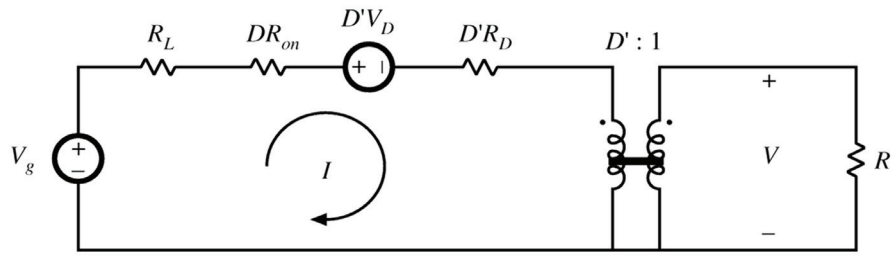
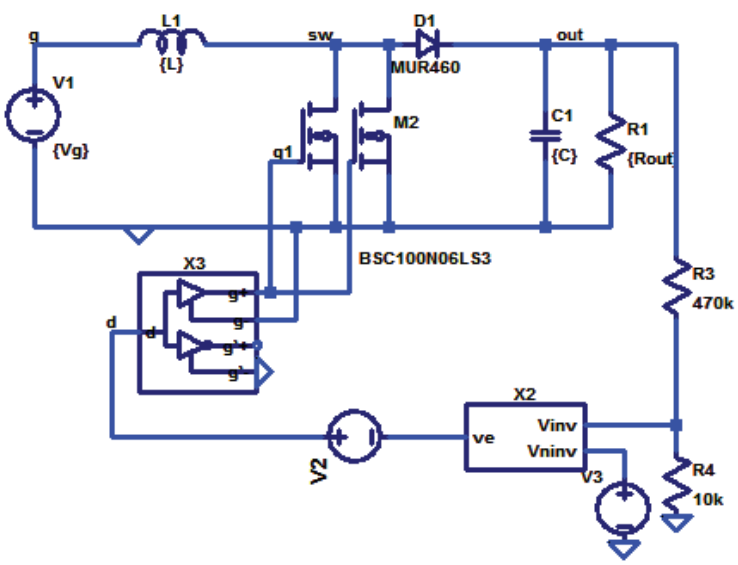
Equivalent Circuit Model



$$V = \left(\frac{1}{D'}\right)\left(V_g - D'V_D\right)\left(\frac{D'^2R}{D'^2R + R_L + DR_{on} + D'R_D}\right)$$

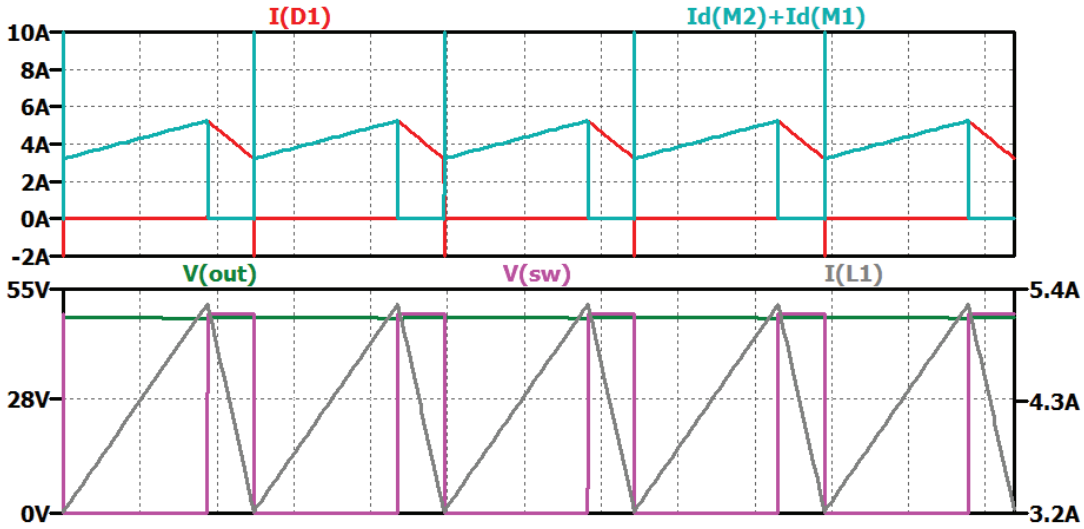
$$\frac{V}{V_g} = \left(\frac{1}{D'}\right)\left(1 - \frac{D'V_D}{V_g}\right)\left(\frac{1}{1 + \frac{R_L + DR_{on} + D'R_D}{D'^2R}}\right)$$

LTSpice Simulation

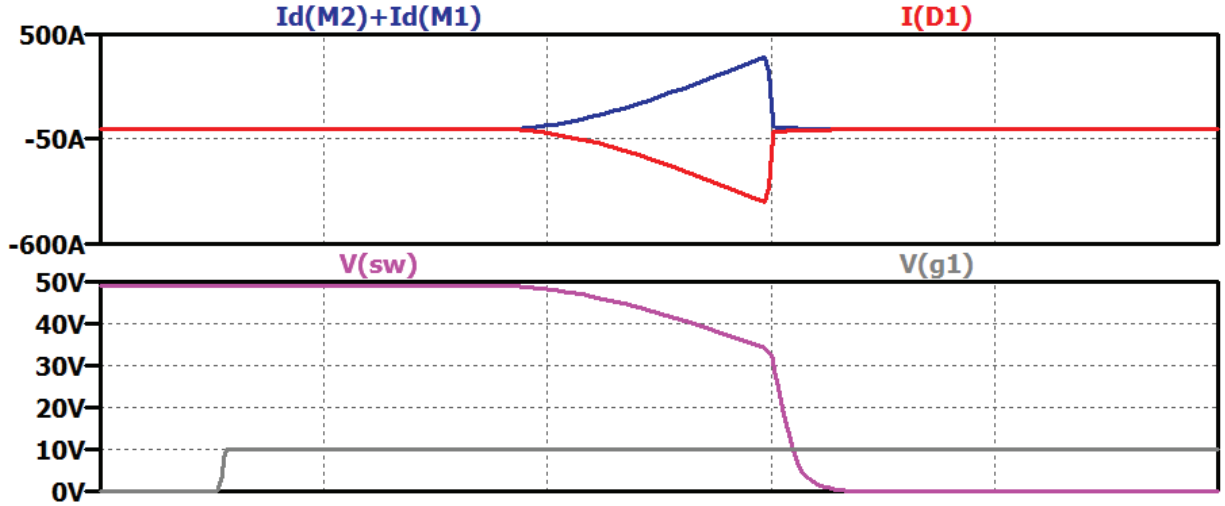


L	C_{out}	f_s	η (Sim)
22uH	22uF	200k	93.9%

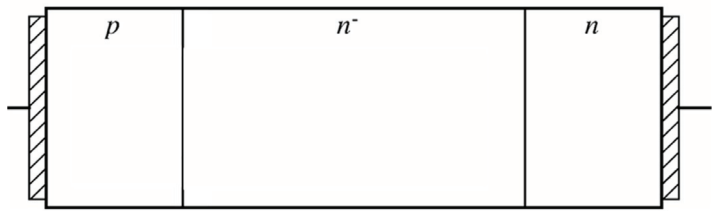
LTSpice Simulation



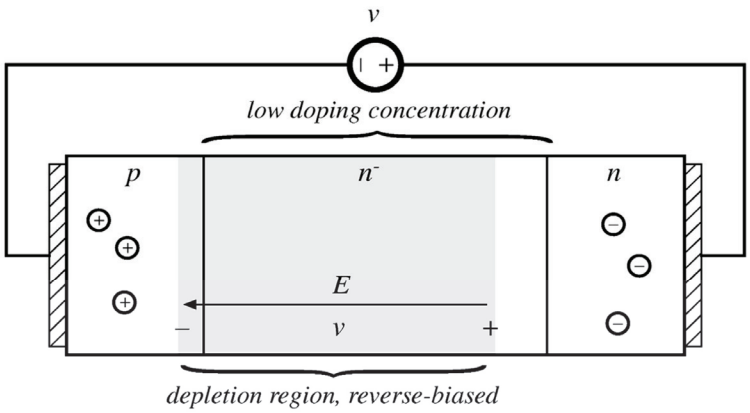
Switching Transition



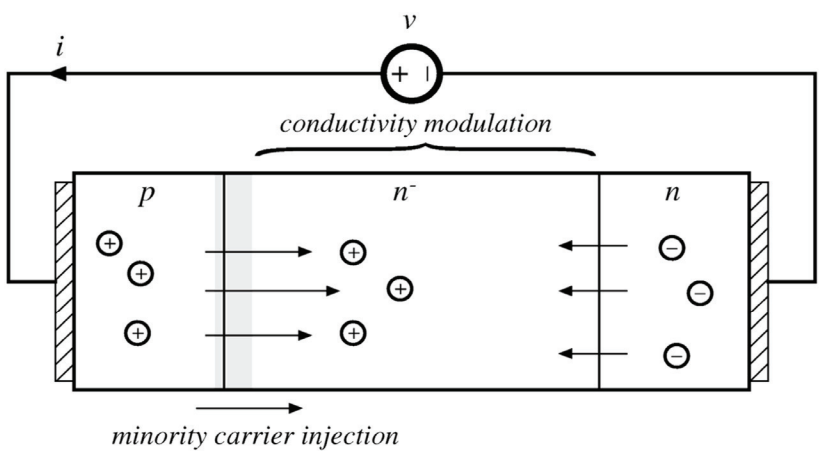
Power Diodes



Reverse Biased Diode



Forward Biased Diode



Diode Stored Charge

The diode equation:

$$q(t) = Q_0\left(e^{\lambda v(t)} - 1\right)$$

Charge control equation:

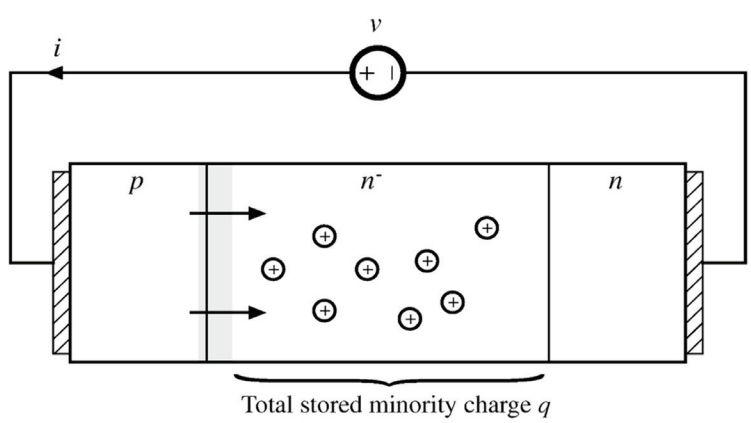
$$\frac{dq(t)}{dt} = i(t) - \frac{q(t)}{\tau_L}$$

With:

λ= 1/(26 mV) at 300 K

τ_L = minority carrier lifetime

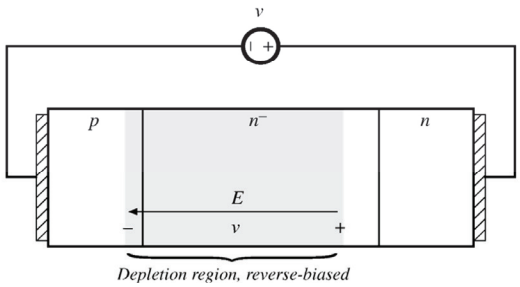
(above equations don't include current that charges depletion region capacitance)

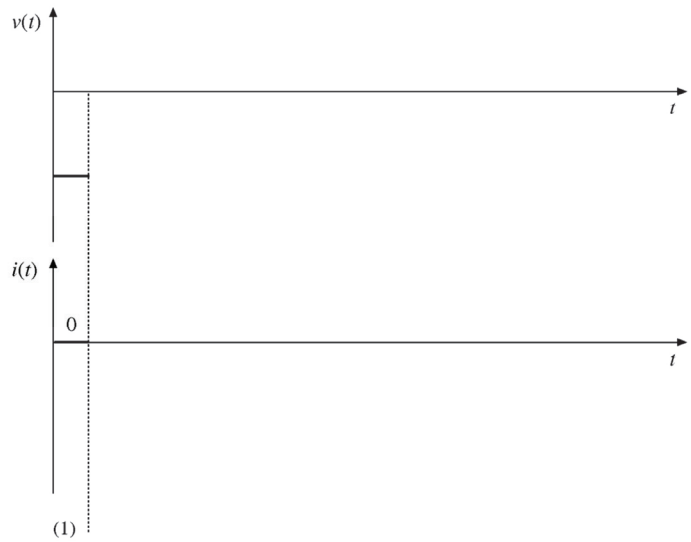


In equilibrium: $dq/dt = 0$, and hence

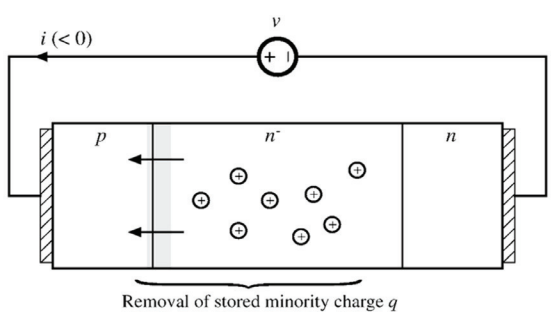
$$i(t) = \frac{q(t)}{\tau_L} = \frac{Q_0}{\tau_L}\left(e^{\lambda v(t)} - 1\right) = I_0\left(e^{\lambda v(t)} - 1\right)$$

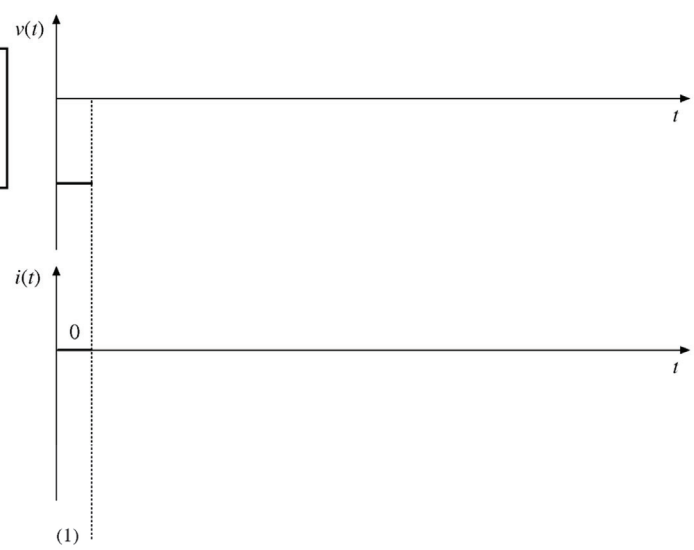
Diode Turn-On



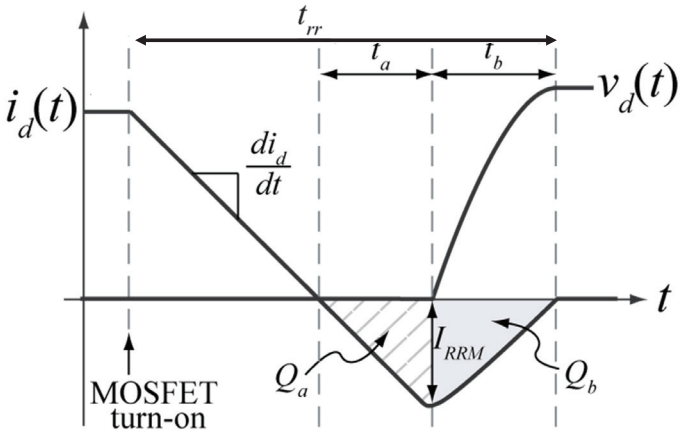


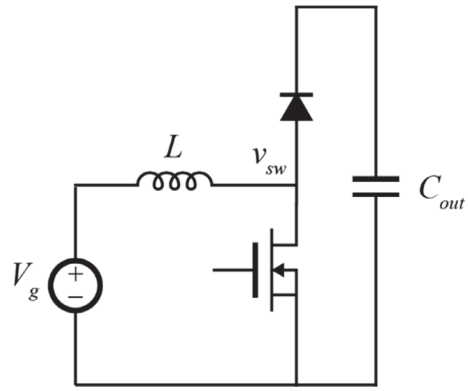
Diode Turn-Off



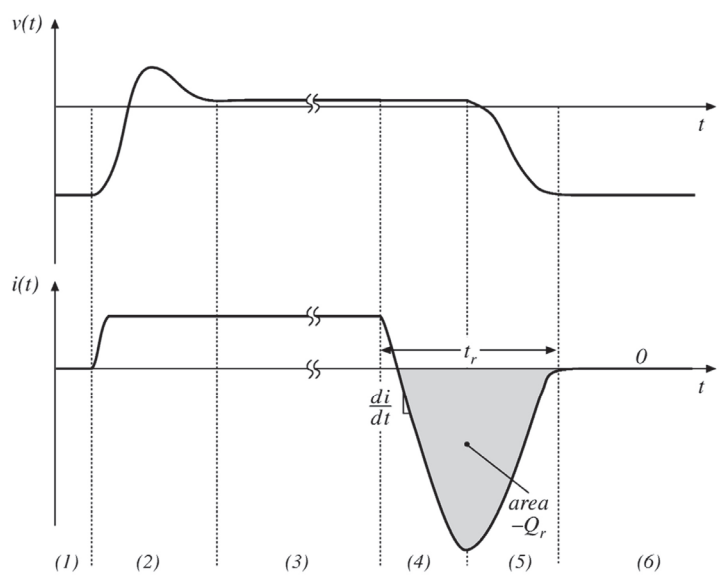


Diode Reverse Recovery





Diode Switching Waveforms



Datasheet RR Characteristics

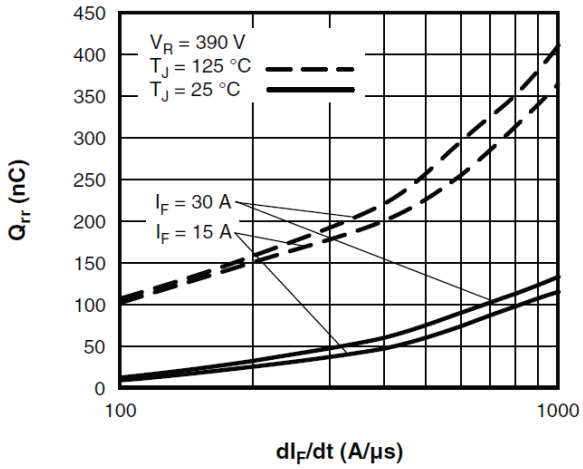


Fig. 10 - Typical Stored Charge vs. dI_F/dt

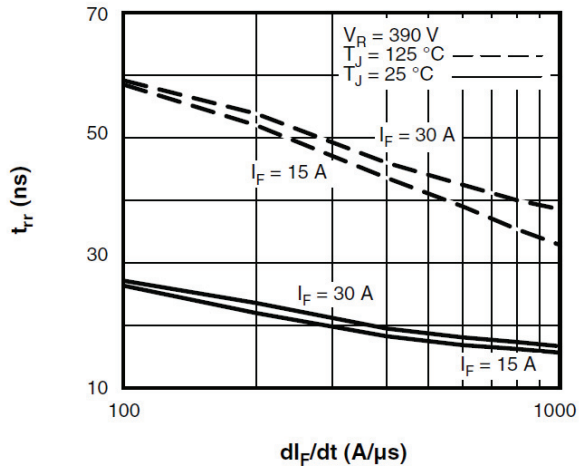


Fig. 9 - Typical Reverse Recovery Time vs. dI_F/dt

Paralleling Diodes

Attempts to parallel diodes, and share the current so that $i_1 = i_2 = i/2$, generally don't work.

Reason: thermal instability caused by temperature dependence of the diode equation.

Increased temperature leads to increased current, or reduced voltage.

One diode will hog the current.

To get the diodes to share the current, heroic measures are required:

- Select matched devices
- Package on common thermal substrate
- Build external circuitry that forces the currents to balance