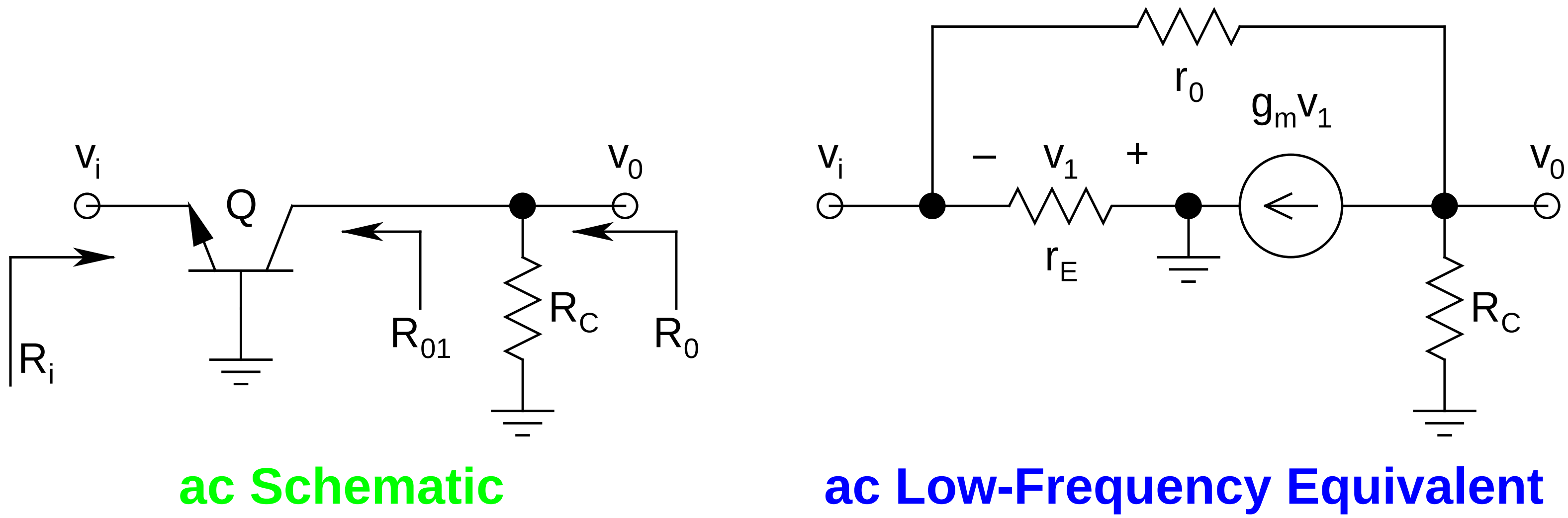
- ***Common-Base*** (CB):



- Note that the ***alternate hybrid-π model appropriate for CB circuit*** has been used
- ***r_0 appears between input and output***

- For now, ***neglect r_0***
- Noting that $v_1 = -v_i$:

$$A_v = \frac{v_0}{v_i} = \frac{-g_m v_1 R_C}{v_i} = +g_m R_C \simeq \frac{R_C}{r_E}$$

- Note that the ***expression*** for A_v is ***identical*** to that for the ***CE stage***, ***without the negative sign in front***
- For this circuit, ***input and output are in phase***
- $A_i = i_c/i_e = \alpha$
- $R_i = r_E$

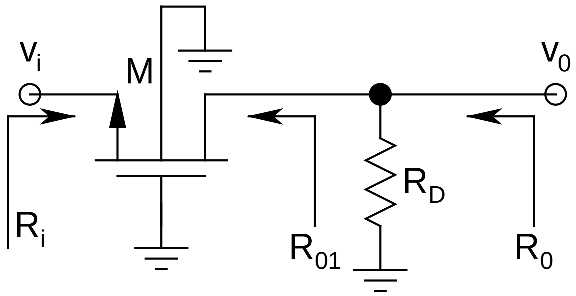
- $R_0 = R_{01} || R_C$

  $R_{01} \to \infty$ (***Why***?)

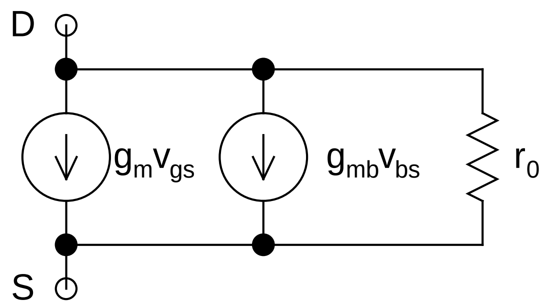
  $\Rightarrow R_0 = R_C$
- ***Ex.: Find A_v and R_i with r_0 included***
- ***With r_0 included***, the circuit shows ***two different values*** of R_{01}:
  - ***When excited by a voltage source***, $R_{01} = r_0$
  - ***When excited by a current source***, $R_{01} = \beta r_0$ (***Show***)

    [***Hint***: ***For this derivation, need to use $g_m r_E = \alpha$***]
  - ***Thus, possibility of huge R_0 under the second case, but R_C ruins it***!

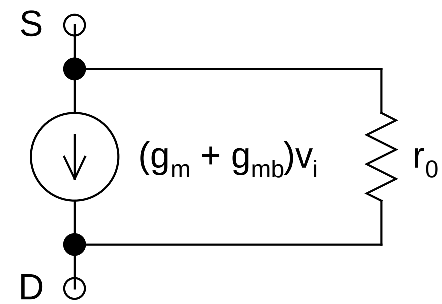
- ***Common-Gate*** (CG):



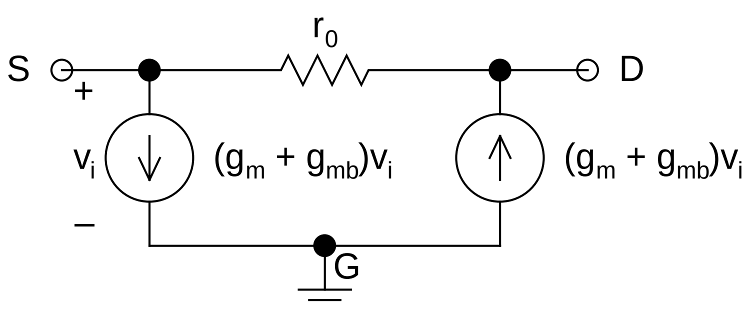
ac Schematic



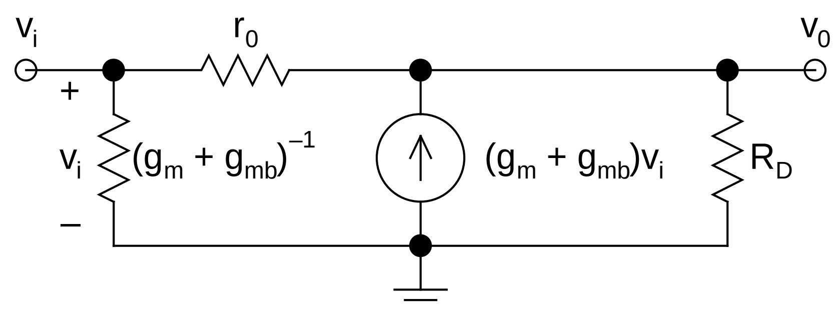
ac Low-Frequency Model for M



Simplified ac Low-Frequency Model for M



Rerouting the current source between S and D to S to G and then from G to D



Final ac Low-Frequency Equivalent for CG Stage

- ***G and B both ground***:

  $\Rightarrow v_{gs} = v_{bs} = -v_i$

  $\Rightarrow g_m v_{gs}$ and $g_{mb} v_{bs}$ can be ***combined to a single current source*** $(g_m + g_{mb})v_i$, ***flowing from S to D***

- ***Reroute this current source from S to G and then from G to D*** (***the circuit remains invariant***)

  $\Rightarrow$ Leads to the ***final ac low-frequency equivalent*** of the CG stage

- ***Note again that r_0 appears between input and output*** (***similar to CB stage***)