If $C_c = 0$ (it doesn't, Zagho at least, but it does),

$A_{v1} = \frac{A_{v2} - A_{v3}}{1 + \frac{A_{v2} - A_{v3}}{1 - \frac{R_{v2}}{R_{v1}}}}$

$A_{v2} = \frac{A_{v3} - R_{v2} - \frac{R_{v1}}{R_{v3}}}{1 + \frac{R_{v2}}{R_{v1}}}$

2 poles

unstable phase margin, sets to 0 threshold

Compensation

Adding zeros to the open-loop response of the amplifier (typically by adding capacitive elements) to improve closed-loop performance

2) to achieve desired phase margin

stability properties

\[ G(m) = \frac{G_m}{1 + \frac{R_{ol}}{G_m}} \]

\[ G_{na} = \frac{C_{ol}}{C_m} \]

\[ G_{na} = \frac{G_{m1} + G_{m2}}{1 + \frac{R_{ol}}{G_{m1}}} \]

\[ C_{ol} = \frac{C_m}{C_{ol}} \]

\[ C_{ol} = \frac{C_s + C_{ol}}{2} \]

\[ \frac{C_{ol}}{C_m} = \frac{C_s + C_{ol}}{2} \]

\[ \frac{C_{ol}}{C_m} = \frac{C_s}{2} \]
If we separated poles on lot

$R_i = \frac{100}{1 + 3j\pi}$

$\text{set } \theta = 45^\circ \text{ need } \phi = 3 \text{ win}$

To test $\theta = 70^\circ \text{ need } \phi = 2 \text{ win}$

What is $\theta^{\circ}$ and $\phi$ gain $\omega/\alpha$?

$A(\omega/\alpha) = 100$

$A(\omega/\alpha) = 100$ when $\phi = -135$

Need $|\omega/\alpha|$ to $0.01$

$A_{22} = \frac{1}{T} = 100$

To move 1 pole $10^3$ lower freq, need

$10^3$ times much capacitance.

So 1) increase $5 \text{ by } 1000x$

2) increase $5 \text{ by } 1000x$

3) increase $5 \text{ by } 1000x$

Problem: might not know $\alpha$.

Solution #2 ok, but may unnecessarily compromise performance.
\[ Z_{\text{miller}} = \frac{1}{\frac{1 + \frac{A_{w,2}}{1 + \frac{A_{w,2}}{1 + A_{w,0}}}}{1 + \frac{A_{w,0}}{1 + A_{w,0}}}} \]

\[ = \frac{1}{\frac{1 + \frac{A_{w,2}}{1 + \frac{A_{w,2}}{1 + A_{w,0}}}}{1 + \frac{A_{w,0}}{1 + A_{w,0}}}} \]

\[ = \frac{1}{\frac{1 + \frac{A_{w,2}}{1 + \frac{A_{w,2}}{1 + A_{w,0}}}}{1 + \frac{A_{w,0}}{1 + A_{w,0}}}} \]

\[ \omega_{1,2} = \frac{c_{w,2}}{\omega_{1,2}} \]

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\[ R_{c1} \quad \text{constant, real} \]
No virtual ground

\[ G_m \text{ calc} \]

\[ \begin{align*}
    i_o &= i_{dlb} - i_{dla} \\
    &= g_m 16 \left( \frac{V_1}{2} - V_{in1} \right) - g_m 15 \left( \frac{V_1}{2} - V_{in1} \right) \\
    &= -g_m 15 V_1
\end{align*} \]

\[ G_m 1 = g_m 15 \]

\[ R_{o1} \text{ calc} \]

\[ \begin{align*}
    i_o &= i_{dlb} + i_{dla} \\
    i_{dlb} &= \frac{V_0}{2r_{o1}} \\
    i_{dla} &= \frac{V_0}{r_{o2}} + \frac{V_0}{r_{o2}} \\
    i_o &= \frac{V_o}{r_{o1}} + \frac{1}{r_{o1}} + \frac{V_o}{r_{o2}} + \frac{1}{r_{o2}} = \frac{V_o}{r_{o1}} + \frac{1}{r_{o1}} + \frac{V_o}{r_{o2}} + \frac{1}{r_{o2}}
\end{align*} \]

\[ R_{o1} = r_{o1} || r_{o2} \]