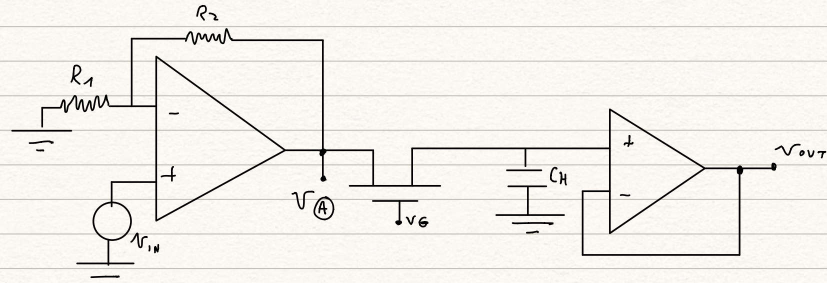
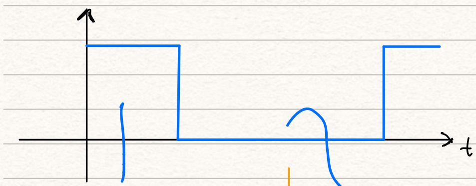
CIRCUITO SAMPLE & HOLD





SAMPLE
MOS dinamico

HOLD
MOS spento

SAMPLE

$V_{GS} > V_{Tn}$

$V_{GD} > V_{Tn}$

$V_G - V_S > V_{Tn}$

$V_G > V_{Tn} + V_{S_{MAX}}$

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

con 2 volt di margine

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

HOLD

$V_{GS} < V_{Tn}$

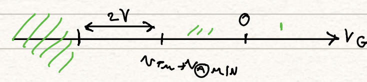
$V_{GD} < V_{Tn}$

$V_G - V_S < V_{Tn}$

$V_G < V_{Tn} + V_{S_{MIN}}$

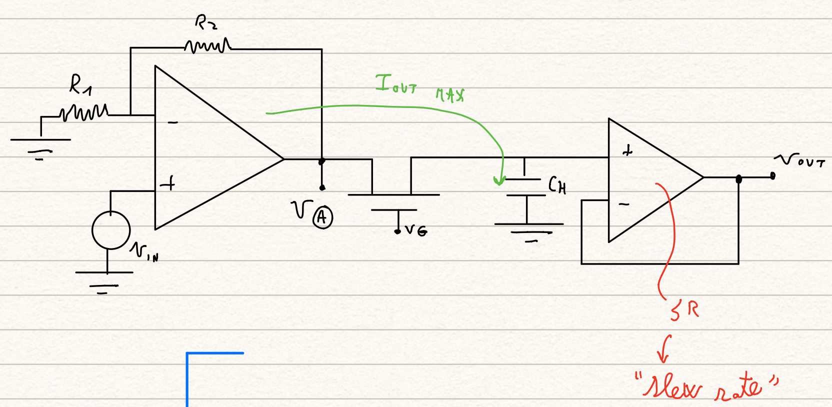
$V_G < V_{Tn} + V_A\big|_{MIN}$

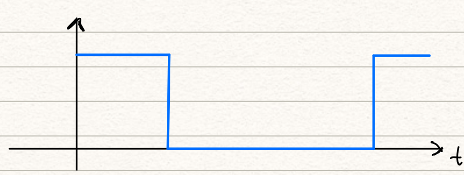
con due volt di margine



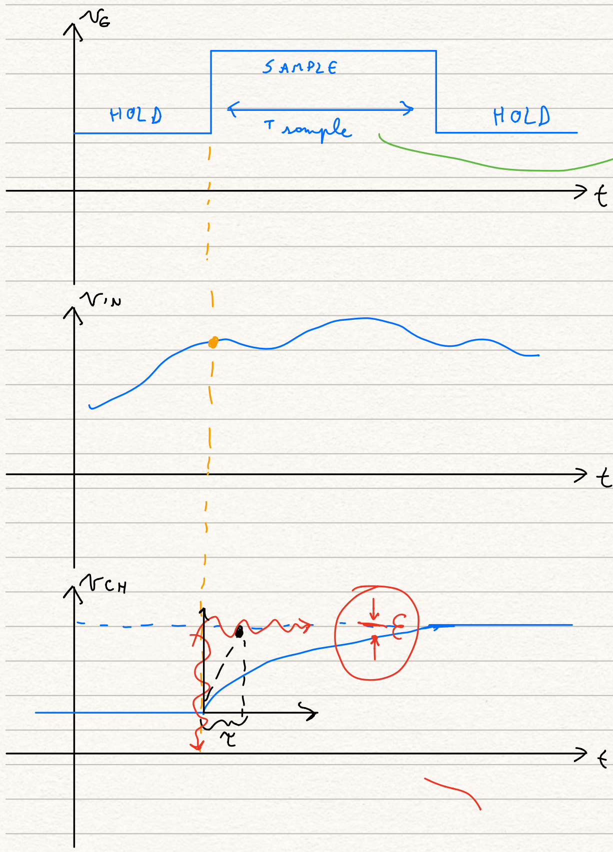
$V_G < V_{Tn} + V_A\big|_{MIN} - 2V$

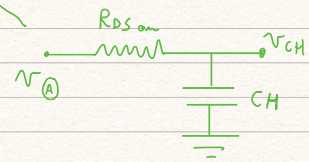
MINIMA DURATA TEMPO DI SAMPLE





Ⓐ Senza limitazioni introdotte dagli OPAMP





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

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

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

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

T_{SAMPLE} minimo deve essere tale che

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

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

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

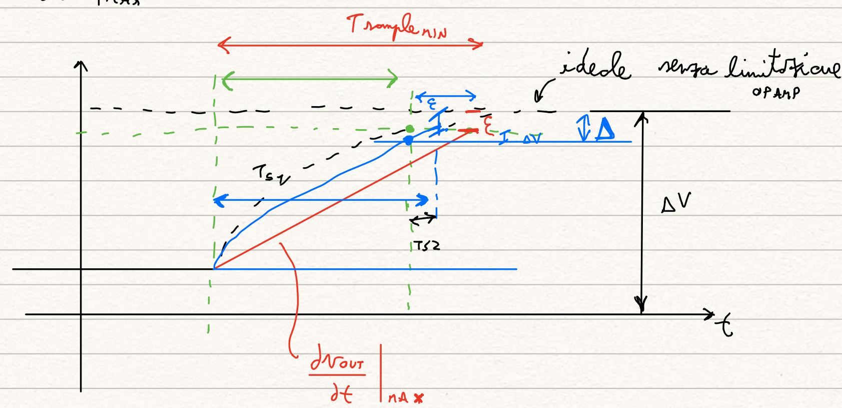
$$-\frac{T_{sample\ min}}{\tau} = \ln\frac{\varepsilon}{\Delta V}$$

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

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

$$\left.\frac{dV_{CH}}{dt}\right|_{MAX} = \frac{I_{OUT\,MAX}}{C}$$

$$\left.\frac{dV_{OUT}}{dt}\right|_{MAX} = SR$$



$T_{S\,MIN}$ $\begin{cases} T_{S1} \text{ pendenza è limitata (ad esempio) da SR} \\ + \\ T_{S2} \text{ la pendenza non è più limitata} \end{cases}$

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} : $\Delta \exp(-t/\tau) = \varepsilon$

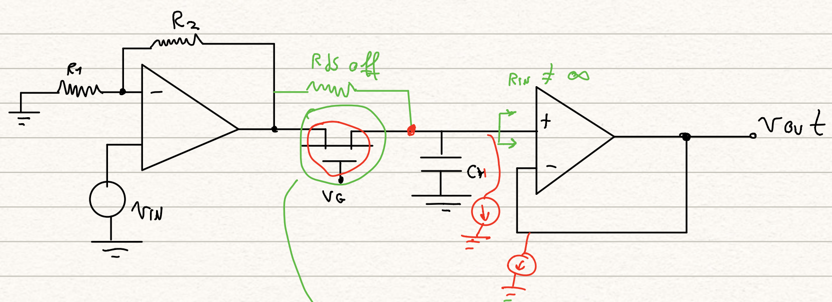
$$\exp\left(-\frac{T_{S2}}{\tau}\right) = \frac{\varepsilon}{\Delta}$$

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

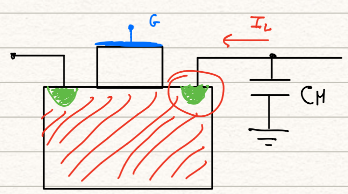
$$T_{S2} = \tau \ln \frac{\Delta}{\varepsilon}$$

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

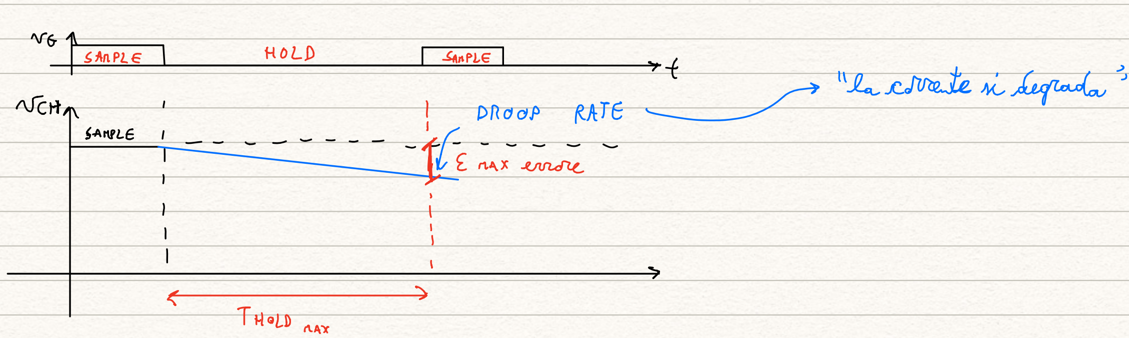
MASSIMA DURATA TEMPO DI HOLD



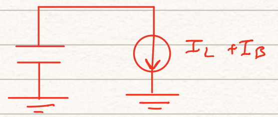
limitazione deriva dal fatto che la capacità si scarichi



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



- *effetto delle correnti*

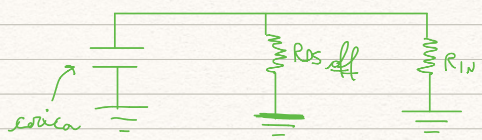


$$\frac{dv_{CH}}{dt} = \frac{I_L + I_B}{C_H}$$

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

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

EFFETTO DELLA SCARICA RESISTIVA



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

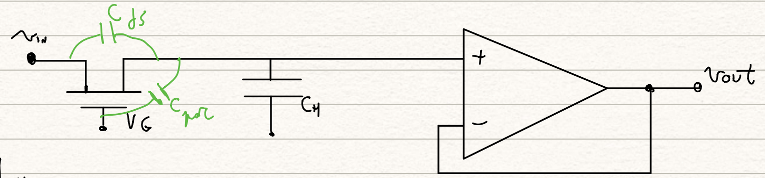
APPROX. LINEARE

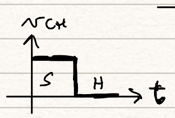
$$\frac{\Delta V}{\tau} \cdot T_{HOLD\,max} = \varepsilon$$

$$\downarrow$$

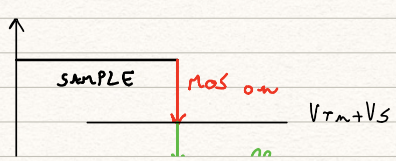
$$T_{HOLD\,max} = \frac{\varepsilon \tau}{\Delta V}$$

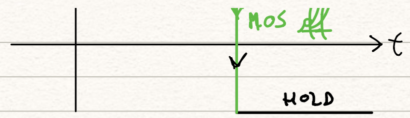
PROBLEMI DI INIEZIONE DI CARICA

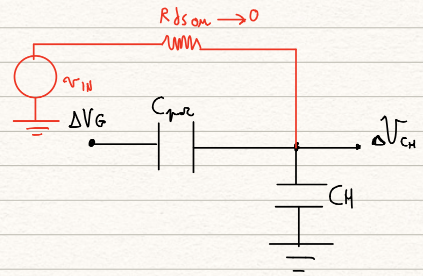




- *effetto di C_{par}*







minimizzo Cpar

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

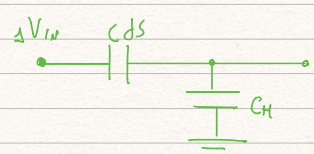
massimizzo CH

spegnimento del mos

$V_{GS} = V_{Tn}$

$V_G = V_{Tn} + V_S$

- effetto di Cds

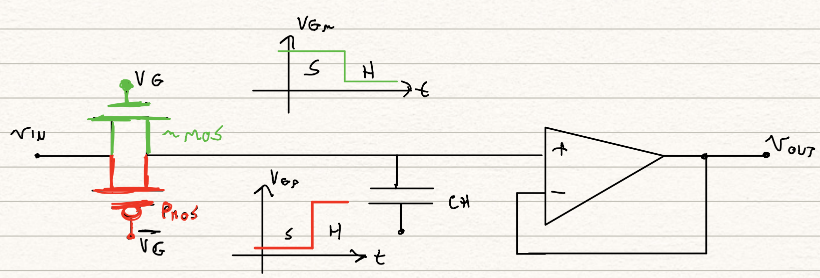


$$\Delta V_{CH} = \frac{C_{ds}}{C_{ds} + C_H} \Delta V_{IN}$$

1. $C_{ds} \ll C_{par}$
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 $V_{GS_n} > V_{Tn}$ $\quad V_{Tn} > 0$

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

① $V_{Gn} - V_S > V_{Tn}$ $\quad$ $V_{Gn} > V_{Tn} + V_{S\,max}$

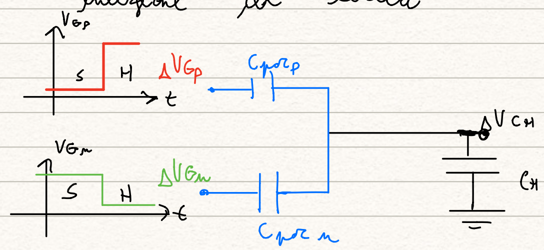
② $V_{Gp} - V_S < V_{Tp}$ $\quad$ $V_{Gp} < V_{Tp} + V_{S\,MIN}$

FASE DI HOLD $\qquad$ transistor off

nmos ① $\quad V_{GSn} < V_{Tn}$ $\quad$ $V_{Gn} < V_{Tn} + V_{S\,MIN}$

pmos ② $\quad V_{GSp} > V_{Tp}$ $\quad$ $V_{Gp} > V_{Tp} + V_{S\,MAX}$

iniezione di carica



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

$|\Delta V_{Gp}| = |\Delta V_{Gn}|$

$\downarrow$

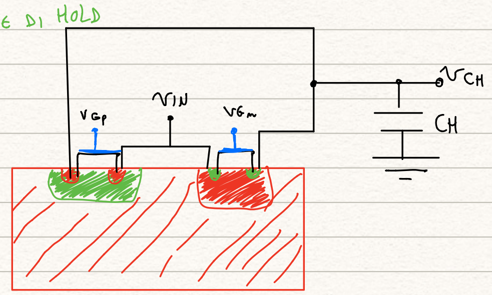
$\Delta V_{CH} = 0$

$$\Delta V_{CH} = \Delta V_{Gn} \frac{C_{por\,n}}{C_{por\,n} + C_H + C_{por\,p}} + \Delta V_{Gp} \frac{C_{por\,p}}{C_{por\,p} + C_H + C_{por\,n}}$$

☺ FASE DI SAMPLE $\qquad$ $R_{ds\,on}$ è il parallelo della $R_{ds\,on\,p}$ e $R_{ds\,on\,n}$

☹ FASE DI HOLD $\qquad$ $R_{ds\,off} = R_{ds\,off\,p} \,//\, R_{ds\,off\,n}$ più piccola!

☺ FASE DI HOLD



le I_L si compensano