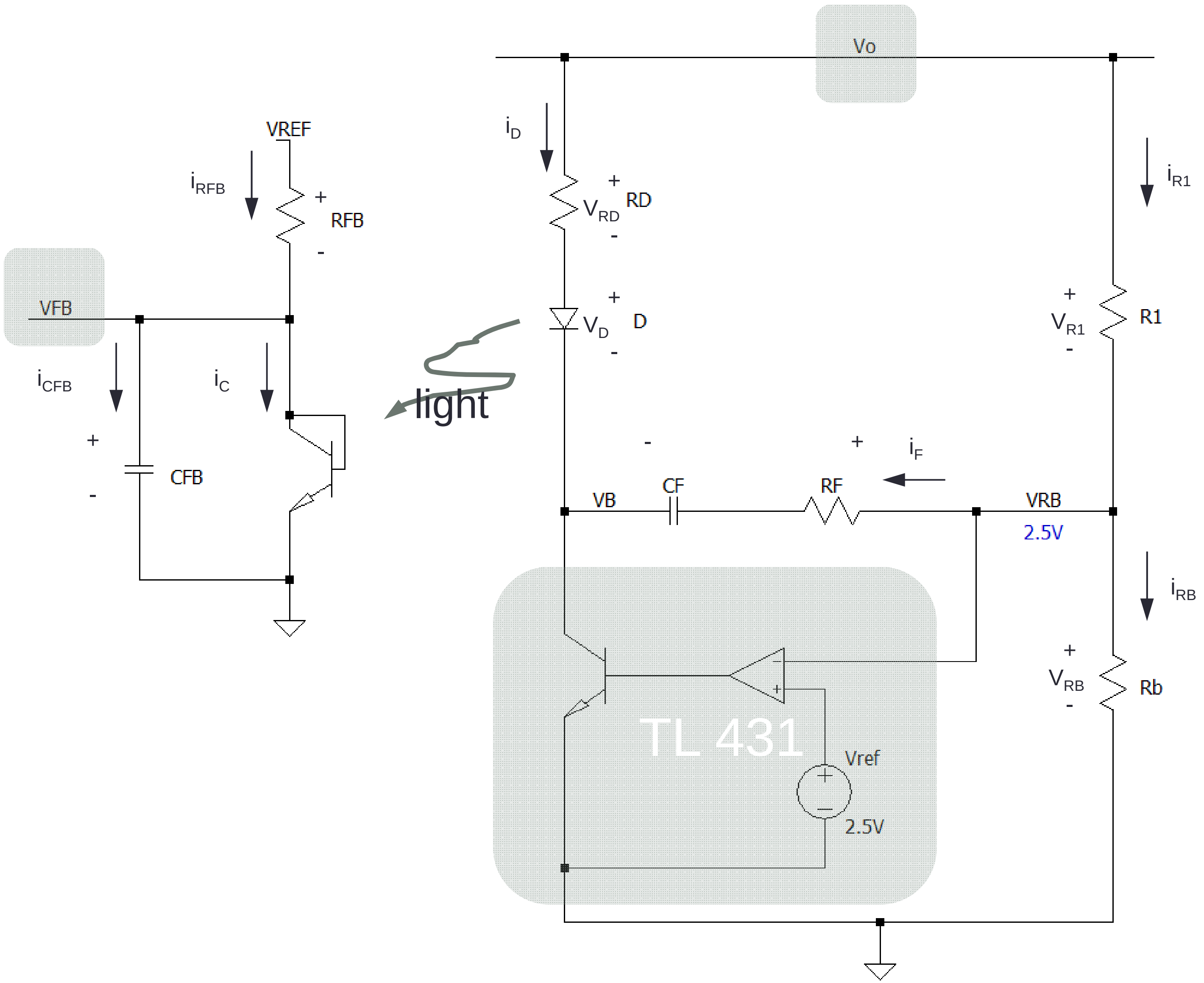
# Controller circuit



# CONTROLLER CIRCUIT



Kirhoff circuit laws applied.

Assume ideal OAMP $\Rightarrow V_{RB} = 2.5V$

$$\left.\begin{aligned} i_{R1} &= \frac{v_o - 2.5}{R_1} \qquad i_{RB} = \frac{2.5}{R_B} \\ i_F\left(R_F + \frac{1}{sC_F}\right) &= V_{RB} - V_B \\ -i_F + i_{R1} - i_{RB} &= 0 \end{aligned}\right\} \text{currents}$$

$$\to \quad i_F = i_{R1} - i_{RB}$$

~~$v_o - R_D i_D - V_D - V_B = 0$~~

$$v_o - R_D i_D - V_D + \left(R_F + \frac{1}{sC_F}\right) i_F - 2.5 = 0 \Big\} \text{voltage.}$$

$$i_D = \frac{1}{R_D}\left(v_o - V_D + \left(R_F + \frac{1}{sC_F}\right) i_F - 2.5\right)$$

$$i_F = \frac{v_o - 2.5}{R_1} - \frac{2.5}{R_B}$$

<u>$i_D$ + $i_F$ Equations:</u>

$$i_D = \frac{1}{R_D}\left( v_o - \underbrace{V_D}_{\text{DC value}} + \left(R_F + \frac{1}{sC_F}\right)\left(\frac{v_o - \overbrace{2.5}^{\text{DC value}}}{R_1} - \underbrace{\frac{2.5}{R_B}}_{\text{DC value}}\right) - \underbrace{2.5}_{\text{DC value}} \right)$$

use small ripple approximation
ONLY <u>ac</u> terms are collected:

$$\hat{i}_D = \frac{1}{R_D}\left( \hat{v}_o + \left(R_F + \frac{1}{sC_F}\right)\frac{\hat{v}_o}{R_1} \right)$$

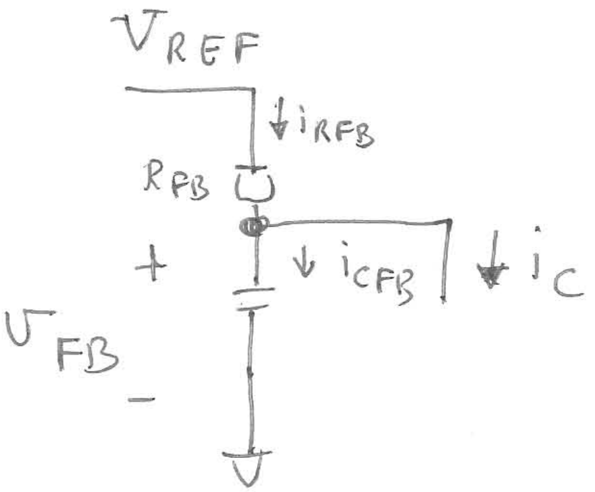
$$\hat{i}_D = \frac{\hat{v}_o}{R_D R_1}\left( R_1 + R_F + \frac{1}{sC_F} \right)$$

$$\boxed{\hat{i}_D = \frac{\hat{v}_o}{R_D R_1}\left( \frac{s(R_F + R_1)C_F + 1}{sC_F} \right)}$$

# The link - opto coupler

$$i_C = K_{op}\, i_D$$

$\uparrow$ opto-coupler gain.




current eq:

$$i_{RF} - i_C - i_{CFB} = 0$$

and

$$i_{CFB} = s\, v_{FB}\, C_{FB}$$

$$\underbrace{\frac{V_{REF} - v_{FB}}{R_{FB}}}_{i_{RF}} - \underbrace{K_{op}\, i_D}_{i_C} - \underbrace{s\, v_{FB}\, C_{FB}}_{i_{CFB}} = 0$$

Small signal model and only $\underline{ac}$ terms. (1. order)

$$\hat{v}_{FB}\left(\frac{1}{R_{FB}} + s\, C_{FB}\right) = -K_{op}\, \hat{i}_D$$

$$\hat{v}_{FB}\left(\frac{s R_{FB} C_{FB} + 1}{R_{FB}}\right) = -K_{op} \frac{\hat{v}_o}{R_D R_1}\left(\frac{s(R_F + R_1) C_F + 1}{s C_F}\right)$$

SO:

$$\frac{\hat{v}_{FB}}{\hat{v}_0} = -K_{op}\frac{1}{R_1 R_D}\left(\frac{s(R_F+R_1)C_F+1}{s\,C_F}\;\frac{R_{FB}}{sR_{FB}C_{FB}+1}\right)$$

$$\omega_{zc} = \frac{1}{(R_1+R_F)C_F} \qquad \omega_{pc} = \frac{1}{R_{FB}C_{FB}}$$

$$\boxed{\frac{\hat{\omega}_{FB}}{\hat{v}_0} = -\frac{\omega_i}{s}\;\frac{s/\omega_{zc}+1}{s/\omega_{pc}+1}}$$

$$\omega_i = \frac{K_{op}R_{FB}}{R_1 R_D C_F}$$