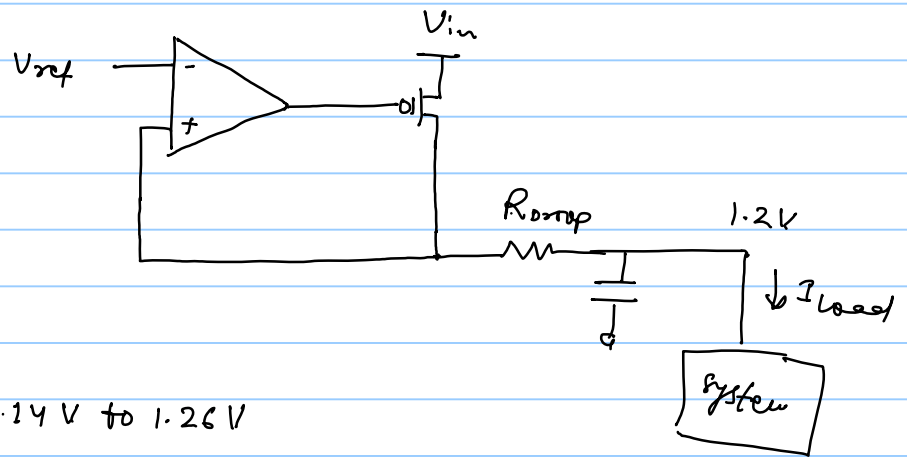
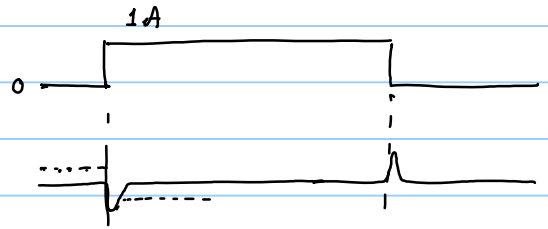
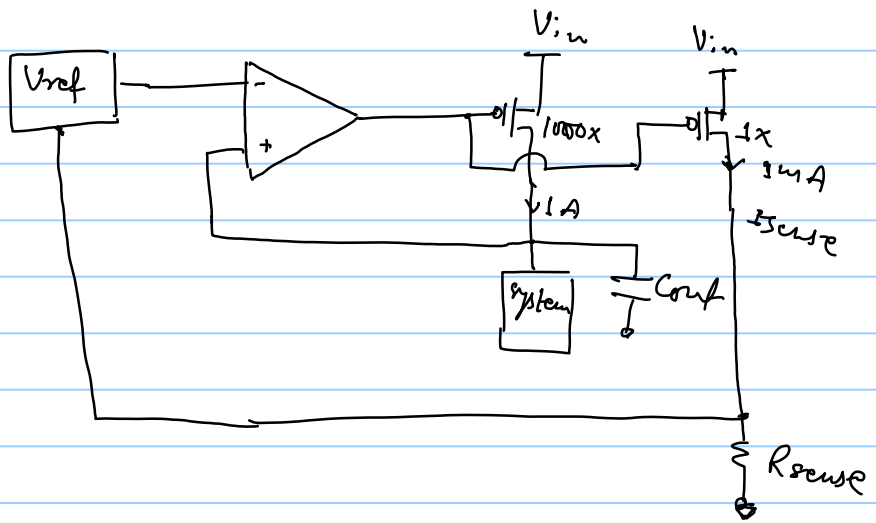
Droop compensation



V_{out} = 1.14 V to 1.26 V

I_{load} = 0 to 1 A

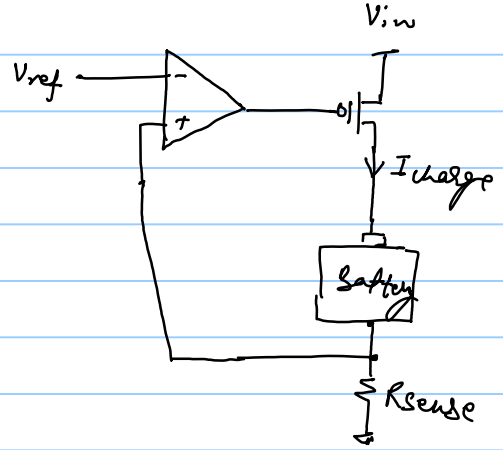



Vref
-
+
Vin
Vin
1000x
1x
1mA
1A
Isense
System
Comp
Rsense

Current Regulator

Applications

1. Battery charger

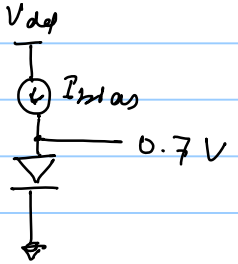


$$I_{charge} = \frac{V_{ref}}{R_{sense}}$$

$R_1 = R_2$

$V_{ref} = 1\,V$

if V_{dd} is not constant then
V_{ref} is not constant.

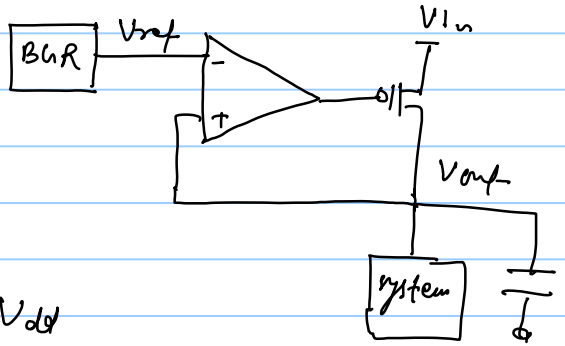


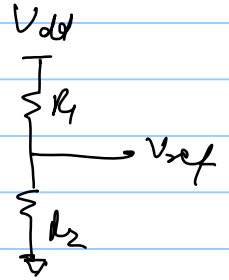
V_{be} is not constant acros tempelature.

we need refelence to be constant aclos tempelature.

Bandgap Voltage Reference

used to provide constant voltage reference across Process, Voltage & Temperature.



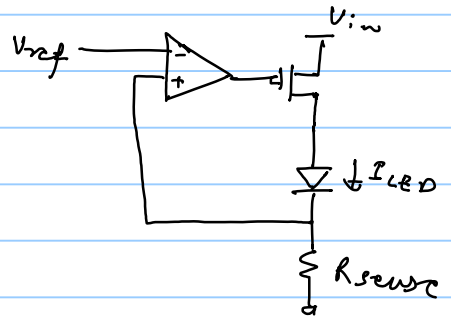


$$V_{ref} = \frac{R_2}{R_1+R_2} \cdot V_{dd}$$

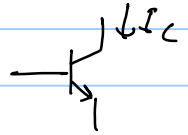
$V_{dd} = 2V$

$V_{ref} = 1V$

2. LED driver



$$I_{LED} = \frac{V_{ref}}{R_{sense}}$$



$$I_C = I_S \, e^{V_{be}/V_T}$$

$$V_{be} = V_T \ln \frac{I_C}{I_S}$$

$$V_T = KT/q$$

$$\frac{\partial V_T}{\partial T} = \frac{K}{q}, \qquad K = 1.38 \times 10^{-23} \; J/K$$

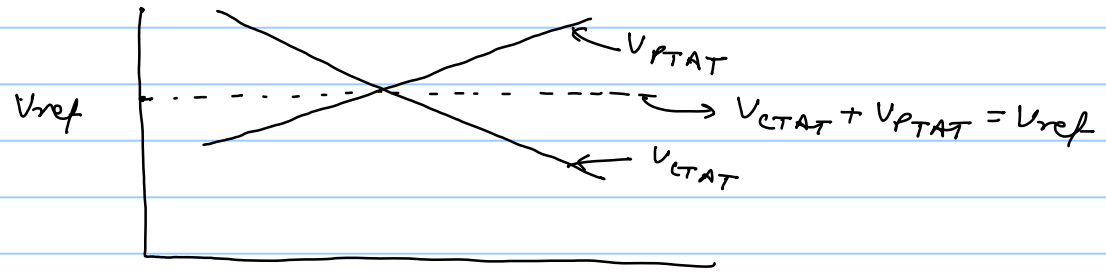
$$q = 1.61 \times 10^{-19} \; C$$

$$\frac{\partial V_T}{\partial T} = 86 \; \mu V/^{\circ}K$$

V_T at room temp. $= 86 mV \times 300$

$\simeq 26 mV$

$V_T \rightarrow$ proportional to temperature

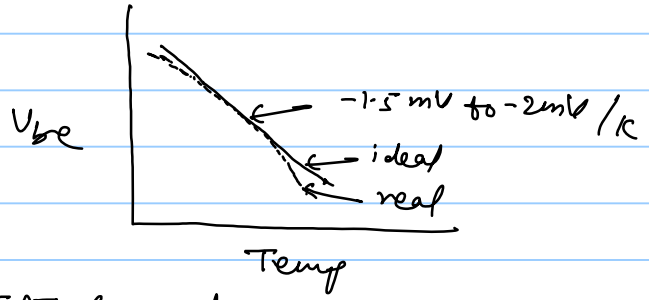


$$\frac{\partial V_{ref}}{\partial T} = 0 = \frac{\partial V_{PTAT}}{\partial T} + \frac{\partial V_{CTAT}}{\partial T} = 0$$

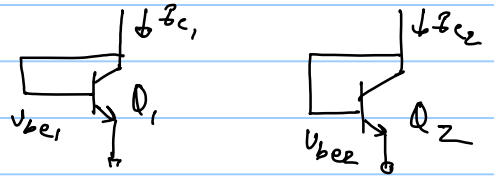
$$\Rightarrow \frac{\partial V_{PTAT}}{\partial T} = -\frac{\partial V_{CTAT}}{\partial T}$$

$$V_{be} = V_T \ln \frac{I_c}{I_s}$$

$\frac{I_c}{I_s}$ → -ve temp. coeff



PTAT Generation



$$V_{be_1} = V_T \ln \frac{I_{C_1}}{I_{S_1}}, \quad V_{be_2} = V_T \ln \frac{I_{C_2}}{I_{S_2}}$$

$$V_{be_1} - V_{be_2} = V_T \left[\ln \frac{I_{C_1}}{I_{S_1}} \times \frac{I_{S_2}}{I_{C_2}} \right]$$

$$\Delta V_{be} = V_T \left[\ln \frac{I_{C_1}}{I_{S_1}} \times \frac{I_{S_2}}{I_{C_2}} \right]$$

Case - 1 $I_{C_1} \neq I_{C_2}$

$I_{S_1} = I_{S_2} \Rightarrow Q_1 = Q_2$ (same size)

$$\Delta V_{be} = V_T \ln \left(\frac{I_{C_1}}{I_{C_2}} \right)$$

$I_{C_1} = m I_{C_2}$

$$\Delta V_{be} = V_T \ln (m)$$

Case - 2 $I_{C_1} = I_{C_2}$

$Q_1 \neq Q_2$

$Q_2 = m Q_1 \Rightarrow \Delta V_{be} = V_T \ln (m)$