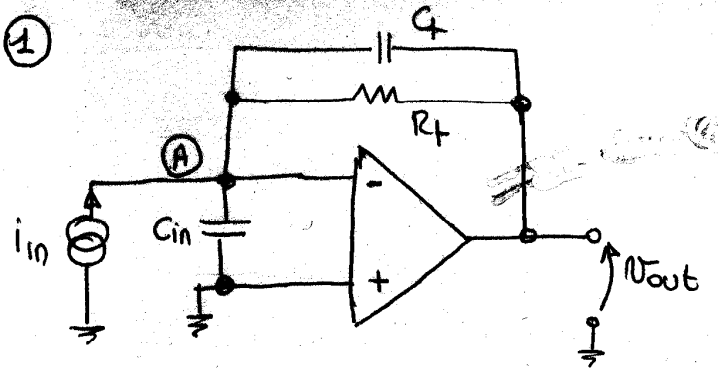
①



LA RETROAZIONE FA SÌ CHE (A) SIA UN NODO DI TERRA VIRTUALE

⇓

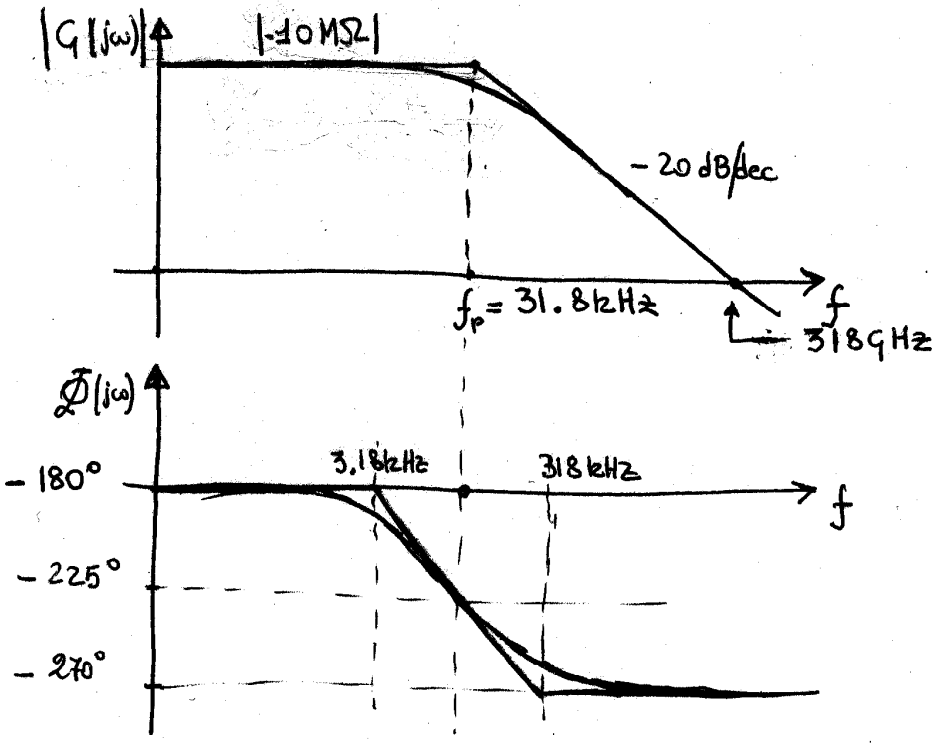
NEL CASO DI OPAMP IDEALE TUTTA LA CORRENTE i_{in} FLUISCE ATTRAVERSO IL PARALLELO DI R_f E C_f

⇓

$$G(s) = \left.\frac{V_{out}}{i_{in}}\right|_{ideale} = -Z_f = -\frac{R_f}{1+sC_fR_f} = -10M\Omega\,\frac{1}{1+s\tau_p}$$

$$\tau_p = 5\,\mu s$$

② DIAGRAMMA DI BODE DEL GUADAGNO IDEALE



(3) (4) (5)

$$A(s) = \frac{A_0}{1 + s\tau_0}$$

ε = ERRORE DI GUADAGNO IN CONTINUA $= \left| \frac{G_{id} - G_{reale}}{G_{reale}} \right| = \left| \frac{G_{id} - \frac{G_{id}}{1 - 1/G_{loop}}}{\frac{G_{id}}{1 - 1/G_{loop}}} \right| =$

$$= \left| 1 - 1/G_{loop}(0) - 1 \right| = \left| \frac{1}{G_{loop}(0)} \right|$$

CALCOLO $G_{loop}(0)$: C_{in} E C_f SONO CIRCUITI APERTI

$$G_{loop}(0) = -A_0$$

⇓

AFFINCHÈ $\varepsilon \leq 1\% \Rightarrow \left| \frac{1}{G_{loop}(0)} \right| \leq 1\% \Rightarrow A_0 \geq 100$

CALCOLIAMO LA POSIZIONE DEL POLO τ_p:

$$GBWP = f_0 A_0 \Rightarrow f_0 = \frac{GBWP}{A_0} = \frac{400\,MHz}{100} = 4\,MHz$$

$$\hookrightarrow \tau_0 = \frac{1}{2\pi f_0} \cong 40\,ns$$

⇓

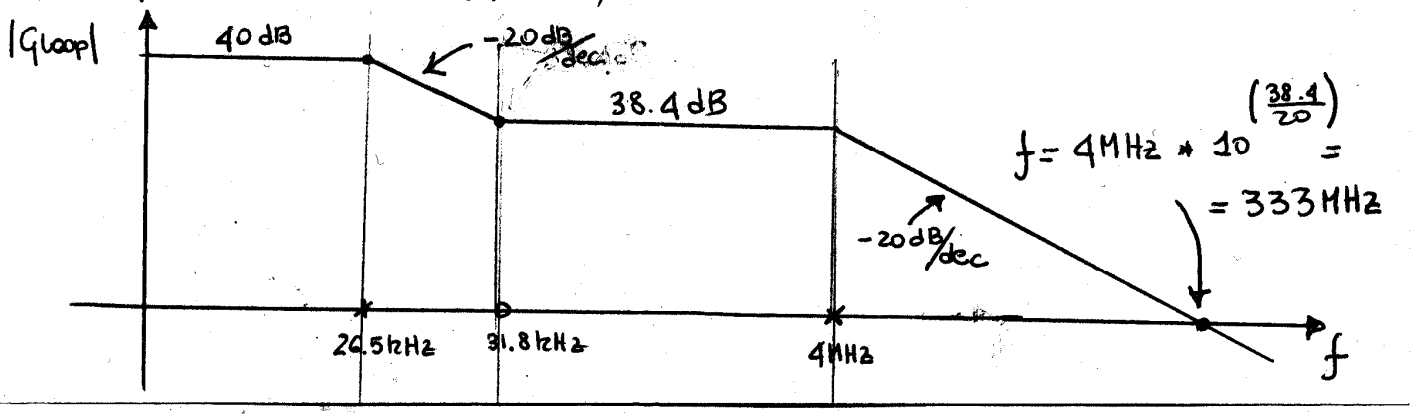
$$G_{id}(s) = -\frac{R_f}{1 + s\tau_p} \quad ; \quad G_{loop}(s) = -\frac{A_0}{1 + s\tau_0} \cdot \frac{\frac{1}{sC_{in}}}{\frac{1}{sC_{in}} + \frac{R_f}{1 + sC_f R_f}} =$$

⇓

$$G_{rendata}(s) = -G_{id} \cdot G_{loop} = = -\frac{A_0}{1 + s\tau_0} \cdot \frac{1 + s\tau_p}{1 + s(\tau_p + C_{in}R_f)} \cdot$$

$$= -\frac{R_f}{1 + s\tau_p} \cdot \frac{A_0}{1 + s\tau_0} \cdot \frac{1 + s\tau_p}{1 + s(\tau_p + C_{in}R_f)}$$

$(\tau_p + C_{in}R_f) = 6\,\mu s \Rightarrow 26.5\,kHz$

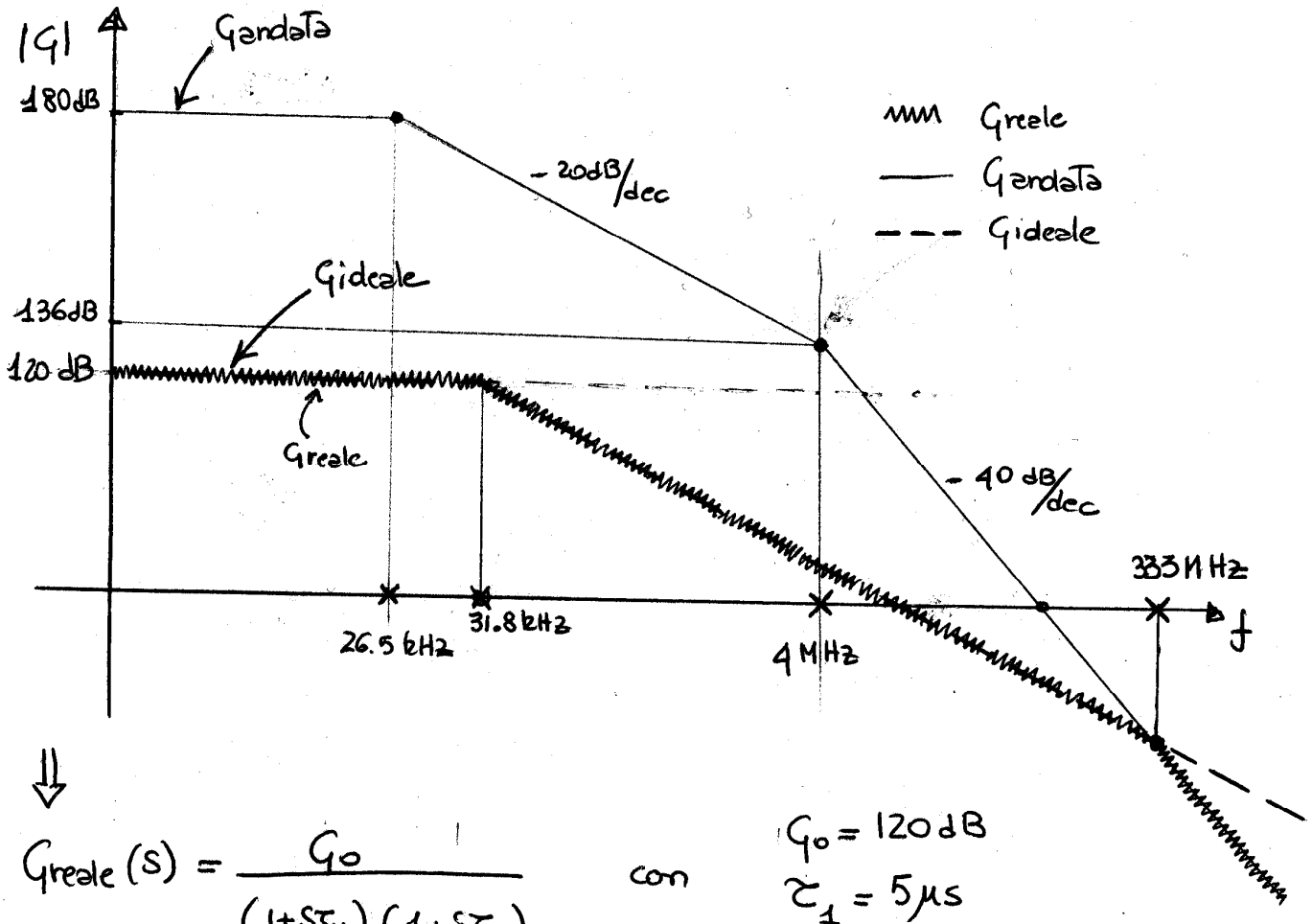


IL CIRCUITO È STABILE POICHÈ G_{loop} TAGLIA L'ASSE 0 dB CON PENDENZA $-20\ dB/dec$

⬇

MARGINE DI FASE $\varphi_M \simeq 90°$ POICHÈ TAGLIO L'ASSE (ZERO dB) PIÙ DI UNA DECADE DOPO L'ULTIMO POLO.

$$\varphi_M = \left[-180° - arTg\left(\frac{333\,MHz}{26.5\,MHz}\right) + arTg\left(\frac{333\,MHz}{31.8\,MHz}\right) - arTg\left(\frac{333\,MHz}{4\,MHz}\right)\right] - (-360°)$$



⇓

$$G_{reale}(s) = \frac{G_0}{(1+s\tau_1)(1+s\tau_2)} \quad \text{con} \quad \begin{aligned} G_0 &= 120\,dB \\ \tau_1 &= 5\,\mu s \\ \tau_2 &\cong 0.5\,ms \end{aligned}$$