

Log Amp

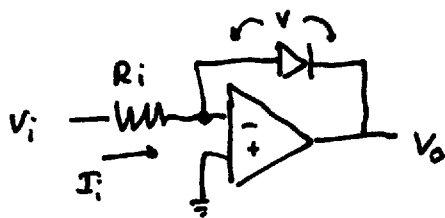
opamps : $r_{in} = \infty$

$r_{out} = 0$

$A = \infty \Rightarrow V_p = V_n$ (unless saturation)

diode : $I = I_0 [\exp(\frac{V}{V_T}) - 1]$

$\approx I_0 \exp(\frac{V}{V_T})$



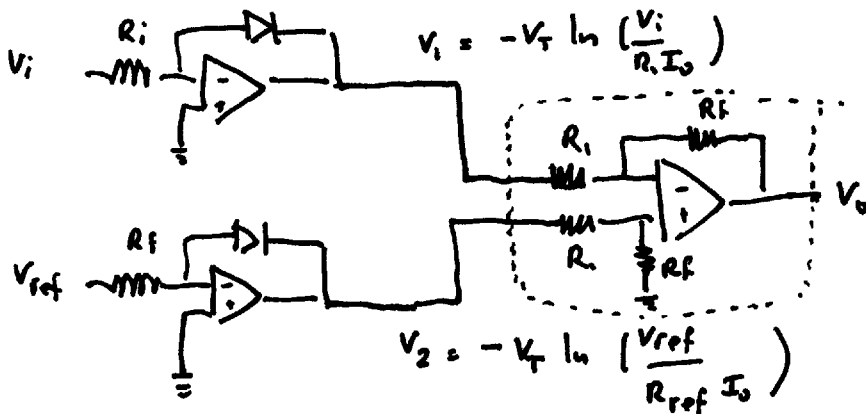
$$I_i = \frac{V_i - 0}{R_i} \rightarrow V_n = V_p = 0 \text{ (virtual ground)}$$

$r_{in} = \infty \Rightarrow I_{diode} = I_i$

$$\frac{V_i}{R_i} = I_0 \exp\left(\frac{V}{V_T}\right)$$

$$\Rightarrow V = V_T \ln\left(\frac{V_i}{R_i I_0}\right)$$

$$V_o = 0 - V = -V_T \ln\left(\frac{V_i}{R_i I_0}\right)$$



$$V_o = V_2 \times \frac{R_f}{R_1} - V_1 \times \frac{R_f}{R_1}$$

$$V_o = \frac{R_f}{R_1} \cdot V_T \left[\ln\left(\frac{V_i}{R_i I_0}\right) - \ln\left(\frac{V_{ref}}{R_{ref} I_0}\right) \right] = \frac{R_f}{R_1} V_T \ln\left(\frac{V_i}{V_{ref}} \cdot \frac{R_{ref}}{R_i}\right)$$

$$= \ln(V_i) \Rightarrow \frac{R_f}{R_1} V_T = 1 \text{ V } (R_f = 40 R_1), \quad \frac{R_{ref}}{R_i} V_{ref} = 1$$