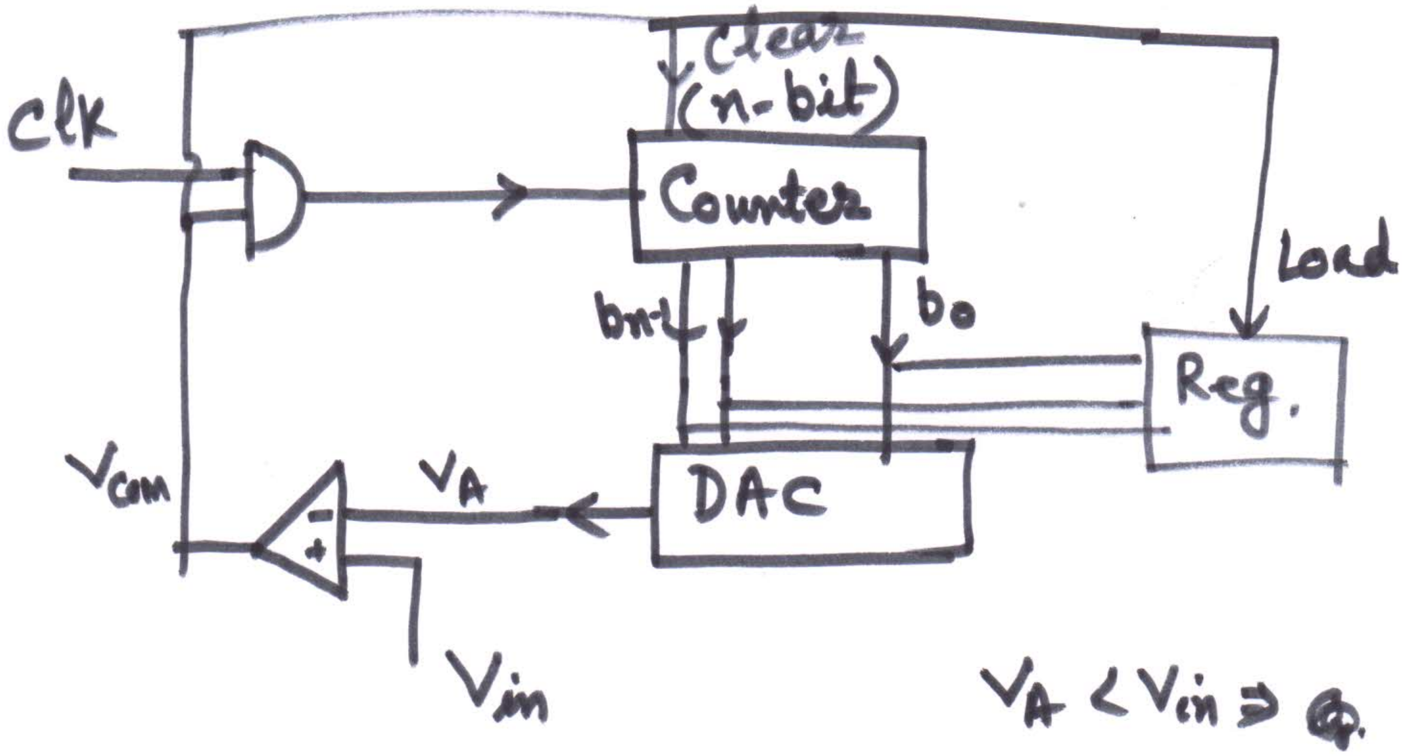
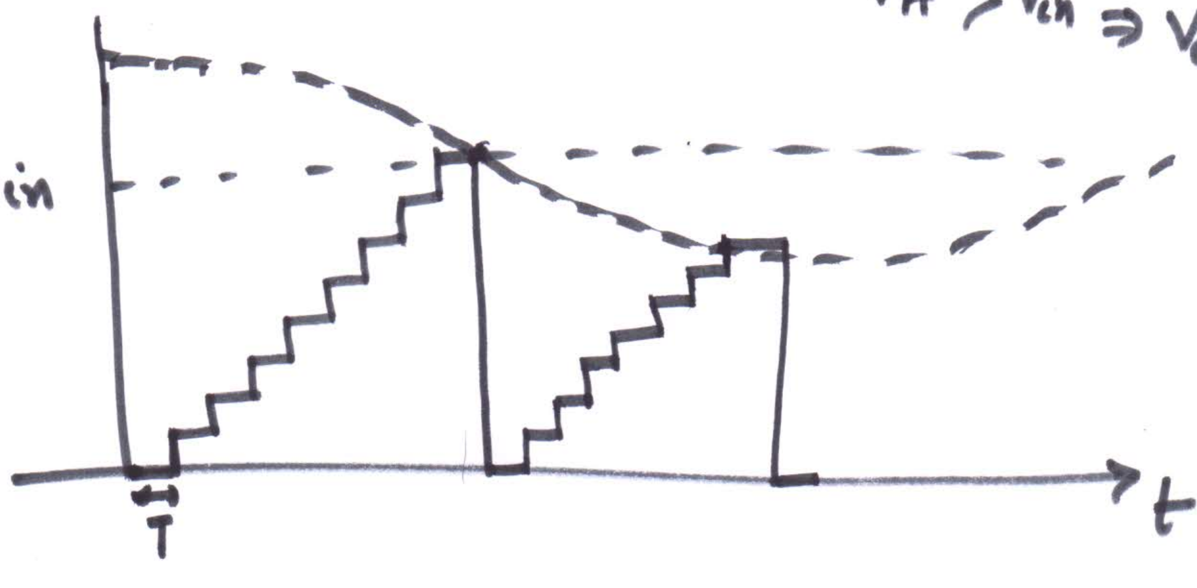
2) Counter type A/D Converter



$V_A < V_{in} \Rightarrow$ $V_{com} = 1$

$V_A > V_{in} \Rightarrow V_{com} = 0$

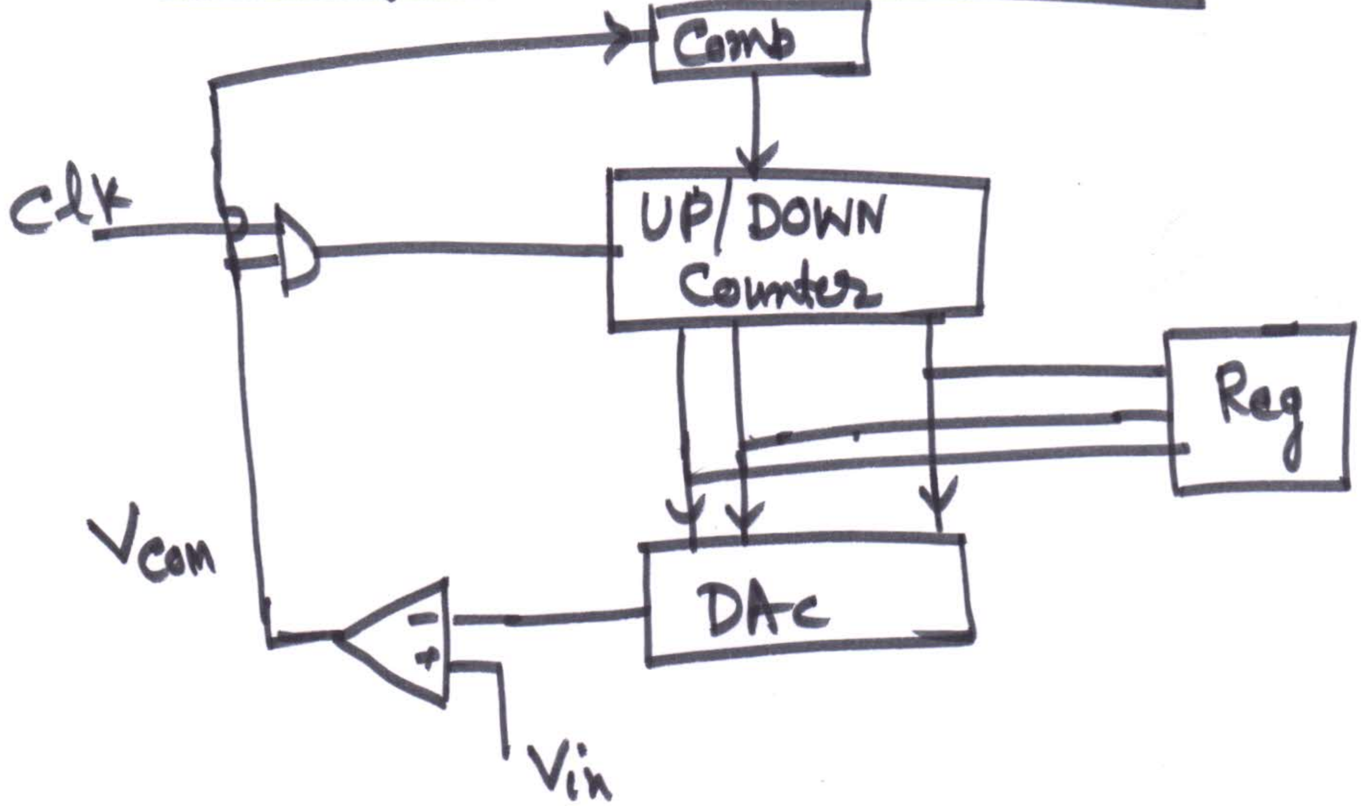


Maximum Conversion Time

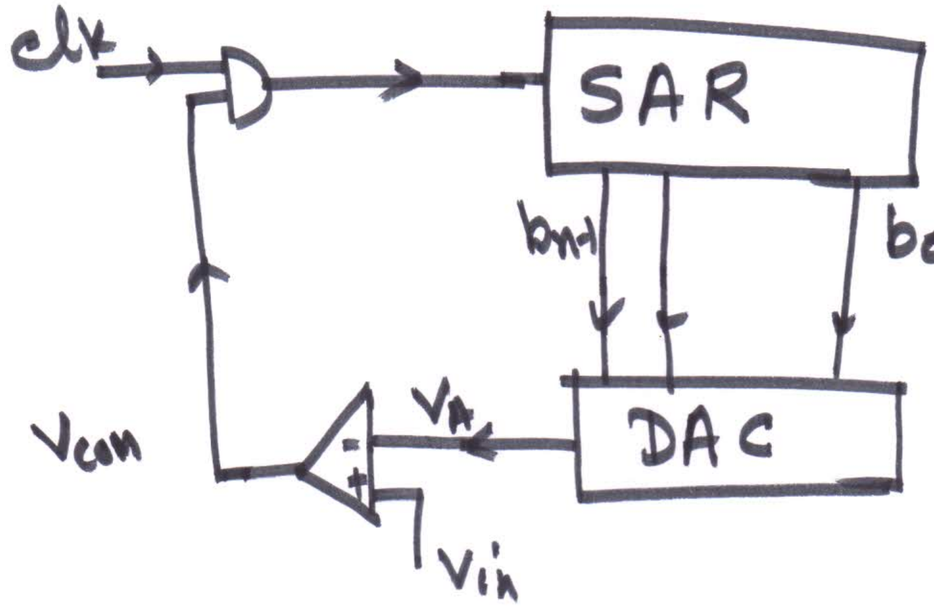
$= (2^n - 1)T$

(slow)

3) Tracking type A/D Converters



4) Successive Approximation (SA) type A/D



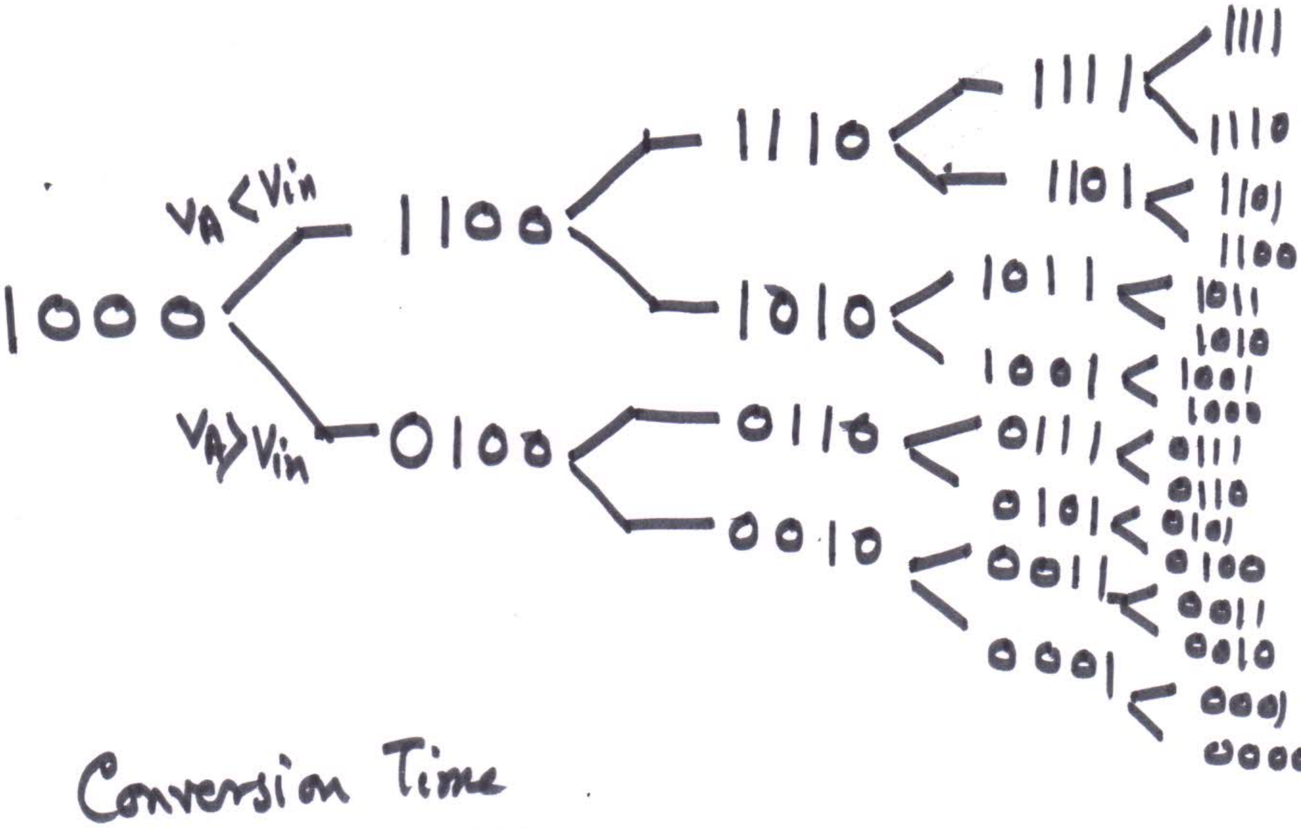
SAR → Successive Approx. Reg.

$b_{n-1}\ b_{n-2} \cdot\ b_1\ b_0$

$1\ 0 \cdots 0\ 0$

$1\ 1\ \ 0\ 0$

ex 4-bit SAR

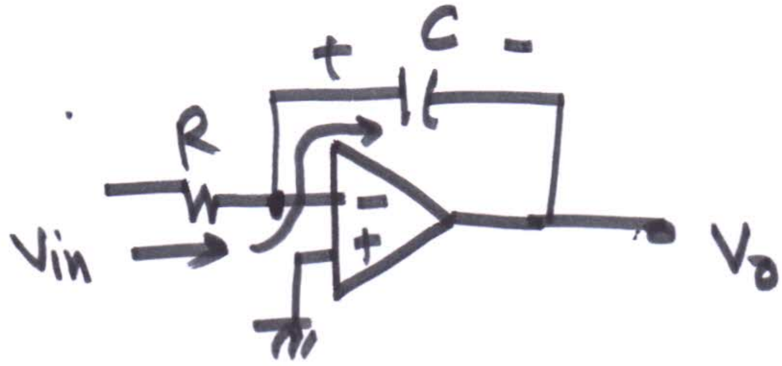


Conversion Time

$= nT$

(Faster)

5> Single Slope A/D Converter



$t \propto V_{in}$

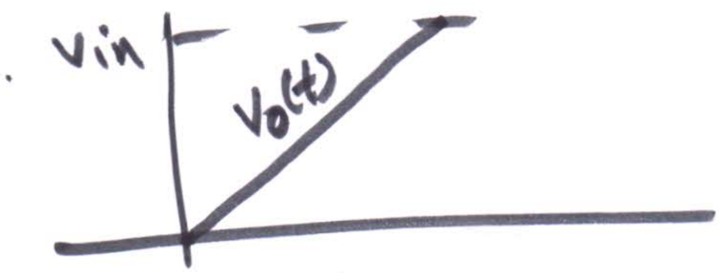
$V_o \propto V_{in}$

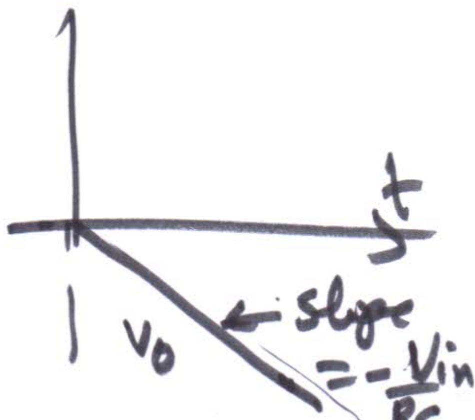
$$\frac{V_{in} - 0}{R} = C \frac{d}{dt}(0 - V_o)$$

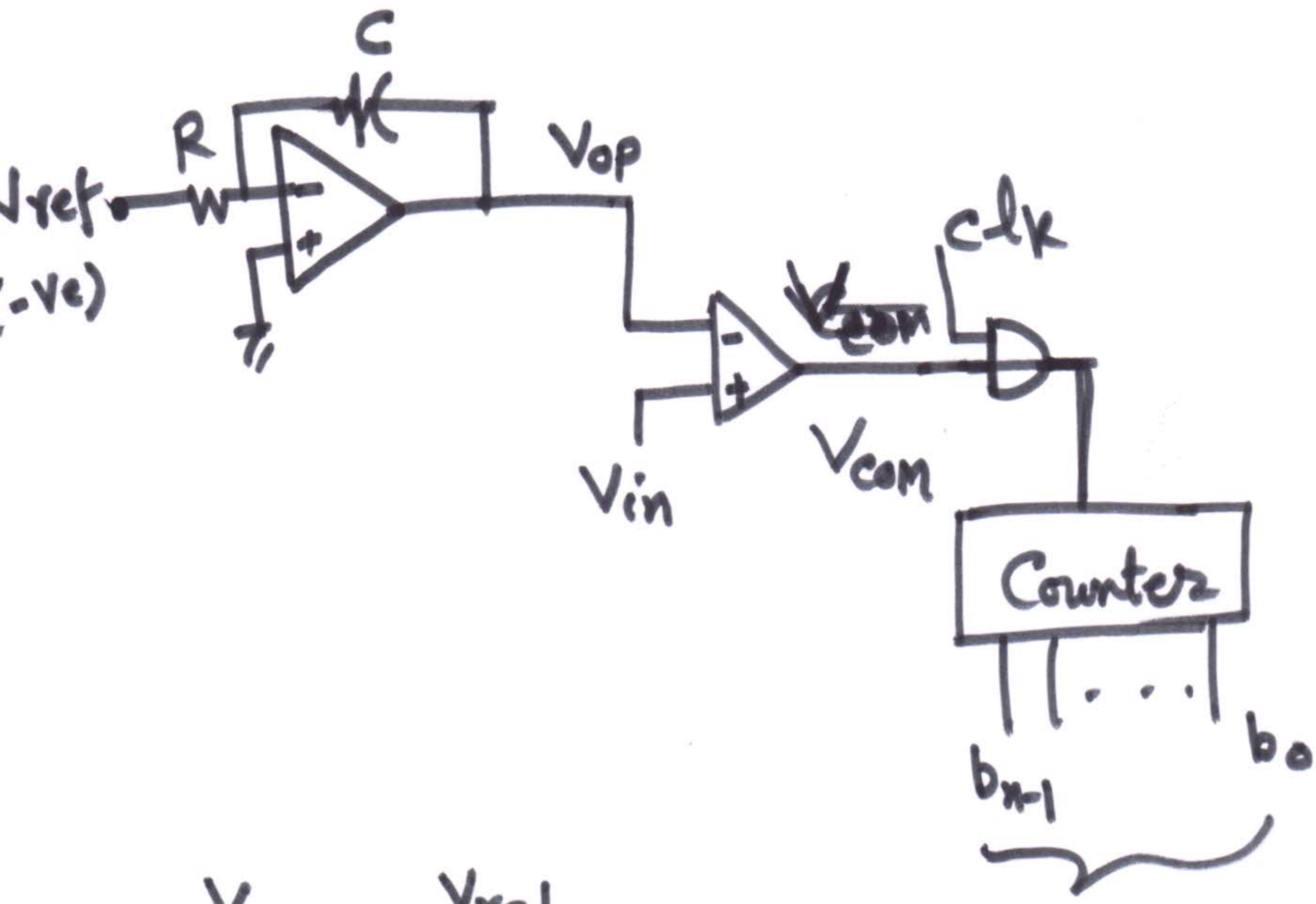
$$\Rightarrow \frac{dV_o}{dt} = -\frac{1}{RC} V_{in}$$

$$\Rightarrow V_o(t) = -\frac{1}{RC} \int_0^t V_{in}\, dt$$

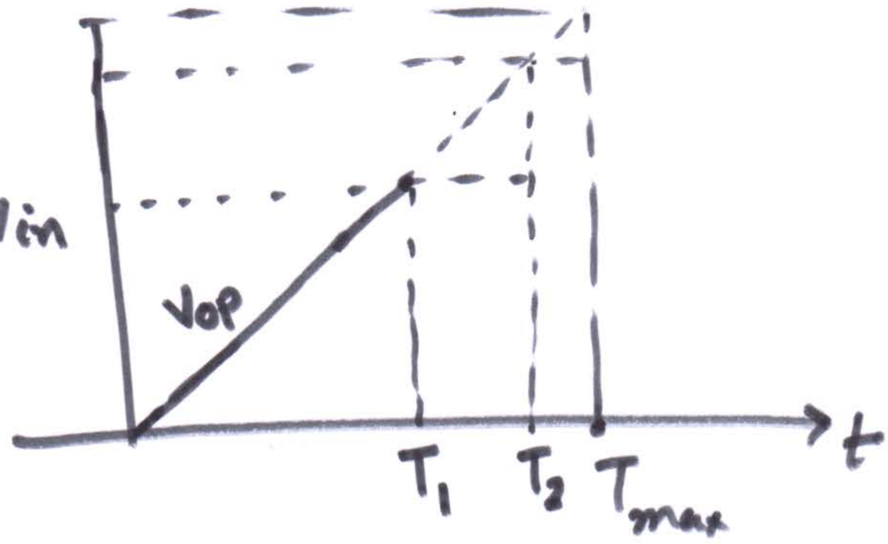
$$= -\frac{1}{RC} \cdot V_{in} \cdot t$$







$$V_{op} = -\frac{V_{ref}}{Rc} \cdot t$$

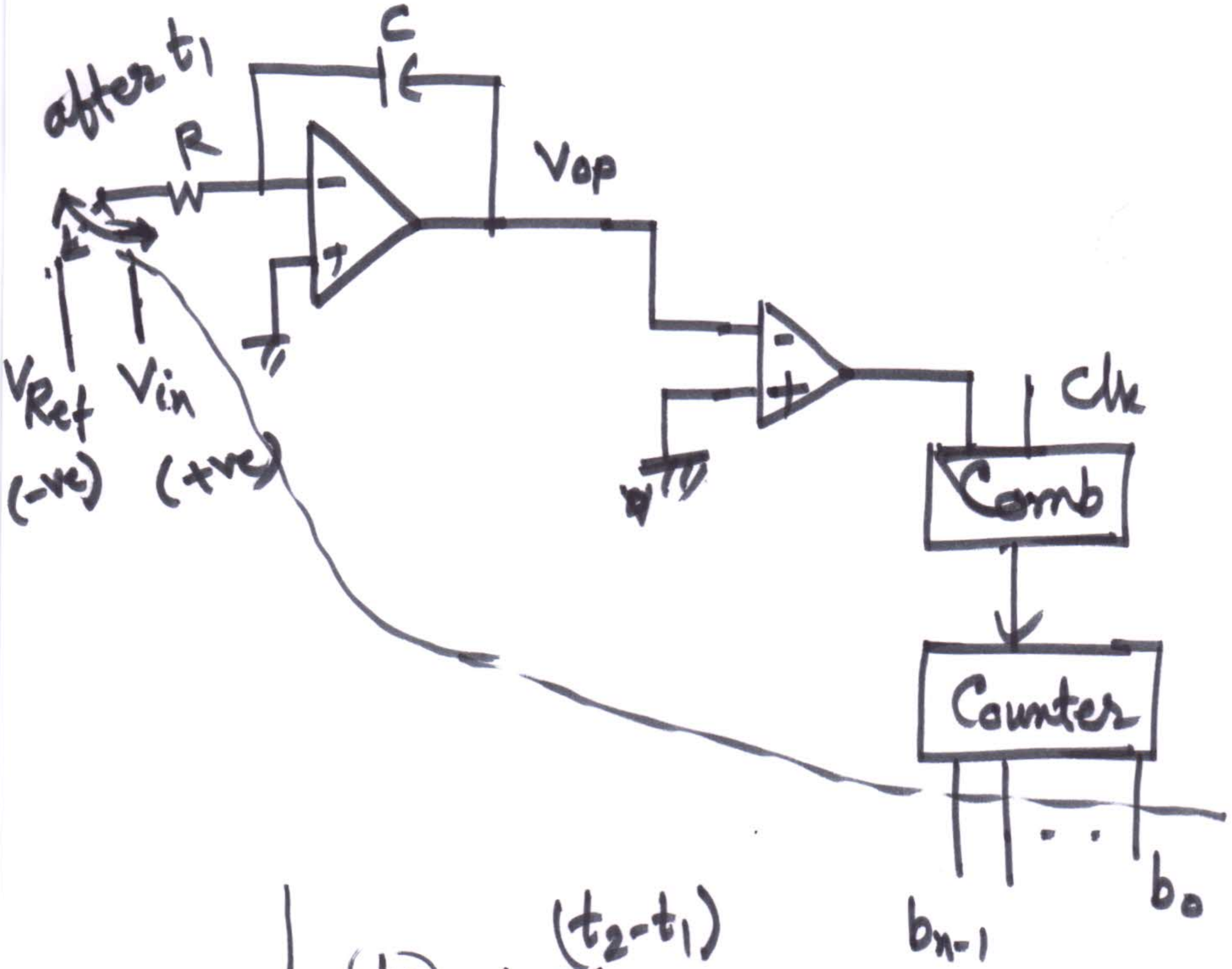


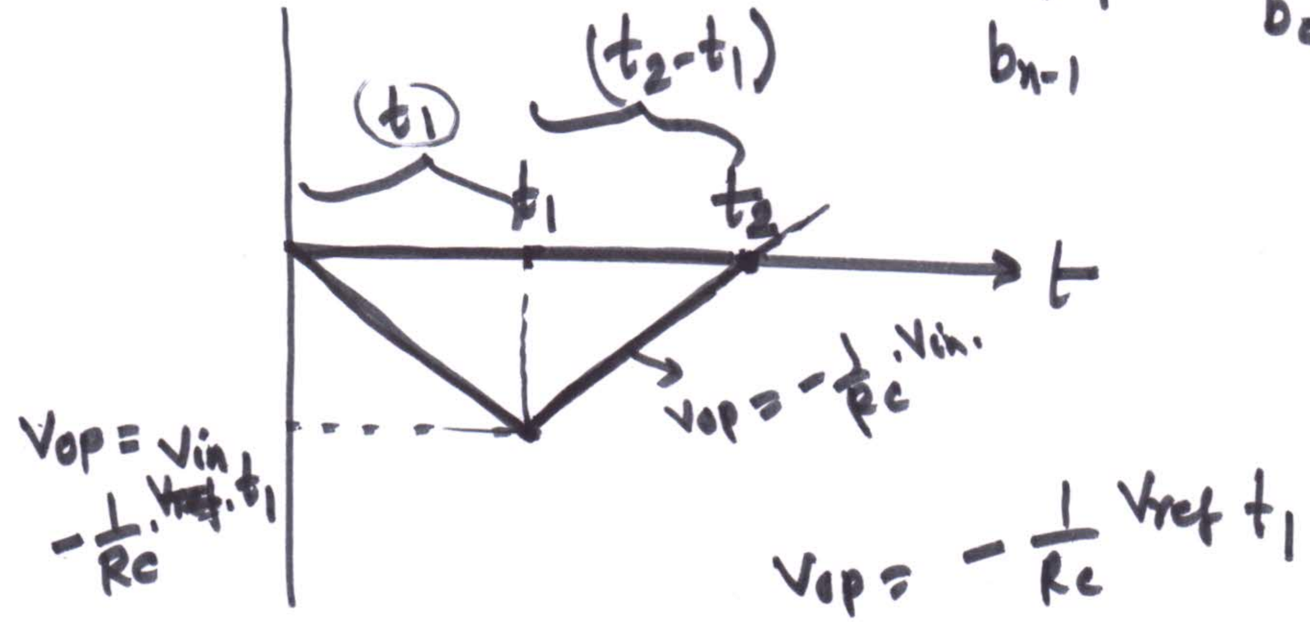
$$T_{max} = (2^N - 1)\,T$$

(slow)

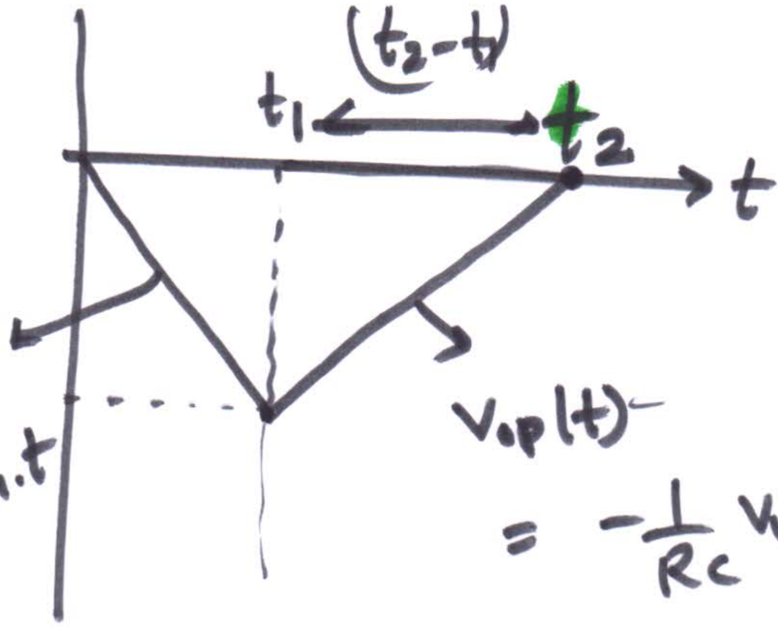
R, C $\longrightarrow$ add some noise.

Double Slope A/D Converter





$$\frac{V_{in}}{\cancel{RC}} = \frac{V_{op}}{(t_2 - t_1)} = -\frac{1}{\cancel{RC}} \times \frac{V_{ref} \cdot t_1}{(t_2 - t_1)}$$



$V_{op}(t) = -\frac{1}{Rc} \cdot V_{in} \cdot t$

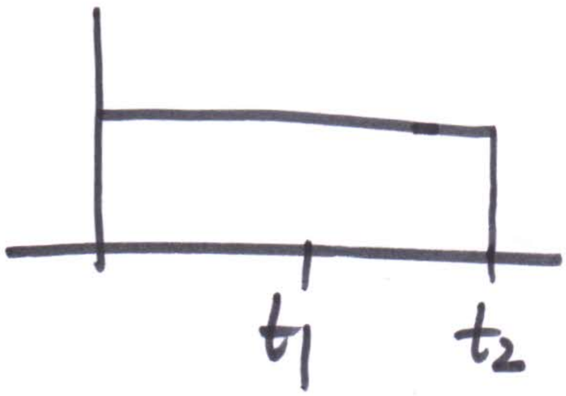
$V_{op}(t) = -\frac{1}{Rc} V_{in} \cdot t_1 + \frac{1}{Rc} \cdot V_{ref} (t - t_1)$

<u>at $t = t_2$</u>

$V_{op}(t) = 0$

$\Rightarrow -\frac{1}{Rc} V_{in} \cdot t_1 + \frac{1}{Rc} V_{ref} (t_2 - t_1) = 0$

$\Rightarrow (t_2 - t_1) = \frac{t_1}{\cancel{t_2}} \times \frac{V_{in}}{V_{ref}}$



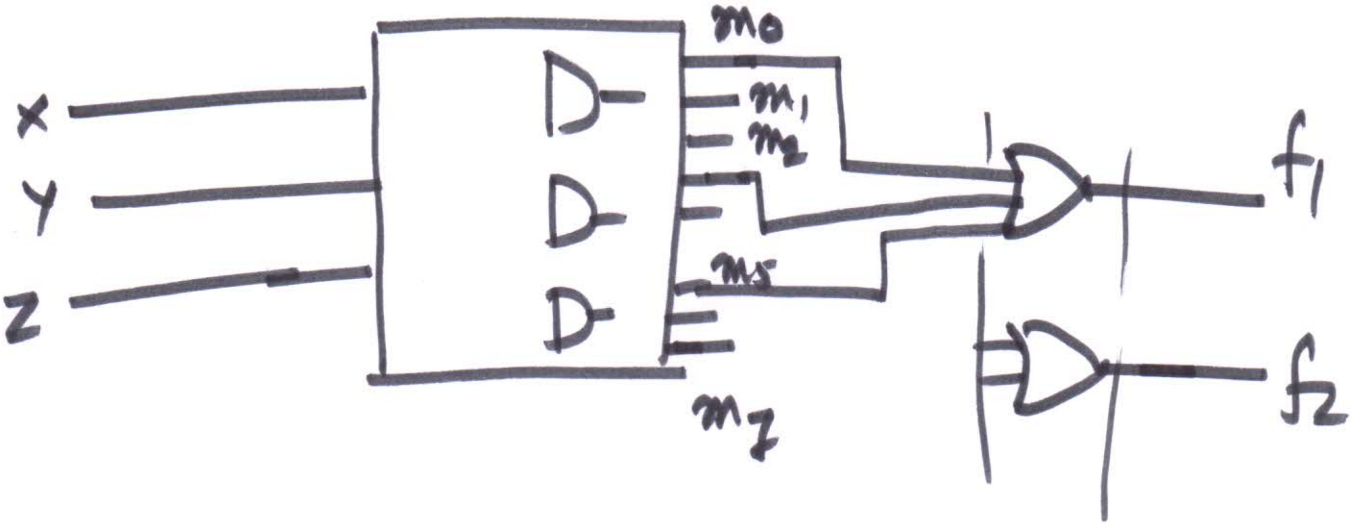
$t_1 = 2^n \cdot T$

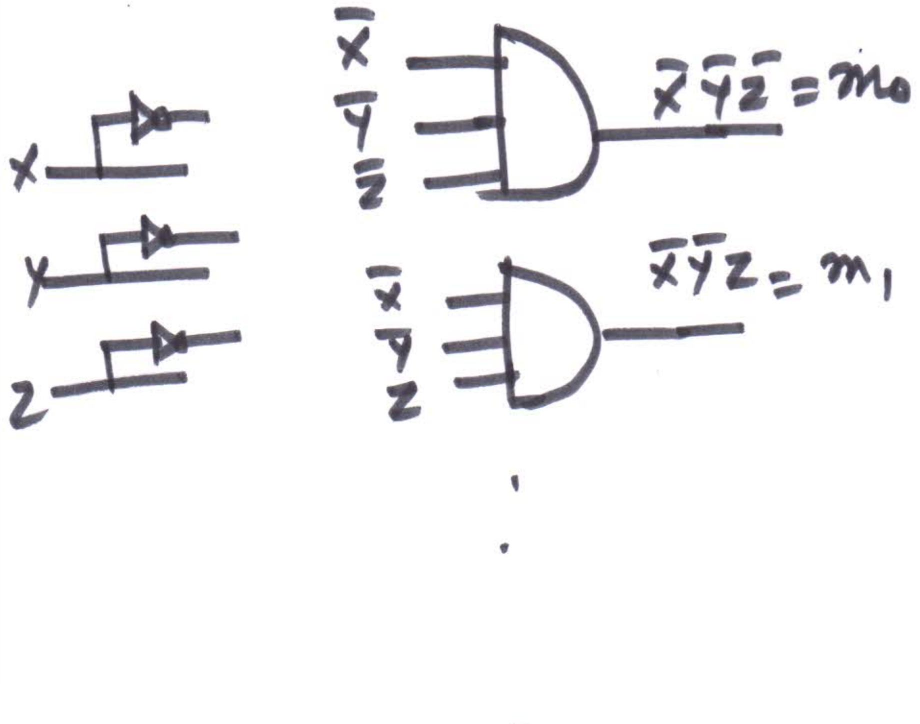
$\underline{\underline{t_2}}$

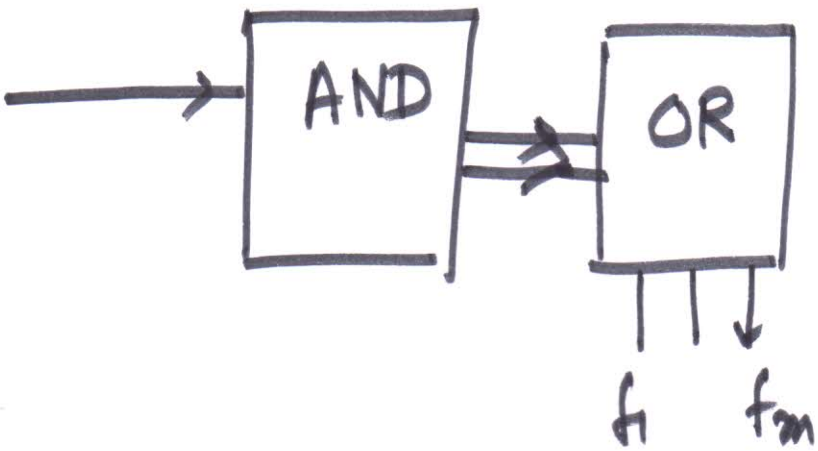
Programmable Logic Devices

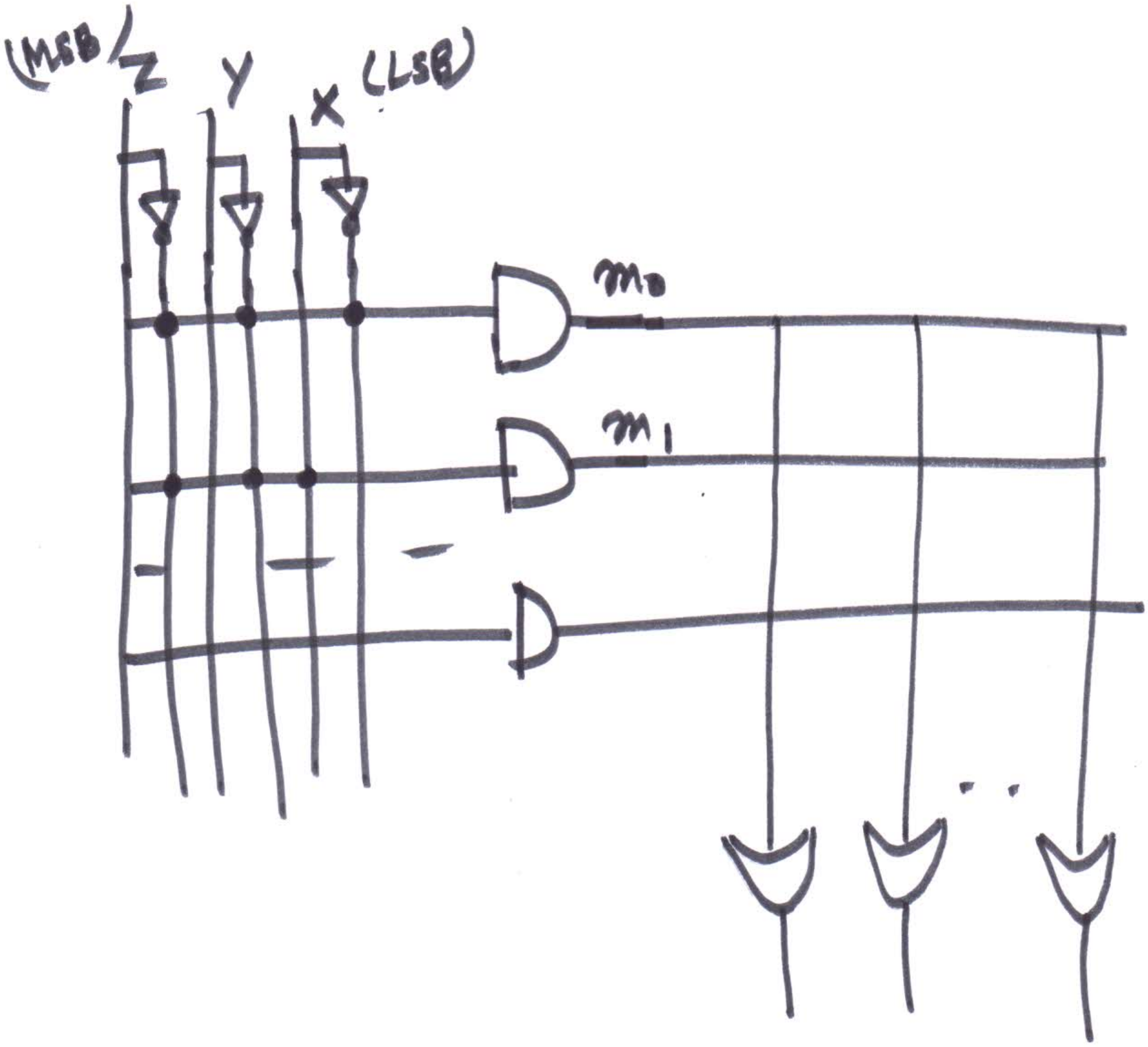
$$f_1^{(x,y,z)} = \sum m(0, 3, 5)$$

$$f_2(x,y,z) = \sum m(1, 4, 6)$$






AND
OR
f1
fm

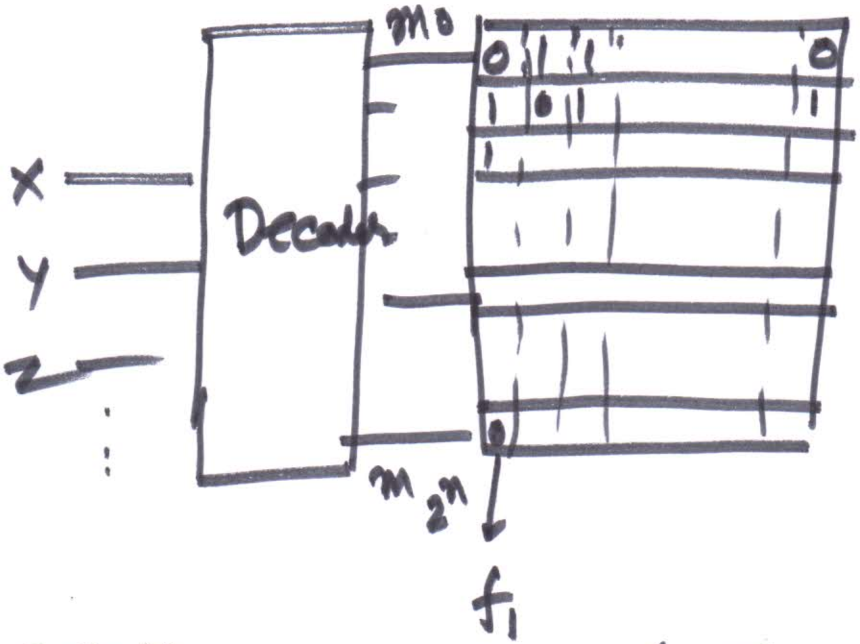

(MSB) Z
Y
X (LSB)
m0
m1

PROM $\rightarrow$ AND Block is fixed
OR Block is programmable

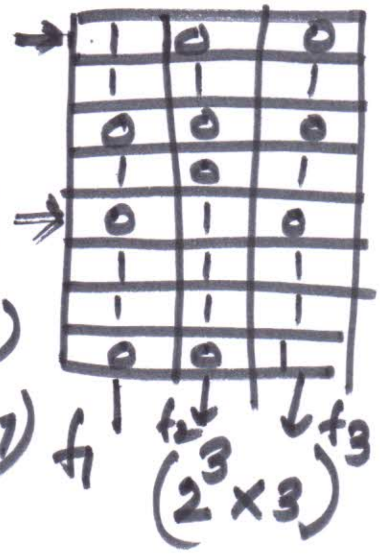
PLA $\rightarrow$ Both 'AND' and 'OR' Blocks are programmale.
(Prog. Logic Array)

PAL $\rightarrow$ AND Block is programmable
OR Block is fixed.
(Prog. Array Logic)

ROM



ex



$f_1 = \sum m(0,1,3,5,6)$

$f_2 = \sum m(1,4,5,6)$

$f_3 = \sum m(1,3,5,6,7)$

PROM