$$\omega_{ugb} = \frac{2\pi F_{sw}}{10}$$

$$\omega_z = 0.09 \text{ Mrad/sec} = \frac{1}{R_p C_i}$$

$$C_i = \frac{1}{R_p \omega_z}$$

Assume, $L = 3.3\,\mu H$, $C = 10\,\mu F$

$V_{dd} = 1.8V$, $V_m = 1V$, $g_m = 1m\,A/V$

$F_{sw} = 1\,MHz$

$$F_{ugb} = \frac{F_{sw}}{10} = 100\,KHz$$

$$\omega_{ugb} = 2\pi \times 100\,KHz = 628\,K\,rad/sec.$$

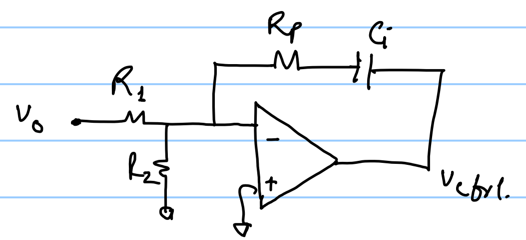
$$R_p = \frac{2\pi \times 10^5}{0.174 \times 10^6 \times \frac{1}{2} \times \frac{1.8}{1} \times 10^{-3}} = \frac{2\pi \times 10^2}{0.174 \times 0.9} \simeq 4K\Omega$$

1. type compensator requires one more zero which can be added by having R_{esr} in output cap.

2. keeping higher g_m requires large C_i $\longrightarrow$ large area.

3. Reducing g_m reduce C_i but at the cost of offset.

Therefore, op-amp-RC compensator is preffered.



$$H_{comp\text{-}II} = -\frac{R_f + \frac{1}{sC_i}}{R_1} = -\left[\underbrace{\frac{R_f}{R_1}}_{K_p} + \underbrace{\frac{1}{R_1 C_i s}}_{K_i = \frac{1}{R_1 C_i}}\right]$$

$$\omega_z = \frac{1}{R_f C_i}$$

$R_1 = 100k$

$k_p = \frac{1}{2}$ of k_p calculated in g_m-C compensator.

$\frac{R_p}{R_1} = 2 \Rightarrow R_p = \underline{200k}$

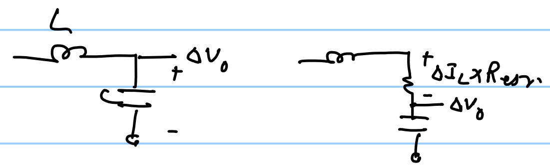
$C_i = \frac{1}{\omega_z \times R_p} = \frac{1}{0.09 \times 10^6 \times 2 \times 10^5}$

$= \frac{10^{-11}}{0.18} = \underline{55\,pF}$

Requires smaller capacitor.

drawback of type-II compensator with R_{esr}.

$\Rightarrow$ output ripple is increased.

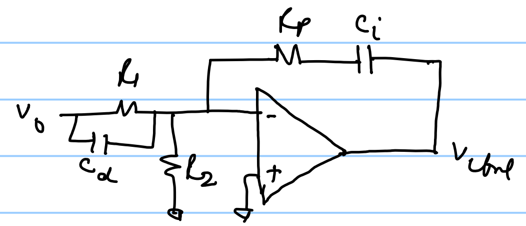


$\Delta V_{o\text{-}total} = \Delta I_L \times R_{esr} + \Delta V_0$

This is not preffered for applications requiring smaller ripple.

Therefore we need to add 2nd zero in the compensator.

typ-II + one zero = type-III



$$H_{comp\text{-}III}(s) = \underbrace{\left(K_p + \frac{K_i}{s}\right)}_{\text{type-II}} \underbrace{\left(1 + s/\omega_{z_2}\right)}_{\text{2nd zero}}$$

$$\omega_{z_2} = \frac{1}{R_1 C_d}$$

$$K_p + \frac{K_i}{s} = \frac{K_i}{s}\left(1 + \frac{K_p}{K_i} s\right) = \frac{K_i}{s}\left(1 + s/\omega_{z_1}\right)$$

$$\omega_{z_1} = \frac{K_i}{K_p}$$

$$H_{comp\text{-}III}(s) = K_i \frac{(1+s/\omega_{z_1})(1+s/\omega_{z_2})}{s}$$

$$\frac{K_i}{s}\left[1 + s/\omega_{z_1} + s/\omega_{z_2} + \frac{s^2}{\omega_{z_1}\omega_{z_2}}\right]$$

$$= \frac{K_i}{s}\left[1 + \underbrace{s\left(\frac{1}{\omega_{z_1}} + \frac{1}{\omega_{z_2}}\right)} + \frac{s^2}{\omega_{z_1}\omega_{z_2}}\right]$$

$$= \frac{K_i}{\omega_{z_1}}\left(1 + \frac{\omega_{z_1}}{\omega_{z_2}}\right) + \frac{K_i}{s} + K_i\frac{s}{\omega_{z_1}\omega_{z_2}}$$

$$= K_p\left(1 + \frac{\omega_{z_1}}{\omega_{z_2}}\right) + \frac{K_i}{s} + \frac{K_p}{\omega_{z_2}} s$$

P	I	D
K_p'	K_i/s	$K_d s$