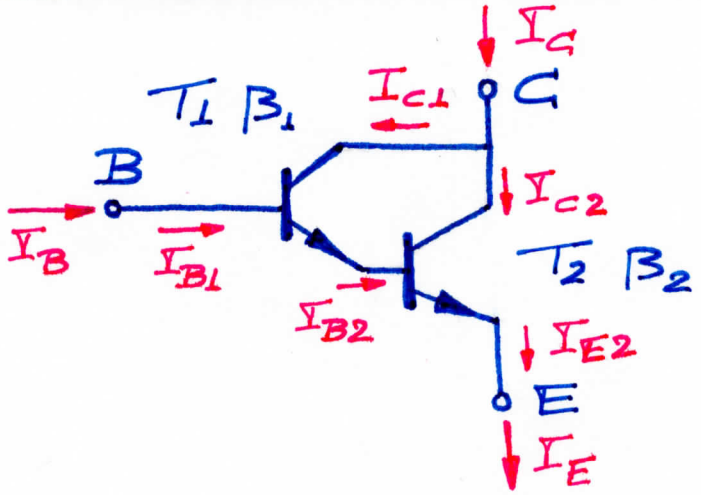
Iconic circuit: Darlington transistor



⇒ Darlington transistor with **B**, **C** and **E**

⇒ Three-terminal device

⇒ Q: What is **BE** voltage of Darlington?

⇒ $V_{BE} = V_{BE1} + V_{BE2} = 0.7V + 0.7V = \underline{1.4V}$

Equations:

$$I_C = I_{C1} + I_{C2}$$

$$I_B = I_{B1}$$

$$I_E = I_{E2}$$

$$I_{E1} = I_{B2}$$

Amplification

$$I_{E1} = I_{B1}(\beta_1 + 1)$$

$$I_{C2} = I_{B2}\beta_2$$

$$= I_{B1}(\beta_1 + 1)\beta_2$$

$$I_C = I_{C1} + I_{C2}$$

$$= I_{B1}\beta_1 + I_{B1}(\beta_1 + 1)\beta_2$$

($I_{B1} \rightarrow I_B$)

$$= I_B(\beta_1\beta_2 + \beta_1 + \beta_2)$$

$$\Rightarrow \boxed{\beta = \beta_1\beta_2 + \beta_1 + \beta_2 \approx \beta_1\beta_2}$$

(β → β of Darlington)

Example: $\beta_1 = 100$ $\beta_2 = 80$ $\Rightarrow$ $\beta \approx 8{,}000$

Note: Darlington has high current amplification

Darlington has BE voltage of 1.4V

Also note:

$$V_{CE2} = V_{BE2} + V_{CE1} \geq 0.9\,V$$

(V_{CE1} → Saturation $\Rightarrow \approx 0.2V$)

T_2 cannot enter saturation.

Can be an advantage for high-speed operation.

Q: Where are Darlington transistors used ?

⇒ Amplifiers with high amplification

⇒ Audio amplifier

⇒ Cell phone RF amplifier

↳ radio frequency