BJT as a switch

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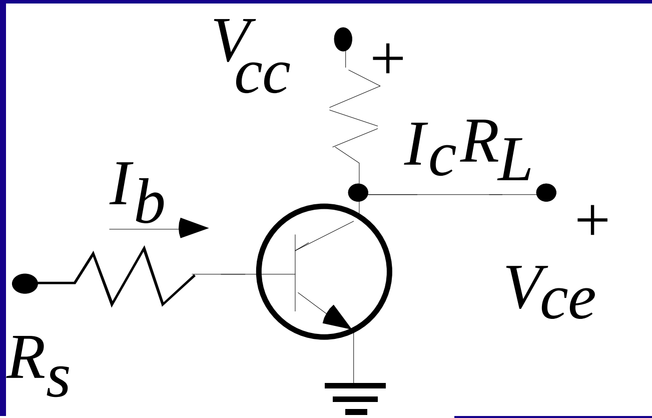
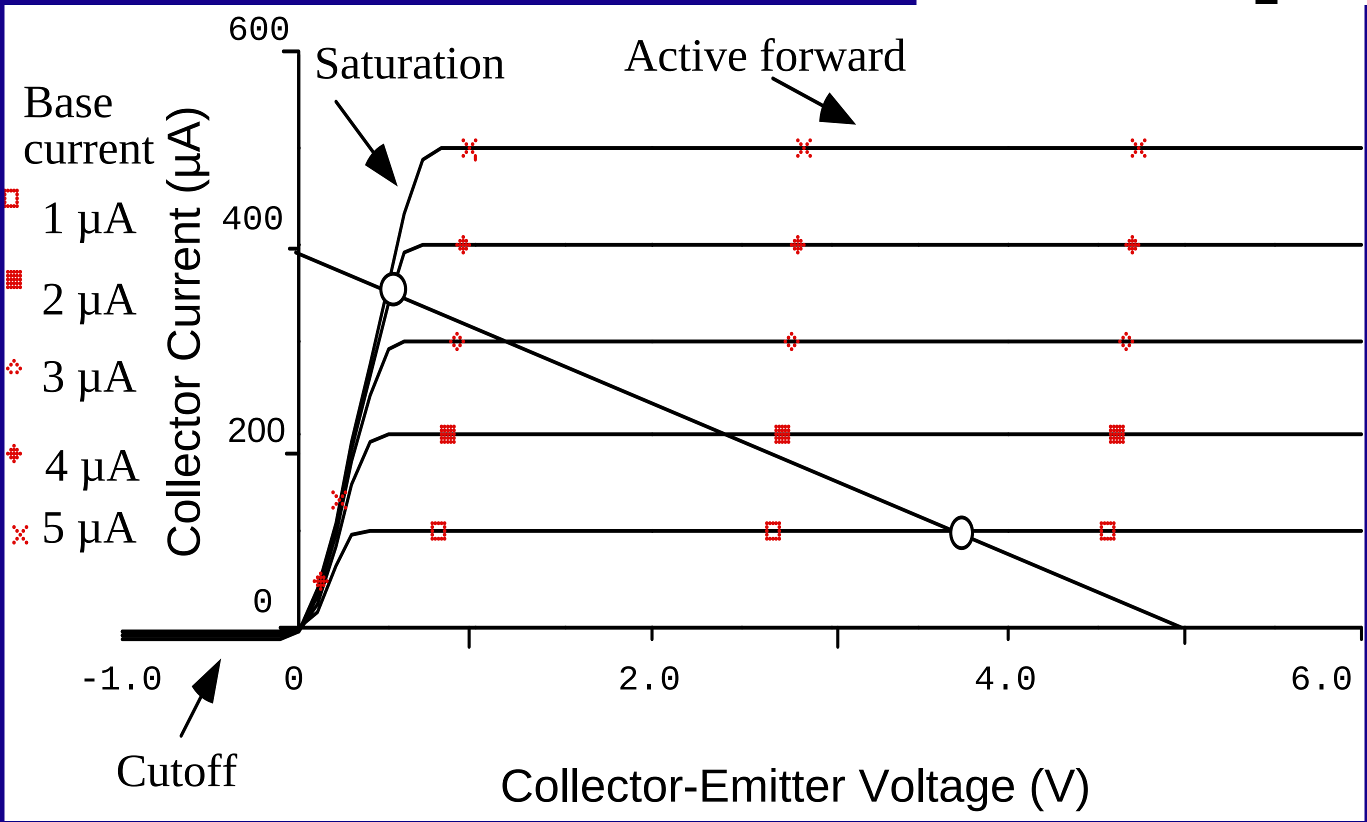
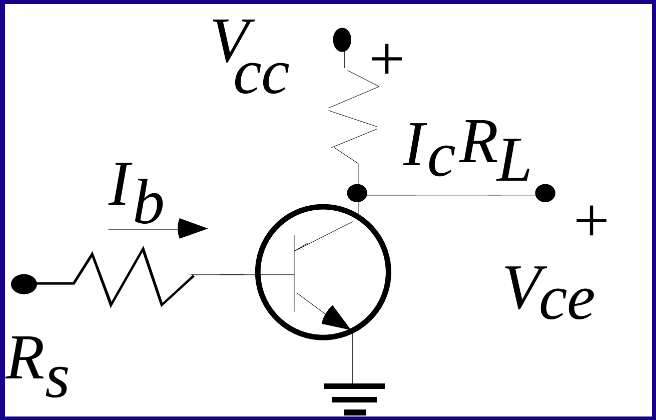
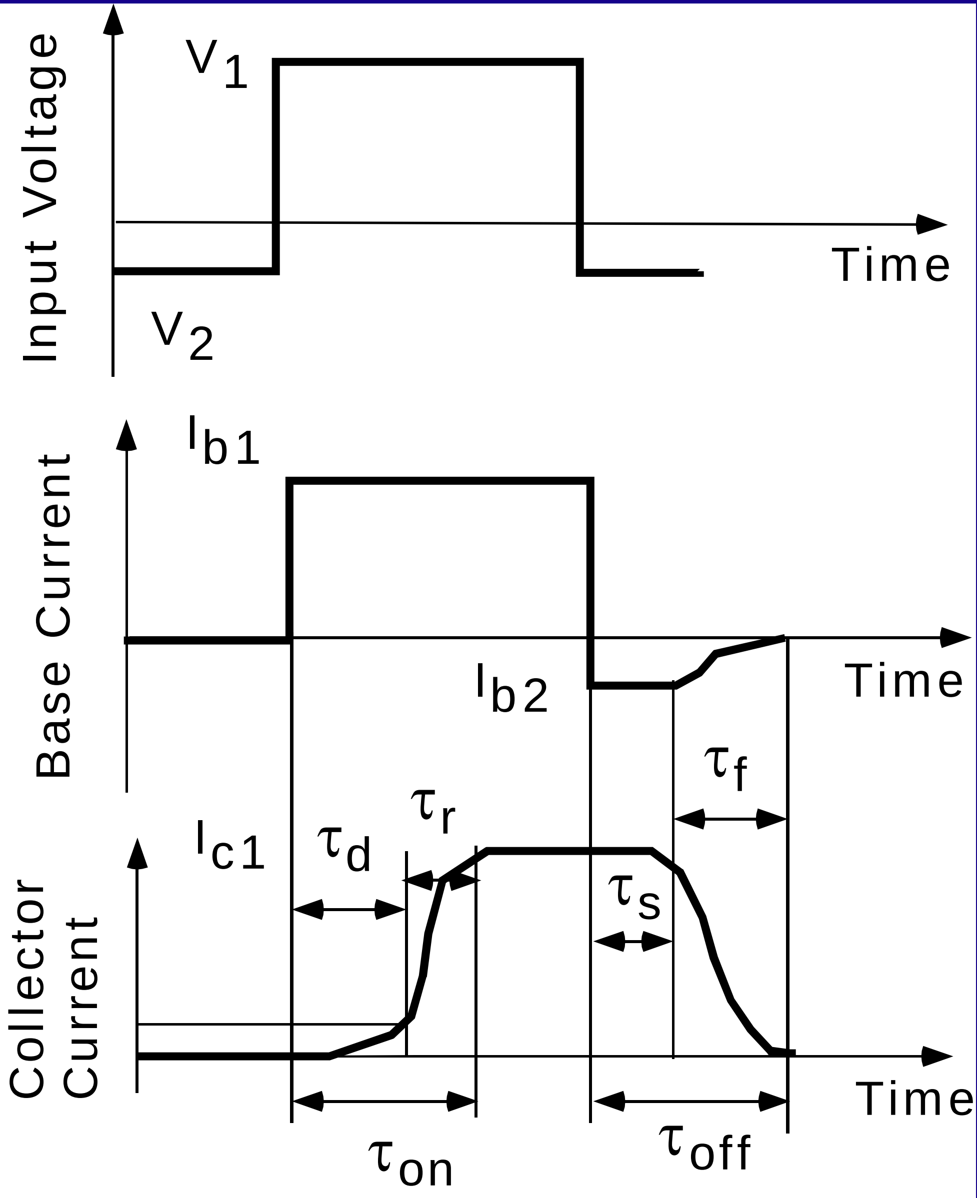
Spice simulation





Ib1 = (V1 - Vbesat)/Rs
Ib2 = (V2 - Vbe)/Rs





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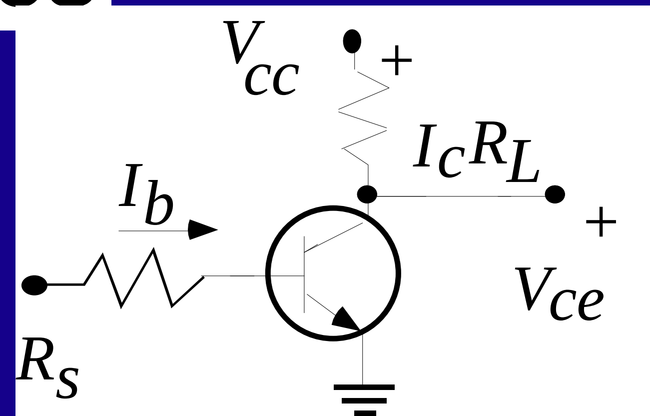
Switching Times



$I_{b1} = (V_1 - V_{besat})/R_s$

$I_{b2} = (V_2 - V_{be})/R_s$

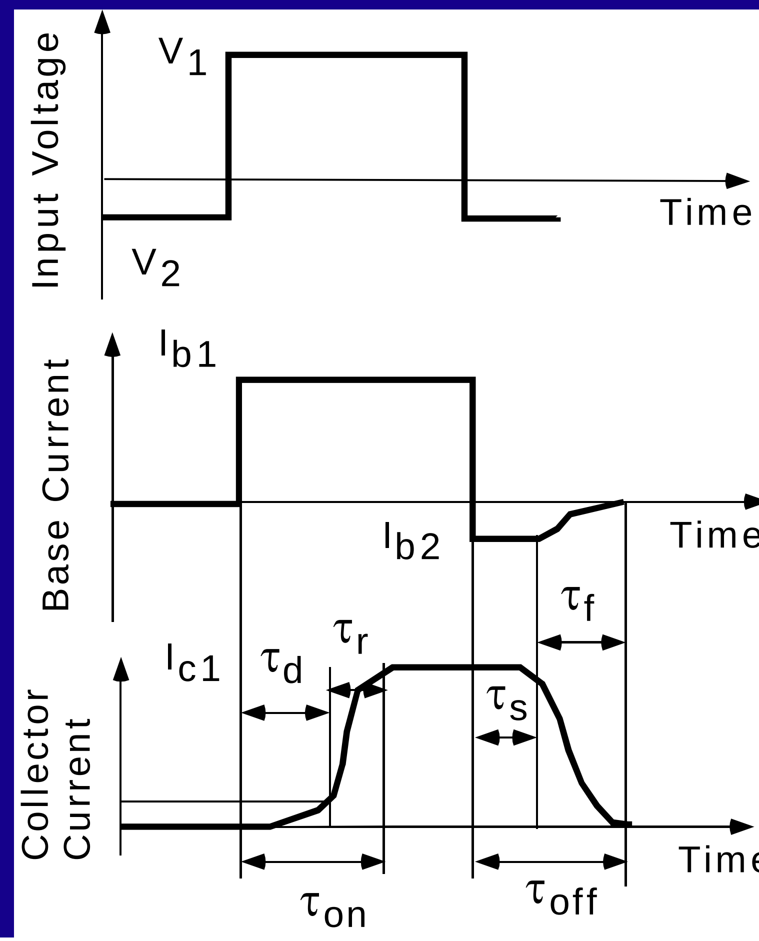
Transistor is driven into saturation when

$I_c = (V_{cc} - V_{cesat})/R_L \sim V_{cc}/R_L$

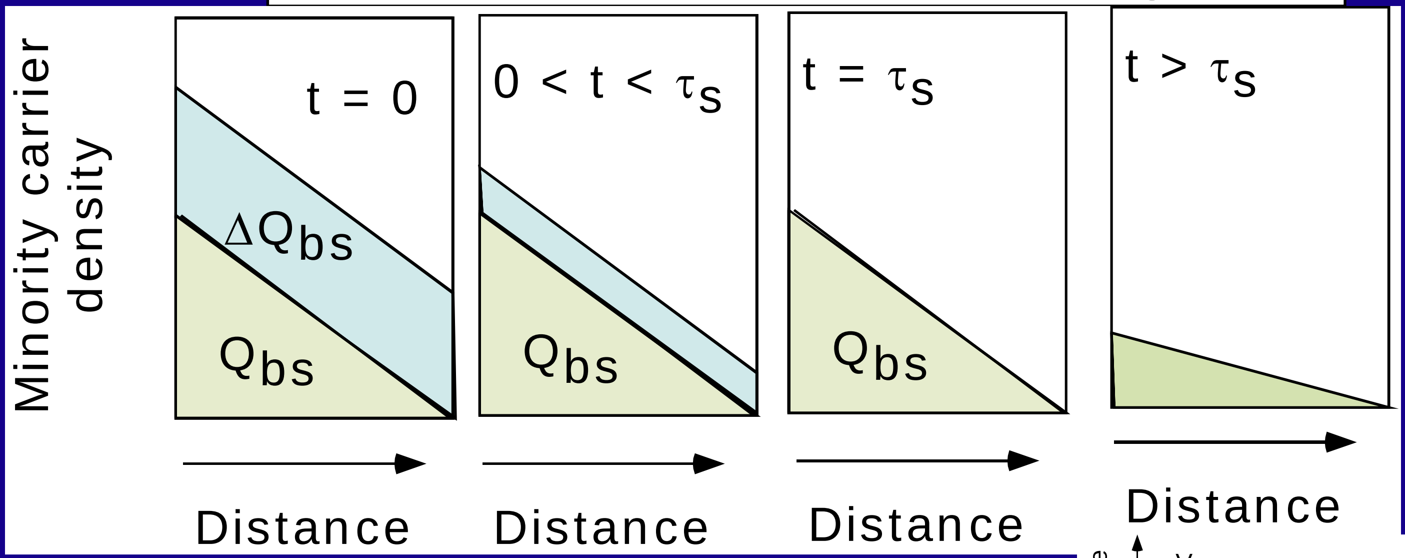
The base current is given by

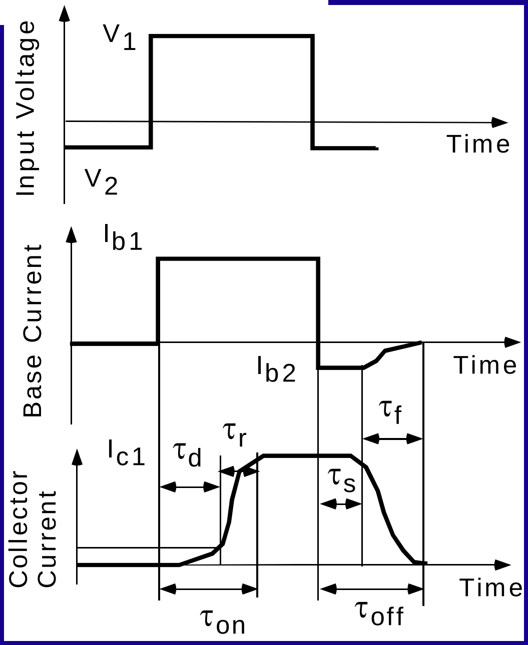
$I_{bs} > I_{ba} \sim V_{cc}/(h_{fe}R_L)$

The excess base current is due to excess recombination current



Time Evolution of Minority Carrier Profiles in the Base (turning off)





Charge Control Equation

$$\Delta I_{bs} = \Delta Q_{bs} / \tau_{sr} + d\Delta Q_{bs}/dt$$

At $t = 0$ $\Delta I_{bs} = I_{b2} - I_{bs}$

The initial condition for ΔQ_{bs}

$\Delta Q_{bs}(0) = (I_{bs} - I_{bs})\tau_{sr}$

The solution:

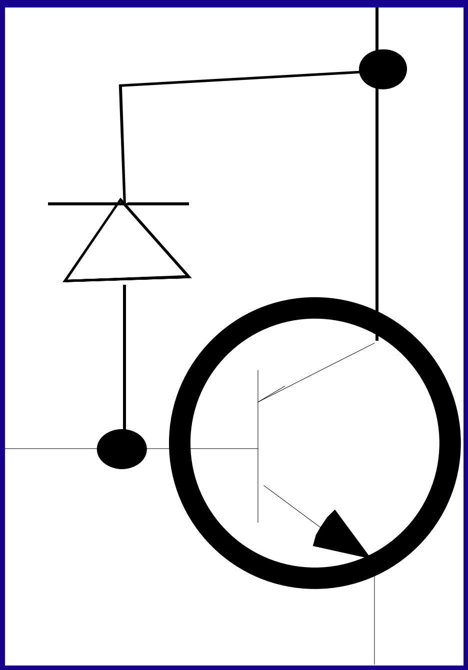
$\Delta Q_{bs} = (I_{b1} - I_{b2}) t_{sr} exp(-t/\tau_{sr}) + (I_{b2} - I_{ba})\tau_{sr}$

τ_{sr} **is reached when** $\Delta Q_{bs} = 0$

Hence

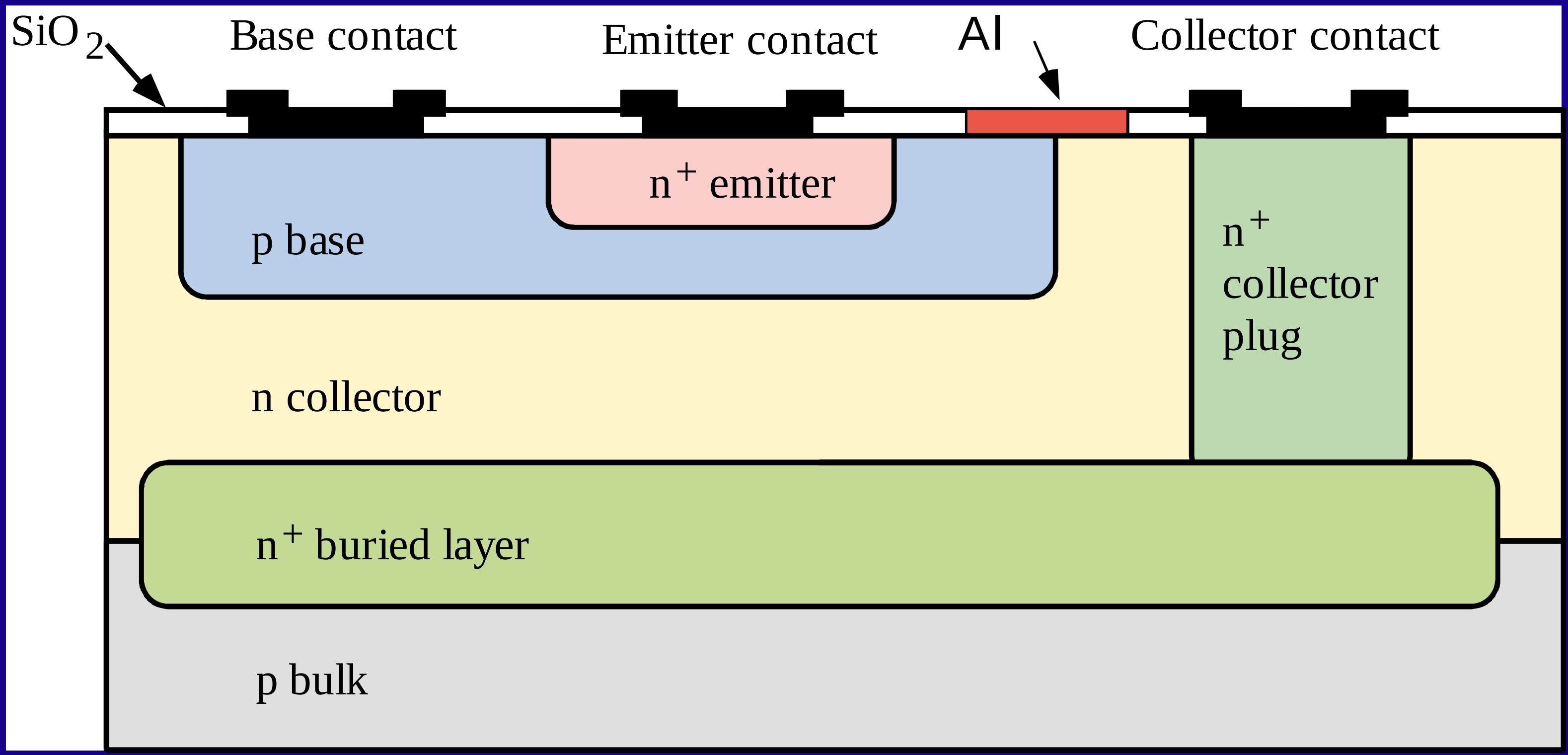
$\tau_s = \tau_{sr} \ln [(I_{b1} - I_{b2})/(I_{ba} - I_{b2})]$

BJT with a Schottky clamp



The turn-on voltage of the Schottky diode is less than that of the collector-base junction. Hence, the transistor is prevented from going into saturation

BJT with a Schottky clamp Implementation



Al Schottky to n-type collector
Ohmic to p-type base