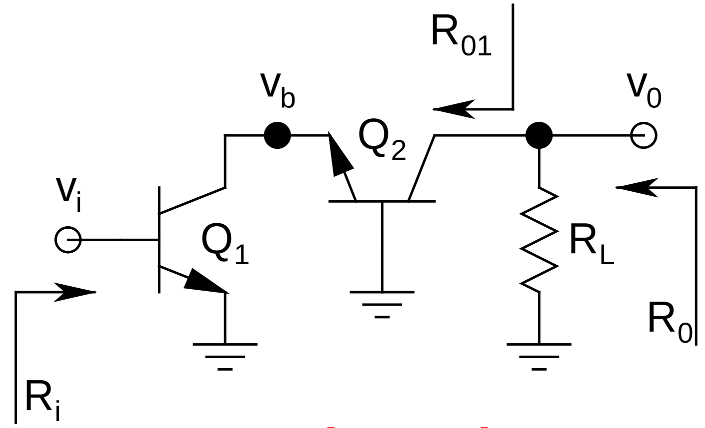
- ***npn Cascode***:
  - ***CE***, followed by ***CB***
  - Known as ***Wideband Amplifier***, due to its ***superior frequency response characteristic***
  - ***Generally, both Q_1 and Q_2 are biased with the same I_C***
  - ***Assuming Q_1-Q_2 have same β***:

    $r_{E1} = r_{E2} = r_E$ and $r_{\pi 1} = r_{\pi 2} = r_\pi$

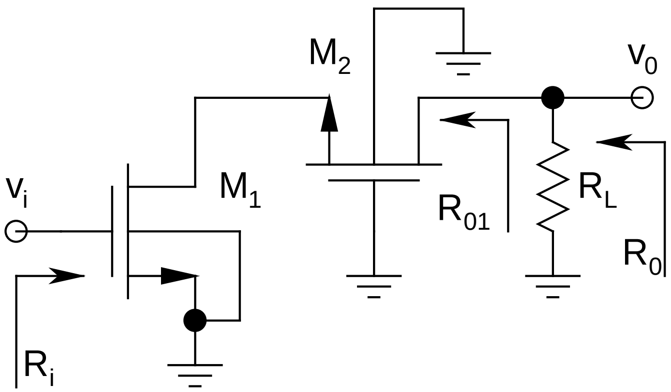


ac Schematic

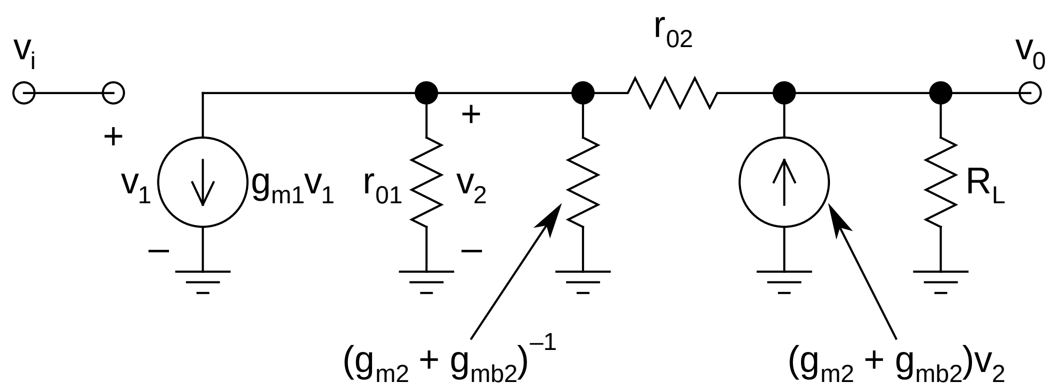
- $R_0 = R_L || R_{01}$
- ***If r_0 is neglected***, then $R_{01} \rightarrow \infty$
- ***If r_0 is included***, then $R_{01} = \beta r_{02}$ (***very high***)
- However, ***it comes in parallel with R_L***

  $\Rightarrow$ ***Overall R_0 is still ~ R_L***
- ***Summary***:
  - ***Moderate voltage gain***
  - ***Moderate input resistance***
  - ***Potential of having very large output resistance***
  - ***Extremely large bandwidth***
  - ***Preferred over a simple CE stage***

- ***NMOS Cascode***:



ac Schematic



ac Midand Equivalent

- ***CS***, followed by ***CG***
- ***Generally, both M_1 and M_2 are biased with the same I_D***
- ***M_1 does not have body effect, but M_2 has***

- ***By inspection***, $R_i \to \infty$ and $R_0 = R_L || R_{01}$
- ***With r_{02} present***, ***the analysis becomes a little complicated*** $\Rightarrow$ ***neglect r_{02}*** $\Rightarrow R_0 = R_L$
- ***Neglecting r_{02}***:

$$v_0 = (g_{m2} + g_{mb2})v_2 R_L$$

$$v_2 = -\, g_{m1}v_1/(g_{m2} + g_{mb2} + g_{01}) \ (g_{01} = 1/r_{01})$$

$$\approx -\, g_{m1}v_1/(g_{m2} + g_{mb2})$$

[since, in general, $g_{01} << (g_{m2} + g_{mb2})$]

$$\Rightarrow A_v = v_0/v_i = -\, g_{m1}R_L \ (\text{since } v_1 = v_i)$$

- ***This is same as the CS stage, however, here broad-banding is happening***!