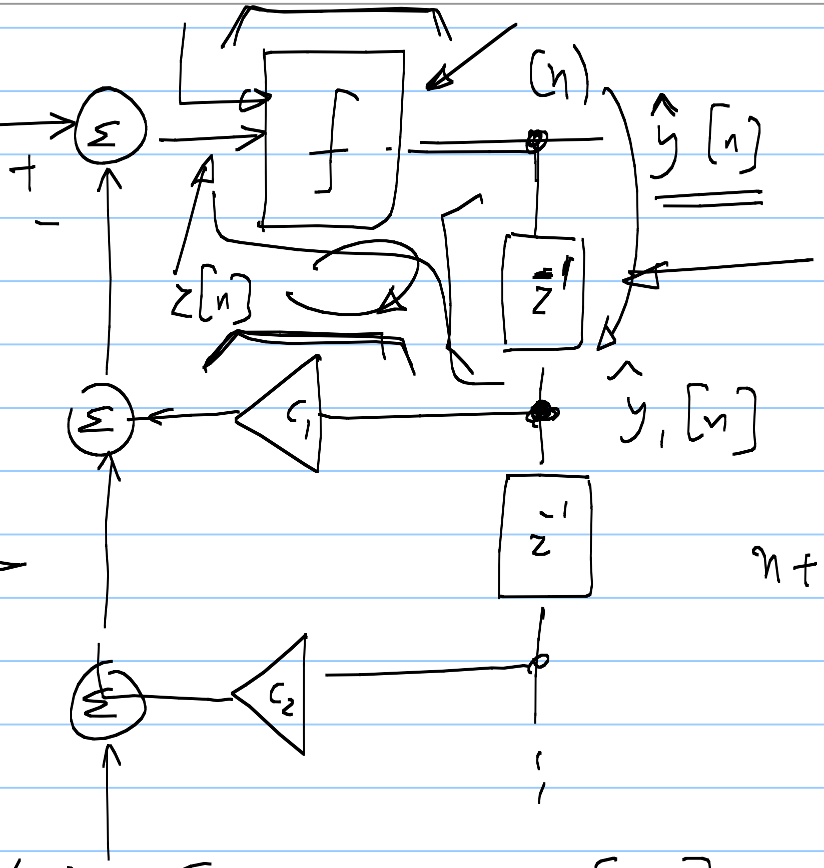
Decision feedback equalizers (DFEs)

08-10-2007



n: $y[n] = \underbrace{(x[n]) + \alpha\, x[n-1]}$

$z[n] = x[n]$

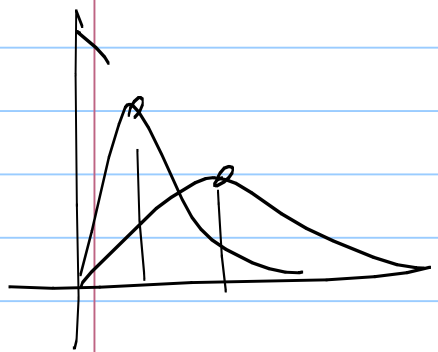
$\hat{y}[n] = x[n]$

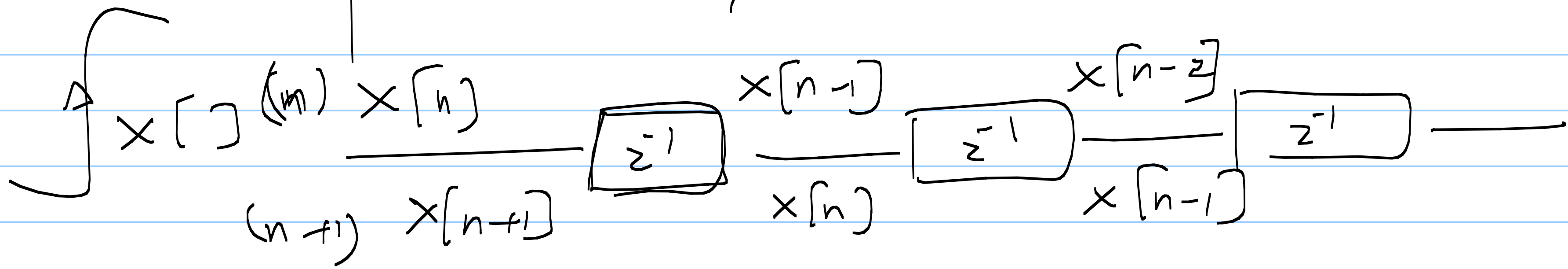
$\hat{y}_1[n] = \hat{y}[n-1]$

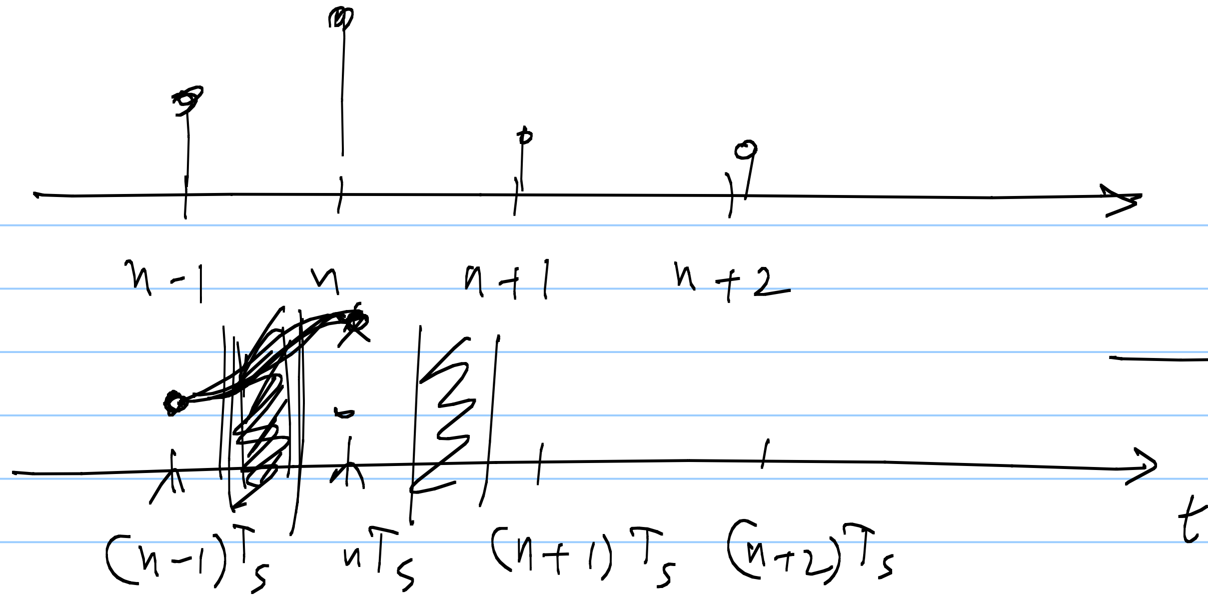
$= x[n-1]$

$n+1$: $y[n+1]$

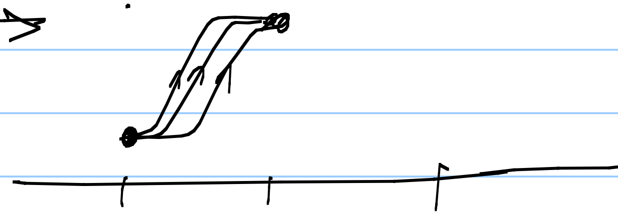
$z[n+1]$

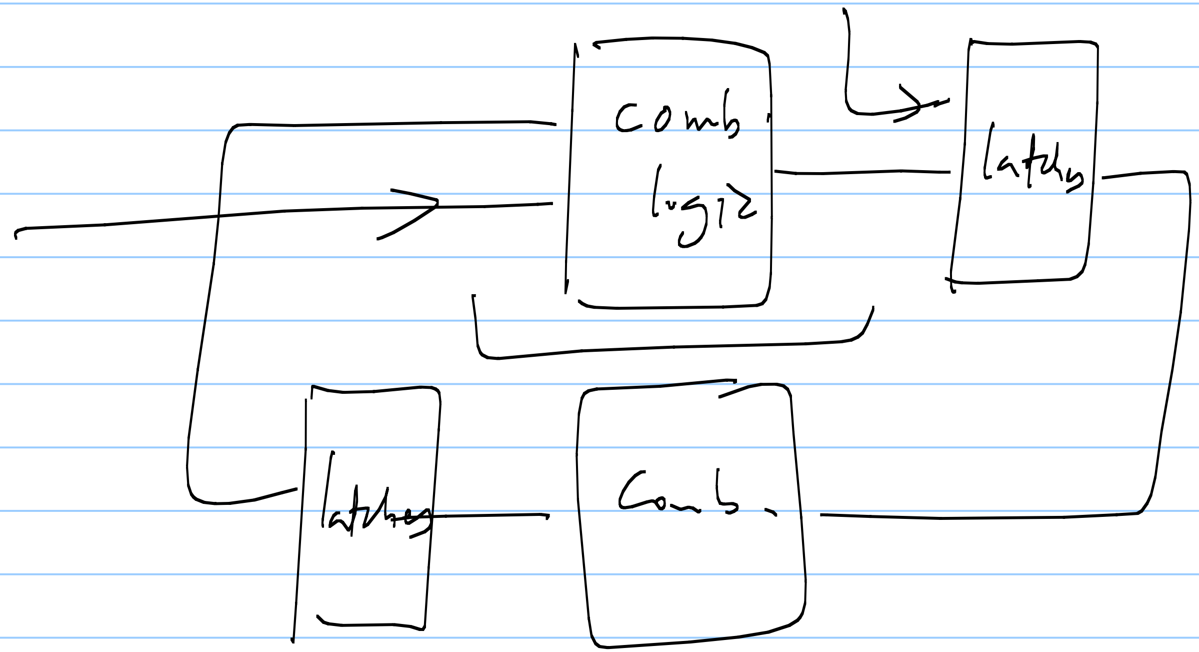






n-1
n
n+1
n+2
$(n-1)T_s$
nT_s
$(n+1)T_s$
$(n+2)T_s$
t





comb. logic
latches
latches
Comb.

$$y[n] = x[n] + \alpha x[n-1] + w[n]$$

$$\hat{y}[n] = \operatorname{sgn}(z[n])$$

$$z[n] = y[n] - \alpha \hat{y}[n-1]$$

$$\hat{y}[n-1] = x[n-1] \quad Q\left(\frac{1}{\sigma_w}\right) \qquad (1 - P_E)$$

$$\hat{y}[n-1] \neq x[n-1] \quad \frac{1}{2}\left[Q\left(\frac{1+2\alpha}{\sigma_w}\right) + Q\left(\frac{1-2\alpha}{\sigma_w}\right)\right] \qquad P_E$$

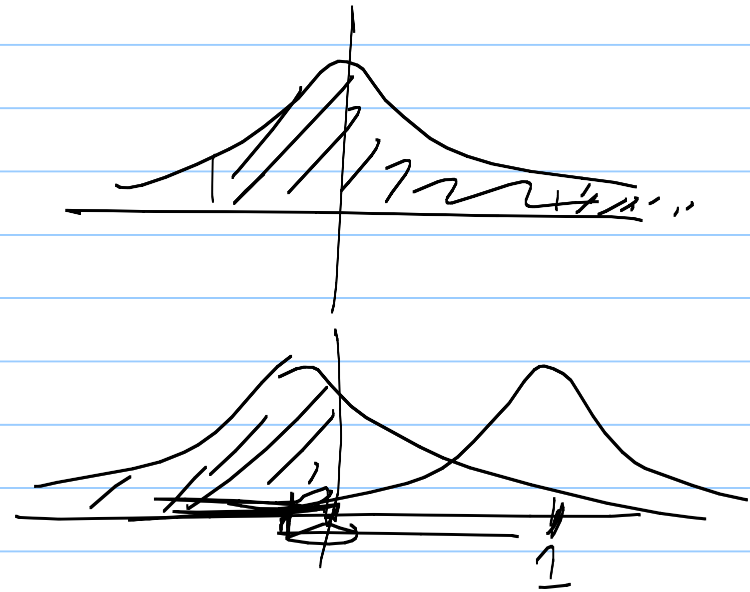
$$P_E = (1 - P_E)\, Q\left(\frac{1}{\sigma_w}\right) + P_E \cdot \frac{1}{2}\left[Q\left(\frac{1+2\alpha}{\sigma_w}\right) + Q\left(\frac{1-2\alpha}{\sigma_w}\right)\right]$$

$$P_E = \frac{Q\left(1/\sigma_w\right)}{1 + \underbrace{Q\left(1/\sigma_w\right)}_{} - \frac{1}{2}\left(\underbrace{Q\left(\frac{1-2\alpha}{\sigma_w}\right)}_{} + \underbrace{Q\left(\frac{1+2\alpha}{\sigma_w}\right)}_{}\right)}$$

* Cursor is normalized to 1

* stabilized value at the input to the slicer = ± 1

$$P_E \simeq \frac{Q\left(1/\sigma_w\right)}{1 - \frac{1}{2} \cdot \underbrace{Q\left(\frac{1-2\alpha}{\sigma_w}\right)}_{}}$$



* There is an enhancement of error rate (error propagation)

* Enhancement is typically not an issue

α:

$$y[n] = x[n] - \alpha^2 x[n-2]$$

$$\underbrace{\sigma_w^2 (1+\alpha^2)}$$

$$Q\left(\frac{1-\alpha^2}{\sigma_w\sqrt{1+\alpha^2}}\right)$$

$$P_E = \frac{1}{2}\left[Q\left(\frac{1-\alpha^2}{\sigma_w\sqrt{1+\alpha^2}}\right) + Q\left(\frac{1+\alpha^2}{\sigma_w\sqrt{1+\alpha^2}}\right)\right]$$

$\frac{1-\alpha^2}{}$ $\quad Q\left(\frac{1-\alpha^2}{\sigma_w\sqrt{1+\alpha^2}}\right)$

$\frac{1+\alpha^2}{}$ $\quad Q\left(\frac{1+\alpha^2}{\sigma_w\sqrt{1+\alpha^2}}\right)$

$$\simeq \frac{1}{2}\left[Q\left(\frac{1-\alpha^2}{\sigma_w(1+\alpha^2)^{1/2}}\right)\right]$$

DFE:

$$\frac{Q\left(1/\sigma_w\right)}{1 - \frac{1}{2} Q\left(\frac{1-2\alpha}{\sigma_w}\right)}$$

FFE: $P_E \simeq \frac{1}{2} Q \left(\underbrace{\frac{(1-\alpha^2)}{\sigma_w (1+\alpha^2)^{1/2}}} \right)$ BER higher

DFE: $P_E \simeq \underbrace{Q\left(\frac{1}{\sigma_w}\right)} \frac{1}{\underbrace{1 - \frac{1}{2} Q\left(\frac{1-2\alpha}{\sigma_w}\right)}}$