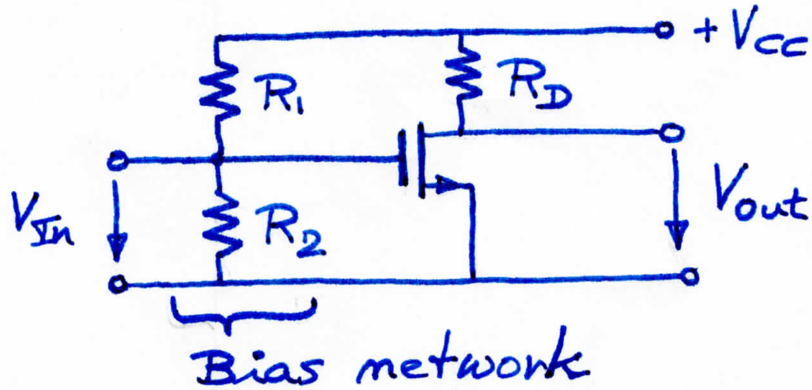
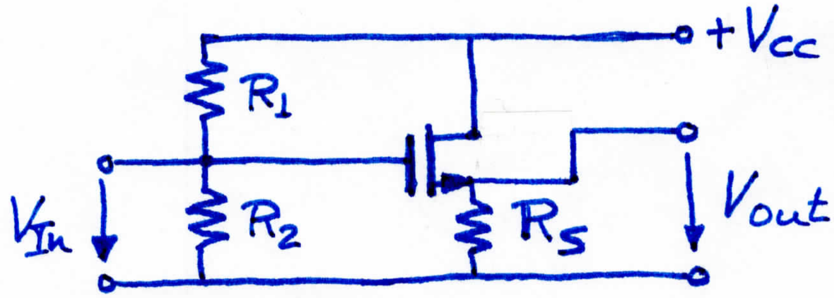
FET Amplifiers

Common Source amplifier



Q: Explain name: Common Source amplifier.

Common Drain amplifier

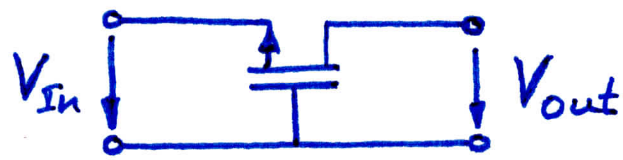


Q: Is D common? ⇒ Yes

Q: Why is D common?

Alternative name: Source follower

Common Gate amplifier

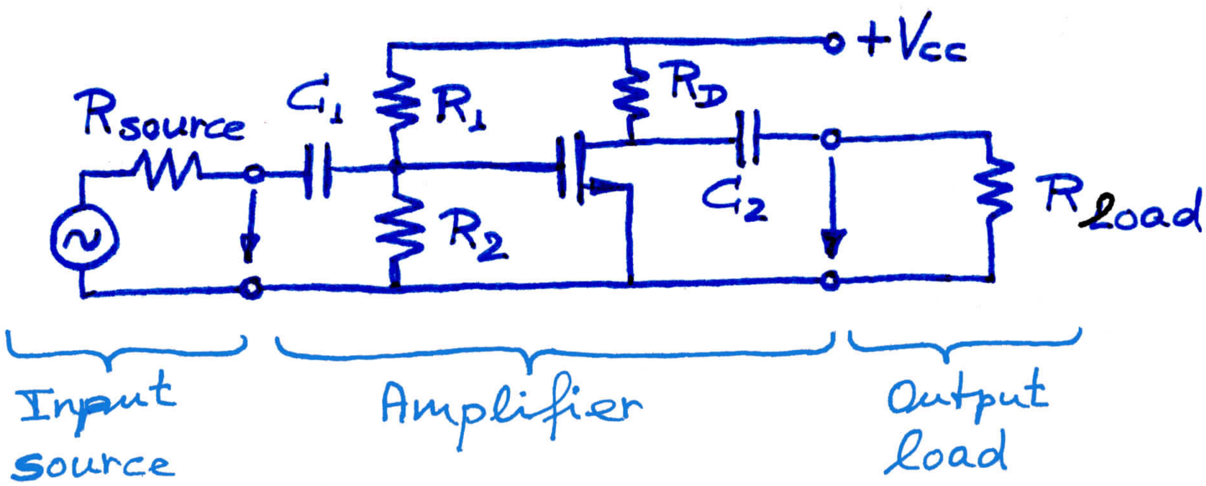


Q: Current amplification ? ⇒ 1.0

Q: Why ?

⇒ Current follower (alternative name)

Common Source amplifier



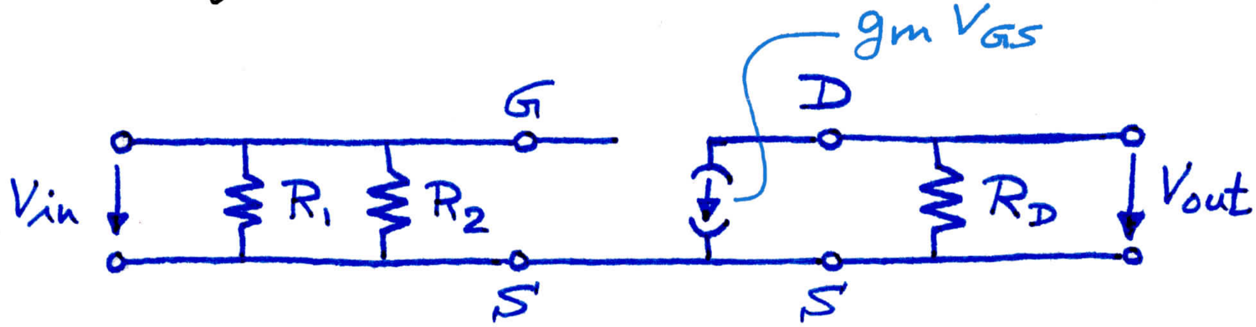
Q: For analysis of amplifier, will R_{source} and R_{load} matter? ⇒ No. Why?

Q: How are C_1 & C_2 dimensioned? ⇒ $C_1 \to \infty$ $C_2 \to \infty$ so that $Z_C = \frac{1}{j\omega C} = 0$

Q: How are C_1 & C_2 dimensioned in practice?

⇒ Dimension C_1 & C_2 to let pass all relevant frequencies.

Small-signal equivalent circuit



Input impedance

$$z_{in} = \underline{\underline{R_1 \parallel R_2}}$$

Output impedance

$$z_{out} = \underline{\underline{R_D}} \qquad (\text{or } R_D \parallel R_{DS} \text{ if } R_{DS} \neq \infty)$$

Current amplification

$$A_{ISC} = \frac{i_{out}}{i_{in}} = \frac{g_m V_{GS}}{V_{GS}/(R_1 \parallel R_2)} = \underline{\underline{g_m (R_1 \parallel R_2)}}$$

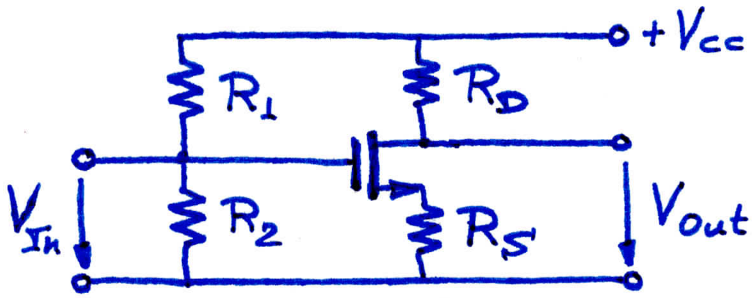
Note: R_1 & R_2 can be very large. Why?

$\Rightarrow A_{ISC}$ can be very large.

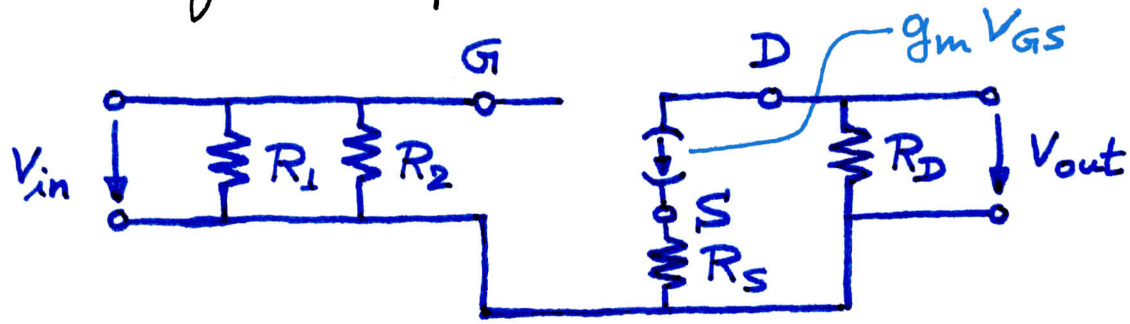
Voltage amplification

$$A_{VOC} = \frac{V_{out}}{V_{in}} = \frac{g_m V_{GS} R_D}{\underset{\hookrightarrow V_{GS}}{V_{in}}} = \underline{\underline{g_m R_D}}$$

Let us add a source resistance



Small signal equivalent circuit



$$z_{in} = R_1 \parallel R_2$$

$$z_{out} = R_D$$

$$A_{ISC} = \frac{i_{out}}{i_{in}} = \frac{g_m V_{GS}}{V_{in}/(R_1 \parallel R_2)} = \frac{g_m (R_1 \parallel R_2)}{1 + g_m R_s}$$

$\hookrightarrow V_{GS} + R_S g_m V_{GS}$

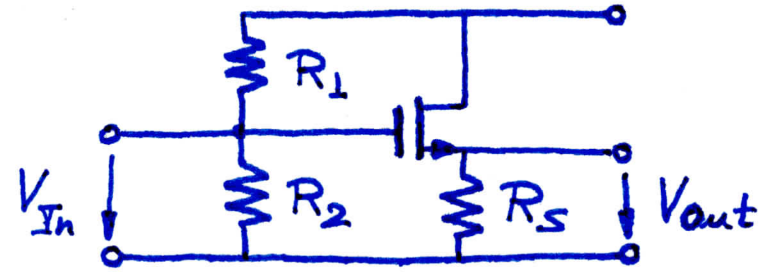
$\Rightarrow R_S$ reduces amplification

$$A_{VOC} = \frac{V_{out}}{V_{in}} = \frac{g_m V_{GS} R_D}{V_{GS} + R_S g_m V_{GS}} = \frac{g_m R_D}{1 + g_m R_S}$$

$\Rightarrow R_S$ reduces amplification

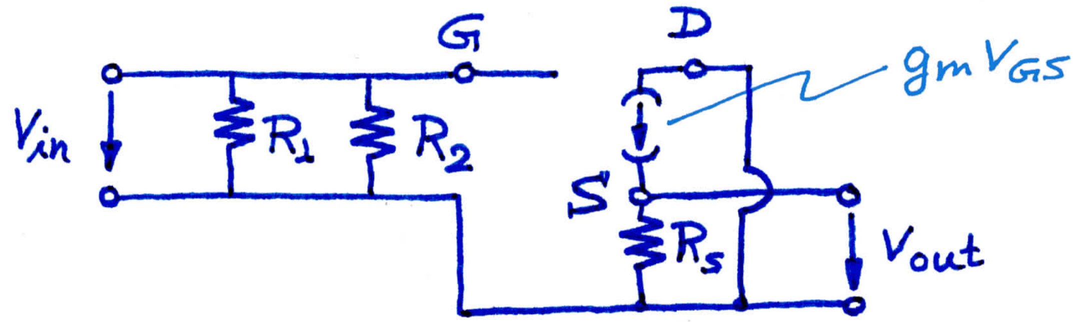
Common Drain amplifier

(also called Source Follower)



Q: Why is this called a common-Drain amplifier?

Small signal equivalent circuit



$$z_{in} = \underline{\underline{R_1 \parallel R_2}}$$

$$z_{out} = \underline{\underline{R_S}}$$

$$A_{ISC} = \frac{i_{out}}{i_{in}} = \frac{g_m V_{GS}}{V_{in}/(R_1 \parallel R_2)} = \underline{\underline{g_m \,(R_1 \parallel R_2)}}$$

$V_{in} \rightarrow V_{GS}$

⇒ For high values of R_1 & R_2 ⇒ $A_{ISC} \gg 1$

$$A_{VOC} = \frac{V_{out}}{V_{in}} = \frac{g_m V_{GS} R_S}{V_{GS} + g_m V_{GS} R_S} = \underline{\underline{\frac{g_m R_S}{1 + g_m R_S}}}$$

$V_{in} \rightarrow V_{GS} + g_m V_{GS} R_S$

⇒ For large R_S ⇒ $A_{VOC} \approx 1.0$

⇒ S voltage follows G voltage

⇒ Alternative name: <u>Source follower</u>