Unidades

$q := 1.6 \cdot 10^{-9}\ C$

Dados

$I_B := 150\ \mu A$ $\qquad I_1 := 1\ mA$

$C_L := 10\ pF$

$V_{DD} := 10\ V$

$V_{Dsat1} := 100\ mV$

Definições da Tecnologia

$V_{TN} := 0.38\ V$ $\qquad K_N := 500\ \dfrac{\mu A}{V^2}$ $\qquad K_B := 1.38 \cdot 10^{-23} \cdot \dfrac{J}{K}$

$V_{TP} := 0.33\ V$ $\qquad K_P := 100\ \dfrac{\mu A}{V^2}$

$K_B \cdot \dfrac{(300 \cdot K)}{q} = 0.026\ \dfrac{kg \cdot m}{s^3 \cdot A}$

$\mu_N := 670\ \dfrac{cm^2}{V \cdot s}$ $\qquad \mu_P := 250\ \dfrac{cm^2}{V \cdot s}$ $\qquad$ (Manual BSIM3v3)

$(tox: Cadence\ measurements)$

$\varepsilon_{ox} := 3.9 \cdot 8.854 \cdot 10^{-14}\ \dfrac{F}{cm}$ $\qquad t_{ox\_N} := 2.73 \cdot 10^{-16}\ cm$ $\qquad t_{ox\_P} := 2.86 \cdot 10^{-16}\ cm$ $\qquad C_{ox\_N} := \dfrac{\varepsilon_{ox}}{t_{ox\_N}}$ $\qquad C_{ox\_P} := \dfrac{\varepsilon_{ox}}{t_{ox\_P}}$

$K_1 := -0.8$ $\qquad K_2 := 0.916666$ $\qquad K_3 := \dfrac{-0.594611}{C_{ox\_N}}$ $\qquad K_4 := \dfrac{0.039177}{C_{ox\_P}}$

Características dos Transístores

$$g_m\left(I_D, V_{Dsat}\right) := \text{if}\left(V_{Dsat} < K_B \cdot \frac{(300 \cdot K)}{q} \cdot 2, \frac{I_D}{\left(K_B \cdot \frac{(300 \cdot K)}{q}\right)}, 2 \cdot \frac{I_D}{V_{Dsat}}\right)$$

$$W\_L_N\left(I_D, V_{Dsat}\right) := \frac{\left(2 \cdot I_D\right)}{K_N \cdot V_{Dsat}^{2}} \qquad W\_L_P\left(I_D, V_{Dsat}\right) := \frac{\left(2 \cdot I_D\right)}{K_P \cdot V_{Dsat}^{2}}$$

$$WN\left(I_D, V_{Dsat}, L\right) := \frac{\left(2 \cdot L \cdot I_D\right)}{K_N \cdot V_{Dsat}^{2}} \qquad WP\left(I_D, V_{Dsat}, L\right) := \frac{\left(2 \cdot L \cdot I_D\right)}{K_P \cdot V_{Dsat}^{2}}$$

Características do Circuito

$$I_{CTAT1} = \frac{V_{CTAT1}}{R_1}$$

$$I_{CTAT2} = \frac{V_{CTAT2}}{R_2}$$

Currents Subctraction

$$V_{REF}(T) = \frac{R_3}{R_1} \cdot \left(V_{CTAT1}(T) - \frac{R_1}{R_2} \cdot V_{CTAT2}(T)\right)$$

$$\frac{\frac{\mathrm{d}}{\mathrm{d}T} V_{CTAT1}}{\frac{\mathrm{d}}{\mathrm{d}T} V_{CTAT2}} = \frac{R_1}{R_2}$$

Achieve Temperature Independence

Начальные приближения

$W\_L_1 := 1$
$R_1 := 1$

Ограничения

$$V_{CTAT1}\left(W\_L_1, R_1\right) = V_{TN} + \frac{1+\sqrt{1+2 \cdot R_1 \cdot V_{TN} \cdot K_N \cdot W\_L_1}}{K_N \cdot W\_L_1 \cdot R_1}$$

$$\frac{d}{dT}\, V_{CTAT1}\left(W\_L_1, R_1\right) = V_{TN}\left(\frac{K_1}{V_{TN}} + \frac{\frac{K_1}{V_{TN}} + R_1 - \frac{K_3}{\mu_N}}{\sqrt{1+2 \cdot R_1 \cdot V_{TN} \cdot K_N \cdot W\_L_1}}\right) + \frac{1+\sqrt{1+2 \cdot R_1 \cdot V_{TN} \cdot K_N \cdot W\_L_1}}{K_N \cdot W\_L_1 \cdot R_1} \cdot \left(\frac{K_3}{\mu_N} - R_1\right)$$

Решатель

Dimensioning of R1 and W_L1

Начальные приближения

$W\_L_2 := 1$
$R_2 := 1$

Ограничения

$$V_{CTAT2}\left(W\_L_2, R_2\right) = V_{TP} + \frac{1+\sqrt{1+2 \cdot R_2 \cdot V_{TP} \cdot K_P \cdot W\_L_2}}{K_P \cdot W\_L_2 \cdot R_2}$$

$$\frac{d}{dT}\, V_{CTAT2}\left(W\_L_2, R_2\right) = V_{TP}\left(\frac{K_2}{V_{TP}} + \frac{\frac{K_2}{V_{TP}} + R_2 - \frac{K_4}{\mu_P}}{\sqrt{1+2 \cdot R_2 \cdot V_{TP} \cdot K_P \cdot W\_L_2}}\right) + \frac{1+\sqrt{1+2 \cdot R_2 \cdot V_{TP} \cdot K_P \cdot W\_L_2}}{K_P \cdot W\_L_2 \cdot R_2} \cdot \left(\frac{K_4}{\mu_P} - R_2\right)$$

Решатель

Dimensioning of R2 and W_L2