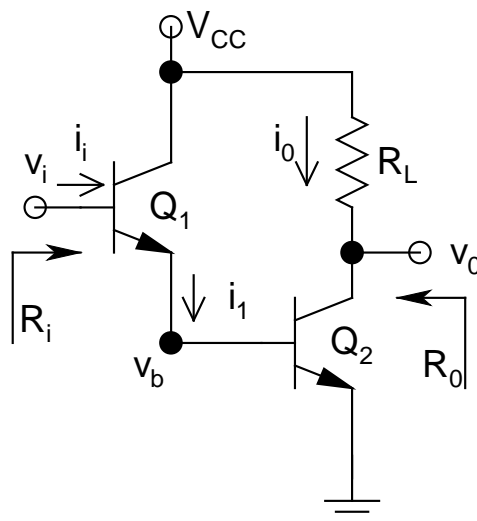
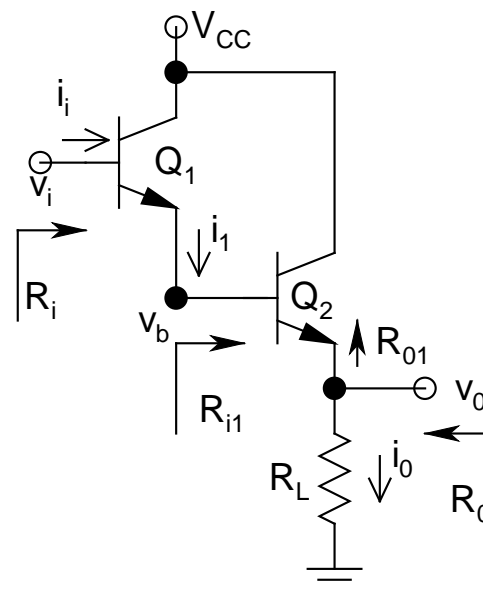


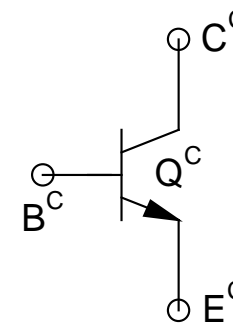
Generic Circuit



CC-CE Stage



CC-CC Stage



Compact Representation

➤ For *DC biasing*:

$$I_{C2} = \beta_2 I_{B2} = \beta_2 I_{E1} \approx \beta_2 I_{C1}$$

$$\Rightarrow r_{\pi 2} = \beta_2 r_{E2} = \beta_2 V_T / I_{C2} = V_T / I_{C1} = r_{E1}$$

➤ For *ac analysis*:

CC-CE:

- $i_1 = (\beta_1 + 1)i_i$ and $i_0 = \beta_2 i_1 = \beta_2(\beta_1 + 1)i_i$
 $\Rightarrow A_i = i_0/i_i = \beta_2(\beta_1 + 1) \approx \beta^2$ (*Huge!*)
- $R_i = r_{\pi 1} + (\beta_1 + 1)r_{\pi 2} \approx 2r_{\pi 1}$
❖ $I_{C2} \sim \text{mA}$, $I_{C1} \sim 10\text{s of } \mu\text{A}$, $r_{E1} \sim \text{k}\Omega$, $r_{\pi 1} \sim 100\text{s of } \text{k}\Omega$ (*Huge!*)
- $v_0/v_b = -R_L/r_{E2}$ and $v_b/v_i = r_{\pi 2}/(r_{\pi 2} + r_{E1}) = 1/2$
 $\Rightarrow A_v = v_0/v_i = -R_L/(2r_{E2})$ (*Moderate*)
- $R_0 = R_L || r_{02} \approx R_L$ (*Moderate*)

➤ Thus, this stage has *huge A_i and R_i* , and *moderate A_v and R_0*

➤ For *ac analysis*:

CC-CC:

- $i_1 = (\beta_1 + 1)i_i$ and $i_0 = (\beta_2 + 1)i_1 = (\beta_2 + 1)(\beta_1 + 1)i_i$
 $\Rightarrow A_i = i_0/i_i = (\beta_2 + 1)(\beta_1 + 1) \approx \beta^2$ (*Huge!*)
- $R_i = r_{\pi 1} + (\beta_1 + 1)(\beta_2 + 1)(r_{E2} + R_L)$
 $\approx r_{\pi 1} + \beta^2(r_{E2} + R_L)$ (*Astronomical!*)
- $R_{i1} = r_{\pi 2} + (\beta_2 + 1)R_L$
- $v_0/v_b = R_L/(R_L + r_{E2})$
- $v_b/v_i = R_{i1}/(r_{E1} + R_{i1})$
- $A_v = v_0/v_i \approx \beta_2 R_L/(2r_{E1} + \beta_2 R_L)$ (*Show!*)

➤ Thus, this stage has *extremely large A_i and R_i* ,
and *A_v is ≤ 1 with no phase shift*

➤ $R_0 = R_L \parallel R_{01}$

$R_{01} = r_{E2} + r_{E1}/(\beta_2 + 1)$ (*by inspection*)

$\approx 2r_{E2}$

$\Rightarrow R_0 \approx R_L \parallel (2r_{E2})$ (*Small*)

➤ Above analysis is *pretty straightforward*, and *assumes that both β_1 and β_2 are high*

➤ *In reality, Q_1 operates with a very low value of I_C (~ 10 s of μA)*

$\Rightarrow \beta_1$ *would drop significantly from its nominal value* \Rightarrow *Full advantage of the circuit can't be exploited*