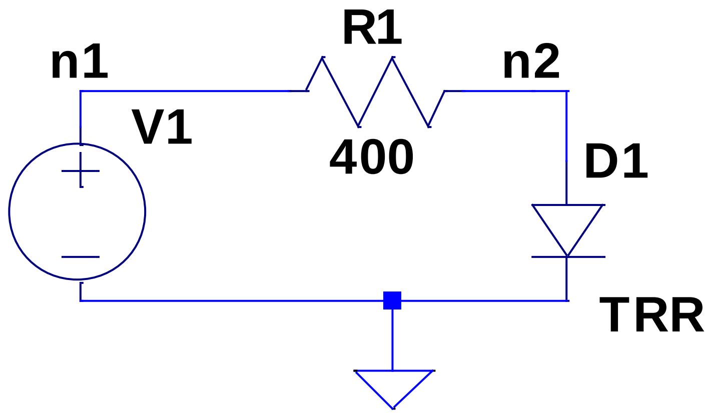
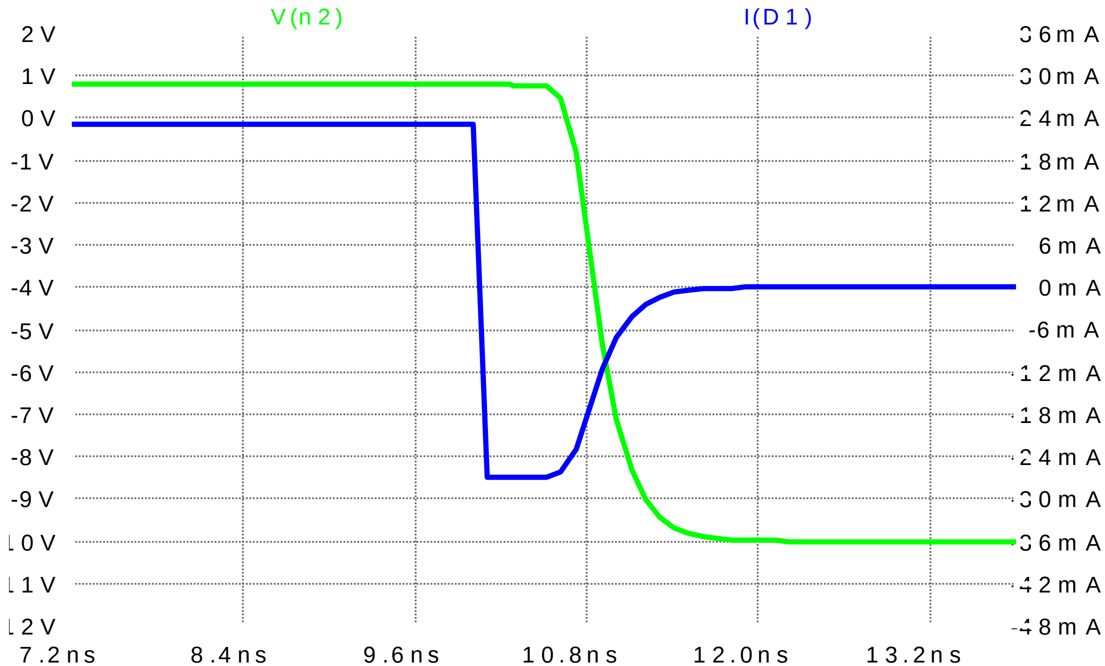
Diode Storage (LTSpice)

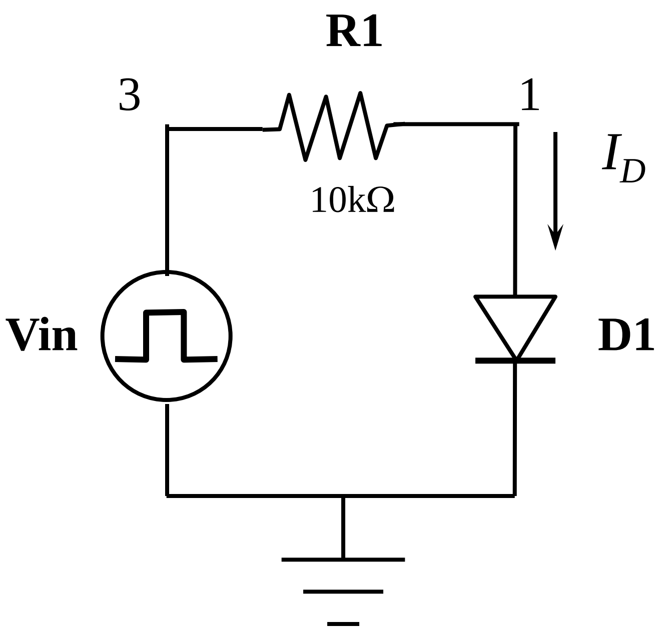
.tran 25n
.INC mylib.lib



PULSE(10 -10 10ns 0.1ns 0.1ns 20ns 40ns)



Diode Storage Time

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Diode storage time
D1 1 0 TRR
R1 3 1 10k
Vin 3 0 DC 0 PULSE(10 -10 50n 0.1n 0.1n 50n 100n)
.Model TRR D
+ IS=1f TT=30n CJO=1p VJ=0.7 M=0.33
.probe
.tran 1n 100n
.print tran V(3) V(1) I(D1)
.end
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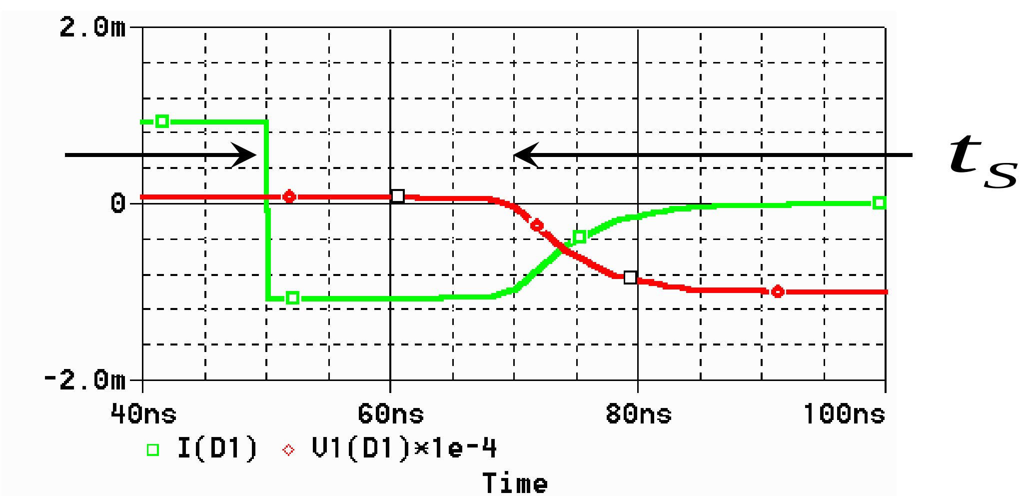


$$t_S = \tau_T \ln\left(\frac{i_F - i_R}{-i_R}\right)$$

$\tau_T := 30$ ns

$i_R := -1.07$ mA

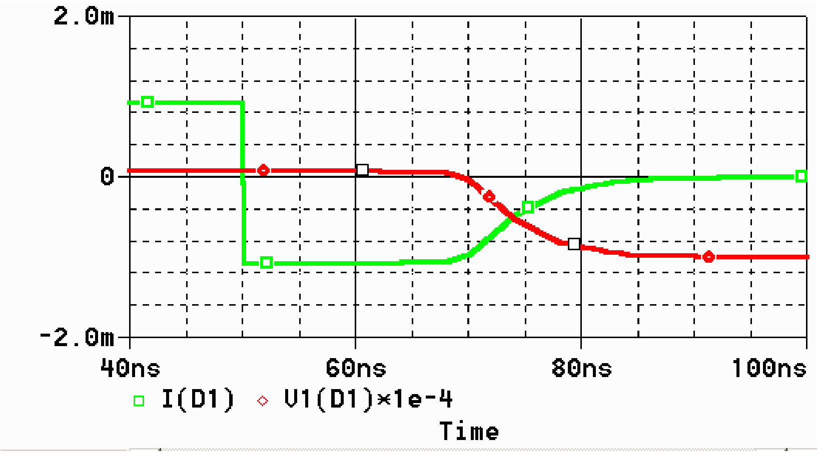
$i_F := 0.93$ mA

$$\tau_T \cdot \ln\left(\frac{i_F - i_R}{-i_R}\right) = 18.8 \text{ ns}$$

Diode Behavior Analysis

When the diode becomes forward biased, electrons from the n-type side of the junction are attracted to the p-type side (and vice versa for the holes). After the electron drifts across the junction, it starts to diffuse toward the metal contact. The time between crossing the junction and recombining with a hole is called the transit time τ_T. A capacitance is formed between the electrons diffusing into the n-side and the holes diffusing into the p-side (minority carriers in each case). This capacitance is often called a diffusion capacitance or storage capacitance.

Consider our SPICE example. The diode is initially forward-biased. At t = 50 ns, the input voltage source abruptly changes from V_F (10 V) to V_R (-10 V). The diode voltage remains at 0.7 V since the diode contains a stored charge that must be removed. Once this happens, the diode depletion capacitance is then charged through resistance R until the current in the circuit goes to zero and the voltage across the diode is V_R. This is an exponential decay process as shown in the probe results.



Reference:
Baker, Li, and Boyce, p 35-39