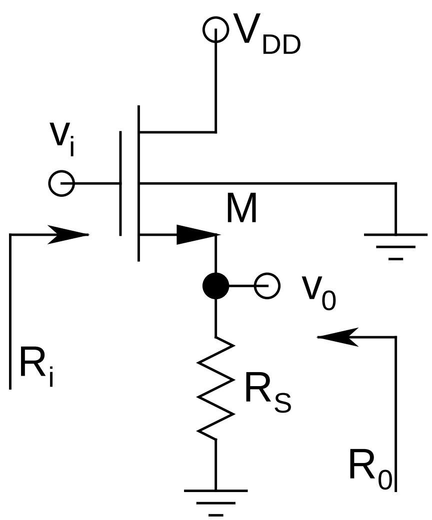
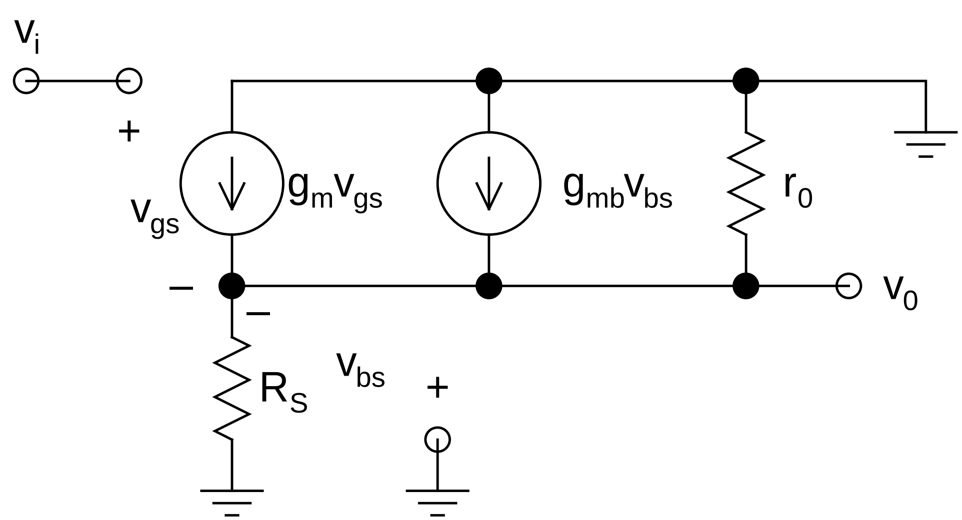
- ***Some special properties of CC Stage***:
  - ***$A_v \leq 1$*** (***by proper design, it can be made to approach unity very closely***)
  - ***Input and output in phase***
  - ***Quite large input resistance***
  - ***Very small output resistance***
- These properties are ***highly desirable*** to prevent ***loading effect*** of ***cascaded stages*** (to be discussed later)
- Thus, this stage is also known as ***Buffer*** or ***Isolator*** or ***Impedance Matcher***

- ***Common-Drain*** (CD):
  - Also known as ***Source Follower***



ac Schematic



ac Low-Frequency Equivalent

- ***Biasing circuit not shown***

- ***Note***: ***Body terminal at ground***, but ***source is at a floating potential*** (***it's the output terminal***)

  $\Rightarrow$ ***Body effect will be very much present for M***

  $\Rightarrow$ ***Can be avoided by putting M in its separate island***

- ***Voltage Gain***:
  - ***KCL at output node***:

$$g_m v_{gs} + g_{mb} v_{bs} = v_0/(R_S \| r_0)$$

with $v_{gs} = v_i - v_0$, and $v_{bs} = -v_0$

$$\Rightarrow A_v = \frac{v_0}{v_i} = \frac{g_m \left(R_S \,\|\, r_0\right)}{1 + \left(g_m + g_{mb}\right)\left(R_S \,\|\, r_0\right)}$$

- ***Simplification***:
  - In general, $r_0 >> R_S$:

$$\Rightarrow A_v \simeq \frac{g_m R_S}{1+\left(g_m + g_{mb}\right) R_S}$$

  - If ***body effect is neglected***:

$$\Rightarrow A_v \simeq \frac{g_m R_S}{1+g_m R_S} = \frac{R_S}{1/g_m + R_S}$$

Note the remarkable similarity with CC stage

  - If $(g_m + g_{mb})R_S >> 1$:

$$\Rightarrow A_v \simeq \frac{g_m}{g_m + g_{mb}} = \frac{1}{1+\chi}$$

- ***Note***:

$$\chi = \frac{\gamma}{2\sqrt{2\phi_F + V_{SB}}}$$

with $V_{SB} = V_0$ (***DC level of*** v_0)

- ***Typical values of*** $\chi \sim$ ***0.1-0.5***
- Thus, A_v ***can depart significantly from its ideal value of unity***
- ***No phase shift between input and output***

➢ ***Input Resistance***: $R_i \to \infty$

➢ ***Output Resistance***: ***By inspection***:

$$R_0 = (g_m + g_{mb} + g_0 + g_S)^{-1} \ (g_0 = 1/r_0, \ g_S = 1/R_S)$$