

Bandgap Circuit

$$\frac{\partial V_{be}}{\partial T} = -2 \text{ mV}/^\circ\text{K}$$

$$\frac{\partial V_T}{\partial T} = 0.086 \text{ mV}/^\circ\text{K}$$

$$\text{from (1)} \quad \alpha = \frac{\partial V_{be}/\partial T}{\partial V_T/\partial T} \approx 23$$

$$V_{bg} = V_{be1} + \alpha V_T$$

at room temp

$$V_{be1} \approx 0.7 \text{ V}$$

$$V_T = 26 \text{ mV}$$

$$\alpha = 23$$

$$V_{bg} = 0.7 + 23 \times 26 \text{ mV} \approx 1.3 \text{ V}$$

$$\text{assume } \frac{\partial V_{be}}{\partial T} = -1.5 \text{ mV}/^\circ\text{K}$$

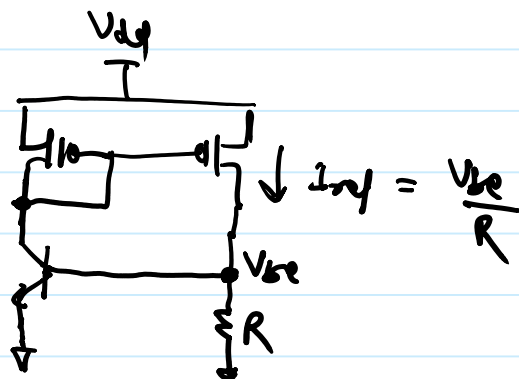
$$\alpha = 17.4$$

$$V_{bg} = 0.7 + 17.4 \times 26 \text{ mV} \approx 1.15 \text{ V}$$

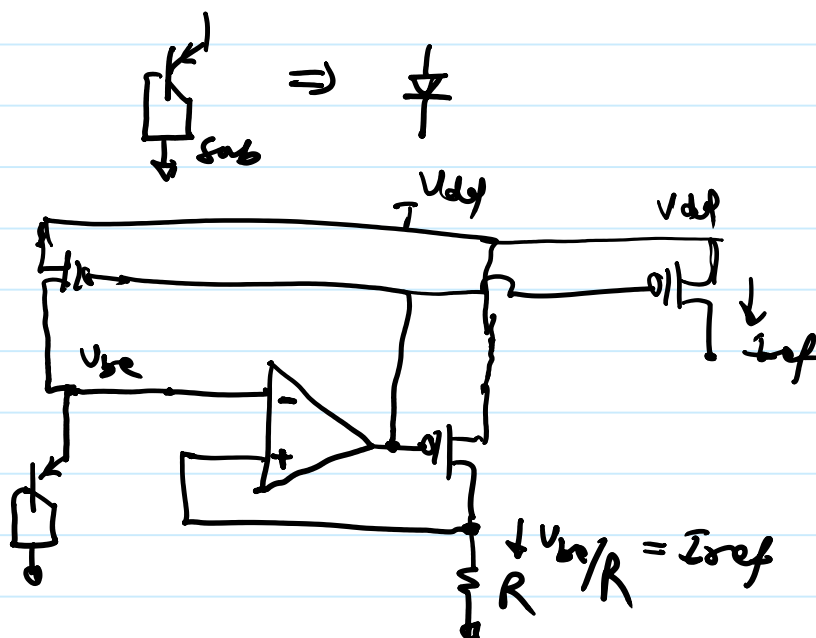
$$V_{bg} = V_{be1} + \left(\frac{R_1}{R_2} \right) \ln(m) V_T$$

$$V_{bg} = V_{be2} + \left(1 + \frac{R_1}{R_2} \right) \ln(m) V_T$$

CTAT Current Reference

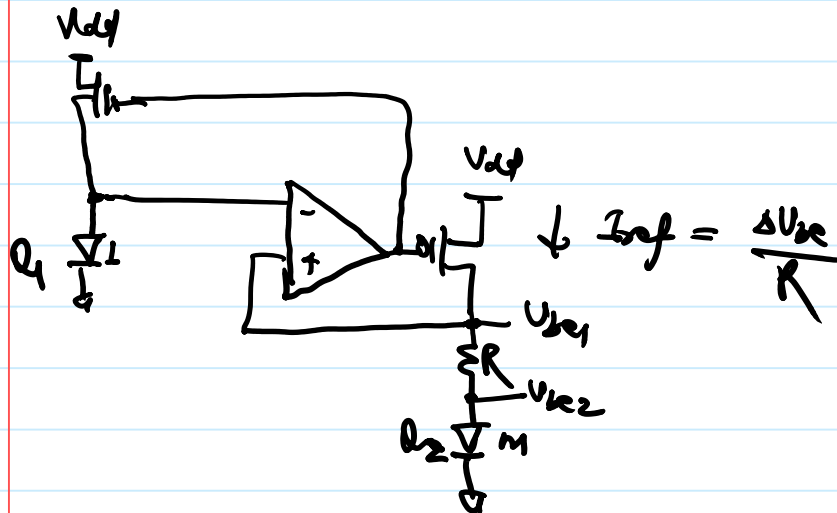
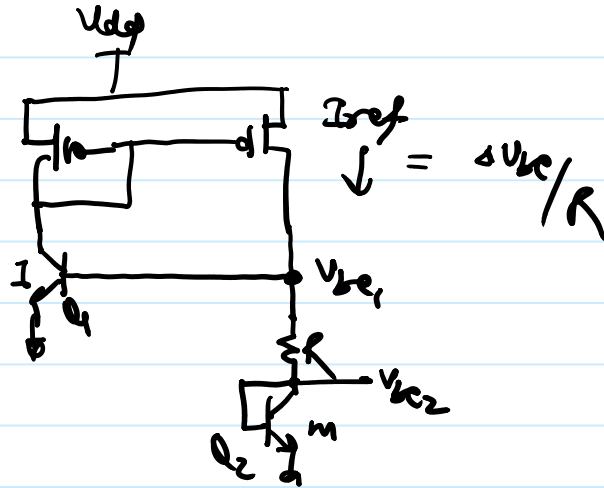


Parasitic PNP

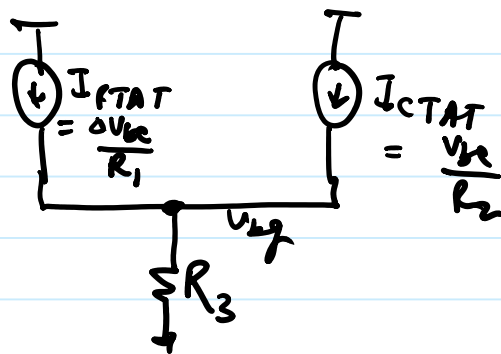


CTAT current reference.

PTAT Current Reference



Current Mode Badgap



$$V_{bf} = \frac{R_3}{R_1} \Delta V_{be} + \frac{R_2}{R_2} V_{be}$$

Sub-14 bandgap reference.

