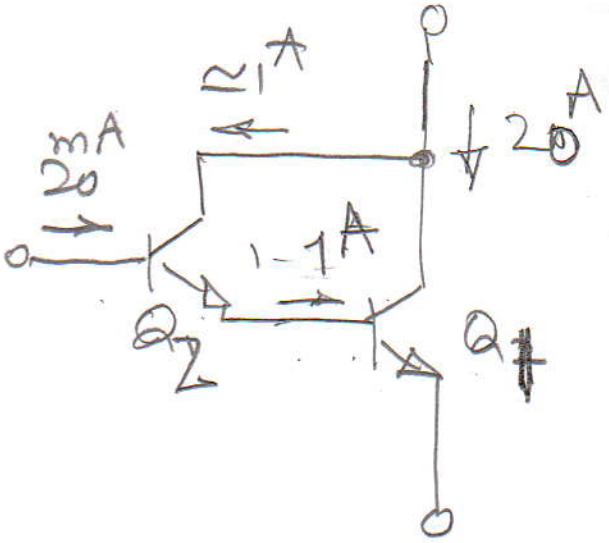
A Few Scattered Ideas and Practical Matters

Darlington Pair



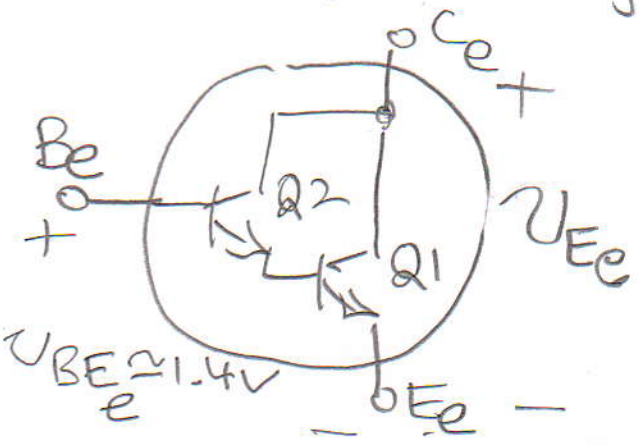
Power Transistor typically have low β (e.g., 10–20)

$\beta_1 = 20$; $\beta_2 = 50$

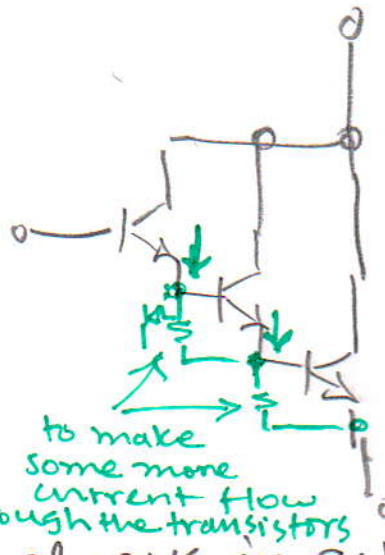
effective $\beta \approx \beta_1 \beta_2$

$= 1000$

named after Sidney Darlington



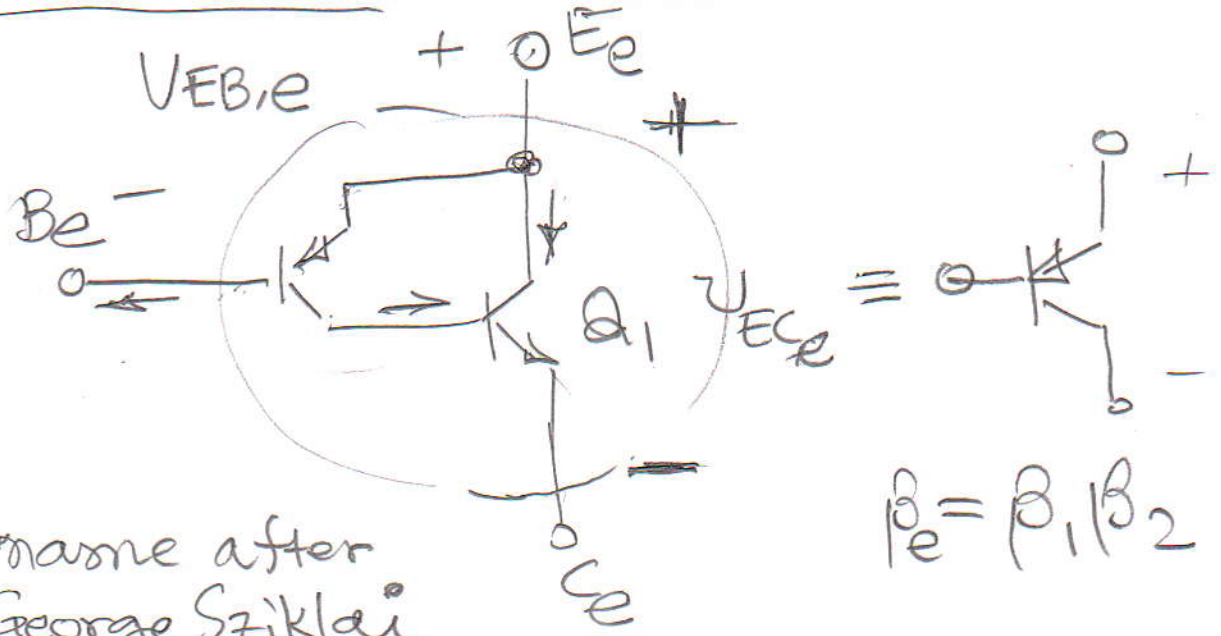
$V_{CE,sat_e} \simeq \underbrace{0.7^V}_{V_{BE,on_1}} + \underbrace{0.3^V}_{V_{CE,sat_2}}$



(Q_1 always in active mode; Q_2 can be saturated).

PNP Power Transistors are even power => avoided by most people altogether.

Sziklai Pair

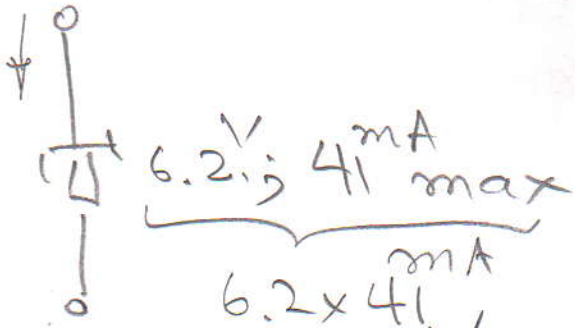


name after George Sziklai

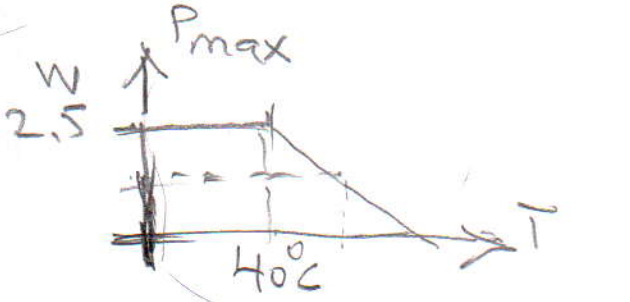
$$\beta_e = \beta_1 \beta_2$$

$$V_{EB,one} = 0.7^V \; ; \; V_{EC,sat_e} = 1.0^V$$

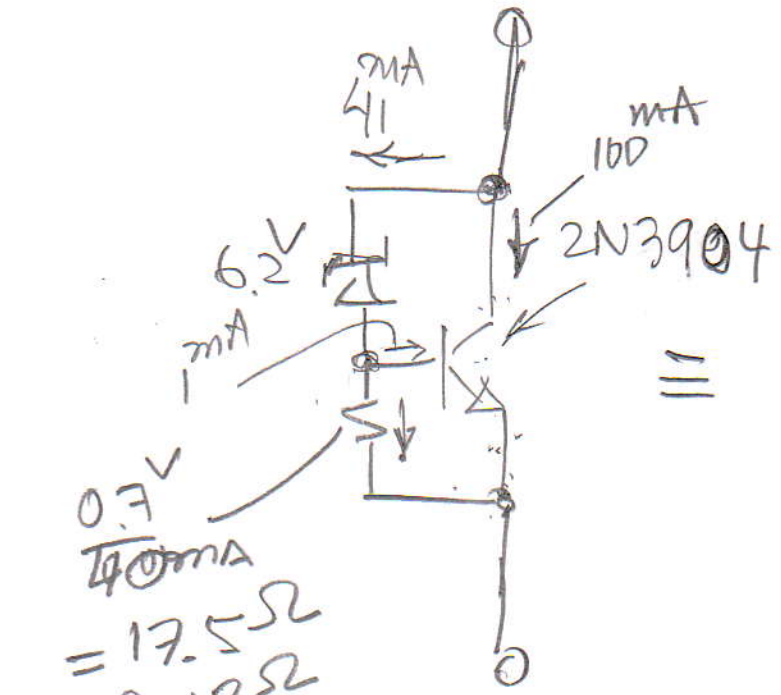
Home-made Power Zener Diode



$6.2 \times 41\ \text{mA} = 0.25\ \text{W}$



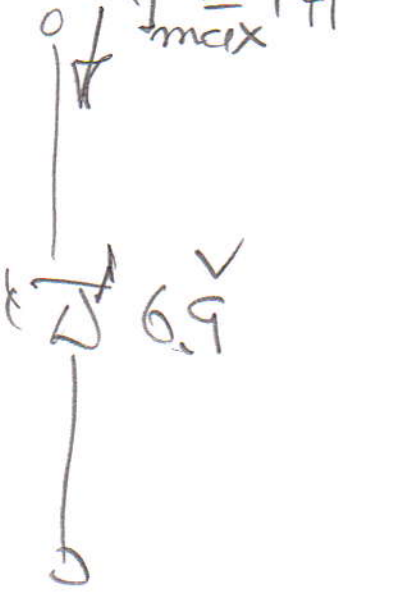
Derating Curves

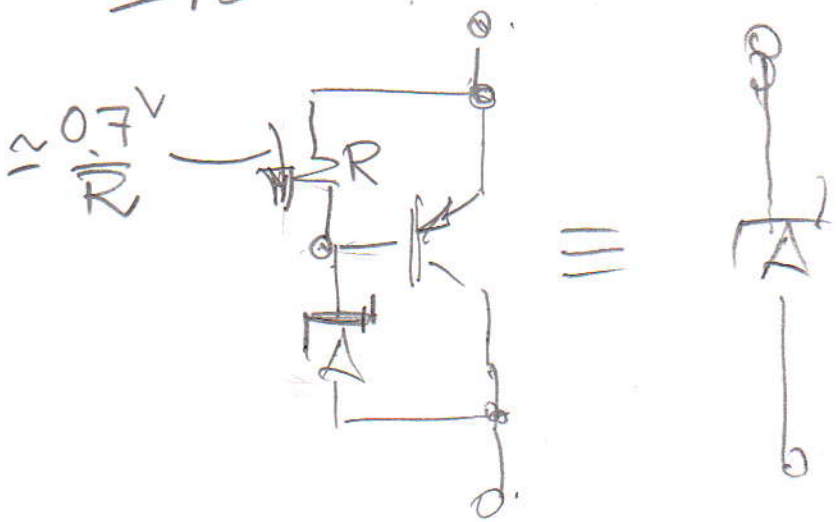


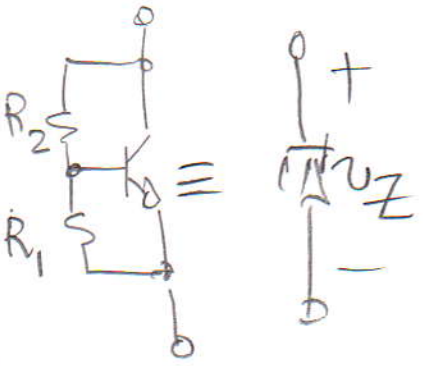
$= 17.5\ \Omega$

$\simeq 18\ \Omega$

$\equiv$



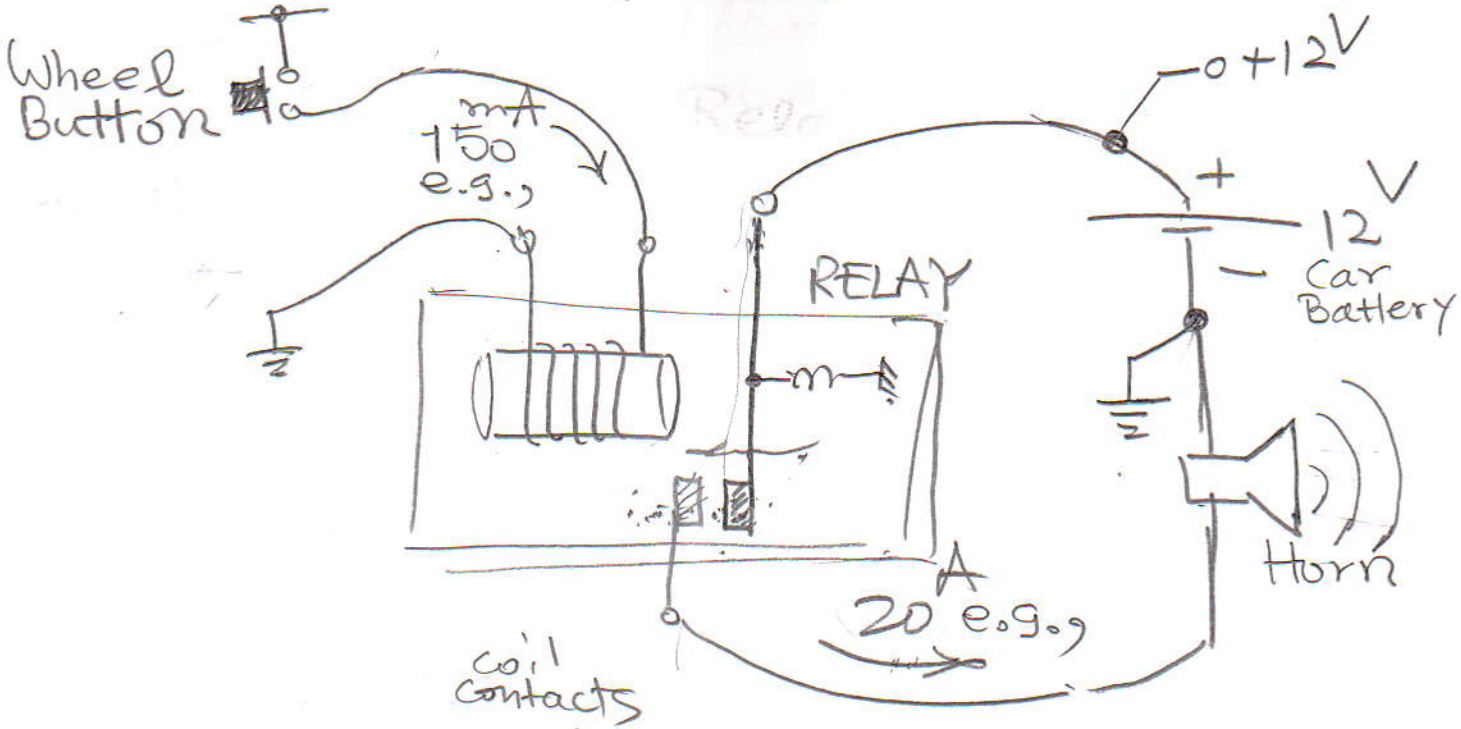


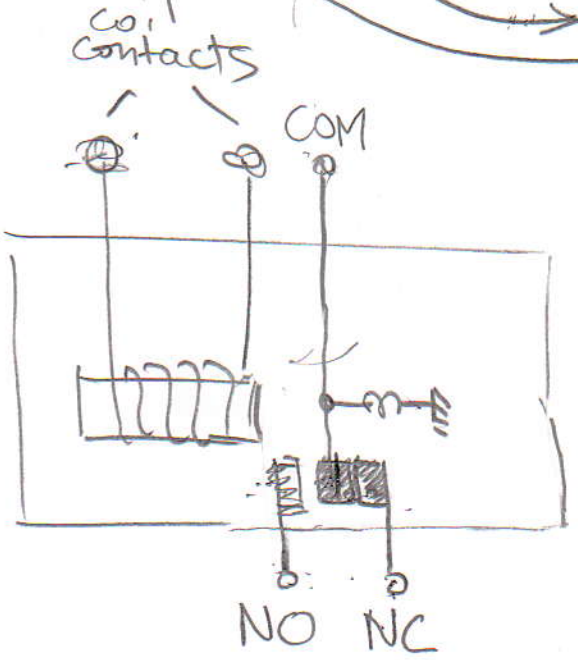


$$V_Z \simeq \frac{0.7}{R_1}(R_1 + R_2)$$

$$\simeq 0.7\left(1 + \frac{R_2}{R_1}\right)$$

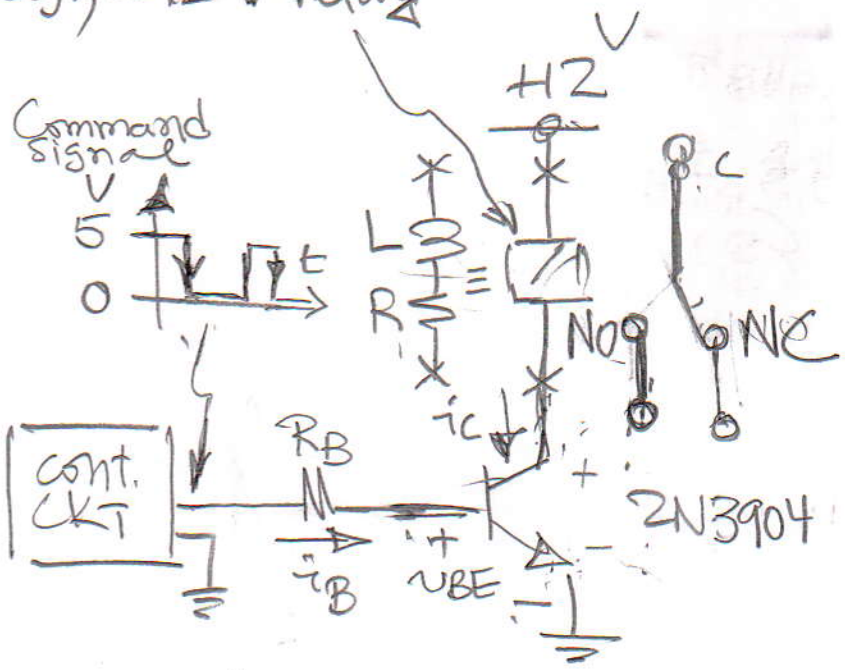
Driving Relays, Motors, Solenoids, etc. (inductive in nature).





COM: Common
NO: Normally-open
NC: Normally-closed

e.g., a 12-V relay



In sat.

$I_C \leq \beta I_B$

$I_B \geq \frac{I_C}{\beta}$

Let $R = 120\ \Omega$

$\Rightarrow I_C = \frac{12}{0.12} = 100\ mA$

Let $\beta = 100$

$\Rightarrow I_B \geq 1\ mA$ for Q to be in sat.

Q: on & saturated

$\Rightarrow v_{RLY} \cong 12\,V - 0.3\,V = 11.7\,V$

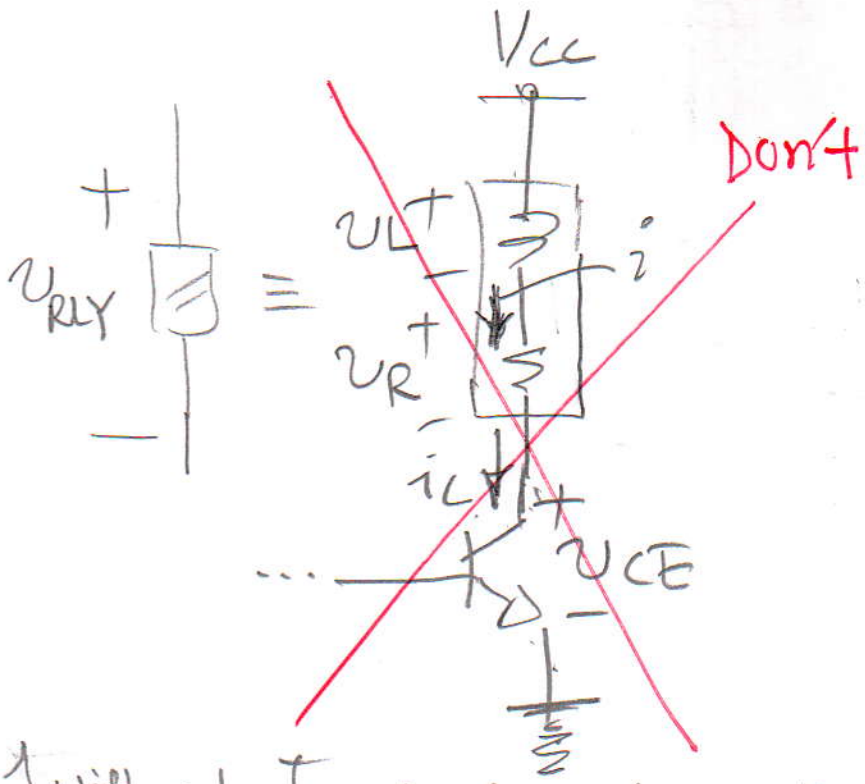
$\Rightarrow I_B \simeq \frac{5\,V - 0.7\,V}{R_B} \geq 1\ mA$

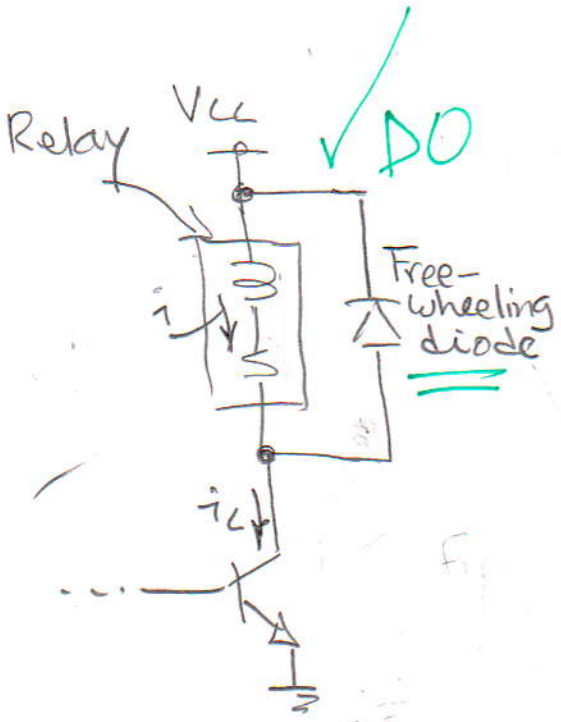
Let $I_B \simeq 1.5\ mA \Rightarrow R_B \simeq 2.9\ k\Omega$ (take $2.7\ k\Omega$)

to ensure $I_B \geq \frac{I_C}{\beta}$

Looks great, but the transistor will die the first time that you turn it off, that is, on the trailing edge of the command signal.

Inductive Kick



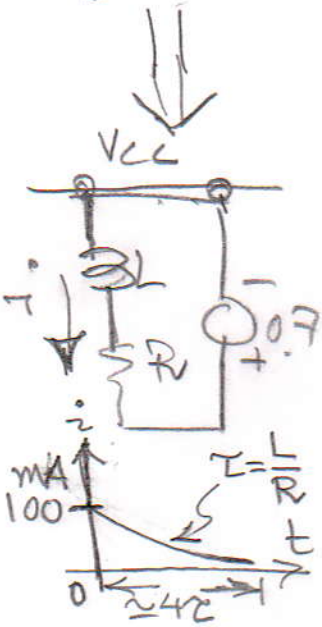


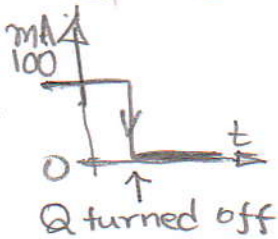
Without Freewheeling Diode

KVL: $v_{CC} - v_L - v_R - v_{CE} = 0$

$$\Rightarrow v_{CE} = v_{CC} - v_R - v_L$$

$$i_C = v_{CC} - v_R - L\frac{di_C}{dt}$$



If i_C 

$$\Rightarrow \frac{di_C}{dt} = -\infty$$

$$\Rightarrow v_{CE} = 12 - 0 - (-\infty)$$

$$= +\infty$$

Transistor gets killed by the "inductive kick"!