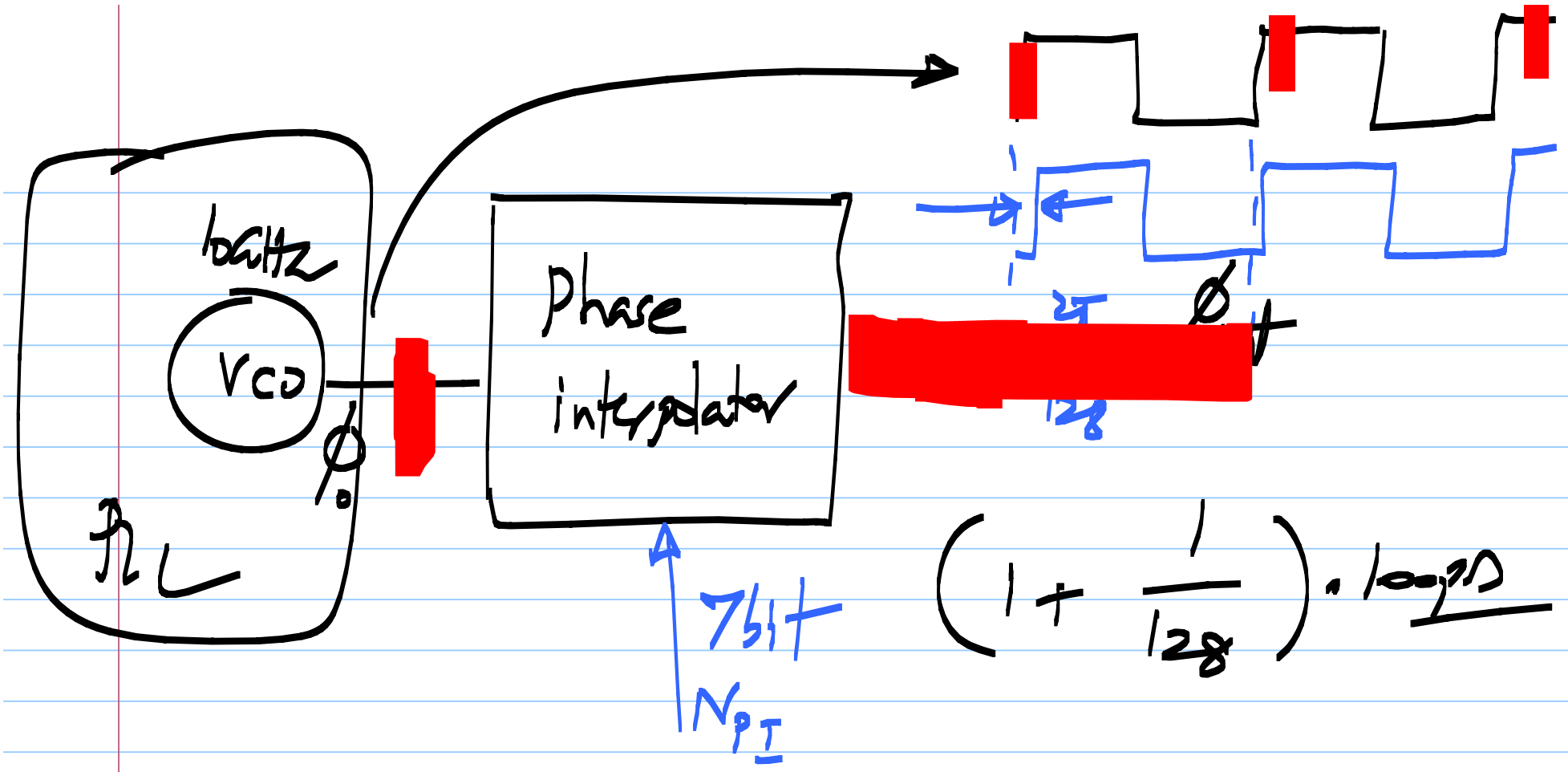
$N_{in} = 0$:

$N_{in} = 1$: $\rightarrow$ $2\pi K_{vco} \cdot V_{LSB} \cdot T_s$ · phase increment in every cycle

N_{in} — $\dfrac{z^{-1}(2\pi K_{vco} \cdot V_{LSB} T_s)}{1 - z^{-1}}$


UP-DN
N_R
$I_{CP}R/V_{LSB}$
$N_C \cdot \frac{z^{-1}}{1-z^{-1}}$
$\frac{I_{CP}T_S}{CV_{LSB}}$
$2\pi K_{VCO} \cdot V_{LSB} \cdot T_S$
$\frac{z^{-1}}{1-z^{-1}}$
$\phi_{VCO}[n]$
V_R
$2\pi K_{VCO} \cdot I_{CP}R \cdot T_S \cdot \frac{z^{-1}}{1-z^{-1}}$
V_C
$\frac{2\pi K_{VCO} \cdot I_{CP}}{C} \cdot T_S^2 \cdot \frac{z^{-2}}{(1-z^{-1})^2}$
+
+
Σ


$\frac{z^{-1}}{1-z^{-1}}$
$\frac{z^{-1}}{1-z^{-1}}$
N_1
N_2
Data
V_p
D_N
Σ
Σ
PI
ϕ_{MCD}



$$\left(1 + \frac{1}{128}\right) \cdot 100\,\text{ps}$$

$$\phi_0 - \phi_{out} = N_{PI} \cdot \phi_{LSB}$$