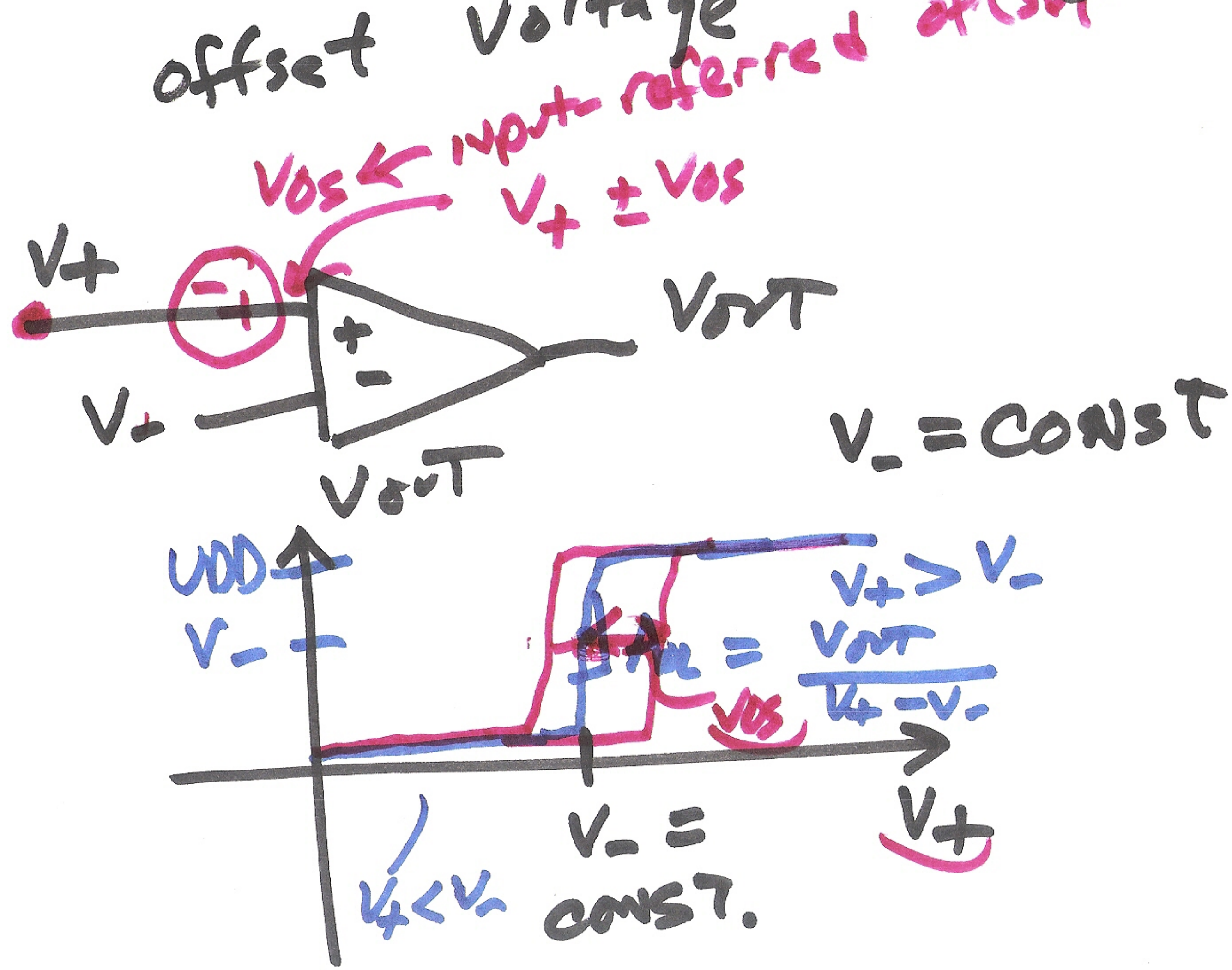
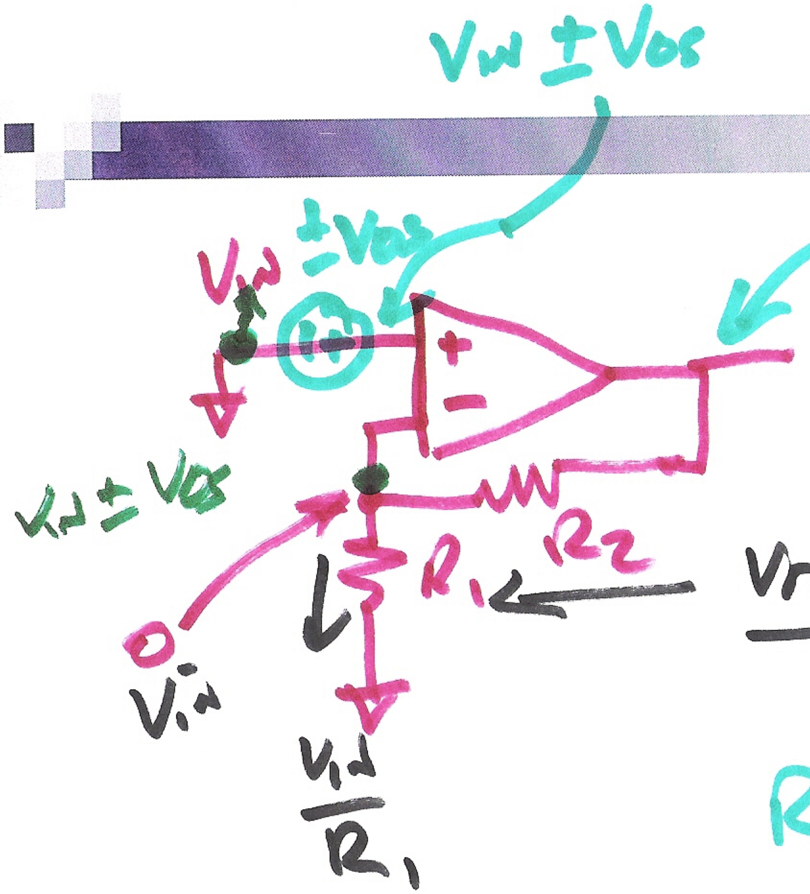
ECE 615 CMOS Mixed-Signal

Lecture 6 September 13, 2010

offset voltage



1)



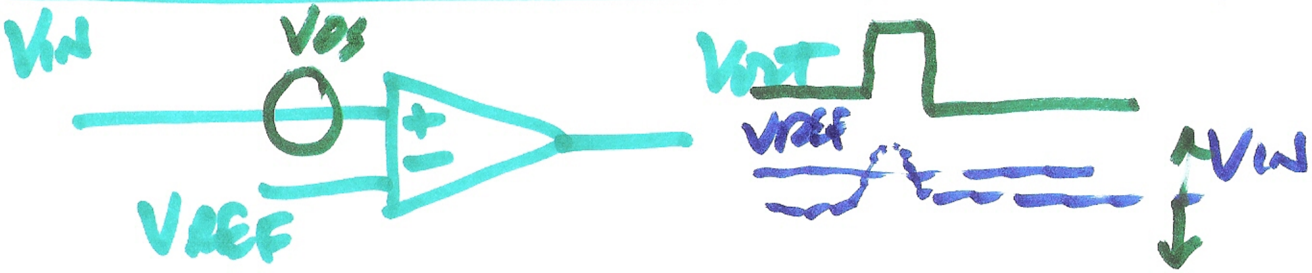
$$A_{CL} = \frac{V_{OUT}}{V_{IN}} = 1 + \frac{R_2}{R_1} = \frac{R_1 + R_2}{R_1}$$

$$\frac{V_{OUT} - V_{IN}}{R_2} = \frac{V_{IN}}{R_1}$$

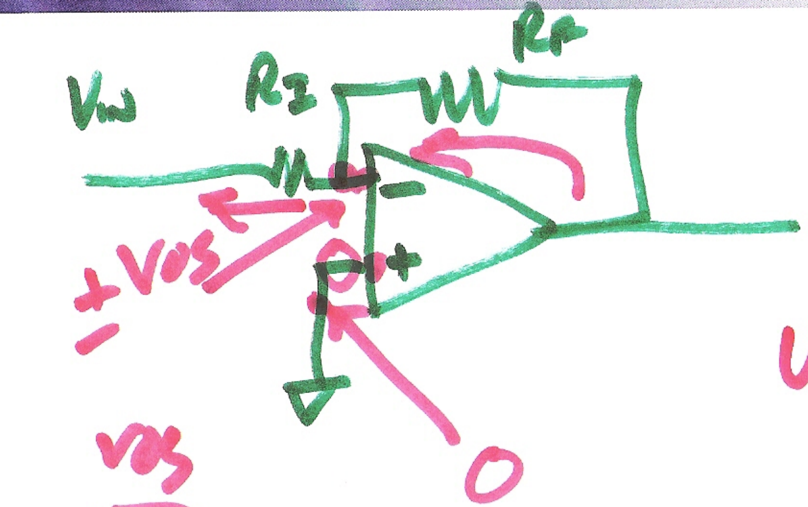
$R_1 = 1K$, $R_2 = 9K$

$$\frac{V_{OUT}}{V_{IN}} = 10$$

What happens if $\pm V_{OS} = \pm 50mV$?



2)



$$V_{OUT} = V_{IN}\left(-\frac{R_F}{R_I}\right)$$

$$V_{OS}\Big|_{V_{IN}=0}$$

$$\frac{\pm V_{OS}}{R_I} = \frac{V_{OUT} \mp V_{OS}}{R_F}$$

$$\pm V_{OS}\left(\frac{1}{R_I} + \frac{1}{R_F}\right) = \frac{V_{OUT}}{R_F}$$

$$\frac{V_{OUT}}{\pm V_{OS}} = 1 + \frac{R_F}{R_I}$$

3)

$CV = Q$

$1/g_m$

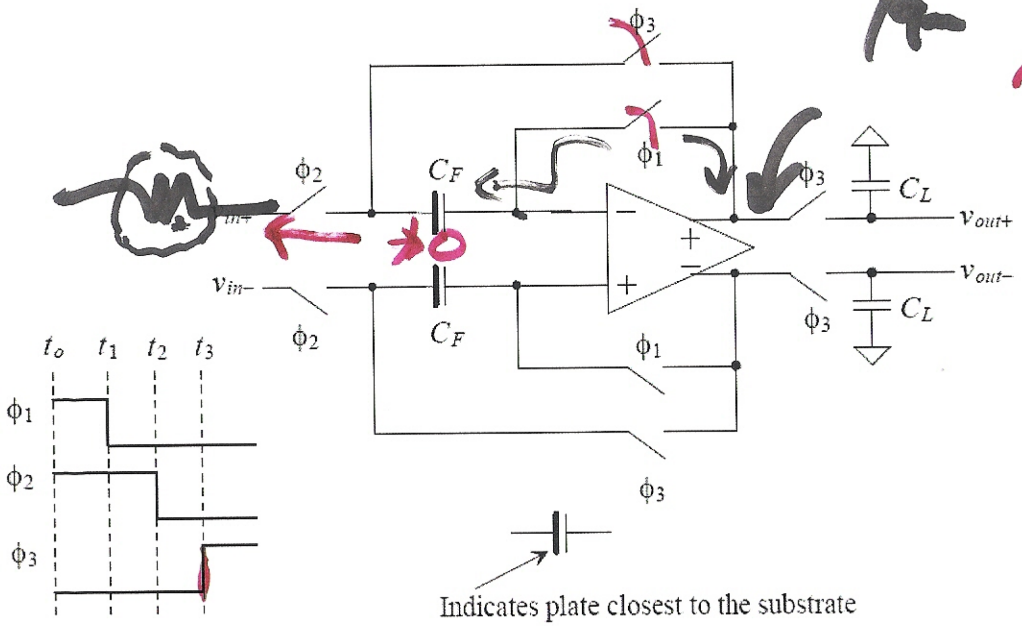
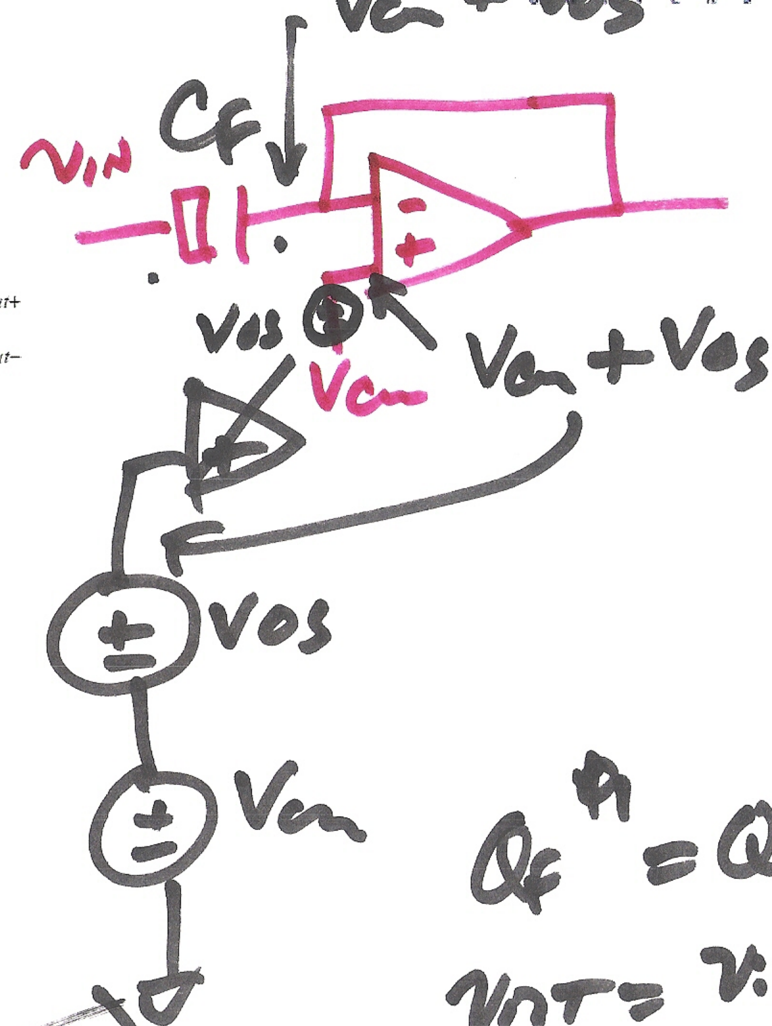


Figure 2.39 Fully-differential S/H differential topology.



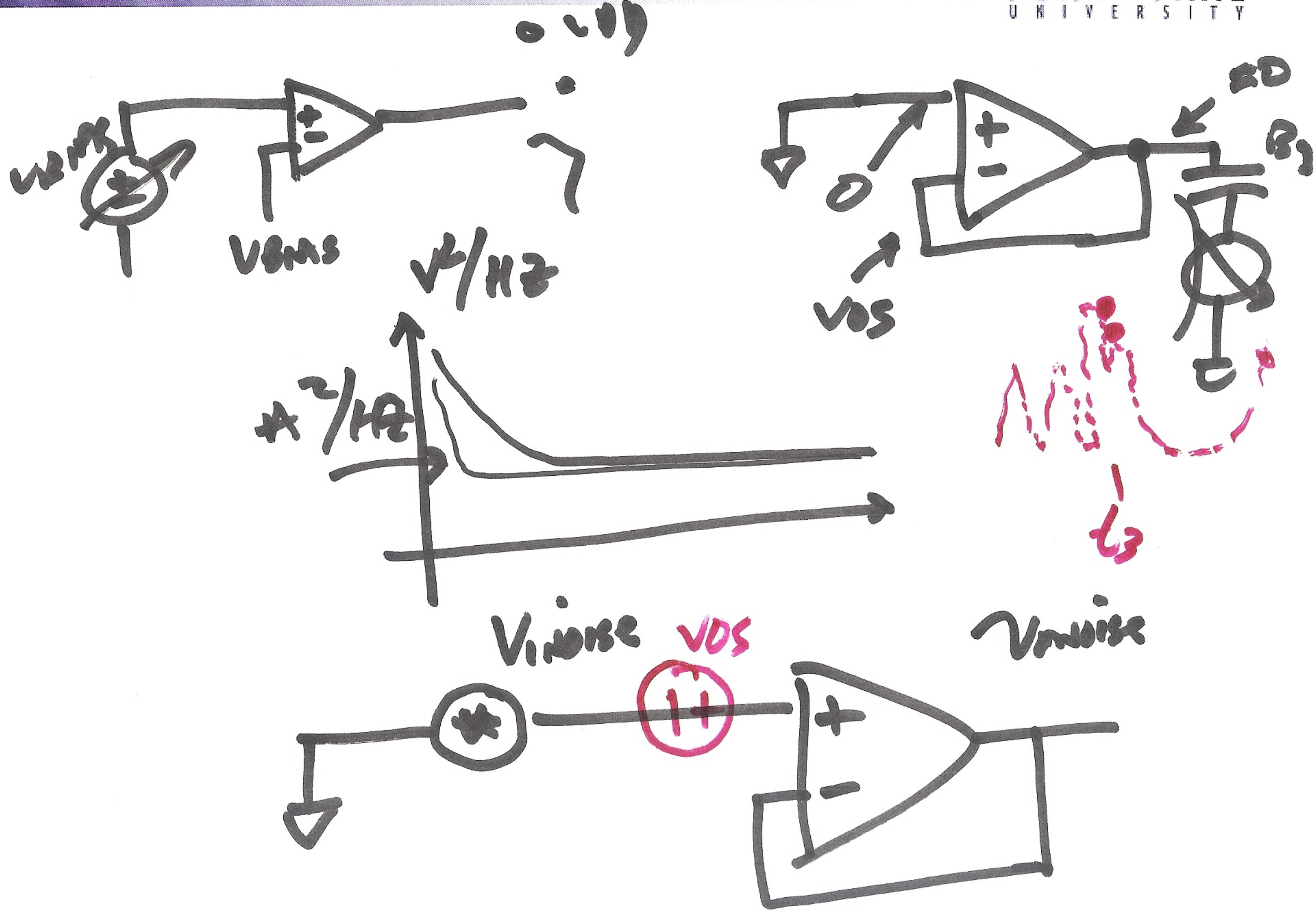
$$Q_F^{\phi_1} = C_F \cdot (v_{IN} - V_{cm} \mp V_{os})$$

$$Q_F^{\phi_3} = C_F (v_{OUT} - V_{cm} \mp V_{os})$$

$$Q_F^{\phi_1} = Q_F^{\phi_3}$$

$$v_{OUT} = v_{in}$$

4)



VBIAS
V²/HZ
A²/HZ
VOS
VINOISE
VOS
VONOISE

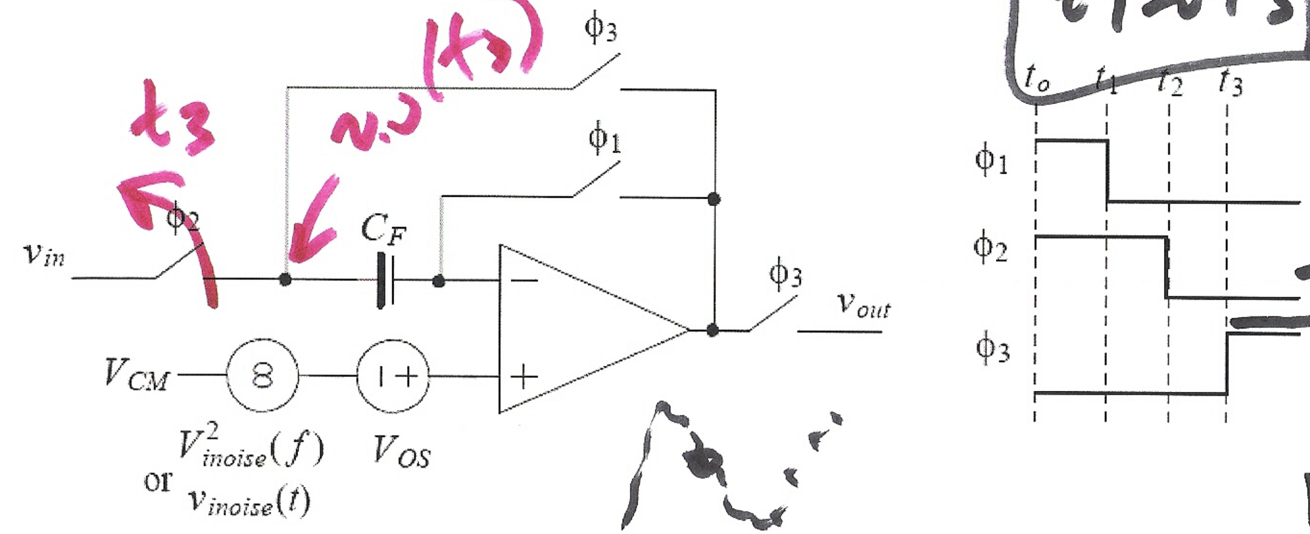


Figure 2.41 S/H with input-referred offset and noise shown.

$t_1 \approx t_3$

$$Q_F^{\phi_1} = C_F \cdot \left(v_{in}(t_3) - V_{cm} - V_{OS} - v_{inoise}(t_3)\right)$$

$$Q_F^{\phi_1} = C_F\left(v_{in}(t_3) - V_{cm} - V_{OS} - v_{inoise}(t_3)\right)$$

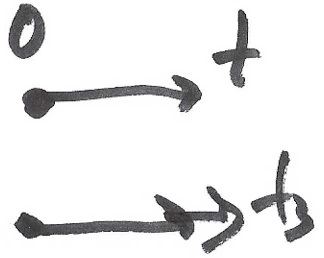
$$\|$$

$$Q_F^{\phi_3} = C_F\left(v_{OUT}(t) - V_{cm} - V_{OS} - v_{noise}(t)\right)$$

$$v_{OUT}(t) = v_{in}(t_3) + v_{noise}(t) - v_{noise}(t_3) \qquad t_3 < t < t_3 + \frac{T_s}{2}$$

b) $V_{onoise}(f) = V_{inoise}(f) + v_{noise}($

$$V_{ONOISE}(t) = V_{INOISE}(t) - V_{INOISE}(t_3)$$



$$V_{ONOISE}(f) = V_{INOISE}(f)\left(e^{j2\pi ft} - e^{j2\pi ft_3}\right)$$

$$= V_{INOISE}(f)\, e^{j2\pi ft_3}\left(e^{j2\pi f(t-t_3)} - 1\right)$$

$$V_{INOISE}(f)\left(e^{-j2\pi ft_3} - e^{-j2\pi f t_3}\right) e^{-j2\pi ft_3}$$

$e^{-j2\pi ft_3}$

$j2\pi f(t+t_3)$

$$V_{INOISE}(f)\left(e^{-j2\pi f(t_3+t)} - e^{-j2\pi f(t_3)}\right)$$

TS/2

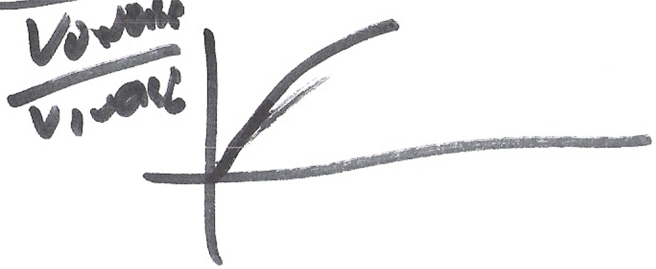
$$V_{INOISE}\, e^{-j2\pi ft_3}\left(e^{-j2\pi ft} - 1\right)$$

7)

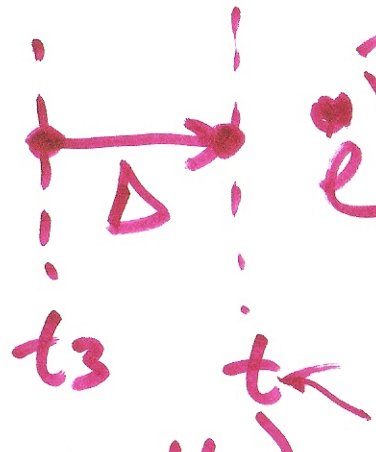
$$V_{onoise}(f) = V_{inoise}(f)\, e^{j2\pi f t_3} \cdot \frac{T_s}{2} \left(e^{j2\pi f (t - t_3)} - 1 \right)$$

$$e^{j2\pi f t_3} \left(\frac{1 - e^{-j2\pi f (t - t_3)}}{e^{-j2\pi (t - t_3)}} \right)$$

$$= 1 - z^{-1}$$



8)



$$e^{-j2\pi f(t-t_3)}, \quad t - t_3 = \Delta$$

$$v_n(t_3)$$

$$v_{noise}(t_3)\, e^{-j2\pi f t_3}$$

$$V_{noise}(f)\, e^{-j2\pi f t_3} \quad (2.73)$$

$$V_{noise}\left(e^{-j2\pi f t} - e^{-j2\pi f t_3}\right)$$

$$V_{noise}\, e^{-j2\pi f t_3}\left(e^{j2\pi f(t_3 - t)} - 1\right)$$

$$t = t_3 + \frac{T_s}{2}$$

CDS