# ECE 5/418 Memory Circuit Design

BOISE STATE UNIVERSITY

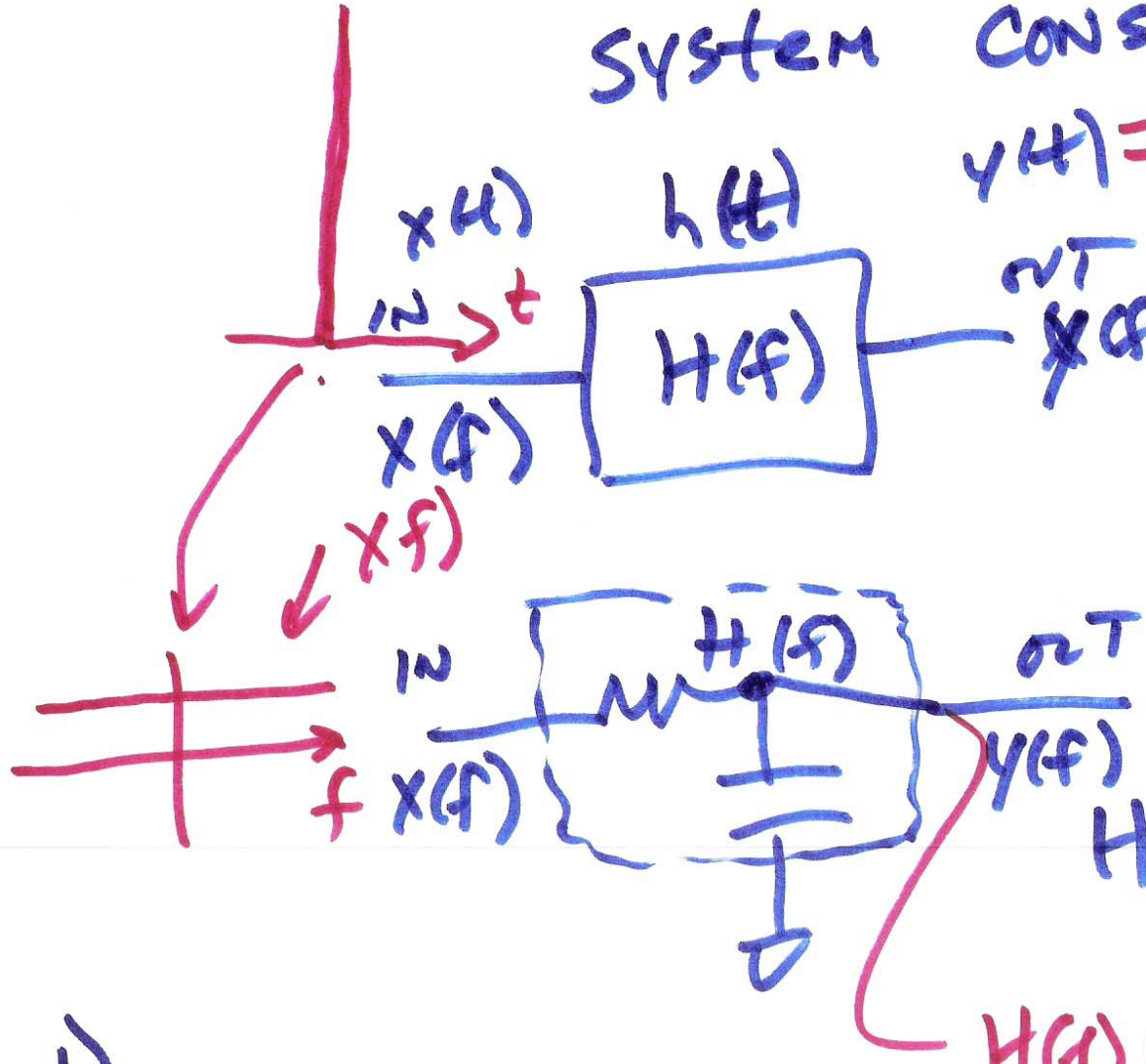
April 18, 2011

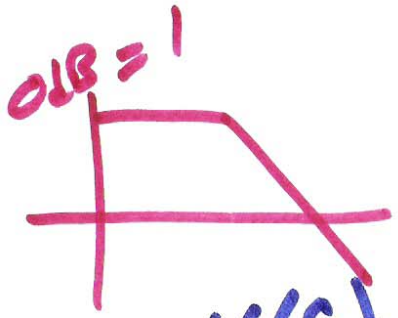
Lecture 21

## System Considerations

$y(t) = h(t)$ $h(t)$ = Impulse response

$\mathcal{F}\{h(t)\} = H(f)$



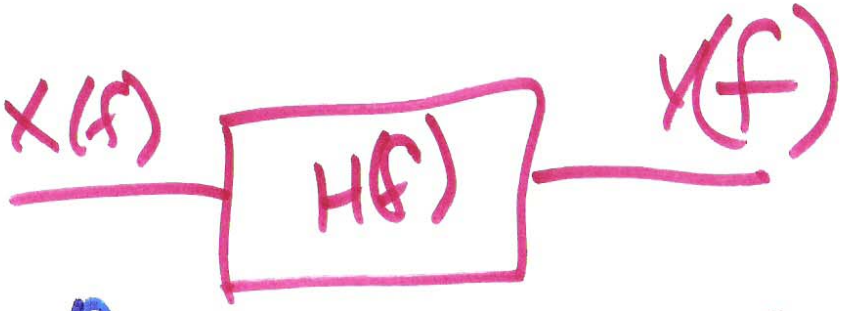

$$H(f) = \frac{Y(f)}{X(f)} = \frac{1}{1 + j2\pi fRC}$$

$$H(f) = \frac{Y(f)}{X(f)}$$

1)

# Distortionless transmission.






$e^{j\theta} = \cos\theta + j\sin\theta$

$|a+jb| = \sqrt{a^2+b^2}$

$\angle a+jb = \tan^{-1}\frac{b}{a}$

$y(t) = x(t-t_0)\cdot K$

$Y(f) = X(f)\cdot e^{-j2\pi f\cdot t_0}\cdot K$

$e^{-j2\pi f\cdot t_0} = \cos(-2\pi f t_0) + j\sin(-2\pi f t_0)$

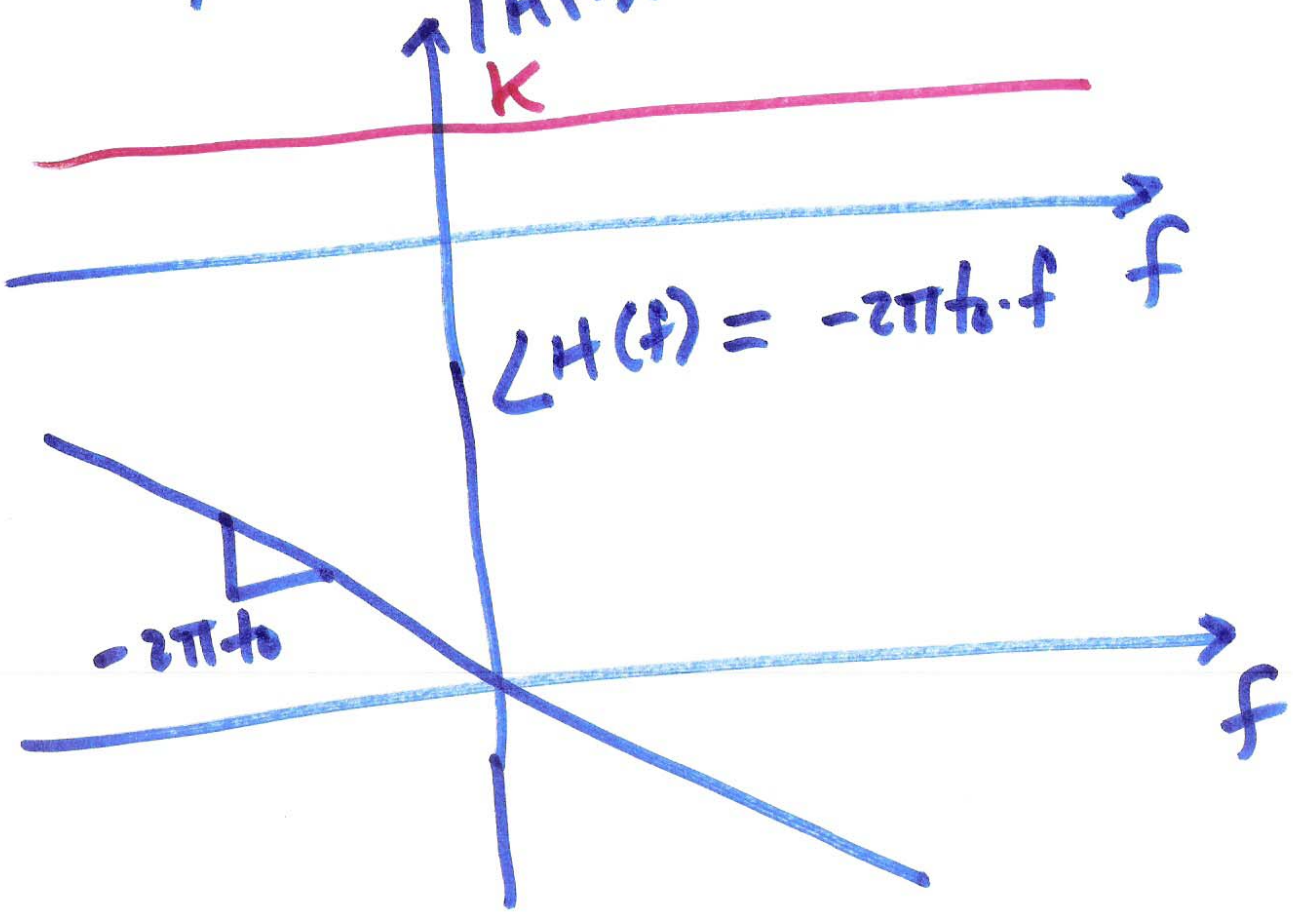
$\left|e^{-j2\pi f t_0}\right| = \sqrt{\cos^2(-\pi f t_0) + \sin^2(\quad)} = 1$

2)

$\tan(-2\pi f t_0)$

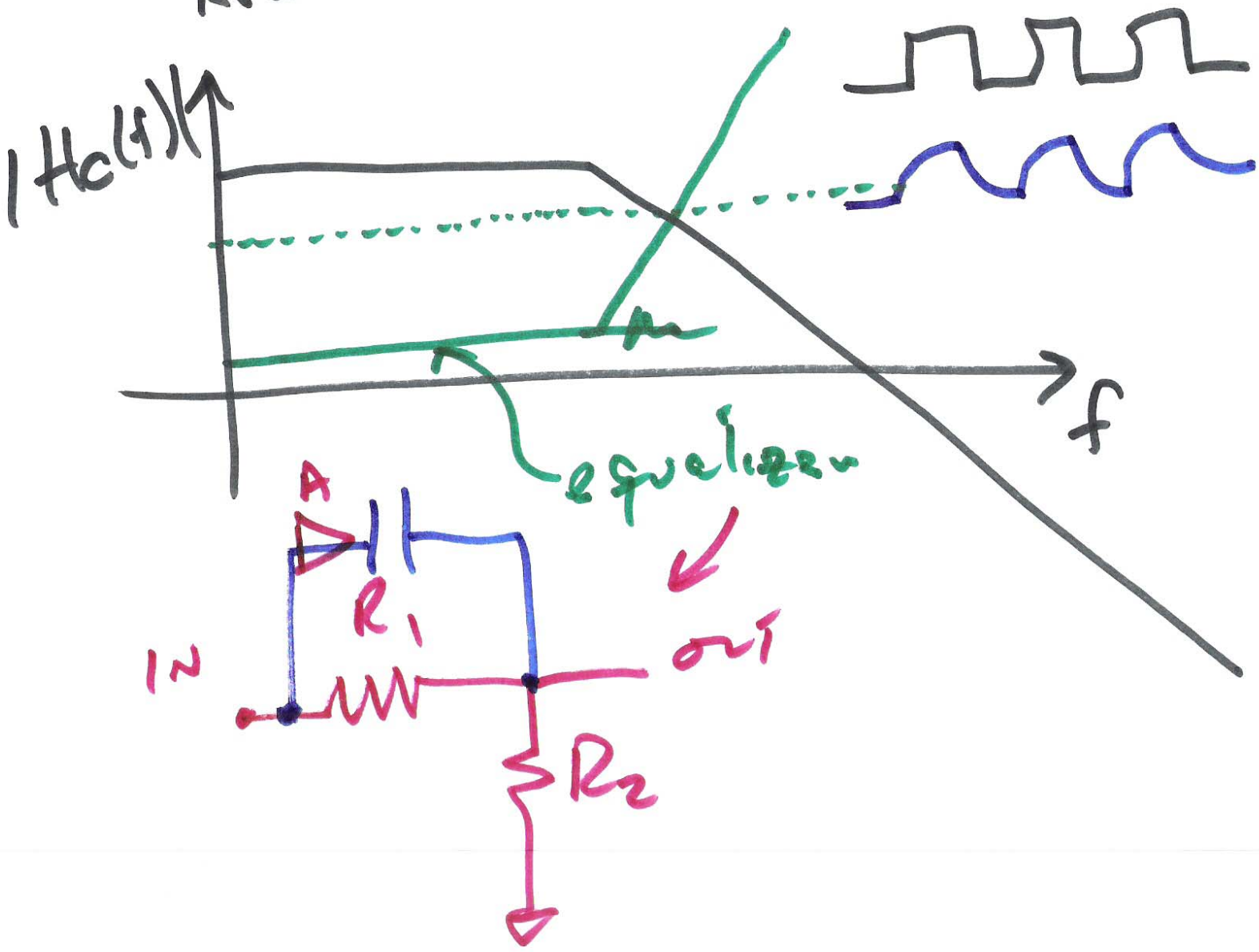
$$\tan^{-1}\frac{\sin(-2\pi f t_0)}{\cos(-2\pi f t_0)} = -2\pi f t_0 = \angle$$

$$y(t) = K \cdot x(t - t_0)$$




3)

# Real Communications channel



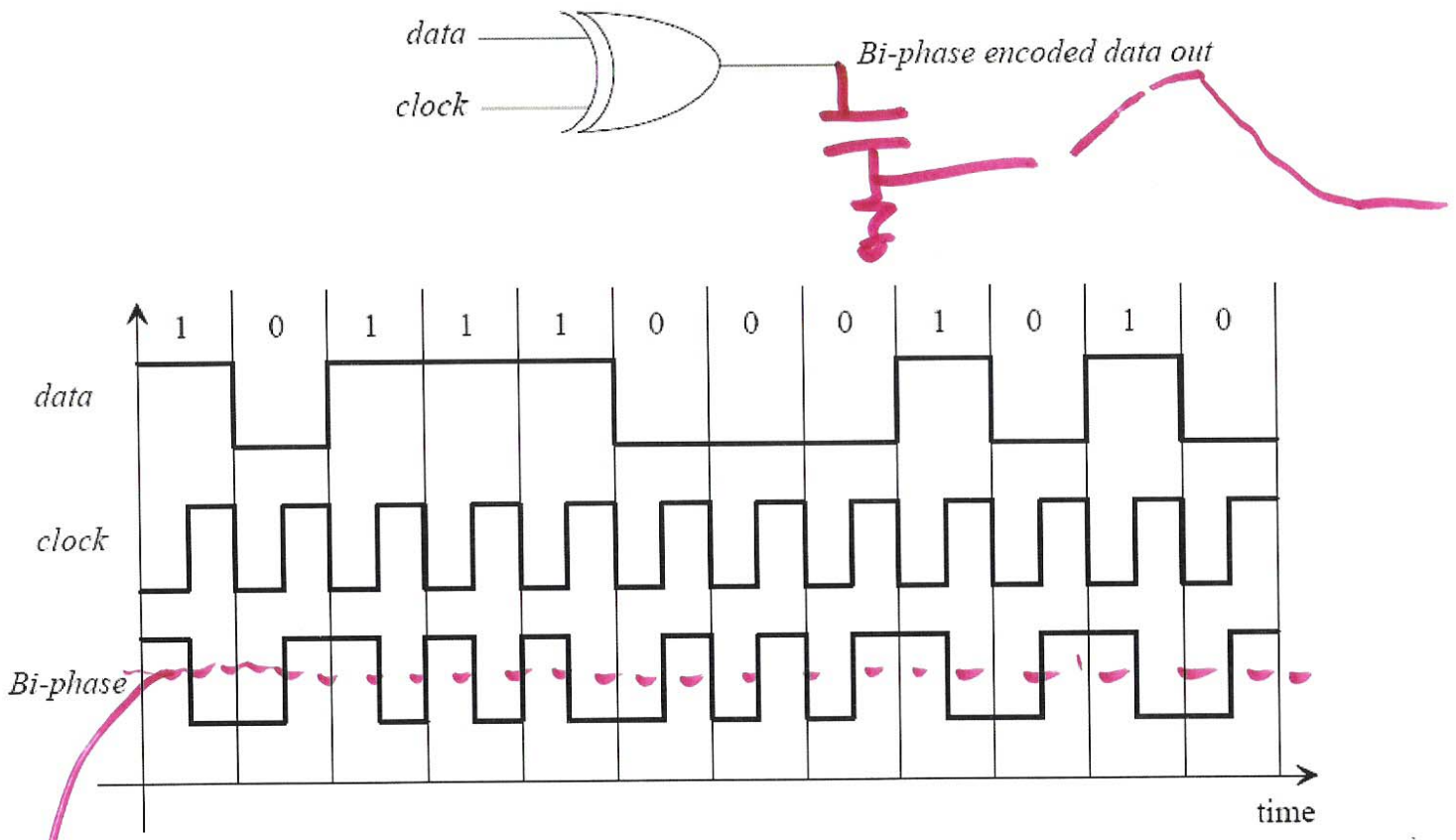



**Figure 19.43** Bi-phase data encoding.


5)

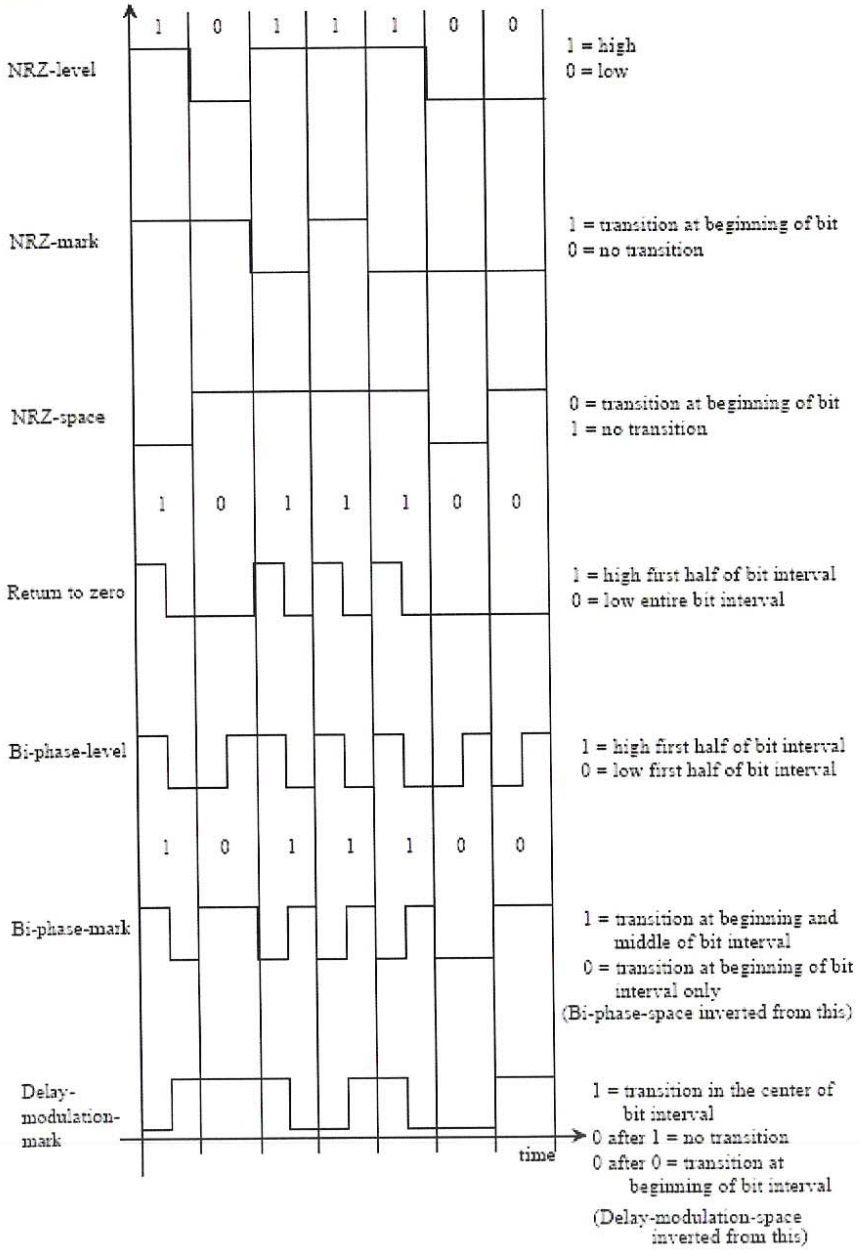
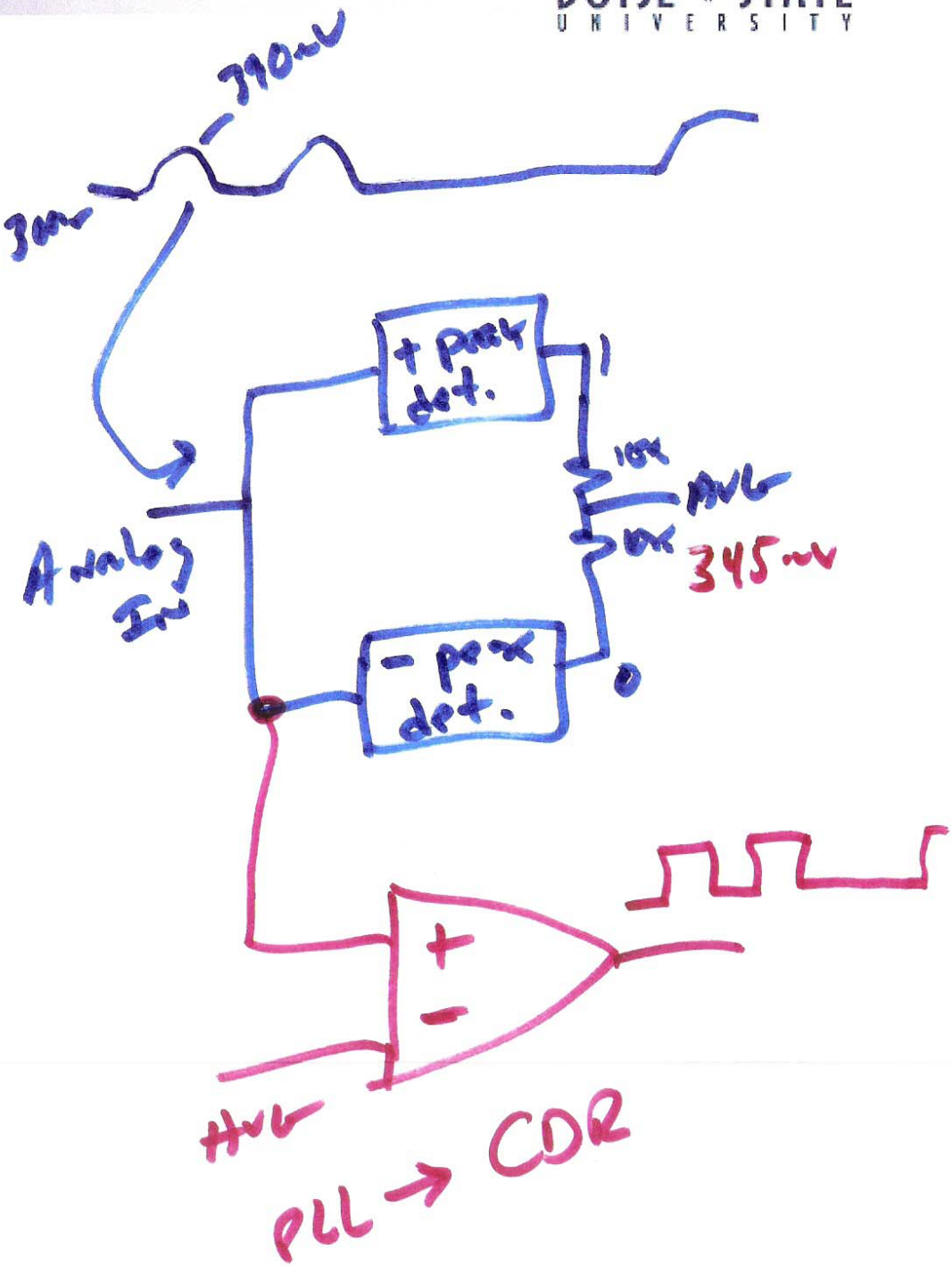



Figure 19.44 Data transmission formats.



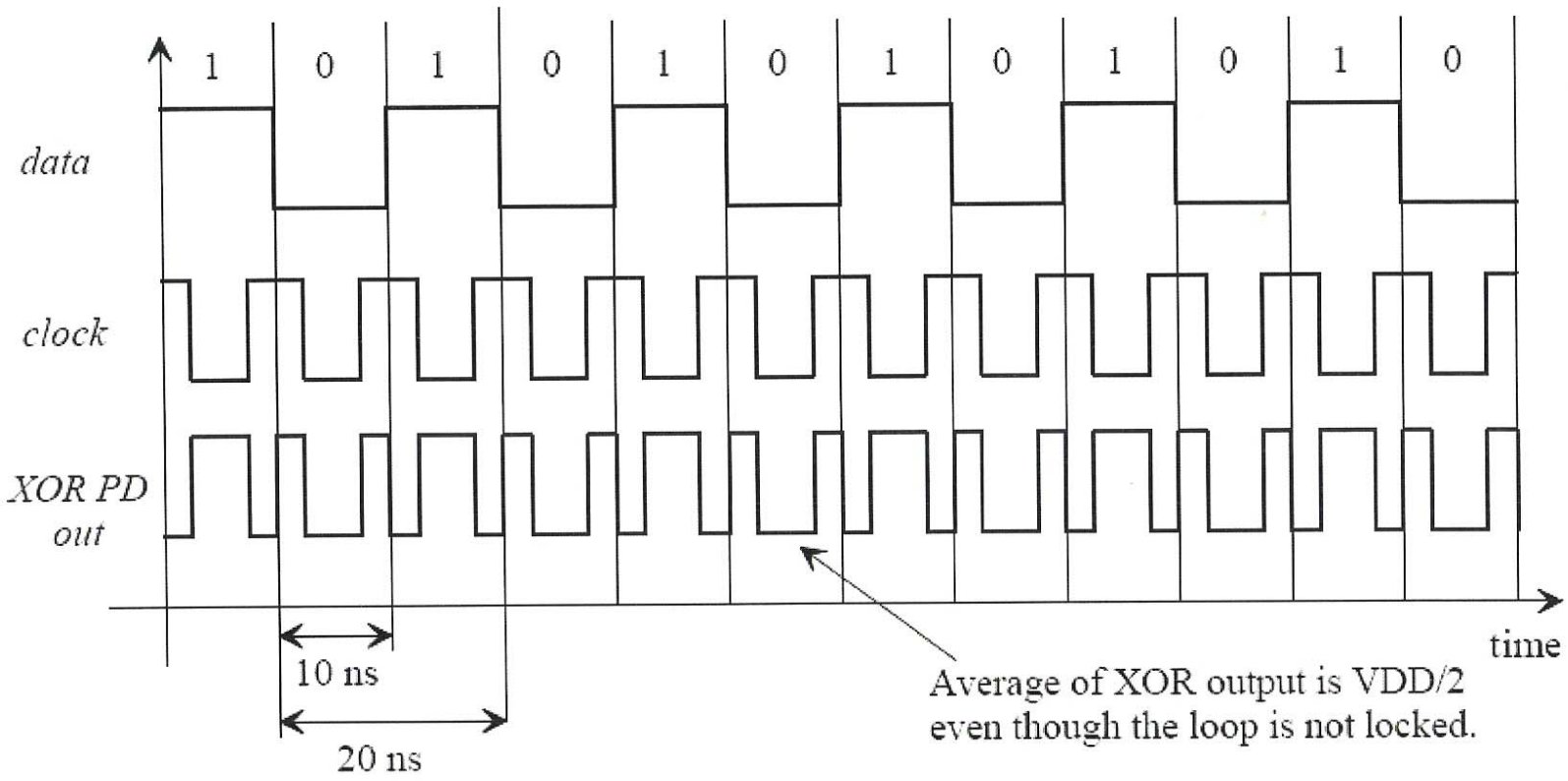



**Figure 19.45** The problems of using clock without the divide by 2 to lock on data.

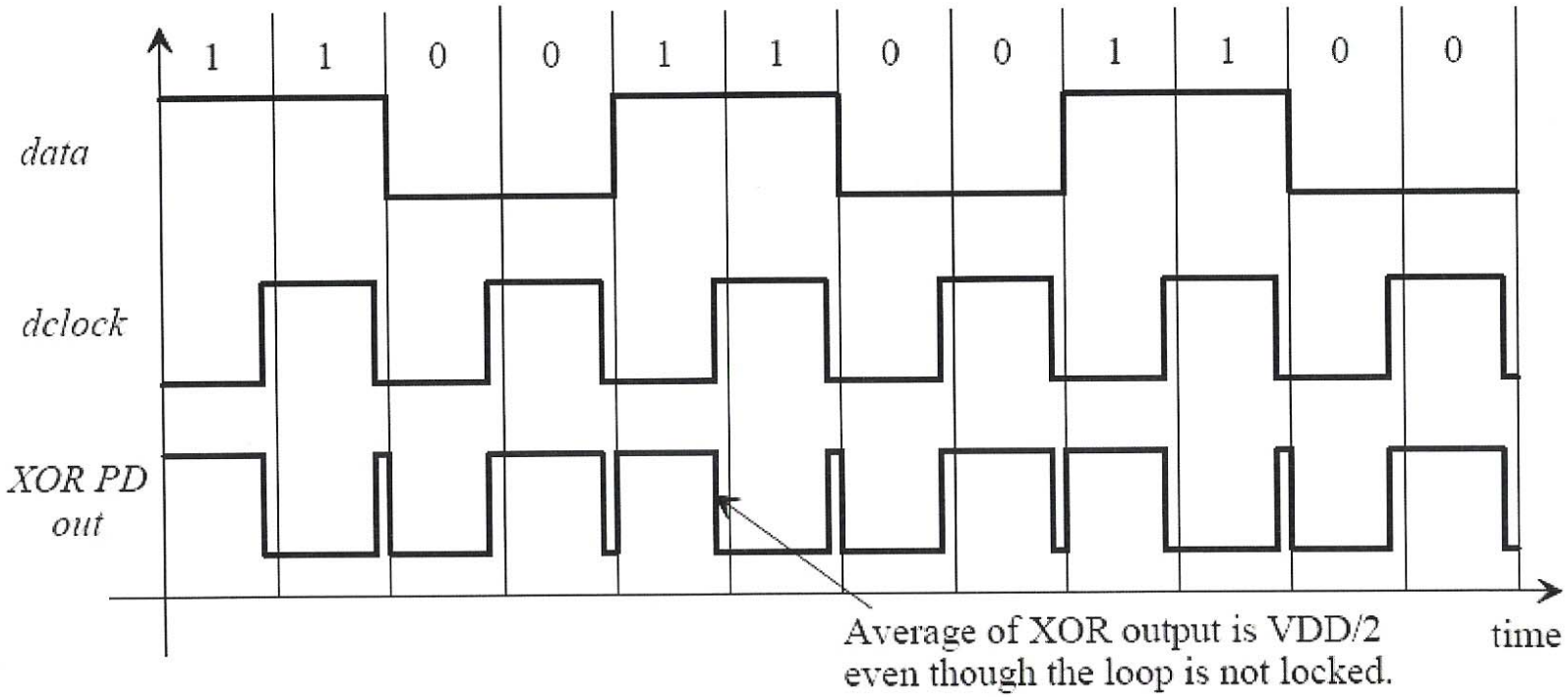
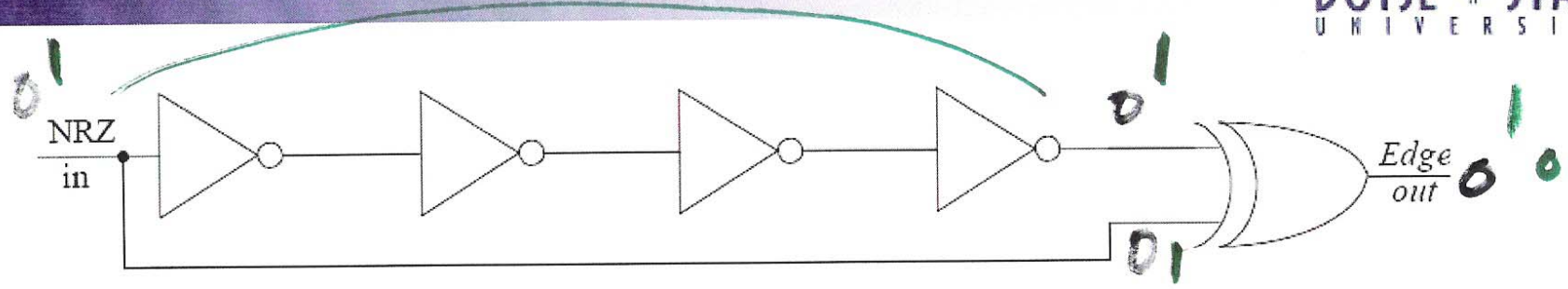



**Figure 19.46** Problems trying to lock on a data stream that is one-half the dclock frequency.



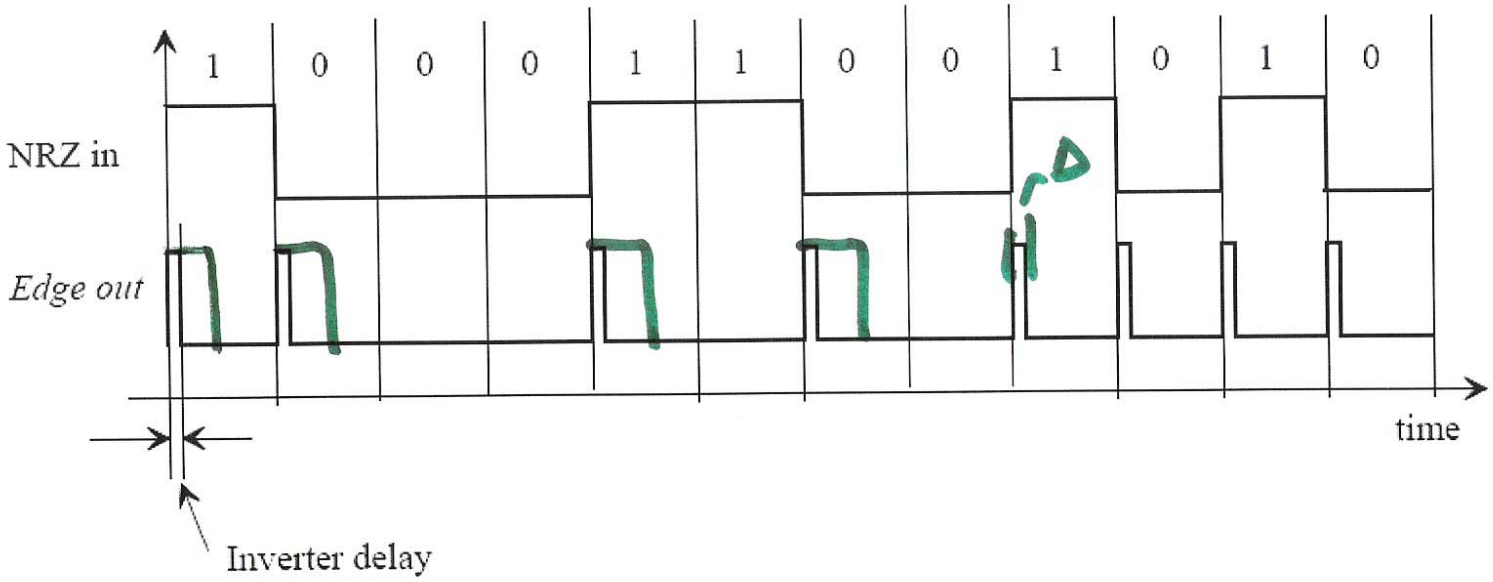
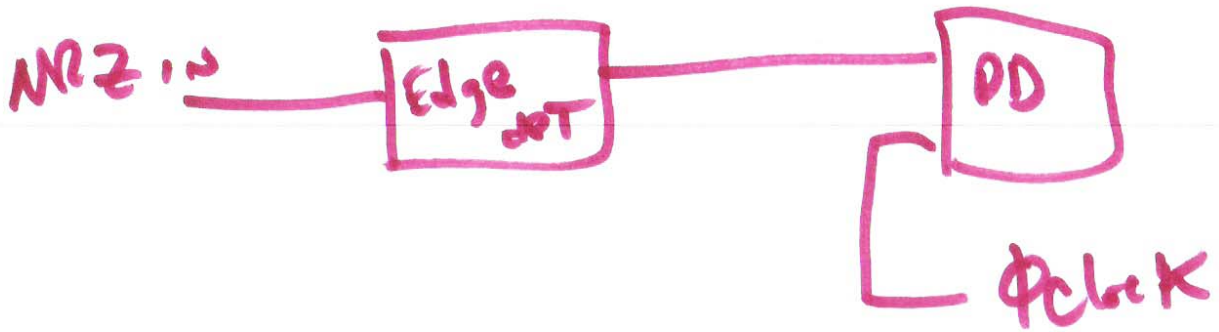
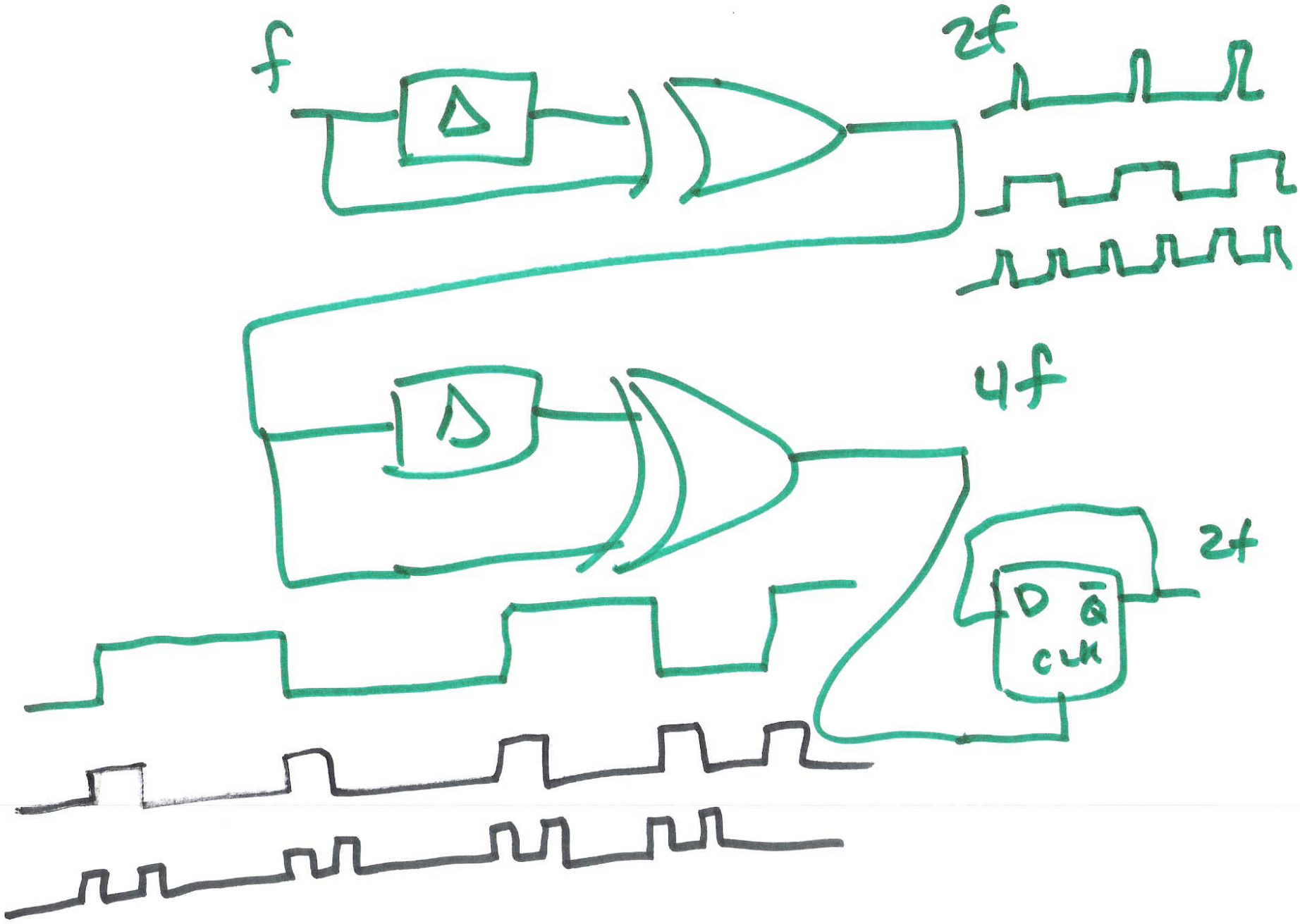




**Figure 19.47** Detecting the edges in NRZ data.




9)


f
2f
4f
2f
D
Q̄
CLK

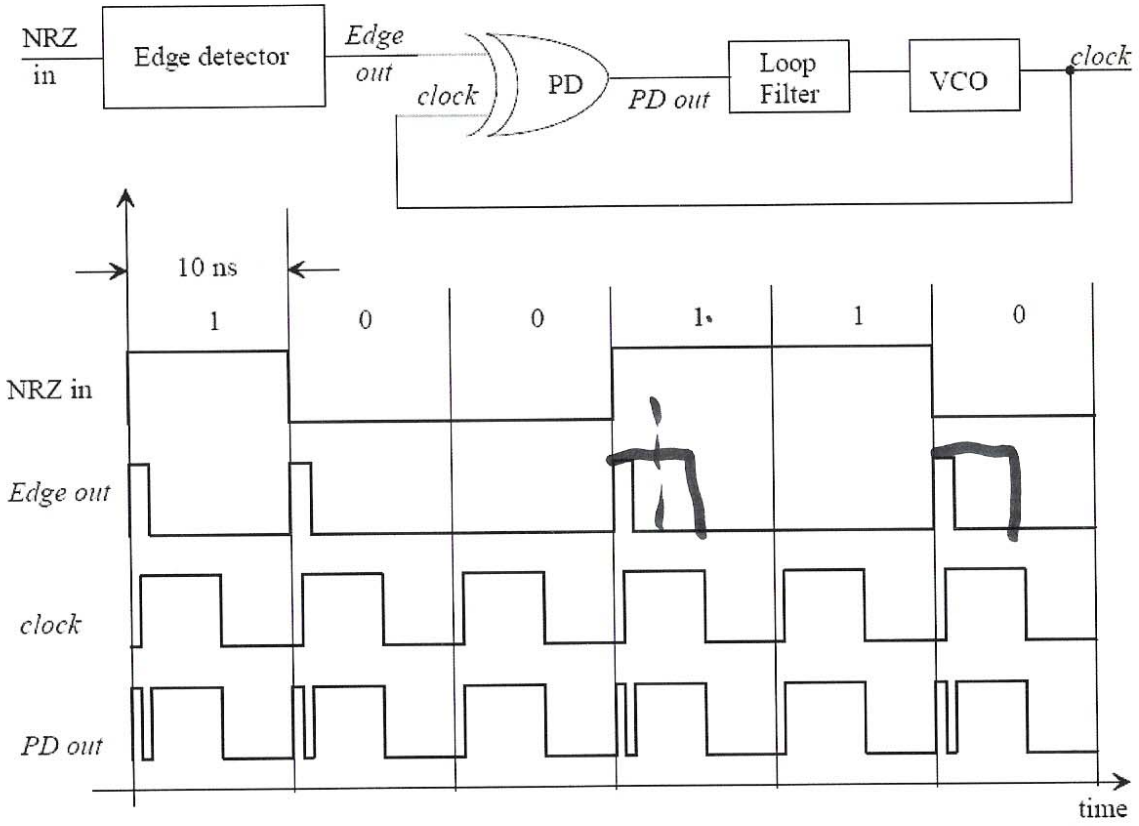
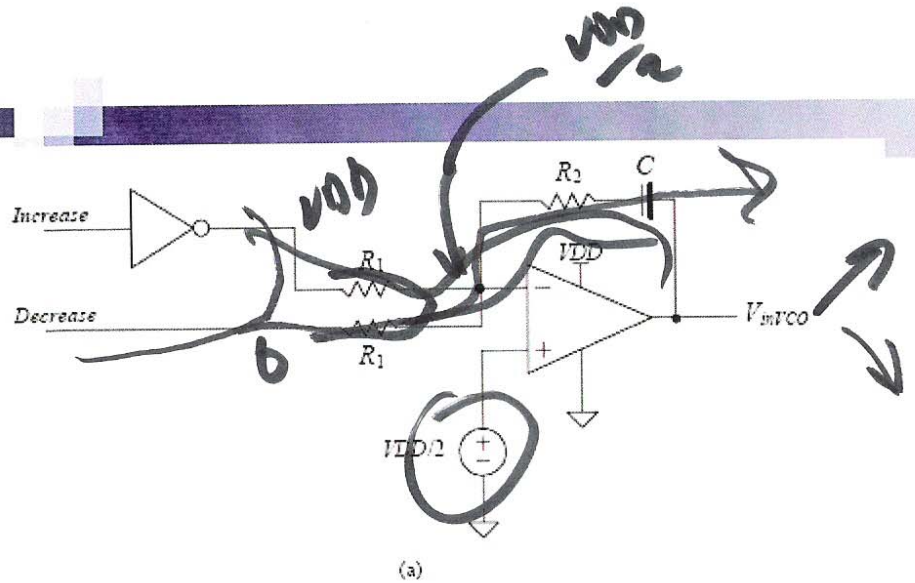
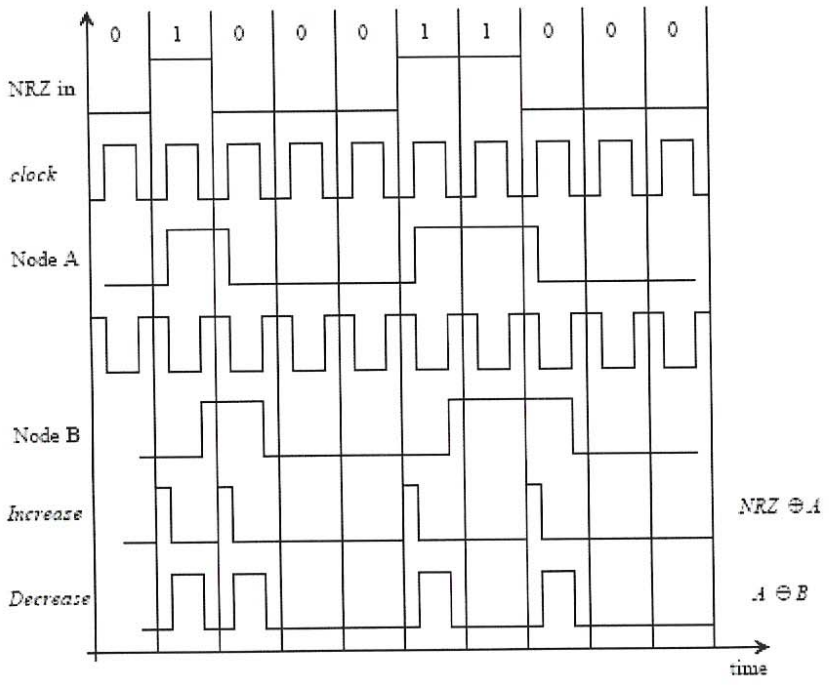



**Figure 19.48** Clock-recovery circuit for NRZ using an edge detector. Note that the DPLL is in lock. when the rising edge of clock is centered on the edge output pulse.




(a)




(b)

**Figure 19.50** (a) Possible loop filter used in a self-correcting (Hogge) DPLL and (b) waveforms when the loop is not in lock and the clock leads the center of the data.

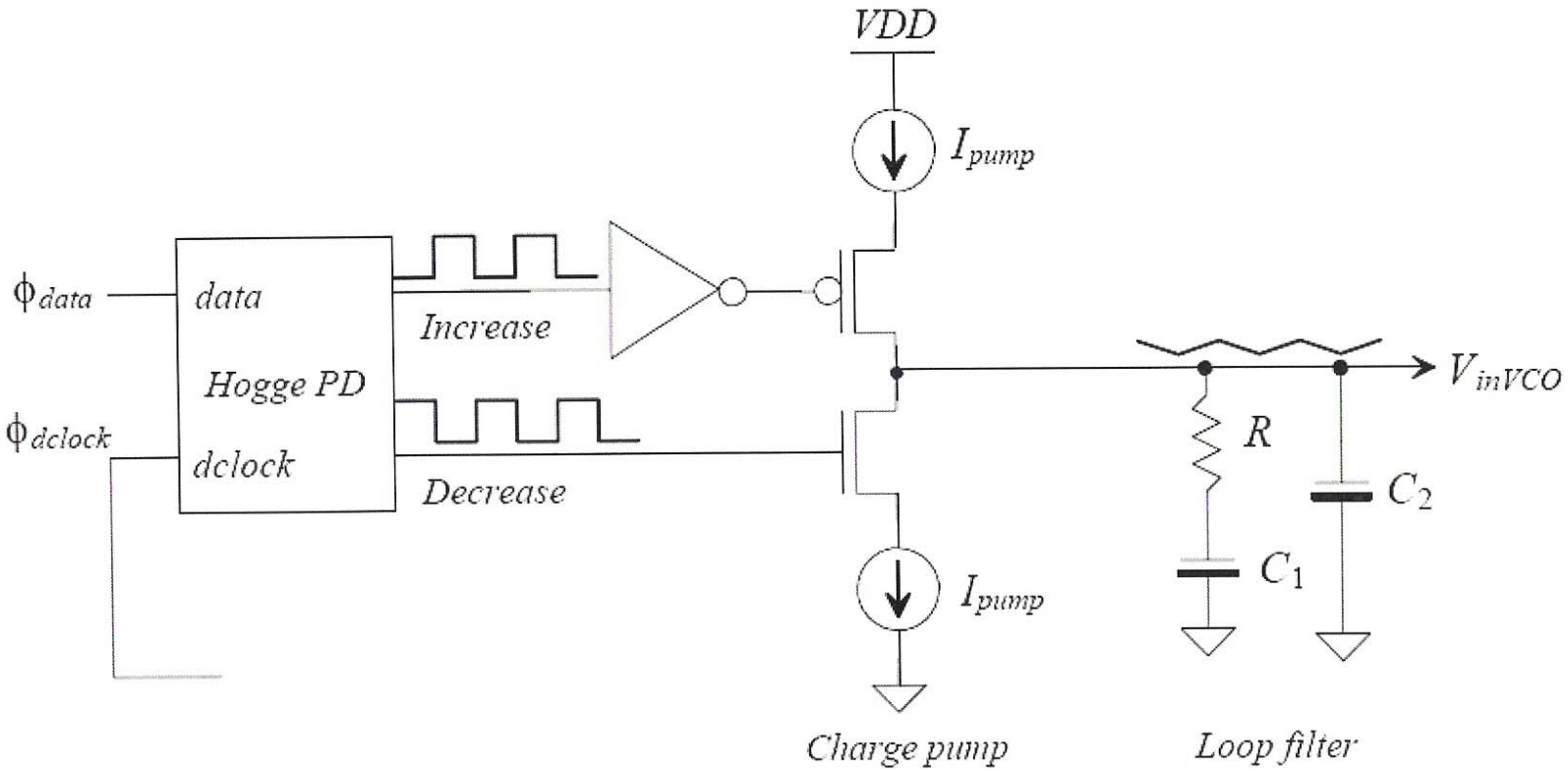



**Figure 19.52** Self-correcting PD with charge pump output.

Hogge phase detector

13)