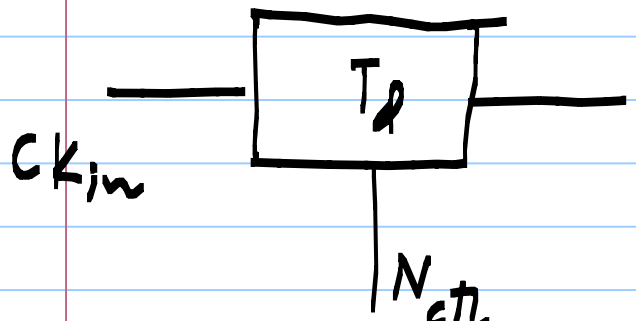
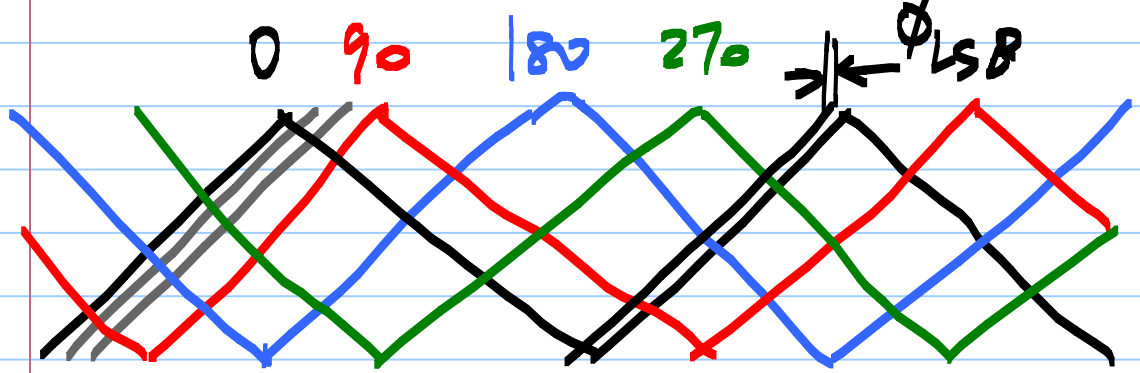
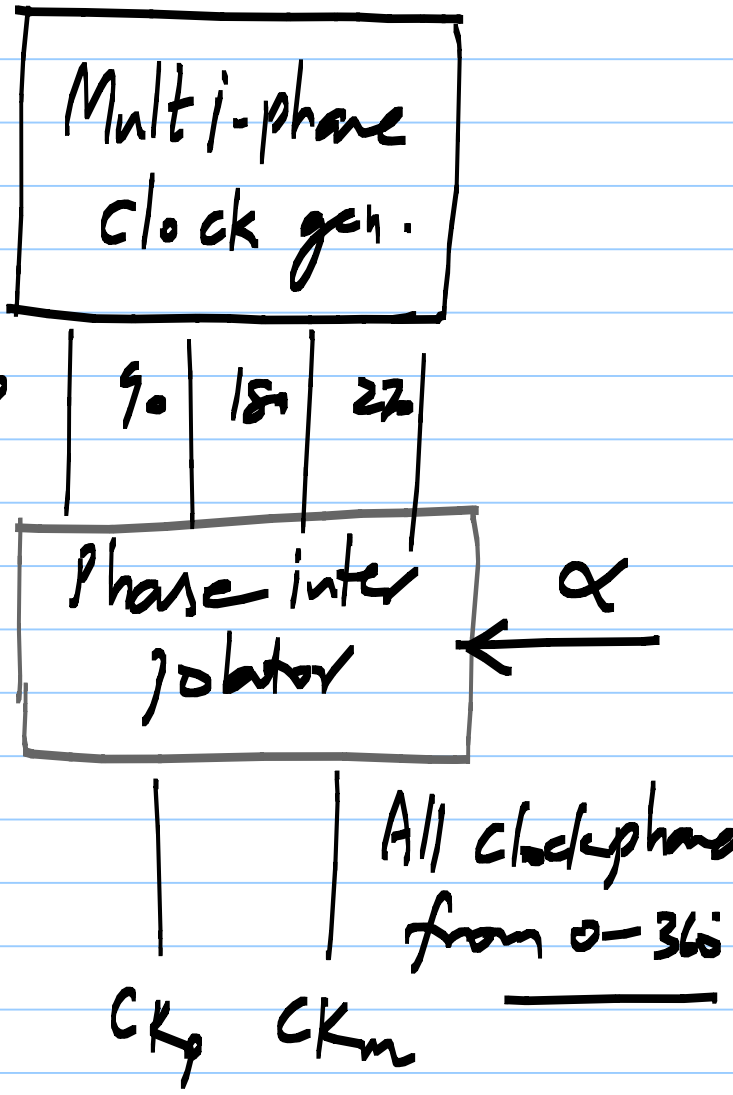
Digital CDR

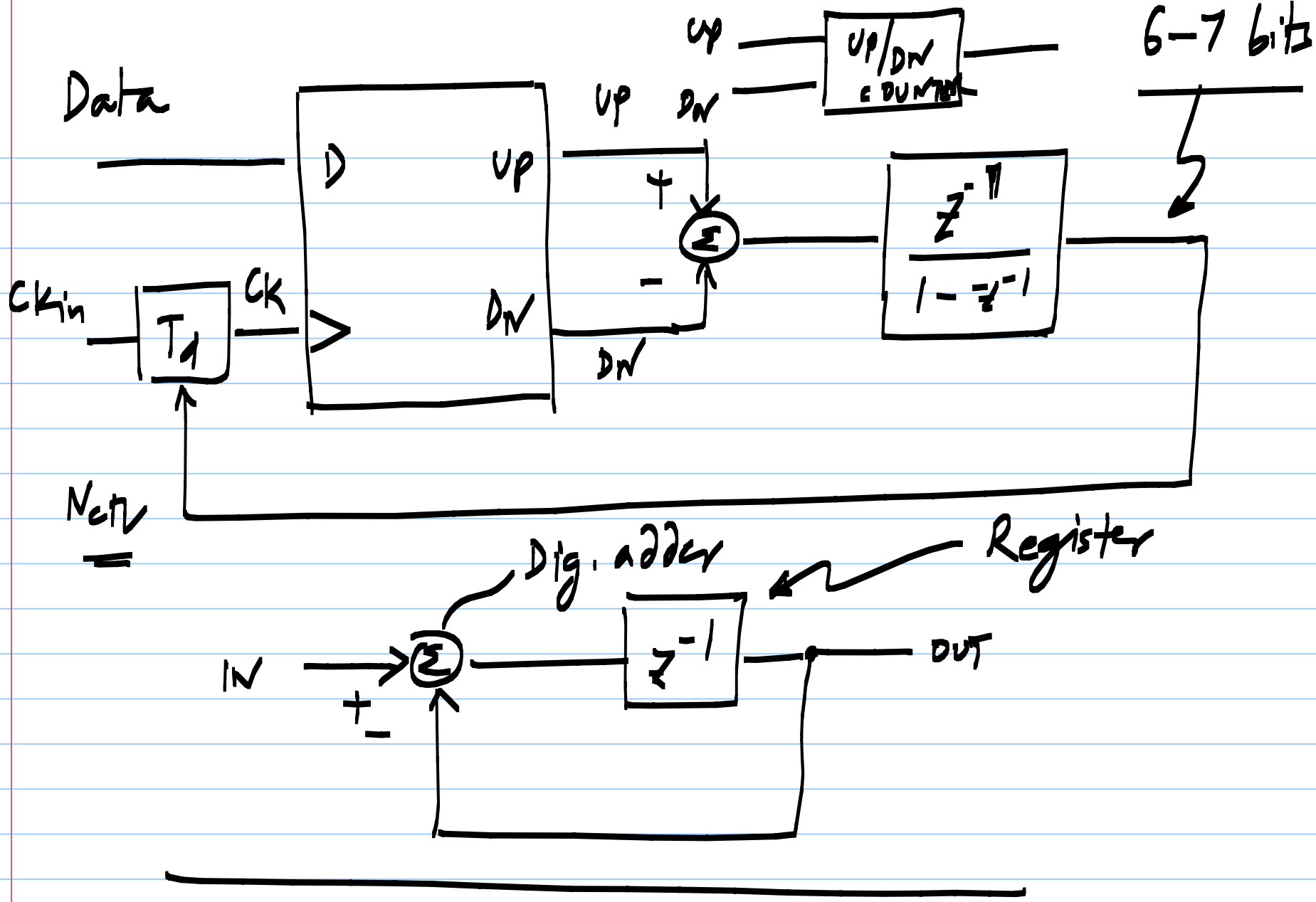
$\alpha \cdot CK_0 + (1-\alpha) \cdot CK_{90}$

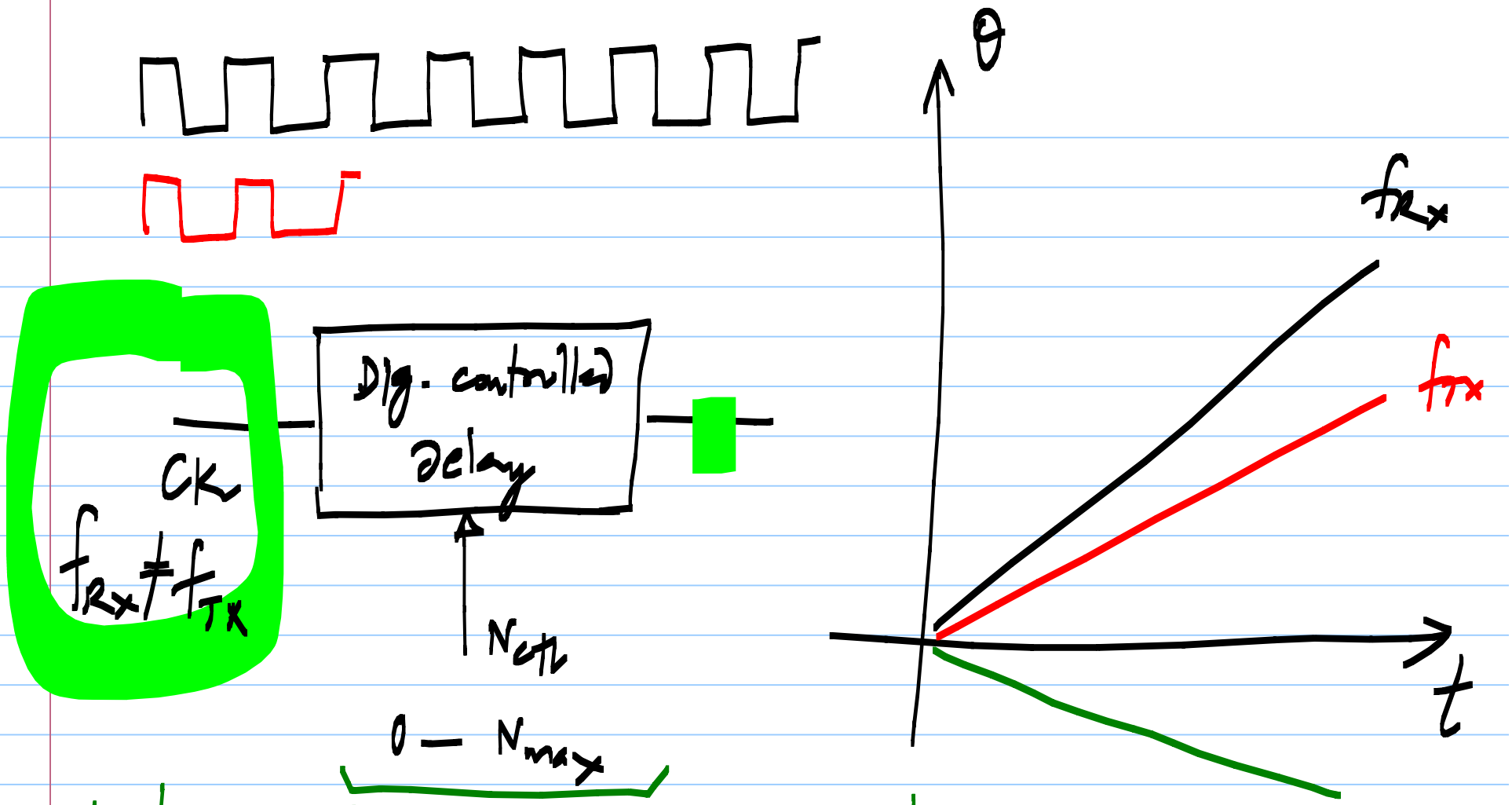


$0 - N_{max}$



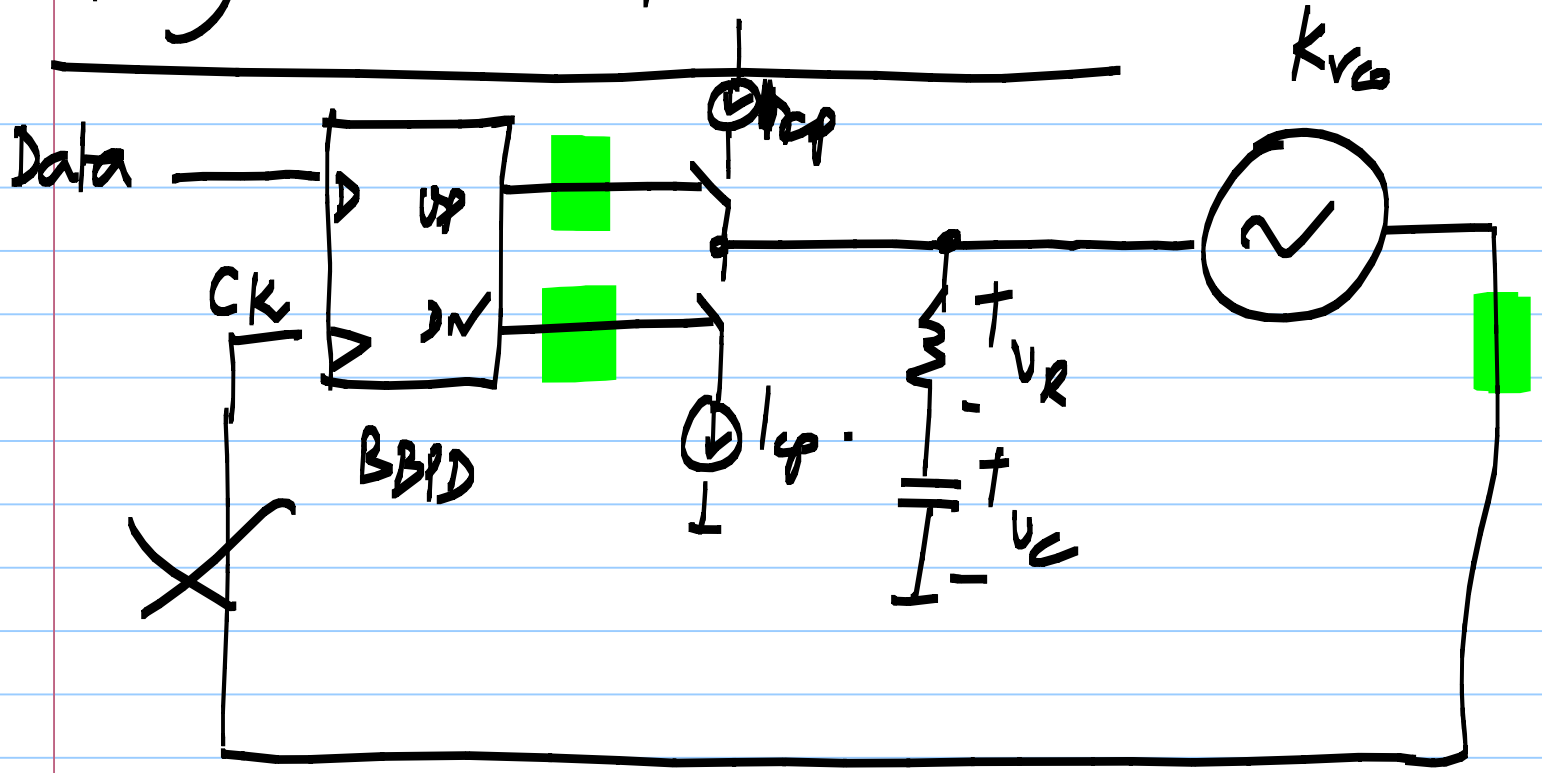



Data
D
UP
DN
CK
CKin
Td
UP
DN
UP/DN
COUNTER
6-7 bits
+
-
Σ
z^-11
1 - z^-1
Ncnt
Dig. adder
Register
IN
+
-
Σ
z^-1
OUT



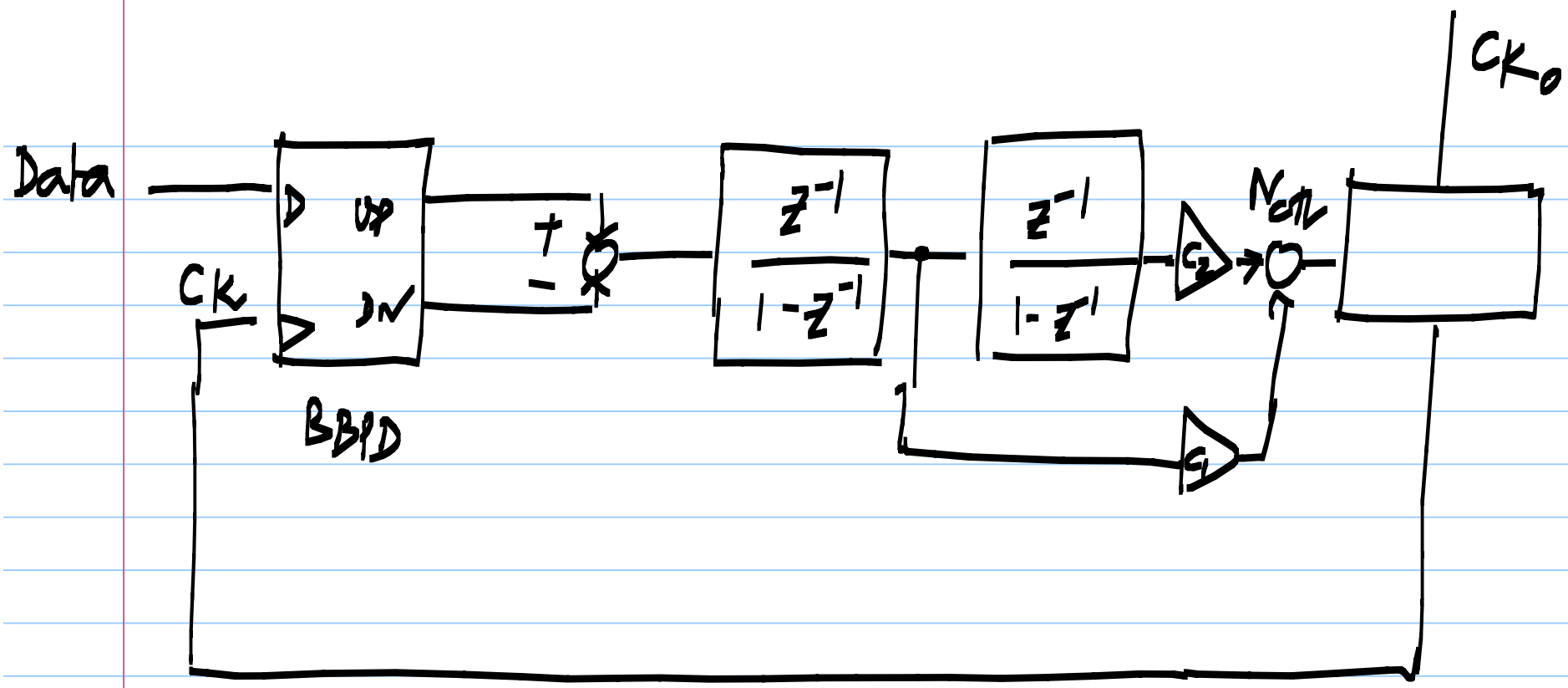
Control word has to be a ramp to generate a different frequency.

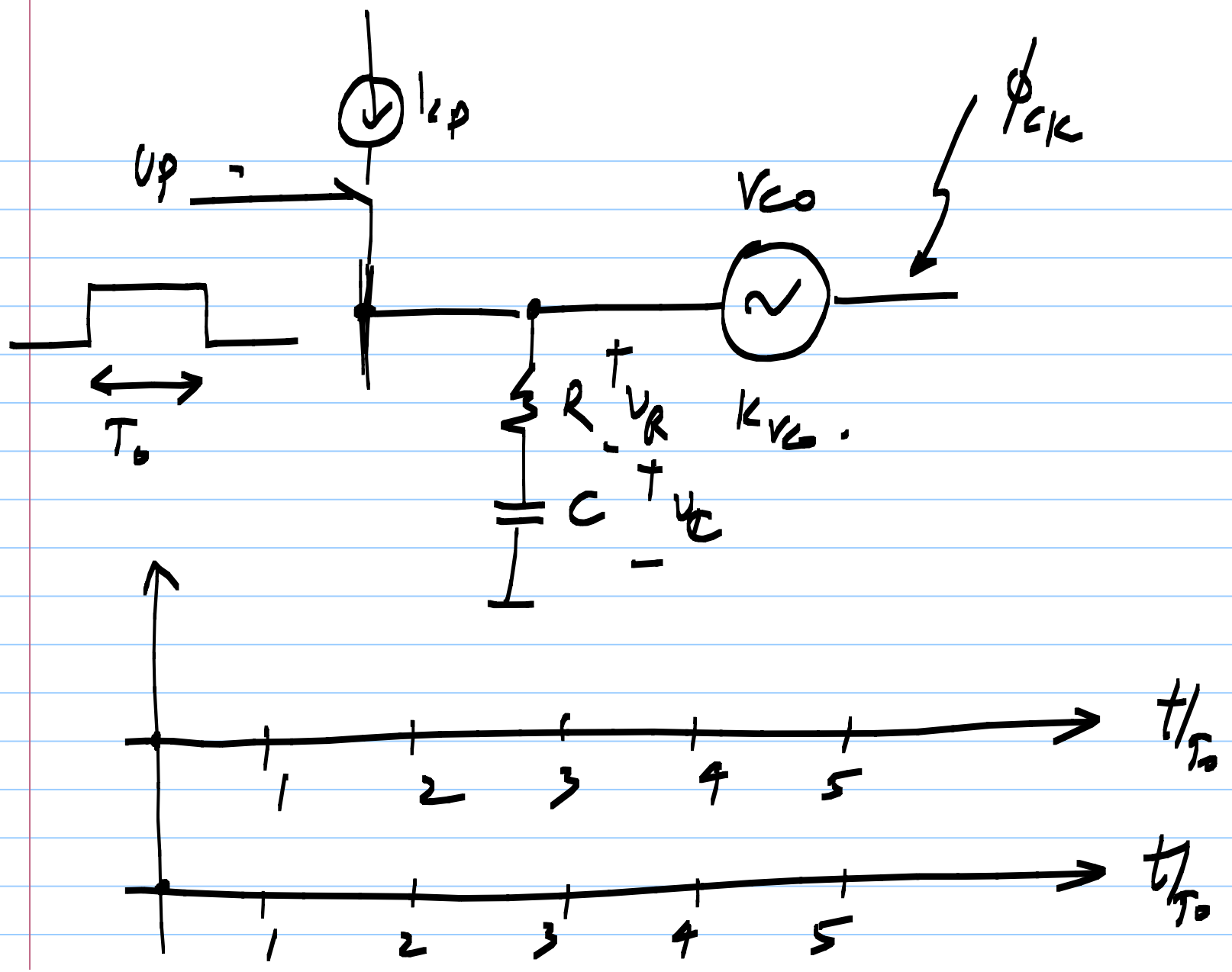
Analog CDR w/o forwarded clock

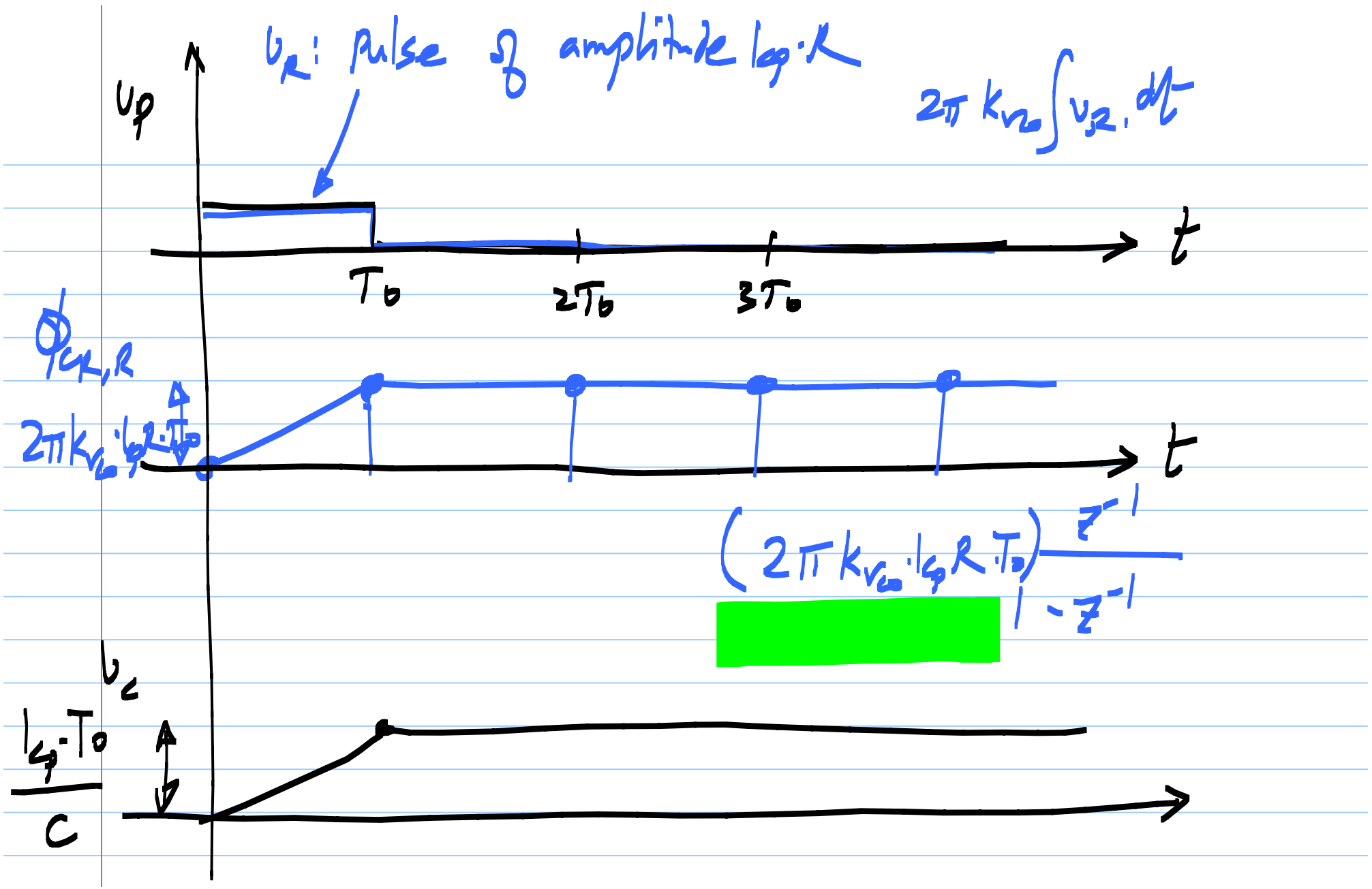


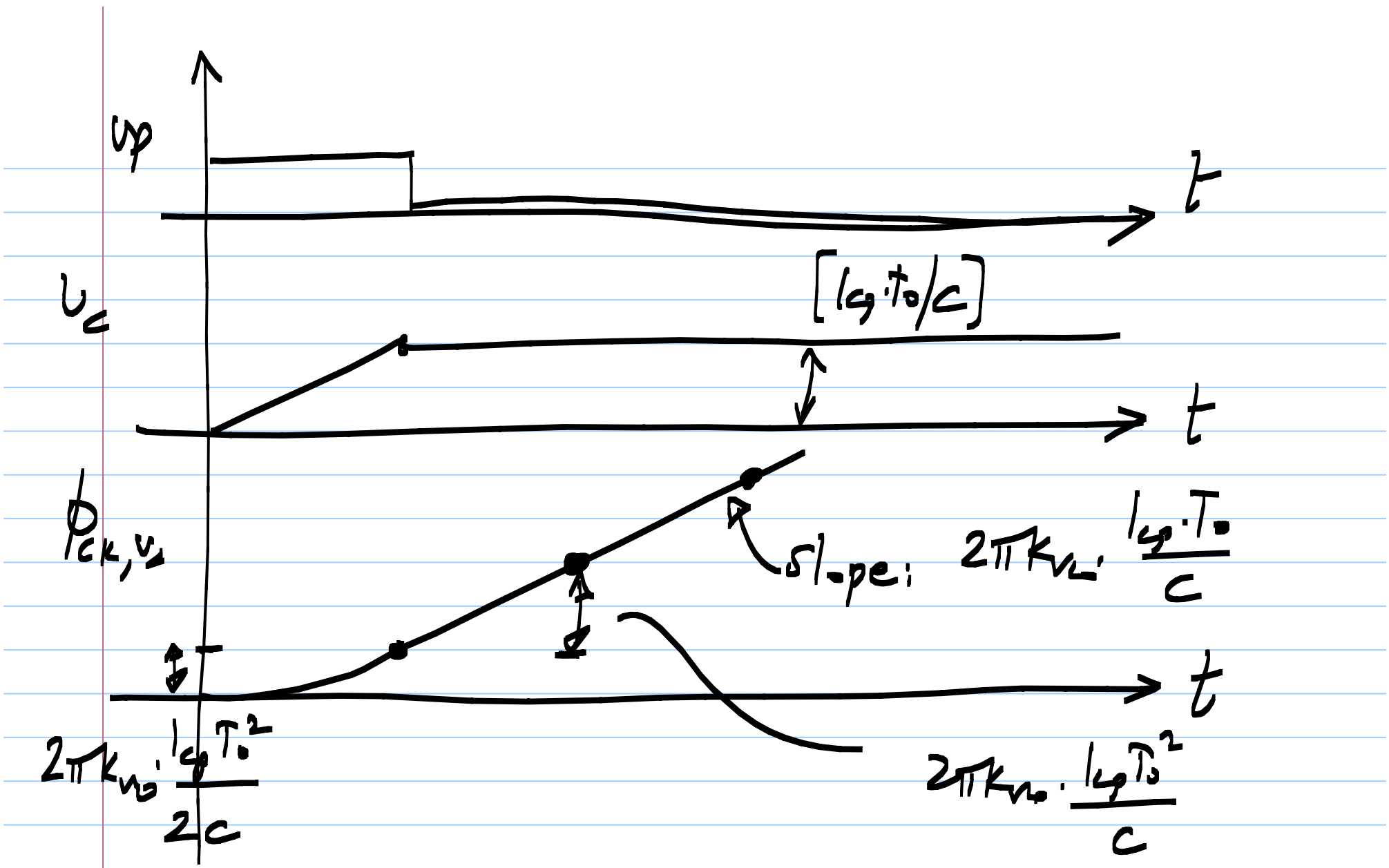
Single up pulse:

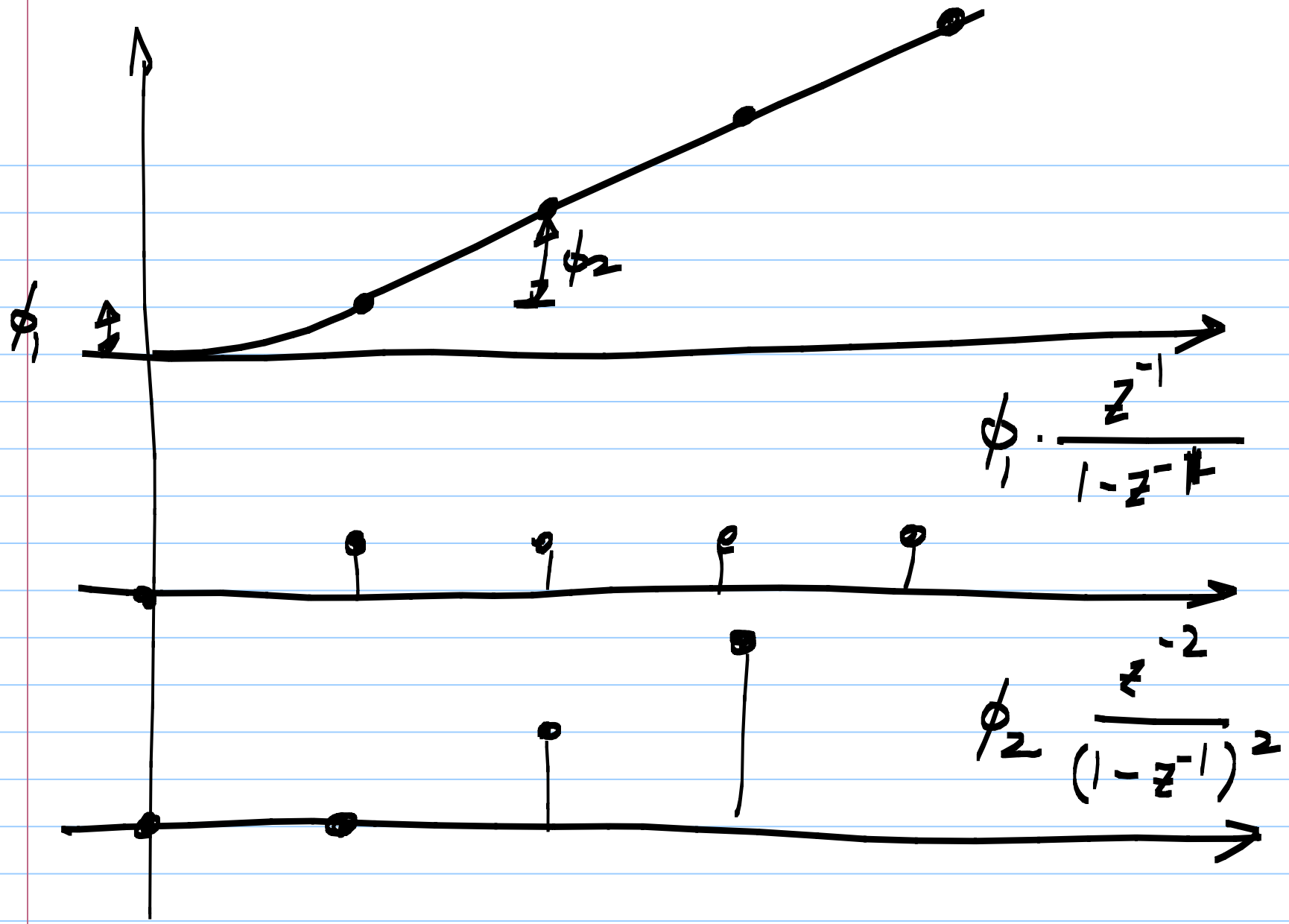
V_R : pulse ⟶ ϕ_{CK} :

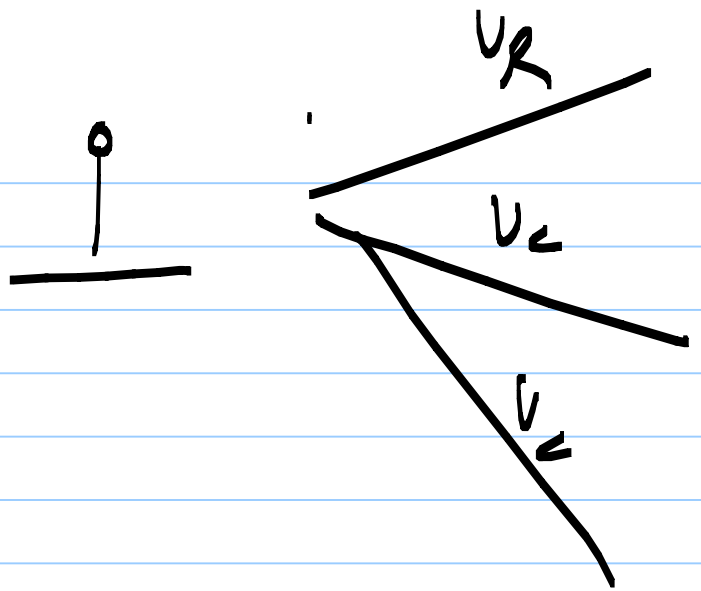

Data
CK
D
UP
DN
BBPD
+
−
z^{-1}
$1-z^{-1}$
z^{-1}
$1-z^{-1}$
C_2
C_1
N_{CTL}
CK_0


I_{cp}
U_p
V_{CO}
ϕ_{CK}
T_0
R
U_R
K_{VCO}.
C
U_C
1
2
3
4
5
t/T_0
1
2
3
4
5
t/T_0


v_R: pulse of amplitude $I_\varphi \cdot R$
$2\pi k_{VCO} \int v_R \, dt$
v_φ
t
T_0
$2T_0$
$3T_0$
$\Phi_{CK,R}$
$2\pi k_{VCO} \cdot I_\varphi R \cdot T_0$
t
$(2\pi k_{VCO} \cdot I_\varphi R \cdot T_0) \frac{z^{-1}}{1 - z^{-1}}$
v_c
$I_\varphi \cdot T_0$
C


u_p
t
u_c
$[l_g \cdot t_0 / c]$
t
ϕ_{ck,u_c}
slope: $2\pi k_{u_c} \cdot \frac{l_g \cdot T_0}{c}$
t
$2\pi k_{u_0} \cdot \frac{l_g T_0^2}{2c}$
$2\pi k_{u_0} \cdot \frac{l_g T_3^2}{c}$


ϕ_1
ϕ_2
$\phi_1 \cdot \frac{z^{-1}}{1-z^{-1}}$
$\phi_2 \frac{z^{-2}}{(1-z^{-1})^2}$



$$\left(2\pi K v_{ca} \cdot l_{cp} R \cdot T_0\right) \cdot \frac{z^{-1}}{1 - z^{-1}}$$

$$2\pi K v_{ca} \cdot \frac{l_{cp} T_0^2}{2C} \cdot \frac{z^{-1}}{1 - z^{-1}}$$

$$2\pi K v_{ca} \cdot \frac{l_{cp} T_0^2}{C} \cdot \left(\frac{z^{-1}}{1 - z^{-1}}\right)^2$$