Addendum for Common-Gate (CG) Amplifiers

The following example illustrates an application of CG amplifier. Consider a small-signal current source of 10 μA and a source resistance of 10 kΩ. If we attempt to deliver the current to a load resistor of 1 MΩ, as shown in the following:

\[ i_s = 10 \mu A \]
\[ R_S = 10 \text{kΩ} \]
\[ R_L = 1 \text{MΩ} \]

The current, \( i_s \), is divided between two resistors, and the actual current deliver to the load is

\[ i_L = i_s \frac{R_s}{R_L + R_s} = (10 \mu A) \frac{10}{1010} = 0.099 \mu A. \]

By adding a common-gate amplifier as a “current buffer” that features a low input and a high output resistances and a unity current gain (-1), as shown below:

\[ i_s = 10 \mu A \]
\[ R_S = 10 \text{kΩ} \]
\[ R_{IN} = 1 \text{kΩ} \]
\[ A_i = -1 \]
\[ R_{OUT} = 10 \text{MΩ} \]

Then

\[ i_{IN} = i_s \frac{R_s}{R_s + R_{IN}} = (10 \mu A) \frac{10}{11} = 9.1 \mu A \]
\[ i_L = -A_i i_{IN} \frac{R_{OUT}}{R_{OUT} + R_L} = 9.1 \frac{10}{11} = 8.3 \mu A \]

The resulting load current is much closer to the source current than the circuit without current buffer.