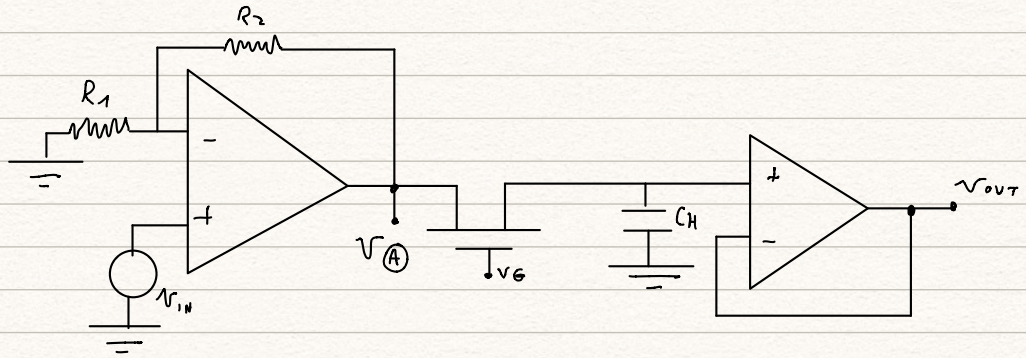
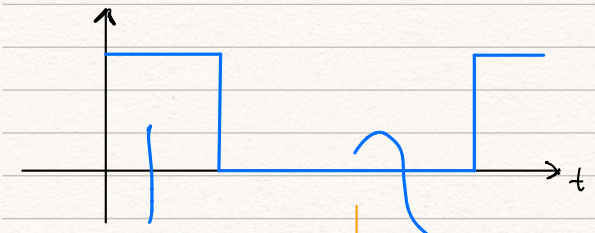
CIRCUITO SAMPLE & HOLD





SAMPLE
MOS chiuso

HOLD
MOS aperto

$V_{GS} > V_{Tn}$
$V_{GD} > V_{Tn}$

$V_G - V_S > V_{Tn}$

$V_G > V_{Tn} + V_S|_{MAX}$

$V_G > V_{Tn} + V_A|_{MAX}$

con 2 volt di margine

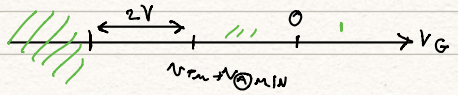
$V_G > V_{Tn} + V_A|_{MAX} + 2V$

$V_{GS} < V_{Tn}$
$V_{GD} < V_{Tn}$

$V_G - V_S < V_{Tn}$
$V_G < V_{Tn} + V_S|_{MIN}$

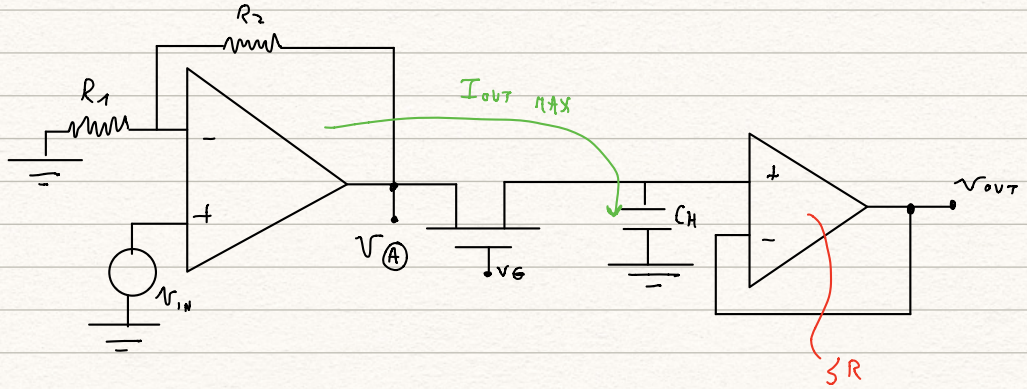
$V_G < V_{Tn} + V_A|_{MIN}$

con due volt di margine

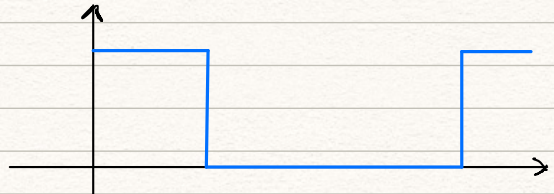


$V_G < V_{Tn} + V_A|_{MIN} - 2V$

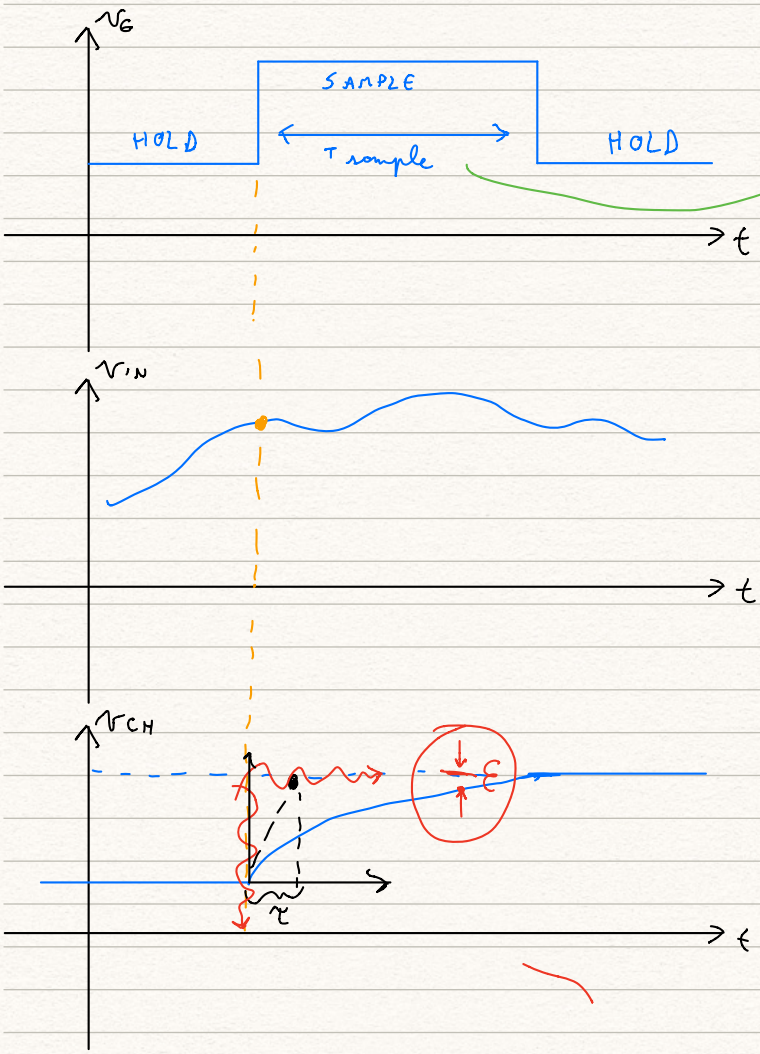
MINIMA DURATA TEMPO DI SAMPLE

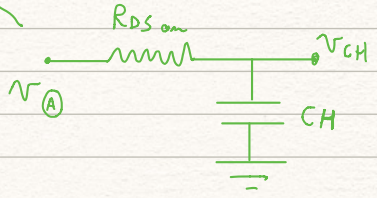


"Slew rate"



(A) Senza limitazioni introdotte dagli OPAMP





$$R_{DS_{on}} \triangleq \left.\frac{\partial V_{DS}}{\partial I_D}\right|_{V_{DS}=0} = \frac{1}{2K_n (V_{GS}-V_{Tn})} =$$

$$= \frac{1}{2\left(\frac{1}{2}\mu_n C_{ox}\frac{W}{L}\right)\left[V_G - V_A - V_{Tn}\right]}$$

$$v_{CH}(t) = \Delta V - \Delta V \exp(-t/\tau)$$

$$v^*(t) = \Delta V \exp(-t/\tau)$$

T_{SAMPLE} minimo deve essere tale che

$$v^*(T_{sample\,min}) = \varepsilon$$

$$\Delta V \exp\left(-\frac{T_{sample\,min}}{\tau}\right) = \varepsilon$$

$$\exp\left(-\frac{T_{SAMPLE\,min}}{\tau}\right) = \frac{\varepsilon}{\Delta V}$$

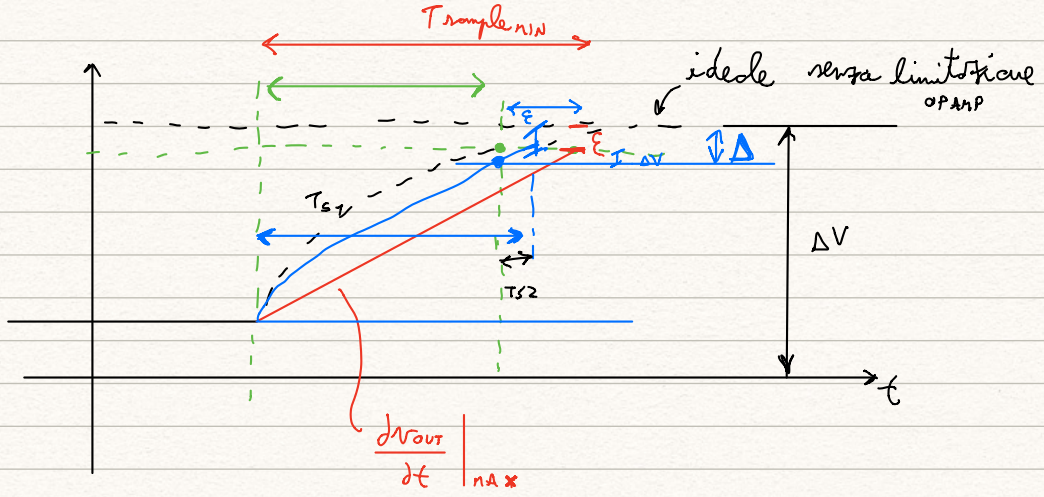
$$-\frac{T_{sample\,min}}{\tau} = \ln\frac{\varepsilon}{\Delta V}$$

$$T_{sample\,min} = \tau \ln\frac{\Delta V}{\varepsilon}$$

(b) Considerando le limitazioni introdotte dagli OPAMP (corrente di uscita del primo opamp limitata, SR finito del secondo OPAMP)

$$\left.\frac{\partial V_{CH}}{\partial t}\right|_{MAX} = \frac{I_{OUT\,MAX}}{C}$$

$$\left.\frac{\partial V_{OUT}}{\partial t}\right|_{MAX} = SR$$



$T_{S_{MIN}}$ = T_{S1} pendenza è limitata (ad esempio) da SR ⊕ T_{S2} la pendenza non è più limitata

T_{S1} :

$$\frac{\Delta V - \Delta}{T_{S1}} = SR$$

$$T_{S1} = \frac{\Delta V - \Delta}{SR} = \frac{\Delta V - SR\tau}{SR}$$

$$\frac{\Delta}{\tau} = SR \longrightarrow \Delta = SR\tau$$

T_{S2} :

$$\Delta \exp\left(-t/\tau\right) = \varepsilon$$

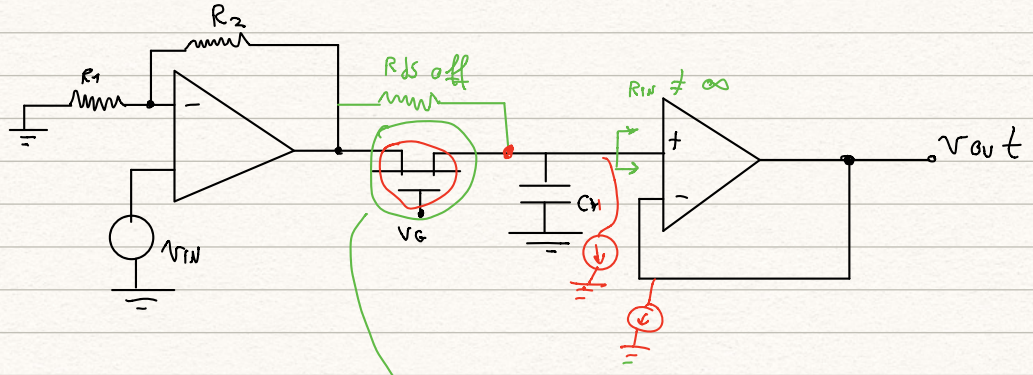
$$\exp\left(-\frac{T_{S2}}{\tau}\right) = \frac{\varepsilon}{\Delta}$$

$$\ln \frac{\varepsilon}{\Delta} = -\frac{T_{S2}}{\tau}$$

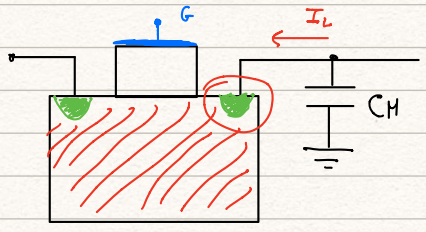
$$T_{S2} = \tau \ln \frac{\Delta}{\varepsilon}$$

$$T_S = T_{S1} + T_{S2} = \frac{\Delta V - SR\tau}{SR} + \tau \ln \frac{SR\tau}{\varepsilon}$$

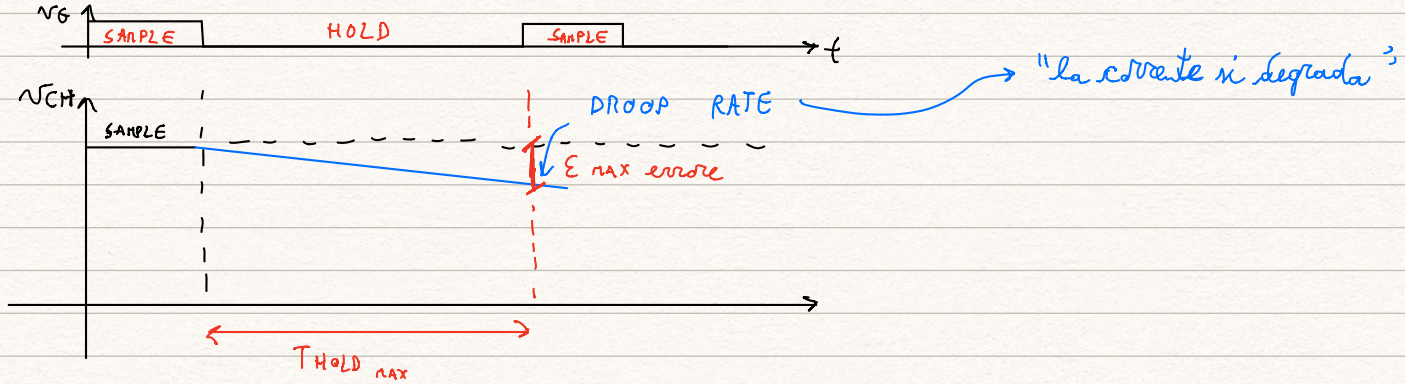
MASSIMA DURATA TEMPO DI HOLD



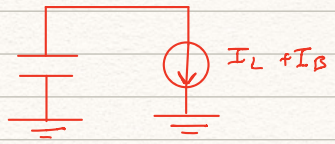
limitazione deriva dal fatto che la capacità si scarichi



- resistenza ingresso buffer non infinita
- resistenza di offset dell'interruttore non nulla è infinita
- opamp buffer correnti di bias
- MOS presenta correnti di perdita delle giunzioni



- effetto delle correnti

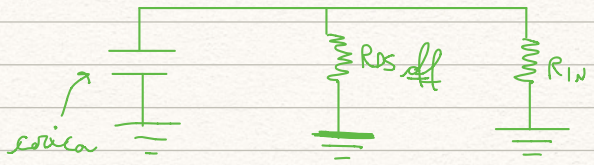


$$\frac{\Delta V_{CH}}{\Delta t} = \frac{I_L + I_B}{C_H}$$

$$T_{HOLD\ MAX} \cdot \frac{I_L + I_B}{C_H} = \varepsilon$$

$$T_{HOLD\ MAX} \leq \frac{\varepsilon\ C_H}{I_L + I_B}$$

EFFETTO DELLA SCARICA RESISTIVA



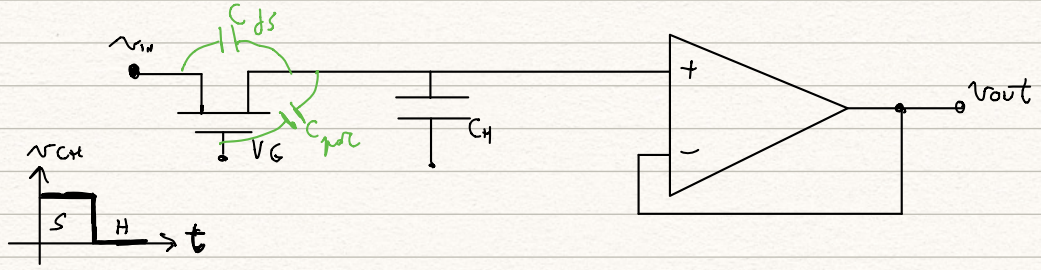
$$\tau = C_H \left(R_{DS\ off} // R_{in}\right)$$

APPROX. LINEARE

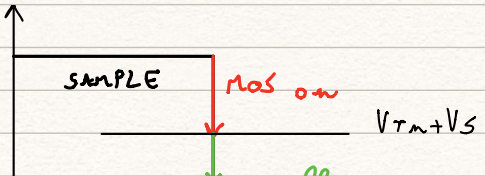
$$\frac{\Delta V}{\tau} \cdot T_{HOLD\ MAX} = \varepsilon$$

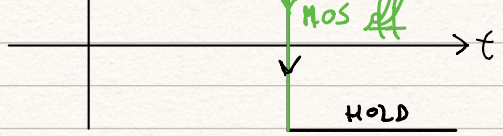
$$T_{HOLD\ MAX} = \frac{\varepsilon \tau}{\Delta V}$$

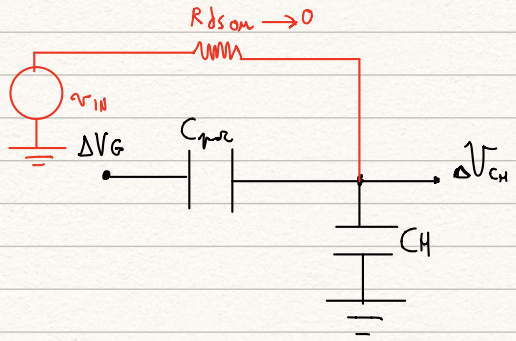
PROBLEMI DI INIEZIONE DI CARICA



- effetto di C_{gd}







$$\Delta V_{CH} = \frac{C_{gsr}}{C_{gsr} + C_H} \Delta V_G$$

C_{gsr}: minimizzo

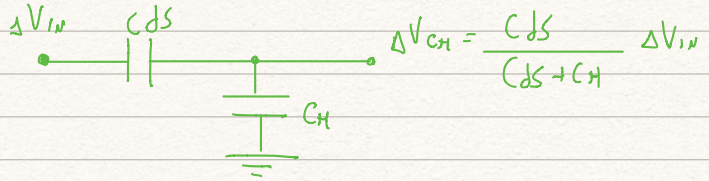
C_H: massimizzo

spegnimento del nos

$V_{GS} = V_{Tn}$

$V_G = V_{Tn} + V_S$

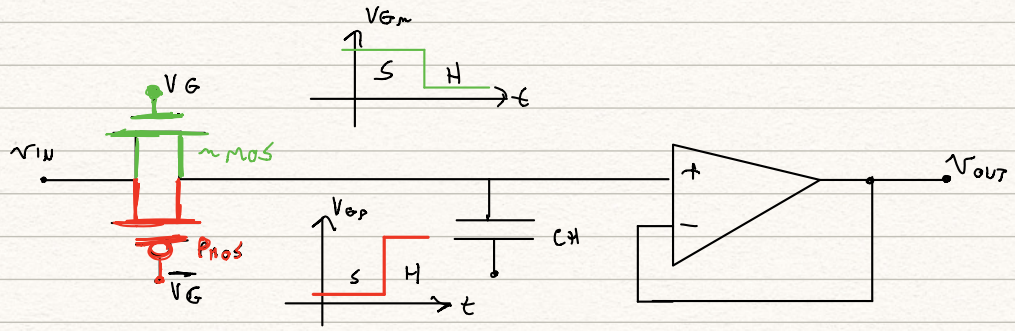
- effetto di C_{DS}



1. $C_{DS} \ll C_{gsr}$
2. $\Delta V_{IN} \ll \Delta V_C$

} NORMALMENTE TRASCURABILE

CONFIGURAZIONE DI CIRCUITO DI S&H a 2 MOS



FASE DI SAMPLE TRANSISTORI OHMICI

① $V_{GSn} > V_{Tn}$ $\quad V_{Tn} > 0$

② $V_{GSp} < V_{Tp}$ $\quad V_{Tp} < 0$

① $V_{G_n} - V_S > V_{T_n}$ $\quad V_{G_n} > V_{T_n} + V_{S\,MAX}$

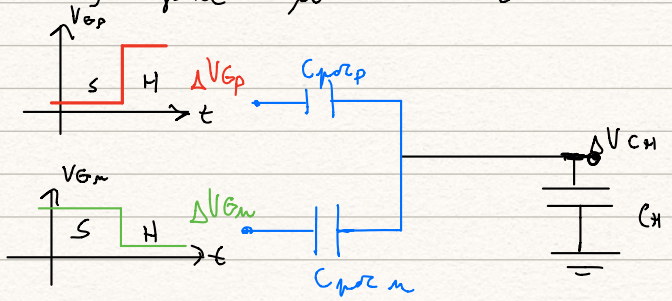
② $V_{G_p} - V_S < V_{T_p}$ $\quad V_{GP} < V_{T_p} + V_{S\,MIN}$

FASE DI HOLD $\quad$ transistor off

nMOS ① $\quad V_{GS_n} < V_{T_n}$ $\quad V_{G_n} < V_{T_n} + V_{S\,MIN}$

pMOS ② $\quad V_{GSp} > V_{Tp}$ $\quad V_{GP} > V_{Tp} + V_{S\,MAX}$

iniezione di carica



$C_{par\,n} = C_{par\,p}$

$|\Delta V_{GP}| = |\Delta V_{GN}|$

$\downarrow$

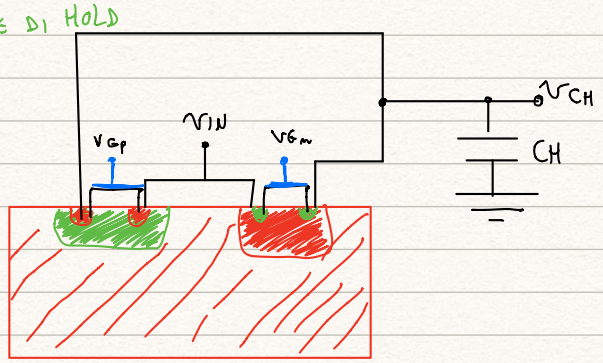
$\Delta V_{CH} = 0$

$$\Delta V_{CH} = \Delta V_{GN} \frac{C_{par\,n}}{C_{par\,n} + C_H + C_{par\,p}} + \Delta V_{GP} \frac{C_{par\,p}}{C_{par\,p} + C_H + C_{par\,n}}$$

☺ FASE DI SAMPLE $\quad R_{ds\,on}$ è il parallelo della $R_{ds\,on_p}$ e $R_{ds\,on_n}$

☹ FASE DI HOLD $\quad R_{ds\,off} = R_{ds\,off_p}$ // $R_{ds\,off_n}$ più piccola!

☺ FASE DI HOLD



le I_L si compensano