Source follower or
Common-Drain
buffer stage

\[ g_{m} = 500 \mu A/V \]
\[ g_{mb} = \chi g_{m} = 100 \mu A/V \]
\[ \chi = 0.2 \]
\[ C_{gs} = 0.27 \mu F, \quad C_{gd} = 0.02 \mu F, \quad C_{sb} = 0.04 \mu F \]
\[ C_{l} = 10 \mu F \]

Small-signal model, including body effect:

\[ A(0) = \frac{g_{m} \left( \frac{1}{g_{m}} + \frac{1}{r_{o}} \right)}{1 + g_{m} \left( \frac{1}{g_{m}} + \frac{1}{r_{o}} \right)} \approx \frac{g_{m} / g_{ms}}{1 + g_{m} / g_{ms}} \]

\[ = \frac{g_{m}}{g_{ms} + g_{m}} = \frac{1}{1 + \chi} \]

where \( g_{ms} = \chi g_{m} \)
\[ \chi = 0.1 \text{ to } 0.3 \]
\[ = \frac{1}{1 + 0.2} = 0.83 \]
Time constants

\[ T_{gd} = C_{gd} R_{in} = (0.02 \, \text{pF})(200 \, \text{kHz}) = 4\, \text{ns} \]

\[ T_L = C_L R_{aut} = (10 \, \text{pF})(1.7 \, \text{k} \Omega) = 17\, \text{ns} \]

\[ R_{aut} = \frac{1}{g_m + g_{mb}} \approx \frac{1}{g_m (1 + \xi)} = 1.7 \, \text{k} \Omega \]

\[ T_{gs} = C_{gs} R_{dgs} \]

\[ \frac{1}{g_{mb}} \ll R_0 \approx \frac{1}{g_{mb}} \]

\[ V_{test} = R_{in} I_{test} - (g_m V_{test} + I_{test}) \frac{1}{g_{mb}} \]

\[ V_{test} \left( 1 + \frac{g_m}{g_{mb}} \right) = (R_{in} + \frac{1}{g_{mb}}) I_{test} \]

\[ \frac{V_{test}}{V_{test}} = \left( R_{in} + \frac{1}{g_{mb}} \right) \frac{g_{mb}}{g_{mb} g_m} \approx \frac{R_{in}}{1 + \xi} \]

\[ \approx R_{in} \frac{g_{mb}}{g_{dgs} g_m} = R_{in} \frac{X}{1 + X} = 0.17 \, R_{in} \]

↑ Notice this is \( 1 - A(0) \) (Miller effect)

\[ C_{gs} R_{dgs} = C_{gs} R_{in} (0.17) = (0.27 \, \text{pF})(200 \, \text{kHz})(0.17) = 9\, \text{ns} \]
\[ \text{BW estimate using } \frac{1}{\text{UTC}} \]

\[ \text{BW} \approx \frac{1}{2n} \frac{1}{T_{gd} + T_{L} + T_{gs}} = 5.3 \text{ kHz} \]

Compare to the \( \frac{1}{2n R_i C} = 80 \text{ kHz} \) without the buffer stage!

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**Note:** complex poles or even instability may happen in the common-drain stage.

A more detailed analysis (e.g. using Nyquist) would be needed to find \( A(s) \) complete and examine the magnitude response and the location of poles/zeros.