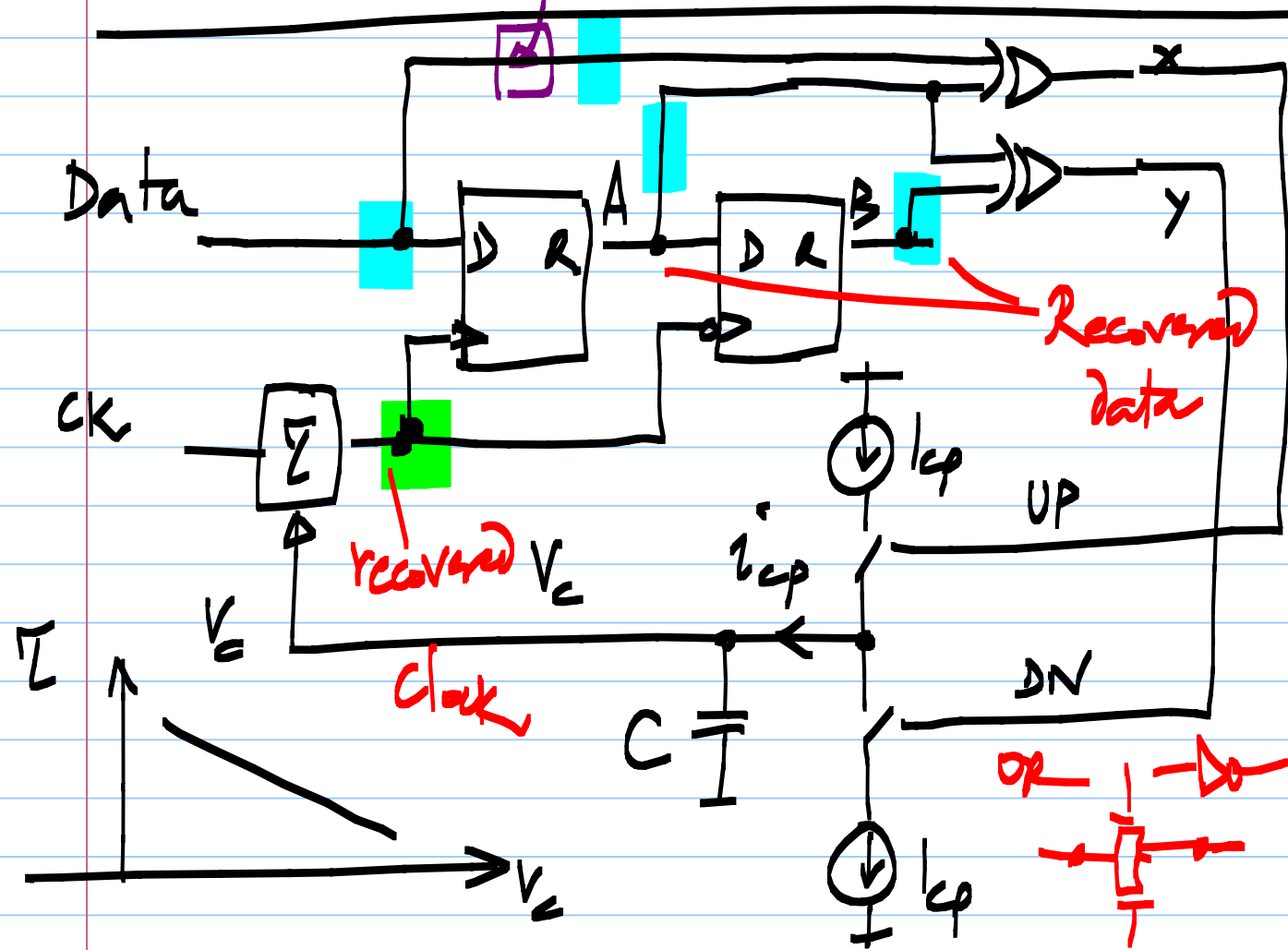
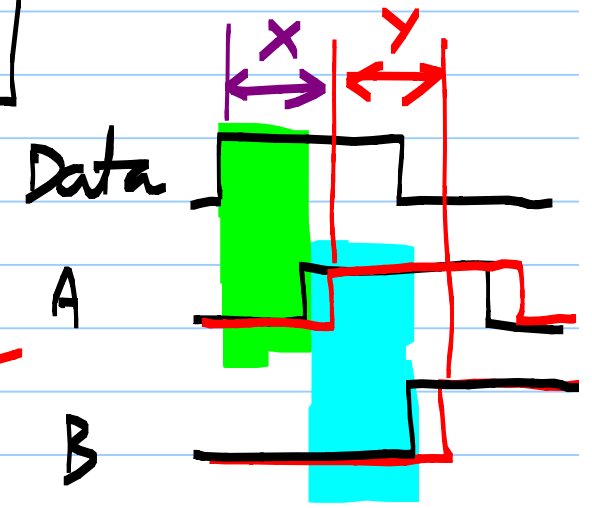
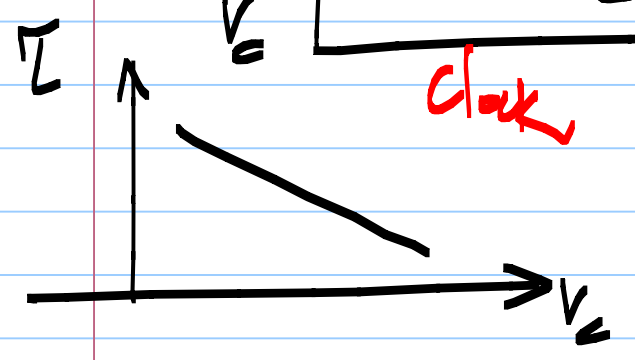


CDR for a forwarded clock system using a linear PD ΔT has to track FF CK-Q delay

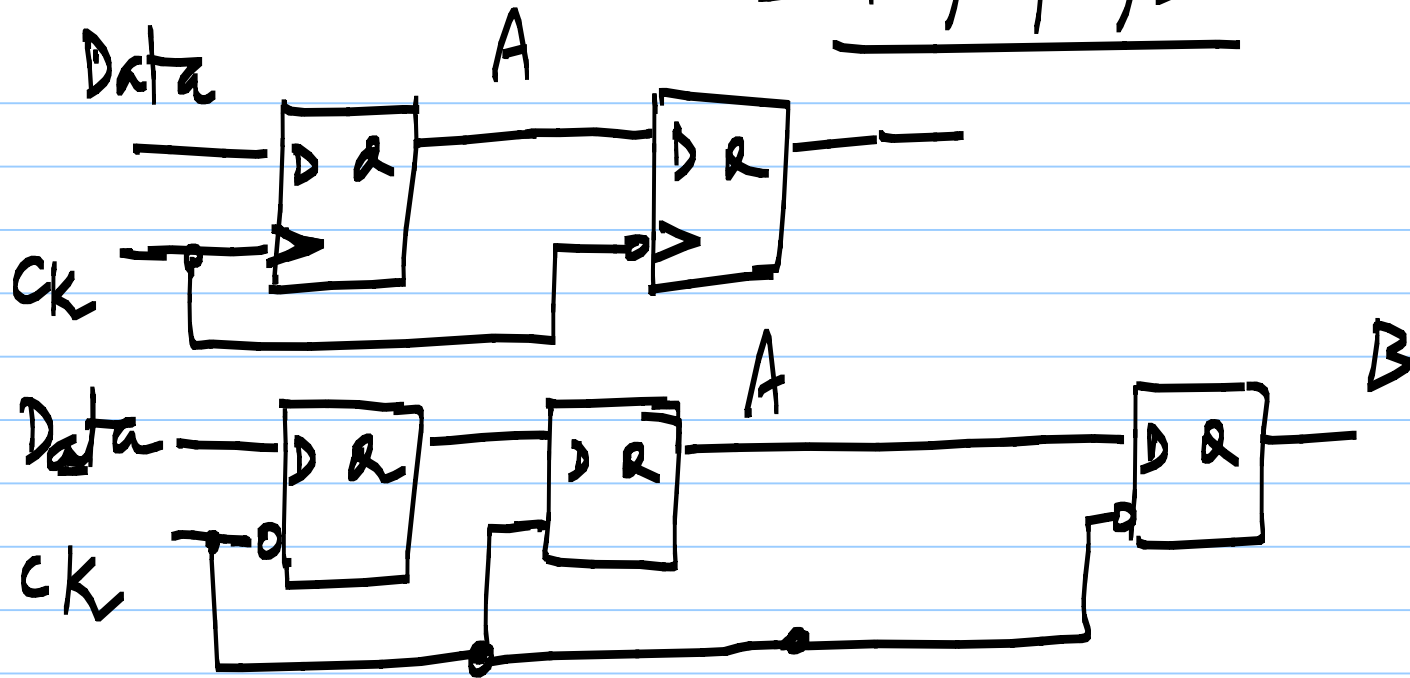
CK-Q delay = 5% of T_0



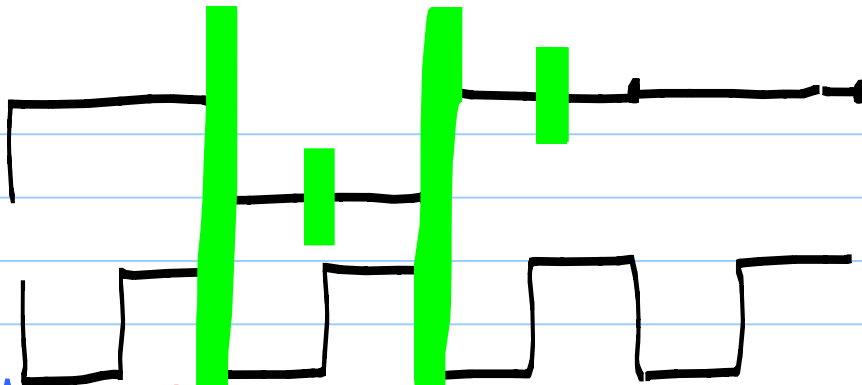
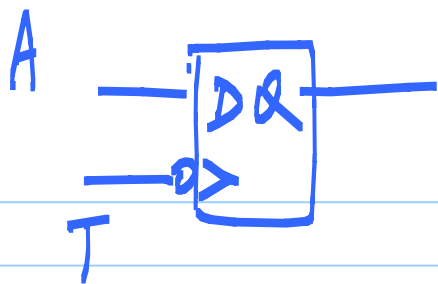
$$\langle i_{cp} \rangle = -\frac{I_{cp}}{2\pi} \phi$$



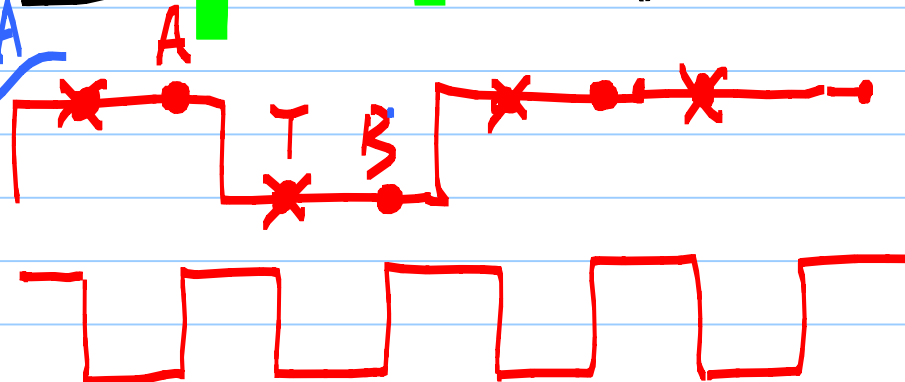
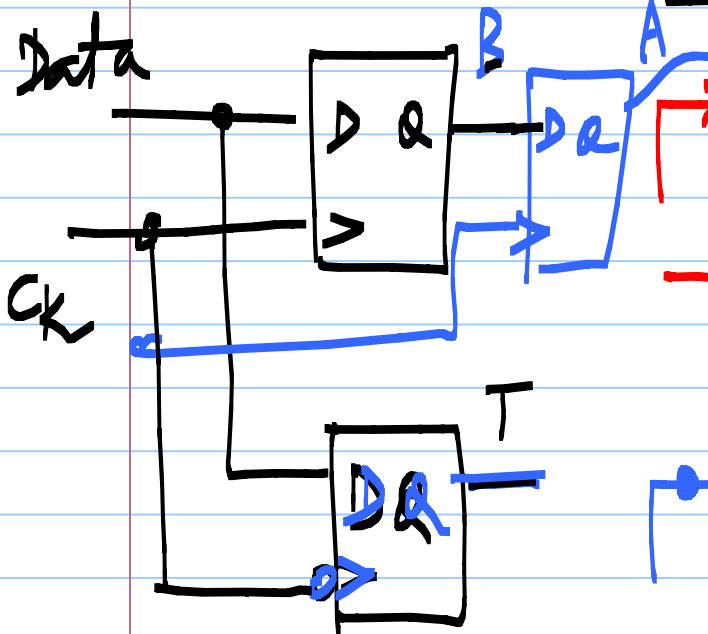
2 Flip flops



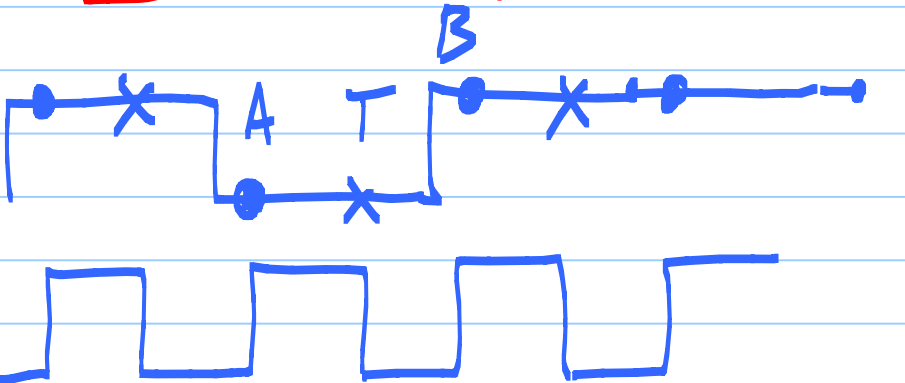
3 level-triggered latches



Aligned



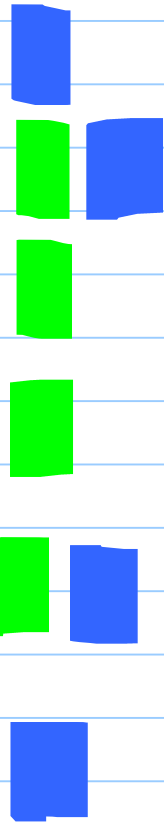
$T=B \neq A$

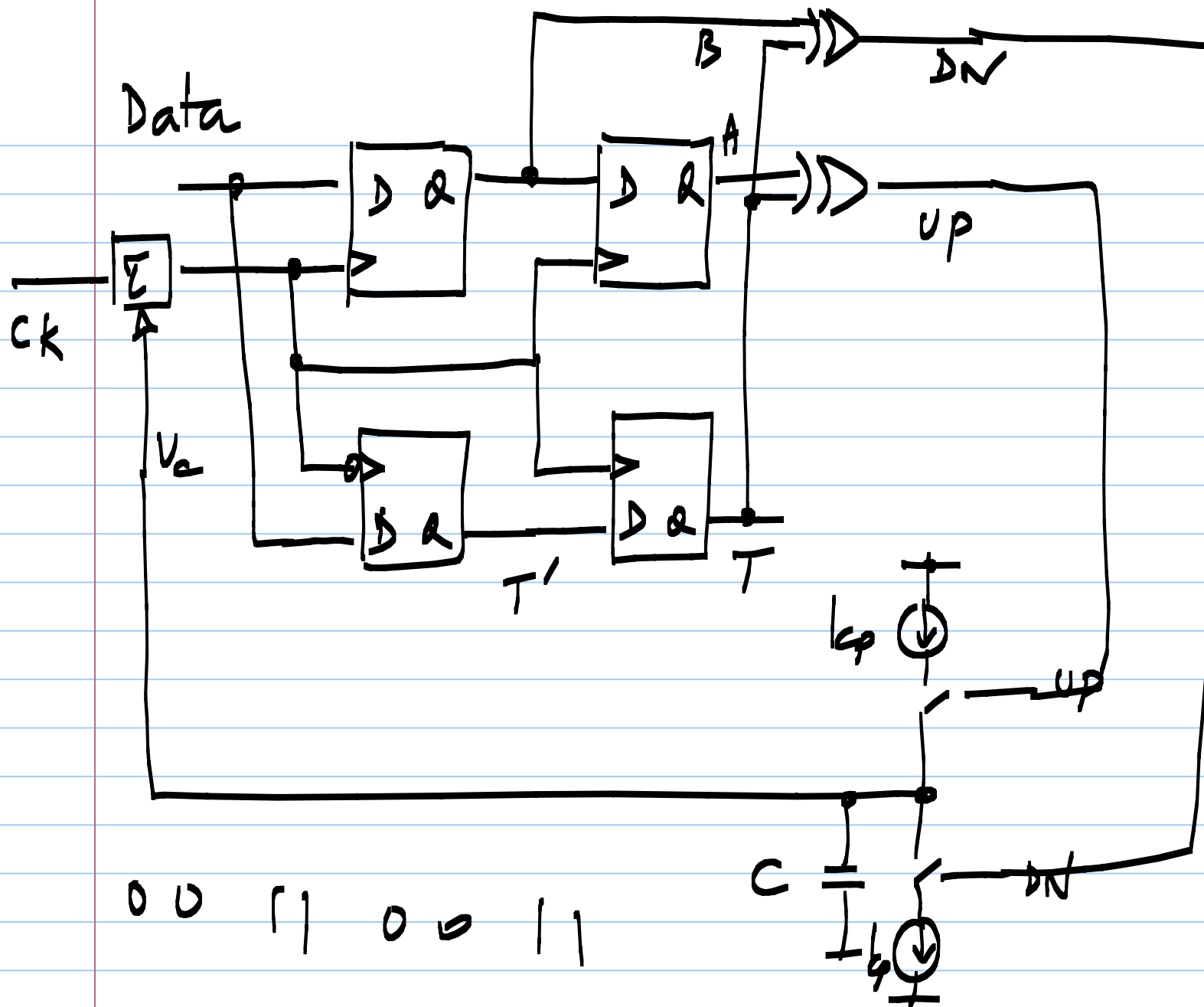


$T=A \neq B$

Early

A	T	B	
0	0	0	-
0	0	1	Early DN = $T \oplus B$
0	1	0	-
0	1	1	Late UP = $T \oplus A$
1	0	0	Late UP = $T \oplus A$
1	0	1	-
1	1	0	Early DN = $T \oplus B$
1	1	1	-





Data

ck

B

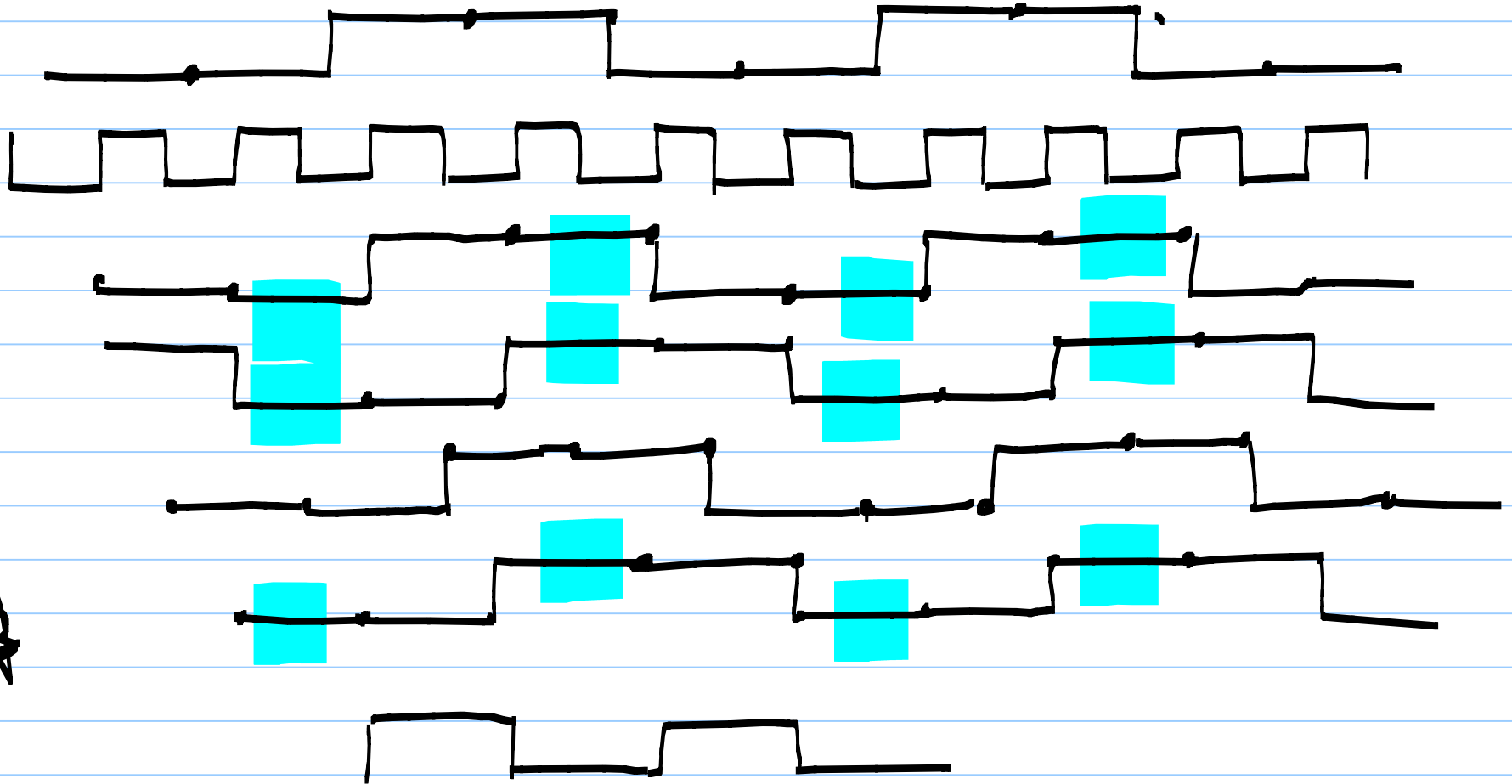
A

T'

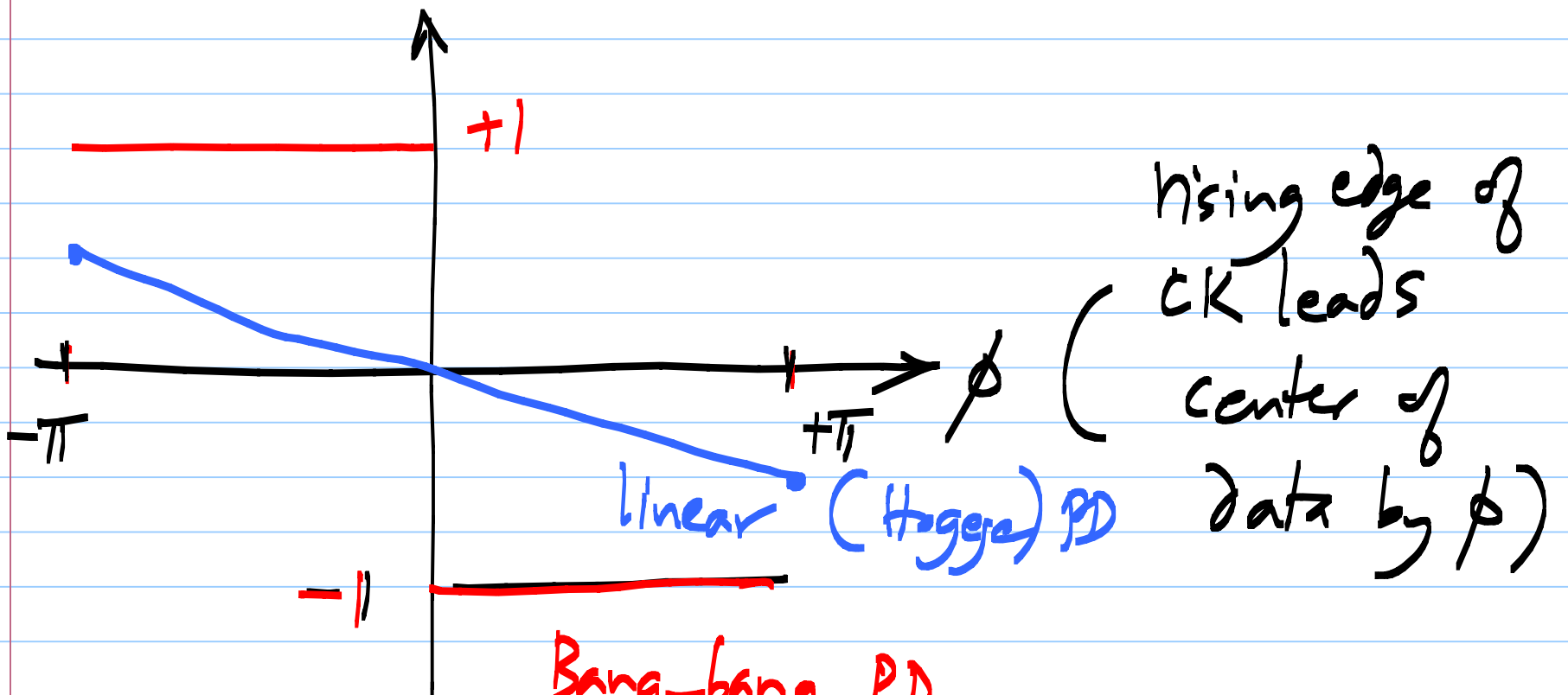
~~T = A~~

Op

DN = 0



Arg (up-down)



Bang-bang PD

(Alexander PD)

Binary PD